ACCELERATING SDG7 ACHIEVEMENT

# POLICY BRIEFS IN SUPPORT OF THE FIRST SDG7 REVIEW AT THE UN HIGH-LEVEL POLITICAL FORUM 2018

7 AFFORDABLE AND CLEAN ENERGY

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**Lead Organizations**

**Facilitated by**

UNITED NATIONS
DEPARTMENT OF ECONOMIC
AND SOCIAL AFFAIRS

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# Preface

Billions of people stand to benefit from the world's achievement of Sustainable Development Goal 7, with its targets on universal access to energy, increased energy efficiency and expanded use of renewable energy through new economic opportunities and jobs, empowered women, children and youth, better education and health, more sustainable, equitable and inclusive communities, and greater protections from, and resilience to, climate change.

We must not let them down. This year's High-Level Political Forum in July will review our progress on SDG 7, under the auspices of the UN Economic and Social Council. This will provide a critical occasion for taking stock, strengthening our energy-related commitments and redoubling our efforts to meet those targets.

As the secretariat for the High-Level Political Forum, UN DESA convened the multi-stakeholder SDG 7 Technical Advisory Group to support the forum's review process, bringing together representatives from governments, UN entities, international organizations and other stakeholders. We commend them for their excellent work in preparing this set of 27 Policy Briefs on SDG 7 and its interlinkages with other SDGs. They have provided fact-based assessments, based on inclusive consultations, which outline clearly where we are now and what needs to be done to scale up and accelerate energy innovation, finance and capacity-building between now and 2030, including those unique to regions and countries in special circumstances.

There is much to do to ensure universal access: about 1 billion people still lack access to electricity and close to 3 billion people rely on wood, charcoal, animal and crop wastes, or other solid fuels to cook their food and heat their homes. The good news is that with the right policies, regulatory frameworks and concerted actions, universal energy access can be accomplished. And it can be done without compromising the greenhouse gas emission reductions called for under the Paris Agreement, as more and more investments are being made in renewable energy and improved efficiency.

We welcome the Global Agenda for Accelerated SDG 7 Action put forward by the SDG 7 Technical Advisory Group to serve as a foundation for concerted action by governments and all relevant stakeholders to fill the current gaps in progress on reaching the SDG 7 targets. It is our expectation that the Group's recommendations, together with the results of February's Global SDG 7 Conference in Bangkok, will help frame the discussions at the High-Level Political Forum. Their work will also provide important inputs for related consultations at the UN Climate Change Conference of Parties, Secretary-General's Climate Summit in 2019, and events connected with the UN Decade of Sustainable Energy for All (2014-2024).

UN DESA will continue to support and strengthen the SDG 7 Technical Advisory Group and to aid the UN development system in delivering simultaneously on the 2030 Agenda and the Paris Agreement.

刘振民

**LIU Zhenmin**
Under-Secretary-General for Economic and Social Affairs
United Nations

# Foreword

Achievement of SDG 7 is within reach, but only if we all take immediate action to scale up our efforts.

Achieving SDG 7 will catalyse actions to meet the Paris Agreement on climate change and reach the other SDGs including poverty eradication, gender equality, mitigation of and adaptation to climate change, food security, health, education, sustainable cities and communities, clean water and sanitation, jobs, innovation, and transport. However, at the current rate of progress, the world will fail to meet SDG 7 targets on energy access, efficiency and renewable energy. The good news is that significant advances in technologies, rapid cost declines and strategic shifts in policies are transforming the energy systems in many parts of the world. We must capitalize on this momentum to mobilize greater political will and cooperation, together with higher levels of public and private investment in a sustainable energy future.

The Global Agenda for Accelerated SDG 7 Action put forward by the multi-stakeholder SDG 7 Technical Advisory Group represents a collective response to tackling these global challenges. Its aim is to help all stakeholders step up, focus and scale up their actions towards the achievement of SDG 7.

We are very grateful to all the members of the Technical Advisory Group, who worked together diligently as part of this inclusive, multi-stakeholder and multisectoral process to provide detailed recommendations for expediting progress on meeting the SDG 7 targets. Their collaborative work, with its careful analysis based on operational experience, and diversity of expertise and viewpoints, provides a model for strengthened coordination and coherence, within and beyond the UN development system. They have produced compelling arguments on how urgently the world needs to move forward towards a sustainable energy future.

We sincerely hope that Member States and all stakeholders—including the international organizations, multilateral development banks, businesses and civil society groups gathered at the High-Level Political Forum this year—will find these recommendations useful as they review and renew their commitments to achievement of the SDGs.

The time to act is now. It is critical that the Global Agenda for Accelerated SDG 7 Action be translated into concrete, time-bound action plans and partnerships to move this work forward quickly, and the SDG 7 Technical Advisory Group will strengthen its efforts towards this end. We are counting on everyone to work together to make the achievement of SDG 7 a reality.

**Co-facilitators of the SDG 7 Technical Advisory Group:**

Sheila Oparaocha, Executive Director, ENERGIA International Network on Gender and Sustainable Energy.

Hans Olav Ibrekk, Policy Director, Section for Energy and Climate Change, Norwegian Ministry of Foreign Affairs

# Summary for Policymakers

Energy is central to the achievement of both the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change. The *Key Messages for Policymakers* presented below are aimed at informing the review of progress on Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all (SDG 7) by the UN High-Level Political Forum in July 2018. These Key Messages are drawn from and build on a series of *SDG 7 Policy Briefs* developed by the multi-stakeholder SDG 7 Technical Advisory Group convened by UN DESA.

1. **We must step up.** Without urgent action, the world will fall short of achievement of SDG 7 and consequently other SDGs. About a billion people currently live without electricity, which significantly limits their development opportunities. Almost three billion people lack access to clean-cooking solutions and are exposed to dangerous levels of air pollution, which results in millions of deaths each year, mostly among women and children. Although power generation using renewable energy is expanding rapidly, little progress has been made on integrating renewable energy into end-use applications in buildings, industry and transport. Meanwhile, the current rate of improvement in energy efficiency (2.2 per cent per year) is less than the 2.7 per cent per year needed to meet the global target. Financial flows, including public and private investments in energy, are also falling short of what is needed.

2. **SDG 7 is within reach.** The transformation of the world's energy systems is already under way and being accelerated by advances in technologies, rapid cost declines, strategic shifts in policies, regulatory frameworks and investments, new business models, concerns for energy security, increased cooperation and sharing of best practices. Capitalizing on this momentum to support achievement of SDG 7 requires strengthened political will, increased levels of investment and action by all stakeholders to scale up the deployment of renewable energy technologies, increase energy efficiency and make clean energy more affordable than ever for the benefit of all.

3. **Achieving SDG 7 will catalyse actions to combat climate change and reach the other SDGs** on poverty eradication, gender equality, mitigation of and adaptation to climate change, food security, health, education, sustainable cities and communities, clean water and sanitation, jobs, innovation, transport, and refugees and other situations of displacement. Special emphasiz should be placed on mainstreaming gender considerations into all SDG-related energy actions, as well as climate change responses, and on promoting energy services for productive end uses to enhance development benefits.

4. **A Global Agenda for Accelerated SDG 7 Action is proposed as a foundation for concerted action** by all stakeholders in support of SDG 7. The Global Agenda presents a set of priority actions to be taken by all stakeholders to accelerate the achievement of SDG 7, based on the analysis in the Policy Briefs and on experiences from existing efforts to date, recognizing the special challenges facing those countries that are most vulnerable and the furthest behind, including least developed countries, small island developing States and land-locked developing countries. This Agenda also aims to better link SDG 7 actions and results with existing intergovernmental processes related to the 2030 Agenda and the Paris Agreement. Key elements of the Global Agenda for Accelerated SDG 7 Action are presented below.

5. **All stakeholders should step up and focus their efforts in support of SDG 7** by forming partnerships and jointly translating the Global Agenda into specific, strategic, bold and time-bound plans of action, including through facilitation of efforts by the UN Secretariat including the UN Regional Commissions and in coordination with the UN development system, international organizations, multilateral development banks, businesses, civil society and other stakeholders. Efforts of the multi-stakeholder SDG 7 Technical Advisory Group should be strengthened to support such actions. Future global milestones in addition to the High-Level Political Forum, including the UNFCCC Conference of the Parties and the Secretary-General's Climate Change Summit 2019, present key global platforms for sharing lessons and inspiring further actions. The UN Decade on Sustainable Energy for All 2014-2024 should also be leveraged to spur global momentum.

# The Global Agenda for Accelerated SDG 7 Action

## Objective

The Global Agenda for Accelerated SDG 7 Action is presented as a foundation for concerted action by all stakeholders in support of achieving SDG 7. It presents a set of priority actions to be taken by stakeholders to accelerate the achievement of SDG 7, based on the analysis in the SDG 7 Policy Briefs developed by the multi-stakeholder SDG 7 Technical Advisory Group convened by UN DESA, as well as experiences from existing actions to date, and recognizing the special challenges facing the countries that are the most vulnerable and the furthest behind. It also aims to better link SDG 7 actions and results with the existing intergovernmental processes at the UN related to the 2030 Agenda and the Paris Agreement. By bringing all stakeholders together, it is also intended to increase coordination, reduce duplications and enhance synergies.

### Priority Actions

The Global Agenda aims to catalyse concerted, strategic, bold, time-bound and measurable actions in support of SDG 7 by 2030, grouped into four interlinked categories:

#### I. Advancing SDG 7 implementation

- ***Make clean-cooking solutions a top political priority*****,** and put in place specific policies, cross-sectoral plans and public investments, supported by renewed game-changing multi-stakeholder partnerships.
- ***Close the electricity access gap*** by establishing detailed plans of action nationally, regionally and globally to "leave no one behind", backed by determined leadership, targeted policies and regulations, multi-stakeholder partnerships, bottom-up actions and increased investment in both on- and off-grid solutions. Cross-border grid connections, on-grid renewable energy solutions and decentralized options will all be required to respond to the differing needs of countries and regions.
- ***Accelerate the pace of transition towards renewable energy*****,** especially in end-use sectors such as transport, buildings and industry, to combat climate change and realize substantial economic, health and environmental benefits.
- ***Harness the potential of decentralized renewable energy solutions,*** which are key to universal energy access and empowerment of people, companies and communities. The rapid growth of decentralized energy systems challenges the structure and economy of the energy sector and requires a new policy and regulatory framework to fulfil its transformational potential.
- ***Scale up investments in energy efficiency across all sectors of the economy*****,** supported by well-designed, evidence-based policies (e.g., building codes, minimum energy performance standards, energy performance labels, cost-reflective energy tariffs and fuel economy requirements), as well as by regional, national and local action plans (with effective enforcement and monitoring).
- ***Double the financing for SDG 7 globally,*** from the current annual level of about US$ 500 billion to US$ 1 to 1.2 trillion per year until 2030. Public finance must be designed to catalyse far larger amounts of private financing. Climate finance should be tapped, as it could effectively contribute to the achievement of SDG 7 as well as the Paris Agreement. Use of inefficient fossil fuel subsidies should be phased out. Special attention needs to be given to those countries, regions, communities and people that are currently left out, including in the advancement of decentralized energy and clean-cooking solutions.
- ***Scale up capacity-building and education***, with renewed, cross-sectoral approaches, to develop human and institutional capacities and required skills in support of universal energy access and energy sector transformation. A network of national, regional and global institutions should be mobilized to facilitate needs assessments, deliver trainings and other capacity-building activities, and develop robust monitoring arrangements. Refresh and realign the curriculum in education institutions to better respond to SDG 7 and other goals.
- ***Enhance innovation systems, including research, development, deployment and diffusion*** in the design and operation of the whole energy system, and especially in the end-use sectors of transport, industry and buildings, through increased public and private investments and increased international cooperation.
- ***Invest in data collection systems and data analysis*** to build institutional capacities at the national level and ensure effective monitoring of the SDG 7 targets, including, as needed, through improved, policy-relevant indicators. Joint work by the global custodians of SDG 7 indicators should be strengthened in order to present a coherent SDG 7 tracking report.

## II. Strengthening interlinkages between SDG 7 and other SDGs

- ***Harness the potential of cross-sectoral interlinkages to maximize multiple benefits and synergies*** by promoting energy as an enabler for all the SDGs. Special attention should be given to the interlinkages between energy and poverty eradication, reduction of inequalities, gender equality, jobs, climate change, food security, heath, education, clean water and sanitation, sustainable cities and communities, innovation, transport, industrialization, peace and security, refugees and other situations of displacement. Risks of trade-offs, such as among sustainable energy, food security and water, will have to be managed, while harnessing the opportunities for synergies.
- ***A unified approach is required to achieve SDG 7 and meet the goal of the Paris Agreement simultaneously.*** Decarbonization of the world's energy systems and attainment of the targets of SDG 7, including ensuring universal access to modern energy by 2030, are mutually reinforcing and must be advanced at the same time.
- ***Integrate gender equality and women's empowerment into all energy actions to advance the SDGs.*** Empower women in the design, production and distribution of modern energy services, by developing their technical and business skills and establishing financing schemes to support gender-specific programmes and women's access to capital. Develop gender-responsive policies, programmes and monitoring systems, and ensure equal participation of women in decision-making bodies in energy institutions, along with sex disaggregation and gender analysis of data to monitor SDG 7.
- ***Promote sustainable and low-carbon cities*** with reliable and affordable public transportation systems, energy-efficient built environments and significant shares of their energy needs met by cleaner energy sources.

## III. Addressing regional priorities

- ***Strengthen cooperation at the regional level*** to promote innovation and facilitate financing; support regional cross-border power grid connectivity to enhance energy security, advance economic integration and sustainable development; and share best practices (including on productive uses) that are responsive to regional needs regarding SDG 7 and its interlinkages with other SDGs.
- ***Prioritize ending energy poverty in the most vulnerable countries.*** Investments (by all stakeholders) in sustainable energy in these countries will have a significant positive impact across different SDGs, and exemplify the true spirit of leaving no one behind. Each country faces specific challenges in its pursuit of sustainable development, and there are serious challenges within many middle-income countries. However, the most vulnerable countries—in particular, African countries, least developed countries, landlocked developing countries and small island developing states—deserve special attention, as do countries in situations of conflict or post-conflict.

## IV. Accelerating transformation towards a sustainable, inclusive and equitable energy future

- ***Promote transformational investments*** in developing sustainable, inclusive and equitable energy systems, including by strengthening energy systems through cross-border grid connections and fully incorporating decentralized renewable energy solutions in energy planning, while recognizing that energy transition will take different paths in different parts of the world. Promoting such a transformation will require multiple and multifaceted actions by all actors, including a concerted, multilateral approach that paves the way for advancing universal energy access through decentralized solutions, while at the same time advancing the Paris Agreement.
- ***Transform human behaviour from energy-intensive lifestyles to more sustainable patterns,*** promoting technological and institutional changes that would result in adequate food, clean water, better education and reduction of poverty and gender inequalities, together with reductions in air pollution and greenhouse gas emissions.
- ***Strengthen decision-making processes by reinforcing improvements in energy data collection, indicators and monitoring efforts,*** adopting, as needed, a broader range of forward-looking indicators on energy for sustainable development, including interlinkages indicators (e.g., energy-health and energy-jobs).
- ***Harness the power of all stakeholders to drive change*** through advocacy, capacity-building, mobilization and collaborative action, including businesses, civil society, women and youth.

## Making it happen

Turning the Global Agenda into action requires increased international cooperation among all stakeholders on specific, strategic, bold and time-bound plans of action and partnerships, including through facilitation of efforts by the UN Secretariat including the UN Regional Commissions and in coordination with the UN development system, international organizations (such as the International Energy Agency and the International Renewable Energy Agency), multilateral development banks (including the World Bank, the Asian Infrastructure Investment Bank and regional development banks), businesses, civil society and other stakeholders. Future global milestones, such as the High-Level Political Forum, the UNFCCC Conference of the Parties, and the Secretary-General's Climate Change Summit 2019, present key global platforms for sharing lessons and inspiring further actions in support of SDG 7. The UN Decade on Sustainable Energy for All 2014–2024 should also be leveraged to strengthen leadership-level engagements, share plans, programmes and lessons, and catalyse action, partnerships and resources globally. The multi-stakeholder SDG 7 Technical Advisory Group should continue to be strengthened and leveraged to support such efforts.

# Contents

## TOWARD A SUSTAINABLE AND EQUITABLE ENERGY FUTURE

# POLICY BRIEF #1

## ACHIEVING UNIVERSAL ACCESS TO ELECTRICITY


### Developed by

International Energy Agency (IEA), United Nations Development Programme (UNDP) and International Renewable Energy Agency (IRENA)

### In collaboration with

The European Commission, UNESCWA, UNECE, UNECA, UNESCAP, EnDev, PBL Netherlands Environmental Assessment Agency, World Bank and Norad

## KEY MESSAGES

### Status of electricity access and progress towards achieving SDG 7.1

- The number of people without access to electricity fell to around 1 billion in 2016 from 1.7 billion in 2000. The number of people gaining access to electricity each year is accelerating, thanks to strong successes in some countries, including Bangladesh, Ethiopia, India, Kenya and Tanzania. Grid electrification has been the source of almost all energy access gained since 2000 and is likely to remain the most favourable option for many households, especially in more densely populated areas.
- To deliver universal energy access by 2030, decentralized options are the least-cost option for 60 per cent of people currently lacking access. Public programmes and private-business models providing electricity access with off-grid solar are thriving, and many countries are also exploiting their renewable potential in the centralized electricity mix.
- However, having a source of electricity is not a guarantee of full access. To serve the needs of households, schools, health centres and local enterprises, electricity needs to be available at the right time, at an affordable price and with a reliable supply and appliances.
- Current progress towards delivering universal access is promising in many parts of Asia and some countries in sub-Saharan Africa, but not in all. Based on recent trends and policies, the number of people without electricity access is expected to remain over 670 million in 2030, with over 80 per cent of those lacking access concentrated in rural areas of sub-Saharan Africa.

### Priority actions

- Guarantee leadership, commitment and strategic planning Elevate universal access to electricity to a high level on the political agenda, backing up commitments with strategic planning, clear policies and regulatory frameworks, and dedicated institutions.
- Identify a strong champion institution for electrification programs, with a clear mandate, the authority and resources to fulfil the mandate, and accountability for achieving that mandate.
- Enable private sector participation To achieve the estimated US$ 52 billion per year in investment necessary to deliver universal access, private investment is needed to complement public spending. De-risking tools, affordable financing and a clear enabling policy framework are needed to attract the private sector.
- Household electrification strategies should take into account other development goals and opportunities to use energy access to stimulate sustainable economic activity.
- Support technology development and standards Decentralized systems are benefiting from innovative control and payment solutions, such as smart metering, customer data management and communications, and mobile payments Electrification planning needs to take into account the dynamic and integrated nature of energy demand and storage, and ensure technical standards and energy efficiency in end-use appliances.
- Address affordability, which remains a critical barrier, by lowering upfront costs in providing targeted financing and subsidies, harnessing new business models such as the pay-as-you-go model, integrating energy efficient appliances with electricity access solutions, and creating sound policies and institutions.

### Electricity access and the Sustainable Development Goals

Energy has long been recognized as essential for humanity to develop and thrive, but the adoption of new United Nations Sustainable Development Goals (SDGs) in 2015 marked a new level of political recognition of the importance of energy to development. The SDGs include, for the first time, a target to ensure access to affordable, reliable, sustainable and modern energy for all. Electricity access is crucial to the achievement of many of the other SDGs. Providing connections to households, however, is not enough to ensure economic and social development. Electricity needs to be available reliably and affordably not only for households to access meaningful services but also for income-generating activities and public services. Improvements and cost declines in decentralized technologies offer new opportunities for delivering universal electricity access, but many challenges remain, particularly for providing electricity access affordably for remote and poor households.

### Current status of electricity access

Efforts to promote electricity access are having a positive impact in all regions, and the pace of progress has accelerated. The number of people without access to electricity fell to around 1 billion in 2016[1] (IEA, 2017; IEA, IRENA, UN Statistics, World Bank and WHO, 2018). Nearly 1.2 billion people have gained access since 2000, but population growth in areas with low access rates has offset some gains (see figure 1.1). Where access to electricity is incomplete, it is characterized by a considerable urban-rural divide.

Most progress has been made in developing Asia, where around 900 million people have gained access since 2000. India accounts for 500 million—one of the largest electrification success stories in history—while universal electrification was announced in China in 2015. Today about nine-in-ten people in the region has access and the absolute number of people without access has halved in the last 10 years despite population growth. Based on current policies and trends, the region is on track to achieving universal access in the early 2030s.

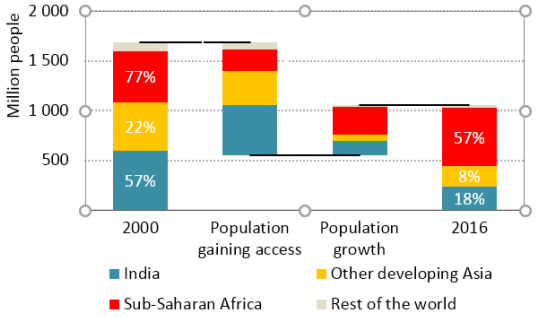
In the past few years, when a peak in the number of people without access was registered in sub-Saharan Africa, there is for the first time a positive trend. Progress has been led by Cote d'Ivoire, Ethiopia, Ghana, Kenya and Tanzania. The vast majority of the 590 million people who remain without access live in rural areas, where the average electrification rate is less than 25 per cent. Despite positive developments, population growth and uneven progress means that on the basis of current efforts, some 600 million will remain without access in 2030 (IEA, 2017).

1 The IEA Energy Access Database, which reports government values for access where available, calculates 1.06 billion people without access in 2016 (IEA, 2017). The World Bank, which relies on survey and modelled estimates, calculates 0.94 billion people without access in 2016 (IEA, 2017; IEA, IRENA, UN Statistics, World Bank and WHO, 2018). Both organizations are working towards assessing differences, a process which is described in chapter 1 of the 2018 Tracking SDG 7 Report.

Around 95 per cent of the global population without electricity access is in Asia and sub-Saharan Africa. While other world regions have reached near-universal access, there are several exceptions, including Yemen and Haiti, where less than half the population has access.

Figure 1.1

**Change in population without access to electricity between 2000 and 2015**




Note: Percentages within the graph indicate the share of population without electricity access. IEA (2017)

Even in countries where access is universal, unplanned service disruptions and power outages can be common; there is no guarantee that supply is affordable, and many rural off- and mini-grid systems can supply only a few hours of electricity services per day. Consequently, even for many of those who have gained access, the absolute level of electricity consumption, and access to electricity services is low. There is no universally accepted minimum threshold for what constitutes electricity access, particularly in establishing policy targets[2].

### Electrification solutions

Grid electrification has been the source of electricity access for an estimated 97 per cent of people who have gained a connection since 2000 (IEA, 2017) and from a system perspective offers the lowest-cost path to household electrification for areas with sufficient density of electricity demand. Given the economies of scale associated with centralized power generation, grid extension and connection will likely remain the most favourable electrification option for many households, particularly those in more densely populated areas. IEA geospatial analysis (IEA, 2017) suggests that to deliver

2 In the IEA's scenarios, a household initially gains access to enough electricity sufficient to power a basic level of energy services, growing over time so that by 2030, the average household has electricity to power four light bulbs operating at five hours per day, one refrigerator, a fan operating 6 hours per day, a mobile phone charger and a television operating 4 hours per day. The Multi-Tier Framework (MTF), developed by ESMAP, is a complex metric of energy access going beyond whether a household has an electricity connection or not. MTF incorporates energy service attributes such as "Capacity", "Reliability", "Quality", "Legality", "Safety" and "Affordability to determine five tiers (from Tier 0 as the lowest to Tier 5 as the highest rating) (IEA and World Bank, 2017).

universal access by 2030, grid extension is the lowest-cost option for around 40 per cent of households that do not currently have access. The importance of centralized generation from renewables is projected to grow, to around half of generation for electricity access to 2030, an increase from the 30 per cent share seen since 2000; coal's role is expected to decline. One barrier, however, is the significant financial weakness of utilities in many cases (Kojima and Trimble, 2016). In such cases, attending to the financial health of the domestic power sector, focusing on "commercially oriented" operations, is of great importance.

Grid extension is less favourable than decentralized options[3] under conditions of complex terrain, low population density, regulatory and institutional hurdles, or high investment and maintenance costs that may not be recoverable by utilities. The IEA estimates that to deliver universal electricity access by 2030, decentralized solutions are the least-cost option for 60 per cent of people lacking access, with the role of grid expansion expected to increase with increasing power demand, urbanization and economic activity. Currently, decentralized access solutions are small but accelerating: the IEA estimates that 33 million people have access to electricity with decentralized renewables (excluding pico solar, which IRENA estimate benefit 114 million users), with the rate of connection accelerating (***IEA 2017).*** IRENA estimates that globally, off-grid renewable electricity capacity for residential and commercial purposes is around 4,030 MW (IRENA, 2017c). Decentralized electricity systems can also have co-benefits for local job creation and economic growth. The dynamics of electrification solutions are not static: in Western economies the network emerged from local systems (both private and municipal) and later interconnected; the same may become true for areas currently gaining access as power demand grows.

Several converging trends are making decentralized options more and more competitive, with the potential to transform the energy access landscape in rural areas. These trends include the declining cost of renewables and storage (historically, most decentralized capacity has been oil-based); the increasing availability and affordability of efficient appliances and lighting; the emergence of new technologies enabling smart metering and mobile payments; the liberalization of energy markets enabling more actors, including the private sector, to participate; and an increased focus from international initiatives, microfinancing institutions and crowd-funding platforms.

Affordable financing models have also been instrumental, two in particular. The pay-as-you-go (PAYG) model has emerged in recent years with considerable momentum. Consumers use their phones to pay a fixed upfront cost for a device—usually a solar panel bundled with battery storage and appliances—and then pay for its use in instalments. Critically, the daily payments can be less than a household pays for poor-quality energy alternatives, such as kerosene for lighting. This model is well-established in East Africa, where mobile money is widely used, and has expanded to more than 30 countries, serving an estimated 700,000 households (REN21, 2017). The PAYG model is scalable with private sector capital; however, so far PAYG businesses have been almost exclusively reliant on international investors, exposing businesses to the foreign exchange risk, which can lead to price increases for consumers.

In Bangladesh, a successful micro-credit model has been in operation for more than a decade. There, the Infrastructure Development Company (IDCOL) channels international funding to microcredit groups and installers, sets technical specifications and loan terms, and certifies products and components for quality-control purposes. While affordability has been key, household loan terms have moved from concessional towards commercial. A cumulative 4.1 million solar home systems have been installed (IDCOL, 2017) and more than 100,000 jobs have been generated. Replicable lessons include adaptation of equipment to local needs, enforcement of product standards and workforce training. A designated "national champion" like IDCOL can be tasked with establishing an overall policy framework within which financing, product certification and other activities unfold.

The sustainability of new energy access models requires that portions of the supply chain and the attendant benefits are localized (developing relevant competencies among domestic enterprises), and that domestic financial institutions develop the needed understanding and capacity to offer lending for off-grid solar and other products.

The role of mini-grids, currently limited, is expected to increase, especially when access initiatives aim to provide electricity for productive and commercial activities as well as households. For sustainable mini-grid development and operation, an enabling environment is needed that covers dedicated policies and regulations, tailored financing mechanisms, enabling institutional frameworks, a focus on capacity-building, and adapted technology. Within such an en abling environment, suitable policies and regulations for mini-grids include a clear rural-electrification strategy, a tailored licensing and permitting framework, a mechanism to address compensation/integration of mini-grids when the main grid arrives, clear rules for setting tariffs which incentivize investment and enable sustainable operation, and measures to facilitate access to finance for both developers and end-users (IEA, 2017; IRENA, 2016).

Anchoring mini-grid development to productive sectors, such as telecom towers or agriculture (irrigation/processing) can provide important, stable long-term revenue to the supplier and increase

[3] "Decentralized" electricity access here encompasses off-grid (stand-alone) systems powering individual households, and mini-grids powering a network of clustered homes and/or businesses.

the financial viability of the mini-grid (as well as having benefits to the local economy and rural development). It is therefore important to promote productive uses sooner rather than later.

### Investment to deliver universal electricity access

Providing electricity for all by 2030 would require an estimated annual investment of US$ 52 billion per year in power generation and infrastructure, equal to 3.4 per cent of average annual global energy sector investment over this timeframe. In the IEA Energy for All scenario, renewables make up around 90 per cent of investment in new capacity. However, the IEA projects that less than half of this needed investment will be made under current trends and policies, and that over 95 per cent of the investment gap will affect countries in sub-Saharan Africa (of the 670 million people projected to be without access in 2030, 600 million are expected to live in sub-Saharan Africa) unless more investment is mobilized. Bundling very efficient appliances with off-grid renewable systems can reduce the overall cost by around one-third (IEA, 2017).

### Interlinkages with other SDGs

Energy (including electricity) is not useful in itself: it is only useful to the extent that it provides desired services and drives actions. Therefore, while it is important to measure energy access directly, the true impact is on enabling the success of other SDGs. Modern energy access is an important factor for the achievement of virtually all development goals, but for some SDGs it is essential.

No poverty (SDG 1); Gender equality (SDG 5); Decent work and economic growth (SDG 8); Industry, innovation, & infrastructure (SDG 9): People deprived of modern energy are trapped in a reinforcing cycle with insufficient means to improve their living conditions and basic services, including lighting, education, health and fresh water to meet basic human needs. At the same time, poor households without energy access spend a significant share of their very limited income on expensive, unhealthy, unsafe, time-consuming and inefficient forms of energy. Modern, affordable energy is essential for breaking this cycle. Moreover, electricity access can improve livelihoods. This is especially the case for women, for whom the chance to work from home can create an independent source of income. The deployment of decentralized energy can create employment in the electricity value chain itself, in assembling, distributing, installing and maintaining equipment, and more broadly support rural economies by removing the barrier a lack of electricity poses to productive activities. Electricity is essential for economic sectors—agriculture, tourism, commerce, industry—to thrive and create income-generating opportunities, increase value added, and therefore revenues, in rural areas. In addition, telecommunications improve access to markets and information.

Zero hunger (SDG 2); clean water and sanitation (SDG 6): Today energy inputs are limited throughout the agri-food chain in developing and least-developed countries, hindering efficient food production and threatening food security. Modern energy offers many benefits. Electricity for irrigation pumps can double the yield of croplands, and refrigeration reduces spoilage. Energy for processing can vastly improve the efficiency of food production, increase the value of the products and generate economic and employment gains, which in rural areas would potentially reduce the pressure towards urban migration. Moreover, installing and operating water extraction, transport and treatment systems requires a considerable amount of energy; expanding these services to poorer populations is dependent on a reliable source of electricity.

Good health and well-being (SDG 3): At present, an estimated 4 million people die prematurely each year due to the use of polluting fuels and technologies in households for cooking, heating and lighting, without adequate ventilation. Women and children suffer most of the worst effects. Providing access to modern energy (including modern cooking facilities) for all can lower the premature death toll by around 1.8 million people per year in 2030 (IEA, 2017). Thermal comfort (heating and cooling) and refrigeration are also key to good health and nutrition. Moreover, health care facilities require reliable electricity to function and power medical devices, and good lighting is needed to provide essential services. Refrigerators used in health clinics with unreliable electricity cause significant failure of vaccines. Yet, an estimated 1 billion people globally are served by health facilities without electricity, including 255 million people in sub-Saharan Africa (Practical Action, 2013). Energy access rates drop dramatically for rural clinics, and those that do have access often have an unreliable supply (WHO and World Bank, 2014); this contributes to the immense health care challenges developing countries face.

Quality education (SDG 4): Ensuring electricity access can reinforce education goals. Well-lit, well-heated and well-cooled schools and households are essential for creating learning spaces for children and adults. Information and communication technologies, on which modern education is based, also require energy input. Conversely, quality education is an enabling factor in achieving SDG 7, given that knowledge and skills influence the feasibility of implementing access solutions from technical, financial and political perspectives.

Climate action (SDG 13): Although electricity generation contributes a large share of global $CO_2$ emissions, delivering universal household electricity access does not pose any threat to achievement of the Paris Agreement. With the growing importance of renewables for electricity access and the relatively low levels of electricity consumption by households in developing countries, delivering universal access would increase global $CO_2$ emissions in 2030 by around 0.2 per cent (70 million tons of $CO_2$) relative to the baseline (IEA, 2017). At the same time, reliable electricity

access can improve the resilience of households and communities to a changing climate.

It is also important to note that there are interlinkages between the three SDG 7 targets themselves. For example, cost reductions in renewables, storage, and energy efficiency as a result of wider global deployment will facilitate rural electrification.

## Policy recommendations

Guarantee leadership, commitment and strategic planning: To make progress in this area, it is essential that governments elevate universal access to electricity to a high position on the political agenda, backing up commitments with strategic planning, clear policies and dedicated institutions. Policy uncertainty and a lack of transparency can create the perception of excessive risk, discouraging investment and halting progress. Governments should map a clear energy development scenario, charting the expansion of the grid and the integration of decentralized solutions into rural electrification strategies, and planning for people moving up the energy ladder. Electrification strategies should also ensure a sustainable and affordable supply, and plan for providing electricity to productive sectors. To maximize socioeconomic benefits, it is important to identify priority areas, such as the electrification of health centres, schools and productive sectors.

Ensure dedicated institutions and enabling policy and regulatory frameworks: Virtually all successful public electrification programs have featured a specific leading institution. A dedicated public-sector "champion" can provide a strong framework for all actors that addresses not only technical and market development issues, but also other critical dimensions such as quality control, training, and adaptation of solutions to local needs. There are a host of stakeholders with important roles to play; it is essential to make these institutions strong, with a clear mandate, the authority and resources to fulfil the mandate, and accountability for achieving that mandate.

Enable private sector participation: The power sector is often represented by government-linked institutions, and most investment is driven by public grant/concessional funding and non-commercial equity in developing countries. To achieve the scale-up needed to deliver electricity for all by 2030 (estimated by the IEA to be US$ 52 billion per year), private investment needs to complement public investment. Policies, regulations and incentive structures can facilitate market development and ensure affordable financing for all electrification solutions. De-risking tools, such as clear targets, streamlined permitting processes, public loans, loan guarantees and risk insurance, can help attract both downstream (end-user) and upstream (enterprise) capital into the off-grid sector. This also necessitates an adequate enabling policy framework, and facilitation of access to commercial debt and equity (see Policy Brief on Finance for SDG 7).

Integrate electrification of productive uses in access strategies: No country has gone from poverty to prosperity without making electricity affordable and available in bulk for productive uses. Household electrification strategies should take into account other development goals, and opportunities to use electricity access to stimulate inclusive, climate resilient and sustainable economic activity. Electrifying communities with grids or mini-grids can allow economies of scale by leveraging power demand from productive sectors where houses, businesses and public services are physically close to one another. Mini-grids are more likely to be economical in more densely populated but remote areas. There is also an important development opportunity in using the provision of energy access to create local jobs, contingent on fostering local skills and competencies. Local entrepreneurs can play a fundamental role in extending electricity access with decentralized solutions. The Addis Ababa Action Agenda commits leaders to providing both public and private investment in energy infrastructure and clean energy technologies with the aim of delivering universal access.

Support technology development and standards: Innovative systems for control and demand-side management are gaining importance in the off-grid sector. Off-grid systems have proven to be effective at providing access to areas that are too expensive to electrify via the grid in the short or medium term. Moving beyond a basic level of electricity consumption is likely to make the case for mini-grid development or grid extension. Mini-grids themselves can be integrated into large networks, if they use compatible equipment. This underlines the need to recognize the dynamic and integrated nature of energy access development and for co-ordinated planning which takes account of ways to upgrade existing systems and integrate decentralized systems into the grid if it arrives. Similarly, grid standards should vary depending on the connected load. There is also a role for governments in putting in place standards and labelling, ensuring quality assurance, and in controlling imports of less efficient and reliable goods. Low-quality goods and poor information can increase a household's costs, erode consumer confidence and spoil new markets.

Energy storage: Many stand-alone renewable solutions typically only offer four hours of limited service (light bulbs, mobile charging, small TV in the evening). To offer higher levels of services, greater generation requires more storage capacity, representing significant additional costs, particularly in a solar PV-battery system. End users can move up the tiers of electrification over time, as their ability to pay increases. At current prices, this makes the systems that include storage uncompetitive in most cases. However, a clear cost reduction trajectory, based on technology learning curve dynamics, is emerging for various storage technologies, and that is likely to continue making these solutions more affordable.

Harness the potential of energy efficiency: This has the potential to improve not only the economics of energy access, but also the reliability and performance of a system. Efficient appliances such as LEDs, low-power TVs, and various types of machinery enable access to energy services at lower levels of power consumption. However, developing countries are often the recipients of second-hand, inefficient appliances, which while more affordable to buy, and in an off-grid system limit the level of energy services a consumer can attain. Pairing off-grid systems with super-efficient appliances can substantially reduce the lifetime cost of a new connection; however, financing is needed to overcome the additional upfront cost burden. Many policies and programmes to improve energy access should broaden to focus on demand technologies and regulate the import of less efficient goods.

Address affordability: This remains a particularly critical barrier to scaling up these solutions. Even though people without electricity access often pay a lot for conventional energy sources, such as kerosene and candles, the upfront costs for off-grid systems may still be higher than most consumers are willing or able to pay. The IDCOL approach and the PAYG business models, which bundle services and appliances, offer scope for overcoming the upfront cost barriers by spreading out payments. In addition to consumer affordability, policies need to ensure that utilities can recover costs and operate sustainably. Governments can help lower the cost of electricity access to consumers and utilities by creating sound policies and institutions, discussed above, by subsidizing decentralized connections to ensure affordability and equity between rural and urban households. Targeted subsidies and financing could be aimed at lowering connection fees, or the upfront costs of equipment and appliances. Also, communities need to have an active voice in the design and implementation of energy access policies.

## REFERENCES

IDCOL (Infrastructure Development Company Ltd.) (2017), "IDCOL SHS Installation under RE Program," Available online at http://www.idcol.org/old/bd-map/bangladesh_map/

IEA (International Energy Agency) (2017), Energy Access Outlook: World Energy Outlook Special Report, OECD/IEA, Paris.

IEA, IRENA, UN Statistics, World Bank and WHO (2018, forthcoming), "Tracking SDG 7: Progress Towards Sustainable Energy. A Joint Report of the Custodian Agencies".

IFC (International Finance Corporation) (2018), "Off-grid solar market report 2018", Dalberg Advisors and Lighting Global, Washington DC.

IRENA (International Renewable Energy Agency) (2018, forthcoming), Measurement and estimation of off-grid solar, hydro and biogas energy, Abu Dhabi.

IRENA (2017a), Rethinking Energy: Accelerating the Energy Transition, Abu Dhabi.

IRENA (2017b), Accelerating Off-grid Renewable Energy: Key Findings and Recommendations from IOREC 2016, Abu Dhabi.

IRENA (2017c), Renewable Energy Statistics, Abu Dhabi.

IRENA (2017d), Renewable Energy and Jobs. Annual Review 2017, Abu Dhabi.

IRENA (2016), Policies and regulations for private sector renewable energy mini-grids, Abu Dhabi

Kojima, M and Trimble, C (2016), "Making Power Affordable for Africa and Viable for Its Utilities". World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/25091

Practical Action 2013 (2013), Poor People's Energy Outlook, Bourton on Dunsmore, UK.

REN21 (Renewable Energy Policy Network for the 21st Century) (2017), Renewables Global Status Report, REN21 Secretariat, Paris.

WHO (World Health Organization) and World Bank (2014), Access to Modern Energy Services for Health Facilities in Resource-Constrained Setting. A Review of Status, Significance, Challenges and Measurement.

World Bank/ESMAP (2015), "Beyond Connections, Energy Access Redefined"

World Bank (2016), "Making Power Affordable for Africa and Viable for its Utilities"

# POLICY BRIEF #2

## ACHIEVING UNIVERSAL ACCESS TO CLEAN AND MODERN COOKING FUELS, TECHNOLOGIES AND SERVICES


## Developed by

World Health Organization (WHO), International Energy Agency (IEA), Global Alliance for Clean Cookstoves (GACC), United Nations Development Programme (UNDP), Energising Development (EnDev) and World Bank

## KEY MESSAGES

### Importance of clean-cooking solutions for achievement of SDG 7

- Universal access to clean and modern cooking fuels and technology is an integral element of ensuring that the broader aims of SDG 7— universal access to modern energy services—are achieved by 2030. Cooking solutions also advance other SDGs, including good health and well-being, gender equality, climate action, and eliminating poverty.
- Despite significant progress on other SDG 7 indicators, access to cooking solutions remains a distant possibility for the 3 billion people—40 per cent of households globally—who still rely on traditional cooking systems daily. An assessment of recent trends and policies indicates that without additional efforts, 2.3 billion people will still be without clean cooking access in 2030. Urgent action is needed to scale up access to modern energy cooking solutions through policies, financing, and technology development, or the world will fall short of SDG 7 and several other related SDGs.

### Priority actions

- Enabling Policies: Governments must prioritize clean-cooking solutions, and translate their global commitments into concrete evidence-based policies and plans to increase access to clean and modern cooking energy.
- Financing and Investment: Governments, development agencies, and the private sector must mobilize funds in order to: scale up promising enterprises so they become profitable, increase consumer choice and financing, and stimulate additional private investment (including through incentives or risk mitigation mechanisms).
- Mainstreaming and multi-sectoral action: Successful clean-cooking solutions are inherently cross-sectoral and should engage diverse public and private stakeholders from across the development and climate spectrum, including but not limited to policymakers for energy, health, environment, and education, as well as private sector actors. Moreover, to optimizse clean cooking impacts, policymakers, implementers, funders, and financiers should aim to mainstream clean cooking into relevant development interventions, such as those impacting health, gender, climate, and environment.
- Technology: Moving people towards cleaner and more efficient cooking solutions that meet local cultural, social and gender needs should be prioritized on the path to achieving universal access. Adequate financial and technological resources are needed to help spur innovation and identify a suite of affordable and scalable clean-cooking solutions. For example, high-performing biomass stoves can serve as an important transitional solution until infrastructure for the cleanest options (such as electricity, LPG, ethanol, biogas, and solar) is built.
- Monitoring: Improved monitoring of household energy use, including primary and supplementary cooking fuels and technologies, as well as those used for heating and lighting, must be adopted to accurately track, measure impact, and assess progress towards achieving universal access. Assessment of impacts on health, environment, climate, gender and livelihood is crucial to understanding the full burden of polluting fuels and technology combinations.

## Clean-cooking access and the Sustainable Development Goals

Closing the household energy access gap is now a priority on the global sustainable development agenda. Having access to reliable, clean, modern cooking energy enables people to live to their full potential.

### Interlinkages with other Sustainable Development Goals

Inefficient cooking contributes to poverty, poor health, gender inequality, environmental degradation, air pollution and climate change. Universal access to clean and modern cooking is integral to reducing poverty and advancing human dignity. The co-benefits of clean cooking can help achieve 10 of the 17 global goals. Moreover, clean cooking is particularly relevant to fulfilling the SDG commitment to "leave no one behind." The harmful consequences of inefficient, traditional cooking disproportionately affect the world's most vulnerable citizens—women, girls, and infants, as well as those living in extreme poverty and displaced populations (WHO, 2016).

In the 2017 SDG Progress Report, Secretary-General Guterres cited household and ambient air pollution as the greatest environmental health threat facing the world today, which cannot be addressed without significant progress on access and adoption of clean and modern cooking. Around 4 million deaths are attributed to traditional cooking methods annually. Exposure to household air pollution (HAP) contributes to a myriad of diseases including acute lower respiratory infections in young children and lung cancer, ischaemic heart disease, chronic obstructive pulmonary disease and stroke in adults. The health and well-being (SDG 3) of women, children, and infants are disproportionately compromised by HAP. Research suggests that the air pollution caused by inefficiently cooking with biomass fuels may increase blood pressure in pregnant women, cause lower birth weight of infants and increase incidence of childhood pneumonia. In addition to these illnesses, polluting and unsafe fuels pose substantial risks for burns and injuries. Fuel collection over long distances with heavy loads can result in personal safety risks and injury as well.

Traditional cooking also poses additional burdens for women and girls, since they typically spend hours each day caring for their families and performing routine, unpaid household chores, such as cooking, cleaning, and collecting water and firewood, time that could otherwise be spent on income-generating activities, education or recreation. Without addressing time poverty that women and girls face, gender equality (SDG 5) cannot be fully achieved.

Furthermore, emissions from traditional cookstoves and fuels also slow progress on environmental and climate-related goals (SDGs 12, 13 and 15), as well as the Paris Agreement. Unsustainable wood harvesting for cooking fuel can contribute to forest degradation, reducing carbon uptake by forests. Additionally, HAP contributes up to 25 per cent of black carbon emissions, one of the most significant climate forcers. Thus, shifting to clean household energy provides an excellent opportunity to realize near-term climate and health co-benefits (WHO, 2016).

Box 2.1.

**Defining clean for health: Clean and modern cooking solutions**

Improving indoor air quality requires defining "clean" for health at point of use. The most recent WHO *Guidelines for indoor air quality: household fuel combustion* (the Guidelines) set new standards for clean burning in the home based on systematic reviews of scientific literature and robust mathematical models. Any type of fuel-technology combination is considered "clean" if its emissions meet WHO Guidelines. Currently available options that are clean at point of use include electricity, gas, ethanol, solar and the highest performing biomass stoves. In order to provide the greatest health benefit, clean fuels and technologies should be used exclusively.

The Guidelines discourage household use of kerosene and unprocessed coal in the home, owing to significant health risks from these fuels. An improved cookstoves (ICS) typically describes a stove with higher efficiency or lower emissions than a traditional stove, but can include a wide range of performance. For fuels and technologies that are not clean at point of use, personal exposure is affected by an array of factors including time spent indoors, proximity to a cookstove and ventilation. Most ICS models do not meet WHO Guidelines, but offer some benefits and can be used as transitional solutions. Further innovation, research and investment may indeed produce affordable and widely available biomass stoves that meet the WHO Guidelines levels.

### Current status of clean cooking fuel and technology access

Worldwide, around 3 billion people lack access to clean and modern fuels and technologies for cooking, meaning that they cook with fuels including fuelwood, charcoal, coal, agricultural residue, dung and kerosene, paired with inefficient stoves. One-third of the global population uses solid biomass as their primary cooking fuel, around 120 million people use kerosene, and 170 million people use coal. Since 2000, the number of people in low- and middle-income countries with access to clean cooking has grown by 60 per cent, but this progress was outstripped by strong population growth, leaving at least 400 million more people without clean cooking today than in 2000 (WHO, 2016 and IEA, 2017). Furthermore, even households that report primary reliance on clean fuels and technologies for

Box 2.2.

**Measuring Energy Access with the Multi-Tier Framework**

Historically, access to clean energy for cooking was equated with the use of non-solid fuels as the primary cooking energy source (in recent years this has been modified since a non-solid fuel, kerosene, is no longer considered clean). However, this binary metric fails to fully capture the interactions between the cookstove, cooking environment and user's experience. For predicting exposure, it is important to consider the interlinkages between cooking emissions, indoor air quality and health risks. A more comprehensive assessment of energy access could better inform energy policy, planning and project implementation.

Through consultations and inputs from multiple agencies, a new multi-tier framework (MTF) for measuring access to energy for cooking has been developed, which includes six attributes: *cooking exposure, efficient heat, convenience, cookstove safety, affordability and fuel availability*. It provides a comprehensive tool to capture information about access to energy for cooking, encompassing various cooking solutions, user behaviour, cooking conditions and use of multiple cooking solutions, as well as convenience and safety aspects. It allows disaggregate as well as aggregate analysis to yield detailed information about various parameters as well as indices that facilitate comparison over time and across geographic areas.

The MTF data are currently being collected in 16 countries and are expected to be available by early 2019. The efforts are also ongoing to mainstream the data collection in the country statistics systems. The MTF is an opportunity to better measure access to modern energy cooking service and informing policy designs.

cooking may supplement with biomass, coal and kerosene—the well-known reality of "fuel-stacking".

Primary reliance on polluting cooking fuels and technologies varies regionally. The African Region, the South-East Asia Region, and the Western Pacific Region have the highest proportions of households primarily using polluting fuels for cooking. China and India are taking a strong stance on clean cooking through government-led policies. In China, residential biomass use has been declining 6 per cent per year since 2010, largely replaced by natural gas, LPG and electricity, especially in urban areas. (IEA, 2017) In India, though the number of people without clean cooking access has leveled off at around 780 million since 2010 and the Government is further ramping up efforts to provide clean cooking energy access through its *Pradhan Mantri Ujjwala Yojana Programme* (PMUY). The PMUY scheme has target of providing free LPG connections to 50 million women living below the poverty line by 2019 (PMUY, 2018).

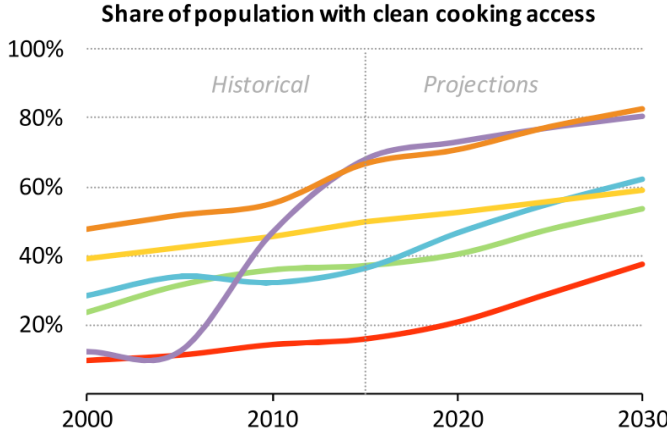
**Are we on track to achieving universal clean cooking access?**

The world is far from being on track to achieve universal access to clean and modern cooking fuels and technologies by 2030; the International Energy Agency's projections estimate that 2.3 billion people will still remain without access to clean cooking facilities in 2030 under current policy and population trends (IEA, 2017).

Countries with dedicated policy initiatives, such as China, India and Indonesia, are exhibiting significant reductions in the population without access to clean cooking. In sub-Saharan Africa, over 300 million people are expected to gain access to clean cooking by 2030. However, clean cooking efforts would not keep pace with the population, leaving 820 million people or 56 per cent of the population reliant on biomass as their main cooking fuel, an increase relative to today's number.

Figure 2.1

**Population with and without access to clean cooking by region in the New Policies Scenario (IEA, 2017)**




**Red: sub-Saharan Africa; Blue: India; Purple: Indonesia; Yellow: Other Southeast Asia; Green: Other developing Asia; Orange: China**

## Key challenges

1. **Supply** Household cooking decisions are often driven by the lack of clean, affordable and available alternatives. Stable supplies of affordable clean fuels and energy sources are essential to enable the adoption of clean household energy. The WHO's normative guidance recommends prioritizing transitional fuel and technologies that provide some level of health benefit in contexts where the shift to universal access to clean fuels and technologies will take time.

2. **Demand** Barriers to sustained adoption of clean cooking practices include the cost of the clean fuel and/or device, consumer preference and practice, cultural appropriateness of the device, perceptions about the taste of food and lack of understanding of the health, livelihood and environmental impacts of polluting fuel use. Fuel and stove stacking is a particular barrier to achieving the full benefits of clean cooking technologies. Similarly, the transition to clean fuels and technologies for other energy end uses (heating, lighting, and others) is essential to ensure the maximal benefits. Large-scale awareness-raising and behavioural change campaigns should be enacted to better ensure long-term adoption of clean-cooking solutions.
3. **Enabling Environment** Monetary and fiscal policies that restrict and inhibit sector growth, lack of prioritization in both funding and implementation, and poor cross-sectoral coordination all prevent the clean-cooking sector from scaling to sustainability. Governments should enact policies that can enable sectoral growth to provide clean and efficient cooking technologies that ensure health, climate and gender impacts. International policymakers and donors can support this process through capacity-building of government officials and providing resources to both public and private cookstove and fuels stakeholders.

## Policy recommendations

About half of the world's people cook their meals and heat and light their homes, using dangerously polluting fuels and devices, with tragic consequences: 4 million dead each year, just from breathing in smoke from fires lit for cooking alone. Most of them are women and children. These deaths are preventable. So too are the countless hours lost to gathering wood, and the significant contribution to atmospheric warming made by pollution from all household combustion. Achieving the 2030 objective requires providing clean cooking facilities to around 3 billion people. The greatest challenge is delivering clean solutions in rural areas, where 1.8 billion people are projected to remain reliant on the traditional use of biomass at the current level of investment. (IEA, 2017)

1. **Future policies should focus on scaling up cooking fuels and technologies that are clean for health, as defined by the WHO Guidelines, to ensure maximum benefits from the energy transition.** Where clean cooking fuels and technologies are reliably and affordably available, they should be scaled up with the help of enabling government policies and investments that support enterprise growth.
2. **During the process of shifting to exclusive use of clean cooking fuels and technologies, transitional options that can provide some health and environmental benefits should be promoted**. In order to ensure that these transitional fuels and technologies are as clean as possible, the performance of these options should be verified with laboratory and field testing.
3. **Governments should increase investments to accelerate the adoption of clean-cooking solutions and overcome barriers such as liquidity constraints, limited access to clean alternatives and poor reliability of clean fuel delivery and availability**. A cumulative US$ 42 billion in investment, the equivalent of around US$ 3 billion per year, is needed to achieve universal access by 2030.
4. **Governments should encourage multi-sectoral coordination and action between health, climate and energy sectors.** A multi-sectoral approach is critical to shift the needle on universal clean-cooking access. Mainstreaming clean-cooking solutions will help ensure they have high impact in these areas, as well as on women's empowerment and livelihoods.

## REFERENCES

Bhatia, Mikul; Angelou, Niki. 2015. Beyond connections—energy access redefined Energy Sector Management Assistance Program (ESMAP). Washington, D.C.: World Bank Group

IEA (International Energy Agency) (2017), *Energy Access Outlook: World Energy Outlook Special Report*, OECD/IEA, Paris.

PMUY, (2018) *Pradhan Mantri Ujjwala Yojana* (2018), Ministry of Petroleum and Natural Gas, Government of India, New Delhi. Available online at http://www.pmujjwalayojana.com/. WHO (2016), *Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Well-being of Women and Children*. Geneva. Retrieved from http://www.who.int/indoorair/publications/burning-opportunities/en/

WHO (2014), *WHO indoor air quality guidelines: household fuel combustion*. Retrieved from http://apps.who.int/iris/handle/10665/141496

WHO (2017), *World Health Statistics 2017: Monitoring health for the SDGs,* WHO, Geneva.

# POLICY BRIEF #3

## SUBSTANTIALLY INCREASE THE SHARE OF RENEWABLE ENERGY IN THE GLOBAL ENERGY MIX

## Developed by

International Renewable Energy Agency (IRENA), United Nations Economic Commission for Africa (UNECA), United Nations Economic and Social Commission for Western Asia (UNESCWA), United Nations Economic Commission for Europe (UNECE), International Energy Agency (IEA), Federal University of Rio de Janeiro, REN21, World Bank and Federal Ministry for Economic Cooperation and Development (BMZ), Germany*

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## KEY MESSAGES

### Status of renewable energy and progress towards achieving SDG 7.2

- The energy sector needs to undergo an accelerated transformation towards a zero-carbon energy system by the second half of this century. Accounting for two-thirds of the world's greenhouse gas (GHG) emissions, the energy sector presents a large opportunity to combat climate change through a shift towards renewable energy. In addition, increasing the share of renewables would lead to US$ trillions in economic growth (IRENA, 2017c). The health, environmental and climate benefits would save up to six times more than the additional costs associated with reconfiguring the energy sector, while creating millions of jobs in the process, and improving the health and well-being of people, in line with the Sustainable Development Goals (IRENA, 2017c).
- The world is currently not on track to achieve the SDG 7 renewable energy indicator 7.2.1 (IEA, World Bank, 2017). Significant additional efforts are needed to achieve the needed acceleration.
- The share of renewables in total final consumption (TFEC) grew marginally in 2015 to reach 17.5 per cent, up from 16.7 per cent in 2010 (IEA and World Bank, forthcoming).
- Renewable energy represented about 22.8 per cent of global electricity generation in 2015, with the rest generated by fossil fuels and nuclear.
- Action on energy use for heating and transport is lagging, with a limited increase in renewable energy shares seen in recent years.

### Priority actions over the next four years

- The renewables share in power generation should grow to 60 per cent by 2030. Rapidly declining costs suggest this is an economically and technically feasible task (IRENA, 2017c).
- Efforts must be strengthened in end-use sectors, particularly in buildings, industry and transport. Sector coupling through the increased electrification of these sectors will increase the use of renewables, improve system flexibility, and improve overall energy efficiency.
- Increased focus is needed on enabling technologies, including a major ramp-up in the production of batteries for transport and static storage.
- Energy sector reforms are required to strengthen the role of electricity regulatory agencies, advance flexible financing mechanisms and incentives and promote smart grid technologies.

### Priority actions towards 2030

- Energy system integration through direct and indirect electrification should be facilitated through policy and regulatory action. Market design for the power sector needs structural modifications.
- Renewable energy and energy efficiency measures need to be accelerated and pursued in tandem. Together, they will account for 90 per cent of the decarbonization needed to stay within the Paris Agreement boundaries (IRENA, 2017c).
- Higher R&D investment is needed for those sectors where options are currently lacking, particularly for transport, manufacturing and buildings (IRENA, 2017a).
- The sharing of experiences and lessons learned, through regional cooperation and other formats, to facilitate the exchange of lessons learned needs to be expanded and strengthened.
- The progress of renewable energy deployment needs to be continuously tracked while improving the quality of data and indicators.

## Renewable energy and the sustainable development goals

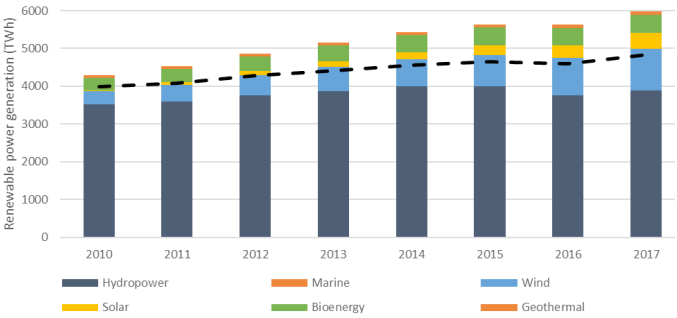
The energy sector—largely based on fossil fuels—needs to undergo an accelerated transformation towards a zero-carbon energy system by the second half of this century. The Paris Agreement endorsed the goal of keeping average temperature increases to no more than 1.5 Celsius, and this implies remaining within the limits of the remaining carbon budget. Accounting for two-thirds of the world's greenhouse gas (GHG) emissions, the energy sector presents a large opportunity to combat climate change through a shift towards renewable energy. In addition, increasing the share of renewables would lead to US$ trillions in economic growth over the next few decades (IRENA, 2017c). The health, environmental and climate benefits would save up to six times more than the additional costs associated with reconfiguring the energy sector, all while creating millions of jobs in the process and improving the health and well-being of people in line with the Sustainable Development Goals (IRENA, 2017c).

### Current status

- Renewable electricity has made significant progress, accounting for well **over 50 per cent of global power capacity additions** in recent years (IRENA, 2018a). Biomass for power, hydropower, geothermal, solar photovoltaic (PV) and onshore wind technologies can all now provide electricity that largely falls within the range of generation costs for fossil fuel–based electricity, increasingly undercutting these (IRENA, 2018b).
- However, in 2016, over 80 per cent of TFEC still came from fossil fuels. The share of renewables in TFEC grew marginally in 2015 to reach 17.5 per cent, up from 16.7 per cent in 2010 (IEA and World Bank, forthcoming). Within the power generation sector, renewables account for 25 per cent (see figure 3.1).
- Because about half of the renewable energy share is in traditional forms of bioenergy, **modern renewable energy accounts for 10 per cent of TFEC**. Under a business-as-usual evolution, this would grow to a 17 per cent[4] share in 2030. Traditional uses of bioenergy must be phased out and replaced, meaning that the increase in modern renewables deployment would need to be even higher.
- The results of the 2017 Global Tracking Framework (GTF) report indicate that the world is not on track to achieve the SDG 7 renewable energy indicator 7.2.1 (IEA, World Bank, 2017) and business-as-usual projections suggest limited growth acceleration till 2030 (IEA, 2017a). Therefore, significant additional efforts are needed.
- Such acceleration is technically and economically feasible but requires strong and concerted action (IRENA 2017c).
- The challenge is to increase the share of renewable energy in the heat and transport sectors, which together account for 80 per cent of global energy consumption.

Figure 3.1:

**Renewable power generation (TWh) and share of total electricity**




Source: IRENA, 2017f

### Projects

The results of the 2017 Global Tracking Framework (GTF) report indicate that the world is not on track to achieve the SDG 7 renewable energy indicator 7.2.1, and most business-as-usual projections suggest limited growth until 2030 (IEA, 2017a).

To substantially increase the share of renewables, growth needs to take place across the spectrum of energy use—not just in the power sector. According to the IRENA Remap analysis, the share of modern renewables in TFEC stood at 10 per cent in 2015 and will increase to around 20 per cent by 2030 under business as usual (IRENA, 2018a). Other analyses show a similar increase to between 18–20 per cent over the period under business as usual (IEA, 2017a).

IEA's Sustainable Development Scenario (IEA, World Energy Outlook, 2017) illustrates that increasing the share of renewables is a key measure for achieving the three critical energy sector goals: an early peak in energy-related CO2 emissions, universal access to modern energy by 2030 and improving energy-related air pollution. In this scenario, the share of renewables in TFEC reaches 23 per cent by 2030 and 21 per cent if just modern renewables are considered, significant scale-up compared with the 15 per cent penetration of modern renewables that current and planned policies would achieve. Achieving these levels requires an accelerated penetration of renewables across all sectors of power, modern heat and transport. In addition, delivering universal access to clean cooking by that time would remove the vast majority of traditional biomass.

The highest growth will be seen in the power sector, where

4 *3.6 per cent annual growth rate*

renewables would increase from 25 per cent of global electricity generation in 2017, to over 60 per cent by 2030 in a high-renewables scenario (IRENA, 2017c). However, progress on energy consumption for heating and transport is lagging. The share of renewables has increased by half a percentage point over the last five years (2010-2015) in both sectors: From 8.1 per cent to 8.6 per cent in *modern* heat and from 2.6 per cent to 3.1 per cent in transport (IEA, 2017b). A scale-up of the overall renewable energy share in TFEC must also include significant increases in the renewable energy share in the end-use sectors (residential and commercial buildings, manufacturing industry, and transport). Sector coupling through electrification will enable a significant increase in the rate of renewables deployment in these demand sectors, while simultaneously providing the energy flexibility needed to operate the power system with high shares of renewables.

The energy transition is technically and economically feasible; energy and climate policies have unlocked cost reductions (IRENA, 2018b), and technology improvements have opened the door to an energy transformation that makes economic sense. Over the past seven years, solar PV module prices dropped by over 80 per cent, and wind turbine prices fell by around 40 per cent to 55 per cent depending on the market. The global weighted average levelized cost of electricity (LCOE)[5] from solar PV fell by 73 per cent between 2010 and 2017 to US$ 0.10/kWh, while for onshore wind it fell by 23 per cent to US$ 0.06/kWh. The outlook for solar and wind electricity costs to 2020, based on the latest auction and project-level cost data, points to the lowest costs yet seen for these modular technologies, which can be deployed around the world. As a result, by 2020 all the renewable power generation technologies that are now in commercial use are expected to fall within the fossil fuel cost range, with most at the lower end or undercutting fossil fuels.

### How to fill the gap to enable substantial increases in renewable energy share

New challenges and opportunities call for a shift in policy and regulatory focus. Integrating the growing share of variable renewable energy (VRE) requires changes in power system planning and operations, and the rise of distributed generation is challenging conventional actors and business models. To capitalize on the opportunities, adjustments are required in physical infrastructure, power market design, system regulations, and operating procedures (IRENA, 2017e). Furthermore, policymaking should consider the wider ecosystem in order to ensure that the energy transition is a just and timely one. This requires enabling all stakeholders to participate, especially communities.

Deploying in tandem renewable energy (RE), energy efficiency and energy flexibility, greatly facilitates this process, reducing the requirements for RE deployment, increasing the rate of RE-share progression, and providing the tools needed to operate a RE-based energy system.

Enabling the transition with the required RE deployment rates requires going beyond the conventional techno-economic context to fully address all the transition's socioeconomic implications. Success in delivering the transition depends on effectively engaging all the stakeholders and society, which requires addressing fair and just transition considerations, holistic and inclusive access, and materializing (and properly sharing) its full welfare potential.

## Policy actions

1. **Increase substantially the share of renewable energy in power generation, which will also require policy and regulatory actions for end-use sectors** (based on IRENA, IEA, REN21 (2018))

In the **power sector**, RE has made significant progress recently and the transformation is well under way. With the right mix of policies, the share of RE-based power generation could increase from the current 25 per cent to up to 60 per cent by 2030. Renewable generation policies aim to translate high-level targets into concrete projects and installations. By 2017, 150 countries had adopted renewable electricity generation targets. Building on these targets, 126 countries had implemented renewable energy policies and regulations in the power sector. Key policies that enable the translation of renewable energy targets into concrete actions range from quotas and mandates (e.g., renewable portfolio standards or renewable obligations), to feed-in policies (e.g., administratively set feed-in tariffs/feed-in premiums, market-set pricing through auctions, and net metering) and fiscal and financial incentives (e.g., tax incentives and rebates).

Choices of policy instruments, and their design, need to be tailored to the specific country context, taking into account the state of the energy market, technology, and specific objectives to be achieved. Over time, policy instruments need to adapt to changing market conditions such as the falling cost of technology and potential challenges related to the integration of variable renewable energy.

However, electricity only makes up 20 per cent of TFEC and to meet the SDG target, substantial efforts are needed to scale-up RE share in **end-use sectors,** particularly addressing the areas of heating/cooling and transport.

In heating, policies to support renewables are country and location-specific. District heating using biomass or geothermal can be incentivized through **public investment in networks** and supported by **heat zoning, taxes on fossil fuels and financial incentives for renewables** (e.g., Denmark). **Grants or tax incentives** can help bridge cost gaps with gas, where they exist, by **subsidizing the**

[5] All the LCOE numbers in this section exclude the impact of any local or federal financial support policies, are for the year of commissioning and are based on IRENAs Renewable Cost Database, which contains cost and performance details of 15,000 utility-scale power-generation projects.

**higher capital costs of renewable options** (e.g., UK). **Grants and subsidies** can also support the greater deployment of renewables for industrial heat (e.g., Brazil, India and South Africa). **Carbon taxes** are deployed in some countries, although currently at a low level. Finally, solar water heaters can be incentivized though **rebate programmes** with **free installations for low-income households** (e.g., South Africa), **mandates** and **building codes** (India and Brazil) and **financial incentives** (e.g., countries in MENA). (IRENA, IEA, REN21, 2018)

In the transport sector, the **removal of fossil fuel subsidies** is a prerequisite for decarbonization through greater use of biofuels and electric vehicles (EVs). **The production, distribution and use of biofuels** can be encouraged through **biofuel obligations/mandates** (adopted in 67 countries as of 2017), tax exemptions for biodiesel production (Argentina, Sweden) and R&D and demonstration programmes (e.g., a trial programme for the use of B20 in trucks and B10 for military/government use in Thailand). **Support for the purchase and use of EVs mostly consists of tax incentives and purchase subsidies.** The global EV fleet doubled to 2 million in just one year, 2016 (IRENA, 2017b) and (IRENA, IEA, REN21, 2018).

In addition, the **electrification of other end-use sectors** such as buildings, and various industries offers the potential to further accelerate the pace of RE deployment while also supporting the objective of improving system flexibility (through sector coupling). Buildings will need to become much more energy efficient and rely largely on electricity for heat (IRENA, 2017a). Smart charging technologies and other measures can help limit peak demands on the system through end-use electrification.

2. **Market design for the power sector needs to be structurally modified to properly deal with a renewables-based electricity system, including the effective articulation of distributed energy resources**

Accelerating this transition requires a rethinking of many aspects of electricity markets. Adjustments are required in power market design, system regulations and operating procedures.

Some of these relate to physical infrastructure, and others are defined by market design and regulation. In particular, markets need to adapt their design and operations to support flexibility measures for storage, demand-side management, and the integration of higher shares of variable renewables, as well as the key role of distributed power generation.

For the integration of renewables, the design of the wholesale markets (day-ahead and intra-day markets), balancing markets, and long-term investment signals should be reinforced. Increasing the time granularity of energy trading and reducing the minimum size of energy products could be some of the options to better represent variable renewables and increasing flexibility in the system. The balancing market should be designed to provide accurate incentives for renewables and other flexibility service providers. In the context of the long-term support, one of the options could be to incorporate transition-focused capacity mechanisms and/or premium tariffs as potential tools for complementing the energy market revenues (IRENA, 2017e).

Regulators should allow distribution companies to interact more often with distributed energy resources or aggregators to efficiently manage network constraints by facilitating the participation of distributed flexibility resources into energy markets, thereby promoting an increase in RE shares. Regulators should enable new streams of revenue for distribution operators, allowing them to have a more active involvement in the transition while simultaneously introducing performance-based economic regulation addressing total system costs (IRENA, 2017e) and (IRENA, IEA, REN21, 2018).

3. **Pursue simultaneous and synergetic deployment of renewable energy and energy efficiency as interrelated technical transition pillars**

A holistic approach is required when planning for the energy transition and the increase of renewable energy shares. Policymakers need to pursue renewable energy and energy efficiency in parallel. When both are pursued in tandem and synergies are exploited, the result is a faster decarbonization of the energy system. Greater efficiency is essential because it reduces overall energy demand and therefore the requirements for RE deployment.

In fact, accelerated energy efficiency is expected to raise the share of renewable energy in 2030 by 15 per cent according to one study (IRENA, 2017g). Renewable energy and energy efficiency offer roughly the same amount of carbon mitigation potential through to 2030, but only when in synergy with each other. Policymakers should adopt integrated policies to ensure that synergies between energy efficiency and renewables are maximized and the risk of policies working against each other is avoided (IEA, World Energy Outlook, 2017).

4. **Need for a broader enabling environment**

Energy policymaking needs to consider socioeconomic dimensions to maximize benefits for welfare and prosperity and to achieve a transition in a just and timely manner. This requires not only **aligning private- and public-sector policies,** but also proper articulation and effective participation of all stakeholders.

The transformation must be aimed at enabling active social involvement in energy system planning and operation, creating new businesses and jobs, pursuing a just transition and helping citizens and industries to flourish by providing additional economic opportunities to increase wealth (IRENA, 2017a), while respecting climate and sustainability constraints.

Business models must therefore be tailored to ensure the fair sharing of benefits and responsibilities among different stakeholders. Regulations also need to enable small and distributed power generators to be able to participate in the power market.

However, beyond the design of business models, direct and effective social involvement is a cornerstone for successful energy system transition, substantially increasing the shares of renewables, and we are lagging well behind in this dimension.

Community-based direct participation in the energy system, both through the deployment of distributed generation and its contribution to sourcing the required energy flexibility, holds a huge potential for increasing renewables shares.

Social financing can also play a major role in renewables deployment by aligning economic resources with the transition requirements, facilitating energy access, and articulating compensatory mitigation contributions to address the fair share of transition burdens.

5. **Technological R&D funding and technological improvement**

- Innovation has played a critical enabling role in progress towards the SDG 7 targets, by reducing costs and enhancing the capabilities of technologies such as solar, wind and energy storage. Significant further innovation is needed, however, in many aspects of the energy system if we are to markedly accelerate the energy transition.
- As the technology to drive the transformation in the energy sector develops and reaches commercialization, the next stage to scale-up renewable energy shares requires the integration of these technologies in dynamic energy systems. Technology innovation needs to be complemented by innovation in systems design, processes, market design and business models in order to accelerate the diffusion and broaden the uptake of innovations.

## Interlinkages with other SDGs

With a holistic approach to policymaking, the global energy transition will fuel economic growth, create employment opportunities, enhance welfare benefits, and help achieve a number of other SDGs. Global GDP could be boosted around 1.4 per cent in 2030 (US$ 1.7 trillion), with the cumulative gain from now to 2030 adding up to US$ 10.3 trillion (IRENA, 2017c). Renewables also improve welfare in ways that are not captured by GDP (almost 5 per cent welfare improvement, compared to reference case, such as reduced health impacts from fossil fuel combustion (IRENA, 2017c) (IRENA, 2016b). Increased energy access enables additional gains, including sustainable livelihoods, social inclusion, gender equality and better quality of life. To achieve universal electricity access by 2030, the pace of expanding access needs to at least double, and estimates suggest that off-grid solutions, for which renewables are increasingly the most cost-competitive option, will provide roughly 60 per cent of the additional generation needed (IRENA, 2016a).

The transformation to a sustainable energy system with a high share of renewables would meet climate goals, and also significantly reduce local air and water pollution. Health, environmental and climate benefits would offer a savings equivalent up to as much as six times the additional costs associated with reconfiguring the energy sector, all while creating millions of jobs in the process (IRENA, 2017c; IRENA, 2017d). Renewable energy also reduces the pressure on water and energy resources. Its use can stimulate economic activity along the agri-food supply chain, reduce losses and enhance food productivity, and provide the energy needed for water pumping and distribution, and food storage and processing (ESCWA, 2016).

Boosting the share of renewables thus holds great potential for addressing the climate and environmental challenge. Doing so not only promises economic gains, but would also help the global community to translate several of the SDGs into reality and thus secure a broad range of important socioeconomic benefits.

## REFERENCES

Credit Suisse (2017) *Global Wealth Report 2017*, Credit Suisse Research Institute, Zurich, ECREE (ECOWAS Centre for Renewable Energy and Energy Efficiency) (2015), *West African Clean Energy Mini-Grid Market: Current Situation and Perspectives*, ECREE, Cape Verde, http://www.ecreee.org/sites/default/files/events/west_african_clean_energy_mini-grid_market_current_situation_and_perspectives_-_nicola_bugatti_se_expert_ecreee.pdf

ESCWA (United Nations Economic and Social Commission for Western Asia) (2016), *Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals - Regional Policy Toolkit*, UN ESCWA, Beirut, https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/water-energy-nexus-regional-policy-toolkit-english_0.pdf

Frankfurt School-UNEP Centre/BNEF (2017): *Global Trends in Renewable Energy Investment 2017,* http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf

IEA (International Energy Agency) and the World Bank, *Global Tracking Framework* (2018 forthcoming).

IEA (International Energy Agency) and the World Bank (2017), *Sustainable Energy for All 2017—Progress toward Sustainable Energy*, World Bank, Washington, DC.

http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_full_report_for_web_0516.pdf

IEA (International Energy Agency) (2017a), *World Energy Outlook*, OECD/IEA, Paris, https://www.iea.org/bookshop/750-World_Energy_Outlook_2017

IEA (International Energy Agency) (2017b), *World Energy Statistics and Balances*, 2017, www.iea.org/statistics/.

IRENA, IEA, REN21 (2018), Renewable energy policies in a time of transition (forthcoming).

IRENA (International Renewable Energy Agency) (2018a), *The Energy Transition: View to 205*0 (forthcoming)

IRENA (International Renewable Energy Agency) (2018b), *Renewable Power Generation Costs in 2017,* IRENA, Abu Dhabi, http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017

IRENA (International Renewable Energy Agency) (2017a) *Accelerating the Energy Transition through Innovation*, IRENA, Abu Dhabi, http://www.irena.org/publications/2017/Jun/Accelerating-the-Energy-Transition-through-Innovation

IRENA (International Renewable Energy Agency) (2017b), *Electric Vehicles technology brief*, IRENA, Abu Dhabi http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/IRENA_Electric_Vehicles_2017.pdf

IRENA (International Renewable Energy Agency) (2017c), [Executive Summary/Chapter [3/4]] of *Perspectives for the Energy Transition: Investment Needs for a Low-Carbon Energy System,* IRENA and International Energy Agency (IEA), Abu Dhabi, www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf

IRENA (International Renewable Energy Agency) (2017d), *Renewable Energy and Jobs: Annual Review 2017*, IRENA, Abu Dhabi, http://www.irena.org/publications/2017/May/Renewable-Energy-and-Jobs--Annual-Review-2017

IRENA (International Renewable Energy Agency) (2017e), *Adapting market design to high shares of variable renewable energy*, IRENA, Abu Dhabi, www.irena.org/publications/2017/May/Adapting-Market-Design-to-High-Shares-of-Variable-Renewable-Energy

IRENA (International Renewable Energy Agency) (2017f), 'Global Overview on Renewable Energy Capacity and Electricity Generation'. IRENA, Abu Dhabi. http://resourceirena.irena.org/gateway/dashboard/?topic=4&subTopic=17

IRENA (International Renewable Energy Agency) (2017g), 'Synergies between renewable energy and energy efficiency'. IRENA, Abu Dhabi. http://www.irena.org/publications/2017/Aug/Synergies-between-renewable-energy-and-energy-efficiency

IRENA (International Renewable Energy Agency) (2016a), Innovation Outlook: Mini-grids, IRENA, Abu Dhabi, http://www.irena.org/publications/2016/Sep/Innovation-Outlook-Renewable-mini-grids

IRENA (International Renewable Energy Agency) (2016b), *Renewable energy benefits: measuring the economics*, International Renewable Energy Agency (IRENA), Abu Dhabi, http://www.irena.org/publications/2016/Jan/Renewable-Energy-Benefits-Measuring-the-Economics

REN21 (2017), Renewables 2017 Global Status Report, REN21 Secretariat, Paris, http://www.ren21.net/wp-content/uploads/2017/06/17-8399_GSR_2017_Full_Report_0621_Opt.pdf

SE4All (Sustainable Energy for All—The Africa Hub) (2017), *Green Mini-Grids Market Development Programme*, https://www.se4all-africa.org/se4all-in-africa/regional-initiatives/green-mini-grids/

# POLICY BRIEF #4

## DOUBLING THE GLOBAL RATE OF IMPROVEMENT IN ENERGY EFFICIENCY


## Developed by

UN Environment, Copenhagen Centre on Energy Efficiency, International Energy Agency (IEA)

## In collaboration with

UNECE, UNESCWA, UNIDO, Federal University of Rio de Janeiro and FIA Foundation

## KEY MESSAGES

### Status of energy efficiency and progress towards achieving SDG 7 objectives

- Improving energy efficiency is critical to achieving all the Sustainable Development Goals. For example, reducing electricity waste (SDG 12) by appliances and equipment means that utility companies can offer electricity to more clients without having to build additional power plants. This helps to keep electricity affordable and reliable (SDGs 1, 7 and 8), which is essential for storing food and medicines (SDGs 2 and 3), running competitive businesses (SDGs 8 and 9), and keeping homes, schools and cities well-lit, comfortable and efficient (SDGs 3, 4 and 11). In turn, growth in air pollution and greenhouse gas emissions are mitigated (SDGs 13 and 15).
- Doubling the global rate of energy efficiency progress is a key enabler of the sustainable energy transition. Every unit of energy saved lowers the energy requirements for renewables expansion and universal access provision. The IEA's Sustainable Development Scenario, which achieves universal access to modern energy by 2030, significantly reduces the damage caused by both indoor and outdoor air pollution, and puts the global energy system on track to achieving the Paris Agreement. The scenario shows energy efficiency accounting for 44 per cent of the cumulative greenhouse gas emissions reductions by 2040 (IEA, 2017).
- About 90 per cent of the Nationally Determined Contributions submitted under the Paris Agreement mention energy efficiency (REN21, 2016). While many countries have put concerted energy efficiency programmes in place, the current rate of global energy efficiency progress falls far short of the annual rate of 2.7 per cent needed between now and 2030.

### Priority actions

- Well-designed, -implemented, and -enforced energy efficiency policies and action plans, including building codes for residential and commercial facilities with energy performance requirements for new construction and major renovations, minimum energy performance standards and labels for electric and electronic products and vehicles, and ambitious sectoral policy approaches, recognizing the multiple development benefits of energy efficiency.
- Combined action on energy efficiency and certain refrigerant gases Significant opportunities for action towards energy efficient cooling and environmentally sound air conditioning exist under the global policy mandate provided by the Kigali Amendment to the Montreal Protocol.
- Robust energy efficiency data collection systems, energy efficiency indicators and clearly defined metrics will help policymakers understand the current state and trajectory of energy use in their economies (including at the subnational level, and by different sectors and end uses), enabling them make informed policy decisions and investments.
- Improve progress in supply-side efficiency: Significant supply side energy efficiency gains are largely untapped in electricity generation, transmission and distribution.
- Maintain global attention and advocacy on energy efficiency as a priority development action area, energy sector reforms, including through capacity-building and empowerment of non-state actors and public stakeholders.
- Develop cost-reflective energy tariffs, and reform damaging fossil fuel subsidies both in energy consumption and energy supply.
- Mainstream energy efficiency procurement and facilitate private sector investment in energy efficiency through training and capacity-building at all education levels.
- Pursue integrated systems approaches on energy efficiency across sectors as a package together with renewables and energy access, acting at the city and country level.

## ENERGY EFFICIENCY AND THE SDGs

### Energy efficiency—more recognition and political will

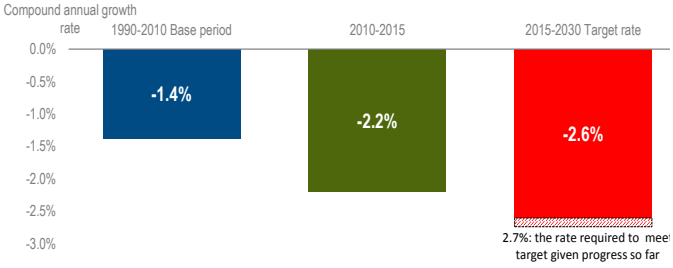
The importance of energy efficiency is increasingly recognized in countries' low-emission and sustainable development strategies and policymaking. There is a surge in adoption of energy efficiency targets and policies, especially in developing countries. Out of the 189 countries that submitted INDCs, 147 countries mentioned renewable energy, and 167 countries mentioned energy efficiency (REN21, 2016). Among the NDCs submitted by developing and emerging economies, 79 included energy efficiency targets (REN21, 2017). About 31.5 per cent of global final energy use is now covered by mandatory policies, which are most effective in improving overall energy efficiency levels, up 17 percentage points since 2005 (IEA, 2017).

By the end of 2016, at least 137 countries had enacted some kind of energy efficiency policy, and at least 149 countries had enacted one or more energy efficiency targets. Of these countries, 48 enacted a new or revised policy in 2016, and 56 countries adopted a new target in 2015 or 2016 (REN21, 2017). Many countries are also taking substantive energy efficiency actions in their effort to reduce urban air pollution, thereby creating local jobs, as well as improving national energy security.

Another boost to global commitments towards energy efficiency improvement came in October 2016, after a historic amendment to the Montreal Protocol to phase down hydrofluorocarbons, climate-harming greenhouse gases mainly used in air conditioning and refrigeration. Philanthropic funds dedicated US$ 53 million to help developing countries move faster towards energy efficient and climate-friendly cooling and air conditioning so as to double the climate benefits.

Figure 4.1

**Change in global primary energy intensity relative to target**




Source: IEA Energy Balances database (2017)

### Progress towards achieving the SDG 7 energy efficiency target

Globally, the energy efficiency improvement rate has been accelerating towards the SDG target for energy efficiency, that is, to double the global rate of improvement in energy efficiency by 2030. Global energy intensity—measured as the amount of primary energy demand needed to produce one unit of gross domestic product (GDP)—declined by 2.2 per cent on average from 2010 to 2015. While this progress is encouraging, more needs to be done to reach the overall SDG 7 target for energy efficiency improvement by 2030.

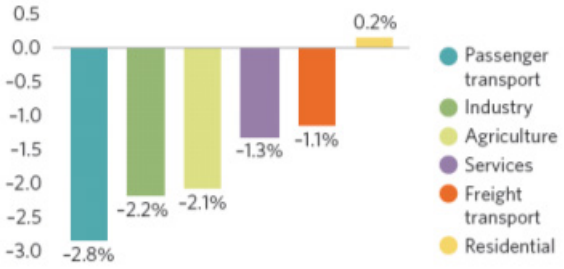
Energy intensity levels in different countries vary widely, depending on their economic structure and development, technology status, and energy mix. Some low-income countries and oil-exporting countries have high primary energy intensity due to their reliance on traditional biomass use and oil dependence, while some developed countries like Denmark, the UK and Japan, have lower primary energy intensity.

In the majority of developed countries, peak energy use occurred between 2005 and 2010. Total energy demand for OECD countries as a whole peaked in 2007. This means that despite these countries' economy growth and income increase, their energy use is no longer increasing. While the majority of countries have declining primary energy intensity, some countries in Africa and South America are seeing an opposite trend. There are also major differences in the energy intensity changes among the big energy consuming countries and regions. For example, in 2016, energy intensity declined by 2.9 per cent in the United States and by 1.3 per cent in the European Union, while China's primary energy intensity fell by 5.2 per cent, making it the country with the biggest energy efficiency improvement. Without China, the decrease in global intensity in 2016 would have been only 1.1 per cent (IEA, 2017).

Among the major energy-consuming sectors, industry is the most important contributor to declining global energy intensity, with an annual reduction of 2.2 per cent in 2012–2014. The residential sector had a small increase in energy intensity (measured in energy consumption per capita) (See figure 4.2). In transport, the progress is encouraging, as widespread diffusion of fuel efficiency standards helped accelerate reductions in energy intensity (measured in energy consumption per passenger-km or ton-km), with passenger transport progressing at 2.8 per cent a year, compared with just 1.1 per cent a year for freight transport. The strongest improvements in the transport sector are seen in passenger buses (4.8 per cent a year since 2010) and sea freight (3.7 per cent) (World Bank and IEA, 2017). Buildings have a long use life, and their energy performance has a high impact on the overall energy efficiency level of service and residential sectors. Given the fact that 36 per cent of global final energy use is consumed in buildings, there is a strong need to improve the energy efficiency of buildings.

Figure 4.2:

**Relative improvement in final energy intensity by end-use sectors, 2012–2014** (*Compound annual growth rate of final energy intensity, per cent)*




Source: World Bank and IEA, Global Tracking Framework 2017 - Progress Toward Sustainable Energy

### Multiple benefits of energy efficiency

Energy efficiency interventions have multiple benefits that are often not taken into account when designing policies aimed at meeting one objective. At the whole economy level, cost-effective energy efficiency investments boost economic growth, by improving business productivity and increasing consumers' disposable income.

Some energy efficiency measures have impacts that cut across many areas. For example, efficient building refurbishment programmes can reduce fuel poverty, improve indoor air quality and tackle chronic health conditions, cut carbon emissions, reduce fuel imports, improve energy system reliability, regenerate neighbourhoods, increase asset values and, during the investment phase, provide local employment opportunities.

### Efficiency and smart systems

"Smart" energy solutions can help reap the benefits of energy efficiency faster and at larger scale. Use of information and communications technology (ICT) to improve energy management is growing across the value chain. From smart generation and distribution (grids), to smart building and home systems and smart mobility, technology options are commercializing and reaching wider markets, utilizing advanced mobile telecommunication and Wi-Fi applications.

### Behaviour and behavioural change

Despite the faster deployment of energy efficient technologies, human behaviour underpins the effectiveness of policies and measures. A smart home avoids wasting energy only if its owner utilizes the features controlling energy use. The mere fact the technologies (such as efficient appliances, thermostats or controls) are installed is not enough. For example, a homeowner who leaves the heating or cooling on when away from home does not achieve any energy efficiency gains.

### Myths

"If energy efficiency really was so cheap, it would happen anyway." Some energy efficiency progress does take place without government intervention. In the most energy intensive industries, more (although not all) available cost-effective efficiency options are taken up, but other sectors suffer from market failures related to lack of information, misaligned incentives, the bounded rationality of consumers, and energy prices that do not take into account the full societal costs of energy consumption, lead to a significant underinvestment in energy efficiency (Brown 2001; Gerarden et al., 2015).

"Energy efficiency is only for developed countries." The cost of energy efficient technologies is decreasing at a fast rate, largely due to commercial deployment at scale. Multiple energy efficiency financing options are now available.

### Measures to fill the energy efficiency gap

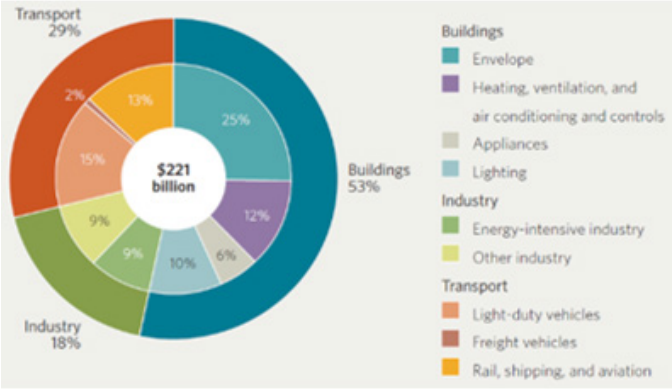
Doubling the global rate of energy efficiency improvement by 2030 would require more and faster energy efficiency action by 2030, to catch up on the lag caused by the slow energy efficiency improvements since 2010. Despite 2012–2014 being slightly better than 2010–2012, rapid development in developing countries and emerging economies implies a need to act now to avoid lock-in of inefficient technologies.

Some of the policies being used to promote energy efficiency include: minimum (mandatory) energy performance standards and labelling schemes; competitive tenders and procurement; fiscal policies; building codes; regulation and pricing; research schemes towards innovation; and advocacy and awareness campaigns. Energy efficiency policies are being implemented in an increasing number of developing countries and emerging economies.

Relatively low energy prices can pose a risk to the continued improvement of energy efficiency, lowering the economic attractiveness of saving energy and investing in energy efficiency.

Figure 4.3

**Global incremental investment in energy efficiency by sector and subsector (2015)**




Source: IEA, Energy Efficiency Market Report 2016

## Policy implications and recommendations

### Energy efficiency in energy access

Energy efficiency has an important role to play in delivering universal access to electricity and clean cooking. More efficient appliances enable constrained electricity grids to provide power for more energy services, and can significantly improve the affordability of off-grid renewable systems.

Compared to a bundle of appliances (four light bulbs, television, fan and refrigerator) with a standard level of efficiency, highly efficient appliances, used with off-grid solar, would save households an average of US$ 150 per year. The additional costs associated with efficient products can be paid via mobile phone as part of a general energy service package (IEA, 2017a).

More generally, there is a role for government in supporting a market transformation towards more efficient products through the use of minimum energy performance standards on new and imported goods, and raising awareness through labelling programmes and other information policies.

### Energy efficiency in renewable energy deployment

Energy efficiency and renewable energy targets are inextricably linked, with progress in either area making it easier to meet both targets.

Faster progress on renewables reduces the world's primary energy intensity. Faster progress on efficiency means that less renewable energy deployment is needed to improve the share of renewable energy in total final energy consumption. Given the relative cost-effectiveness of energy efficiency interventions, making progress on efficiency is particularly important in reducing the overall costs of sustainable energy development. In this context, there is a key role for government in considering energy efficiency policies in connection with renewable and wider energy systems policies. In many cases, a ramp up in energy efficiency ambition would be the most cost-effective strategy to pursue first.

Recent examples where energy efficiency and renewable energy are integrated in policymaking include the EU Nearly Zero Energy Building Directive (2012), the Mexican Sustainable Housing Programme (2016) and the Indian Energy Conservation Building Code (2017).

### Barriers, drivers and enablers

Governments play a crucial role in creating enabling environments for energy efficiency deployment. This section lists key top-down measures that can help overcome the main hindrances to full energy efficiency development.

Energy pricing reforms through the adoption of market-oriented principles, progressive pricing, and the removal of fossil fuel subsidies are some of the strongest tools to align market signals with environmental goals.

Global fossil fuel subsidies were on the order of US$ 5.3 trillion in 2015, or 6.5 per cent of global GDP, according to the IMF (Cody et al., 2015). Fossil fuel subsidies are 3.5 times larger than the financing required to meet the SDGs for basic social protection, universal health and education.

Energy efficiency at scale requires aggregation of many small energy savings, which taken individually usually translate into small-size investments and proportionately high associated transaction costs, discouraging financial institutions to consider such investments. Governments can lead by example by mainstreaming energy efficient public procurement and address the lack of awareness among investors about energy efficiency projects and technologies, high-perceived end-user credit risks, low collateral asset value, high upfront costs and short payback period requirements.

Governments must ensure that sufficient human and financial resources are allocated to all units within ministries, national and regional administrations responsible for the development and enforcement of energy efficiency regulations, secondary legislation and programmes.

Among the most internationally successful implementation policies on energy efficiency is the adoption of minimum performance standards for energy-using products and buildings, together with information to consumers through labelling schemes and building codes that require energy efficiency standards. The potential savings for global regulations on energy efficient products if current minimum energy performance requirements had been harmonized globally would be on the order of 8,950 TWh, equivalent to closing 165 coal-fired power plants, or taking 132 million cars off the road (European Commission, 2015).

Detailed, reliable, timely data collection on energy use in all economic sectors has proven to be critical to the deployment of strategies and policies by governments and facilitation of private investment in energy efficiency, particularly by energy service companies. Moreover, the introduction of energy management systems and follow-up monitoring and evaluation efforts help to raise the transparency of actions and build confidence in energy efficiency as an investment proposition.

To deliver energy efficiency at scale, there is a need to increase capacity-building and the number of qualified workers on energy efficiency. Tertiary education, as well as technical vocational education and training, need to capacitate energy efficiency "white-collar" and "blue-collar" professionals by "greening" existing skills and providing new skills. From national and local government officials to professional practitioners, education associated with the energy transition should receive special attention on the way to the 2030 Global Agenda targets. Training and capacity-building provide an employment pathway towards greener industry, with enhanced engendered training opportunities.

Peer-to-peer exchanges and South-South Cooperation represent knowledge sharing, training and capacity-building options for countries and their experts.

**Multi-stakeholder action and international cooperation**

Energy efficiency action is of interest to various stakeholder groups. It is happening under several overarching multilateral frameworks: the 2030 Development Agenda and its goal on energy, the climate agenda with the 2015 Paris Agreement, $CO_2$ limits for new fleet by the navigation and aviation sectors, and in 2017 the Kigali Agreement on refrigerants.

The Sustainable Energy for All initiative was instrumental in raising the political relevance of energy efficiency as an integral part of SDG 7, and the Global Tracking Framework reports have been maintaining the focus on progress towards the global 2030 energy efficiency target.

Countries have been individually and collectively adopting and enhancing their energy efficiency ambitions through strategies and plans. The ASEAN, G20 and the Clean Energy Ministerial have made energy efficiency a high policy priority.

Partnerships with the private sector aim at enabling faster market transformation for energy efficient products and services. Consumer groups have played important roles in awareness raising efforts, and a significant portion of the target beneficiaries are urban dwellers. Bringing groups together around a shared vision, with complementary action, is necessary to ensure the collective impacts required.

Partnerships and action by subnational and non-state actors

Action by subnational and non-state actors, including regional and local governments and businesses, is key to enhancing future progress on climate and sustainable energy.

The 2017 UN Environment Emissions Gap Report assessment suggests that the aggregated additional impact of the various non-state initiatives is of the order of a few Gt $CO_2$ eq in 2030, over and above current NDCs (UN Environment, 2017). This is potentially a significant contribution to closing the gap. Enhanced monitoring and reporting of non-state actions and resulting emissions reductions be will be essential to making pledged actions transparent and credible.

The Marrakech Partnership for Global Climate Action was launched by the High-Level Champions at the COP22 in 2016 and is designed to structure and enhance coherence of the activities of the various coalitions, initiatives and organizations with a view to mobilizing climate action up to 2020 by parties and non-party stakeholders.

The first Yearbook of the Marrakech Partnership informs parties about what has been achieved during the year by non-party stakeholders, and spotlights how pre-2020 ambition can be accelerated. The Yearbook highlights three key emerging trends:

- Climate action in the context of the Marrakech Partnership is growing and getting more diverse; more non-party stakeholders, subnational governments, businesses and civil society organizations are making commitments and taking action. Many of those actions, in addition to mitigation, relate to increasing resilience.
- Climate action is spreading to the South and has scaled up in the lowest-income countries, facilitated by links with the SDGs and the Sendai Framework for Disaster Risk Reduction.
- Climate action is delivering: initiatives are moving forward from being just commitments on paper and are delivering a variety of outputs and creating the conditions needed to fully meet commitments.

Worldwide, energy efficiency action has to be maintained, scaled up and accelerated for the SDG 7 target on energy efficiency to be attained by 2030, and to deliver throughout the timeframe on a range of multiple benefits across the other SDGs.

## REFERENCES

Brown, M.A. (2001). Market failures and barriers as a basis for clean energy policies. Energy Policy (29) 1197–1207.

Coady, D.; Parry, I.; Sears, L.; Shang, B. (2015). How large are Energy Subsidies? IMF Working Paper WP/15/105. May 2015, International Monetary Fund (IMF).

European Commission (2015). Savings and benefits of global regulations for energy efficient products. Directorate-General for Energy. Brussels

Gerarden, T. D.; Newell, R. G., and Stavins, R. N. "Assessing the Energy-Efficiency Gap." Cambridge, Mass.: Harvard Environmental Economics Program, January 2015.

IEA, 2017. Energy Efficiency 2017. IEA, Paris.

IEA (2017a). World Energy Outlook 2017 Special Report on 'Redrawing the: Energy-Climate Map', Paris.

REN21 (2016). Renewables 2016 Global Status Report. REN21 Secretariat, Paris.

REN21 (2017). Renewables 2017 Global Status Report. REN21 Secretariat, Paris.

UN Environment (2017). The Emissions Gap Report 2017. United Nations Environment Programme (UNEP), Nairobi.

UN Environment and IEA (2017): Towards a zero-emission, efficient, and resilient buildings and construction sector: Global Status Report 2017.

World Bank & IEA (2017). SEforALL Global Tracking Framework 2017—Progress toward Sustainable Energy. World Bank, Washington DC.

# POLICY BRIEF #5

## FINANCING SDG 7

**Developed by**

United Nations Development Programme (UNDP) and UN Environment

**In Collaboration with:**

IRENA, UNECE, UNESCWA, SEforAll and World Bank

## KEY MESSAGES

### Status of financing for SDG 7

- Given the scale of the investment needs, a key characteristic of financing for SDG 7 is the central role of private finance. If SDG 7 is to be met, limited public finance will need to catalyse and be blended with far larger sums of private finance.
- The overall financing requirement to meet SDG 7—across renewable energy, energy efficiency and universal access—is estimated at US$ 1,058 to 1,266 billion per year until 2030 (IEA and WB, 2015; IEA, 2017a). While progress is being made to scale up financing, current annual financing levels are significantly below this level, at approximately US$ 514 billion (IRENA and CPI, 2018; IEA, 2017b). Moreover, investment is not spread equally, with developed countries and some middle-income countries accessing finance, but many developing countries left out.

### Priority actions over the next four years

- A key priority area is ensuring universal access to electricity and clean cooking fuels. In electrification, given fast-moving, recent developments in digital finance and private sector models for off-grid solar solutions such as pay-as-you-go (PAYG) solar, mini-grids, there is an immediate need in many countries to put in place enabling policy environments and to provide financial de-risking instruments to private sector actors. In clean cooking, current levels of access are far behind the stated SDG 7 objectives, and there is a need to dramatically increase investment, much of which is currently public finance.

### Priority actions towards 2030

- A wide range of public measures can promote financing for low-carbon energy investment. In practice, context-specific combinations of measures are typically deployed for a particular technology and market. This policy brief describes several categories of public measures: demand-side interventions (policy de-risking, financial de-risking, and direct financial incentives (including carbon pricing and fossil-subsidy reform)); and supply-side interventions (financial system reform, and new low-cost asset classes). A positive development is that a growing body of good-practice examples and success stories for each of these categories is emerging. Looking ahead, while a number of countries already have enabling environments, the opportunity from now to 2030 is to continue to build on and to spread good practices to the many countries which currently have gaps in their frameworks. This can be prioritized in the developing countries currently lagging in their ability to mobilize finance for SDG 7.
- Digitalization and "fintech" solutions (mobile money, data risk analytics) have the potential to deeply disrupt finance in the years ahead and are opening the door to new, scalable low-carbon energy business models, for example in universal electrification and small-scale, distributed energy. Digitalization, particularly in developing countries, further offers a future financial system which is more efficient, inclusive and resilient. Policymakers can embrace digital finance and seek to make it an integral part of their planning.
- Via initiatives such as the UN Environment Inquiry, momentum has been building around aligning financial systems with sustainable development. In low-carbon energy, many developing countries face challenges due to underdeveloped domestic financial systems. International finance can step in to a degree, but this in turn can expose investors to foreign exchange risk. The long-term, sustainable solution is to fast-track reform of domestic financial sectors, bringing depth and liquidity, with the aim of a balanced mix of domestic and international finance flowing to low-carbon energy.

## Financing SDG 7

This brief addresses financing to achieve SDG 7's objective of ensuring "access to affordable, reliable, sustainable and modern energy for all" by 2030. SDG 7 has three interconnected subcomponents: (1) ensuring universal access to electricity and clean cooking fuels, (2) doubling the share of renewable energy in the world's energy mix, and (3) doubling the global rate of improvement in energy efficiency.

### The financing universe

Financing for sustainable energy involves many actors, public and private, domestic and international. Public actors include domestic governments and international actors (bilateral and multilateral agencies, development banks and climate funds). Private finance in turn involves a full range of actors: households, businesses, banks, capital markets, institutional investors, insurance providers, and philanthropy groups. National financial landscapes are diverse, with some countries relying on microfinance and other countries with a full suite of financial services.

Given the scale of the investment needs, and energy investments' revenue and savings generating potential, a key characteriztic of financing for SDG 7 is the central role of private finance. If SDG 7 is to be met, limited public finance will need to catalyse, and be blended with, far larger sums of private finance.

### Accessing finance at scale

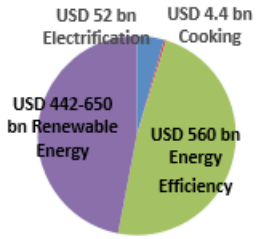
The overall financing requirement to meet SDG 7 is estimated at US$ 1,058 to 1,266 billion per year until 2030 (IEA and WB, 2015; IEA, 2017a)[1] (see Figure 5.1). While progress is being made to scale up financing, current annual financing levels are significantly below this level, at approximately US$ 514 billion (IRENA and CPI, 2018; IEA, 2017b).

There is currently an annual financing gap in the range of US$ 500 to 750 billion per year. Moreover, investment is not spread equally, with developed countries and some middle-income countries accessing finance, but many developing countries left out.

[1] Estimates for investment needs per year until 2030 are from the 2015 SEforAll Global Tracking Framework (IEA and WB, 2017). These estimates align with the SDG 7/ SEforAll objectives. In this brief, the estimates have been updated for electrification (IEA, 2017a). Other estimates of investment needs have been modelled, for example the *IEA New Policies* and *IRENA REMap Doubling Case* scenarios, as stated in the 2017 SEforAll Global Tracking Framework (IEA and WB, 2017). However, since these estimates do not all align with the SDG 7 objectives, they are not used in this brief.

Figure 5.1

**Annual financing needs to 2030 to meet SDG 7**




Source: IEA and WB, 2015; IEA, 2017a

The following is a breakdown of investment by sector.

### Renewable energy[2]

Renewable energy financing requirements to meet SDG 7 are estimated at US$ 442 to 650 billion per year until 2030 (IEA and WB, 2015). Actual renewable energy investment was US$ 263 billion in 2016 (IRENA & CPI, 2018), with solar and wind the leading technologies. 2016 investment levels decreased 20 per cent with respect to 2015, however this was partly due to hardware cost reductions, and 2016 nonetheless represented a record for annual new installed capacity.

Developing countries accounted for 48 per cent of 2016 investment, with China the biggest recipient (REN21, 2017). Globally, 90 per cent of renewable energy investment in 2016 was financed by private sources. However, public finance is still significant in many developing countries, accounting for a 49 per cent share in Latin America and the Caribbean, 41 per cent in sub-Saharan Africa, and 24 per cent in South Asia (IRENA and CPI, 2018).

Utility-scale projects, using asset finance, contributed US$ 187.1 billion in 2016 investment, and small-scale distributed assets, a growing sector, US$ 39.8 billion (UN Environment, 2017).

### Energy efficiency

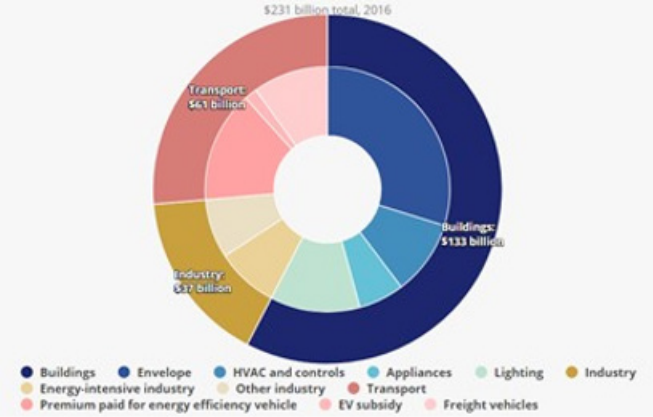
Energy efficiency financing requirements to meet SDG 7 are estimated at US$ 560 billion per year to 2030 (IEA and WB, 2015). Overall energy efficient investment[3] was US$ 231 billion in 2016, with energy efficient measures in buildings accounting for close to 60 per cent (Figure 5.2). Total 2015 investment grew by a rate of 5 per cent year per year (IEA, 2017b).

[2] Large hydro is treated differently by reference source. IRENA and CPI, 2018 figures, which include the headline 2016 investment figures quoted here of US$ 263 billion, include large hydro (IRENA and CPI, 2018). (REN21, 2017) and (UN Environment, 2017) do not include large hydro.

[3] The IEA counts investment in energy efficiency as the additional cost of an "energy efficient good" relative to an "average efficiency good." In effect, this efficiency premium is the additional investment required to drive efficiency improvements and subsequent energy savings. The efficiency premium is calculated in different ways for the sectors.

Figure 5.2

**Global incremental investment in energy efficiency by sector and subsector**




Source: IEA, 2017b

Energy efficient investments are largely via cash and savings of households and businesses (REN21, 2017), with commercial bank lending, leasing, ESCO models, and other approaches, also contributing. Private finance, depending on the sector, can be significant; for example, it is estimated to have accounted for 94 per cent of global energy efficient investment in the building sector in 2015 (IEA and WB, 2017). Public finance can be channelled via various entities, including Green Investment Banks.

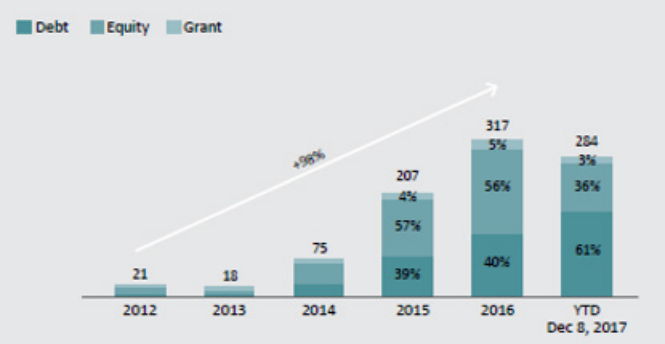
### Universal access: electrification

The financing requirements for universal electrification to meet SDG 7 are estimated at US$ 52 billion per year to 2030. These amounts are primarily needed for India and sub-Saharan Africa. Currently, investment levels are approximately half this, estimated at US$ 19.4 billion per year in 2013-2014 in SEforAll's 20 high-impact countries, which account for 80 per cent of the global access deficit (SEforAll, 2017).

To date, nearly all investment has been directed to grid expansion, with donor financing accounting for 55 per cent of total investments in 2013 (REN21, 2017). Continued grid expansion is anticipated to remain a significant public funding need. However, this sector is in the midst of transformative change. In sub-Saharan Africa, private sector models for off-grid solar solutions (solar home systems, mini-grids) are now estimated to be the lowest-cost option for 75 per cent of the future connections needed to meet SDG 7 (IEA, 2017a). Financing for private sector off-grid solutions has started to take off, albeit from a low base, in particular for pay-as-you-go (PAYG) solar home systems (figure 5.3). Recent illustrations are M-KOPA's US$ 80 million debt and equity financing (October 2017), and Off-Grid Electric's US$ 55 million equity round (January 2018).

Figure 5.3

**Annual financing for PAYG solar companies (US$ million)**




Source: WB, 2018

### Universal access: cookstoves

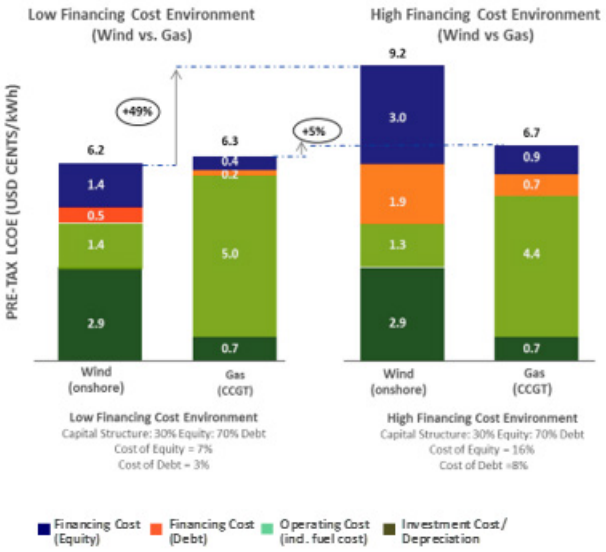
The financing requirements for universal access to clean fuels and technologies for cooking to meet SDG 7 are estimated at US$ 4.4 billion per year to 2030 (IEA and WB, 2015). The latest estimates of current investment levels, for 2013, range from US$ 32 million for residential cookstoves (SEforAll, 2017) to US$ 240 million (GACC, 2014). Private finance in this sector is very limited; SEforAll estimates that in 2013 public financing in the form of grants accounted for US$ 26 million of the total US$ 32 million per year, with international public finance predominating.

### Access to low-cost financing

A further challenge for financing SDG 7 is accessing low-cost financing. Given low-carbon energy's upfront capital intensity, low-carbon energy is highly sensitive to financing costs, and is penalized vis-à-vis conventional energy in high financing cost environments (figure 5.4). Such high financing costs can reflect a range of low-carbon energy investment risks that exist in early-stage markets. Providers of debt and equity capital price these risks into their cost of financing. Barriers limiting the availability of capital in developing countries can also raise financing costs.

Figure 5.4:

**Comparison of the levelized cost of utility-scale wind and gas in high and low financing cost environments**




Source: (UNDP, 2017)

Actual financing costs for low-carbon energy vary widely depending on the technology and context. In developed countries and certain developing countries, low financing costs are being secured for mature technologies, particularly for large, utility-scale renewable energy. However, in many developing countries financing costs for low-carbon energy can be prohibitively expensive. In such markets, UNDP estimates that financing costs can account for up to 60 per cent of the life-cycle cost of low-carbon energy (UNDP, 2017) (figure 4).

## Policy implications

In assessing policy implications for financing SDG 7, a range of public interventions are available. The suitability of public measures for a specific country and market depends on the particular national and local circumstances. Combinations of public measures are typically deployed. This brief describes the main categories of public interventions.

## Demand for capital

Given the central role of private finance, a key role for public finance for SDG 7 is in improving the risk-return profile of investment opportunities which are seeking private capital—here termed "demand- side interventions". Public finance can be applied in the form of instruments that either *reduce* (policy de-risking), *transfer* (financial de-risking) or *compensate for* (direct financial incentives) risk.

### Policy de-risking instruments

**Policy de-risking instruments** can be understood as programmes, policies and regulations that *reduce* the risks the private sector faces when investing in low-carbon energy. These are typically implemented by domestic governments and can take a wide variety of forms. Well-designed policy de-risking instruments can provide the long-term stability, visibility and transparency that is critical to attract and sustainably scale up private sector investment.

A growing body of evidence of good practice policy instruments for low-carbon energy is emerging, particularly for mature technologies. In utility-scale renewable energy, these instruments include auction processes, which have recently been successful in developing countries, and reforms to ensure financially sound utilities (cost-recovery). In energy efficiency, these include the design, implementation and enforcement of various minimum energy efficient standards such as green building codes or lighting and appliance requirements. Public procurement, with its high volumes, can be used effectively to prime energy efficient product markets. Policy de-risking instruments, tracked by initiatives such as the World Bank's *RISE* (WB, 2017), are increasingly being deployed; by end of 2016, 176 countries had renewable energy targets; and 137 countries had enacted energy efficiency policies (REN21, 2017).

In general, while a number of countries have well-designed policy environments, many countries still have gaps in their frameworks and can benefit from further improved deployment of good practice instruments.

A priority area is in universal electrification, where, given fast moving developments in digital finance, technology efficiencies and private sector models for off-grid solutions, there is an immediate need in many countries to put in place enabling policy environments (including integrated energy planning and implementation), and to lay the groundwork for private sector entrepreneurship and investment.

Looking to the future, countries can benefit by introducing well-designed policies for small-scale, distributed energy solutions, in both renewable energy and energy efficiency. Relatedly, standardized contracts, indicators and terms for low-carbon energy can reduce transaction costs and facilitate emerging aggregative investment vehicles and asset classes. In more mature renewable energy markets, investors will increasingly seek well-functioning, innovative policies on grid planning for variable renewable energy (capacity markets, demand side management). Also, further ahead, a new frontier in renewable energy—moving beyond power generation—will be applications in heat and transport.

### Financial de-risking instruments

**Financial de-risking instruments** can be understood as financial products which *transfer* risks related to investment opportunities from the private investor to the public sector. These instruments are typically provided by development banks (multilateral (MDBs), bilateral or national), and/or national governments (including ministries of finance). They can take many forms, most often investment loans, but also guarantees, public equity and other products. When implemented, financial de-risking instruments can bring comfort and engage the commercial financial sector in early-stage markets and can be key to achieving first-of-a-kind investments.

In terms of deployment, in 2016, MDBs[4] committed US$ 21.2 billion in climate mitigation finance products, nearly all directed to low-carbon energy. Public recipients accounted for US$ 14.2 billion of this total, and the private sector US$ 7 billion. Investment loans accounted for 71 per cent of the US$ 21.2 billion total. These products are central to blended finance approaches, and co-financing amounted to US$ 39.9 billion (IDB et al., 2016).

For the future, there is a need for continued and scaled-up provision of financial de-risking instruments. Multilateral and bilateral development banks can increasingly structure their products to attract the private sector. The MDB's *Maximizing Financing for Development* initiative is building momentum towards this objective. Innovation in products, and alignment in activities with areas of emerging SDG 7 private sector activity, such as small-scale renewable energy and universal electricity access, can also be beneficial.

### Direct financial incentives

**Direct financial incentives** can be understood as direct financial transfers or subsidies to low-carbon energy investments. These instruments *compensate* the private sector for the outstanding investment risks that exist in early-stage markets, increasing the financial return component in an investment's risk-return profile. These instruments are intrinsically results-based and can take a variety of forms, including: premium tariffs, upfront capital subsidies, tax credits, waiving of VAT, and tradable renewable portfolio standards.

Significant resources can be allocated to direct financial incentives for renewable energy. For example, in 2015, expenditures for such instruments in Europe and Norway amounted to US$ 66 billion, considerably more than direct public investment in these markets (IRENA and CPI, 2018).

In general, direct financial incentives for low-carbon energy can be a costly approach to catalysing private finance, and should be well-designed, used sparingly and in a targeted fashion (UNDP, 2013). Suboptimally designed incentives can generate fiscal burdens and result in policy reversals, creating uncertainty and additional risk for the private sector.

Within SDG 7, there are two areas meriting particular consideration for direct financial incentives. The first is universal access to energy, particularly financial support to private developers providing energy services via mini-grids and solar home systems, or similar programmes targeting consumers. The second is energy for public infrastructure in rural areas (clinics, water pumps, public lighting, etc.), where improved energy access can contribute to a number of SDGs. Recent trends in public investment suggest this is already starting to occur to some extent (IRENA, 2018).

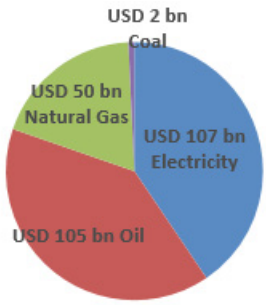
In addition, financing SDG 7 will benefit from engagement on two policy areas, carbon pricing and fossil fuel subsidy reform, which are closely related to direct financial incentives. These two areas each improve the relative competitiveness of low-carbon energy investment opportunities, removing distortions and creating a level playing field vis-à-vis conventional energy. More broadly, both instruments can be fiscally beneficial, and create overall economic efficiencies.

**Carbon pricing**, in the form of a carbon tax or a cap-and-trade regime, economically internalizes the climate externality of greenhouse gas emissions. As of the end of 2017, there were 47 national and subnational carbon pricing initiatives in 42 countries, covering 14.6 per cent of global GHG emissions (WB, 2018). Opportunities exist to expand carbon pricing to new jurisdictions, and to continue to refine and enhance the effectiveness of existing schemes.

The IEA estimates global **fossil fuel consumption subsidies** in 2016 at US$ 264 billion (IEA, 2017c), with electricity subsidies representing the largest share at US$ 107 billion (Figure 5.5). Current fossil fuel subsidies are often regressive, benefiting higher income households. Reform can be politically challenging, and proceeds may need to be rechannelled to compensate vulnerable social groups. In recent years, a number of countries have begun reform processes; further progress in this area will be an important contribution to facilitating financing for SDG 7.

Figure 5.5

**Fossil-fuel subsidies by sector, 2016**




Source: IEA, 2017c

[4] Figures for MDBs refer to WB, IDB, EIB, EBRD, AFDB, and ADB.

## Supply of capital

Public policy can also seek to shape the availability of private financing for low-carbon investment opportunities in SDG 7, here termed "supply-side interventions".

### Financial system reform

Domestic financial systems are varied and complex, involving a mix of actors (private and public), regulations, norms and dynamics. In recent years, increasing momentum has been building around **aligning financial systems with sustainable development**, including low-carbon energy. Initiatives such as the *UN Environment Inquiry into the Design of a Sustainable Financial System* have provided global leadership, accompanied by country-level strategies and actions.

In low-carbon energy, many developing countries are currently held back by underdeveloped domestic financial systems. This limits access to affordable, local currency financing. International finance can step in to a degree, but this in turn can expose investors to foreign exchange risk. A long-term, sustainable solution is to develop the depth and liquidity of domestic financial sectors, with the aim of a balanced mix of domestic and international finance flowing to low-carbon energy.

Potential financial system reforms are wide-ranging, including policies addressing barriers related to capital allocation, risk assessment and improving transparency. Reforms can be carefully considered, weighed against the need for overall system stability. For example, central banks can reform liquidity or collateral requirements for commercial bank lending, facilitating longer-term loans for low-carbon energy.

### New low-cost asset classes

Emerging asset classes and sources of capital for low-carbon energy, such as green bonds and impact investment, are a growing source of low-cost, longer-term financing.

In 2017, **green bond** issuance—one of the lowest-cost forms of capital due to the depth and liquidity of the bond markets—was a record US$ 155.5 billion, a 78 per cent increase over 2016 levels. Green bonds in renewable energy amounted to US$ 51 billion, energy efficient buildings, US$ 45 billion and clean transport, US$ 24 billion (CBI, 2018).

**Impact investment** represents investments made with the intention to generate social and environmental impacts, alongside a financial return (GIIN, 2017). Impact investors range from banks and institutional investors, to family offices and foundations. According to GIIN, in 2016, new impact investment flows totalled US$ 22 billion, and were anticipated to rise to US$ 25.9 billion in 2017 (GIIN, 2017).

Policymakers can play an important role in scaling up new low-cost energy asset classes. For green bonds, there is a need to continue to raise awareness, to strengthen certification, and to deepen and spread issuance and demand within existing and new markets. Emerging new green bonds include aggregative asset classes for small-scale, low-carbon energy assets. Development banks can co-invest in green bond funds and provide credit enhancement to innovative issuances.

For impact investment, a variety of actions can be taken. For example, in January 2017, members of the UNEP Finance Initiative launched the "Principles for Positive Impact Finance", a framework for investors to analyse, monitor and disclose the social, environmental and economic impacts of the financial products and services they deliver (UNEP FI, 2017).

## Cross-cutting

### Digital finance

Finance is constantly evolving, and technology has always been a central driver of this evolution. However recent developments in **digitalization** and "fintech" solutions have the potential to deeply disrupt finance, acting in unprecedented and transformative ways. These new digital technologies can be applied in multiple ways, from mobile money, to enhanced data risk analytics, to the Internet of Things (IoT) and advances in artificial intelligence (AI).

In low-carbon energy, digitalization is opening the door to novel business models and value propositions, with particular opportunities in new private sector models and enhanced end-user experiences in universal electrification and small-scale, distributed energy (both renewable energy and energy efficiency). More generally, digitalization offers a future financial system which is more efficient, inclusive and resilient, and would enable developing countries in particular to accelerate their financial system development.

Policymakers can embrace digital finance and seek to make it an integral part of their planning. Some early lessons in low-carbon energy are emerging. For example, in universal electrification, experiences with mobile money indicate that an initial light touch policy approach, leaving the space for innovation and consulting regularly with fintech actors, can result in a vibrant and competitive market. As markets mature, related issues such as consumer protections and privacy can also begin to be addressed by policy measures.

## REFERENCES

Climate Bonds Initiative (CBI), 2018. Green Bond Highlights 2017

Global Alliance for Clean Cookstoves (GACC), 2014. 2013 Results Report: Sharing Partner Progress on Path to Adoption of Clean-cooking solutions.

Global Impact Investing Network (GIIN), 2017. Annual Impact Investor Survey 2017. Inter American Development Bank et al. (IDB et al.). 2016. Joint Report on Multilateral Development Banks' Climate Finance

International Energy Agency (IEA), 2017a. Energy Access Outlook 2017.

International Energy Agency (IEA), 2017b. Energy Efficiency.

International Energy Agency (IEA), 2017c. World Energy Outlook 2017.

International Energy Agency and the World Bank (IEA and WB), 2015. Sustainable Energy for All 2015—Progress towards Sustainable Energy

International Energy Agency and the World Bank (IEA and WB), 2017. Sustainable Energy for All 2017—Progress towards Sustainable Energy

International Renewable Energy Agency (IRENA), 2018 (forthcoming). Measurement and estimation of off-grid solar, hydro and biogas energy

International Renewable Energy Agency and Climate Policy Initiative (IRENA and CPI), 2018. Global Landscape of Renewable Energy Finance

Renewable Energy Policy Network for the 21st Century (REN21), 2017. Renewables 2017. Global Status Report

Sustainable Energy for All (SEforAll), 2017. Understanding the Landscape

UN Environment and Bloomberg New Energy Finance (UN Environment), 2017. Global Trends in Renewable Energy Investment

United Nations Development Programme (UNDP), 2013. Derisking Renewable Energy Investment.

United Nations Development Programme (UNDP), 2017. Lebanon: Derisking Renewable Energy Investment.

UNEP Finance Initiative (UNEP FI), 2017. The Principles for Positive Impact Finance

World Bank (WB), 2017. Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policymakers

World Bank (WB), 2018. Carbon Pricing Dashboard

# POLICY BRIEF #6

## SUSTAINABLE ENERGY TECHNOLOGY INNOVATION

### Developed by

United Nations Industrial Development Organization (UNIDO), International Renewable Energy Agency (IRENA), International Energy Agency (IEA) and UN Environment

### In collaboration with

CTCN

## KEY MESSAGES

### Status of sustainable energy technology innovation and progress towards achieving SDG 7

- Innovation has played a critical enabling role in progress towards the SDG 7 targets, by reducing costs and enhancing the capabilities of technologies such as solar, wind and energy storage. Significant further innovation is needed, however, in all aspects of the energy system if we are to markedly accelerate the energy transition and achieve the SDG 7 targets.
- Innovation priorities are shifting. Innovation in power generation technologies will further reduce costs and accelerate uptake, but the most pressing innovation needs are now in the end-use sectors of transport, industry and buildings, as well as in the design and operation of the whole energy system.
- Innovation is needed to enable increased electrification of those end-use sectors, accompanied as well by innovations in the systems that will facilitate the integration of high shares of variable renewable power. Emerging technologies such as the digitalization of grid services, local and grid-scale battery storage, smart charging for electric vehicles, wider utilization of mini-grids, and many others, will be key enablers.
- Beyond electrification, additional innovation is needed to develop the technology solutions that can help affordably decarbonize activities such as iron and steel making, cement production, chemicals and petrochemicals production, freight and maritime transport, and aviation.
- Delivering that innovation will require increased and focused action. That action will need to be better coordinated across national governments, international initiatives and the private sector. Public and private sector investment must significantly increase. Improved data collection and analysis is also needed to better target efforts and track progress. Action today is a matter of urgency, as technology innovations can take many years to reach wide-spread deployment.

### Priority actions towards 2030

- Increase public-sector investment in research, development and demonstration, as a starting point in line with pledges made by Mission Innovation members at COP21, but going beyond that to deliver further increases in the 2020s.
- Mandate established international platforms to work collaboratively to develop an improved globally shared understanding by key public and private sector investors of the critical sustainable energy innovation needs of developed, emerging and developing markets.
- Enhance existing data collection and information-sharing activities on public and private sector spending for sustainable energy technology innovation.
- Support and encourage established international platforms to strengthen knowledge diffusion and establish more cross-border cooperation on sustainable energy research and innovation.
- Establish many more bilateral and multilateral public/private-funded commercial-scale demonstration projects and "real-world" pilot programmes for innovative sustainable energy technologies and processes.
- Encourage the development of internationally harmonized technical standards and quality-control requirements that will facilitate the cross-border trade of innovative sustainable energy technologies.

Champion a systemic approach to innovation that considers not just technology innovation but also innovations in systems, processes, market design and business models in order to accelerate the diffusion and uptake of innovations.

## OVERVIEW

This document provides policymakers with a high-level overview of the status of technology innovation in the context of SDG 7. It briefly summarizes the progress made to date and provides illustrative examples of areas that require increased innovation efforts in power generation, end-use sectors and the systems as whole. It highlights the key policy considerations that should be taken into account when developing actions to accelerate innovation.

### Sustainable energy technology innovation and SDG 7

The global energy system is changing, driven by technological innovation and new policy priorities.

The ways in which people access energy (SDG target 7.11)[1] are a part of this change. Analysis based on IEA data indicates that from 2006 to 2016 nearly all those who gained access to electricity worldwide did so through new grid connections. Over the past five years however off-grid and mini-grid systems have been making headway and this trend is expected to increase (IEA, 2017a).

In an even more accelerated fashion, the way in which energy is produced (SDG target 7.2)[2] is transforming as renewables continue to gain ground over power generation from fossil fuels. In the power sector, in 2016, renewables accounted for two-thirds of all global net capacity additions.

Energy efficiency, largely enabled through progress made in energy system optimization and energy management systems standards, (SDG target 7.3)[3] has improved at a fast rate since 2010 (2.2 per cent per year).

However, despite the positive trends observed in recent years, global efforts still fall short of the ambitious targets set out in SDG 7. While SDG 7 confirms the general understanding that sustainable energy solutions should be operationalized for the benefit of humankind and the environment, their use is currently inadequate, and unequal, as only a fraction of countries utilize their sustainable energy resources efficiently. These current insufficient efforts are being further challenged. Rising living standards mean more people will buy appliances, electronic devices and other goods powered by electricity, driving up energy needs, while innovative transportation technologies are also gaining momentum and are projected to increase electricity demand.

Innovation in energy technologies and associated systems and processes is crucial for addressing future pressures and sustaining changes in the sector, and at the same time tackling the environmental and health problems associated with climate change and air pollution (IEA, 2017b).

### Progress in energy technologies

In recent years there have been impressive reductions in the costs of key renewable energy technologies, particularly in solar power and on-shore wind. These cost reductions have been primarily driven by economies of scale but have been enabled by innovation.

Over the past seven years, solar photovoltaic (PV) module prices dropped by over 80 per cent, and the global weighted average levelized cost of electricity (LCOE)[4] fell by 73 per cent to US$ 0.10/kWh in 2017. On-shore wind turbine prices fell by 30–40 per cent between 2010 and 2017, with their LCOE falling by 23 per cent to US$ 0.06/kWh in 2017. Utility-scale solar PV projects commissioned in 2017 had LCOEs as low as US$ 0.05/kWh and on-shore wind was as low as US$ 0.04/kWh (IREANA, 2018), making these technologies competitive with conventional power generation.

Progress is also being made in enabling technologies necessary for a higher uptake of renewable energy into the grid. For example, recent technological developments and innovations in energy storage systems have led to the emergence of a variety of battery chemistries offering a diversity of performance capabilities and costs. Lithium-ion batteries, in particular, have undergone major improvements, and are estimated to have doubled in energy density and reduced in cost tenfold in the last 10 to 15 years (Van Norden, 2014).

### Trends in energy innovation

Signs are positive that energy technology innovation is accelerating at a historically unprecedented pace. It is driven by a convergence of forces that are reshaping the electric power industry (including climate change, the need for resilient infrastructure, increasing stress on resources, and decentralized supply) and enabled by the interaction of various disciplines, such as data and information networks, which have traditionally not been linked with energy. As the rate of interlinkages increases and improvements in data and information networks accelerate, we can expect rapid advances in the innovations that exploit the interactions of these technologies.

The rapid progress in energy technology requires more intelligent and integrated energy infrastructure on the distribution end of the energy system to secure the reliability and durability of the grid. Today's grid technology innovations

[1] By 2030, ensure universal access to affordable, reliable and modern energy services.

[2] By 2030, increase substantially the share of renewable energy in the global energy mix.

[3] By 2030, double the global rate of improvement in energy efficiency.

[4] LCOE numbers in this section exclude the impact of any local or federal financial support policies, are for the year of commissioning and are based on IRENAs Renewable Cost Database, which contains cost and performance details of 15,000 utility-scale power generation projects.

are exploring its transformation from a system where electricity flows in one direction to a platform that can detect, accept and control decentralized consumption and production assets, so that power and information can flow as needed in multiple directions. These innovations are expected to allow traditional utility consumers to play an increasingly influential role in the future of energy systems by giving them the opportunity to also act as producers of energy who can provide services to the larger energy system.

Furthermore, technologies such as sensors, robotics and advanced analytics, which together form advanced interconnected systems capable of quickly analysing large amounts of data, are developing potentially transformative solutions, across various sectors, for improving energy efficiency and managing more variable renewable energy. This development is driven by continuous improvements, and the cost-performance curve of core digital technology building blocks: computing power, data storage, and bandwidth utilization (Hegel et al., 2013).

#### Tracking investment in energy innovation

Technology innovation is a key driver of change in the energy sector, yet information is scarce on the level of investment in energy research, development and demonstration (RD&D) activities (key enablers of innovation). However, the IEA tracked US$ 19 billion of public spending on all forms of clean energy RD&D worldwide in 2015, including funding by certain state-owned enterprises; RD&D spending on clean energy, and on energy technology generally, has not risen in the past four years. Private sector spending is difficult to accurately track accurately but the data that has been gathered suggests that most private-sector energy R&D is focused on the oil, gas, and thermal power sectors, and most public R&D supports sustainable energy technologies (IEA, 2017c).

## Innovation gaps and opportunities

Encouraging progress has been made in some key technologies, but the pace of change is not sufficient.

Analysis by IRENA shows that energy efficiency and renewable energy have the potential to achieve 90 per cent of the emissions reductions needed by 2050, with renewables having the potential to account for two-thirds of primary energy supply in 2050. To deliver on that potential, however, the annual growth of the renewables share in total final energy consumption needs to rise sevenfold on average until 2050 (IRENA, 2017). Similarly, global energy efficiency, as measured by the world's primary energy intensity, has improved at a faster rate (2.2 per cent per year) since 2010 than in the previous two decades (1.4 per cent per year). Nevertheless, this progress still falls short of the annual rate of 2.7 per cent needed over the period to 2030 to put the world on a sustainable development pathway.

For around one-third of energy-related emissions projected in 2050 (IREANA and IEA, 2017), few economically attractive options for decarbonization exist today. Higher investment in innovation is needed if we are to achieve the cost reductions and performance improvements at the pace required to transition the world's energy systems to low carbon by 2050. A substantial increase in investment in innovation would support accelerated deployment of today's clean energy technologies (further reducing costs and facilitating the integration of clean energy technologies to address local conditions) and finding solutions for those missing sectors, particularly for transport and industry.

Taking such actions is in countries' self-interest. Renewable energy and energy efficiency technologies, stimulated by government-driven efforts, would bring major benefits to countries beyond decarbonizing the energy sector (ibid), by increasing wealth, promoting social inclusion and improving environmental quality and health.

Policymakers need to consider that action to foster innovation today is a matter of urgency, as a full-scale energy transition will take decades due to the different technology steps, the long lifespan of capital stock, and the current role of fossil fuels in all aspects of economies and lifestyles. Their actions should nurture innovation, supporting both RD&D to improve performance and costs, and fresh approaches to the deployment and scale-up of key innovations to fully realize their potential. While it is the private sector that ultimately must bring innovations to market, governments have a critical role to play in facilitating that effort.

#### Innovation needs in the power sector

Relatively established technologies such as hydropower, solar and on-shore wind will continue to improve through further innovation, which will reduce costs, improve performance and adapt systems to more applications. In addition, however, technologies that are not widely deployed today will have to play an important role in the transformation of the power sector. Increased innovation is needed to ensure these technologies achieve their full potential.

IRENA's analysis suggests that more than 14 per cent of the $CO_2$ abatement potential, or 4.5 Gt CO2/yr (ibid), could come from a combination of the following technologies that are not widely deployed yet[5]:

- Concentrating solar power

[5] A more comprehensive overview can be found in IRENA's report "Accelerating the energy transition through innovation" (IRENA, 2017).

- Ocean energy
- Offshore wind
- Geothermal energy
- Enabling electrification—batteries and electric vehicles
- Heat and cold storage

The additional investment needs for these technologies are estimated at US$ 5.71 trillion, from 2015-2050.

### Innovation needs in the end-use sectors

The electrification of end-use sectors (heating and cooling, transport) could offer win-win situations for reducing emissions while also supporting the integration of higher shares of variable renewable energy in power systems. Beyond electrification, carbon capture and storage (CCS), advanced biofuels, and fuel switching are some of the innovative emission reduction solutions for sectors such as iron and steel making, cement production, chemical and petrochemical production, maritime transport, aviation, freight and the replacement of non-sustainable traditional biomass.

Industry and buildings are the most challenging sectors, followed by some transport modes. These sectors require new technology solutions to be developed and then quickly commercialized. For example only 1 per cent of global demand can directly respond to shortages or excess supply. IEA estimates that about 20 per cent of electricity consumption worldwide will be available for demand response in 2040 (IEA, 2017a).

Addressing the needs of the end-use sector will require innovation in a suite of emerging technology solutions that offer significant impacts. Examples include:

- High-performance low-cost batteries for electric vehicles
- Advanced biofuels, biochemicals and biomaterials
- New cement types that reduce cement clinker needs
- New marine shipping solutions
- Solar thermal and other renewable solutions in the urban environment
- Renewables-based clean-cooking solutions that meet consumer needs
- Digitalized demand response systems
- CCS for cement clinker production, iron making, waste incineration and biomass processes.

### Wider system innovations

With the rapid cost decreases for solar PV and wind, the issue of system integration of variable renewables is an increasingly pressing priority. Innovations in energy storage and demand response will play important roles in the energy transition, providing flexibility to energy systems, improving the management and increasing the potential to accommodate further distributed generation.

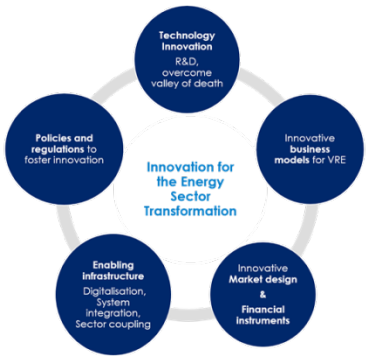
Key technologies that require further innovation to better enable the energy system to accommodate higher shares of renewables include:

- Short- and long-term energy storage solutions
- Super grids that take advantage of the benefits of geographical distribution of renewables
- Power-to-X approaches that offer efficient uses for electricity supply surpluses
- Digitalization of power systems (smart grids)
- Market models that provide real time price signals to encourage demand response
- Standardized off-grid solutions for rural areas and remote locations.

In addition to innovation in technologies, improvements are needed in the energy system to support and accelerate wider adoption and scale-up of clean energy. Above all, innovations are needed in enabling infrastructure, business models, market designs and system operation.

Figure 6.1

**innovation for the Energy Sector Transformation**




Source: IRENA (2018) Opportunities of the Energy Transition (available at: http://www.mofa.go.jp/files/000340293.pdf).

### How to fill the gap in sustainable energy technology innovation?

Addressing these innovation needs at the pace required to deliver the SDGs requires collective action from national governments, international initiatives and the private sector. Key considerations

include:

**Better data on public and private sector spending on sustainable energy technology innovation is vital.** Relevant data is needed to enable decision makers to better identify gaps and opportunities to enhance the efficiency of resource allocation. Measurement of progress in clean energy innovation needs to go beyond the flow of money and also focus on performance indicators.

**Cost reduction is the priority.** The main goal of the innovation efforts in low-carbon technologies should be to ensure cost competitiveness without the need for subsidies. In that way, innovation will contribute to maintaining an accelerated scaling up of low-carbon technology, irrespective of fossil fuel price volatility and independent of climate policy agreements.

**The active engagement of the private sector is critical.** Mobilizing the innovation capacity of the private sector is of prime importance. While traditionally public supported research provides a source of knowledge and discovery, the private sector is playing an increasingly prominent role in this regard and is crucial for bringing new technologies into the market. Businesses, entrepreneurs and investors are best suited to identify, evaluate and support the most promising ideas for commercialization and turn innovations into products and companies.

**Innovation requires a multidisciplinary portfolio approach.** The most attractive new solutions may be found at the interface of different areas, such as between the energy sector and ICT. Innovation is an uncertain process and so innovation policy frameworks need to ensure that effort is balanced between potentially competing approaches. Flexibility in innovation policy design is also important. The portfolio of low-carbon technologies may change as technology progress and transition pathways evolve. Continuous monitoring and adjustments will be needed.

**Innovation is broader than technology R&D.** Innovation covers the complete technology lifecycle. Increased R&D investments are important but in isolation will not bring the needed results. Efforts should also cover the demonstration, deployment (technology learning) and commercialization stages. Innovations in business models, market designs, enabling infrastructure and systems operation, are equally crucial to achieve the energy transformation.

**Innovation challenges span borders.** In addition to efforts at the national level, international collaboration can be an essential enabler of accelerated progress. In particular, governments working together to increase cross-border and public-private collaboration can use a range of mechanisms, including technology collaboration programmes, mission innovation, innovation accelerators, and regional centres.

**Policy incentives are lacking in key sectors.** The sectors with the least progress in innovation for decarbonization are those where proper policy incentives and long-term perspectives are lacking. This includes heavy industry, as well as freight transportation and aviation. Governments should consider prioritizing options that can stimulate private sector innovation in these sectors.

**Some industries require global, sector-specific agreements.** The aviation, shipping, iron and steel, cement, chemical and petrochemical sectors cannot be transformed through national policies alone owing to their global nature. For those sectors, global agreements for the deployment of innovative technology solutions are indispensable.

**Sustained innovation for electricity networks and system integration technologies could enable accelerated growth of renewable power.** Technology advancements, notably in PV and wind energy technologies, offer scope for reducing production costs. However, policies should address infrastructure challenges and market design issues to improve system integration of renewables.

**Energy efficiency must go hand in hand with decarbonized generation.** Significant opportunities exist in renovating and refurbishing existing capital stock. Furthermore, optimization of energy systems in industry can result in substantial and cost-effective energy savings, and energy management systems standards can deliver systematic and sustained energy performance improvements, driving behavioural change in organizations across different sectors. Building on these opportunities, the deployment of connected devices, automated controls, advanced monitoring systems and analytics is offering new and improved possibilities for energy efficiency within individual facilities and across energy systems. However, such activities should not happen in isolation. Policies and regulation should leverage beneficial synergies by promoting the dissemination of digital technologies and supporting energy efficiency improvements and the adoption of sound energy management practices.

**Manoeuvring the innovation race** The vast and increasing speed of digitalized technology development could lead to a first-mover advantage for pioneering countries or companies. This would give the few top runners large economic influence and if regulations are weak the power to lever out social and environmental standards. Countries could therefore not only be increasingly challenged to provide suitable framework conditions for innovation, but also to protect existing standards and to expand them to newly developing digital branches (UNIDO 2017).

**The needs of both developing and emerging economies need**

**to be considered.** Historically, innovation for low-carbon technology has been driven by industrialized economies. However, a large amount of future growth in energy consumption will come from developing and emerging economies with different economic, technological and geographical contexts. Energy services and technology performance needs are often very different in these developing economies, compared with developed ones. Therefore, a more significant effort is needed to find innovative solutions for developing countries. Obvious examples include clean-cooking solutions and decentralized off-grid technologies for providing electricity access.

**The interlinkages between SDG 7 with other goals need to be exploited.** SDG 7 is closely interlinked with other goals such as poverty eradication, food security, urbanization, water, education, health, gender, environment, climate change and economic growth. Innovation is a key enabler of most if not all the SDGs. While Goal 9 includes a specific focus on innovation (build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation), clean energy technology innovation can play an essential role in achieving other goals if the interlinkages between them are appropriately utilized.

## REFERENCES

Hegel et al. (2013), Available online at: https://www2.deloitte.com/content/dam/Deloitte/es/Documents/sector-publico/Deloitte_ES_Sector-Publico_From-exponential-technologies-to-exponential-innovation.pdf

IEA (2017a), World Energy Outlook

IEA (2017b), Energy Technology Perspectives

IEA (2017c), World Energy Investment

IRENA and IEA (2017), Perspectives for the energy transition: Investment needs for a low-carbon energy system

IRENA (2017), Accelerating the energy transition through innovation

IRENA (2018), Renewable Power Generation Costs in 2017, ISBN : 978-92-9260-040-2

UNIDO (2017), Accelerating clean energy through industry 4.0, Available online at: https://www.unido.org/sites/default/files/2017-08/REPORT_Accelerating_clean_energy_through_Industry_4.0.Final_0.pdf

Van Norden (2014), Available online at: http://www.nature.com/news/the-rechargeable-revolution-a-better-battery-1.14815#batt2

# POLICY BRIEF #7

## ENHANCING CAPACITY-BUILDING FOR SDG 7

**Developed by**

TERI University and United Nations Development Programme (UNDP)

**In collaboration with**

UNDESA and FIA Foundation

## KEY MESSAGES

### Status of capacity-building and progress towards achieving SDG 7

- A number of capacity-building strategies and activities have been used to promote access to clean energy, and a wider deployment of energy efficiency and renewable energy technologies and services, including: knowledge transfer, technology cooperation, policy advice, investment measures, technical know-how transfer, learning by doing, pilot programmes and training of staff.
- Human and institutional capacity-building activities are contextual and often designed as "one off" interventions that are undertaken in silos and lacking synergies; therefore, their impacts may not be long-lasting or lead to transformational changes. Gender aspects of capacity-building are often neglected, especially in the context of access to modern energy uses.
- Guidelines for national and regional capacity-building are presented in the Implementation Framework for Energy Capacity-building, which emphasizes the inclusion of stakeholders associated with each of the three SDG 7 targets.
- There are several capacity needs assessment tools that have been developed for the energy sector, but often these have not been used in national plans and training programmes or by educational institutions or the private sector.

### Priority actions over the next four years

- National governments must take the lead in developing human and institutional capacities in support of the energy transformation, advanced through a coordinated approach by development partners.
- Establish a platform or integrate/consolidate existing platforms and institutions dealing with capacity-building. The focus needs to be on integrated multi-stakeholder approaches to designing capacity-building plans, with holistic, gender-inclusive, integrated frameworks for SDG 7 in a relevant global institution.
- Effect capacity-building at the country and regional level by designating national focal institutions and adequately resourcing them. These institutions would have responsibility for undertaking integrated capacity-building needs assessments at various levels, involving policymakers, the private sector, academia and communities; determining the delivery mechanisms; and putting in place exacting monitoring and dynamic tracking mechanisms. The broader and integrated approach needs to be complemented with targeted and specialized SDG 7 capacity-building, with specialized agencies and institutions.
- Define cross-sectoral integrated targets between SDG 7 and other SDGs, and track their achievement through an appropriately designed monitoring and evaluation framework.

### Priority actions towards 2030

- Create a network of the global and national institutions identified above to institutionalize capacity-building for SDG 7 and related SDGs. This network should evolve to function as a:
  - f) Knowledge bank: repository for contextually mapped knowledge resources on policies, regulations and actions for energy access, energy efficiency and renewable energy;
  - g) Clearinghouse(s): platform for active information and experience exchange at international, regional, national, subnational or local levels;
  - h) Resource centre: provide online tools for capacity-building needs assessments to facilitate project development, resource assessments, access to finance, public-private partnership models; and
  - i) Help desk: an online help desk for customizing actions/interventions at the local level.
- Refresh and realign the curriculum in higher education institutions including doctoral and post-doctoral works to better respond to the needs of SDG 7 and related goals.

## CB and SDG 7

### Current status

Sustainable energy availability influences people's lives and is an engine for poverty alleviation, social progress, empowerment of women and youth, equity, enhanced resilience, economic growth and development, and environmental sustainability. SDG 7's focus on access to affordable, reliable, sustainable and modern energy is underpinned by three targets: ensuring universal access to energy services (7.1), increasing the share of renewables in the energy mix (7.2) and doubling the rate of energy efficiency improvements (7.3). At the same time, the Agenda 2030 document stresses the integrated, indivisible nature of all goals and targets and the need to balance the three pillars of sustainable development.

Despite decades of efforts on the above three targets of sustainable energy, the task of achieving them continues to be daunting (see Policy Briefs on each of the targets), in part because these three targets are often dealt with through different institutional mechanisms with very little coherence in approach. Little capacity (the means to plan and achieve) exists to address the inter-linkages between SDG 7 and other sustainable development goals. Therefore, a renewed, concerted effort on capacity-building is required to achieve the energy and related goals of Agenda 2030.

One of the most comprehensive definitions of capacity-building (or development) comes from UNDP: "Capacity development starts from the principle that people are best empowered to realize their full potential when the means of development are sustainable—home-grown, long-term, and generated and managed collectively by those who stand to benefit." In the same document, UNDP goes on to make an important distinction between skill and capacity development: "For an activity to meet the standard of capacity development …, it must bring about transformation that is generated and sustained over time from within. Transformation of this kind goes beyond performing tasks; instead, it is more a matter of changing mindsets and attitudes." (UNDP, 2009)

However, operationalizing capacity development in such terms has proven to be a challenge. In line with the global conventions that contribute to SDG 7 directly and indirectly, specific programmes targeting capacity-building have been funded by the Global Environment Facility. In addition, many bilateral agencies, multilateral development banks and UN agencies support national capacity-building measures through programmes for knowledge transfer, technology cooperation, policy advice and investment measures, or a combination of know-how transfer, training of local staff and preparation of studies. Such approaches are expected to lead to long-term and sustainable results by strengthening the strategic capacity of partner institutions and organizations. However, these are often narrowly targeted programmes with insufficient resources and fragmented mandates to deal with capacity issues across the energy services value chain.

### Are we on track to achieving capacity-building for SDG 7 energy goals?

Several innovative approaches have been adopted to effect transformational changes in the energy sector. On the technical side, innovations include: pay-as-you-go (PAYG), net metering, prepaid meters, and mobile apps. On the institutional side, efforts to combine energy demand and uses have led to increased productivity and livelihood opportunities. The Global Fuel Economy Initiative, a partnership of concerned international bodies, is working towards ensuring real improvements in fuel economy and the deployment of fuel economy technologies. Employment generation in sustainable energy has been increased through several trainings. Different financial mechanisms and business models have been tested through piloting and creating credit guarantee schemes, setting up ESCOs, and addressing barriers in financial, technical, regulatory, policy and institutional and implementation of energy sector projects. Technology and business model demonstrations, pilot programmes, and new innovative schemes all need to be scaled up; building capacity to operationalize at a wider level is critical for this, but has been lacking so far.

It is now well recognized that the need for further capacity-building to achieve the ambitious SDG 7 energy goals is critical at all levels across all countries. The capacity-building linked to programme-specific innovations are narrowly focused and often the capacity so built is lost to the sector over time. There is no systematic plan to ensure that the capacity-building infrastructure of a country is aligned to meet the needs of the energy sector.

Knowledge sharing, learning by doing, pilot studies, education and capacity-building programmes are a few examples of capacity-building interventions.[1] Different donor and expert agencies have analysed and implemented capacity-building initiatives in different context and locations. Some of the results indicate the need for capacity development to centre around development of human resources along entire value chains, build institutional capacities and support generation of data and improved analytical capabilities.

### Key challenges

Fragmented approaches to capacity-building, neglect of gender concerns and limited institutional mandates are key challenges to an integrated approach to SDG 7. Significant resources are needed to address the organizational weaknesses in adapting tools and implementing capacity development efforts. Dedicated institutional networks for addressing energy issues are lacking. While the need for capacity-building has been emphasized in all

[1] PAGE (2016), Integrated Planning and Sustainable Development: Challenges and Opportunities

major intergovernmental meetings, on both climate change and sustainable development, as well as in all key global agreements, capacity-building remains largely at the project level and not leading to transformational changes and sustainability of impacts.

Several observations have also been made on the need to vest capacity-building responsibilities in institutions of higher learning within countries/regions (Hugo et al. (2017); African Development Bank (2013)). Alluding to the inadequacy of resources allocated towards capacity-building efforts, AfDB noted that "A critical review of capacity development for the power industry indicates that donors are typically experiencing difficulties with funding stand-alone capacity-building programmes. Once again, this is partly due to problems related to measuring the tangible impact of such initiatives relative to their cost." (African Development Bank, 2013)."

Clearly the need for capacity-building is stronger in developing countries. Developing countries with a large unmet demand for energy have to address the challenges of achieving access to all and ensure overall sustainability through energy efficiency and renewable energy adoption. Developed countries, on the other hand, need a greater push towards meeting the energy efficiency and renewable energy targets of SDG 7. Hence, depending on development priorities, the capacity development needs of different countries and clusters such as developing, developed and transition economies would be quite different. Besides country priorities, the capacity-building framework and its implementation for achieving SDG 7 also has to recognize the fact that energy is a means to address various other developmental goals.

### Interlinkages with other SDGs

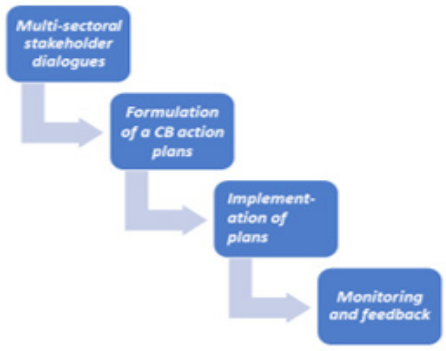
The complex and often nonlinear linkages of SDG 7 with other SDGs require a holistic and systematic approach to building capacities for a wide range of stakeholders across different sectors. It can be done only with recognition of the enabling role of energy for meeting other goals, which demands strengthening of cross-sectoral and inclusive planning, policy formulation and implementation processes. Hence, any capacity-building measure must be implemented through a mechanism that is sensitive to cross-cutting institutional aspects, decision-making processes, and upstream-downstream linkages with other goals. For example, once the focus narrows from providing energy to agriculture as a sector to meeting the need for irrigation, the solutions can vary from biotechnology to higher water-use efficiency, better water management, selling surplus electricity generated from solar PV panels to distribution companies, water conservation (drip irrigation), and pumps operating on conventional or on renewable energy. The range of partnerships and actors involved, and also the efficiency and coverage of the solutions, could be vastly different from those in practice today. Such a change would contribute to achieving not only SDG 7 but also SDG 2, SDG 6, SDG 12, and SDG 13. Therefore, for an integrated approach to tackling SDG 7 the framework or design of capacity-building initiatives has to include processes that are cross-sectoral and institution-driven as opposed to siloed project-driven approaches.

### Design of capacity-building initiatives for SDG 7

The African Development Bank has observed that (i) capacity-building must be viewed as a core goal in its own right rather than as a collateral objective, (ii) capacity-building is a long-term exercise and should be viewed as an investment project with limited immediate pay-offs and (iii) to succeed, capacity-building must be stakeholder-owned rather than donor-driven, while making use of local and regional expertise wherever possible (African Development Bank, 2013). UN agencies (UNDP, UN Women, UNEP) engaged in supporting capacity-building programmes pursue dedicated capacity development goals with partner agencies for SDGs. Recent years have seen a major focus on developing country action plans for implementing sustainable energy goals. Elements of capacity-building and training are included in these documents, but there is still a demonstrable lack of a systemic and long-term approach to capacity-building. An implementation framework of capacity-building for different groups of countries and regions should ideally comprised four steps, as shown in figure 7.1.

Figure 7.1

**Implementation framework for energy capacity-building**




**Step 1 must include stakeholders associated with each of the three energy targets but must also address itself to gender concerns and the synergies within the SDG 7 targets and the interlinkages with other SDGs.** Step 1 also emphasizes a scenario analysis related to the implications of addressing SDG 7 and sensitization of policymakers and implementers at the same time. Finally, it stresses the importance of discussing and defining cross-sectoral integration targets between SDG 7 and other SDGs at the country level.

**Step 2 asserts that each country should develop an action plan for capacity-building of stakeholders** to address energy needs in a manner that favourably impacts achievement of SDG 7 and linked SDGs. The need to develop an understanding of the needs for capacity-building across all sectors and stakeholders is therefore a prerequisite for establishing a plan of action for capacity-building. Further, it will be natural to have different sets of capacity-building needs and skill provision for countries in the short, medium and long terms.

**Step 3 involves implementation of the action through national systems and processes** for the most sustainable long-term results, and finalizing targets and indicators to monitor progress in implementation. It signifies the criticality of setting in place cross-sectoral governance mechanisms to ensure coherence of the implementation of the overall capacity-building efforts.

**Step 4 involves 360 degree data-based review and feedback** for tracking changes in performance and facilitating dialogues to improve policies and practices (Acheson Report, 1988). In this context, it is critically important to rapidly build the capacity of organizations dealing with data collection and analysis in order to ensure relevant analysis and timely feedback for course correction or modification.

## Policy Implications/Recommendations

### Policy frameworks for SDG 7

A clearly defined, long-term policy framework for achieving nationally determined energy targets, which would lend confidence to market players and financial institutions, is an essential prerequisite for investments that stakeholders along the value chain would make in capacity-building. Such a policy framework itself would need to be comprehensive in its formulation and must recognize the vertical (national to local) and horizontal (cross-sectoral) interlinkages of SDG 7.

### Administrative empowerment

Several countries, developing countries in particular, offer energy and related services through government ministries/departments and public sector organizations. Siloed functioning of administrative entities is counterproductive to an integrated, indivisible approach to SDGs. Unless new rules or empowering mechanisms are designed and implemented, it would be difficult to translate intent into output (Hugo, et. Al, 2017). At the same time, the role of the private sector is still limited and can be enhanced for innovations and resource mobilization to SDG 7 capacity-building. It is important to emphasize the need to find resources for capacity-building, such as those being provided by the Global Environment Facility for efficiency of vehicles, where the smallest amounts of funding can create massive resource savings.

### Institutionalize capacity-building

Assign responsibilities to a key institution or institutions to ensure that the trained workforce needed to support energy transformation is in place. This would have to be done across the value chain of specific energy activities. From a longer-term perspective, vest the responsibility for refreshing and realigning the higher education curriculum feeding into SDG 7 in appropriate higher education and regulatory institutions (Warren, A. et al., 2014; Weidner, H., M. Jänicke, 2002). Eventually this should lead to a governance framework that would ensure a smooth transfer of knowledge from the capacity-building institutions identified above to the energy delivery related institutions in the country.

### Create a network of the global and national institutions

Once key institutions are identified and operational at the national level, it would be desirable to develop a network of such institutions. This network should evolve to function as a:

a) Knowledge bank: repository for contextually mapped knowledge resources on policies, regulations and actions for access, energy efficiency and renewable energy;

b) Clearinghouse(s): platform for active information and experience exchange at international, regional, national, subnational or local levels;

c) Resource centre: providing online tools for capacity-building needs assessment to facilitate project development, resource assessments, access to finance, and public-private partnership models; and

d) Help desk: an online help desk for customizing actions/interventions at the local level.

Refresh and realign the curriculum in higher education institutions to better respond to the needs of SDG 7 and related goals.

### Provisioning for delivery and monitoring

The focused capacity-building national plan developed for SDG 7 would be designed through appropriate stakeholder engagement but would need to be supported by the resources required—financial, knowledge, tools and human resources—to get desired outcomes. Governments would need to identify the organizations that would implement the capacity-building plan, ensure that they are adequately resourced or have access to international resources, build accountability systems and monitor for delivery against performance indicators.

Design and implement an exacting monitoring and evaluation framework to ensure that the institutions are adequately responding to the rapidly evolving needs of the sector. Prepare an accompanying incentive framework for performance.

## REFERENCES

PAGE (2016), Integrated Planning and Sustainable Development: Challenges and Opportunities

Rehling Uwe, Karcher Henning, Merina Pradhan (2014). Capacity-building in Developing Countries, Science Forum

http://www.unwomen.org/en/news/in-focus/women-and-the-sdgs/sdg-7-affordable-clean-energy

Acheson Report (1988), Independent inquiry into inequalities in health. Stationery Office. London

African Development Bank, (2013). "Energy Sector Capacity-building Diagnostic & Needs Assessment Study". Volume 1. Sub-Saharan Power Sector Capacity-building Diagnostic & Needs Assessment. Tunisia. Available at https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Energy_Sector_Capacity_Building_Diagnostic_and_Needs_Assessment_Study.pdf

Hugo L, S. Fifita, I. Talab, C. Marschel, L. F. Cabeza (2017). "Critical challenges and capacity-building needs for renewable energy deployment in Pacific Small Island Developing States (Pacific SIDS)". Renewable Energy, Volume 107, Pages 42-52, ISSN 0960-1481, https://doi.org/10.1016/j.renene.2017.01.029.

United Nations Development Programme (2009). "Capacity Development: A UNDP Primer". New York.

United Nations (2011). Sustainable Energy for All. "A Vision Statement by Ban Ki-moon Secretary-General of the United Nations". New York. Available at http://www.se4all.org/sites/default/files/l/2014/02/SG_Sustainable_Energy_for_All_vision.pdf

Last accessed on 08/01/2017

United Nations Department of Economic and Social Affairs (UNDESA) (2016). "Synthesis of Voluntary National Reviews". New York. Available at https://sustainabledevelopment.un.org/content/documents/126002016_VNR_Synthesis_Report.pdf pp 46 - 48. Last accessed on 08/01/2017

Warren, A., L. Archambault, R. W. Foley (2014). "Sustainability Education Framework for Teachers: Developing sustainability literacy through futures, values, systems, and strategic thinking". Journal of Sustainability Education, Vol. 6, ISSN: 2151-7452

Weidner, H., M. Jänicke (2002). "Summary: Environmental capacity-building in a converging world". Capacity-building in National Environmental Policy (pp. 409-443). Springer Berlin Heidelberg.

# POLICY BRIEF #8

## INTERLINKAGES AMONG ENERGY, POVERTY AND INEQUALITIES


### Developed by

United Nations Development Programme (UNDP) and University of Bergen

### In collaboration with

UNESCAP and Federal Ministry for Economic Cooperation and Development (BMZ), Germany*

* Represented by the Division for Energy; Infrastructure; Raw Materials and the Division for 2030 Agenda for Sustainable Development; Reducing Poverty and Inequality at the Federal Ministry for Economic Cooperation and Development (BMZ), Germany.

## KEY MESSAGES

### Status of energy/poverty/inequality linkages and progress towards achievement of SDG 7

- SDG 7 is a condition for economic development, poverty alleviation (SDG 1) and reducing inequalities (SDG 10). Progress on SDG 7 can be seen as a means towards achieving other SDGs and the principle "Leave no one behind".
- Unequal access to energy and low human development are highly correlated. The concept of "energy poverty" includes "fuel poverty" in the developed world, but is most often used in the context of lack of access in the developing world to electricity, and/or clean cooking fuels or technologies. About 1.2 billion people still lack access to electricity and nearly 40 per cent of the people in the world lack access to clean cooking fuels.
- In situations where people do have access to energy, the poorest often end up paying disproportionate shares of income for energy, in part because of the higher upfront costs for energy-efficient equipment. The cost impacts of public clean energy incentive schemes may also disproportionately burden poorer taxpayers, and public money tends to favour national grid infrastructure over smaller-scale off-grid development.
- Private sector financing will be necessary to complement public sector finance in realizing universal energy access in conjunction with renewable energy uptake. This is often prevented by high financing costs as a result of a range of technical, regulatory, financial and informational barriers and their associated investment risks. Public-private partnerships may be able to make private-sector energy solutions affordable for low-income households.

### Priority actions

- Policy targets need to take into account the quality of energy access. The Multi-tier Matrix for Measuring Access to Household Electricity Supply outlines six different levels of energy access from 0 to 5. It is only at Tier 3 and above that there are new opportunities for productive uses that lead to poverty reduction and reduced inequality. Policy targets formulated for energy access should transcend a binary approach (access or not) and institute timelines and milestones for percentages of population that can graduate to Tier 5 (full) access to energy, while also acknowledging "fuel poverty" and supporting energy efficiency investments by low-income households.
- For private sector financing to contribute to clean energy access, policymakers should analyse the investment risks contributing to high financing costs and address the risks in a systemic and integrated manner. Policy de-risking instruments geared towards renewable energy uptake should be prioritized, as these offer the most cost-effective future solutions. Market transformation will usually require combining these with financial de-risking instruments, supplemented by direct financial incentives as required.
- Policymakers can address the interlinkages between energy, poverty and inequality by combining Tier 5 ("full") energy access with the promotion of productive energy use, while acknowledging "fuel poverty" and supporting energy efficiency investments by low-income households. The distribution and quality of energy access is determined by several sociotechnical and political economic drivers which operate differently across scales. As cities, regions and countries undertake energy transitions, they must "democratize" the energy sector so it is responsive to a range of stakeholders and held accountable for provision of clean energy in an equitable and inclusive manner.

## Interlinkages among energy, poverty and inequalities

Energy is an "intermediate" commodity. It is valued not so much for its own sake as for the services it enables. It powers appliances, equipment, and machinery, and also has lighting and thermal applications. In relation to the SDGs, one might say that SDG 7 is primarily useful in that it helps to achieve other SDGs. Thus, the success of SDG 7 is a precondition for the success of all other SDGs. However, for several SDGs such as SDG 1 (No Poverty) and SDG 10 (Reduced Inequality) there is especially a strong link with SDG 7. Due to its instrumental value for improving the living conditions and capabilities of households, access to energy is also a means to achieve the principle "Leave no one behind".

The interlinkages between energy, poverty and inequality have been acknowledged widely, but are interpreted using different concepts. "Energy poverty" is a concept used in interpretations varying from "fuel poverty" in developed countries to "lack of energy access" in the developing world.[1] In energy and development studies scholarship, energy poverty is commonly defined as (a) lack of access to electricity networks or (b) dependence on burning solid biomass, such as wood, straw, and dung, in inefficient and polluting stoves to meet household energy needs (Laldjebaev et al., 2016). In this policy brief, our discussion focuses on the interlinkages between energy, poverty and inequality from the latter, developing world perspective, with the interpretation of "energy poverty" mainly relating to the lack of energy access and the factors driving it.

Despite the important role that sustainable energy plays in poverty reduction, about 1.2 billion people still lack access to electricity and nearly 40 per cent of world's population still rely on solid fuels for cooking and heating (UNDP, 2017). Poor people also pay a high price—in cash or in labour—for the energy they use. Moreover, they spend a much greater share of their household income on energy than do wealthy people, not only because their incomes are so much smaller, but also because the fuels and equipment they use are so much less efficient than modern fuels and equipment. No country has managed to substantially reduce poverty without greatly increasing the use of energy.

In the first edition of the Poor People's Energy Outlook in 2010, Practical Action framed lack of access to energy services as a form, an outcome and a cause of poverty. It is a form of poverty because it restricts human capabilities to meet their needs and realize their full potential. It is an outcome of poverty because low-income individuals are limited in their financial abilities to afford goods and services that their better-off fellow citizens enjoy, even if those goods and services are ultimately unsuitable or unsustainable. And it is a cause of poverty because it "reinforces constraints in income generation potential, because many product and service-based enterprises and public services either rely on energy or are substantially improved in their productivity, profitability, or efficiency by the introduction of improved forms of energy access." Taken together, a "vicious circle" is created whereby "a lack of energy access leads to limited income-earning capability, which reduces purchasing power, which in turn limits the access to energy that could improve incomes" (Practical Action, 2010).

Box 8.1

**Clean cooking and poverty alleviation[2]**

- Clean energy access is critical for women's health, education and productive activities and is strongly related to reducing poverty and inequality for women since in many parts of the world women spend more time than men cooking and collecting water and fuel.
- Improving energy access would reduce the drudgery of women's unpaid labour and care work, enabling them to access education and employment options and enhance their livelihoods.
- According to a recent study by the McKinsey Global Institute, empowering women to participate in the global economy on an equal basis with men would add US$ 12 trillion worldwide by 2025 (McKinsey Global Institute, 2015). Women invest 90 per cent of their income back into their families and their welfare, which has a positive knock-on effect, with lasting effects for generations to come.

Reducing the global disparity in energy is key to reducing income inequalities, gender inequalities and inequalities in other dimensions such as rural/urban income disparities. A lack of adequate, reliable and affordable supplies of modern energy disproportionally impacts women and children. It is also more severe in rural communities and it limits their productive opportunities, enterprise growth and employment, exacerbating income inequality and persistent poverty. The use of alternative and unsafe energy sources often has severe consequences on health, which in return impacts poverty levels. In addition, some regions with the lowest energy consumption and greenhouse gas emissions, for example, countries in sub-Saharan Africa and South Asia, are the most vulnerable to climate change impacts and will suffer the most. Sustainable energy can help build resilience of these communities against climate change impacts and reduce inequality between and among nations.

Less often discussed but equally important is the relation between public expenditures on clean energy development and the translation of these costs to the taxpayer. While the costs of clean energy incentive schemes are usually borne by all taxpayers, these programmes can disproportionally affect the poor if the policies

[1] A COST Action on European Energy Poverty is seeking to bridge this gap: http://www.cost.eu/COST_Actions/ca/CA16232.

[2] The topic of access to clean cooking is mentioned here because

are not sufficiently designed to cushion vulnerable households with social safety nets. Another crucial consideration for equal distribution of public expenditures is the far stronger focus on national grid infrastructure; small scale off-grid development is often neglected and not eligible for similar public funds allocation as compared to national infrastructure.

## Status of Implementation

### Quality of energy access

Access to electricity used to be defined as whether or not a household had access to electricity. This, however, does not account for different levels of access to electricity provided to end users. Electricity is only useful if it allows the desired energy services to be run adequately. Different energy services require different levels of electricity supply in terms of quantity, time of day, supply duration, quality and affordability.

Figure 8.1

**Electricity access and illustrative technology options (IEA, 2017)**

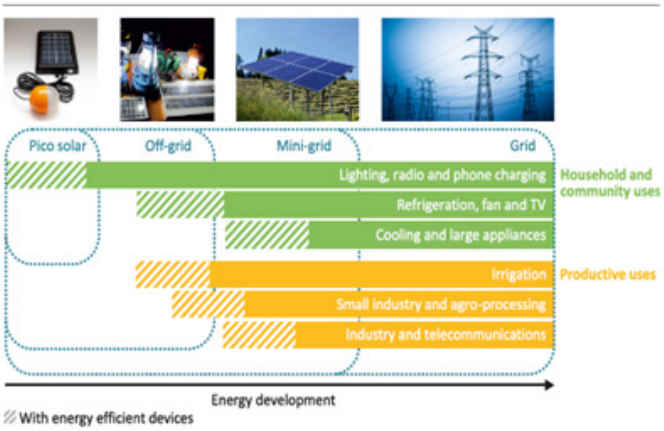
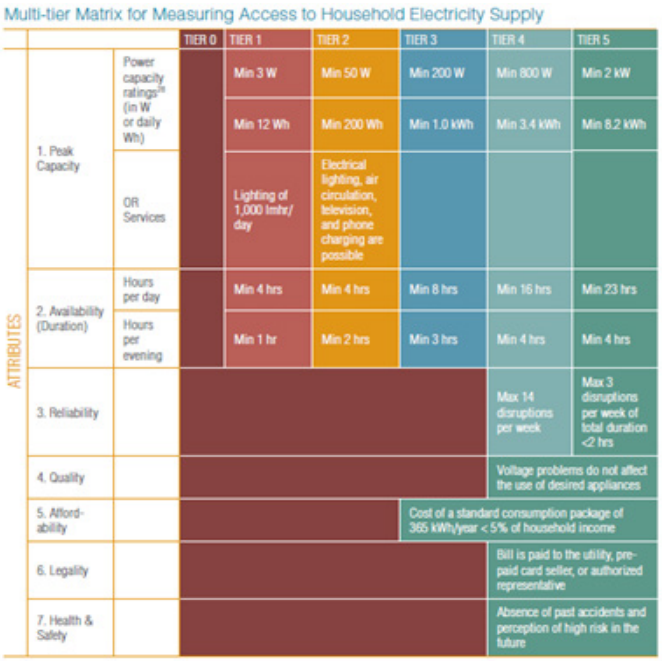



Figure 8.1 illustrates how investments in various energy systems (ranging from the most basic pico solar system, to off-grid and local mini-grids, to the most advanced system with access to an integrated electricity grid) result in incremental levels of access to electricity, and the possibility for end users to utilize more advanced end-use technologies with increasing access levels.

More recently, a comprehensive framework was developed to measure levels of access to electricity provided to end-users, where successive thresholds of supply allow for increased use of end-use equipment (appliances) (ESMAP, 2015). This framework defines 6 levels for electricity access. Tier 0 represents the baseline situation with no access to electricity and consequently no access to energy services. Subsequently, Tier 1 represents the most basic level, Tier 2 a more advanced level and ultimately Tier 5 the most advanced level (see figure 8.2).

Figure 8.2




**Multi-tier Matrix for Measuring Access to Household Electricity Supply (ESMAP, 2015)**

Today, the tracking of progress on energy access is mainly based on a binary perception of access to energy. However, it is clear that lower-tier levels of energy access may not contribute much to poverty alleviation, if at all. It is only from Tier 3 onwards that we may see growth in home businesses and new enterprises. For energy access to lead to poverty reduction and reduced inequality we therefore need to aim at Tier 5 or "full" energy access for all.

### Barriers to energy access improvement and their associated investment risks

SDG 7 provides opportunities to drive a transition towards clean energy access for all. However, sustainable energy in developing countries often faces technical, informational, financial and regulatory barriers that create associated investment risks, both real and perceived.

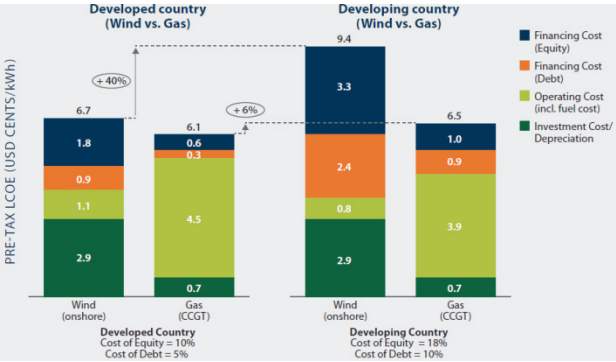
In pre-market conditions, as in many of the poorest countries and communities, these barriers to sustainable energy can act as immediate "show-stoppers". For example, investment is often impeded by a lack of access to affordable financing and capital scarcity due to lack of legal frameworks, underdeveloped economies and weak financial sectors. This presents a challenge for scaling up sustainable energy solutions, as higher returns are needed to compensate for the greater investment risks found in

of its importance for alleviating poverty and reducing inequality. Detailed discussion of clean cooking can be found in Policy Brief 2 and detailed discussion on gender inequality is addressed in Policy Brief 12.

early-stage markets. Under these conditions, sustainable energy interventions become very sensitive to financing costs, making them less attractive and less cost-competitive than conventional solutions, as illustrated in figure 8.3.

Figure 8.3

**The impact of financing costs on wind and gas power generation costs (UNDP, 2013)**




In those cases, a market transformation approach is needed that assists governments in implementing combinations of public instruments that systematically target these barriers and investment risks, with the aim of cost-effectively achieving risk-return profiles that attract investment in sustainable energy at scale. An investment's risk-return profile can be improved through reducing risk, transferring risk or compensating for risk. Measures that reduce or transfer risk result in lower financing costs. Any residual risk may then be addressed by measures that compensate for risk. All public interventions to promote sustainable energy act in one or more of these three ways.

The public sector should be aware that there may be cases where private sector engagement can lead to increased consumer prices or where energy infrastructure is solely built in areas where returns are highest. In these cases, public-private partnerships may be able to contribute to solutions that avoid this risk.

### Sociotechnical and political economic drivers of equity and quality of energy access across scales

The nature of energy access is determined by a variety of processes at multiple scales. These are characterized not only by techno-economic factors, but also by path dependence, incumbency, inertia and resistance to change. At the global scale, the geopolitics of infrastructure (oil and gas trade links, multinational treaties) modulates energy transition pathways. At the national scale, energy remains a sensitive political issue, with public perceptions driving the commitments of governments, along with economic and technical concerns. At the subnational regional scales, population demographics and intersecting factors such as class and ethnic factors matter. At the local scale, norms along religious and gendered lines determine access within communities and households.

Recognition of the multi-scalar and intersectional nature of drivers of energy poverty is finally gaining ground. But it must be translated into affirmative action, adoption of transparency measures, and substantive public participation in decision-making on energy services. This is necessary in order to systematically reduce inequalities in energy access and address energy poverty. Such action requires policy measures that are responsive to the political economic and sociotechnical realities of energy within multi-scalar administrative contexts (Sareen, 2017). Otherwise we run the risk of actors with entrenched interests pushing for regressive courses of action in the energy sector at great public cost.[3]

### Energy and poverty alleviation in light of fuel poverty and energy efficiency

The links between energy and poverty alleviation, as well as reducing inequalities, may be seen most obviously in the context of access to clean energy, but there are also cases of energy poverty related to "fuel poverty". In situations where people have access to energy, it is often the poorest that end up paying disproportionate shares of their income to energy, in part because the higher upfront costs of investments in energy efficient equipment are more difficult to bear for low-income households (Simcock et al. 2017). Energy poverty widens this discussion to encompass factors related to the built environment, including reliable, safe and comfortable access.

Fuel poverty is mainly associated with developed countries where low-income households have difficulty keeping their homes warm at a reasonable cost. However, it also relates to low-income households in developing countries, since especially for people in the poorest countries, the most inelastic segment of demand is energy for cooking and heating to ensure basic survival. Enhancing access to modern and cleaner forms of household energy is important for this group owing to its potential for increasing income levels. Just as important, however, is the need to reduce their expenditures on energy services. Previous analysis has shown that in most countries poor people spend a higher share of their income on energy than the non-poor, both for electricity as well as fuels (IISA, 2012).

Access to energy will not alleviate poverty if it is not affordable for the lowest-income households. In some cases, tariff systems with progressive fee structures (cross-subsidies) have been introduced as solutions to this challenge. However, such solutions may also create counterproductive signals to clean energy development for low-income households. It may lead to clean energy such as solar systems being of most interest to households with higher utility fees, thereby creating distortions in the business model of the utility, which may lose its higher-paying customers. Careful consideration of energy price policies is needed while alternative

[3] See the Mapping Power project for a comparative study of 15 Indian states along these lines: http://www.cprindia.org/projects/mapping-power.

policies to cushion vulnerable households with social safety nets are preferred.

Electricity access and clean cooking are therefore only part of the desired policy objectives to reduce poverty. Equally important is access to energy efficient and low-cost end-use options and devices used by the poor in agro-processing, small scale value-addition processes, water pumping, housing and transportation.

## Policy recommendations

### Quality of energy access

The policy discussion on energy access must move from a binary to a qualitative understanding of access to energy. The five-tier framework of energy access can provide a graded picture to attune action to the context and emphasize the relation between quality of energy access and poverty and inequality (ESMAP, 2015). Policy targets formulated for energy access should move beyond the binary concept and set timelines and milestones for percentages of population with Tier 5 ("full") access to energy.

### Barriers to energy access improvement and their associated investment risks

In order to allow private sector financing to contribute to access to energy, thereby reducing poverty and inequality, policymakers should analyse the investment risks contributing to high financing costs and address the risks in a systemic and integrated manner. Policy de-risking instruments geared towards renewable energy uptake should be the first choice for action as these offer the most cost-effective and sustainable future solutions, while market transformation will usually require a mix of policy and financial de-risking instruments, supplemented by direct financial incentives as required.

### Sociotechnical and political economic drivers of equity and quality of energy access across scales

Policymakers must act on the emerging consensus that energy poverty and inequitable access persist (a) due to political economic factors that can be dealt with through more participatory decision-making and transparency measures in the energy sector; and (b) due to the misrecognition of sociotechnical factors that modulate energy access at different scales and must be taken into account in national and regional energy policies. As cities, regions and countries undertake energy transitions, we must utilize the opportunity to democratize this sector into one that is responsive to public interest. Regulators, administrators, and utilities alike must be held accountable for provision of quality access to clean energy in an equitable, inclusive manner.

### Energy and poverty alleviation in light of fuel poverty and energy efficiency

The interlinkages between energy, poverty and inequality can be addressed by policymakers in combining Tier 5 ("full") energy access with promotion of productive use of energy, but also by acknowledging the concept of "fuel poverty" and support for energy-efficiency investments by low-income households.

## REFERENCES

ESMAP (2015), Beyond Connections. Redefining Energy Access. The International Bank for Reconstruction and Development/The World Bank Group

IEA (2017) Energy Access Outlook 2017: World Energy Outlook Special Report. Methodology for Energy Access Analysis. OECD/IEA Paris

IISA (2012), Energy, Poverty and Development, Karekezi, S., S. McDade, B. Boardman and J. Kimani, GEA Chapter 2, weblink: http://www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter2_development_hires.pdf

Laldjebaev K., B. K. Sovacool, K. S. Kassam (2016), Energy security, poverty and sovereignity—Complex interlinkages and compelling implications, in: International Energy and Poverty—the emerging contours, chapter 7, Routledge

McKinsey Global Institute (2015), The power of parity: How advancing women's equality can add $12 trillion to global growth.

Practical Action (2010), Poor People's Energy Outlook

Sareen, S. (2017). Energy distribution trajectories in two Western Indian states: Comparative politics and sectoral dynamics. Energy Research & Social Science.

Simcock, N., Thomson, H., Petrova, S., and Bouzarovski, S. (Eds.) (2017). Energy Poverty and Vulnerability: A Global Perspective. Routledge Explorations in Energy Studies.

UNDP (2007), Human Development Report: Fighting Climate Change—Human Solidarity in a Divided World, New York

UNDP (2013), Derisking Renewable Energy Investment, New York: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/derisking-renewable-energy-investment.html

UNDP (2017), Delivering Sustainable Energy in an Changing Climate—Strategy Note on Sustainable Energy 2017-2021, New York, accessible online: http://www.undp.org/content/undp/en/home/librarypage/climate-and-disaster-resilience-/undp-s-energy-strategy-.html

# POLICY BRIEF #9

## WATER-ENERGY-FOOD NEXUS FOR THE REVIEW OF SDG 7


### Developed by

Food and Agriculture Organization (FAO)

### In collaboration with

OPEC Fund for International Development, IRENA, IEA, UNECE, UNICEF, The European Commission, Federal Ministry for Economic Cooperation and Development (BMZ), Germany*, UN Environment, ENERGIA and UNESCWA

*** Represented by the Division for Energy; Infrastructure; Raw Materials and the Division for 2030 Agenda for Sustainable Development; Reducing Poverty and Inequality at the Federal Ministry for Economic Cooperation and Development (BMZ), Germany.**

## KEY MESSAGES

### Status of the Water-Energy-Food Nexus approach and progress towards achieving the SDGs

- The Water-Energy-Food (WEF) Nexus is a policy and planning approach designed to manage trade-offs and synergies in addressing the challenges of simultaneous demands for huge increases in water, energy and food supplies over the next decades. The importance of each these sectors is evidenced by the fact that they have their specific SDGs. At the same time, they also contribute significantly to several other SDGs, and to the implementation of the Paris Agreement.
- The WEF Nexus approach is increasingly used at the project level and supported by some governments, civil society organizations, international development partners, the private sector and research institutions, but progress has been much slower in mainstreaming the Nexus approach into policymaking, institutional contexts and planning processes.
- Implementation of the WEF Nexus approach faces a number of challenges, which can vary depending on country situations and geography (e.g., sharing a trans-boundary river basin). However, governance issues are the most challenging, including a lack of policy coherence, institutional coordination and information, as well as stakeholder power differences and politics at different levels. Another concern is that despite a strong gender dimension in the WEF sectors, gender aspects are often overlooked in the use of the WEF Nexus approach.
- There are resources that can support the adoption of the WEF Nexus approach, including well-proven WEF Nexus technologies, tools and practices. Key advantages of the Nexus approach for operators are that it reduces costs and risks and attracts increased investments and financial support. It also offers opportunities for stakeholder dialogues and public awareness-raising.

Given the challenges in mainstreaming the use of the WEF Nexus in policies and programmes, actions to that end should adopt a step-wise process through practical approaches, which might be better than striving for the "ideal".

### Priority actions

- Document, advertise and further support practical cases where the use of the WEF Nexus approach has led to successful outcomes.
- Fill knowledge gaps, in particular through support to knowledge platforms and the improvement of data collection relevant to the WEF sectors.
- Strengthen attention to gender aspects, and financial support to SMEs that embrace the WEF Nexus approach.
- Keep fostering multi-stakeholder dialogues at all levels and with a wide variety of partners, including the private sector. Prioritize capacity development at the local government and community levels as a basis for incorporating WEF Nexus decision-making into actions related to the WEF sectors.
- Strengthen participatory approaches and address power differences, in particular regarding the implementation of WEF-related interventions at the local level.
- Strengthen the capacity of national decision makers relevant to the WEF sectors, building on existing structures and mechanisms as much as possible, but also seeking new avenues for collaboration.
- Promote horizontal and vertical coordination in planning WEF-Nexus relevant action

## Introduction

Agriculture is the largest user of the world's freshwater resources, accounting for 70 per cent of total global water withdrawals (FAO, 2011a). The energy sector (primary energy production and electricity generation) accounts for only 10 per cent of water withdrawals and 3 per cent of total global water consumption (IEA, 2016). An estimated 30 per cent of global energy consumption occurs along food supply chains (FAO, 2011b), and the water sector accounts for 4 per cent of total global electricity consumption (IEA, 2016), while the energy supply sector accounts for nearly 15 per cent of global freshwater withdrawals annually (IRENA, 2015). Without adequate water and energy, global food needs cannot be met.

At the same time, cities and industry, too, claim increasingly more water, energy, food, and land resources. The challenge of managing simultaneous demand and supply in the water, energy and food sectors will be exacerbated in the near future if we continue with "business-as usual". Feeding a global population that is expected to reach 9.8 billion people by 2050 will require a 60 per cent increase in food production (compared with 2012 levels) and substantial avoidance of food losses along value chains. Global energy consumption is projected to grow by almost 30 per cent between 2016 and 2040 according to IEA's New Policies Scenario (IEA, 2017). Total global water withdrawals for irrigation are projected to increase by 10 per cent by 2050 (FAO, 2011a), but less than 2 per cent by 2040 for the energy sector, from 2014. However, energy-related water consumption would rise by 60 per cent (IEA, 2016).

An integrated approach is required to account for the close links between water, energy and food in addressing the daunting challenge of fulfilling simultaneous demands in a sustainable manner. The Water-Energy-Food (WEF) Nexus offers an approach to sector planning, policy and technology decisions that identifies potential trade-offs and explores synergies in their production and use, taking into account the finite amounts of (and often stressed) natural resource assets and the challenges of climate change. More broadly, the WEF Nexus addresses some of the key development challenges of our age—growing demands for goods and services related to population growth, rapid urbanization, changing diets and economic development—through equitable and sound management of resources within planetary boundaries and in the context of climate change.

### Links between the Water-Energy-Food Nexus, the Sustainable Development Goals and the Paris Agreement

Although water, energy, and food security are recognized as SDGs in their own right, progress towards the majority of the SDGs is directly related to the sustainable use of resources such as land, food, water, and energy. WEF Nexus knowledge platforms and stakeholder dialogues can serve as "bridging institutions" for different stakeholders in achieving the SDGs (including SDG 17—Partnerships for the Goals).

The WEF Nexus approach can help in the implementation of the SDGs in at least three ways:

- Identify potential trade-offs at the policy design stage (e.g., targets related to food security, bioenergy and thermal power capacity additions);
- Support the identification and development of solutions that positively benefit multiple SDGs (e.g., decentralized renewables in agri-food);
- Better link SDGs in their implementation through a process that avoids the "silo" approach, which prevailed with the MDGs.

There are particularly close interlinkages between the WEF Nexus and climate change, which makes this approach especially relevant to implementation of the Paris Agreement (SEI, 2011). Energy and food/agricultural production are major drivers of climate change, and at the same time, agriculture and water are among the most climate-vulnerable sectors.

Climate policies can improve water, energy and food security (e.g., through afforestation, soil carbon sequestration and renewable energy), but they can also negatively impact, or be impacted by, WEF resources. For instance, promotion of renewable energy that consumes water might lead to CO2 reduction, but also to an unsustainable increase in water demand. Similarly, diminished water availability due to climate conditions might limit the renewable energy-related climate strategies a location could pursue. At the same time, policies and practices related to the WEF sectors—such as those included in climate-smart agriculture and smarter energy solutions resulting from digitization, can offer solutions to both climate change mitigation and adaptation. Furthermore, and in rural developing economies in South Asia and sub-Saharan Africa, a switch from solid biomass (wood, agricultural residue, animal dung) to clean cooking fuels can be part of the solution to reduce carbon emissions and increase carbon retention in trees, while also improving the quality of soils for agriculture.

The inclusion of gender concerns in the WEF Nexus approach shows us how women's work currently facilitates access to water and energy for small-scale agriculture, productive enterprises, and household uses in rural developing countries, while policies to improve women's access to (pumped) water and modern energy sources can support increased production of food, economic development and women's empowerment. The analysis of the roles and contributions of women and men in the water, energy and food sectors helps in understanding the importance of women food producers, yet at the

same time their exclusion from rights to own and control critical factors of production (Kelkar et al., 2017). This analysis highlights the need for gender sensitivity in the design and management of WEF Nexus actions. Inadequate attention is currently being paid to reducing gender imbalances in household decision-making related to WEF matters (e.g., agricultural practices, water use, cooking fuel) (Nathan et al., 2018, forthcoming), but gender considerations are beginning to be systematically included in the WEF Nexus work of some organizations, such as the Commonwealth Scientific and Industrial Research Organization. CSIRO, 2017).

### Status of implementation of the WEF-Nexus Approach

Due to its importance in achieving both the SDGs and the Paris Agreement, the WEF Nexus approach has recently received increased attention in international initiatives (e.g., SEforAll and the World Economic Forum) as well as support from the research/academic sector, governments, the private sector and international development partners.

To date, there are very few examples of mainstreaming the WEF Nexus approach in national policies, programmes and institutions—though it has been introduced to some extent in Austria, Germany, Mauritius and Qatar. In part, this is explained by governance challenges discussed later.

However, the approach is increasingly being used at the project level, often with support from international development partners and/or the private sector. Food producers (farmers and/or agri-food companies) are accustomed to managing their production according to the availability of water and energy. However, the increased risks of resource scarcity, associated with the realities of climate change, require them to "change gears" in addressing these challenges.

### Challenges and opportunities

While the trends that give impetus to adopting a WEF Nexus approach are global in nature, the implications and challenges vary according to different contexts (OFID, 2017).

For low-income countries, the highest priority is to simultaneously close the large energy, water and food security gaps. Access to data, technologies, knowledge, and finance is key for setting up viable business models and developing integrated nexus solutions—particularly in agriculture—and can help accelerate progress towards sustainable development and poverty reduction.

Emerging economies have witnessed rapid growth, which also means increased consumption of goods and services per capita, including regarding the WEF sectors. A focus on resource-use efficiency and good governance will ensure adequate, inclusive and sustainable supply of water, energy and food under these circumstances.

Industrialized countries have higher per capita resource demands, and large external resource footprints that put pressure on resources. In this case, the challenge is to substantially reduce their footprints while ensuring adequate economic growth.

Given the nature of the WEF Nexus (i.e., cross-sectoral and focused on key resources for people's livelihoods, ensuring policy coherence and good governance are crucial for its sound and fair implementation. Until very recently, implementation focused primarily on technical solutions, whereas governance did not receive much consideration, particularly in the context of the institutions and politics governing the WEF sectors. WEF Nexus decisions are often based more on political than technical factors because the current reality of increased resource demand, scarcity and climate change impacts, means that decisions on the production and use of WEF resources entail trade-offs—and hence winners and losers (Scott, 2017; Weitz et al., 2017). Stakeholder differences in knowledge, and ultimately power, often prevail in WEF Nexus area decision-making. Therefore, one has to go beyond trade-offs and synergies in considering WEF nexus issues, and better understand the nature of stakeholder interactions in dealing with these issues.

One important factor is that limited information undermines evidence-based decision-making. This is frequently owing to the lack of reliable and up-to-date data on the status of the WEF sectors, as well as insufficient awareness of the benefits of using the WEF Nexus approach by relevant sector players and inadequate accounting of externalities due to low or no pricing of water and energy use, particularly in developing countries.

Within governments, there may be lack of motivation to coordinate by relevant sectoral bodies because the transaction costs of coordination are perceived to be higher than the benefits. Therefore, besides awareness of the benefits, incentives to collaborate are also needed. Fragmentation is sometimes compounded by international and bilateral development support, and different priorities among the sectors (line ministries) often hinder collaboration with other sectors and long-term planning.

Ministries/institutions with an overarching mandate (bridging institutions) like trans-boundary river commissions or planning ministries/environmental ministries are sometimes in a better position to take up and promote the WEF Nexus approach. The management of international trans-boundary river basins presents specific challenges concerning politics, diversity of scales and perspectives, and the importance of state actors; applying the WEF Nexus approach can help to address such challenges through a more integrated and inclusive approach that can alter existing actor dynamics (Keskinen et al., 2016).

Companies offering WEF Nexus solutions to small and medium-sized players in the agri-food value chains are mostly innovative, early-phase enterprises with a common problem regarding access

to adequate finance. In order to attract investment and enlarge their businesses or "build scale", these entities need de-risking mechanisms and enablers of access to higher levels of finance. Some financial support mechanisms for WEF small and medium-sized enterprises are emerging—such as the OFID-REEEP WEF Nexus Revolving Capital Pool (OFID, 2016). At the same time, some interesting ways exist to address the challenges related to the WEF Nexus.

There are several ways to reduce the energy footprint in the water sector, including improved energy efficiency (e.g., in irrigation), energy recovery (e.g., in wastewater treatment, which can also produce energy), and reduced leaks, which waste both water and energy. The freshwater footprint of the energy sector can be reduced through greater use of alternative water sources, water recycling and improved efficiency in the power plant fleet. The energy sector can also provide the agricultural sector with its produced water after treatment, as is being done by some oil/gas companies in the US. Carbon and water footprints can be useful tools for measuring and monitoring, and low footprints can also be valuable assets in marketing products (UNESCO, 2012).

Farmers and private sector companies are usually interested in water- and/or energy-saving practices that reduce their operational expenses and also contribute to de-risking their operations in situations where these resources are or might become scarcer (REEEP, 2014). Several efforts are being undertaken to integrate water and energy planning (IRENA, 2017). The World Bank's "Thirsty Energy" work in South Africa is an example of this (World Bank, 2017).

The use of renewable energy can, depending on the technology used and local conditions, have significant positive effects on optimizing water use while ensuring enough food production. However, this can also face several constraints, as shown by the cost-benefit analysis (both monetized and non-monetized) of introducing renewable energy in selected food value chains, which was recently undertaken by FAO (FAO 2017 a and b). In particular, non-monetized costs of women's labour, whether in cultivation or cooking, are ignored in cost-benefit calculations, leading to an overuse of both women's labour and the biomass extracted with it (Nathan et al., 2018, forthcoming).

WEF Nexus-related investments contribute substantially to achieving all SDGs, and these investments are promoted in the agendas of both national governments and development finance institutions. For example, OFID's Corporate Plan 2016-2025 expresses the institution's readiness to mobilize resources to tackle energy, water and food security in an integrated way (OFID, 2017). Indeed, over the coming decade, OFID will commit 70 per cent of its funding to the WEF sectors, plus transportation as an enabling component.

Inclusive governance in the WEF sectors can contribute to addressing power imbalances between different actors, as well as different levels of government, including through stakeholder dialogues—such as the recent EU/BMZ-funded WEF Nexus Regional Dialogue Programme, the ESCWA Water-Energy Nexus and Water-Food Nexus Projects in the Arab Region, and the "Integrating Approach" used in Colombia.

### Recommendations on scaling up the use of the WEF Nexus approach

Scaling up successful WEF nexus experiences would require a major paradigm shift in the fragmented way programmes are currently implemented in the WEF sectors. This will not be easy and will not happen overnight. From a pragmatic point of view, this means that developing a step-wise process through practical approaches might be better than striving for the "ideal" (Scott, 2015).

The following recommendations in that direction are proposed:

a) As regards *political/institutional aspects*:

- **Take into consideration the political economy of solutions put forward** Make analysis of political systems, stakeholders and power relations an integral part of all suggestions/solutions for WEF-nexus issues. Solutions should be formulated that promote policy coherence as well as an enabling environment (access to information, rule of law, etc.).
- **Build effective, accountable and inclusive institutions at all levels** Integrate the building and/or strengthening of institutions into policymaking for, and implementation of, WEF-nexus approaches. Effective, accountable and inclusive institutions as well as rule-based regulatory/legal environments are crucial in promoting a participatory and citizen-oriented implementation of actions related to the WEF sectors.
- **Strengthen local NGOs**, given their close links with local populations, hence their key role in raising awareness and facilitating implementation of development actions (UN ESCWA, 2013).
- **Prioritize capacity strengthening of decentralized government institutions** Indeed, it is decision-making at the local level that will largely determine how trade-offs and synergies in the WEF nexus are implemented, when promoting the WEF Nexus approach with governmental institutions. Emphasize the efficiency gains and the conflict prevention potential of the Nexus approach, despite higher upfront costs of inter-sectoral coordination and planning. Enable broad stakeholder involvement, not only at the governmental level, but also for citizens, in order to allow

for bottom-up solutions, knowledge sharing and conflict mitigation.

- **Support both horizontal and vertical coordination** Both types of coordination may often be met with resistance. Progress regarding the above-mentioned interventions, in particular those related to stakeholder processes and capacity-building, have proven to strengthen such coordination in an unforced, somewhat "organic" way.

b) As regards *knowledge management*:

- **Document and advertise successful WEF Nexus management cases** because these help raise interest and provide the arguments for scaling up Nexus approaches.
- **Improve the knowledge basis** regarding WEF Nexus' current and future status. IRENA (2015) has reviewed the most common WEF Nexus tools. Most of them concern scenarios based on modelling, however, FAO proposes two tools that are based on existing situations: the nexus assessment methodology (FAO, 2014), and the cost-benefit analysis of clean energy technologies in agri-food chains (FAO, 2017 a and b).
- F**ill knowledge gaps and collect and make data available**, including on water consumption in the energy sector; energy utilization across the water supply chain; water and energy use and needs at all stages of agri-food chains; environmental impacts on the use of water, energy and land in food production; GHG emissions; and social impacts (employment, and gender considerations).
- **Support interregional/international exchange of experiences** on the use the Nexus approach in planning and policymaking. Provide case studies/good practices; which can be transferred to other national/regional contexts. Knowledge platforms such as the Germany/EU-funded WEF Nexus Resource Platform (GIZ, 20016a) and the energypedia/Powering Agriculture portal (Energypedia, 2018a) provide good examples about sharing nexus experience and information.

c) As regards *appropriate technologies and good practices*:

- **Promote well-proven technologies in all the WEF sectors.** Social acceptance, risks, workloads and opportunity costs have to be sufficiently taken into account when promoting these technologies.
- Where possible, **co-locate water and energy infrastructure**, allowing the waste stream of one to be utilized by the other (or by the agricultural sector), allowing for a reduction in by-products, minimization of transportation costs and lower energy and water requirements.
- **Strengthen capacities of WEF resource users** Make WEF sector stakeholders aware of the risks associated with inappropriate use of water and energy, and then enable them to employ clean energy as well as energy- and water-efficient technologies and practices. The capacity of direct resource users to assess options, make informed decisions on investment, handle technologies, and access finance, is key for scaling up the Nexus approach. Awareness and Information of consumers on sustainable energy use is also important in order to create a demand to buy these products. Concrete examples of capacity development include the GIZ/FAO Toolbox on Solar Powered Irrigation Systems (Energypedia, 2018b) to strengthen skills in Nexus technology, and the OFID-REEEP WEF Nexus Revolving Capital Pool regarding financial support mechanisms (OFID, 2016).

d) As regards stakeholder processes:

- **Foster stakeholder dialogue** at different levels (especially public/private sector engagement): An interesting experience at the regional level concerns the EU/BMZ-funded WEF Nexus Regional Dialogue Programme (GIZ, 2016b), and the "Integrating Approach" used in Colombia to implement SDGs (Communitas Coalition, 2013) provides a good example of fruitful and inclusive dialogue at national level;
- Strengthen participatory approaches and address power differences, including differences related to gender, as these are often crucial in achieving sustainable and equitable implementation of actions related to the WEF sectors. The WEF Nexus approach adds to the typical stakeholder processes an element of equality between sectors, which helps in addressing power differences. IIED has developed one of the few compilations on "power tools", which are also relevant to WEF Nexus implementation (IIED 2001).

## REFERENCES

Communitas Coalition 2013. The Integrating Approach—A Concept Paper from the Government of Colombia to assist in defining the architecture of the SDG Framework. http://communitascoalition.org/pdf/Integrating_Approach_7OCT2013.pdf.

CSIRO. 2017 Gender in a changing world. https://www.csiro.au/~/media/LWF/Files/SDIP/17-0055_LW_BROCHURE_GenderCapabillity_4ppBrochure.pdf.

Energypedia. 2018a. Welcome to the Powering Agriculture Portal, https://energypedia.info/wiki/Portal:Powering_Agriculture.

Energypedia, 2018b. Toolbox on Solar Powered Irrigation Systems (SPIS), https://energypedia.info/wiki/Toolbox_on_SPIS.

FAO. 2011a. The state of the world's land and water resources for food and agriculture (SOLAW)—Managing systems at risk. Rome: Food and Agriculture Organization of the United Nations and London,

Earthscan. http://www.fao.org/docrep/017/i1688e/i1688e.pdf.

FAO. 2011b. Energy-smart food for people and climate. Issue Paper. Rome: Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/014/i2454e/i2454e00.pdf.

FAO 2014. Walking the Nexus Talk: Assessing the Water-Energy-Food Nexus in the Context of the Sustainable Energy for All Initiative. FAO Environment and natural Resources Working paper # 58. http://www.fao.org/3/a-i3959e.pdf.

FAO and USAID 2015. Opportunities for Agri-Food Chains to Become Energy-Smart. http://www.fao.org/3/a-i5125e.pdf.

FAO 2017a. Costs and benefits of clean energy technologies in the milk, vegetable and rice value-chains—Intervention level.

FAO 2017b. Measuring impacts and enabling investments in energy-smart agrifood chains—Findings from four country studies, December 2017.

GIZ. 2016a.—The Water, Energy and Food Security Resource Platform. https://www.water-energy-food.org/about/introduction/

GIZ 2016b. The Nexus Dialogue Programme Phase 1 (2016–2018)—The Water Energy Food Security Nexus. https://www.water-energy-food.org/fileadmin/user_upload/files/2016/documents/nexus-secretariat/nexus-dialogues/Water-Energy-Food_Nexus-Dialogue-Programme_Phase1_2016-18.pdf.

IEA. 2016. World Energy Outlook 2016- Excerpt- Water-Energy Nexus. Paris: OECD/International Energy Agency. https://www.iea.org/publications/freepublications/publication/world-energy-outlook-2016---excerpt---water-energy-nexus.html.

IEA. 2017. World Energy Outlook 2017. Paris: OECD/ International Energy Agency. https://www.iea.org/weo2017/.

IIED 2001. Power tools: for policy influence in natural resource management. http://www.policy-powertools.org/.

IRENA 2015. Renewable Energy in the Water, Energy & Food Nexus. http://www.irena.org/publications/2015/Jan/Renewable-Energy-in-the-Water-Energy--Food-Nexus.

IRENA 2016. Solar pumping for irrigation: Improving livelihoods and sustainability. http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Solar_Pumping_for_Irrigation_2016.pdf.

IRENA 2017. Renewable Energy Benefits: Decentralized Renewable Energy Solutions in the Agri-Food Chain. http://www.irena.org/publications/2016/Sep/Renewable-Energy-Benefits-Decentralized-solutions-in-agri-food-chain.

Kelkar, G., Nathan, D., Mukhim, P., Dzuvichu, R. 2017. Energy, Gender and Social Norms in Indigenous Rural Societies. Economic and Political Weekly. 52, 1.

Keskinen, M; Guillaume, J; Kattelus, M; Pokka, M; Rasanen, T and Varis, O. 2016. The water-energy-food nexus and the transboundary context: Insights from large Asian rivers. Water. 8, 193 (2016). http://www.wdrg.fi/wp-content/uploads/2016/05/TransboundaryNexus.pdf.

Nathan, D., Shakhya, I., Rengalakshmi, R., Manjula, M., Gaekwad, S., and Kelkar, G. 2018 The Value of Women's Labour in Production and Fuel Use: A Framework for Analysis. Economic and Political Weekly. (forthcoming).

OFID 2016. The 2030 development Agenda: Energy access a keystone. OFID Pamphlet Series #40, January 2016. https://www.arabdevelopmentportal.com/sites/default/files/publication/902.the_2030_development_agenda_energy_access_a_keystone.pdf.

OFID 2017. The energy-water-food nexus: managing key resources for sustainable development. OFID Pamphlet Series #41, December 2017. http://www.ofid.org/Portals/0/Publications/Pamphlet per cent20Series/OFID_PAM41_web.pdf.

REEEP 2014. Making the Case: How Agrifood Firms are Building New Business Cases in the Water-Energy-Food Nexus—Report prepared for FAO. https://www.reeep.org/sites/default/files/REEEP_Making_The_Case.pdf.

Sarni, W. 2015. Deflecting the scarcity trajectory: Innovation at the water, energy, and food nexus. Deloitte Review Issue 17.

https://dupress.deloitte.com/dup-us-en/deloitte-review/issue-17/water-energy-food-nexus.html.

Scott, A. 2017. Making governance work for water–energy–food nexus approaches. CDKN Working Paper, June 2017. https://cdkn.org/wp-content/uploads/2017/06/Working-paper_CDKN_Making-governance-work-for-water-energy-food-nexus-approaches.pdf.

SEI 2011. Understanding the Nexus https://www.sei-international.org/mediamanager/documents/Publications/SEI-Paper-Hoff-UnderstandingTheNexus-2011.pdf.

SEI 2014. Cross-sectoral integration in the Sustainable Development Goals: a nexus approach. Discussion Brief. https://www.sei-international.org/mediamanager/documents/Publications/Air-land-water-resources/SEI-DB-2014-Nexus-SDGs-integration.pdf.

UNESCO 2012. Carbon and Water Footprints. Concepts, Methodologies and Policy Responses. http://unesdoc.unesco.org/images/0021/002171/217181E.pdf.

UN ESCWA 2013. The role of NGOs and civil society organizations in the deployment of renewable energy in rural and remote areas in the Arab Region—The need to transform constraints into opportunities. http://css.escwa.org.lb/SDPD/3229/1wp.pdf.

UN ESCWA 2016. Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals. Regional Policy Toolkit. https://www.unescwa.org/publications/water-energy-nexus-regional-policy-toolkit https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/water-energy-nexus-regional-policy-toolkit-english.pdf.

WBCSD 2015. Co-optimizing Solutions: water and energy for food, feed and fiber. http://www.wbcsd.org/Projects/Climate-Smart-Agriculture/Resources/Co-optimizing-Solutions-water-and-energy-for-food-feed-and-fiber.

Weitz, N; Strambo, C; Kemp-Benedict, E and Nilsson M. 2017. Closing the governance gap in the water-energy-food nexus: Insights from integrative governance. Global Environnemental Change 45 (2017), 165-173. https://www.sciencedirect.com/science/article/pii/S0959378017300031 .World Bank 2017. Thirsty Energy: Water-Smart Energy Planning in South Africa. http://www.worldbank.org/en/news/feature/2017/06/15/thirsty-energy-water-smart-energy-planning-in-south-africa.

# POLICY BRIEF #10

## HEALTH AND ENERGY LINKAGES—MAXIMIZING HEALTH BENEFITS FROM THE SUSTAINABLE ENERGY TRANSITION

### Developed by

World Health Organization (WHO)

### In collaboration with

Climate and Clean Air Coalition, Global Alliance for Clean Cookstoves, UN Environment, UNICEF and United for Energy Efficiency

## KEY MESSAGES

### Status of health–energy linkages and progress towards achievement of the SDGs

- Policies designed to meet SDG 7 targets on energy access, energy efficiency and renewables have the potential to also provide vast benefits for human health (SDG 3), and spur progress across the entire Sustainable Development Agenda. However, to realize this opportunity, closer cooperation is needed at all levels between actors and decision makers, and especially between health and energy sectors.
- Lack of access to clean fuels and technologies for cooking currently has negative effects on the health of 3 billion people, and related household air pollution is a cause of some 4 million deaths from noncommunicable diseases (including heart disease, stroke and cancer), as well as childhood pneumonia. Inefficient household energy use is a particular health and livelihood risk for women, children and infants. Access to clean fuels and technologies has the potential to save millions of lives each year.
- In urban areas, air pollution (largely generated from the inefficient use of energy in homes, and in the transport, industry and building sectors) is putting over 90 per cent of the world's urban populations at increased risk of heart, brain and respiratory disease.
- Energy access challenges also affect health care delivery. Around 25 per cent of health care facilities in 11 sub-Saharan African countries have no access to electricity, a major barrier to the delivery of essential primary health care.

### Priority actions

- Increase the availability of "'clean for health'" household energy solutions through reforms of national fuel subsidies, regulatory frameworks, and standards, elimination of market barriers, and an increased focus on building markets for clean and modern fuels and technologies (by means of innovations in financing and business models for household stove designers and distributors, including in remote locations).
- To improve urban health, promote investments in clean renewable energy, energy-efficient networks and pollution-free public transportation, and revise tax incentives and building codes to encourage energy-efficient, healthy homes.
- Facilitate collaboration between energy and health sector decision makers to ensure that health facility energy needs are adequately prioritized in national strategies, and promote the development of local industries to provide energy services for health care facilities in resource-constrained settings.

## Health and Energy in the context of the Sustainable Development Goals

Energy sustains us, connects us and sometimes even saves us. We use it to cook our meals, to light and heat our homes, to get where we want to go, to produce and use most goods, and to power our medical devices and health-care systems. Having access to reliable, clean, modern energy sources enables people to live to their full potential. Conversely, living without reliable energy constrains people's possibilities, and undermines their health and well-being. A lack of electricity limits the availability of life-saving care in health-care facilities, affecting lighting, heating, ventilation and cooling systems, blood banking, cold-chain vaccine storage, and ICT services. Without reliable energy, businesses cannot operate, transport systems cannot function, and homes and workplaces cannot be heated and cooled to a comfortable level. For billions who rely on polluting fuels and devices, for example burning wood in an inefficient stove to cook meals, the resulting household air pollution poses a deadly, daily health risk.

In pursuit of SDG 7, the global community aims to meet three targets by 2030: ensure universal access to affordable, reliable and modern energy services; increase substantially the share of renewable energy in the global energy mix; and double the global rate of improvement in energy efficiency.

Investing in energy access, renewables and energy efficiency—the three target areas of SDG 7—will be instrumental in unlocking progress across the Sustainable Development Agenda. Accelerating efforts to achieve SDG 7 will reduce poverty, contribute to more inclusive, sustainable economic growth, and generate especially great health benefits, particularly among vulnerable populations (women, children). Close to 600,000 children under age 5 die each year from respiratory infections, such as pneumonia, attributable to the joint exposure of indoor and outdoor air pollution (WHO, 2016). Women and girls are the primary procurers and users of household energy services, and bear the largest share of the health risks and other burdens associated with the reliance on polluting and inefficient home energy systems.

This briefing highlights how policies to achieve these three targets can create significant benefits for health, through focused actions in three key settings: households, cities/urban environments and health-care facilities. It summarizes recommendations for prioritizing "energy for health" policies and interventions in each of these settings, offering intermediate targets to focus efforts in the energy and health sectors.

### Access to clean and modern household energy and health

Three billion people rely on polluting fuels and technologies for their daily cooking needs. Over a billion people still lack access to electricity, and must rely on candles and kerosene lamps to light their homes. Their homes are dangerous places to be simply because the energy sources they use release high-levels of pollutants that are harmful to their health. Achieving universal access to affordable, reliable and modern energy (SDG Target 7.1) will improve the health and well-being of some of the most vulnerable people in the world. It is the poorest countries, and within countries, the most vulnerable populations (e.g., women, children), who lack access to clean, affordable energy alternatives such as electricity, gas, biogas and other low-emission fuels and devices to meet their most basic cooking, heating and lighting needs.

Fundamental public health goals enshrined in SDG 3, such as improving child survival and preventing noncommunicable diseases, simply cannot be achieved without expanding access to clean household energy. Household air pollution resulting from the inefficient use of clean fuels and technologies for cooking alone is responsible for some 4 million deaths and over 146 million disability-adjusted life years (DALYs) each year (WHO, 2016); more than the total number of deaths from HIV/AIDs, malaria, and tuberculosis combined. Household air pollution is the leading risk factor for childhood pneumonia, accounting for over 50 per cent of all childhood pneumonia deaths or about 530,000 deaths each year. It is also responsible for a substantial fraction of deaths from noncommunicable diseases: about one-third of all premature deaths from chronic obstructive pulmonary disease; one quarter of deaths from stroke; and close to one-fifth of deaths from lung cancer and ischemic heart disease. (See figure 10.1)

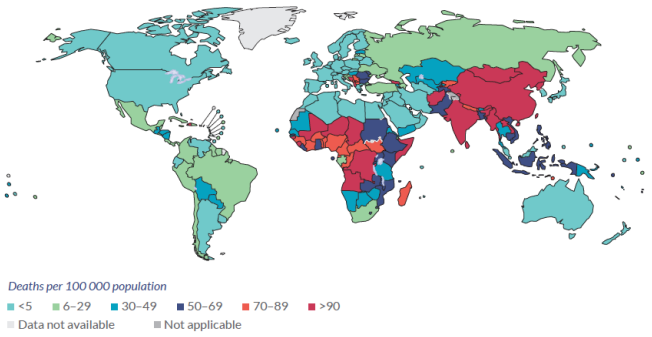
Box 10.1

**Achieving SDG 7 will be instrumental for achieving multiple SDG 3 targets:**

- **3.2: Reducing the neonatal and under-5 mortality rates.** ("By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.")
- **3.4: Reducing the mortality rate attributed to cardiovascular disease, cancer, chronic respiratory disease.** ("By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.")
- **3.9: Reducing the mortality rate due to household and ambient air pollution.** ("By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.")

Figure 10.1

**Deaths per 100,000 population from household air pollution caused by using mainly polluting fuels and technologies for cooking, 2012 (WHO, 2016)**




Components of household air pollution (i.e., black carbon, methane) are also major climate drivers. Inefficient use of energy in the home is responsible is a major source of black carbon emissions (the second most important climate-forcing pollutant after carbon dioxide) and is a major source of methane, which contributes to the formation of ground-level ozone or smog.

Ensuring universal access to clean and energy in the home can save lives now and in the future, helping to accelerate the achievement of SDGs on health (especially targets 3.2, 3.4 and 3.9—see box 10.1). The International Energy Agency (IEA) estimates that 1.8 million lives a year could be saved between now and 2030 from strong and concerted actions taken to achieve the universal energy access target. (IEA, 2017a)

Beyond SDG 3 and SDG 7, accelerating access to clean household energy will unlock progress towards multiple SDGs, like SDG 5 on gender, SDG 11 on cities and SDG 13 on climate . In addition to gender, health and well-being benefits for children, and, in particular, girls, can be significant. Available survey data from 13 countries showed that girls in sub-Saharan African homes using mainly inefficient biomass cookstoves spend about 18 hours weekly collecting fuel or water, while boys spend 15 hours; in homes mainly using cleaner stoves and fuels, girls spend only 5 hours weekly collecting fuel or water, and boys just 2 hours. (*WHO, 2016)* use of modern and clean energy in the home can alleviate the drudgery and safety risks associated with traditional household energy use and the resulting time savings provide the opportunity

Box 10.2

**Support for accelerating universal energy access: examples of global initiatives and partnerships**

***Sustainable for Energy for All*** is a non-profit organization working with leaders in government, the private sector and civil society to drive action toward achievement of SDG 7 and the Paris Climate Agreement, which calls for reducing greenhouse gas emissions to limit climate warming to below 2 degrees Celsius. SEforAll provides a knowledge hub, hosted by the World Bank in collaboration with other partners, to benchmark progress towards SEforAll's objectives through its Global Tracking Framework and other knowledge products. More than 100 countries have engaged with SEforAll, providing financial or in-kind contributions or working on tailored national strategies and investment plans to deliver on SEforAll's objectives.

***Global Alliance for Clean Cookstoves*** is a public-private partnership hosted by the UN Foundation to save lives, improve livelihoods, empower women and protect the environment by creating a thriving global market for clean and efficient household cooking solutions. The Alliance's "100 by 20" goal calls for 100 million households to adopt clean and efficient cookstoves and fuels by 2020. It works with a strong network of public, private and non-profit partners to accelerate the production, deployment, and use of clean and efficient cookstoves and fuels in developing countries.

**United for Efficiency (U4E)** is a global public-private partnership, led by UN Environment, supporting countries to save up to 20 per cent of their electricity usage by moving their markets to high-efficiency appliances and equipment. U4E works to inform policymakers of the significant environmental and economic savings and benefits available as well as promoting global best practices. http://united4efficiency.org/accelerating-the-transition-to-high-efficiency-products/

***Energy Sector Management Assistance Program*** *(*ESMAP) of the World Bank is a global knowledge and technical assistance program. ESMAP's mission is to assist low- and middle-income countries to increase know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP's current activities are organized around energy access, renewable energy, and energy efficiency with specific thematic work on: energy subsidy reforms; energy sector governance, markets, and planning; and providing knowledge as a global public good through the SEforAll Knowledge Hub. Gender dimensions are mainstreamed across the entire work program.

for more schooling, income generation and/or leisure for women and children.

Lack of access to clean and modern energy services in the home is not limited to rural areas. On average, around 22 per cent of households in urban areas lack access to clean fuels and technologies for cooking, and 5 per cent still lack access to electricity (WHO, 2016; World Bank, 2017). In many cities and peri-urban areas, inefficient household fuel combustion is a major source of air pollution and related health impacts. A recent study shows that much of the air pollution in New Delhi, around one-fifth, is actually caused by the air pollution generated from inefficient cookstoves in and around the mega-city (Aman et al. 2017)

The adoption of clean and modern energy services in the home also presents an unparalleled opportunity to realize climate and health co-benefits. Inefficient household fuel combustion is a significant source of both greenhouse gases and short-lived climate pollutants. Globally, residential biomass combustion is thought to account for around 25 per cent of global black carbon emissions (a health-damaging pollutant) in the air (WHO, 2016) and is a major cause of glacier melting. Affordable and reliable sources of clean and modern energy services in the home present an opportunity for climate change mitigation and reduce the health impacts from climate-sensitive diseases.

Current trends suggest that the global community is moving too slowly, and needs to act with more urgency (IEA, 2017; World Bank, 2017). The International Energy Agency's projections show that at the current rate of progress, only 91 per cent of the world's people will have electricity access in 2030, while only 72 per cent will have access to clean cooking energy by 2030. (More financial resources are applied to electricity access.) While technology advances and falling costs are bringing clean energy within reach of more households, significant policy and finance gaps remain. A 2017 IEA report estimates that an additional US$ 786 billion cumulative investment is needed in the period to 2030 to meet the universal energy access target, or increase of 3.4 per cent in current energy expenditure. Policymakers have an opportunity to remove some of the barriers (e.g., cost, supply, tariffs, market expansion) for the long-term of adoption of clean cooking, heating and lighting services and products. Paired with the important and substantive work of both global and local energy access initiatives, we have the opportunity and partnerships (see box 10.2) to save millions of lives and improve the livelihoods of billions of people. (IEA, 2017; WHO, 2016).

Figure 10.2

**Clean and modern household energy linkages with other SDGs**


## Policy recommendations on access to energy and health:

- "Making the clean available" (Smith and Sagar, 2014) Improve the availability and affordability of suitable household energy solutions that are clean for health at the point-of-use (such as LPG, electricity, ethanol and biogas) through policy levers such as national subsidy reform (e.g., removing kerosene subsidies); increasing availability of clean fuels and technologies including to remote locations and refugee settings; facilitating behavioural changes by developing fuel and technologies with the end user in mind; eliminating barriers to establish a market for clean and renewable energy solutions; and enacting regulatory frameworks and standards that promote clean household energy.

- "Making the available clean" New technologies are being developed that can burn widely available renewable fuels such as wood and dung almost as cleanly as gas, but further technical development of the next generation of scalable and affordable low-emissions stoves is needed. Energy and health sector policymakers can help spur the rate of development, dissemination and sustained adoption of these cleaner-burning biomass stoves and devices through incentives to support innovation, market promotion, national standards for clean household energy solutions, behavioural change and awareness programmes, and regulatory frameworks that enable investments in, and penetration of, clean fuels and technologies.

- Mobilizing significant monetary resources will enable the clean cooking sector to scale up. Funding should advance innovative finance and business models that support household consumers, stove designers, and distributors.

### SDG 7 and urban population health

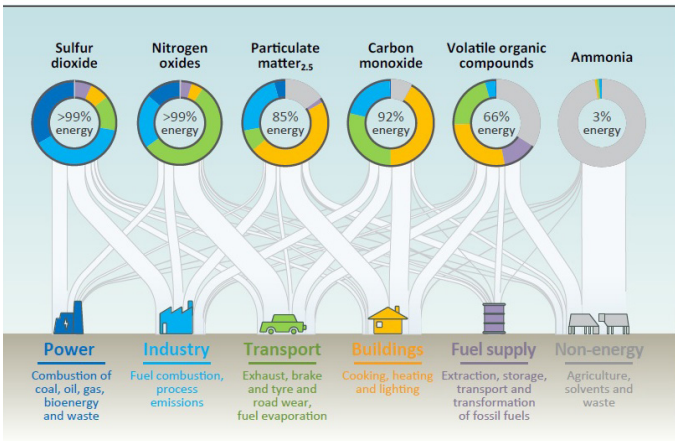
More than half of the world's people now live in cities, and by 2030, almost 60 per cent of the world's population will dwell in cities (UN Habitat, 2016). In particular the urban populations in low-income countries are projected almost to triple, increasing by over 500 million, by 2050. The number of megacities has been increasing, and 47 cities have more than 10 million inhabitants in 2018. This rapid and often unplanned urbanization is associated with the rise of several environmental burdens, for example air pollution and unsustainable mobility that contribute to increases in noncommunicable diseases, such as heart disease, cancer and diabetes.

Cities are responsible for more than 70 per cent of global $CO_2$ emissions and only 12 per cent of the cities in the global WHO database meet the WHO air quality guidelines values (air quality levels designed to protect public health from ambient air pollution). (*WHO, 2016)*

Inefficient energy use by industry, transport, waste burning, construction activities and buildings represents a major cause of air pollution and related ill health in urban and peri-urban areas (figure 10.3). While in the EU and some countries and cities in the Americas measures have been adopted that have contributed to substantial reductions in the levels of air pollution—although exposure is still on average above the WHO guidelines—the trend has been the opposite in most low- and middle-income settings, in particular in Africa and Asia. Current trends suggest that energy demand is expected to increase in almost all key economic sectors in cities, particularly in developing cities with rapid growth. For instance, the International Energy Agency's projections show that energy demand and emissions from the transport sector alone will continue to increase by 2050 unless a substantial set of avoid/shift/improve measures are put in place in the years to come (IEA, 2016).

Figure 10.3

**Selected primary air pollutants and their sources (IEA, 2016)**




Human activities can be planned and designed in ways that promote public health, for example minimizing the production of air pollution. Other sectoral policies should take into account the significant health benefits that the transition to a sustainable, energy-efficient economy offers. Policies and interventions aimed at promoting smart energy system controls, waste-to-energy approaches and strategies to efficiently manage industrial emissions and excess heat can create sustainable urban energy systems, ensuring access to energy for all while decoupling development from emissions of air and climate pollutants (box 10.3).

Box 10.3

**Global action for sustainable urban environments**

*The WHO and CCAC Urban Health Initiative* is working to improve air quality in cities and countries to reduce the health burden and health costs from air pollution-related diseases and support sustainable growth. Actions to reduce air pollution can also bring added climate benefits, as many of the air pollution sources are also heavy emitters of short-lived climate pollutants (SLCPs), such as black carbon and methane, as well as carbon dioxide. Over the next five years, the Urban Health Initiative aims to increase public demand for action to reduce SLCPs and other air pollutants. At the same time the initiative is supporting national, city and subregional efforts to improve air quality, strengthening capacity of the health sector, and creating health and cost evidence for rapid mitigation action.

*Sustainable Mobility for All (SuM4All)* is building from the successful experience of the energy sector (SE4All), the SuM4All brings together a diverse and influential group of stakeholders—multilateral development banks, United Nations agencies, bilateral donor organizations, non-governmental organizations, civil society and academic institutions—with a commitment to speak with one global voice and act collectively to implement the Sustainable Development Goals (SDGs) and achieve a world in which people and goods move equitably, efficiently, safely and in an environment-friendly way. SuM4All provides knowledge, advocacy, guidance and financing mechanisms to achieve the four global objectives, tracked through its Global Tracking Framework and Global Roadmap of Actions.

**Policy recommendations on urban population health**

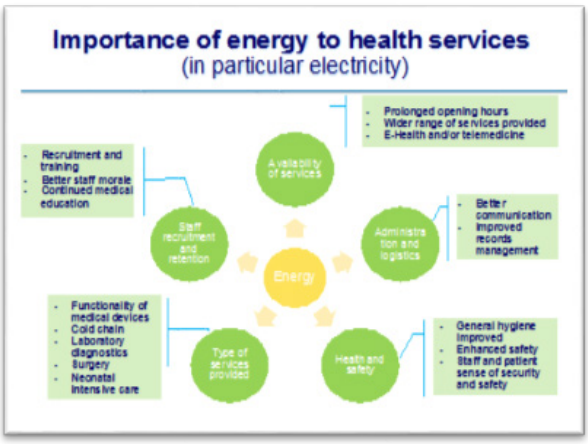
- Prioritize investments in energy-efficient networks, building codes and waste management systems to enable and promote healthier cities.
- Adopt holistic, innovative land use planning (e.g., compact cities, energy efficient public transport, walking and cycling networks, green spaces) to improve population health and reduce health inequities while saving energy.
- Scale up renewable energy technologies in cities (e.g., solar street lamps) to increase safety and liveability of cities.
- Use tax-incentives, innovative financing, stringent building energy codes and other mechanisms to encourage more energy-efficient and healthier housing.
- Soot-free buses, electric mobility and other public transport related initiatives also offer opportunities to reduce energy intensity, increase efficiency while at the same time providing benefits for public health.

**Energy in health-care facilities:**

Each of the three target areas addressed under of SDG 7—access, renewables and efficiency—are critical enablers of expanding and ensuring access for quality health care. In the absence of power, many basic life-saving interventions in health facilities cannot be performed safely or at all: lighting operating and examination rooms, sterilizing equipment to prevent infection, refrigerating vaccines and medicines and blood for transfusions, powering medical devices for diagnosis and treatment, hygiene and infection control measures. These, and many more critical health-care functions, require a reliable electricity supply. In the absence of power, many basic life-saving interventions in health facilities cannot be performed safely or at all (figure 10.4).

Figure 10.4

**Examples of energy links with health services**




Powering health facilities with clean sources of energy, when coupled with energy efficiency measures, will reduce health-sector dependency on fossil fuels, lower carbon emissions and reduce operating costs. It may also promote energy independence and resilience in the health sector, particularly in the face of wider disruptions to the energy grid or energy supply chain.

It will not be possible to meet SDG 3 and realize universal health coverage if the health facilities providing essential services do not have reliable electricity.

Available data on electricity supply in health facilities in low-income settings is limited. Findings from a WHO analysis of health survey data from 11 sub-Saharan countries suggest that as many as one in three health facilities do not have electricity at all. While nearly all hospitals included in the survey data were connected to the central grid, only about 30 per cent reported that they had reliable power and did not experience regular electricity outages *(Adair-Rohani, 2013).*

Resolving the energy gap in health facilities will require that decision makers from the energy and health sectors work closer together to ensure that health facility energy needs are adequately prioritized in national energy sector strategies, as well as in health sector development plans.

The costs of solar PV and other renewable energy technologies are declining, making them increasingly affordable even in low- and middl-income settings. But the falling costs of technology alone will not ensure energy security and resilience for health facilities. Simply installing solar panels, batteries and some LED lights in a rural clinic is not sufficient on its own. The health sector must make energy services an essential service and commodity, and correspondingly dedicate resources towards ensuring the sustained availability of energy services.

Health facility staff need to be trained to operate and maintain these systems. Energy services need to be integrated into health facility management plans so that there is an appropriate delegation of responsibility and resources to ensure the sustained operation and maintenance of these services. And, perhaps most importantly, market-based service delivery models should be used to provide energy services to health facilities, as this will better ensure the development of a robust local supply chain and service sector that can provide maintenance and after-sales services, particularly for off-grid and renewable energy installations.

**Policy Recommendations on energy in health care facilities:**

- Ensure that health facility energy needs are appropriately articulated in the context of national energy plans and strategies, in particular those aimed at addressing critical industries and end users of energy services.

Box 10.4

**Contribution of SDG 7 to the realization of universal health coverage and other SDG 3 targets in a health facility context**

| Relevant SDG 3 target(s) | Contribution of SDG 7 |
|---|---|
| 3.1: "By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births." | A key pillar of the Global Strategy for Women's, Children's and Adolescent's Health aimed at reducing maternal and newborn mortality is to bring pregnant mothers into health facilities and improve the quality of care provided to them at the time of birth. Ensuring that these facilities have reliable electricity will ensure that the core operating conditions needed to provide safe, quality maternal and newborn care are in place. |
| 3.2: "By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births." | |
| 3.8: Achieve universal health coverage (UHC), including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all. | Health facilities are a key service delivery platform that will be used by countries to realize UHC and related health targets. Health facilities must have an appropriate infrastructure, including a reliable power supply, in order to provide this basic package of essential health services (Sternberg et al., 2017) |
| 3.12: Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing states. | Health workers will remain in and will be more motivated to work in remote health facilities that have reliable power. In such context, off-grid renewable energy technologies therefore have significant potential to contribute to this SDG3 target. |

- Develop and implement clean energy policies to promote increased health-sector reliance on clean energy, promote energy efficiency and ensure that appropriate resources and responsibilities are allocated to the management (and maintenance) of health facility energy resources.
- Identify incentives and market-based service delivery models to ensure energy security in health facilities and encourage the development of local service industries to sell, support and service energy services targeted for health care facilities, especially for primary care facilities in resource constrained settings.

## REFERENCES

WHO (2016), "*Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Well-being of Women and Children",* World Health Organization, Geneva. Available online at http://www.who.int/indoorair/publications/burning-opportunities/en/

Aman et al.(2017) Amann M, Purohit P, Bhanarkar AD, Bertok I, Borken-Kleefeld J, Cofala J, Heyes C, Kiesewetter G, et al. (2017). Managing future air quality in megacities: A case study for Delhi. Atmospheric Environment 161: 99-111.

DOI:10.1016/j.atmosenv.2017.04.041.

World Bank (2017) *Global Tracking Framework,* World Bank. Washington D.C. 2017 Available at http://gtf.esmap.org/downloads

IEA (2017a), *Energy Access Outlook 2017: From Poverty to Prosperity*; International Energy Agency, Paris.

UN-Habitat (2016) *World Cities Report 2016*. UN-Habitat: Nairobi.

IEA (2017b) *World Energy Outlook 2017,* International Energy Agency, Paris, 2017. Available at (https://www.iea.org/weo2017/).

IEA (2016) "*Energy and Air Pollution*", International Energy Agency, Paris 2016.

Adair-Rohani et al., (2013). "Limited electricity access in health facilities in sub-Saharan Africa: a systematic review of data on electricity access, sources and reliability." *Global Health: Science and Practice1 (2).*

Sternberg, et al. (2017) "Financing transformative health systems towards achievement of the Sustainable Development Goals: a model for projected resource needs in 67 low-income and middle-income countries", *Lancet Global Health 2017;* 5: e875–87. Available online at http://www.thelancet.com/journals/lancet/article/PIIS2214-109X(17)30263-2/fulltext?elsca1=tlxpr

# POLICY BRIEF #11

## EDUCATION AND ENERGY

**Developed by**

United Nations Children's Fund (UNICEF)

**In collaboration with**

UNDESA

## Key Messages

### Status of education and energy and progress towards achieving the SDGs

- Globally over 291 million children go to primary schools without any electricity, 188 million in sub-Saharan Africa, South Asia and Latin America.
- Educational facilities require energy for lighting, cooking, heating, cooling, water delivery and purification, as well as information and communication technology (ICT), including for disaster and medical emergencies. Efforts towards achieving the SDG 7 target of universal access to affordable, reliable, modern energy services also contribute to the sustainable development goal of ensuring inclusive and quality education for all (SDG 4).
- About 57 million children still do not go to school, half of them in sub-Saharan Africa. Although education levels have increased over the years, globally about 103 million young people still lack basic literacy skills, almost 60 per cent of them female (UN, 2017) and youth literacy levels tend to be lower in countries with electrification rates below 80 per cent.
- School attendance and performance levels have been shown to increase with increased electrification rates—especially for lighting and equipment (including ICT). Electrification allows schools to stay open for a better learning environment, extended operating hours of study, and teacher preparation and training after hours.
- Schools with better access to sustainable energy can also be used as a place for addressing other community services, such as clean water, hygienic sanitation, health and emergency services.
- Efforts to electrify schools have lagged behind, leaving millions of children without access to electricity—more prominently in disadvantaged and rural communities.

### Priority actions

- Increase efforts and coordination among different stakeholders to gather quantitative and qualitative data and information on access to energy in educational facilities to drive evidence-based decision-making.
- Adopt enabling policies that incentivize and prioritize investment in energy access in the education sector.
- Reinforce policies that facilitate a more coordinated approach in the public sector for collaboration in the provision of energy and education infrastructure and services.
- Build support for these policies through stakeholder engagement, public advocacy and outreach to influence decision makers.
- Enhance public awareness and education to adults and children about sustainable energy in order to facilitate necessary behavioural changes, build a technical skill base and encourage youth innovation to advance sustainable energy solutions.

## Energy in Education in the context of the Sustainable Development Goals

Access to modern, reliable and affordable energy is critical for development and contributes directly to achieving positive educational outcomes. Education facilities require energy for lighting, cooking, heating, cooling, water delivery and purification, and information and communication technology (ICT), including for emergency and medical emergencies. Lack of access to sustainable energy forces schools, dormitories, kitchens and staff facilities to rely on unsustainable sources such as biomass, charcoal or kerosene for lighting and cooking purposes. This exposes students and staff to indoor air pollution, creating health risks ranging from headaches to respiratory diseases, which compromises their health and learning abilities.

There is a positive correlation between access to electrification, particularly for lighting, and improved education. For instance, research in Bhutan showed that children in electrified households experienced a total of 274 more days of schooling than those living in households without access to electricity. Similarly, research in rural villages in Madagascar demonstrated that the electrification of households affects children's ability to keep up with school and helps reduce gender inequalities by providing girls, who are traditionally more engaged in housework than boys, opportunities to study after sunset. (UNICEF, 2015)

Access to reliable and sustainable energy in educational facilities allows them to extend their operating hours and improve the quality of education by providing a place for teachers to prepare lessons or receive training, contributing to teacher retention by improving their quality of life. For example, in rural areas of Kenya, 75 per cent of head teachers reported that recruiting and retaining teachers was a problem, but 60 per cent said better lighting would encourage teachers to work in remote regions. Over a third of teachers said that they use a solar light for marking, lesson planning and extra classes (Smart Villages, 2017).

Overall, efforts in achieving SDG 7 target of universal access to affordable, reliable, modern energy services also contribute to the sustainable development goal of ensuring inclusive and quality education for all (SDG 4).

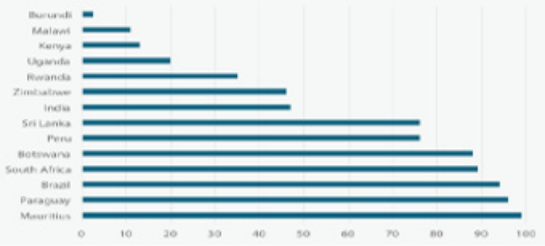
### Current Status

Up-to-date energy access data in the education sector is scarce, but available research shows clear trends and correlations between electrification and education.

In terms of primary school access to electricity, sub-Saharan Africa has the lowest rate with 35 per cent, followed by South Asia with 48 per cent and Latin America with 93 per cent. Globally over 291 million children go to primary schools without access to any electricity, and 188 million of these pupils live in the in the regions mentioned above. It is worth noting that not only does sub-Saharan Africa have the lowest levels of electricity, it is also the region with the lowest levels of learning (UNDESA, 2014).

Figure 11.1

**Percentage of primary schools with access to electricity in selected countries**




Source: Practical Action, 2013

A quality education is instrumental in improving people's lives. Throughout the years, there has been a tremendous progress towards increasing access to education and enrolment rates in schools. Enrolment in primary education in developing countries is at 91 per cent, yet about 57 million children still do not go to school. And over half of those children live in sub-Saharan Africa.

Access to sustainable energy can help advance the education sector in numerous ways. Electrification at schools is associated with a better experience and opportunities for children as lighting significantly allows for better learning environment, extended operating school hours used for studying, teacher preparations and the facilitation of training for community members. School attendance also increases with lighting, especially in regions which face poor sunlight penetration. Qualitative research in Bangladesh demonstrated that teachers consider it almost impossible to teach under conditions of low light (Practical Action, 2013). In the Philippines, teachers have reported cancelling schools in rainy weather when classrooms are not adequately lit for teachers and students ( Valerio, 2014). They have also reported cases during school days where they have to travel as long as an hour to get to the nearest city, to be able to print teaching materials and test papers. Facilitating the use of ICT—possible only through access to electrification—therefore enhances more effective use of time and resources for teachers and students, heightens the quality of education, combats the widening digital divide, and builds essential skills for the modern economy. For example, in Ethiopia children in middle school using laptops scored significantly higher in finding analogies and categories than those without (Hansen et.al., 2012).

Electrification of educational facilities can bring overall benefits to the community too, as schools can be used as integrated service platforms for children, where clean water, nutritious meals and

primary health services can be provided in a safe environment. For instance, electricity can energize water delivery and purification systems, emergency radio or disaster warning alarms, and refrigeration of both food and vaccines.

Furthermore, sustainable energy improvements, including energy efficiency, in kindergartens, schools, dormitories, kitchen and staff quarters, provide clear benefits in meeting basic energy needs and enhancing the well-being of students and staff alike. Reliable and affordable energy is a prerequisite for accessing clean water and sanitation. Renewable energy for lighting and hot water systems; energy-efficient building designs, space heating and appliances; and cleaner cooking fuels in schools, dormitories and kitchens, all go a long way in ensuring a hospitable, comfortable and safer environment for students and teachers to study, stay healthy and productive. What is more, evidence suggests schools can save on energy expenses by up to 25 per cent through simple behavioural and operational measures alone. The savings can then be utilized in other priority areas in schools (US EPA, 2011).

Simultaneously, sustainable energy measures also provide considerable benefits in reducing indoor air pollution and related health risks, particularly for children. Indoor air pollution, largely caused by the use of solid fuels, contributes to over half a million child deaths under 5 (UNICEF, 2015). Countries currently suffering from critical air pollution levels such as China, India and Mongolia are gradually making efforts towards adoption of sustainable energy solutions in public service facilities, including in the education sector, to reduce and mitigate children's exposure to air pollution. Incidentally, adoption of energy-efficient building designs in kindergartens in Mongolia have resulted in improved indoor air quality, warmer classroom environment and better health outcomes for children and staff, with a nearly 30 per cent reduction in absenteeism due to illness (GIZ, 2016 ). Essentially, by transitioning towards a more sustainable energy pathway, educational facilities can simultaneously achieve multiple benefits, including improved learning environments, better health, energy savings and positive environmental and economic conditions.

### How are we faring—Are we on track?

Under the current rate of progress, the 2017 Global Tracking Framework report shows that we are not on track to achieve the SDG 7 energy targets globally. On closing the energy access gap, 1.06 billion people still live without electricity. Efforts to electrify schools have lagged behind even more, leaving millions of children without access to electricity, more so in disadvantaged and rural communities. In India for example, only 27 per cent of village schools have electricity compared with 76 per cent of schools in towns and cities. In Peru, fewer than half of rural schools are equipped with electricity, a library or toilets for boys and girls. In Sri Lanka, roughly one in five schools lack access to electricity and in South Africa half or more of the public primary schools lack access to electricity (UNDESA, 2014). It is worthy of note that South Africa also has one of the highest grid connection rates on the continent (UNDESA, 2014).

Recent trends in the education sector indicate that basic literacy skills have improved tremendously over the years, but more efforts are needed to achieve universal education goals, as 103 million youth worldwide still lack basic literacy skills, of which 60 per cent are young women (UN, 2017). Secondary education also remains a huge challenge, and according to projections, by 2035 only 63 per cent of the world's 20 to 24 year olds will have completed upper secondary school (Smart Villages, 2017).Dropouts are a continuing issue, mostly in sub-Saharan Africa, where at least 20 per cent of the children enrolled are not expected to reach the last grade (Smart Villages, 2017).

Youth literacy rates tend to be lower in countries with electrification rates below 80 per cent. School performance has also been shown to increase in correlation to electrification rates, with primary school completion rates enhanced with greater electrification (UNDESA, 2014). Advancing access to energy can therefore play a crucial role by complementing other educational investments in improving schooling and educational attainment.

### Key challenges and recommendations

Barriers to limited access to sustainable energy in educational facilities pertain broadly to (a) weak policy complementarities and coordination across energy and education sectors to meaningfully facilitate access; (b) issues of affordability and high upfront capital costs; (c) technical barriers, including reliability of power supply, maintenance and after-sales services; and (d) information and awareness on the multiple benefits of energy and implications on educational outcomes.

Although energy access has gradually advanced over the years, the number of students globally still without access highlights the need for carefully targeted measures to address the challenges.

First, sufficient quantitative and qualitative information is required to clearly reflect the magnitude of the challenge and to drive evidence-based decision-making. As it stands, data is often a key difficulty and challenges mount when trying to obtain data on energy access in the education sector. Challenges pertaining to limited data then translate into limited information, which in turn undermines evidence-based decision-making. Therefore, increased efforts at data generation and analysis are needed for better insights and sound decision-making.

Second, enabling policies that incentivize and prioritize energy access in the education sector should be put in place and enforced. Limited quantitative data makes it challenging to authoritatively

estimate the financing needs to electrify the education sector. The IEA estimates that US$1 trillion investment is needed to achieve universal access to energy by 2030; this offers a broad signal of the magnitude of investment required to adequately reach out to the education sector (IEA, 2017).

Leveraging private sector finance is critical. A policy environment that incentivizes private sector financing is needed to promote innovative business and service delivery models for provision of quality energy services—particularly in underserved areas. A suite of Public Private Partnership (PPP) models have been successfully demonstrated for infrastructure and service provision in the education sector. This can be extended to investments in school electrification programmes, too. Several case studies exist where PPP models have been successfully employed in school electrification programmes, including in Argentina, South Africa and the Philippines.

It is also imperative to reinforce policies that facilitate a more coordinated approach among public agencies for collaborating in the provision of energy and education infrastructure and services. In terms of ensuring reliability of energy access, technical problems of connections and equipment can be offset through the use of strong regulatory frameworks, national standards, quality assurance and certification systems. In fact, these have been shown to facilitate more reliable local manufacturing and maintenance activities, reduce costs and improve quality of service.

Furthermore, policy advocacy, stakeholder engagement, public awareness and education are vital not only in influencing decision makers, but also in facilitating necessary knowledge, attitude and behavioural changes among children and adults on the benefits of sustainable energy. Separately, the incorporation of energy education in curricula has been demonstrated to build a necessary technical skill base from early on, creating a youth generation that can act as change agents, while simultaneously allowing greater youth innovation to advance sustainable energy solutions.

### Interlinkages with other Sustainable Development Goals

Energy access, energy efficiency and renewable energy for educational facilities also affects other SDGs besides SDG 4, including good health and well-being (SDG 3), clean water and sanitation (SDG 6), and gender equality (SDG 5) among others. Other than providing lighting, electricity in schools can have a multiplier effect on community services when it is used to access, deliver and purify water for drinking and sanitation, circulate air to provide a comfortable indoor climate, heat the space during winter and refrigerate food and medical supplies.

Solar PV systems and solar pumps have been successfully used in educational facilities to provide better access to safe water and hygienic sanitation. UNICEF's Global Solar Water Pumping Programme, for instance, deploys renewable energy across 35 countries to access, treat and supply safely managed water to children, their families and communities, prioritizing public service facilities such as health facilities, schools and community centres. In Kenya, before electrification schools would tend not to clean their toilets due to lack of water, and water-borne diseases such as skin infections, typhoid and cholera were common, leading to "rampant absenteeism of students and teachers"; electrification was successfully used to rectify these issues. (UNDESA, 2014).

With regard to gender empowerment, energy access has been found to directly contribute to time and labour benefits for women and girls. This, in turn, enhances their ability to attend school and educational activities. In Mali for instance, electrification has increased levels of girls' school attendance, improved performance, and drastically improved girl-to-boy ratios. Similarly, a study conducted in 52 developing countries showed that numerous countries with lower electricity access have lower girl-to-boy ratios in schools. Nepal, for instance, showed an increase in girl student enrolment by 23.3 per cent across a sample of villages that had received school electrification (UNDESA, 2014).

## REFERENCES

Barnes D, et al., (2014), "The Development Impact of Energy Access", <www.researchgate.net/publication/299883395_The_Development_Impact_of_Energy_Access>, accessed 20 January 2018.

Benjamin K. Sovacool, Sarah E.Ryan (2016) "The geography of Energy Education".

<www.sciencedirect.com/science/article/pii/S1364032115016020>, accessed 20 January 2018.

Commission of the European Communities, "Action plan for energy efficiency: realizing the potential" 545 final, Brussels 19.10.2006. <www.ec.europa.eu, accessed on 23/2/2008>, accessed 20 January 2018.

GIZ, Public Investment in Energy Efficiency (PIE Project), Project Brief.

Hansen, N., Koudenburg, N., Hiersemann, R., Tellegen, P. J., Kocsev, M. R., and Postmes, T. (2012). Laptop usage affects abstract reasoning of children in the developing world. Computers & Education, 59, 989–1000. doi: 10.1016/j.compedu.2012.04.013

International Energy Agency (IEA), "Energy Access Outlook: World Energy Outlook Special Report, OECD/IEA, Paris" www.iea.org/bookshop/750-World_Energy_Outlook_2017, accessed January 20 2017.

Practical Action 2013 (2013). Poor people's energy outlook 2013: Energy for Community Services. Rugby: Practical Action Publishing, https://policy.practicalaction.org/policy-themes/energy/poor-peoples-energy-outlook, accessed January 20 2018.

United Nations (UN) 2017, www.un.org/sustainabledevelopment/education/ accessed on March 28, 2018.

Nikolaos Zografakis, Angeliki N.Menegaki, Konstantinos, P.Tsagarakis2008, "Effective education for energy efficiency", https://

www.sciencedirect.com/science/article/pii/S0301421508002024, accessed on January 21, 2018.

Smart Villages 2017, "Education and the Electrification of Rural Schools, Technical Report 13", http://e4sv.org/wp-content/uploads/2017/05/TR13-Education-and-the-Electrification-of-Rural-Schools_web-1.pdf, accessed March 28 2018.

United Nations Department of Economic and Social Affairs (UNDESA) 2014, "Electricity and education: The benefits, barriers, and recommendations for achieving the electrification of primary and secondary schools" https://sustainabledevelopment.un.org/content/documents/1608Electricity per cent20and per cent20Education.pdf, accessed January 20, 2018.

State of the Planet 2017, "Forging Partnerships for Resilient, Low-Carbon Electricity Systems"

http://blogs.ei.columbia.edu/2017/10/13/forging-partnerships-for-resilient-low-carbon-urban-energy-systems/ accessed on January 21 2018.

United Nations Children's Fund (UNICEF) 2015, "Sustainable Energy for Children" www.unicef.org/environment/files/UNICEF_Sustainable_Energy_for_Children_2015.pdf

US Environmental Protection Agency (US EPA) (2011), "Energy Efficiency Programs in K-12 Schools", https://www.epa.gov/sites/production/files/2015-08/documents/k12_guide.pdf?mc_cid=aa90e19a1a&mc_eid=0fb244538a, accessed January 22 2018.

Valerio, Ana Patricia, "The link between Electricity and Education" Devex, 30 June 2014, www.devex.com/news/the-link-between-electricity-and-education-83789, accessed on March 29 2018.

http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html World Bank/IEA, 2017. "Sustainable Energy for All: Global Tracking Framework", http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_full_report_for_web_0516.pdf, accessed on January 21, 2018.

Zografakis et al., 2007, N., Dasenakis, D., Katantonaki, M., Kalitsounakis, K., Paraskaki, I., 2007. "Strengthening of energy education in Crete. In: Proceedings of SECOTOX Conference and the International Conference on Environmental Management, Engineering, Planning and Economics", Skiathos, 24–28 June.

# POLICY BRIEF #12

## GLOBAL PROGRESS OF SDG 7— ENERGY AND GENDER

### Developed by

ENERGIA, World Bank—Energy Sector Management Assistance Program (ESMAP) and UN Women

### In collaboration with

SEforALL and IEA

## KEY MESSAGES

### Status of gender and energy and progress towards achieving SDGs

- Over 1 billion people in the world lack access to electricity, and close to 3 billion lack access to clean cooking.[2] Women bear the greatest burden of this energy poverty—it is their unpaid time and labour that is expended to gather biomass fuels for cooking, collect water or manually process grains and other foods. Household air pollution, linked to burning fuels such as wood, animal waste and charcoal, is responsible for about 2.8 million deaths every year, mostly among women and children.
- Greater access to energy services can improve women's health and well-being, free up their time and enable their economic empowerment, thereby supporting the achievement of SDG 5.
- While some countries and regions are on track to achieve electricity for all, under current policies and trends, 2.3 billion people will still lack access to clean-cooking facilities in 2030. In recent years, going beyond their traditional role as "users" and "beneficiaries," women are playing a role in expanding energy access, thereby becoming part of the solution. A number of actors have started working on the intersection of gender, energy and sustainable development, and in advancing gender equality, social inclusion and women's empowerment in the energy sector.

### Priority Actions

- Integrate gender and energy actions within all SDGs and establish gender-responsive global and national energy sector policies backed by evidence, such as sex-disaggregated data and analysis. Continue to build expertise and experience on gender issues across the energy value chain, from off-grid distribution and consumption to policy/pricing to generation and energy production. Energy sector institutions including energy ministries and utilities should be supported in developing gender-responsive programmes, monitoring systems and data collection methods.
- Promote and invest more in clean-cooking technologies and decentralized sustainable energy technologies that support gender equality and women's economic empowerment, involving women in the design and distribution of modern energy equipment and services. Within the energy industry itself, barriers to women executives, entrepreneurs and employees must fall, and their representation on national and global energy bodies grow.
- Governments must raise their efforts to promote women-centric business models for expanding energy access to all, including at the last mile, through capacity-building, partnerships with local stakeholders, expanding women's access to finance and building a conducive enabling environment for women entrepreneurs.
- International and national energy and climate change programmes and mechanisms such as the Green Climate Fund and Nationally Determined Contributions must be supported to meaningfully integrate gender concerns in programming.

## Gender and Energy Nexus

The Sustainable Development Goals (SDGs) seek to change the course of the twenty-first century, addressing key challenges such as eradicating poverty and hunger, eliminating inequalities and violence against women and girls and combating climate change. *Gender equality and women's empowerment are prerequisites for achieving these and other global goals.* Thus, achieving gender equality and women's empowerment is a stand-alone goal—SDG 5—and also integrated across the other goals, with many targets specifically recognizing gender equality and women's empowerment as both an objective and part of the solution.

Box 12.1

**Gender and Energy Facts and Figures**

- High reliance on biomass for cooking in many countries means that women and children without clean cooking access spend an average of 1.4 hours/day collecting fuel.
- Only 4 of 72 countries analysed (6 per cent) had women ministers overseeing national energy policies and programmes.
- A study of more than 1,500 companies found that having more women on boards of directors led to more investment in renewable energy.
- Thirty-five per cent of the workforce in renewable energy companies are women, compared with 20-25 per cent in the broader energy sector.
- Women accounted for less than one-third of those employed in scientific R&D across the world.

Sources: C3E/IEA Technology Collaboration Programme, "Women in Clean Energy: Knowledge, Gaps and Opportunities" (2017); IEA Energy Access Outlook 2017; IRENA Director-General

There is a clear and important intersection between energy access and gender equality. Women and children are often disproportionately affected by lack of energy access, in that large amounts of their time and labour must typically go towards meeting daily needs (for example gathering biomass for cooking or manually processing grain or other food in the absence of machines). Additionally, lack of access has important implications for the intersection of gender-equality considerations and many of the other SDGs. Sustainable modern energy fuels development, from the light that allows a child to do her homework to street lamps allowing women to travel safely home at night. Universal access requires energy to be affordable and reliable. Generating it must not irreversibly harm the environment, highlighting the need for renewable energy.

In households, women are often the primary energy managers. But sustainable modern energy infrastructure and technology tend to reach women and girls last, even if it is vital for relieving their disproportionate share of unpaid care and domestic work and enhancing their economic opportunities. This situation is obscured by the lack of sex-disaggregated data and gender statistics.

Women are key agents of change and, as primary energy managers in households, they could play powerful roles in extending access to sustainable modern energy, adopting energy efficiency technologies and improving consumer behaviours. Each stage of energy planning and policymaking needs to factor in gender dimensions and actively advance women's leadership. Women need to be involved from start to finish in the design of modern energy-access technologies and programmes and empowered to become more involved in the provision of energy services. Within the energy industry itself, barriers to women executives, entrepreneurs and employees must fall, and their representation on national and global energy councils and other fora must grow.

### Are we on track to achieve SDGs and gender-equality and energy-access objectives?

**A number of SDGs are more likely to be achieved if the gender-energy-poverty nexus is recognized and integrated into development policies and planning.** Significant among these are SDG , which seeks to "ensure access to affordable, reliable, sustainable and modern energy for all" by 2030, and SDG 5, which aims to "achieve gender equality and empower all women and girls", and these are inextricably linked. Integration of gender and energy issues can help reap benefits at multiple levels, contributing to most SDGs through improving the quality of services provided for maternal health, food security, clean water, entrepreneurship, agriculture and education. At the same time, women's participation can increase the project and policy effectiveness and efficiency of energy-sector interventions and the achievement of SDG 7.

Focus is still needed on the multiple tiers of access to clean and affordable energy. Global electrification reached 86 per cent in 2016 and close to universal access was achieved in urban areas (96 per cent), while rural areas lagged behind at 73 per cent. (IEA and World Bank, 2017) This means that over 1 billion people still do not have access to electricity, particularly in sub-Saharan Africa and South Asia. Global access to clean fuels and technologies for cooking reached 62 per cent in 2015. *(ibid)* However, 2.8 billion people still lack access to clean cooking, mainly in rural sub-Saharan Africa and Asia-Pacific (IEA, 2017). Thirty-eight per cent of the global population and almost 50 per cent of the population in developing countries lack access to clean cooking, relying on solid biomass, coal, and kerosene (IEA, 2017; WHO, 2016). Polluting fuels are used for cooking in 75 per cent of households in rural

communities across the world, 91 per cent of rural households in Africa, and 82 per cent of rural households in the Western Pacific. Women and children in many places spend on average 1.4 hours a day collecting solid fuels (i.e., wood, crop wastes, charcoal, coal or dung) and women spend several hours per day cooking with inefficient stoves, limiting time available for them to pursue other economic, family or leisure activities.

In countries that rely heavily on solid biomass and coal for cooking, household air pollution is responsible for 2.8 million premature deaths every year (IEA, 2017), linked to fumes from biomass fuels. Africa alone accounts for about 600,000 deaths each year as a result of household air pollution (Africa Progress Panel, 2015), and approximately 60 per cent of these victims are women (ESMAP, 2011 and IRENA, 2013 cited in UN Women, 2017). Two underresearched but often-mentioned links between health and energy poverty are sexual assault and the physical burdens of carrying heavy loads of fuel and water. Some evidence indicates that women and girls are at risk of sexual violence when they collect fuel and water or when they are outside after dark (Rewald, 2017), especially in the absence of community lighting.

In most countries, even though the potential for improved or clean cook stoves to eliminate the time and health burdens of cooking with biomass is understood, it has been challenging to encourage households to adopt new cooking technologies (Rewald, 2017; IEA, 2017). Significantly, the policy commitment to clean cooking has lagged behind as well. In 2014, more than 140 countries had renewable energy targets and support policies in place, but almost all of these were for the power sector (ADB, 2015). Under current policies and trends, 2.3 billion people will still lack access to clean-cooking facilities in 2030 (IEA, 2017). Women and children bear the greatest burden of energy poverty. In contrast, access to and use of clean energy brings interconnected, corollary benefits related to greater gender equality, economic productivity, educational opportunities, and more.

In addition to fuel collection and cooking, the burden of a number of other time- and labour-consuming activities typically carried out by women can be eased by modern energy applications, which increase efficiency and productivity, thus improving well-being and freeing up time for leisure and rest. Village transport surveys in Ghana, Tanzania, and Zambia showed that women spend nearly three times as much time in transport activities compared with men, and carry, on their heads, about four times as much in volume as men, primarily water, firewood and crops for grinding (Blackden and Wodon, 2006). Time spent on fetching water can be significantly reduced through piped water supply. Processing staple foods, such as grain grinding, is a time-consuming manual task performed daily by many women, which can be eased by modern energy. Lack of sustainable transportation, water pumps, electric appliances, and other tools and equipment that require energy access, means that women in poor households have to exert much more of their own energy.

Box 12.2

**Key Gender Issues Across the Energy Sector**

| | |
|---|---|
| **Energy Access**<br>*Household Energy and Rural Electrification* | Time poverty due to fuel collection and cooking; gender-based violence related to fuel collection; health impacts, as women and children are disproportionately affected by indoor air pollution; and lack of access to information and financing for energy services or technologies. |
| **Electricity Infrastructure**<br>*Generation, Transmission, and Distribution* | Displacement, inequity in ownership or land titling during resettlement; inequitable access to new jobs in areas such as energy, engineering, tourism or services; inequitable benefit sharing due to lack of land titles or government identification; gender-based violence related to migration, new roadways and traffic patterns; and exposure (mostly affecting men) to hazardous work on energy infrastructure such as electrical wiring and chemical handling. |
| **Clean Energy**<br>*Renewable Energy and Energy Efficiency* | Women and female-headed households having less information on new technologies that can create opportunities for employment and training; lack of access to financing and collateral to purchase such technologies or services; lack of voice in household decision-making about energy options and electricity use that can impact behavioural change or adoption of improved energy services. |
| **Energy Policy**<br>*Subsidies, Tariffs and Reforms* | Female-headed households are often poorer and may suffer more from rapid tariff increases than male-headed households; men often have power over household budgets and decision-making; men may be more affected than women by direct job losses in heavy manufacturing; women may not be included in policy consultations and decision-making due to societal norms. |

Source: ESMAP 2017

### Interlinkages with other SDGs

Addressing gender and energy issues offers potential gains across a number of SDGs in addition to SDG 7, notably those linked to poverty (SDG 1), health and well-being (SDG 3), education (SDG 4), gender equality (SDG 5), and climate change (SDG 13).

Access to electricity can support women's economic empowerment by facilitating productive and employment opportunities. In Nicaragua, access to reliable electricity increases the likelihood of rural women to work outside the home by approximately 23 per cent (Grogan and Sadanad, 2013). A recent study from Brazil showed that in rural areas with access to electricity, girls are 59 per cent more likely to complete their primary education (SEforALL, 2017a). Electricity also gives people the opportunity to charge mobile phones, increasing connectivity and employment opportunities and, where the financial infrastructure exists, access to services like mobile banking (GSMA, 2015). Moreover, as investments in renewable energy increase, there is potential to consider ways to help foster equitable employment opportunities for both men and women (World Bank ESMAP, 2018).

Engaging women in energy value chains, as employees and as entrepreneurs, helps augment their incomes. When a woman is given an opportunity to earn an income, it helps in many other areas of her life. Studies show that women reinvest 90 per cent of their income in their families and communities, while men reinvest only 30 to 40 per cent; thus, the implications for economically empowering women can reach far beyond the individual (Borges, 2007). Women are also more likely than men to invest a large proportion of their household income in the education of their children, including that of girls (Lewis, 2013; IMF, 2013). According to the ILO, women's work, both paid and unpaid, may be the single most important poverty-reducing factor in developing economies (IMF 2013, Borges 2007).

Aside from eliminating or at least reducing household air pollution, addressing gender and energy issues can have discernible impacts on global health. Improved lighting and hygiene associated with clean energy and safely managed water would help reduce maternal mortality rates. The maternal mortality ratio is strongly correlated with access to electricity (UN Women, 2014 cited in Smart Villages, 2015). Yet 1 billion people globally are served by health facilities without electricity: in India 46 per cent of the health facilities, serving an estimated 580 million people, are without electricity (Practical Action, 2013). An analysis of health facility survey data for Bangladesh revealed that electrified clinics are open on average an hour longer (IEG, 2008), and electrified households in the country reported a higher proportion of child deliveries assisted by medically trained persons (36 per cent) compared to those in non-electrified villages (23 per cent). In addition, higher proportions of electrified households reported antenatal care, pregnancy check-ups by medically trained personnel, tetanus injections during pregnancy and post-natal check-ups after delivery (Barkat et al., 2002 cited in Smart Villages, 2015). There are also opportunities to integrate gender considerations within energy efficiency programmes that focus on retrofitting schools and hospital.

### Advances in the gender and energy nexus

Perhaps the most pertinent reason for considering women's roles insofar as the SDGS are concerned is the fact that women are slowly and steadily becoming a part of the solution in the energy access gap, which the conventional business as usual approaches are unable to solve (SEforAll, 2017c). In recent years, going beyond their traditional role as "users" and "beneficiaries," women are playing a role in expanding energy access, thereby becoming part of the solution to expand energy access for all (Dutta et al., 2017). There is also growing evidence that greater gender diversity—particularly on boards and in other leadership positions, including in the energy sector—benefits business in meaningful financial and non-financial terms, such as through improved profitability and innovation capacity (Ernst and Young, 2016; World Bank ESMAP, 2018). This section discusses the progress that has been made in addressing these nexus issues as well as the persisting gender gaps.

In recent years, a number of actors have started working at the intersection of gender, social inclusion, sustainable energy and climate change. The legitimacy of gender inclusion and energy access as an interrelated issue area is now well established; studies show positive benefits when these issues are tackled together (UN Women, 2016). A global movement is under way to create a more inclusive approach to energy access, with women and marginalized people taking centre stage—no longer as victims, but as agents and accelerators of change (SEforAll, 2017a). This is strengthened by several recent international agreements, which provide a framework for gender and energy work, including: the Istanbul Programme of Action for 2011–2020 which charts out a path for Least Developed Countries (LDCs), highlighting energy access as a priority area for action, along with gender equality and the empowerment of women; the Sustainable Energy for All (SEforALL) initiative, launched by the United Nations Secretariat in 2012; and the 2016 Paris Agreement on climate change, which formally recognizes the intersection of climate change and gender equality, empowerment of women, and realization of their rights, and mandates gender-responsive adaptation actions and capacity-building activities. The SEforALL business plan moved from positioning women as victims/beneficiaries to leaders and change agents in the energy transition, and launched the People-Centered Accelerator to form a voluntary partnership of stakeholders interested in advancing gender equality, social inclusion and women's empowerment in the sustainable energy sector. Additionally, many organizations focus specifically on women and girls in the gender and energy nexus, such as UN Women, Women for Women International, and the

Global Fund for Women.

The World Bank's Energy Sector Management Assistance Program (ESMAP) was an early mover on gender and energy and has played an important role in ensuring that gender issues in energy go beyond advocacy to produce concrete results in investment, project design, and implementation, by focusing on knowledge generation and supporting pilot interventions at the country level. ESMAP has helped curate a strong set of best practices, developed online training and tools and is producing a series of reports and guides on gender issues across energy topics such as electricity infrastructure, geothermal, mini-grids, energy efficiency and behavioural change, and clean cooking. Through its gender and energy regional programmes in Africa and East Asia and Pacific, ESMAP is currently engaged in over 30 countries and has developed a roster of gender experts, who have been repeatedly called upon to provide expertise in lending and non-lending activities of the World Bank. Some examples of project-level activities in Africa include capacity-building and economic empowerment, data collection and evidence building, and behavioural change and consumer outreach. In East Asia and Pacific, gender experts are providing support in areas such as surveying male and female customers of energy cooperatives; developing gender action plans and gender-informed beneficiary schemes for a hydropower project; improving outreach mechanisms for ethnic minority women affected by a hydropower project; applying baseline data collection, and monitoring and evaluation tools; promoting women's leadership and employment; and supporting clean cooking programmes through guidance notes.

**Gender integration in energy policy and regulation:**

A number of positive developments at the regional and national level have recognized the centrality of gender considerations in energy-sector interventions and development. The ECOWAS Policy for Gender Mainstreaming in Energy Access, adopted in June 2017, is one such instance, where 15 countries have committed to address existing gender barriers in expanding energy access in West Africa. This gender-responsive energy policy aims to increase general awareness of gender and energy within government, academia and at large; mainstream gender perspectives into all public-sector energy activities; achieve gender balance in public sector energy–linked jobs and decision-making roles; and ensure women have equal opportunity to participate in the private energy sector. (SEforALL 2017a)

An accompanying ECOWAS regulation mandating gender-impact assessments for energy projects is now under consideration. Similar efforts are being taken up in East Africa (by the East Africa Centre for Renewable Energy and Energy Efficiency) and in Southern Africa (Southern Africa Centre for Renewable Energy and Energy Efficiency) (SEforALL, 2017a). A recent review of gender integration in energy policies in 15 East and South African countries shows a positive trend in integrating gender dimensions into energy policies (UN Women, 2017). More than 60 per cent of the policies acknowledge the need for enhancing women's participation in policy- and decision-making in the sector, and more than half note the need to enhance women's access to energy services and technologies as a means of empowerment. Some of the policies also identify specific actions to tackle the challenges identified. About 40 per cent of the policies highlight the link between women's empowerment and enhanced environmental sustainability in the sector.

While progress has been made, gender considerations are often absent in energy planning and policy (Clancy, 2017). Regarding electrification projects, even though the impacts and risks of energy development should be addressed in environmental and social impact assessments, mitigation plans are not always funded, monitored or disaggregated by gender. Consultations, policy planning, and decision-making in the energy sector do not always consider gender and social inclusion issues and stakeholders. Since women and other so-called vulnerable groups are left out of energy plans and surveys, baselines for measuring development benefits usually do not exist.

**Women in energy entrepreneurship:**

Significant evidence is now emerging to show that: energy interventions that take into account women's needs are more likely to have a significant impact on addressing gender equality and household and community energy poverty; and ensuring women's equal participation in energy interventions has much higher potential benefits for all (UN Women, 2016; Glemarec et al., 2016). One such emerging strategy is women's entrepreneurship in energy, which represents a huge economic growth potential (SEforALL, 2017c). Even though 80 per cent of the people without energy access and reliant on biomass for cooking have incomes of less than US$ 3 per day, together they spend US$ 37 billion per year on meeting basic energy needs (World Economic Forum, 2013). However, the conventional private sector actors find it difficult to tap this potential as operating distribution channels to reach last-mile markets remains a challenge: customers in remote areas do not shop through standard retail channels; local distribution chains are fragmented; and sales volumes are low.

Women and their organizations are uniquely positioned to play a critical role in bridging this gap at the last mile. A large number of women are engaged in small and medium-sized enterprises (SMEs); female ownership represents 30 per cent to 37 per cent of all SMEs (8 million to 10 million women-owned firms) in emerging markets (IFC and McKinsey Women SME mapping exercise 2011). This provides a ready springboard for selling energy products and services, leveraging their networks to promote adoption of new technologies. They are effective spokespeople for

use of clean energy, endorsing marketing messages, and taking advantage of women-to-women communication strategies. This is important since women play a key role in spending decisions in homes: women make or influence 80 per cent of buying decisions and control US$ 20 trillion in global spending. It is projected that by 2028 women will control close to 75 per cent of discretionary spending worldwide (Ernst & Young, 2012, cited in SEforALL, 2017b). Because women are close to their customers and know local circumstances, women entrepreneurs have enormous potential to manage supply chains and acquire new credit-worthy customers in rural areas, lowering customer acquisition costs (Glemarec et al., 2016). New research from Ernst and Young also shows that women entrepreneurs are powerful job creators—even outperforming their male counterparts on this front. As a result, a number of energy enterprises have begun to employ women as sales representatives in order to reach energy markets in "last mile" and other contexts.

**Networks and partnerships in gender and energy:**

ENERGIA's Women's Economic Empowerment programme works closely with women energy entrepreneurs in hard-to-reach areas across Nepal, Indonesia, Kenya, Nigeria, Tanzania, Uganda and Senegal. The "last-mile" distribution model, centred around women-led micro- and small-scale businesses, has led to a robust programme with 4,153 women entrepreneurs involved in selling and distributing clean energy products or adopting clean energy to boost the productivity of existing businesses. A number of partnerships and networks are also emerging, such as the WPower, the Global Alliance for Clean Cookstoves and the Shine Campaign, bringing together resources and paying attention to gender equality and social inclusion in catalysing distributed clean energy development at scale to meet the 2030 goal of universal energy access (SEforALL, 2017a).

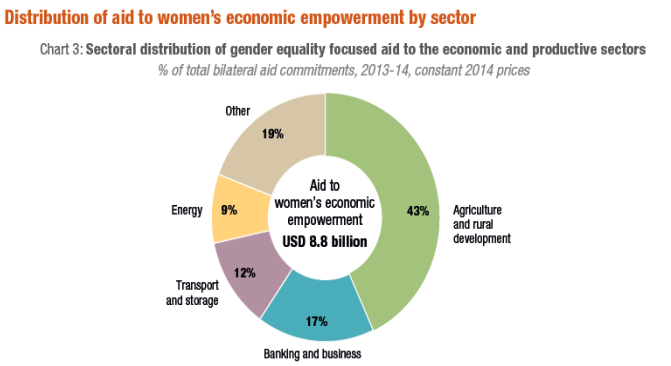
Networks such as the Clean Energy, Education and Empowerment Initiative (C3E), Women of Renewable Industries and Sustainable Energy (WRISE), Women in Solar Energy (WISE), Entrepreneurial Women in Renewable Energy (EWiRE) and the Global Women's Network for the Energy Transition (GWNET) are also spreading ideas, mobilizing support and providing encouragement, to build a cadre of women leaders in the energy sector.

## Persistent bottlenecks and challenges

While there is considerable momentum on the gender and energy nexus globally, and new innovative women-centric business models are emerging, it appears that potential gains are not being fully realized owing to persistent gender barriers—and gaps such as continued dependence on biomass for fuel, with attendant time, energy poverty and health issues exacerbated by climate change and environmental degradation. What are the bottlenecks that need to be addressed to make meaningful progress?

Figure 12.1

**Distribution of Aid to Women's economic empowerment by sector**




### Funding Barriers

The OECD DAC Network on Gender Equality (GENDERNET) in June 2016 noted that only a very small proportion of ODA for women's economic empowerment is directed to the energy and transport/storage sectors (9 per cent and 11 per cent respectively). (OECD DAC Network on Gender Equality (GENDERNET) 2016)

A recent study by SEforALL points out that while a wide range of activities, including advocacy, research, capacity-building, training, networking, and convening, have been funded, there is a need to step up investment and private-sector engagement. Recent data collected through desk research and structured interviews on 174 programmes showed that just 12 per cent of organizations are focused on moving capital into sustainable energy solutions that address gender and social inclusion. Grants need to be increased in amount and tenor to respond to the most frequently cited barrier—lack of access to multi-year funding –and used to leverage more and varied types of sustained funding, including commercial investments. More methodical inclusion of women-centred funds into existing sustainable energy financing vehicles is a key need, recognizing that there are both rights-based and efficiency-based arguments for doing so. Availability of financing also remains a primary bottleneck for women energy entrepreneurs. (SEforALL, 2017a)

**Women's representation in the energy sector** A cross-country comparison of women's representation in national parliaments showed that globally only 19 per cent of parliamentary seats were occupied by women in 2015. (SEforALL, 2017a) Moreover, women's labour force participation has not seen significant improvements since 2000, with the global average being two women for every three men. In 2016, women still represented just 40 per cent of the global labour force and 23 per cent of national decision makers (SEforAll, 2017a).

In ministries of energy, women are overrepresented in administrative positions, men in managerial and technical areas. The main factors encouraging gender policies that promote women's representation in the energy sector are national regulatory frameworks with clear objectives on gender, corporate social responsibility policies, gender awareness within the utility and utilities' demand for labour and specific skills (World Bank ESMAP, 2018).

The gender and energy sector is specifically challenged by the lack of women in technical fields, limiting their participation in energy companies and their involvement as entrepreneurs, outside of the retail segment of the value chain. Women's familiarity with new technologies is also usually lower than men's, particularly in rural settings. Women's groups that can benefit from access to energy for productive use may not know what technologies are available to them or may not have the technical skills to use the devices (SEforALL, 2017a).

**Discriminatory social norms and practices** Barriers related to cultural and social norms must be addressed for sustainable energy initiatives that aim for gender equality and social inclusion to succeed. Women and girls face multiple and intersecting inequalities and forms of discrimination. Because of prevailing discriminatory gender norms, women and girls tend to be less educated than men and boys, with less access to information, skills, training and labour markets, while facing greater risks of violence and harmful practices. This complexity influences their decision-making power and exercise of voice and agency, and constrains their access to land and productive resources, technology and information, and education and health services. Based on data for 161 countries, only in 37 per cent do women and men have equal rights to own, use and control land. In 59 per cent, while the law guarantees women and men the same rights, customary and religious practices often discriminate against women and undermine the full implementation of national legal codes. In the remaining 4 per cent, women explicitly have no legal right to own, use or control land[1]. Moreover, social tariffs for electricity are not equally accessible to female- and male-headed households. These constraints jeopardize women's chances of success as entrepreneurs in the sustainable energy sector.

Women-owned enterprises account for a third of businesses in the formal economy worldwide, but the majority in developing and emerging economies are informal micro- and small enterprises with little growth potential. Women working in family-owned businesses are often not considered full shareholders or compensated equally. Nevertheless, women's enterprises can be important vehicles for economic empowerment, leading to improved incomes and contributing to poverty reduction in the household and community. Yet discriminatory social norms and family responsibilities can prevent women from even starting a business. Policies are needed to address discriminatory property and inheritance laws that inhibit women's entrepreneurship, as well as to facilitate women's access to markets, credit, financial services and products, infrastructure and technology, procurement opportunities and social protection (IFC 2013, ILO and GIZ 2013).

**Data availability** Lack of high-quality data and, more precisely, lack of sex-disaggregated data and gender statistics, is a major impediment to projects in the gender and energy nexus. Gender statistics on energy access are almost never available at any level. Additionally, many practitioners struggle to agree to and capture quantifiable measures of women's empowerment, either selecting overly broad or overly narrow indicators, trying to balance the efforts required to collect data with the usefulness of that data, and then finding that measurements are not directly comparable across organizations. This, in turn, makes it difficult to convincingly raise awareness on the topic. Judging from the level of advocacy that programmes and organizations are engaged in and the presence of the activity in all regions, the level of awareness of the gender and energy nexus seems quite low, even among the international community, national governments and the private sector.

## Policy Implications/Recommendations

### Build gender-responsive global and national energy sector policy regimes through evidence-based policy advocacy

Against a backdrop of declining production costs for renewable energy technologies and international commitments on energy and climate change as well as gender, the time is ripe to build a cohesive, strong and multi-stakeholder movement on gender, social inclusion, women's empowerment and sustainable energy. Platforms that bring together diverse actors and elevate the profiles of locally grounded individuals and groups should be supported. Resources are needed to support the consolidation of evidence-building efforts, lobbying demands, message coordination among groups and a high-level strategic mobilization plan to build gender and social inclusion more firmly into sustainable energy opportunities, financing and services. When sustainable energy becomes widely viewed in political spheres not just as an issue area but as a matter of human rights and women's rights, the door will open for follow-on actions, budgeting, and policy reform (SEforALL, 2017a).

### Promote and invest in decentralized sustainable energy technologies that support gender equality and women's economic empowerment

Rapidly falling renewable technology costs and new business models mean that decentralized energy solutions hold great promise to accelerate universal sustainable energy access and support women's reproductive and productive work. Decentralized sustainable energy technologies—both at the individual systems level, such as solar home systems, and at the mini-grid level

servicing 50 to 100 households or an entire community—are the cheapest solutions for energy access in an increasing number of locations worldwide. Women should be directly involved in the development, deployment and benefits of these business models and technologies (Glemarec et al., 2016).

**Scale up women's energy entrepreneurship approach as an effective business model, including to reach last-mile communities**

As part of their energy access strategies, governments should raise their efforts to promote women-centric business models for expanding energy access to all, including at the last mile. They should (from SEforALL, 2017c):

- Leverage the work done by women's networks, including women entrepreneurs and civil society organizations working simultaneously on the delivery of energy services, poverty reduction and gender equality.
- Build the capacity of organizations working on women-centric business models to develop technical, business and leadership skills and advocacy capability, with a focus on elevating the level of women to become leaders at all levels.
- Expand women's access to finance, by developing financing instruments, mechanisms, and specific loan products for women, including microfinance and mobile banking.
- Engage with manufacturers, suppliers and distributors to partner with women's formal and informal networks as distributors/resellers.
- Support governments in reforming the business environment for women, including tax administration and regulations, especially for smaller, informal sector firms.

**Prioritize clean-cooking fuels and technologies**

The lack of access to sustainable energy for cooking continues to have severe socioeconomic impacts on the poor—women and children in particular. While there have been notable advances in electrification, not enough has been done to ensure clean cooking. Women should be at the centre of policies and programmes on clean cooking. To move away from reliance on solid biomass for cooking, policies and programmes need to reflect local needs and expectations, account for social and cultural factors, clearly address health risks and empower women, as they are the central decision makers in household cooking matters.

National governments should be encouraged and supported to demonstrate greater political and financial commitment to ensure that all households in the region switch to clean fuels and clean, efficient stoves and have access to decentralized renewable energy solutions in the short term. Supporting R&D of innovative, low-emissions technologies to provide household energy services should be a top priority for the global development agenda (WHO, 2016).

**Engender energy sector programming through support for national and locally led initiatives**

Advocating for strategies and planning approaches that enable the inclusion of women at every stage of the design, implementation, delivery and monitoring of energy services is critical if those services are to respond to the needs and priorities of women and girls. Gender and energy issues are often location-specific. For this reason, adapting strategies to specific gender contexts and energy situations is important. In most successful initiatives, local level engagement is a critical success factor with locally driven issue identification, problem solving, know-how, and mobilization of local capabilities. In policy arenas—whether for a sector strategy or regulatory change—national and local level engagement is manifested through buy-in and ownership, which translates into greater likelihoods of gender-sensitive provisions being put into practice (SEforALL, 2017a).

- Ensure that energy sector policies highlight the challenge of gender equality and include a visible commitment to addressing it
- Mobilize and commit funding for gender and energy programmes and activities within organizations and businesses for research, pilot activities and capacity-building
- Establish gender-sensitive targets and indicators for energy sector programmes and routinely report on progress
- Include explicit objectives for women's energy access, participation, labour mobilization and leadership in energy infrastructure programme documents
- Ensure energy sector projects track the participation of and benefits to women and girls and other disadvantaged groups

**Include systematic and sex-disaggregated data collection and analysis of gender statistics as part of programming and to support policy formulation**

Lack of sex-disaggregated data and gender statistics is a major gap in achieving equal access to energy for men and women, without which the extent of unequal access cannot be grasped. Universal energy access cannot be achieved without more gender-responsive programmes and policies—which in turn require better data collection, gender-sensitive indicators and gender analyses. For women to be actively involved in decision-making, data collection on women's and men's resource use, knowledge of, access to and control over resources and economic opportunities must be improved.

## REFERENCES


ADB (2015), "Sustainable energy for all—Tracking progress in Asia and the Pacific: A summary report". Mandaluyong City, Philippines: Asian Development Bank, 2015.

Africa Progress Panel (2015), "Africa progress report: power people planet—seizing Africa's energy and climate opportunities". Available at http://www.africaprogresspanel.org/wp-content/uploads/2015/06/APP_REPORT_2015_FINAL_low1.pdf.

Barkat, A., Khan, S.H., Rahman, M., Zaman, S., Poddar, A., Halim, S., Ratna, N.H., Majid, M., Maksud, A.K.M, Karim, A., and Islam, S. (2002), "Economic and Social Impact evaluation study of the Rural Electrification Program in Bangladesh". Dhaka: Human Development Research Center (HDRC), NRECA International Ltd, Rural Electrification Board of Bangladesh and USAID for the Rural Power for Poverty Reduction Program.

Blackden, C.M. and Wodon, Q. (eds) (2006), "Gender, Time Use, and Poverty in Sub-Saharan Africa". World Bank Working Paper No. 73. Washington, DC: The World Bank. http://siteresources.worldbank.org/INTAFRREGTOPGENDER/Resources/gender_time_use_pov.pdf

Borges, P. (2007), "Women empowered: Inspiring change in the emerging world". New York: Rizzoli.

Clancy, J.S. (2017), "Gender matters in energy access". J S Clancy, Professor of Energy and Gender/Principal Investigator ENERGIA Gender and Energy Research Programme, CSTM, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands.

Dutta, Soma; Kooijman, Annemarije; Cecelski, Elizabeth W. (2017), "Energy access and gender : getting the right balance". Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/463071494925985630/Energy-access-and-gender-getting-the-right-balance.

Ernst and Young (EY). "Women in Power and Utilities Index." 2016.

ESMAP (2015), "The state of the global clean and improved cooking sector". Technical report 007/15. The Energy Sector Management Assistance Programand Global Alliance for Clean Cookstoves.

Blackden, M. and Wodon, Q. (2006), "Gender, Time Use, and Poverty in Sub-Saharan Africa", World Bank Group.

Grogan and Sadanand (2013), "Rural electrification and employment in poor countries: Evidence from Nicaragua," World Development 43 pp. 252-265.

Glemarec, Yannick, et al. (2016), "Removing barriers to women entrepreneurs' engagement in decentralized sustainable energy solutions for the poor". AIMS Energy, 2016, 4(1): 136-172. doi: 10.3934/energy.2016.1.136.

GSMA (2015), "Bridging the gender gap: Mobile access and usage in low and middle-income countries". Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/02/GSM0001_03232015_GSMAReport_NEWGRAYS-Web.pdf.

IEG (2008), "The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits". Washington DC: The World Bank Independent Evaluation Group.

International Energy Agency (IEA) and the World Bank (2017), "Sustainable Energy for All 2017—Progress toward Sustainable Energy" (Washington, DC., 2017). Available at http://www.worldbank.org/en/topic/energy/publication/global-tracking-framework-2017.

International Energy Agency (IEA) and the World Bank (2015), "Sustainable Energy for All 2015—Progress Toward Sustainable Energy" (June), World Bank, Washington, DC. Doi: 10.1596/978-1-4648 -0690-2

International Energy Agency (2017), "Energy Access Outlook: From Poverty to Prosperity: World Energy Outlook Special Report". Paris.

IFC and McKinsey Women SME mapping exercise 2011.

International Finance Corporation (2013), "IFC jobs study: assessing private sector contributions to job creation and poverty reduction".

ILO and GIZ (2013), "Is Small Still Beautiful? Literature Review of Recent Empirical Evidence on the Contribution of SMEs to Employment Creation". By Jan de Kok and others. Available at http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---ifp_seed/documents/publication/wcms_216909.pdf

IMF (2013), "Women, Work, and the Economy: Macroeconomic Gains from Gender Equity". IMF Staff Discussion Note. Prepared by Katrin Elborgh-Woytek, Monique Newiak, Kalpana Kochhar, Stefania Fabrizio, Kangni Kpodar. Philippe Wingender, Benedict Clements, and Gerd Schwartz. September 2013.

International Finance Corporation (2012) From Gap to Opportunity: Business Models for Scaling Up Energy Access. http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/learning+and+adapting/knowledge+products/publications/publications_report_gap-opportunity.

Lewis, Joshua (2013), "Short-run and long-run effects of household electrification," paper presented at Economic History Workshop, Queen's University, Kingston, Ontario, Canada, April 25. http://www.hec.ca/iea/seminaires/131105_Joshua_Lewis.pdf

OECD DAC Network on Gender Equality (GENDERNET) 2016. Tracking the money for women's economic empowerment: Still a drop in the ocean. June 2016.Available at file:///D:/ASoma/undp-gender/material/Tracking-the-money-for-womens-economic-empowerment.pdf.

O'Dell, K., S. Peters, and K. Wharton (2014), "Women, Energy, and Economic Empowerment: Applying a Gender Lens to Amplify the Impact of Energy Access". Deloitte University Press. https://dupress.deloitte.com/dup-usen/topics/social-impact/women-empowerment-energy-access.html.

Orlando, Maria Beatriz, Vanessa Lopes Janik, Pranav Vaidya, Nicolina Angelou, Ieva Zumbyte, and Norma Adams. (2018), "Getting to Gender Equality in Energy Infrastructure: Lessons from Electricity Generation, Transmission, and Distribution Projects". Energy Sector Management Assistance Program (ESMAP) Technical Report. Washington, DC: World Bank.

Practical Action (2013), "Poor people's energy outlook 2013". Available at https://policy.practicalaction.org/resources/publications/item/poor-people-s-energy-outlook-2013.

Rewald, Rebecca (2017), "Energy and Women and Girls: Analyzing the Needs, Uses, and Impacts of Energy on Women and Girls in the Developing World," Oxfam Research Backgrounder series (2017): https://www.oxfamamerica.org/explore/ research-publications/energy-women-girls.

SEforAll (2017a), "Opening Doors: Mapping the Landscape for

Sustainable Energy, Gender Diversity & Social Inclusion". Sustainable Energy for All, Vienna, Austria.

SEforAll (2017b), "The evidence base for gender and inclusion in sustainable energy". People centred Accelerator Working Paper, Nov 2017.

SEforALL (2017c), "Scaling sustainable access pathways for the most vulnerable and hardest to reach people", People centred Accelerator Working paper. November 2017.

Smart Villages (2015), Smart villages: the gender and energy context. http://e4sv.org/wp-content/uploads/2015/08/03-Technical-Report.pdf.

UN Women (2016), "Leveraging Co-Benefits between Gender Equality and Climate Action for Sustainable Development: Mainstreaming Gender Considerations in Climate Change Projects".

UN Women (2017). "Brief. Gender, energy and policy. A Review of Energy Policies in East and Southern Africa". https://olc.worldbank.org/sites/default/files/Gender per cent20Energy per cent20and per cent20Policy- per cent20A per cent20Review per cent20of per cent20Energy per cent20Policies per cent20in per cent20East per cent20and per cent20Southern per cent20Africa- per cent20Web-per cent20HR.pdf.

World Bank (2014). Clean and Improved Cooking in Sub-Saharan Africa: A Landscape Report. Report No. 98664. Washington, DC: World Bank Group, Africa Renewable Energy Access Program (AFREA), and Energy Sector Management Assistance Program (ESMAP). http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/0 8/18/090224b08307b414/4_0/Rendered/PDF/Clean0and0impr000a0land scape0report.pdf.

World Bank ESMAP (2015). The state of the global clean and improved cooking sector. Technical report 007/15. The Energy Sector Management Assistance Programand Global Alliance for Clean Cookstoves.

World Bank ESMAP (2017). Social Inclusion, Gender and Energy Fact Sheet. http://esmap.org/sites/default/files/2017-05/Gender_Fact per cent20Sheet_Mar per cent202017_Optimized_2.pdf.

World Bank ESMAP (2018). "Getting to Gender Equality in Energy Infrastructure". Washington D.C. Available at https://openknowledge.worldbank.org/handle/10986/29259

World Economic Forum (2013). "Scaling Up Energy Access through Cross-sector Partnerships". Prepared in collaboration with PwC. http://www.pwc.com/gx/en/sustainability/publications/assets/pwc-wef-scaling-up-energy-access-through-cross-sector_partnerships.pdf.

WHO (2016). "Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Well-being of Women". Available at http://www.who.int/indoorair/publications/burning-opportunities/en/.

# POLICY BRIEF #13

## INTERLINKAGES BETWEEN ENERGY AND JOBS


### Developed by

International Renewable Energy Agency (IRENA), The European Commission and International Labour Organization (ILO)

### In collaboration with

Norad

## KEY MESSAGES

### Progress towards employment linked to achievement of SDG 7

- Energy is essential to a well-functioning economy, and the transition to more sustainable energy systems will enhance the socioeconomic resilience of communities around the world.
- The share of renewable energy in total final energy consumption rose to 19.3 per cent in 2015. The number of people employed, directly and indirectly, in the renewable energy sector (excluding large hydropower) rose from 5.7 million in 2012 to 8.3 million in 2016, and that number could expand to 25 million by 2030 with proper policy support. Solar PV has emerged as the single largest employer in the renewable energy sector, followed by liquid biofuels and wind. With manufacturing of renewable energy equipment concentrated in a few countries, employment opportunities in other countries will mostly lie in project development, sales, construction and installations, and operations and maintenance.
- Energy efficiency and renewable energy create more jobs than the fossil fuel industry, enabling net employment gains as the energy transition unfolds. Trends in renewable energy jobs have remained positive, in contrast to traditional energy industries, which have been facing employment cuts due to changing dynamics in the energy sector.
- Available data in the energy access context is still limited, but evidence from Bangladesh and East Africa suggests expanding employment as off-grid solutions become more widely available. The combination of energy access and an enabling environment facilitates rural development.
- Access to energy is necessary but by itself not sufficient for creating productive and decent jobs, and complementary initiatives to stimulate the productive use of energy may be required.

### Priority Actions

- Improve data collection, and quantitative and qualitative analysis, regarding employment rates in grid-based and off-grid contexts, including disaggregation by gender and other socioeconomic factors
- Provide an enabling environment with stable and predictable policy support for the expansion of renewable energy and energy efficiency
- To avoid skills gaps, promote coordination between the renewable energy sector and educational/training institutions, with integration of renewables modules into vocational training and technical courses, and find ways to draw on skilled workers from other relevant industries, offering retraining as necessary
- To augment local value creation, governments should adopt policies in support of value chain development, including incubation of new businesses, capacity-building programmes for suppliers, formation of industry clusters, and provision of infrastructure
- To draw on all available talent, governments should develop policies geared towards specific groups. Particular measures are needed to overcome the barriers that women confront, including gender diversity targets, greater workplace flexibility, and sensitivity training, along with mentorship and training programmes.
- Governments and other stakeholders should also put in place policies to support workers who are affected by the transition to renewable energy including through unemployment benefits, relocation grants, job-search assistance and re-skilling programs.
- Efforts are needed to support investments in renewable energy development, and to adopt and update equipment standards and quality-control measures to ensure maximum effectiveness of installed renewable energy capacities.
- Active labour market policies, skills development and social protection strategies can smooth the energy transition for fossil fuel-dependent communities. These include proactive consultations, retraining programmes, social protection measures and investments in support of economic diversification.

## Policy Brief on the interlinkages between energy and jobs

Energy is essential to a well-functioning economy, and it must be accessible, reliable and affordable. Absence of these conditions may spell job loss and missed job-creation opportunities. Therefore, SDGs 7 and SDG 8 (Decent work and Economic growth) are linked in important ways, to the extent that in many contexts, achieving SDG 7 can be considered a precondition for achieving SDG 8, in that almost all jobs that are decent and productive also entail access to energy. Where enterprises and households suffer from either a lack of access to modern energy or unreliable and poor-quality energy services, improving access will likely support new opportunities inside as well as outside the energy sector. Where energy access is already a reality, the employment effects of achieving SDG 7 will mainly come from the shift to more sustainable energy sources.

The transition to a more sustainable energy system has important employment ramifications in its own right and enhances the socioeconomic resilience of communities around the world. Unfettered climate change—in the form of extreme weather, rising global temperatures, changes in rainfall patterns, and spreading disease vectors—will increasingly weaken economic activity and undermine livelihoods by disrupting supply chains, destroying productive assets, displacing people and affecting the health and productivity of workers.

New employment opportunities develop from adopting renewable energy sources, and a skilled workforce is indispensable to a successful energy transition. Without well-trained, experienced workers, renewable energy deployment and energy efficiency targets may be missed or the quality of equipment and installations could suffer. Workers and communities whose livelihoods rely on fossil fuel–based industries will be displaced and must be offered protection.

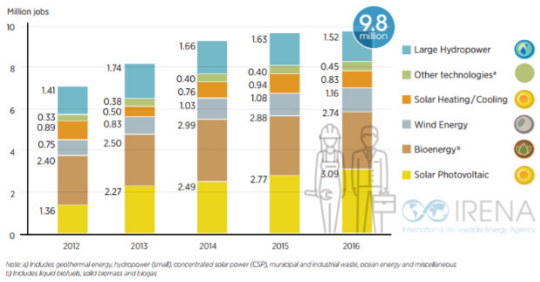
### Current status

Most of the investment and analytical attention has gone to grid-connected renewable electricity in urban and industrial contexts. By contrast, available information in the energy access context, especially in rural settings, remains more limited for the time being.

The expansion of installed renewable energy capacity has translated into a growing workforce. According to IRENA, the renewable energy sector worldwide employed 8.3 million people, directly and indirectly, in 2016 (IRENA, 2017a).[1] Direct employment in large hydropower adds another 1.5 million, for a total of 9.8 million (see Figure 13.1). This is up from 7.1 million jobs in IRENA's initial assessment (5.7 million without large hydropower). Solar photovoltaic (PV) employment has more than doubled since 2012. Liquid biofuels, large hydropower and wind power are the next-largest employers.

Figure 13.1

**Global renewable energy employment, 2012-2016**




Growth in employment has been facilitated by rapidly falling costs, especially for wind and solar PV equipment. Feed-in tariffs provided the initial support for the growth of renewables markets. More recently, auctions are facilitating cost discovery and are bringing about some of the lowest project costs on record. In recent years, these positive developments were somewhat moderated by fluctuating investment levels and by policy changes and uncertainties in some countries, underscoring the continued importance of a stable and favourable regulatory framework.

At present, China, Brazil, the US, India and member states of the European Union (EU) are leading employers in the renewable energy sector. They are the principal manufacturers of solar panels, wind turbines and other equipment, and are home to the largest deployment markets. Recent years have seen a considerable shift towards East Asian countries, spurred by strong policies there to stimulate domestic installations and to support the emergence of globally competitive manufacturing facilities.

Equipment manufacturing is highly concentrated in a few countries, but with adequate policy support, some production and assembly can be localized. Most countries can expect to create employment principally in other segments of the value chain—in project development, sales and distribution, construction and installation, and operations and maintenance (IRENA and CEM, 2014). This is also the case in the energy access context; most of the solar PV equipment used in decentralized applications is produced in China and a few other countries. Inputs needed for small hydropower and biogas projects, on the other hand, are often supplied domestically.

Clean and affordable energy also entails the replacement of fossil fuel energy sources beyond electricity production. It entails increasing the use of biomass and waste in industry, transport and

[1] The estimate is based on an extensive annual review of available databases, studies and estimates. The jobs numbers include direct and indirect employment along the renewables value chain but exclude induced jobs. These are generated when employees of the renewable energy sector spend their salaries on goods and services throughout the economy.

heat generation (IEA, 2015a).

"Another important component of a transition to a low-carbon energy system is greater energy efficiency in the transport sector, industry and buildings, suggesting policies related to mobility, industrial processes, generation, distribution and use efficiency." (IEA, 2015)

Rising employment numbers are important but so is the quality of jobs. The push for continued cost-cutting, and non-standard working arrangements (e.g., temporary or informal work) may affect staffing levels, wages and access to social protection. Yet these factors determine the disposable income available for spending on goods and services and thus influence the extent of induced employment and socioeconomic development

**Net employment effects**

Studies indicate that renewable energy technologies create more jobs than fossil fuel technologies. For instance, per dollar of expenditure, spending on renewable energy will produce nearly 70 per cent more jobs than spending on fossil fuels (Chen, 2017). Similarly, solar PV could create more than twice the number of jobs per unit of electricity generation compared with coal or natural gas (UKERC, 2014). Biomass and waste as sources of energy can also have important employment implications in agriculture and waste management. In developing countries increased demand for biomass may not necessarily increase employment, as a large share of the population already depends on agriculture but will shift crops and may impact local food prices and food security.

To some extent this is due to the fact that renewable energy technologies are not yet as fully matured as conventional technologies. Labour productivity in the renewable sector can be expected to rise. The ongoing mechanization of biofuels feedstock harvesting in Brazil is already lowering the requirement for agricultural labourers and is leading to changes in required skills. Production of equipment such as solar PV panels and wind turbines is also subject to increased automation, as are operation and maintenance (O&M) activities.

Still, the energy transition from fossil fuels to renewables will likely be accompanied by net employment gains. In addition to the expansion of renewable energy, jobs will be created through investments in smart grids, modern transmission and distribution networks, storage capacity to help integrate variable renewable energy supplies into the grid, charging infrastructure for electric vehicles and other measures. Important employment gains are expected in the construction sector and R&D as current buildings are retrofitted and transport and production processes altered to be more energy efficient.

Meanwhile, dynamics within the fossil fuel sector (rising mechanization, overcapacities and industry consolidation) are increasingly translating into job losses, especially in the coal industry. Renewable energy employment could expand to around 25 million people worldwide by 2030, outpacing job losses in the conventional energy sector by some 6 million workers (IRENA, 2017a). A key challenge for policymakers will be to ensure that the energy transition is fair, which requires smoothing the adjustment for affected workers and communities.

Greater energy efficiency translates into direct employment opportunities in R&D for energy efficiency technologies, production of materials such as building insulation and of equipment such as more efficient appliances, and finally in the installation and maintenance of such materials and equipment, with strong employment gains expected in the construction sector. Energy efficiency allows for money to be spent elsewhere in the economy. On a job-creation level and considering the economic linkages across industries, each US$ 1 million spent in energy efficiency supports 7.72 jobs, while similar expenditures in the renewable and fossil fuel sectors create 7.49 and 2.65 jobs, respectively (Garret-Peltier 2017). But if overall energy demand continues to increase regardless, greater efficiency will not necessarily entail job loss in extracting, refining and distributing fuels, or in producing electricity.

Other important factors for employment effects are the scale and business models through which the transition will be realized. An energy sector that is dominated by a few large-scale utilities is likely to have a very different effect from a sector where households and small and medium-sized enterprises (SMEs) can be actively involved in aspects of generation, installation, distribution and maintenance, as illustrated in some of the examples below. Ultimately the structure of the renewable energy sector presents countries with an important set of policy choices of how they would like this sector to be structured in terms of ownership, respective roles of public and private sectors, levels of decentralization, roles of households, and the different business models through which energy will be provided. And it is recommended that the different employment effects of these policy choices be explicitly considered in the decision-making process.

**Skills requirements of renewable energy**

Due to the diversity of technologies, the renewable energy sector requires a wide variety of skills and occupations, ranging from construction workers to plumbers and electricians, and technicians and engineers with various specializations. The bioenergy supply chain also requires people in agricultural occupations for feedstock planting, harvesting and processing. The renewable energy sector spans not only many technical professions, but requires planners and administrators, legal experts and financial specialists. Utility-scale plants require different skill profiles than smaller facilities,

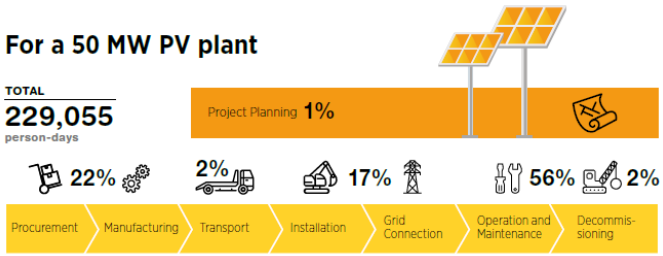
especially deployments in an energy access context.

Analysing the occupational patterns and skills needs of a typical 50 megawatt (MW) solar PV project, IRENA's *Leveraging Local Capacity for Solar PV* (IRENA, 2017b) found that a total of 230,000 person days are needed along the value chain (see figure 13.2). Operations and maintenance account for 56 per cent, manufacturing for 22 per cent, and construction and installation for 17 per cent. Construction workers (35,500 person days) and factory workers and technicians (32,000 person days) are the most numerous occupations.

Figure 13.2

**Employment impacts in the solar PV value chain source: IRENA, 2017b.**

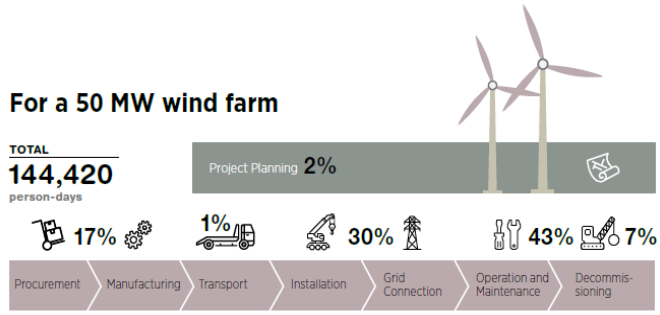
Similarly, for onshore wind, IRENA found that a typical 50 MW




project requires a total of 144,000 person days (see figure 13.3). Operations and maintenance represent 43 per cent of the total, construction and installation 30 per cent, and manufacturing 17 per cent. Construction workers (26,600 person days) are the single largest occupational contingent, followed by factory workers (close to 12,500 person days).

Figure 13.3

**Employment impacts in the onshore wind power value chain. Source: IRENA, 2017c.**




For a given project, the duration of different types of jobs along the value chain varies, but a steady pipeline of projects blurs distinctions between limited-duration jobs and permanent ones. Construction and installation typically lasts a few weeks or months. Manufacturing jobs (and related occupations such as in procurement and transportation) depend on the pace and degree of fluctuation in the demand for equipment over time. Operations and management jobs are quasi-permanent in that a given renewable energy power plant can have a lifetime of up to about 20 years.

### Employment through reliable energy access

Measuring the employment effects stemming from energy access is difficult due to lack of data, the informality of many of the jobs, the complexity of the energy access landscape across a multitude of actors and initiatives, varying technologies, and scales of deployment. Electricity access can be provided through grid extension, mini-grids and stand-alone devices. Boosting access to cooking fuels entails the manufacture and distribution of improved cookstoves, for which very limited employment information is available (IRENA, 2012; ILO, 2017).

In addition to projects intended to improve energy access, there are also large-scale wind, solar and bioenergy facilities that are located in rural areas but whose output is destined for grid-connected communities. Many of the inputs come from abroad, so local employment is mostly created in construction. Absent dedicated community development and skill-building efforts, lasting socioeconomic benefits may be scarce.

The potential for job creation through decentralized renewable energy solutions for electricity and modern fuels is enormous. Some experience has been gathered on the ground, with regard to small-scale solar (also see Policy Brief #1):

- Bangladesh's rural solar programme, based on a microfinance model, has succeeded in installing more than 4 million solar home systems to date. In the process, more than 100,000 jobs were created. This includes more than 80,000 jobs in installations and in the value chain, and 30,000 jobs in manufacturing and assembly (Barua, 2015). Training and quality control are important dimensions of this programme.
- The spread of the "pay-as-you-go" model in East Africa is creating additional employment, though still at a relatively small in scale for the time being. Start-up companies like M-KOPA, Off-Grid Electric, Azuri, BBOXX, or Mobisol are the main exponents of a business model that has so far created thousands of jobs in the sale, distribution and installation of decentralized solar panels but carries the potential for much larger impacts.

As the cost of renewables has come down, one of the last remaining hurdles in this area is linked to distribution, and in particular to the "last-mile" connections, which often still remain costly or require too large an upfront investment. In addition, as renewables substitute for conventional energy such as kerosene, charcoal or

firewood, net employment effects, job quality and other benefits must be considered. Charcoal production, transport and trading are labour-intensive, providing livelihoods for millions of people (Openshaw, 2010). Rough estimates available for replacing kerosene lamps with solar lanterns (UNEP, 2014) suggest that the net balance can be positive.

#### Consumptive and productive uses of energy

Beyond the jobs created by energy access, there are broader employment and development opportunities. Consumptive uses of energy reduce household drudgery such as gathering of fuelwood, freeing up time that may be spent on education and income-generating activities. Access to cleaner energy also permits improvements in education (electricity boosts study hours) and health (reduced exposure to indoor air pollution from traditional biomass) and increases disposable household income (where clean energy sources are cheaper than conventional polluting sources), resulting in economic gains at the local level.

Meanwhile, productive uses of electricity or mechanical power can help small and medium-sized enterprises improve their productivity, raise the quality of their goods and services, and increase sales. Agriculture (irrigation, agro-processing, etc.) is a primary beneficiary, but light manufacturing, commercial activities and communications also benefit (ILO, 2017). A review of 50 studies from Africa, Asia and the Americas on impacts of electrification at the household and enterprise level found that, on average, access leads to increases of 7 per cent in school enrolment, 25 per cent in employment (with particular benefits accruing to women), and 30 per cent in incomes (Jimenez, 2017).

Even so, access to energy is generally understood to be a necessary but insufficient condition for economic development. Among the additional enabling factors are availability of finance, knowledge and skills, managerial capacity, access to markets (roads, infrastructure, social networks) and a conducive regulatory environment (Practical Action Consulting, 2012).

#### Gender as a central factor for success

Employment in the energy sector as a whole is traditionally male-dominated. However, findings from an IRENA survey (IRENA, 2016) suggest that at 35 per cent of the labour force, the share of women in modern renewable energy is higher than in conventional energy. The specifics vary from country to country and from one renewable energy technology to another. In the US, for instance, the share of women in the solar industry rose quickly from 19 per cent of the workforce in 2013 to 28 per cent in 2016 (Solar Foundation, 2017).

An online survey with focus on the Middle East and North Africa region (BNEF, CEBC and IRENA, 2017) confirmed findings from other parts of the world that women continue to face challenges owing to a range of attitudinal obstacles and structural barriers. These include a lack of background in the STEM (science, technology, engineering and mathematics) fields but also dated perceptions of gender roles, discrimination in pay and a persistent glass ceiling for managerial positions. Redressing the situation will require a number of initiatives, including offering greater flexibility in the workplace and greater support for women through mentorship and training. In the energy access context, female entrepreneurs also need better access to finance.

#### Supporting displaced workers and communities

As the energy sector transitions away from fossil fuel–based sources and into renewables and greater efficiency, workers and communities relying on fossil fuel–based industries will lose out. Employment in the extraction of petroleum, mining of coal, petroleum refinery and electricity production from coal—among other industries—will decrease. These workers and the related communities will need to transition to new economic activities to sustain their livelihoods, prompting support from governments and other stakeholders in the form of social protection, re-skilling programs, relocation grants, entrepreneurship, job search assistance, industrial development and other forms of support (ILO, 2015).

## Policy implications/recommendations

The ILO's Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for all (2015) provide a comprehensive policy portfolio to advance the transition towards clean and affordable energy but also to ensure it promotes decent work and protects workers, individuals and communities who may lose out as a result. This policy package includes macroeconomic and growth policies, industrial and sectoral policies, enterprise policies, skills development, occupational safety and health, social protection, active labour market policies, rights and social dialogue. The following are some of the key recommendations:

#### Improve data

Available information in both on- and off-grid environments remains uneven, underscoring the importance of more systematic collection of quantitative and qualitative data at sufficiently disaggregated levels. The need for better data is particularly strong in the context of rural energy access and with regard to working conditions.

#### Avoid skills gaps

Some skills gaps already exist for technical and engineering positions and could grow as the renewable energy sector continues to expand. Unalleviated, this could hinder a smooth energy

transition, contributing to project delays or even cancellations, cost overruns and faulty installations. Improved monitoring of labour market dynamics and projections of likely skills needs are critical tasks. Better coordination between the renewable energy sector and educational institutions is essential for developing renewable energy curricula, integrating renewables modules into vocational training courses, supporting apprenticeships, and establishing common quality standards.

### Retrain workers and retain expertise

Part of the challenge is to find ways to draw on skilled personnel from relevant other industries and to undertake retraining efforts as necessary (IRENA, 2017d). Ensuring the retention of skilled and experienced workers is also critical, and this requires adequate wages, decent job conditions and clear opportunities for career advancement (ILO, 2015).

### Mainstream gender

Governments and the private sector need to work on removing barriers to entry for women's employment in the renewable energy sector and to better include gender perspectives in policy-formulation, education and training measures, access to finance, and various support services. The benefits are twofold—creating equal opportunities for women and reducing the risk of a growing skills gap.

### Develop local supply chains

To maximize socioeconomic benefits, countries seek to localise portions of the value chain (and the associated jobs) by leveraging domestic content (IRENA, 2017a). To be successful, however, such policies need to be part of a broader effort to develop viable domestic supply chains (incubating new businesses, building up the know-how and capacities of enterprises, providing supportive infrastructure, encouraging industrial clusters, etc.). They also need to be linked to training and skill-building efforts.

### Support workers and communities who may lose out

Generating a smooth energy transition path requires addressing the fear that communities, now reliant on the fossil fuel industry, will lose jobs, incomes, and economic vitality. This creates political resistance to an accelerated transition, but can be addressed through just transition strategies. These include retraining programmes, relocation grants, social protection measures, proactive consultations with communities, incubation of new businesses, and investments in support of economic diversification (ILO, 2015).

## REFERENCES


BNEF (Bloomberg New Energy Finance), CEBC (Clean Energy Business Council) and IRENA (2017), Women in Clean Energy. Middle East and North Africa Survey 2017.

Chen, Y. (2017), *Renewable Energy Investment and Employment in China*, PERI Working Paper Series Number 439, Political Economy Research Institute (PERI), University of Massachusetts, Amherst, MA.

ILO (International Labour Organization) (2017), Rural Renewable Energy Investments and their Impact on Employment, STRENGTHEN Publication Series, Working Paper No. 1, Geneva.

Garrett-Peltier, H. (2017). "Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model", Economic Modelling, Vol. 61, pp. 439–447.

Jimenez, R. (2017) Development Effects of Rural Electrification, Inter-American Development Bank, Policy Brief No. IDB-PB-261.

IEA (International Energy Agency) (2015). Energy Technology Perspectives 2015, Paris.

ILO (International Labour Organization) (2015). *Guidelines for a just transition towards environmentally sustainable economies and societies for all,* Geneva.

IRENA (International Renewable Energy Agency) (2017a), Renewable Energy and Jobs—Annual Review 2017, Abu Dhabi.

IRENA (2017b), Leveraging Local Capacity for Solar PV, Abu Dhabi.

IRENA (2017c), Leveraging Local Capacity for Onshore Wind, Abu Dhabi.

IRENA (2017d), Renewable Energy Benefits: Understanding the Socioeconomics, Abu Dhabi.

IRENA (2016), Renewable Energy and Jobs—Annual Review 2016, Abu Dhabi.

IRENA (2012), Renewable Energy Jobs and Access, Abu Dhabi.

IRENA and CEM (Clean Energy Ministerial) (2014), The Socioeconomic Benefits of Solar and Wind Energy.

Openshaw, K. (2010), "Biomass Energy: Employment Generation and its Contribution to Poverty Alleviation," Biomass and Bioenergy, Vol. 34, pp. 365–378.

Practical Action Consulting (2012), People's Energy Outlook 2012: Energy for Earning a Living, Rugby, United Kingdom.

Solar Foundation (2017), National Solar Jobs Census 2016. A Review of the U.S. Solar Workforce, Washington D.C.

UKERC (2014), Low Carbon Jobs: The Evidence for Net Job Creation from Policy Support for Energy Efficiency and Renewable Energy.

UNDP (United Nations Development Programme) (2012), Integrating Energy Access and Employment Creation to Accelerate Progress on the MDGs in sub-Saharan Africa, New York.

UNEP (United Nations Environment Programme) (2014), Light and Livelihood: A Bright Outlook for Employment in the Transition from Fuel-based Lighting to Electrical Alternatives, Nairobi.

# POLICY BRIEF #14

## INTERLINKAGES BETWEEN ENERGY AND SUSTAINABLE CITIES

### Developed by

United Nations Human Settlements Programme (UN-Habitat), United Nations Economic Commission for Europe (UNECE) and UN Environment

## KEY MESSAGES

### Status of the interlinkages between energy and sustainable cities and progress towards achieving SDG 7

- The world is experiencing unprecedented trend of increasing urbanization, especially in the global South. By 2030, cities and towns are expected to house around 60 per cent of the world's projected 8.2 billion people, up from 7 billion people in 2007, with the urban population increasing by around 1 million people per week and with an exponential increasing demand for modern energy.
- Cities and towns globally consume up to 75 per cent of energy, and are responsible for 70 per cent of greenhouse gas (GHG) emissions, along with 70 per cent of resource use. At the same time, 80 per cent of GDP is generated in cities.
- Cities and towns in developing countries have limited access to modern energy, and energy demand is growing faster than supplies. Between 20 per cent and 40 per cent of urban dwellers in developing countries do not have reliable access to electricity. Recourse to traditional biomass use comes with consequences for air quality, health and environmental degradation.
- Growth in urbanization comes with the need to supply housing and basic infrastructure for the new urbanites, the way in which cities are planned and designed will influence energy intensity of these systems. At present energy efficiency improvements in the buildings and construction sector are outpaced by the floor space added. Similarly, improvements of efficiency of vehicles has been outpaced by increasing demand for transport services.
- A reflection of national mix in the energy systems, most urban areas are heavily reliant on fossil fuels as their main sources of energy, and generate a significant amount of GHG emissions. Investments in clean, reliable and affordable energy are critical for sustainability in cities, together with greater energy and resource efficiency in the built environment (housing and infrastructure).
- In developed countries with nearly 100 per cent energy access, an increasing number of cities have initiated major programmes for an energy transition from a fossil fuel–driven economy to cleaner energy generation, increasing the share of renewables in their energy mix, and modern district energy systems, retrofitting old buildings to reduce their operating costs and carbon footprints.
- More cities have committed to 100 per cent renewable energy targets, and the demand in cities for clean, reliable and affordable energy is increasing exponentially as national and local governments adopt low-carbon measures to address climate change. For example, the Global Covenant of Mayors for Energy and Climate brings together over 7,000 cities and towns committed to reducing their carbon footprint through well-elaborated climate action plans.
- Reductions in the costs of energy efficiency and renewables, together with greater competition in the business sector, provide cities with an unprecedented opportunity to transform, decarbonize, and enhance the resilience of, their energy systems.

### Priority actions

- Promoting sustainable cities requires multi-sectoral investments and integrated policies. Key actions areas include: (a) planning, design and implementation of compact and accessible cities with strategic densification and abundant green and blue areas; (b) adoption of clean, efficient, safe and affordable public transportation and non-motorized transport options; (c) deep renovation of existing building stock and designing of energy and resource efficient and resilient new buildings; (d) generation of energy from locally available clean energy sources; (e) adoption of efficient municipal waste management systems with resource recovery; (f) promoting efficiency in the use of resources, including water and electricity, in the commercial and industrial sectors, as well as in the generation and transportation of energy; and (g) use of nature-based solutions.
- In order to achieve universal energy access, cities in developing countries need increased electricity supplies, green technology transfer, capacity development and responsive consumption. Policymakers should make more efforts to increase investments in energy access particularly for the urban poor who live in informal settlements. There is also a strong need for policy reform in the energy sector, to take into account new technology innovations, the transition away from centralized national energy utilities as monopolies and lowered costs for off-grid energy systems.
- Cities in developing countries should invest in green industrial transformation (SGD 9), creating new jobs (SDG 8) in connection with manufacturing and assembling (SDG 12) cleaner energy technologies, and electric appliances.

## Energy and sustainable cities and the Sustainable Development Goals

### Key challenges

The main challenges are in the form of market barriers, inappropriate policy frameworks, and financing gaps, as well as limited capacity for design, planning and implementation, plus lack of affordability and reliability of energy. This is particularly the case in poor and vulnerable urban communities, Least Developed Countries and Small Island Developing States, where citizens disproportionately lack access to modern energy services. The case for increased energy access for urban poverty alleviation in this context is compelling. However, actions have been too slow at both the national and local levels. In terms of a transition to modern renewable energy, cleaner energy technologies are still not exempted from taxes in many counties, and fossil fuels still receive heavy subsidies. Energy efficiency measures and actions in cities have not received the necessary attentions it deserved to reduce the carbon emission. A significant amount of energy could be save by adopting proper urban planning with high density and promoting energy demand management.

*Low energy access in cities of developing countries*

The current level of energy generation in developing countries is far below the amount required for countries' economic growth, wealth creation and improvement of the people's living conditions; it is impossible for these countries to achieve ~~create~~ sustainable cities with the current energy supply. Power shortages and rationing are too common and contribute to the high cost of doing business in developing countries. Despite the shortages of modern energy, African citizens pay the highest energy tariff of the world; the majority of urban dwellers are considered energy poor, as they spend between 10 per cent to 30 per cent of their income on energy services.

*Wood energy*

Wood is one of the dominant renewable energy sources in the UNECE region where some of the most efficient bioenergy systems have been developed. This region achieved 98 per cent access to clean fuels and technology for cooking in 2014, up from 95 per cent in 2000, but 23.3 million people in remote rural regions still relied on inefficient solid fuel systems for cooking in 2014, often using locally gathered firewood. The fuel typically is burnt in a controlled combustion wood stove or a traditional high mass combined space heater and/or cooking oven. Inefficient stoves allow users to generate heat from low or no-cost local resources.

### How to fill the gap to achieve SDG 7 for sustainable cities development

The sectors discussed below require major interventions in the form of policy reforms, investments, capacity-building, and scaling up.

*Low-energy access in cities in developing countries*

Between 20 per cent and 40 per cent of urban dwellers in developing countries do not have reliable access to electricity. Policymakers should make more efforts to increase investments in energy access, particularly for the urban poor who live in informal settlements. Access to electricity should be improved. Partnerships are needed among the key players, including the government, the private sector and civil society organizations.

*Energy generation in cities: cities are becoming prosumers*

The New Urban Agenda adopted during Habitat III Conference in Quito in 2016, commits countries to the generation and use of renewable and affordable energy in urban areas. Cities become energy "prosumers" when they produce part of the energy that they consume. Urban areas are endowed with renewable energy sources such as wind, solar and other resources, as well as municipal wastes, which could be used to generate additional energy. Putting all these potential resources into use could reduce cities' carbon footprints.

Investment in clean energy offers cities the possibility to directly control on-site power generation, as opposed to the traditional centralized power grid controlled by a parastatal or the central government. Significant progress has been made in the adoption of feed-in tariffs and grid connection regulations allowing citizens and private entities to generate and sell clean energy to central or local energy grids, although their adoption remains slow in developing countries.

*Cities and national governments are adopting responsive energy efficient policies and practices, and municipal energy strategies*

Cities are adopting more energy efficient policies and practices in the transport, buildings, industry, and commercial sectors. The number of energy efficient building codes adopted by countries, and by-law at city level, has increased in the last five years. Numerous countries have included energy-efficiency interventions in their NDCs, with attention to cities.

Local governments need strong support to encourage, enable, measure and regulate sustainable energy, as well as inform decisions on deployment options, including adaptation to, and anticipation of, new technologies and changing energy requirements.

Cities and local governments, as managers of local infrastructures, can develop solutions that integrate energy and end uses such as buildings, industry, transport, waste, or sanitation, maximizing efficiencies, stimulating innovation in energy generation technologies, and reducing consumption. Although several local and national governments are committed to increasing the share of their sustainable public procurement to reduce environmental and carbon footprints, and to foster market growth, very little is happening on the ground. Procurement manuals and procedures

should be updated to include sustainability principles.

*District energy systems in cities*

District energy system in cities is a new concept of an energy generation and distribution system that focuses on energy efficiency and renewable energy.

Distributed electricity generation will become a key feature of new and existing cities, complementing sustainable utility-scale power plants, which are often outside cities. Cogeneration and district energy networks also provide the flexibility and storage to integrate an increasing share of renewables into the energy mix, while simultaneously improving energy efficiency through demand aggregation, increased scale of production sources and use of waste heat.

*Planned urban form*

Proper design and planning of urban forms, infrastructure and buildings, according to local environment and climates, could reduce significantly the demand for more energy and other resources for their operations. Energy and resource efficiency have not been applied consistently in major urban sectors such as industry, transport, buildings and infrastructure. Some cities are already integrating sustainable energy considerations in their urban neighbourhood designs, planning and management through use of performance metrics for energy production and consumption in zoning and land-use planning, permitting, infrastructure, buildings and transport decisions.

*Energy and buildings: the green building council expansion*

As buildings consume more energy than any other sectors, the adoption of green building concepts is gradually taking shape in most urban areas. Green building councils are being created to promote the adoption of sustainable building design practices. There are different types of green building rating systems that promote environmentally friendly building design associated with responsible consumption of resources (water, energy, material and land) and reduction of waste. Massive deployment and integration of green building principles could be made through building permits where all new buildings are required to adopt minimum energy performance standards. This will not only reduce energy waste in the built environment but can also allow buildings to generate additional energy through their rooftops.

*Smart energy grid and "smart" sustainable cities*

Smart grids are enabling major energy efficiency and resilience gains. Using ICTs, the grid is able to manage energy demand and use the most efficient energy source on the system.

Smart energy grids also allow for the deployment of electric transport systems, which are starting to contribute to the reduction of the carbon footprint of the urban transport sector, particularly when the electric power used is from renewables.

*Cities and industrial development*

Urbanization and industrialization are two interlinked processes, with energy as a common denominator. In fact, the availability of energy drives both urbanization and industrialization. These are transformative processes for job creation, economic growth, and wealth creation.

*Availability of financial resources to stimulate the uptake of energy access to sustainable cities development*

The Paris Agreement on climate change calls for all countries to allocate sufficient resources to invest in a low carbon economy, including a sustainable energy sector. Although some countries have allocated resources for green energy generation, access to these financial resources remains a big challenge. However, there are Green Investment Banks with qualified expertise and Kenya has a newly created Green Bond programme aimed at developing a domestic green bond market focusing on climate and infrastructure targets. The Cities Climate Finance Leadership Alliance (CCFLA) is a group of leading organizations that are mobilizing investments into low-carbon and climate-resilient infrastructure in cities and urban areas internationally.

### Interlinkages with other SDGs

Energy is a cross-cutting driver of all the 17 SDGs. From a social point of view, lack of access to energy is one of the biggest constraints to the main scope of Agenda 2030 on eradication of extreme poverty (SDG 1), including for the urban poor estimated at 1 billion people globally.

Energy access contributes to improving the quality of life, since it supports better health-care services and a greater life expectancy (SDG 3) and the possibility of having access to quality education (SDG 4). The use of electricity allows replacement or facilitation of time-consuming activities in informal settlements and in peri-urban areas, especially for women and children (SDG 5), allowing them to develop their human and social potential and empowering their roles within their households and society. In addition, modern energy provides access to electricity and gas, and the use of less-polluting systems for cooking and heating (SDG 2), and it is the driver of industrialization (SDG 9), telecommunication services (SDG 9), creation of jobs (SGD 8), good production and consumption (SDG 12). It is critical for the supply of safe and drinking water (SDG 6), which is badly needed in cities in developing countries, as well as for the development of inclusive human settlements (SDG 11). In relation to the economic dimension, energy allows the creation of jobs (SDG 8). Energy efficiency and increasing the share of renewable energy in the energy mix is crucial to mitigate the risks of climate

change (SDG 13) and limit the use of unsustainable firewood, which remain the major cooking fuel in informal settlements, reducing deforestation and soil degradation (SDG 15).

## Policy Implications/Recommendations

With cities being major consumers of energy and contributors to GHG emissions from inefficient systems that lead to energy wastage, the built environment in urban area offers greater opportunities for the achievement of SDG 7, SDG 11 and SDG 13. This can be achieved through planning and designing for greener and more compact cities, green buildings, adoption of energy efficiency, clean energy generation, reduction of waste and promotion of responsive consumption practices.

However, there is a need for committed leadership to drive the energy transition in cities. Capacity-building and tools development are needed for practitioners, such as architects, engineers and other experts, on sustainable building design. Training institutions should initiate or strengthen training courses on a sustainable built environment.

Urban planners should design cities, towns and neighbourhoods with minimum wastage of resources and maximum use of locally available renewable energy resources.

Investors should be engaged to finance efficient buildings and appliances through green mortgages; this will help remove financial barriers. Above all, the following key actions should be addressed:

*Sharing information and technical expertise*

Public awareness is crucial to stimulate consumer demand for sustainable products and to promote behavioural change. All urban energy projects and programmes should promote non-technological measures supporting behaviour shifts, such as knowledge-sharing and public information campaigns. This will complement the different initiatives being carried out at the community level to engage the public and educate people to understand issues related to climate change and energy transition.

*Closer cooperation among energy stakeholders, and partnerships*

Achieving sustainability in cities requires that all stakeholders work in closer cooperation and avoid working in isolation. Main stakeholders, including power utilities, national and subnational governments, academia, the private sector and civic society organizations should work more closely to ensure that sustainable energy goals be achieved.

*Energy efficient building codes*

Considering that fossil fuel–related energy will still be leading the energy sector in the coming years, national and local governments should enact mandatory minimum energy performance standards, and ratings and labels for energy efficiency in buildings, equipment, and appliances, especially lighting, heating and air-conditioning units, to reduce energy consumption and GHG emissions. Similarly, energy efficiency measures in buildings should consider efficiency in energy supply, and target the reduction of fossil fuel primary energy such as through the promotion of building integrated renewables, nearly net zero operating emission performance as proposed by the Global Alliance for Building and Construction (GABC), in the Roadmap for transition towards low - GHG and resilient buildings.

*Switch energy sources in the transport sector.*

Some developed countries like Norway and Germany have set targets for cleaner transport systems by 2025 and 2030. Electric vehicles can now be seen in the streets of developing countries. This is a good trend that needs to be encouraged. Priority should be given to the switch to non–fossil fuel–based transport, such as renewable energy based public transport and electric vehicles, as well as increased use of other forms of eco-mobility and non-motorized transport reducing the use of single cars.

*Compact and densify cities through proper integrated urban planning measures.*

Decarbonizing cities requires low-carbon urban-planning measures. This includes the allocation of adequate, sufficient and equitable areas for the built and open spaces. The built spaces should not exceed 50 per cent and the remaining 50 per cent should be allocated to streets, gardens and other open spaces. Sustainable cities should adopt adequate density and compact patterns with an average of 150 people per hectare. Connectivity is also equally important as it links different city spaces together. Mixed land use, combining economic and residential activities and basic services, avoids the need for transport and promotes a social mix of classes by integrating affordable housing as well. "*Compact, resource efficient cities could see cuts of 36-54 per cent in GHG emissions, and in metals, land, energy and water use*." Weight of the Cities

Key Performance Indicators for Smart Sustainable Cities, such as those developed by UNECE and the International Telecommunication Union (ITU) with 14 other United Nations system organizations, will enable cities to measure their progress over time, compare their performance to other cities and through analysis and sharing allow for the dissemination of best practices and set standards for progress in meeting the SDGs at the city level.

*Capacity-building*

Long-lasting development requires that the actors and beneficiaries are fully involved in clean energy generation. Any meaningful programme on sustainable energy should include technology transfer and capacity-building components. Capacity-building in producing energy in cities is vital, considering that this sector has been for so long dominated by utility companies and other

large energy providers based on centralized power generation and distribution systems.

*Gender dimension*

Contributions and concerns of women and men regarding energy in cities need to be addressed, given that their needs, expectations and aspirations could be different. The gender dimensions of sustainable energy in cities should be incorporated into the design, planning and implementation of projects. In reporting on such projects or programmes, gender-disaggregated data on access to energy and finance for energy, as well as employment in the energy sector, should clearly show how men and women benefitted from the intervention. Women and children living in informal settlements or peri-urban areas are among the chief victims of indoor air pollution from cooking on traditional stoves, so decision-making about promoting cleaner cooking programmes in urban areas should include women.

*Involvement of urban youth in green technologies for sustainable development*

Young people under 30 years old constitute over 60 per cent of the African population; most of them are disenfranchised and live in urban areas without formal jobs. Empowering them to participate in activities focusing on resource efficiency and renewable energy is key to the achievement of sustainable city development. In the past few years, several training initiatives to empower youth through training on green technologies have revealed that these disenfranchised sectors of the society could increase energy access through local production and assembly of solar street lights and solar lanterns.

Engage stakeholders to promote energy efficiency and responsible consumption.

Policies in regard to land management, particularly in remote areas where traditional biomass is often the only accessible heating option, might need to be revisited to allow the legal harvesting of biomass and encourage its regrowth. Formal adoption of sustainability criteria is needed for the management of renewable feedstocks and efficient energy conversion of wood pellets. Integration of sustainable land management and efficiency is possible through cooperation among multiple stakeholders.

Improvements in energy efficiency are possible through establishment of incremental targets. This is illustrated by improvements in energy conversion rates and reductions in particulate matter emissions from high-efficiency residential wood-energy systems.

Wood can be a traditional or a modern type of energy; the key is in the "system" used to turn that biomass into energy. A high-efficiency combined heat and power (CHP) is a modern system that can use biomass; likewise high-efficiency stoves.

## REFERENCES

Energy Efficiency for Sustainable Cities: Achieving SDGs 7 and 11 http://sdg.iisd.org/commentary/guest-articles/energy-efficiency-for-sustainable-cities-achieving-sdgs-7-and-11/.

IEA, 2009, Cities, towns and renewable energy: Yes in my Front Yard, www.iea.org.

UNDESA, 2013, World economic and social survey: Sustainable development challenges.

Fondazione Eni Enrico Mattei, SDG 7 as an enabling factor for sustainable development: the role of technology innovation in the electricity sector. http://ic-sd.org/wp-content/uploads/sites/4/2017/01/AlloisioUpdate.pdf. www.feem.it

http://www.citiesclimatefinance.org/.

Weight of the Cities, http://www.resourcepanel.org/reports/weight-cities

GABC, Global roadmap: towards low-GHG and Resilient Buildings. https://globalabc.org/uploads/media/default/0001/01/0d6a71a346ea7e6841b1b29c77eba6d6ae986103.pdf.

# POLICY BRIEF #15

## INTERLINKAGES BETWEEN ENERGY AND CLIMATE CHANGE

### Developed by

United Nations Framework Convention on Climate Change (UNFCCC), International Renewable Energy Agency (IRENA), The European Commission and UN Environment

### In collaboration with

African Climate Policy Centre, UNECE, UNESCWA, Federal University of Rio de Janeiro and WMO

## KEY MESSAGES

### Status of energy and climate and progress towards achieving energy and climate objectives (SDG 7 and SDG13)

- The energy sector accounts for roughly two-thirds of all anthropogenic greenhouse-gas (GHG) emissions. (IEA,2015). Effective action towards a low-carbon and climate-resilient energy system is essential for achieving the objectives of the Paris Agreement and the 2030 Agenda. Worldwide, about 1.1 billion people had no access to electricity in 2016 and up to a billion more have access only to unreliable electricity networks (IEA, 2017a), with the biggest challenges in Africa. However, with the right balance of policies, universal energy access can be achieved without compromising global climate objectives.
- Advances in renewable energy and energy efficiency have contributed to a decoupling of economic growth and energy-related emissions in a number of countries, and carbon dioxide emissions from energy and industry have remained largely stable since 2014. (UN Environment, 2017] However, the current rates of deployment of renewable energy and promotion of energy efficiency are not advancing fast enough to bend the emission curve.
- Climate change threatens energy security worldwide, and making energy systems climate-resilient will help countries achieve their sustainable development goals. Also, renewable energy deployment can contribute to climate change adaptation. Global GHG emissions in 2020 are likely to be at the high end of the range of the scenarios consistent with the Paris Agreement's goal of keeping global mean temperature well below 2°C or 1.5°C. Global peaking of GHG emissions as soon as possible is critical in order to maintain reasonable chances to attain to these goals.

### Priority Actions

- Decarbonization of the world's energy system must become a uniting vision for governments and all other stakeholders to achieve the SDGs and meet the Paris Agreement's goal. Governments will need to urgently ramp up their efforts and substantially increase their levels of ambition.
- Measures identified by the IEA as instrumental in achieving a near-term global peak in GHG emissions include: increasing energy efficiency and the use of low-carbon technologies; phasing-out least-efficient coal-fired power plants; increasing investment in research and innovation of new technologies in the energy sector, in particular of renewables; phasing out subsidies to fossil-fuel consumption; and reducing methane emissions from oil and gas production (IEA, 2015).
- Additional technological innovation will also be required, and modernization of electricity grids to ensure minimum losses and maximum flexibility, in order to integrate large shares of variable renewable generation, and respond to developments in storage, digitalization and electric vehicles.
- Governments must create an appropriate enabling policy framework, including through renewable energy and climate targets; systematic integration of climate change, renewable energy and energy efficiency in planning and policymaking processes; measures to provide long-term stability for private investments in renewables and energy efficiency; carbon pricing; and environmental taxes.
- Institutions at all levels need strengthening to implement effective policies, engage stakeholder groups (including the private sector and local communities), facilitate access to clean energy research and technology, and promote investment in energy infrastructure and clean energy technology, building on best practice examples that encourage cost-effective investment from a variety of financial streams.
- Developed countries should scale up their level of financial support to developing countries, with a concrete road map to achieve the collective mobilization goal of jointly providing US$ 100 billion annually by 2020 and beyond.

## Interlinkages between energy and climate

The United Nations Climate Change Conference (UNFCCC) in Paris in 2015 adopted a transformative, universal climate change agreement. This landmark agreement articulates the social and economic opportunities offered by a low-emission and climate-resilient future, as well as the intrinsic relationship of climate change action, sustainable development and poverty eradication.

The 2015 Paris Agreement represents a historic turning point in global response to the need for urgent action at scale to mitigate climate change. The Agreement set the specific goal of limiting warming to well below 2°C above pre-industrial levels and pursuing efforts to limit the warming to 1.5°C. It requested all parties to the UNFCCC to set and implement Nationally Determined Contributions (NDCs) that form the foundation of the Agreement.

At the same time, the UN 2030 Agenda and the Sustainable Development Goals (SDGs) call for action by all countries to improve the lives of people everywhere. Specifically, SDG 7 calls for universal access to affordable, reliable, sustainable and modern energy for all, along with urgent action to increase substantially the share of renewable energy and double the rate of improvement in energy efficiency. Since 2015, in the context of SDG 7, energy has been at the centre of global efforts to induce a paradigm shift towards low-carbon energy systems, green economies, poverty eradication and ultimately sustainable development.

In addition, the 2015 Sendai Framework for Disaster Risk Reduction 2015–2030 calls for sustainable use and management of ecosystems and integrated environmental and natural resource management approaches that incorporate disaster risk reduction. Risk management is one of the key elements that binds together the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change.

Both, the Paris Agreement and the 2030 Agenda (together with SDGs, in particular SDG 7), set clear directions and a path for humanity towards development that is powered by clean energy, based on efficient use of resources and defined by resilience to climate impacts.

### Current status of energy and climate change combating effort

As the energy sector contributes around two-thirds of global greenhouse gas (GHG) emissions, it has tremendous potential in mitigating climate change and reducing the gap between the emissions reductions necessary to achieve these agreed targets at lowest cost and the likely emissions reductions from full implementation of the NDCs.

This energy-sector decarbonization can be achieved while simultaneously fulfilling the targets of SDG 7, including ensuring access to affordable, reliable, sustainable and modern energy for all by 2030. This is confirmed by IRENA's analysis indicating that renewable energy technologies, in combination with greater energy efficiency gains, can achieve most of the required emission reductions by 2030 and 2050. Also, the recent IEA analysis shows that universal energy access can be achieved without causing any net increase in GHG emissions (IEA, 2017b).

### Slower growth in global GHG emissions

Total global GHG emissions have continued to increase since 1970. In 2016, the total was estimated (including emissions from land use, land-use change and forestry (LULUCF)) at about 51.9 gigatons (Gt) of carbon dioxide equivalent ($CO_2$ eq), and excluding LULUCF at about 47.8 Gt $CO_2$ eq. The growth in total global GHG emissions was slower in the past three years as these emissions (excluding LULUCF) only increased by 0.9 per cent in 2014, 0.2 per cent in 2015, and 0.5 per cent in 2016 (UN Environment, 2017).

### Economic and population growth continue to drive the increase in global GHG emissions

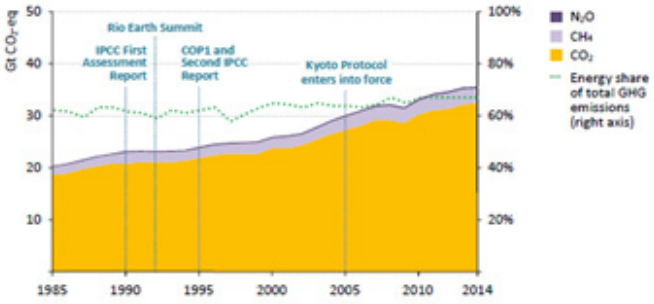
Globally, economic and population growth continue to be the most important drivers of increases in GHG emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply. Between 2000 and 2010, both drivers outpaced emission reductions from improvements in energy intensity. Over that period, increased use of coal relative to other energy sources reversed the long-standing trend of gradual decarbonization of the world's energy supply. Since 2010, however, a move away from coal in many countries has led to a decoupling of emissions growth from Gross Domestic Product (GDP) growth at the global level (IPCC, 2014).

### Energy as a major contributing sector to global GHG emissions

Global $CO_2$ emissions from fossil fuel combustion, cement production and other industrial processes account for about 70 per cent of total global GHG emissions, and were estimated at a total of 35.8 Gt $CO_2$ eq for 2016. These emissions have remained more or less stable for the past three years, reversing the previous steady increase. This may indicate a decoupling of energy- and industry-related $CO_2$ emissions from economic growth during these years, in which global GDP increased by between 2 per cent and 3 per cent annually. The main drivers have been reduced growth in coal use since 2011, mostly in China and in the United States, growing renewable power capacity and generation, especially in China and India, combined with enhanced energy efficiency and structural changes in the global economy (IEA, 2017a).

Figure 15.1

**Global anthropogenic energy-related greenhouse-gas emissions by type. Source: IEA, 2015. Energy and climate: state of play**




However, the trend is still over a relatively short period, and could be reversed if growth in the world economy accelerates. Also, continued investment in more traditional technologies, especially coal-fired power stations, implies technological lock-in and related emission levels over the long term.

Energy is also a major contributor to air pollution, affecting human health and causing environmental degradation. Reducing air pollution and related health problems can be a key driver for the wider deployment of renewable energy in many countries and cities, as is the case in China.

### Energy as a contributing sector to adaptation to climate change

Climate change poses significant challenges to energy systems by affecting natural systems, changing climate variables and modulating the frequency and intensity of extreme weather events. These impacts change the water, temperature, and wind regimes that provide the basis for modern energy systems. Climate change induces vulnerabilities and risks for energy production (including fossil fuel extraction), storage, transportation, transmission and consumption.

Energy sector reform can also contribute to adaptation and resilience. For example, renewable energy deployment promotes the diversification of the power supply and builds resilience through improved energy access.

Climate risks affecting energy systems are well documented:

- Higher temperatures increase energy needs for cooling, and lower efficiencies of thermal power generation;
- Water scarcity can cause shutdowns of thermal power plants and reduced output from hydropower plants;
- Permafrost melting fractures pipelines; and
- Intensified storms jeopardize offshore energy operations, and damage power plants, transmission systems and power grids.

There is a clear need to adapt energy systems and to increase their resilience and potential as contributors to adaptation. However, significant challenges must be addressed. An important first step is cooperation among governments, organizations and stakeholders to identify how climate risks affect specific energy sector operations.

### Progress in promoting sustainable energy with impact on climate change options

In the 2017 report "Progress towards the Sustainable Development Goals", the United Nations Secretary-General concluded that progress in every area of sustainable energy has fallen short of what is needed to achieve energy access for all and to meet targets for renewable energy and energy efficiency. He emphasized that meaningful improvements demand higher levels of financing and bolder policy commitments, together with the willingness of countries to embrace new technologies on a much wider scale than what has been observed so far (Economic and Social Council, 2017). For SDG 7, progress has been mixed for the three main targets of energy access, increasing renewable energy and doubling energy efficiency.

According to the IEA, around 86 per cent of the global population had access to electricity in 2016, meaning that 1.1 billion people, predominantly rural dwellers, still live without electricity. While the number has dropped substantially from 1.6 billion in 2000, more than half of those still without electricity live in sub-Saharan Africa (IEA, 2017b).

Progress on providing access to clean cooking facilities has been slower. Despite growing awareness of the health risks of indoor cooking with solid fuels, and after decades of effort targeting access to modern cooking, the IEA estimates that in 2016 2.8 billion people (38 per cent of the population) still did not have access to clean-cooking facilities, almost the same number of people as in 2000 (IEA, 2017b).

The share of renewable energy in final energy consumption grew modestly from 2012 to 2014, from 16.9 per cent to 17.3 per cent, and has continued to grow steadily since then. Most of the increase was from renewable electricity from water, solar and wind power. Solar and wind power still represent a relatively small share of energy consumption, despite their rapid growth in recent years. The challenge is to increase the share of renewable energy in the heat and transport sectors, which together account for 80 per cent of global energy consumption. (REN21, 2017).

From 2012 to 2014, three-quarters of the world's 20 largest energy-consuming countries had reduced their energy intensity—the ratio of energy used per unit of GDP. The reduction was driven mainly by greater efficiencies in the industry and transport sectors.

(REN21). However, that progress is still not sufficient to meet the target of doubling the global rate of improvement in energy efficiency.

Looking at the future options and opportunities to ensure universal affordable, reliable, sustainable and modern energy for all in the **2017 Energy Access Outlook**, the IEA underscored the need for a new level of political agreement on the importance of access to modern energy services and linkages to climate change. Without this, the targets of SDG 7 and 13 will likely not be met by 2030.

The IEA outlined the opportunities stemming from the declining cost of decentralized renewables, increased access to affordable energy, efficient appliances and the use of mobile platforms that are changing the way we think about providing energy access. It further provides a pathway for achieving access to modern energy for all by 2030, identifying policy priorities and detailing investment needs, and suggests how such energy access intersects with other issues such as gender, health and climate change.

The IEA concluded that achieving energy for all by 2030 will not cause a net increase in global GHG emissions. Providing energy for all would have a minimal impact on global energy demand, with an increase of 0.2 per cent (37 million tons (Mt) of oil equivalent) relative to the IEA base case. However, the corresponding rise in emissions of around 0.2 per cent (70 Mt of CO2) in 2030, is more than offset, as reducing the biomass used for cooking provides a net GHG reduction, which would save around 165 Mt of $CO_2$ eq. from methane and nitrous oxide. (IEA, 2017)

## Are we on track to achieving climate goals?

Since late 1990s many countries have taken action under the UNFCCC and the Kyoto Protocol to mitigate climate change and adapt to its negative impacts. The Paris Agreement has generated and incentivized action at scale by both governments and the private sector. The latest ambitions for climate action are manifested in the NDCs, submitted under the Paris Agreement by all countries, which focus on climate mitigation, but also in many cases contain adaptation components.

### More ambitious NDCs are needed to close the emission gap

The IPCC established that mitigation scenarios in which it is likely that the temperature change caused by anthropogenic GHG emissions can be kept to well below 2 °C relative to pre-industrial levels are characterized by atmospheric concentrations in 2100 of about 450 parts per million (ppm) CO2 eq. These scenarios include substantial cuts in anthropogenic GHG emissions by mid-century through large-scale changes in energy systems, and potentially land use. (IPCC, 2014)

According to the UN Environment Gap Report 2017, the NDCs cover only approximately one-third of the emission reductions needed to be on a least cost pathway for the goal of staying well below 2°C. A large gap exists between 2030 emission levels and those consistent with least cost pathways to the 2°C and 1.5°C goals respectively. The 2°C emissions gap for the full implementation of both the conditional and unconditional NDCs for 2030 is estimated at 11 to 13.5 Gt $CO_2$ eq. The gap in the case of the 1.5°C target is estimated at 16 to 19 Gt $CO_2$ eq.

**Global greenhouse gas emissions under different scenarios and the emissions gap in 2030. Source: UN Environment 2017. Gap report**

Global GHG emissions in 2020 are likely to be at the high end of the range of the scenarios consistent with the 2°C and 1.5°C goals respectively, making it increasingly difficult to be on track to meet the 2030 emission goals.

Therefore, to close the 2030 emissions gap, urgent action is needed to significantly enhance the ambition in the new and updated NDCs informed through the Talanoa Dialogue. For the climate targets in the Paris Agreement to remain credible and achievable, all countries will need to contribute to significantly enhancing their national ambitions, augmenting their national policy efforts in accordance with respective capabilities and different circumstances, and ensuring full accounting of subnational action.

### Sufficient mitigation potential exists

If the emissions gap is not closed by 2030, it is extremely unlikely that the goal of holding global warming to well below 2°C can still be reached, given the sudden and costly reductions in post-2030 emissions that this would require. The assessed global scenarios show that if least-cost trajectories are followed, then emissions of all greenhouse gases should not exceed 42 Gt CO2 eq in 2030.

There is a proven emission reduction potential that is sufficient to close the gap. A systematic assessment of sectoral mitigation options presented in the UN Environment Emissions Gap Report 2017 shows that the gap can be closed before 2030 by adopting already known and cost-effective technologies, often by simply adopting or adapting best practice examples already deployed in the most innovative country contexts.

The assessment also shows that the total emission reduction potentials in 2030 amount to 30–41 Gt CO2 eq/year depending on assumptions and uncertainties, with costs below 100 US$/t CO2 eq. This is more than double the 2030 emissions gap for the 2°C goal.

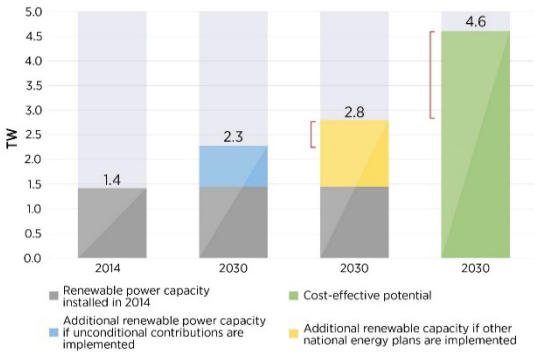
It is remarkable that a large part of this potential comes from just six relatively standardized categories, mostly relating to energy (solar

and wind energy, efficient appliances, efficient passenger cars) and in addition forestry, afforestation and stopping deforestation. The measures in these six categories sum up a potential of 15–22 Gt CO2 eq, making up over 40 per cent of the total potential. All these measures can be realized at modest or even net-negative incremental costs, and proven policies exist that can be replicated.

Specifically on renewable energy, the IRENA's NDC analysis indicates that renewable energy targets in NDCs are often less ambitious than targets that countries have already established in their national energy plans and strategies, and that the cost-effective potential for renewables is much higher than what is captured in NDCs. This suggests significant opportunities for increased ambition in the renewable energy component of NDCs.

Figure 15.2

**Renewable energy components in G20 NDCs, national targets and cost-effective potential**




## How to reduce the emission gap while also meeting energy access for all and air-quality goals

Limiting the global mean temperature rise to well below 2°C with a probability of 66 per cent would require an energy transition of exceptional scope, depth and speed. An ambitious set of policy measures, including the rapid phase-out of fossil fuel subsidies, $CO_2$ prices rising to unprecedented levels, extensive market reforms and stringent low-carbon and energy-efficiency measures would be needed to achieve this transition.

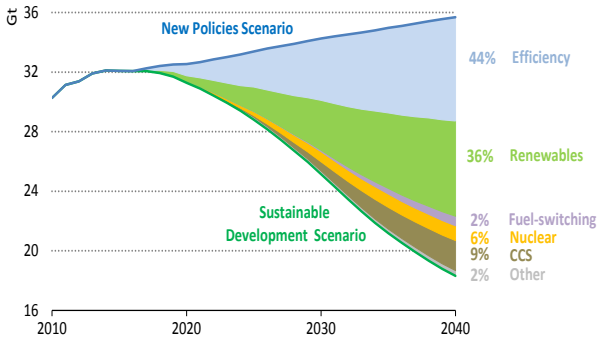
This is confirmed by the IEA scenarios that outline how the energy sector could contribute to achieving the well below 2°C target (known as the 450 Scenario). In 2015, the IEA put forward a set of short-term measures to bring forward a peak in $CO_2$ emissions (the Bridge Scenario), with measures including increasing energy efficiency, phasing out least-efficient coal-fired power plants; increasing investment in new technologies, including renewables; phasing out subsidies to fossil-fuel consumption; and reducing methane emissions from oil and gas production). While some of these measures have been included within the NDCs, the remaining emissions gap projection shows that considerable further action is required. (IEA, 2015).

Government action to close the emissions gap is urgent, but it competes with other pressing energy-related policy priorities. These include energy access—the main goal of SDG 7—and tackling the health impacts of energy-related air pollution among others.

A new **2016 IEA scenario**, the Sustainable Development Scenario, shows how all three objectives can be met simultaneously, at relatively little extra cost. This aims to convince governments that they need not abandon other energy priorities in order to pursue climate objectives.

Figure 15.3

**Impact of policies in the energy sector in reducing GHG emissions by 2040 under sustainable development scenario. Source: IEA, World Energy Outlook 2017**




In the Sustainable Development Scenario, full energy access is achieved by 2030. In addition, by 2040, the number of deaths attributed to air pollution drops by half relative to what would occur with existing and planned policies. In parallel, annual energy-related $CO_2$ emissions drop to around 18 Gt by 2040, driven primarily by a large increase in energy efficiency and deployment of renewables. $CO_2$

Also, the IRENA Remap scenario provides a detailed analysis of the $CO_2$ emission reductions by technology by 2050 that proves the feasibility of achieving more than 70 per cent emission reductions in 2050 compared to 2015.

### Promoting renewable energy sources

The shift towards renewable energy is being made not only because of the climate benefits but also because of positive impacts on welfare, trade, jobs and GDP. Also, such a shift is essential to reduce local air pollution and address related health problems. Renewables, including decentralized applications, can also play a

key role in providing electricity access to the most difficult-to-reach populations in developing countries (IEA, 2017b).

Best practices for policy options aim at increasing the share of renewable energy in the energy supply mix by facilitating grid access and promoting distributed generation for renewables, establishing renewable energy targets, providing fiscal and financial incentives and putting in place feed-in tariffs or setting up auctions to decide tariff levels.

IRENA analysis (2017a) has shown that to cost-effectively raise the share of renewables in the global energy mix, in line with meeting the 2 °C goal, renewable energy investment needs to be scaled up significantly above the current level. The decarbonization of the energy sector would require a total of US$ 25 trillion to be invested in renewables up to 2050, or on average more than US$ 700 billion per year. Full implementation of renewable energy components would require more than US$ 1.7 trillion between 2015 and 2030. As public sources are generally limited, most of such investment should come from the private sector.

All energy subsectors (electricity, heating and cooling, transport) should contribute to climate change mitigation. Although electricity generation from renewables increased significantly (by 20 per cent or 1100 TWh) during the period 2011–2015, progress in deploying renewables in heating and cooling, and scaling-up of renewables in the transport sector, is slow. (IRENA, 2017a)

#### Advancing energy efficiency

Energy efficiency measures often provide positive financial returns and can support energy security, greater reliability of energy systems and provide social and environmental benefits.

Best practice policy options for increasing energy efficiency include: the introduction of electrical appliance standards and labelling programmes, provision of economic incentives, energy performance standards for buildings and certification programmes, fuel efficiency standards and the encouragement of energy efficiency in industry.

By the end of 2016, at least 137 countries had enacted some efficiency policies, including 48 countries that adopted new or revised policies during the year. New or revised energy efficiency targets also have been adopted in all regions of the globe: 149 countries have one or more energy efficiency targets in place; 56 of these countries adopted new targets since 2015.

#### Strengthening carbon pricing, limiting coal-based power and creating a just transition

Putting a meaningful price on CO2 emissions is viewed by many as critical to achieving the 2 °C goal at least cost. While carbon pricing policies have been spreading globally, both through taxes and permit trading schemes, the geographic coverage and prevailing price levels are, for the most part, lower than what is required.

Avoiding building new coal-fired power plants and phasing out existing ones is crucial to closing the emissions gap. This will require careful handling of issues such as employment impacts, investor interests, grid stability and energy access to achieve a just transition.

#### Promoting technologies

Fostering the development of new technologies will facilitate further decarbonization necessary to achieve the 2 °C goal. The use of policies and financial frameworks to grow green technology markets can combat climate change, reduce pollution and create a more sustainable society.

Enabling technologies are facilitating and advancing the deployment of renewable energy. ICT (information and communication technology), storage systems, electric vehicles and heat pumps, to name a few, are facilitating and advancing the deployment of renewable energy.

Carbon capture and sequestration (CCS) technologies need to play a role in low-carbon scenarios compatible with the Paris Agreement, both for industry and power generation. Deployment has so far been slower than anticipated, however, and costs remain high; national-level attention is needed to support the widespread adoption of CCS.

For both current and evolving technologies, it is essential to ensure that international technical and financial support is available to facilitate action in developing countries and that signals are provided to innovators by governments to create sustainable markets for low-carbon technologies, fill in R&D funding gaps, and create enabling infrastructure.

#### Promoting adaptation to climate change

Ensuring that energy systems are climate resilient and contribute to adaptation efforts requires action and cooperation by governments and all stakeholders. The 2030 Agenda is an opportunity to ensure climate-resilient low-carbon energy systems, in synergy with providing electricity access to rural populations.

In their NDCs, more than 50 countries (out of 167 which have submitted a NDC) identify the energy sector as an adaptation priority and identify specific measures. According to IRENA, 43 Parties already recognize in their NDCs the potential contribution of renewables, although only a handful of them include quantified targets. (IRENA, 2017a).

Governments can provide direction and coordination for enhancing the resilience of energy systems by:

- Providing climate-information and data;
- Integrating climate change considerations into energy policies;
- Ensuring synergies between mitigation and adaptation;
- Promoting flexibility and diversification (e.g., through distributed generation and mini-grids);
- Inter-sectoral institutional coordination;
- Safety and efficiency standards;
- R&D of adaptation technologies,
- Reporting frameworks;
- Finance for resilience of energy systems.

The UNFCCC process to formulate and implement national adaptation plans (NAPs) enables governments to identify long-term adaptation needs, plan their adaptation measures, and integrate adaptation into sectoral development plans. NAPs provide a vehicle for planning adaptation efforts in the energy sector. Financial support for developing countries for their NAPs is available from variety of bilateral and multilateral funding mechanisms, including the Green Climate Fund.

Energy sector stakeholders, especially utilities, transmission systems operators and energy companies, need to address the risks and adapt their facilities and supply chains by:

- Considering climate risks in all plans, projects, and day-to-day operations;
- Adopting "hard" measures, such as flood barriers, reinforcing infrastructure, or moving facilities to safer locations;
- Applying "soft" measures, such as building redundancy measures into facility design, adopting dry cooling technologies for thermal generation, or designing wind turbines that can be lowered to the ground during a gust.

In addition to pre-emptive adaptation measures, governments and stakeholders can take contingency measures to deal with impacts that were not anticipated in the preparatory stages and to recover from inevitable damage. This could be in the form on insurance instruments, set-off funds, and/or emergency preparedness measures.

## Partnerships and action by subnational and non-state actors

Action by subnational and non-state actors, including regional and local governments and businesses, is key to enhancing future progress on climate and sustainable energy.

The **2017 UNEP Gap** assessment suggests that the aggregated additional impact of the various non-state initiatives is on the order of a few Gt $CO_2$ eq in 2030, over and above current NDCs. (UN Environment, 2017). This is potentially a significant contribution to closing the gap. Enhanced monitoring and reporting of non-state actions and the resulting emissions reductions be will be essential to making pledged actions transparent and credible.

The Marrakech Partnership for Global Climate Action was launched by the High-Level Champions at the COP 22 in 2016 and is designed to structure and enhance coherence of the activities of the various coalitions, initiatives and organizations with a view to mobilizing climate action up to 2020 by Parties and non-Party stakeholders.

The first Yearbook of the Marrakech Partnership informs Parties about what has been achieved during the year by non-Party stakeholders, and spotlights how pre-2020 ambition can be accelerated. The Yearbook highlights three key emerging trends:

- Climate action in the context of the Marrakech Partnership is growing and getting more diverse; more non-Party stakeholders, subnational governments, businesses and civil society, are making commitments and taking action, and in addition to mitigation, many of those actions relate to increasing resilience.
- Climate action is spreading to the South and has scaled up in the lowest income countries, facilitated by the link with SDGs and the Sendai Framework for Disaster Risk Reduction.
- Climate action is delivering: initiatives are moving from being commitments on paper, to actions, and are delivering a variety of outputs and creating the conditions to fully meet their commitments. (UNFCCC, 2017).

## REFERENCES

Climate Transparency, 2017: Brown to Green: The G20 transition to a low-carbon economy, c/o Humboldt-Viadrina Governance Platform, Berlin, Germany, www.climate-transparency.org.

IEA, 2015: Energy and Climate Change. World Energy Outlook Special Report, OECD/IEA, Paris.

IEA, 2016: Energy, Climate Change and Environment (Chapter 7: Enhancing Energy Sector Resilience to Climate Change). OECD/IEA, Paris.

IEA, 2017a: World Energy Outlook 2017, OECD/IEA, Paris.

IEA, 2017b: Energy Access Outlook 2017: from Poverty to Prosperity, IEA, Paris.

IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change.

IPCC, 2014b: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate

Change. Field, C.B. et al. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 659-708.

IRENA, 2017a: Untapped-potential-for-climate-action-NDC.

IRENA 2017b: Perspectives for Energy Transition 2017.

REN21, 2017: Renewables 2017 Global Status Report, REN21 Secretariat, Paris.

UNFCCC, 2016: Climate Action Now, Summary for Policymakers.

UNFCCC, 2017: Yearbook of the Marrakech Partnership

UN, General Assembly, 2015: Transforming our world: the 2030 Agenda for Sustainable Development, Resolution 70/1.

UN Environment, 2017: The Emissions Gap Report 2017, A UN Environment Synthesis Report.

Economic and Social Council, 2017: Progress towards the Sustainable Development Goals, Report of the Secretary-General, E/2017/66.

World Bank 2011: Climate Impacts on Energy Systems. ESMAP.

World Bank, 2017: State of electricity access report, ESMA

[1] See pillar 1 of the Global Strategy here: http://www.who.int/entity/life-course/partners/global-strategy/global-strategy-2016-2030/en/index.html and the WHO (2016) standards for improving quality of maternal and newborn care in health facilities: http://apps.who.int/iris/bitstream/10665/249155/1/9789241511216-eng.pdf?ua=1

[2] The IEA finds that 2.8 billion people lack access to clean cooking (2.5 billion rely on the traditional use of solid biomass, 120 million on kerosene, 170 million on coal). See IEA Energy Access Outlook 2017, iea.org/energyaccess. Global Tracking Framework figure is 3.04 billion.

# POLICY BRIEF #16

## INTERLINKAGES BETWEEN ENERGY AND TRANSPORT

### Developed by

FIA Foundation, UN Environment, United Nations Economic Commission for Europe (UNECE), International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO)

## KEY MESSAGES

### Status of energy and transport and progress towards achieving SDG 7

- At the global level, the transport sector was responsible on average for 28 per cent of total final energy consumption annually between 2010 and 2015, and consumed around 60 per cent of global oil products.
- In many developed countries, the transport sector is the single largest energy user. Globally, transport energy demand has been rising faster than any other sector. Energy consumption in the transport sector is set to continue to grow, predominantly in non-OECD countries, with the greatest growth in Asia.
- Transport (aviation, inland transport[1] and maritime transport) is a key driver of economic and social development and the energy that powers it should be clean, renewable and low carbon. However, overall, transport is not on track to achieve sustainable mobility targets.
- Road vehicles are responsible for the largest share of transport energy use. Improving the efficiency and fuel economy of vehicles will help in managing energy demand, saving money and minimizing climate and air quality impacts from emissions. As road transport increasingly shifts towards vehicles powered by electricity, it is vital that the electricity used is low carbon, and that local energy systems are able to manage and to respond to changes in demand.
- While energy demands from shipping and aviation represent a relatively low proportion of total transport demand, energy use in these sectors is increasing and further policies and technology measures that promote fuel efficiency are needed.

### Priority actions

- Implement fuel economy policies to improve the efficiency of light duty vehicles (aerodynamics, engines and power trains), and promote electric and zero emission vehicles through new standards, fiscal incentives and improved consumer information.
- Introduce measures to improve the efficiency of trucks, including fuel economy standards and voluntary "green freight" initiatives to improve vehicle efficiency and consolidate journeys through advanced logistics and hubs, where possible.
- Phase out inefficient transport-related fossil-fuel subsidies, including direct and indirect policies (e.g., inefficient fiscal measures) that encourage wasteful consumption.
- Introduce sustainable transport policies, irrespective of political frontiers, that invest in safe walking and cycling infrastructure, with ring-fenced funding and strong linkages to efficient, connected and affordable public transport systems.
- Continuous progress is needed in setting international policies and standards under International Civil Aviation Organization (ICAO), and International Maritime Organization (IMO) to address emissions from international aviation and maritime transport, respectively.
- Accelerate research in efficient batteries and energy storage systems, including hydrogen and fuel-cell technologies, to reduce prices and increase the range of electric-powered vehicles and develop necessary charging/refuelling infrastructure.

## Transport and the 2030 Agenda

### The importance of transport for achieving the SDGs

Transport is a vital sector for achieving the Sustainable Development Goals. Transport supports the achievement of virtually all the goals, including those associated with economic and social development, connecting goods with markets, supporting agricultural productivity and access to services. Safe, clean and sustainable transport that is affordable and accessible to all is critical for sustainable development.

Transport is fuelled by energy and is therefore directly linked to SDG 7 on affordable and clean energy. Sector stakeholders can contribute to target 7.2 by increasing the share of renewables in the transport energy mix, and to target 7.3 through measures that improve passenger/freight distance travelled per unit of energy input. Targets 7.A and 7.B also have links to transport. The sector's capacity to innovate may prove increasingly relevant to these two targets for 2030 through investment in research and development (R&D) and as nascent technologies mature (for example, solar highways and induction-based charging of electric vehicle (EV) batteries that use them).

### Current energy use from transport

Energy use in transport has increased significantly in correlation with world population growth and economic development. At the end of the twentieth century there were 500 million private cars in use globally. By 2015, that number had doubled to 1 billion. Over 20 million cars are sold each year in China alone, and the number of vehicles will continue to grow. Energy use from inland freight, aviation and shipping continues to increase in response to the growing demand for goods and domestic and international travel.

The transport sector's share of global total final energy consumption in 2015 was 28.8 per cent. In the same year, it consumed 65 per cent of global oil supply. In total, transport consumes over 100 quadrillion British thermal units (Btu) per year. The majority (96 per cent) of this energy is in the form of petroleum or other liquid fuels, with a very small proportion as electricity. The share of electricity used in the sector is expected to increase gradually along with natural gas. (IEA, 2015).

Road transport accounts for around three quarters of transport energy consumption, with light duty vehicles responsible for around half, and a quarter is used by trucks and buses. Air and maritime transport are each responsible for around 10 per cent, while the railways share is the lowest of all modes at 3 per cent (EIA, 2017).

### Key challenges

Virtually all (96 per cent) of future increases in transport energy use are expected to be in non-OECD economies. Recent increases in OECD countries' demand have been predominantly in aviation and shipping. Currently 70 per cent of global trade in value and 80 per cent by volume is carried on board ships. Estimates vary, but most reference scenarios suggest population growth and rising incomes could result in around a 50 per cent increase in demand by 2040 compared with 2015 levels (ibid). Total freight transport demand is expected to triple from 112,000 billion ton-kilometres in 2015 to 329,000 billion ton-kilometres in 2050. Airfreight volumes are expected to grow faster than other modes at about 5 per cent annually. Trucks are the fastest growing source of global oil demand and could account for 40 per cent of oil demand growth to 2050. Without policy action, they are likely to overtake light duty vehicles in the coming decades as the largest energy user (World Bank, 2017).

### How to fill the gap

The transport industry is a major global energy consumer and the dominant consumer of oil and its products. Improving the energy efficiency of vehicles, aircraft and ships and increasing the share of renewables in the fuel mix will be crucial to achieving the targets set out in SDG 7. A series of measures must be defined and put in place in order for the transport sector to contribute to achieving SDG 7 worldwide by 2030. These measures will need to be tailored to achieve the global targets while recognizing sectoral specificities, local socioeconomic circumstances, environment and development needs.

Measures to improve energy efficiency and integrate renewables into transport systems commonly diverge on the boundary between the urban scale and the inter-urban and international transport scales. It is important to take into consideration and respond to the particularities of these transport subsectors—their environments, economics and stakeholders. Developing rail infrastructure so that freight and passengers can be transported between cities by train rather than road would reduce the energy intensity and carbon footprint of transport. Developing intermodal freight infrastructure to support the shift of freight transport to more energy efficient modes, namely rail and inland waterways, and improving transport logistics to reduce the number of journeys required— "green freight" initiatives—will increase the energy efficiency of international freight transport.

At the urban scale, the "avoid, shift, improve" mitigation framework describes pathways for improving the sustainability of transport:

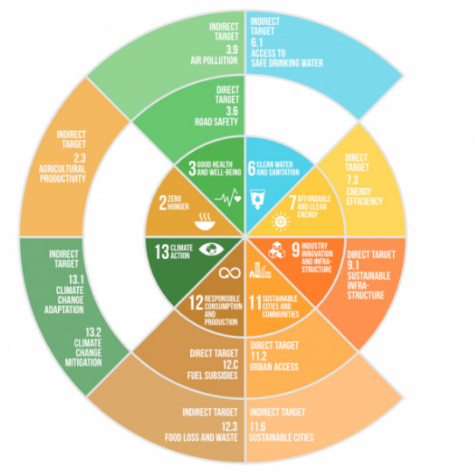
- reducing travel demand and minimizing unnecessary travel;
- shifting to lower emission alternatives;
- improving the technological performance of vehicles.

One programme promoting this framework is UN Environment's

and FIA Foundation's Share the Road programme, which works to promote policies for cycling in cities in developing country. Similarly, UNECE and WHO Europe's Transport Health and Environment Pan-European Programme (THE PEP) promotes and provides support for developing policies that encourage walking, cycling and a shift to greater use of public transport in urban centres in the ECE region.

Figure 16.2:

**Transport and the SDGs**




Source: SLOCAT

Beyond context-specific measures, incremental and continuous improvements in vehicle fuel efficiency will be key for ensuring the transport sector's contribution to achieving SDG 7. Most internal combustion engines are inefficient at converting fuel into usable energy. Most gasoline combustion engines average around 20 per cent efficiency. Diesels are typically higher, approaching 40 per cent in some cases. In sum, only 20 to 40 per cent of the energy in the fuel burned in engines of road vehicles is actually employed to move them; the rest is rejected as heat. This is also true for aircraft turbojet engines, while marine diesel engines on large ocean-going ships (the main maritime energy users) can have slightly higher efficiencies of around 50 per cent (shaft power output) and even 55 per cent when waste heat recovery is employed.

In addition to improving the efficiency of petrol combustion engines, further measures are needed to support expansion of the fleet of road vehicles propelled by alternative and renewable fuels, such as liquefied natural gas (LNG) and biofuels, hydrogen and fuel cells, and expanding the fleet of hybrid electric vehicles (HEV) and electric vehicles (EV). The extent of the contribution of EVs will depend both on improving battery vehicle range on a single charge without adding significant additional cost and on the construction of EV charging infrastructure networks. The use of sustainable aviation fuel and other clean energy in air transport is another challenging area. Some industry-wide progress has been realized already, including the approval of five production processes for sustainable aviation fuels and a number of airports distributing such fuels, which has led to 100,000 commercial flights being powered with sustainable aviation fuels through 2017.

### Interlinkages with other SDGs

Transport is linked with virtually all SDGs. Direct impacts of transport on progress in achieving the SDGs and their targets include reducing road traffic deaths (target 3.6), which are a factor of the safety features of vehicles, the design of infrastructure and traffic systems and the behaviour of participants in traffic. Further key links are with Goal 13 on climate change (target 13.2 on mitigation), Goal 11 on cities (target 11.6 on emissions and air quality) and Goal 3 on health (target 3.9 on air pollution). Transport is responsible for around a quarter of $CO_2$ emissions, and diesel fuels are associated with emissions of a particulate matter, including "black carbon", which acts as a short-lived climate pollutant, particularly in areas covered by ice and snow, by absorbing heat and contributing to warming. Over 3 million people die each year from the impacts of outdoor air pollution, and transport is associated with a large proportion of this, particularly in cities (WHO, 2016).

Notable links are also observed in relation to SDG 8 on decent work and economic growth. The transport industry plays an important role in today's economy. It has a substantial impact on economic growth and provides a significant proportion of employment in high-income countries around the world. In the European Union, the industry directly employs 10 million people (while the indirect and induced employment figures it generates are several orders of magnitude higher) and is responsible for 5 per cent of the economic area's GDP (European Commission, 2011). Taking into account the strong projected long-term rate of increase of demand for transport-related products and services in developing countries, the industry will be a very important element in the equation to achieve the targets of SDG 8.

Transport systems consumption of energy extends beyond that of vehicles that carry persons and freight. The manufacturing of vehicles and the construction and maintenance of transport infrastructure are energy-intensive industries that can seek opportunities to improve their resource intensity throughout their products lifecycles. In this broader perspective, transport systems and energy consumption very much impact SDG 9 on industry, innovation and infrastructure and SDG 12 on responsible consumption and production, and they will in turn be impacted by measures taken by governments and industry stakeholders to achieve these goals (such as target 12.C on rationalizing inefficient fossil fuel subsidies that encourage wasteful consumption). Finding sustainable solutions for end of life management of EV batteries

(scarce resource recycling) is a prime example of the transport-energy-resource sustainability nexus challenge for society. Finally, the evolution of transport systems and related industries will also affect the achievement of targets relating to SDG 14 on life below water and SDG 15 concerning life on land.

## Policy Implications

Due to increasing demand for mobility and freight transport, without successful green technology and green behaviour transitions, the energy intensity and environmental impact of transport may increase substantially.

### Improving vehicle efficiency

Agreeing on approaches to manage growth in emissions from inland transport modes, aviation and shipping will limit their respective passenger and freight transport energy intensities. The amount of $CO_2$ released into the atmosphere from fuel combustion is directly proportional to the amount of fuel burned. Therefore, improvements in petrol combustion engine efficiency reduce the per unit of distance covered and per passenger/freight carried $CO_2$ emissions. These improvements would reduce harmful environmental and human health impacts (environmental and social sustainability) and the amount of energy employed per unit of distance and passenger/freight carried, which will in turn save money and reduce energy intensity (resulting in immediate and upstream economic and environmental sustainability impacts).

The Vehicle Regulations developed by the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29)[1] and subsidiary working groups, prescribe $CO_2$ emission limits and thereby fuel economy standards for road vehicles, both light and heavy duty, with internal combustion engines, in Europe. However, it is often suggested that the current standards are not challenging enough and there are also issues around enforcement and the actual efficiency of vehicles in real-world conditions.

The Global Fuel Economy Initiative (GFEI—www.globalfueleconomy.org) is working in 70 countries to promote improved fuel efficiency, and to support governments as they evaluate policy options.

In addition to energy efficiency standards in the realm of construction of vehicles and their engines, there are well-tested financial and non-financial instruments that have been used in the past decades to restrain the energy intensity of transport.

One obvious measure is increasing the price of energy through fuel taxes, thereby encouraging road users to adopt more energy efficient behaviour or to consider other transport modes. However, high fuel taxation can have important implications for mobility, if it is not associated with measures promoting alternative transport options (public transport, ride sharing, bicycling, etc.).

Taxation of new cars based on $CO_2$ emission levels, or engine power, can also promote the use of energy-efficient and low-emission vehicles. A differentiated tax system on the purchase of new vehicles by taxing cars according to their $CO_2$ emission levels has, in the past, been successful in European countries. Another example is bonus-penalty programmes that promote replacing cars with newer, more environmentally friendly versions. Owners receive bonuses if the new replacement car is more energy efficient than the old one, while they are penalized for replacing their vehicle with ones that have more energy-intensive engines.

Congestion-charging programmes have been used as financial instruments to reduce car use in urban environments (including in Stockholm, London, Rome, and Milan). Exemptions for EVs and HEVs provide an impetus for their purchase by city dwellers.

Examples of non-financial instruments include the establishment of rules for public authorities that will serve as good examples for road users, such as mandatory procurement of energy-efficient vehicles for government institutions. Further measures worth considering are vehicle fuel efficiency educational campaigns that promote driver behaviour, such as maintaining steady speeds, anticipating traffic, slow and smooth accelerations and maintaining tire pressure at optimal levels.

In the aviation sector, ICAO has developed standards for aircraft engine $CO_2$ emissions and fuel economy (ICAO, 2009) and the IMO has set similar standards for ship engines (IMO, 2017). IMO regulations for energy efficiency of ships apply to internationally trading ships of 400 gross tonnage and above and make mandatory the Energy Efficiency Design Index (EEID) for new ships, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. ICAO adopted the first ever global certification $CO_2$ standard for aeroplanes, which will apply to new aeroplane-type designs from 2020 and to aeroplane-type designs which are already in production in 2023 (UNFCCC, 2017). ICAO also facilitates operational improvements in aviation, such as Air Traffic Management (ATM) for better use of airspace, more efficient air routes and less congestion in the sky, as well as promotes green airports to reduce aviation-related $CO_2$ emissions at the ground level.

In 2017, 192 member States adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which will contribute to achieving the international aviation sector's goal of carbon-neutral growth from 2020, together with other $CO_2$ mitigation measures (ICAO, 2018). CORSIA is strongly supported

1 WP.29 is the leading international institution for harmonization of safety and environmental provisions for road vehicles. The three agreements that it administers cover 143 United Nations Regulations (1958 Agreement), 19 United Nations Global Technical Regulations (1998 Agreement) and 2 rules for Periodical Technical Inspections (1997 Agreement). All United Nations member States may accede to and apply regulations under the three vehicle agreements, https://www.unece.org/trans/main/welcwp29.html.

by the aviation sector as the only global market-based instrument for international aviation, compared to a patchwork of different national and regional financial/economic instruments.

### Modal shift and infrastructure development

Modal shifts are unlikely without substantial changes in costs/pricing, strong regulatory measures and changes in governance structures. Policy measures that may affect transport mode choices include economic instruments such as fuel taxes, congestion and emissions charges, labour and safety regulations and investments in infrastructure and service improvements.

The construction of infrastructure to support a modal shift in passenger and especially freight transport is necessary in order to achieve a reduction in energy intensity of transport systems, especially in light of population growth projections and economic development targets. This means investment in the construction of rail networks to shift freight transport from truck to rail, where possible, and to establish intermodal terminals in key ports where freight can be transferred from ships to trains for transportation inland.

In the recent past, public sector investment in the rail industry has been modest in most of the world (with the exception of some European and Asian countries), with much of it focusing on upgrading. A radical increase in rail investments may be required to reduce prices and improve services, allowing rail to increase its market share.

In passenger transport, the use of intermodal facilities can be encouraged by ensuring that there are proper alternatives to car travel and by providing appropriate infrastructure to allow travellers to use different modes. National authorities can facilitate passenger use of intermodal transport by financing transport interchanges and generally improving public transport facilities and their accessibility at urban centres.

### Increasing the share of renewables and sustainable alternative fuels in transport

Achieving a substantial increase of renewable energy in the transport energy mix will depend on setting ambitious targets for shares of advanced biofuels and other alternative fuels with low-carbon lifecycle emissions in the transport energy mix; deployment of higher proportions of EVs in vehicle fleets; and the expansion of renewable electricity generation capacities (on grid and decentralized). It is important to note that if the electricity powering EVs is not generated from renewable sources, the related emissions are simply displaced from the vehicle tailpipe to the fossil fuel power plant.

Apart from using cleaner energy, and using it in a more efficient way (electric motors are superior in efficiency compared to internal combustion engines), EVs are, in the future, expected to be a key part of smart electricity grids. Their batteries will be used as grid storage devices, with the energy stored in them available to be dispatched when necessary (if they are parked and plugged in) to balance the electricity grid during daily peak loads.

Government, private sector and academia collaboration on R&D for EVs and their components (most importantly batteries), and investment in required infrastructure (i.e. charging stations in cities and along national roads and highways) are basic preconditions for the uptake of EVs. Challenges in this respect include the reinforcement of electricity distribution networks, their upgrading to allow a higher uptake of intermittent renewables into the grid and construction of the charging infrastructure itself. In addition, the end of life management (collection, depositing and/or recycling) of EV batteries is a process that is still maturing. The stock of natural resources from which the batteries are constructed is limited; extraction processes are energy intensive; and used batteries can emit toxic gases if damaged. It is therefore key for the industry to develop environmentally sustainable and economically efficient technologies and processes for their recycling (or other solutions for reuse) before the market is overwhelmed with depleted EV batteries.

Hydrogen and fuel cells can also improve the energy efficiency of transport beyond applications limited to road vehicles. A number of rail and shipping companies have announced the commercial rollout of trains and ships running on hydrogen fuel cells during the 2020-2025 period. Technological solutions for overcoming challenges in transport and storage of hydrogen are on the horizon, while the current state of the art already has solutions for its safe use. However, a number of challenges remain, in particular addressing the capital costs of establishing fuelling station networks and the corresponding required infrastructure for hydrogen fuelled road vehicles.

Because of deep technological gaps, renewable electricity will not substitute for liquid fuels in air and seaborne transport in the near future. Consequently, aviation stakeholders are working towards a gradual increase in the share of drop-in biofuels that can provide significant life-cycle emission reductions for passenger and freight aviation in comparison with the industry dominant fossil fuels of today. European Union countries have established, through the European Advanced Biofuels Flightpath,[2] the goal of reaching a minimum of 40 per cent low-carbon sustainable biofuels in national aviation by 2050. Within the United Nations system, ICAO's Global Framework for Aviation Alternative Fuels[3] provides a platform for coordination of national policy actions to accelerate

[2] https://ec.europa.eu/energy/en/topics/biofuels/biofuels-aviation.

[3] https://www.icao.int/environmental-protection/GFAAF/Pages/default.aspx.

the appropriate deployment of sustainable alternative jet fuels and a stage to exchange information and best practices and draw attention to the need for increased harmonization for sustainability. In addition, the ICAO Conference in October 2017 agreed on the ICAO Vision as a pathway towards a significant proportion of conventional aviation fuels being replaced by sustainable aviation fuels by 2050. The ICAO Vision will be periodically reviewed in the run up to the convening of the next ICAO Conference by 2025, with a view to updating the vision with a quantified 2050 goal. ICAO is also leading a number of studies and projects with the objective of increasing the use of clean energy, including the installation of solar panels at airports, in cooperation with the European Union, UNDP and GEF.

IMO adopted amendments to the MARPOL Convention, which have led to a significant decrease in the sulphur content in fuels used by international shipping. This mandatory requirement will contribute to massively reshaping international shipping's fuel mix. Further GHG emissions reduction opportunities in the current development of the IMO GHG Strategy include the uptake of low- and zero-carbon-based fuels.

The wording of target 7.2 of SDG 7: "by 2030, ***substantially increase*** the share of renewable energy in the global energy mix", is quite open. As such, it presents an opportunity for countries that are able to dedicate sufficient resources to define voluntary targets for shares of renewables in their transport sectors by 2030, thereby taking the lead with proactive policy examples that may be replicated elsewhere.

## REFERENCES


EIA (2017), International Energy Outlook, Chapter 8: Transportation sector energy consumption, https://www.eia.gov/outlooks/ieo/pdf/transportation.pdf.

European Commission (2011), "Transport 2050: The major challenges, the key measures" (MEMO/11/197), http://europa.eu/rapid/press-release_MEMO-11-197_en.htm.

GFEI (2016), Working Paper 14, "Estimating the fuel efficiency technology potential of heavy-duty trucks in major markets around the world", https://www.globalfueleconomy.org/data-and-research/publications/gfei-working-paper-14.

GFEI (2017), Working Paper 15, "International comparison of light-duty vehicle fuel economy 2005-2015: ten years of fuel economy benchmarking", https://www.globalfueleconomy.org/data-and-research/publications/gfei-working-paper-15.

GIZ, Sustainable Urban Transport and Energy Efficiency, Module 5h, http://www2.giz.de/wbf/4tDx9kw63gma/SUT_module5h.pdf.

ICAO (2009), Technology Standards, https://www.icao.int/environmental-protection/Pages/technology-standards.aspx.

ICAO (2016), Environnent Report,

https://www.icao.int/environmental-protection/Pages/ENV2016.aspx.

ICAO (2017a), 2nd Conference on Aviation and Alternative Fuels (Oct. 2017),

https://www.icao.int/Meetings/CAAF2/Pages/default.aspx.

ICAO (2017b), Green Airports Seminar, Nov. 2017,

https://www.icao.int/Meetings/greenairports/Pages/default.aspx.

ICAO (2017c), International Civil Aviation Convention, Annex 16 (Environmental Protection), Volume III ($CO_2$ Standards), http://www.fzt.haw-hamburg.de/pers/Scholz/materialFM1/ICAO-2017_Annex16_Volume3_CO2CertificationRequirement.pdf.

ICAO (2018a), Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), https://www.icao.int/environmental-protection/Pages/market-based-measures.aspx.

ICAO (2018b), Assembly Resolutions A39-1, A39-2, A39-3,

https://www.icao.int/environmental-protection/Pages/default.aspx

IEA (2015), Total Final Consumption, https://www.iea.org/Sankey/#?c=World&s=Final per cent20consumption.

IEA (2017), Future of Trucks report, https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf.

IMO (2017), Greenhouse Gas Emissions, http://www.imo.org/en/OurWork/environment/pollutionprevention/airpollution/pages/ghg-emissions.aspx.

REN21 (2017), Renewables 2017 Global Status Report (GSR), http://www.ppmc-transport.org/another-record-breaking-year-for-renewable-energy-more-renewable-energy-capacity-for-less-money.

UNCTAD (2017), Review of Maritime Transport, http://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf.

UNECE (2015), Transport for Sustainable Development—The case of inland transport, https://www.unece.org/fileadmin/DAM/trans/publications/Transport_for_Sustainable_Development_UNECE_2015.pdf.

UNFCCC (2017), The 47th Session of the UNFCCC Subsidiary Body for Scientific and Technological Advice, November 2017, Agenda Item 10, http://unfccc.int/documentation/submissions_from_non-party_stakeholders/items/7482.php.

WEC (2012), Global Transport Scenarios 2050, https://www.worldenergy.org/wp-content/uploads/2012/09/wec_transport_scenarios_2050.pdf.

WHO (2016), Ambient (outdoor) air quality and health, September 2016, http://www.who.int/mediacentre/factsheets/fs313/en/.

World Bank (2017), Sustainable Mobility for All (SuM4ALL) Global Mobility Report 2017, http://sum4all.org/publications/global-mobility-report-2017.

# POLICY BRIEF #17

## POLICY BRIEF ON ENERGY IN SITUATIONS OF DISPLACEMENT

## Developed by

The Office of the United Nations High Commissioner for Refugees (UNHCR), International Organization for Migration (IOM), United Nations Institute for Training and Research (UNITAR), UNEP-DTU, Die Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, UN Foundation, Practical Action, Global Alliance for Clean Cookstoves (GACC) and Moving Energy Initiative

## KEY MESSAGES

### Issues and status of energy access among displaced people and progress towards SDG 7

- The United Nations estimates that, in 2018, over 135 million people around the world will need humanitarian assistance. For many of these people, access to energy will be critical for survival, and how they access it will impact their health, livelihoods, safety and well-being. Of the displaced people who are living in camp settings, the majority are without energy access and rely on wood-based fuels for cooking.
- Lack of access to safe and sustainable energy exposes millions of displaced women and girls to heightened risks of sexual and gender-based violence. Insufficient provision of fuel forces women and children to travel long distances to collect firewood, increasing the risks of rape, sexual and physical assault and conflict. Adequate lighting can improve safe access to other services, including markets, communal latrines or the routes between home and any public place.
- Access to safe, reliable and clean energy solutions can be challenging to achieve during humanitarian crises. With a shortage of funding for energy programming, as well as limited policies and practice on energy provision within the humanitarian sector, current energy practices are often inefficient, polluting, unsafe for users and harmful to the surrounding environment.
- Displaced people are unlikely to be included in government plans to scale up energy access. Often, they live in isolated areas or informal settlements alongside others who are also marginalized. Displaced people are also usually not part of country development plans, though they can be particularly affected. Even if displaced people return to their home areas, they often remain in fragile post-conflict/disaster situations with limited energy services.
- At present, humanitarian operations—particularly vital logistics and power for clinics, schools, water and offices—are highly dependent on diesel generators, with high annual fuel costs, and additional delivery costs. Opportunities for cost savings are available through energy efficiency and renewable energy.

### A global plan of action and identified priorities

- In January 2018, key United Nations agencies, NGOs, civil society groups and representatives from member States and the private sector started a process to develop a **Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement** with the vision that "every person affected by conflict or natural disaster has access to affordable, reliable, sustainable and modern energy services by 2030."
- To support this vision, reduce carbon emissions and free up scarce resources, a second aim for the plan is that "energy efficiency is prioritized in the humanitarian system, and humanitarian organizations substantially increase their use and programme implementation of renewable energy". Only by mainstreaming renewable energy access in both emergency and protracted phases will sexual and gender-based violence, environmental impacts and cost efficiency issues be appropriately addressed.
- To achieve this vision, the partners highlighted key challenges and identified preliminary steps to improve energy access for displaced people in the following five priority areas:
  a) Coordination and planning
  b) Policy and advocacy
  c) Innovative finance
  d) Technical expertise and capacity-building
  e) Data, evidence, monitoring and evaluation
- The steering group, consisting of UNHCR, IOM, UNITAR and other key partners, is guiding the development of the Global Plan of

Action, which will be launched at the High-Level Political Forum 2018 in New York.

## Displaced people and the sustainable development goals

Energy is often referred to as an "enabler"—an essential ingredient in daily life. Without access to energy, we cannot cook, keep ourselves warm, work or study after dark, or conduct most income-generating activities. This applies as much to displaced people as to anyone else. Currently, over 135 million people need humanitarian assistance (UN OCHA, 2018). This includes refugees, internally displaced people (IDPs), returnees to areas rebuilding after conflict or disaster, and returnees settling outside their areas of origin. An average of 26.4 million people per year have been displaced from their homes by disasters since 2008 (IDMC, 2017), a trend likely to continue as climate change increases the likelihood and frequency of natural disasters.

While achieving SDG 7 relies on national policies, plans and programmes, and will be led by countries for their citizens, displaced people are unlikely to be part of these plans. Often, they live in isolated areas or informal settlements alongside communities that are sometimes also left behind in development planning and are less likely to be a priority. To deliver on the SDG 7 principle of "leave no one behind", humanitarian agencies, NGOs and host governments must extend energy access to displaced people. At the same time, development agencies, donors, investors and the private sector can partner with humanitarian organizations. Doing so will help achieve many other SDGs, as there are co-benefits of switching to clean and sustainable energy. Studies show that two thirds of the SDGs depend on access to clean and affordable energy.

### Status of energy access for displaced people

In situations where large numbers of people are moving within or across borders to escape dangerous circumstances and persecution, access to energy is a priority for basic survival. Cookstoves and safe and accessible fuel are needed to be able to eat, ensure optimal health and reduce exposure to protection risks while gathering fuel (WFP, 2012). Heating is needed to keep warm. Light is needed to address protection and safety, and power is needed to charge mobile phones that enable communications and allow for contact with lost family members. Simply put, energy access impacts food security, nutrition, health, protection, shelter, telecommunications and other key sectors highlighted in the humanitarian system.

Despite this, the majority of displaced people do not have access to safe, reliable and clean energy. For example, of the refugees who are living in camp settings, around 90 per cent are without electricity access and 80 per cent rely on solid fuels such as firewood and charcoal for cooking (Lahn and Grafham, 2015). Current energy practices are often inefficient, polluting, unsafe for the users and harmful to the surrounding environment. Moreover, humanitarian operations rely on fossil fuels (mostly diesel) to enable efficient and rapid delivery of essential services to the communities in need and for powering premises in remote locations.

Energy access for displaced people is not yet recognized as a formal priority in the humanitarian system. Consequently, funding shortages (including for both initial investments and multi-year solutions), inadequate policies and lack of capacity hamper the humanitarian community from providing clean and sustainable energy in situations of displacement (Bellanca, 2014). In recent years, however, the community of actors engaged in the nexus of energy and humanitarian assistance has grown and cohered. The advent of SDG 7, combined with record levels of global displacement (UNHCR, 2017), presents an opportunity for this community to expand and improve energy programming in humanitarian settings. At this stage, high-level commitments from governments, United Nations agencies and NGOs, and long-term support from donors, are needed to capitalize on existing momentum and ensure that "modern and sustainable energy access for all" includes the millions of displaced people worldwide.

### Energy for humanitarian operations

Electricity generated for humanitarian operations is primarily produced by fossil fuel powered generators (predominantly using diesel). Among the reasons are the following factors:

- site planning in emergencies based on tried and tested models and known suppliers;
- limited availability of measured, standardized data on energy demand for camp-wide operations, or on emission levels and consumption patterns;
- limited knowledge about potential interventions to reduce fuel demand and introduce sustainable clean energy practices;
- lack of funding for upfront costs of sustainable energy solutions;
- other priorities of primary concern before energy needs;
- hesitation related to building up infrastructure projects against the temporary character of humanitarian assistance support.

Data on energy production and consumption for humanitarian assistance is often unavailable, inaccurate and/or outdated. For instance, the electricity consumption of office buildings, hospitals or water pumping stations is usually unmeasured and therefore unknown. This information is necessary to plan adequately sized renewable energy power stations and conduct cost-benefit analyses in the transition to sustainable systems.

## Key challenges

### Planning and coordination

Good coordination is vital for delivering protection and humanitarian assistance; it results in fewer gaps and duplication. In the context of energy access in displacement settings, coordination is even more important for two reasons. First, no formal mechanism exists to coordinate energy-related interventions. Second, the issue of safe access to fuel and energy cuts across numerous sectors—health, food security, nutrition, protection, education, water and sanitation, telecommunications and more. Moreover, it involves a broad set of actors, including humanitarian agencies, government representatives, the private sector, development professionals, technical experts, researchers, donors, investors and others.

At present, energy-related assistance in displacement settings is still largely funded and implemented by different individual agencies, with limited reference to each other or to lessons learned in previous interventions.

### Policy and advocacy

The policy and advocacy challenges in this sector can be divided into three levels: local/national; agency/implementer; and donor.

At the local/national level, challenges include national priorities that may not include displaced populations; lack of a ministry or ministries dedicated to energy or displaced people; unclear legal status of displaced populations, including their right to work, freedom of movement and access to services; policy/tax disincentives for the private sector; and broader political challenges.

At the agency/implementer level, challenges exist around coordination of energy projects and funding for large scale interventions; limited expertise on energy products and services; procurement policies; lack of accountability and leadership for the sector; lack of collaboration between humanitarian and development agencies (the humanitarian-development divide); and lack of mainstreamed rules/guidelines for incorporating energy into the humanitarian programme cycle.

At the donor level, challenges include funding priorities that may not be aligned with the needs of the affected population; limited experience in cash programming and/or market-based approaches; limited understanding of how and where energy "fits" into the humanitarian sector; lack of donor coordination and multi-year financing; and policy coherence with the climate finance agenda.

### Sustainable energy financing for humanitarian assistance

Energy issues have not been at the forefront of resource mobilization for humanitarian efforts. Currently, funding for humanitarian assistance comes largely through grants, where energy is considered among other life-saving priorities. Commercial finance for energy has not played any significant role in this sector. In addition, funding for humanitarian assistance is generally short-term (maximum 1-2 years) due to donor regulations and policies, and because the length of a humanitarian crisis is often unpredictable. This short-term thinking and unpredictability makes it difficult to provide safe and appropriate energy solutions in acute displacement settings, cover higher upfront costs for renewable energy, or plan power purchase agreements. For protracted situations, a lack of funding leads to the same low rate of clean or renewable energy interventions.

The Moving Energy Initiative estimates that there is currently a funding gap of US$ 335 million to provide all refugees with basic levels of energy access for cooking and lighting (Lahn and Grafham, 2015). Moreover, in the context of camps for displaced people, electricity for camp infrastructure is mainly provided through diesel generators, instead of applying renewable energy technologies. A transition towards more sustainable financing is required since fuel alone costs camp operators an annual estimated US$ 100 million.

### Technical expertise and institutional capacity

The work involved in the design, implementation and evaluation of energy solutions is technical, complex and tied to legal and governance frameworks. Staff with experience on both energy and humanitarian situations are needed to:

- Conduct quality assessments of energy needs and recommend context-appropriate solutions;
- Provide user training on the proper installation, use, maintenance and benefits of specific energy products;
- Develop energy strategies that incorporate considerations for the health, safety, livelihoods and well-being of crisis-affected people—especially women and children—and their surrounding environment; and
- Identify opportunities to transform short-term solutions into long-term income-generating activities, such as locally producing improved cookstoves or firewood alternatives.

These activities build the capacity of affected communities to cope with future disasters and encourage humanitarian actors to consider longer-term strategies.

Unfortunately, there is a severe shortage of technical expertise and programmatic knowledge in the humanitarian-energy nexus. This is exacerbated by high staff turnover and the overall lack of resources and priority allocated to energy in humanitarian budgets and response plans. Energy roles are often assigned to staff members who have extremely limited time to provide attention to this issue. Insufficient funds are available to hire external experts, as energy programming is often extrabudgetary. Standardized training, resources and tools for humanitarian energy programming are rare and widely dispersed.

### Data, evidence, monitoring and evaluation

In general, readily available data, specific evidence and in-depth analysis on energy access for displaced people is extremely limited. Few detailed studies exist on the impacts of existing energy programmes in displaced settings, including data from monitoring and the knowledge emerging from those programmes. Few studies compare cross-cutting issues or regional evidence. Practitioners, field staff or researchers do not often share data and/or receive inadequate training on existing evidence and tools. There is a lack of standardized or published information. Where data is available, for example from pilots and start-up projects, it is not consistent or available openly. Each pilot often has its own set of indicators and reporting structures, making it difficult to compare evidence across programmes. Insufficient learning from existing programmes, as information is often not published or made available to other practitioners, results in duplicative projects with poor results.

## How to fill the gap and achieve sustainable energy access for displaced people

### Improved planning and coordination

Establishing formal planning and coordination mechanisms for energy in displacement settings should be considered, with the aim of directly engaging key decision makers and programme staff at all levels. Crucially, displaced people and host communities must be included in the design and implementation of energy programmes to ensure that their needs and priorities are reflected. Some informal coordination mechanisms, including the Safe Access to Fuel and Energy (SAFE) Humanitarian Working Group, currently exist at the global and national levels and could be incorporated into this process.

### Policy changes and increased advocacy

At an international, multilateral level, policymakers should recognize the need for energy for displaced people and include the provision of safe and sustainable energy to displaced populations in global policy agendas. At the agency level, organizations of all types engaged in humanitarian assistance need to incorporate energy considerations and best practices into core programming. At the national level, host countries can examine where sustainable energy solutions can contribute to national and local sustainable development objectives—facilitating relevant aid and investment—and consider how to incorporate displaced people as empowered and productive members of society.

### New financing mechanisms

In the short term, funding for energy programming needs to be incorporated into budgets for humanitarian assistance. Given the cross-cutting nature of energy access, funding for energy activities could be incorporated into existing budgets for health, food security, protection and other areas. In the long term, there is a need to bolster finance for sustainable infrastructure and renewable energy investments, as well as support humanitarian agencies to incorporate energy programming into their budgets, address energy needs in displacement settings and shift to more environmentally sustainable modes of delivery. To match the growing needs and achieve progress on a larger scale, new financing mechanisms need to be explored, such as CAPEX free business models, crowd investments, a shift from grant funding to impact investment or corporate engagement, peer to peer transitions and blockchain-backed applications.

### Building Institutional Capacity for Better Energy Response

Training and technical expertise must be incorporated into sustainable energy solutions and targeted, audience appropriate capacity-building techniques should be made available institutionally, from top level policymakers to end-users. The skills and capacities of displaced people and host communities should be utilized to ensure that they have an active role in future energy interventions with appropriate technical knowledge to enable delivery and to create jobs and livelihood opportunities for both displaced and host communities. Where possible, cleaner or renewable technologies should be introduced together with proven energy technologies that communities know and can maintain.

### Improved Data, Evidence, Monitoring and Evaluation

Coordinated effort around data for energy needs and interventions must be high-quality, accurate and relevant for users. Relevant data should be automatically collected utilizing already existing mechanisms, when possible, and integrated into humanitarian responses. Data should be digitally shared openly between stakeholders. Where possible, data should be harmonized and standardized to enable comparison and to facilitate effective monitoring and evaluation.

## Interlinkages with other Sustainable Development Goals

Studies show that two thirds of the SDGs depend on access to clean and affordable energy.

### Environment

Improving energy response for displaced people has a direct link to the environment. With access to renewable, reliable energy sources, harmful environmental practices such as deforestation from firewood collection and $CO_2$ emissions from diesel generators can be mitigated. Energy assessments and environmental assessment should be carried out in parallel.

### Economic Development

Having access to sustainable energy enables livelihood opportunities. For example, micro-businesses like barbers and tailors can operate machinery, and use increased hours of light to for income generating activities.

### Gender Equality

Energy poverty has a direct effect on women's and girls' quality of life as they are traditionally the family members spending time collecting firewood over long distances in often remote locations, which exposes them to risks of sexual and gender-based violence, including rape and sexual assault. The lack of fuel for cooking and other household needs can also increase tensions, the risks of intimate partner violence and conflict with surrounding communities.

### Education

Reducing the burden of firewood collection on children and young people can improve school attendance and retention, increasing access to education.

## REFERENCES

Bellanca, R (2014), "Sustainable Energy Provision Among Displaced Populations: Policy and Practice", Chatham House.

IDMC (The Internal Displacement Monitoring Centre) (2017), 2017 Global Report on Internal Displacement, Geneva.

Lahn, G. and Grafham, O. (2015), "Heat, Light and Power for Refugees: Saving Lives, Reducing Costs", Chatham House.

Lehne, J., Blyth, W., Lahn, G., Bazilian, M. and Grafham, O. (2016), "Energy services for refugees and displaced people", Energy Strategy Reviews, Moving Energy Initiative.

MEI (2016), Moving Energy Initiative Resources and Toolkits. Available at https://mei.chathamhouse.org/.

UN OCHA (2018), 2018 Global Humanitarian Overview, Geneva.

UNHCR (2018), Figures at a Glance, Geneva.

UNITAR (2018), More information about the Global Plan of Action, http://onlinelearning.unitar.org/global-plan-of-action/.

World Food Program (WFP) (2012), Handbook on Safe Access to Firewood and Alternative Energy, Rome.

# POLICY BRIEF #18

## ACHIEVING SDG 7 IN AFRICA

### Developed by

United Nations Economic Commission for Africa (UNECA)

### In collaboration with

The African Development Bank, ENERGIA, UNCTAD, UNESCWA, RCREEE, SACREEE, ECREEE, EACREEE, FIA Foundation, IRENA, UNIDO and IEA

# KEY MESSAGES

## Status and progress towards achieving SDG 7 in Africa

- While countries in North Africa have attained nearly universal access to electricity and clean cooking, and a few countries in the rest of Africa are making good progress towards achieving universal access by 2030, most of the continent is unlikely to achieve SDG 7 with existing policies and commitments. Due to future projected population growth (from 1.3 billion people in 2017 to 1.7 billion in 2030), roughly the same number of people are likely to be without access to electricity in 2030 as in 2016 (590 million). For those who have access to electricity in sub-Saharan Africa today, the average per capita consumption remains the lowest in the world. The number of people without access to clean cooking has continued to increase, reaching 846 million in 2015. Biomass continues to play an important role in the energy transformation agenda in Africa. Based on current policies and commitments, the number of people without access to clean cooking will reach 900 million by 2030.
- Renewable electricity capacity exceeded 38 GW in 2016 (about 23 per cent of the total), driven mainly by developments in wind, s**o**lar PV, geothermal and large hydropower.
- Energy intensity remains high (6.0 MJ/USD in 2014), largely as a result of overreliance on inefficient biomass and weak energy efficiency policies and programmes.
- To ensure the attainment of SDG 7 in Africa by 2030, investments of approximately US$ 34.2 billion per year are needed (US$ 32.5 billion per year for electricity access and US$ 1.7 billion a year for clean cooking).

## Priority Actions

- Put in place coherent policies and an enabling environment to leverage limited public resources in order to mobilize necessary investments from the private sector (including from domestic resources), capitalizing on falling technology costs for renewable energy.
- Address data gaps and reliability (especially on biomass) to inform investment planning, develop greater capacity to collect and analyse energy data, harmonize data-collection methodologies and strengthen existing data-collection systems.
- Develop in-country human and institutional capacities for energy planning and management and greater engagement with the private sector.
- Ensure that climate resilience is fully integrated into the planning and implementation of energy infrastructure and investments, especially for hydropower systems, which are at risk from climate change and variability.
- Promote sharing of good practices and experiences with both on-grid and off-grid systems, including business models and instruments to attract private sector investments. Promote coordination of the various regional and sub-regional programmes on energy access to synergize and share experiences.
- Systematically prioritize energy efficiency across all sectors and capitalize on quick wins in energy efficiency in cities, industries, buildings and transportation, recognizing that energy efficiency gains enhance access.
- Promote investments in strengthening the grid for greater efficiency and increased penetration of variable renewable power and promote cross-border interconnections to accelerate access to electricity.
- Promote local content enhancement across the full renewable energy value chain as a catalyst for longer term enhanced deployment of renewables with wider socio-economic benefits.
- Accelerate efforts to encourage innovation in energy services and promote collaborative research and development at the regional level.

## ACHIEVING SDG 7 IN AFRICA

### Current status

Of the 54 African countries, 33 are currently defined as Least Developed Countries (out of 47 countries globally). These countries have very large rural populations, oft existing policies and commitments, which affects attainment of the other SDGs. This is despite the numerous programmes at the regional, subregional and national levels aimed at increasing access to modern energy.

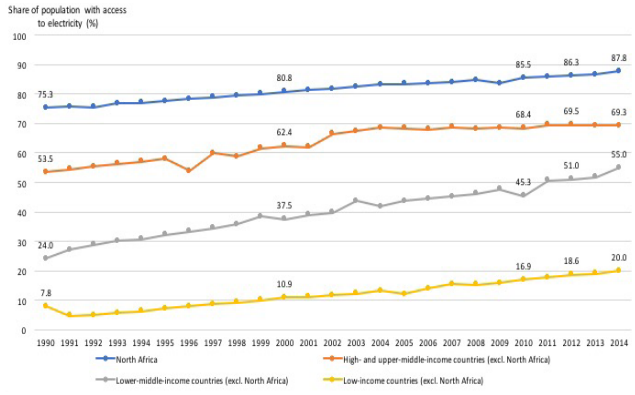
Energy access (SDG 7.1)

The electrification rate increased by 12.9 percentage points (to 43 per cent) in the 20 years from 1990 to 2010—increasing from 186 million people to 444 million, with the addition of 12.8 million people per year. However, the total population during the same period increased annually by 20.65 million, outpacing electrification efforts. Between 2010 and 2012, the rate increased to 45.1 per cent, and the number of people gaining electricity each year doubled to 25 million, while the total population grew by 27.5 million per year. In 2012-2014, the rate continued to grow, reaching 46.9 per cent, while the global average was 85.6 per cent (ECA, 2017).

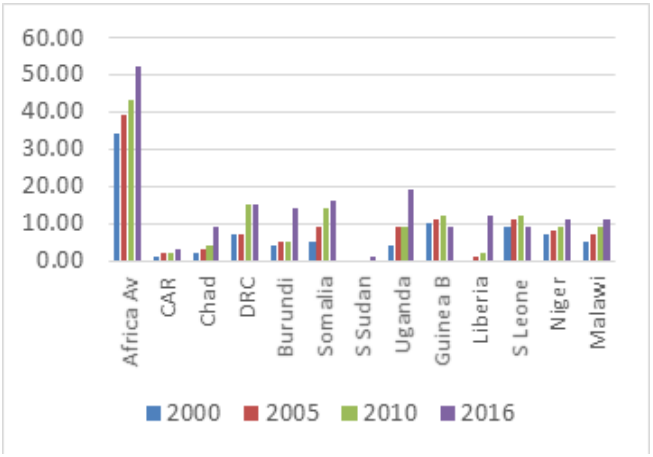
According to the 2017 IEA Energy Access Outlook, the electrification rate increased from 34 per cent in 2000 to 52 per cent in 2016, compared to 64 to 86 per cent on average for developing countries, and 87 to 97 per cent for the Central and South America region, over the same period. While the number of people gaining access to electricity in Africa has been increasing over the years, due to population growth rates, the region is lagging behind.

Figure 18.1

**Share of population with access to electricity by subregion, 1990-2014. Source: (a) IEA and World Bank (2017); (b) extracted from IEA (2017).**




(a)




(b)

Since 2013, however, the rate of access to electricity has surpassed the rate of population growth in Africa: the number of people lacking access to electricity decreased from 640 million in 2013 to 590 million in 2016, with average urban and rural electrification rates of 77 per cent and 32 per cent, respectively. North African countries have close to 100 per cent electrification. In sub-Saharan Africa, urban electrification rates range from as low as 4 per cent (South Sudan and Central African Republic) to 100 per cent (Cabo Verde and Mauritius), while rural electrification rates range from 1 per cent (Central African Republic, Chad, Democratic Republic of Congo, Djibouti, South Sudan, Burkina Faso, Guinea, Guinea-Bissau and Niger) to 71 per cent (Ghana and Swaziland), 89 per cent (Cabo Verde), 99 per cent (Seychelles) and 100 per cent (Mauritius). The average per capita consumption of 200 kWh per year in sub-Saharan Africa remains the lowest in the world. This compares unfavourably to 1,600 kWh in the European Union; 1,075 kWh in India and 4,066 kWh in China.

Although the resource potential and demand are high, the current total electricity installed capacity in Africa is only around 170 GW. The electricity supply mix is dominated by coal at about 35 per cent, reflecting the dominance of South Africa (where 90 per cent of electricity comes from coal); however, over 50 per cent of the coal power plant units are more than 40 years old. Despite its huge potential, hydropower only contributes about 23 per cent of electricity supply.

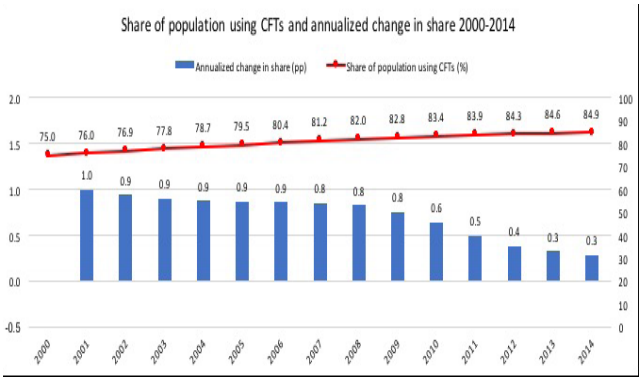
Africa is also the worst performing region in terms of access to clean fuels and technologies (CFTs). According to the Sustainable Energy for All Global Tracking Framework 2017, between 2000 and 2010, the share of the population using clean-cooking solutions barely increased (from 24.4 to 25.6 per cent), representing a yearly increase of just 6.9 million new users. The population increased annually by 23 million during the same period. Between 2010 and 2012, the share remained almost flat at 25.7 per cent, as there

were only 7.5 million new users of CFTs per year, while the total population increased by 27.5 million people per year. The pace of adoption of CFTs remained almost stagnant, at 0.1 per cent during the period 2012-2014. The share reached 25.8 per cent with 8 million new users yearly, against an additional 29 million people per year. To reach universal access by 2030, the rate of adoption of clean-cooking solutions needs to increase dramatically.

The IEA Energy Access Outlook 2017 shows that the share of the population without access to clean-cooking solutions in North Africa was less than 1 per cent in 2015, compared to 84 per cent in sub-Saharan Africa, where no-access levels ranged from 95 per cent in some countries (such as Central African Republic, Democratic Republic of Congo, Burundi, Djibouti, Rwanda, Nigeria, Malawi and United Republic of Tanzania) to 2 per cent in Mauritius and Seychelles. Although the share of the population without access to clean-cooking solutions has been decreasing, the total number of people without access actually increased from 610 million to 846 million between 2000 and 2015, with 783 million people depending entirely on solid biomass for cooking in 2015. As a result of the low level of access to clean-cooking solutions on the continent, about 500,000 premature deaths per year in the region are attributable to poor indoor air pollution resulting from biomass combustion—more than the annual number of deaths from malaria (IEA, 2017a).

Figure 18.2

**Share of population using clean cooking fuel technologies (CFTs), 2000-2014. Source: IEA and World Bank (2017)**



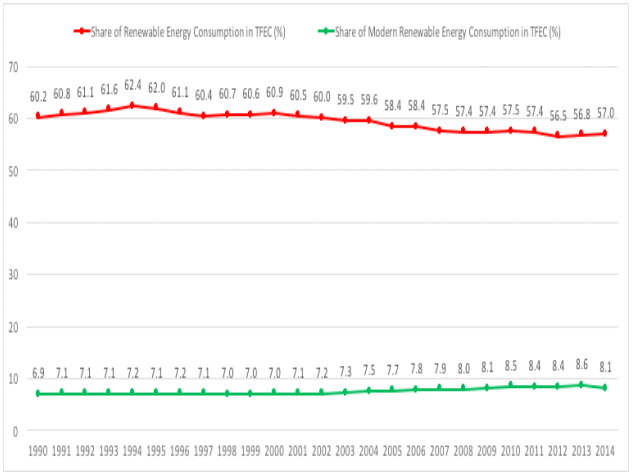

### Renewable energy (SDG 7.2)

The share of renewable energy in total energy consumption in Africa was the highest in the world in 2014, at 57 per cent, mostly traditional biomass consumption. The region also recorded the highest share of total energy consumption in the world, at 48.9 per cent, in 2014. The share of renewable energy in the total energy consumption in Africa decreased slightly between 1990 and 2012, from 60.2 per cent in 1990 to 57.5 per cent in 2010, and 56.5 per cent in 2012; it peaked at 62.4 per cent in 1994.

Most renewable energy in Africa is derived from biomass. According to the IEA about 780 million people in sub-Saharan Africa rely on solid biomass for cooking, and this number has grown by 44 per cent since 2000 (IEA, 2017b). The penetration of modern renewables is lower than the world average and modest, except for large hydropower plants.

Figure 13.3

**Total renewable energy and modern renewable energy share in Africa, 1990-2014.**




Source: IEA Energy Balances (2016) and UN Statistics

In terms of renewable electricity, the total installed capacity exceeded 38 GW in 2016 (about 23 per cent of total electricity capacity), driven mainly by developments in wind, solar PV, geothermal and large hydropower in South Africa, Morocco, Ethiopia and Kenya, among others.

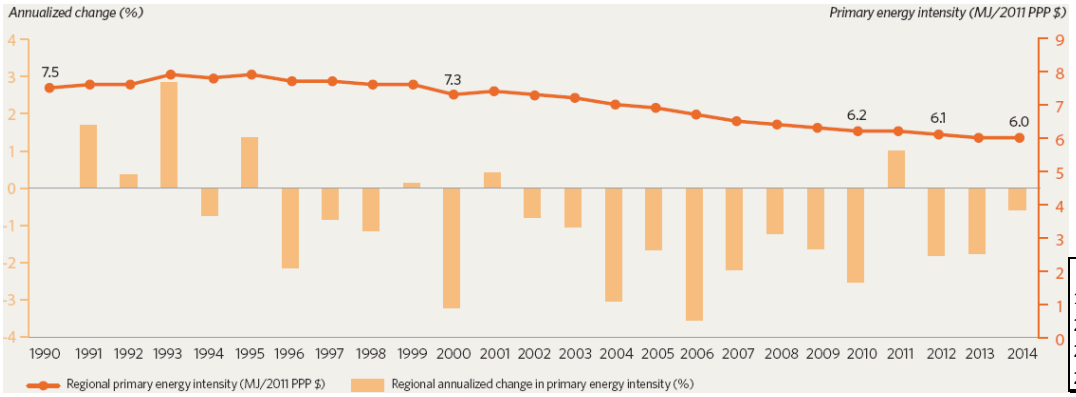
Under the Paris Agreement on climate change, all African countries have included renewable energy actions (covering all technologies and end-use applications) as commitments to tackle climate change and spur economic growth. The Africa Renewable Energy Initiative (AREI)—launched at COP21—is an ambitious continental initiative that aims to add 300 GW of new renewable electricity capacity on the continent by 2030. IRENA's report—Africa 2030: Roadmap for a Renewable Energy Future—shows that this will require US$ 70 billion per year for generation, transmission and distribution (IRENA, 2015). Mobilizing such volumes of investment would require substantial political will, and innovative and ambitious policies, including an enabling environment for mobilizing private sector finance, both from foreign direct investment and domestic resources.

### Energy efficiency (SDG 7.3)

Africa reported comparatively high rates of energy intensity in 2014 at 6.0 MJ/US$ (i.e. megajoules per 2011 purchasing power

Figure 18.4

**Energy intensity and annual change in intensity in the African region, 1990-2014. Source: IEA and World Bank (2017)**




| CAGR of energy intensity | |
|---|---|
| 1990-2000 | -1% |
| 2000-2010 | -2% |
| 2010-2012 | 0% |
| 2012-2014 | -4% |

parity dollar), compared to the global average of 5.5 MJ/US$. In the period 1990-2010, energy intensity in the region decreased from 7.9 MJ/US$ in 1993 to 6.2 MJ/US$ (Figure 3), with a compound average growth rate (CAGR) of -2 per cent between 1990 and 2000. The improvement in energy intensity was -1.7 per cent in the period 2000-2010, driven by GDP growth that coincided with a global surge in commodity prices, particularly for oil. Energy intensity declined in the period 2010-2012 by -0.4 percentage point, mainly due to a dip in oil prices in 2009, but accelerated again to -1.2 per cent in the period 2012-2014, as GDP returned to higher levels when the oil prices recovered briefly until 2015 (IEA and World Bank, 2017; ECA, 2017a).

Energy intensity changes have varied by economic sector. Energy intensity in the industrial sector returned to a negative CAGR in the periods 2010-2012 and 2012-2014, after trending higher during the period 2000-2010. The lowest energy intensity was in the agricultural sector, at 0.5 MJ/US$, in 2014, however, it never exceeded 0.76MJ/US$ from 1990 to 2014. Following two decades of declining trends, energy intensity in the services sector shot up in the periods 2010-2012 and 2012-2014, which can be attributed to improved infrastructure for information and communications technology. The residential sector had slight changes in energy intensity, which may be a combination of poor capture of energy consumption and GDP data, and a general shift to more efficient CFTs (IEA and World Bank, 2017; ECA, 2017a).

## Are we on track to achieving SDG 7 in Africa?

Africa is far from being on track to achieving SDG 7 targets. While a few countries, including Ethiopia and Kenya, are presently on a trajectory towards universal access to electricity, progress is uneven and 600 million people are still projected to be without electricity by 2030 on the basis of existing policies. Access to clean-cooking solutions is even less promising, with the number of people without access to clean-cooking solutions expected to increase to 900 million, 820 million of whom will rely primarily on biomass for cooking in 2030 (IEA, 2017a).

Renewable energy is essential for delivering sustainable and clean electricity access, air pollution reduction and climate goals. Strong growth in renewable electricity capacity is anticipated to increase its share in power generation to 36 per cent in 2030 with current and planned policies, driven mainly by hydro, solar PV and wind, up from 18 per cent in 2016. However, limited policies targeting renewable heat and transport means that the overall share of modern renewables in total final energy consumption would remain relatively low at 11 per cent in 2030, up from 7 per cent in 2015.[1] In order to deliver on sustainable development and climate objectives, the IEA Sustainable Development Scenario shows that the renewable energy share in TFEC needs to grow to 22 per cent in 2030 and 32 per cent in 2040 (IEA, 2017b). Progress in energy efficiency is also expected to be uneven and slower than the world average, with annual improvements anticipated to decline at a rate of 1.8 per cent per year under current policies, less than half the rate required to achieve sustainable development objectives (IEA, 2017b).

With the year 2030 just over 12 years to come, most of the continent will not achieve all the SDG 7 targets, especially universal access and energy efficiency targets, given the low base from which most countries started and the lack of meaningful investments. The greatest challenge is access to clean cooking, and it is clear that this target will not be reached by a majority of African countries, save for North African countries where the share of population without access to clean cooking is less than 3 per cent. In sub-Sahara Africa, only Mauritius and Seychelles have almost universal access to clean cooking, followed by South Africa at over 80 per cent with access (IEA, 2017a).

[1] Including traditional biomass, the share of renewable energy in TFEC is anticipated to decline from 58 per cent in 2015 to 54 per cent in 2030 (IEA, 2017a).

## Key challenges

### Low power generation capacity

The electricity installed capacity in Africa was 147 GW in 2012, reaching about 168 GW in 2016 (AfDB, 2017), mostly from fossil fuels (coal, oil and gas). Excluding South Africa and North African countries, the rest of Africa has an installed capacity roughly equal to that of South Africa and is just under the 53 GW of solar PV addition in China in 2017 or just over the installed capacity in Thailand. Renewable energy, mainly large-scale hydropower, makes up a quarter of the electricity capacity (IRENA, 2017). In most cases, the generation is very inefficient, with some of the generation assets nearing retirement age.

### Cost of rural electrification

Many countries have rural electrification programmes—including rural electrification agencies and sometimes dedicated funds—to accelerate electrification in rural areas where the majority of the population lives and lacks electricity access. For example, all Southern African countries have rural electrification agencies or units, except Seychelles and Mauritius (which are already fully electrified).

Limited grid coverage inhibits further growth in rural electrification; the focus has largely been on grid electricity for urban areas. For the majority of countries between 80 to 95 per cent of the unserved communities are targeted to receive electricity supply through grid extension (World Bank, 2010). There is growing a realization about the cost implications of grid connection as the mechanism for rural electrification. The investment required to extend grid coverage in rural areas is significant, and the investment gap is wide. Off-grid technology options—mini-grids and individual systems—are increasingly being considered as cheaper supply options for small consumers residing far from the grid network.

Also, rural electrification is viewed more as a social service. As such, demand in rural areas is in most cases suppressed. Eventually most rural electrification initiatives end up being rural lighting projects. There is a need to shift towards stimulating productive uses of electricity and energy services as options for stimulating growth economic using decentralized power systems.

### Financing gap

There is a huge financing gap. In Africa, excluding North Africa, the IEA estimates that investments of US$ 34.2 billion per year are needed to ensure energy access for all by 2030. This consists of US$ 32.5 billion per year for electricity access and US$ 1.7 billion a year for clean cooking (IEA, 2017a). In the case of renewables, the Frankfurt School-UNEP Centre/BNEF 2017 report on global trends in renewable energy investment shows that of the US$ 242 billion invested in renewables in 2016, only about US$ 3.5 billion was in Africa (Frankfurt School-UNEP Centre/BNEF, 2017)—US$ 894 million in South Africa, US$ 660 million in Morocco, US$ 648 million in Kenya and US$ 745 million in Egypt. Most African countries are not tapping the huge potential of domestic resource mobilization to finance their energy transformation. However, domestic resource mobilization for Ethiopia's US$ 4.7 billion Grand Renaissance dam was targeted to raise 12 billion birr (about US$ 550 million) from the public, through domestic and diaspora bonds. To date over 8 billion birr has been raised. In South Africa, domestic resources constitute well over 70 per cent of the investments in the renewable energy procurement programme. This programme also demonstrates how investment transformation can happen when the political will and right polices are in place. Over US$ 14 billion in investments so far are committed to renewable energy procurement in the country. Already over 6 GW of renewable electricity capacity is contracted, with 3.27 GW dispatched to the grid in 2017.

## Interlinkages with other Sustainable Development Goals

The importance of SDG 7 is not confined solely to access to clean and affordable energy, renewable energy and energy efficiency but also is central to the attainment of all of the other SDGs. For example:

### Industrialization (SDG 9)

Renewable energy has a critical role to play in powering Africa's industries, as well as in creating industries along the low carbon, climate resilient and inclusive development pathway. With rapidly declining renewable technology prices, especially solar and wind power, the potential for renewables to transform industrialization get higher and higher with the renewables learning curve. In Ethiopia, for example, industrial parks (such as the eco-friendly Hawassa Industrial Park[2]) are being developed and powered with renewable power sources and promoting cleaner production.

### Climate change (SDG 13)

Renewable energy and energy efficiency are key for decarbonization of the energy sector. The Economic Commission for Africa has been analyzing and reviewing the nationally determined contributions (NDCs) to climate action of all Africa countries under the framework of the Paris Agreement on climate change. These NDCs all include renewable energy and energy efficiency actions for climate change mitigation and adaptation. For example, as elaborated by IRENA, adding 300 GW of renewable electricity in Africa by 2030 from hydropower, wind and solar would result in a climate benefit of 310 megatonnes (Mt) of $CO_2$ reduction in emissions by 2030, compared to the baseline business-as-usual scenario (IRENA, 2015).

[2] See, for example, http://www.ena.gov.et/en/index.php/economy/item/3345-hawassa-industrial-park-to-be-fully-operational.

### Gender and health (SDG 5 and SDG 3)

There are strong linkages between gender-based constraints and structural transformation (UNCTAD, 2017). Gender-based roles at the household level, especially in rural areas, presuppose that women should do the work of fetching water and firewood, cooking, nurturing children and general upkeep of households. ENERGIA (2012) has elaborated an effective framework for mainstreaming gender into energy sector and practice in a way that ensures gender equity, particularly leading to an inclusive development framework that empowers women and girls and gives them more free time for productive and self-interest activities, thus contributing to accelerated attainment of SDG 5. Concerning SDG 3 on health, access to modern energy forms and services could cut the number of premature deaths from indoor smoke and air quality by up to 500,000 according estimates by the IEA (IEA,2017a).

## Policy implications

### Creating investment climate, particularly for decentralized energy systems

In many African countries, energy provision is seen as a public good and the public sector provides funds and implements most energy programmes, with little private-sector finance and participation. However, there are some significant shifts. For example, energy projects under the Pogramme for Infrastructure Development in Africa (PIDA) envisage substantial private- sector participation. Through political will and policy reforms that create the enabling environment and investor confidence in most African countries, there have been significant public-private partnerships (PPPs) in the energy sector, particularly in the power sector. Starting with countries such as Morocco, South Africa, Kenya and, more recently, Ethiopia, among others, there have been significant private sector investments in on-grid renewable energy projects. However, there is still a long way to go in mobilizing private sector investments to drive accelerated energy access on the continent, unless concerted and urgent actions are taken by policymakers, in partnership with development partners to boost investor interest and create the enabling environment and framework for return on investment.

Connecting the grid to most rural areas, especially the sparsely populated areas far away from urban centres is generally not financially viable. Urgent actions to support and incentivize accelerate deployment of decentralized technologies are crucial if the energy access target of the SDG 7 is to be achieved in Africa. A number of African countries are deploying solar home systems in their rural electrification programmes and these are mainly supported by development partners. However, in spite of providing alternative power, the impact of these systems on improving livelihoods is limited. Generally, such systems are still costly and only provide minimal power, and are not suited for higher valued added stages of production (UNCTAD, 2017). Recognizing that the private sector is not the panacea for attaining SDG 7 in Africa, it is in rural energy access that innovations in business models, supported by carefully designed public interventions, are needed the most to spur new investments access to modern energy. In the past, investing in renewable energy technologies deployed in rural areas was risky, owing to regulatory and policy uncertainties, as well as an impoverished market. However, recently there has been an emergence of digitalized decentralized energy services business models (such as M-KOPA that has, over the last six years, connected over 600,000 homes with solar power[6]) that are already making transformative impacts towards access to clean and affordable energy on the continent.

A number of countries are creating a good environment for rural-based energy, but these reforms are still nascent and need to be accelerated. The renewable energy space is still dominated by international firms and finance in partnership with public institutions. There is little participation by local project developers or independent power producers (IPPs) because the latter often do not have access to credit like their international counterparts. International firms are crowding out local firms in supplying renewable energy options, as is the case in South Africa, Zambia and a host of other African countries. In a recent Zambian 100-MW bid, only one out of 11 firms that qualified was African—and this company came from South Africa (McDaid, 2016). The formation of special credit facilities at the national level will assist local project developers. An example is the Ugandan Energy Credit Capitalization Company (UECCC), supported by KfW, a German development bank, which is offering advisory services and funding for renewable projects in the country.

### Capacitating energy service providers

Skills development, both soft and hard, should be at the centre of interventions to promote and accelerate energy access. This ensures sustainability and localization of technologies and practices. Special funds are needed for strategic programmes aimed at improving the capacity of energy services providers in the both the public and private arena at the national and local levels. This is an area that has been identified as a serious impediment in rolling out energy interventions in Africa. There are regional centres of excellence (some established and others recently created) already embarking on supporting their member States with polices, as well as human and institutional capacity to enhanced energy services provision. These institutions include the African Institute for Economic Development and Planning (IDEP) which is developing a comprehensive capacity development programme for energy supply and demand management and planning, as well as sub-regional institutions—such as West Africa's ECOWAS Centre for

[3] http://solar.m-kopa.com/about/our-impact/.

Renewable Energy and Energy Efficiency (ECREEE), Southern Africa's Centre for Renewable Energy and Energy Efficiency (SACREEE), North Africa Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) and East Africa's Centre for Renewable Energy and Energy Efficiency (EACREEE).

## REFERENCES

African Development Bank (AfDB), 2017, Annual Development Effectiveness Review 2017: Chapter 2—Light Up and Power Africa, AfDB, Abidjan.

ECA (UN Economic Commission for Africa), 2016, Economic Report on Africa: Greening Africa's Industrialization, Addis Ababa.

ECA, 2017a, Sustainable Energy for All Global Tracking: Report on Africa, Addis Ababa.

ECA, 2017b,Promoting Infrastructure Development for Africa's Industrialization, Addis Ababa.

Energia, 2016, Mainstreaming Gender in Energy Sector Practice and Policy: Lessons from the Energia International Network.

Frankfurt School-UNEP Centre/BNEF, 2017, Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org (Frankfurt am Main).

IEA (International Energy Agency), 2017a, Energy Access Outlook: World Energy Outlook Special Report, OECD/IEA, Paris.

IEA, 2017b, World Energy Outlook, OECD/IEA, Paris.

IEA and the World Bank, 2017, Sustainable Energy for All 2017: Progress toward Sustainable Energy, World Bank, Washington D.C. License: Creative Commons Attribution CC BY 3.0 IGO.

International Renewable Energy Agency (IRENA), 2015, Africa 2030: Roadmap for a Renewable Energy Future, Abu Dhabi.

McDaid, L. 2016. Opportunities for Investing in Renewable Energy Sector in Africa, Southern African Faith Communities' Environmental Institute (SAFEI), https://www.kirkensnodhjelp.no/contentassets/c1403acd5da84d39a120090004899173/briefing-paper-2016-opportunities-for-investing-in-renwable-energy-sector-in-africa.pdf

UNCTAD (UN Conference on Trade and Development), 2017. The Least Developed Countries Report 2017: Transformational Energy Access, United Nations, Geneva.

# POLICY BRIEF #19

## ACHIEVING SDG 7 IN ASIA AND THE PACIFIC

### Developed by

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)

### In collaboration with

ADB, AIIB, FIA Foundation, IEA, IRENA and UNDP

## KEY MESSAGES

### Status and progress towards achieving SDG 7 in Asia and the Pacific

- Although the region made remarkable progress on electricity access in the last decade, according to the Global Tracking Framework, over 420 million people still have no access to electricity, almost 10 per cent of the region's population. The region is on track to reach nearly universal access to electricity by 2030, however there are some countries with acutely low access rates, mainly Pacific islands.
- Almost 2.1 billion people rely on polluting and unhealthy cooking fuels and technology, nearly half the population, and the region is far from being on track to achieve universal access by 2030.
- The share of renewable energy, including both traditional and modern forms, reached 18.3 per cent of the region's total final energy consumption in 2014, down from 23 per cent in 1990, though up from a low of 17.9 per cent in 2011. Modern renewables comprised 6.8 per cent of total final energy consumption in 2014, up from 6.2 per cent in 2012. In absolute terms, renewable energy consumption increased from 29.3EJ in 2012 to 31.1 EJ in 2014.
- The region has demonstrated a long-term steep decline in energy intensity, falling from 9.1 MJ/2011 PPP$ in 1990 to 6.0 MJ/2011 PPP$ in 2014, and progressing towards convergence with the 2014 global average of 5.4 MJ/2011 PPP$.

### Priority actions

- Governments need to maintain their commitments in order to sustain the current increases in electricity access rates. Reaching the last mile puts a spotlight on off-grid solutions, which require the respective authorities to put in place adequate regulations, including provisions for potential integration of on-grid and off-grid infrastructure. Countries with acutely low access rates require particular attention from both their governments and development partners.
- National and regional targets for clean cooking fuels and technologies should be established, and clean cooking must be better integrated into energy policy frameworks. Greater investments are needed to support the expansion of technology and fuel distribution networks, and the development of options that meet consumer needs and cultural preferences. New employment opportunities for women are also important—with greater economic value attributed to women's time, households are more likely to choose more efficient technologies with reduced fuel gathering requirements.
- The dramatic cost reduction of renewable energy technologies presents an opportunity to meet growing demand with renewable energy sources instead of fossil fuels. To realize this scenario, concerted efforts at promoting renewables are needed in Asia and the Pacific, with supportive policies and initiatives from governments as well as other stakeholders, including carbon emissions pricing, and energy market and fossil fuel subsidy reforms. Governments can affect investment flows towards modern renewable energy by reducing risks, extending fiscal and non-fiscal incentives, and providing more conducive legal frameworks and regulatory stability for the business and technology choices of investors.
- Tightened energy efficiency regulations are particularly urgent for the industry sector, which is responsible for more than 35 per cent of regional sectoral fuel consumption. Such efforts must target large as well as small and medium-sized enterprises. In the building sector, a priority is to develop stringent building codes for new buildings. Considering the continuous growth of the transport sector, the implementation of efficiency measures in this sector will become especially important in the long term.

## SDG 7 in Asia and the Pacific

The Asia-Pacific region comprises 58 economies, ranging from developed to least-developed, with a population of 4.3 billion, about 60 per cent of the world total. Economies in the region produce approximately one-third of the world's gross domestic product (GDP), consume more than half of the global energy supply and include important oil and gas producers. As the region is leading the world in terms of rising energy demand, and some of its countries have the largest deficits in energy access, the decisions and actions taken by Asia-Pacific countries will have an enormous impact on progress towards achieving global sustainable energy objectives, including SDG 7. In 2014, Asia and the Pacific produced 55.2 per cent of global emissions from fuel combustion, nearly two-thirds of which were from coal. Though facing many challenges, Asia-Pacific countries are demonstrating global leadership across the three main pillars of sustainable energy—access, efficiency and renewables—offering strong commitments and innovation in those areas. New technologies and approaches have emerged, and as the Paris Agreement turned the world's focus toward decarbonization, countries across the region have offered up new and increasingly ambitious targets to improve energy efficiency and to increase their renewable energy share.

## Current Status[4]

### Energy Access

A substantial portion of the Asia-Pacific population still experiences the negative effects of energy poverty on sustainable development: over 420 million people lack access to electricity, and nearly half the region's population still relies on polluting and unhealthy cooking fuels and technology. Significant energy access disparities exist between rural and urban populations, and between countries in the region. Rural populations, in particular women and children, bear the largest burden of energy poverty.

*Electricity*

- More than 420 million people (9.7 per cent) of the population in Asia-Pacific remained without access to electricity in 2014, with about 389 million of those people located in rural areas.
- Between 2012 and 2014, an estimated 93.1 million people in Asia and the Pacific gained access to electricity as the population grew by about 83.8 million.
- The regional rate of electrification rose to 90.3 per cent, up from 89.8 per cent in 2012, though national rates vary widely.
- Urban areas are gradually approaching universal access, reaching 98.7 per cent in 2014, while rural areas have stayed at 83.3 per cent since 2012.

In the period 2012-2014, China, India and Pakistan each provided between 13 and 16 million additional people with access to electricity. Afghanistan, Bangladesh, Indonesia, and the Philippines extended electricity service to between five and nine million people.

*Clean Cooking*

- In the Asia-Pacific region, almost 2.1 billion people—nearly half of the region's population and more than a quarter of the global population—remain without access to clean cooking.
- The World Health Organization (WHO) estimates 92 deaths per 100,000 people are attributable to household air pollution in developing Asia.
- In 2014, the regional rate of access to clean cooking reached 51.2 per cent, up from 39.8 per cent in 2000.
- In 2014, only 12 Asia-Pacific economies had clean cooking access rates of at least 99 per cent.
- The average annual share increase in access to clean cooking has hovered around 0.8 per cent over the period 2000-2014, well below the pace required to achieve universal access by 2030.

### Renewable Energy

The Asia-Pacific region has achieved remarkable economic growth over the past decades, resulting in new levels of prosperity, as well as new and expanded economic sectors. Historically, this growth has been largely powered by the consumption of fossil fuels. However, today, the region is facing the consequences of local pollution and climate change, as well as exposure to the volatile energy commodity prices, which is primarily the result of an over-reliance on carbon-based energy sources. Although the Asia-Pacific region leads the world in the renewable energy sector with more installed capacity and consumption than any other region, further efforts are needed to enable clean energy to play a greater role within national and regional energy systems.

- The share of renewable energy consumption, including both traditional (mostly traditional biomass) and modern forms, such as solar, wind, hydro, modern biofuels and geothermal, reached 18.3 per cent of the region's total final energy consumption in 2014, down from 23 per centin 1990, though up from a low of 17.9 per cent in 2011.
- In 2014, modern renewables comprised 6.8 per cent of total final energy consumption, up from 6.2 per cent in 2012, indicating a promising accelerating upward trend.

[4] The data in this section is based on ESCAP (2017a), Asia-Pacific Progress in Sustainable Energy, Bangkok.

- In absolute terms, total renewable energy consumption amounted to 31.1 EJ in 2014, up from 29.3 EJ in 2012, continuing a long-term steady increase.
- Investments in renewable energy (excluding hydropower plants of over 50 MW) rose from US$ 97.2 billion in 2012 to reach an all-time high of US$ 171.1 billion in 2015, but fell dramatically to US$ 114.8 billion in 2016.
- The estimated yearly investment needed in Asia and the Pacific to meet the renewable energy goal by 2030 is US$ 298 billion, but current investment levels fall short.

### Energy Efficiency

Over the past decade, the region has made significant progress in decoupling the growth of energy demand and economic output, with significant recent advancements occurring in the industrial sector. Innovative technology has been developed and deployed, with countries such as China and Japan acting as global leaders in the introduction of energy efficiency into various sectors. Nonetheless, Asia and the Pacific remains one of the most energy-intensive among the global regions, and the uptake of energy efficiency is unequal among member States and between sectors.

- The region has demonstrated a long-term steep decline in energy intensity, falling from 9.1 MJ/2011 PPP$ in 1990 to 6.0 MJ/2011 PPP$ in 2014, and progressing towards convergence with the 2014 global average of 5.4 MJ/2011 PPP$.
- The region's energy savings between 2012 and 2014 were equivalent to the 2014 total final energy consumption of the Republic of Korea and Thailand combined.
- Supply-side efficiency in power generation showed a long-term upward trend, with regional thermal power generation efficiency increasing from 33.4 per cent in 1990 to 38.8 per cent in 2014.
- The industrial sector is responsible for the largest drop in energy intensity during the period 2012-2014, with a 3.2 per cent average annualized change in energy intensity, though the service and, to a lesser extent, agricultural sectors were also reported to have made progress in that regard, at 2.5 per cent and 0.8 per cent, respectively.
- Energy efficiency gains in China between 2006 and 2014 eliminated the need for more than US$ 230 billion in investment for new power generation in the country, nearly half of the region's total installed capacity.
- The Asia-Pacific region needs an average of US$ 211 billion in annual investment to reach the 2030 efficiency target, but current levels fall short.
- Asia-Pacific is still the most energy intensive region and will reach Europe's levels only in 2030, should the current progress rate be maintained.

### Are we on track to achieving SDG 7 in Asia and Pacific?

The energy transition needed to achieve SDG 7 and its targets is only going to be successful if efforts are made to curb demand growth, and if remaining growth is met by a supply of cleaner energy sources. A comparison of different outlooks for Asia and the Pacific demonstrates that aggressive measures must be taken to control energy demand towards 2030. According to the business-as-usual scenarios developed by the ADB and the IEA, energy demand may grow by more than 2,000 Mtoe by 2030.[8] Policies announced to date (including Nationally Determined Contributions, NDC) could result in a slight demand reduction. More progressive policies and technologies on energy efficiency could decrease this even further. However, the achievement of SDG 7 and more ambitious targets beyond 2030 require a demand reduction of 25 per cent compared to the business-as-usual case.

Fossil fuels cannot be phased out overnight and are part of all forecasts. In the business-as-usual scenario the share of fossil fuels remains between 70-80 per cent. To be on track for sustainable development, this share must drop below 70 per cent. In the business-as-usual predictions, on average coal retains 40-50 per cent, oil remains at 25 per cent and there is a slight increase in gas, from 10 per cent to 15 per cent. This leaves renewable energy (including bioenergy, hydro and other renewables) at around 15 per cent, which would represent a decrease instead of a substantial increase in the share of renewables.

Although the Asia and the Pacific region has experienced significant improvement in energy intensity, meeting the SDG 7 target will require scaled up action. By maintaining its average rate of the last two years up to 2014, Asia and the Pacific would double its annual average achievement rate between 1990 and 2010. However, historic primary energy intensity and the 1990-2010 average improvement rate indicate that this will be challenging for the region and would require a significant effort. The progress made in China provides reason for optimism. The region's largest economy, accounting for 55 per cent of Asia-Pacific's industrial energy consumption in 2014, helped drive improvements by continuing to adopt aggressive energy efficiency measures in the industrial sector. This included the elimination of outdated technologies and establishment of standards, resulting in a 4.5 per cent reduction in industrial energy intensity. If the rest of the region could attain reduction rates of this magnitude, Asia-Pacific would be well on track to meeting the SDG 7 target. However, this would require sustained government commitment. (IEA, 2017b)

[5] The data in this section is based on these two scenarios: ADB (2013), Energy Outlook for Asia and the Pacific, Manila; and IEA (2017a), World Energy Outlook 2017, Paris.

With existing and planned policies, Asia-Pacific is set to achieve the most basic level of near universal electricity access (99 per cent) by 2030. Much of the region's total progress is projected to be driven by populous countries such as India. However, some countries (such as the Democratic People's Republic of Korea, Papua New Guinea, Solomon Islands, Timor-Leste, Vanuatu, and American Samoa) face current access levels of less than 50 per cent, and may struggle with providing electricity to large shares of their populations. The Pacific SIDS are generally heavily reliant on imported fossil fuels for both transport and electricity generation, which makes them highly vulnerable to fluctuations in global oil prices, and increases the cost of doing business. Targeted efforts and assistance are needed in order to ensure that no one will be left behind. All governments with access deficits would need to make efforts to ensure that even the last mile is reached, enabling everyone to take full advantage of the multiple benefits of energy services. This comes at a cost, as experience has shown that reaching the last 10-15 per cent is the most expensive and time-consuming part of the challenge. In the cases of China and Thailand, increasing electrification from 30-40 per cent to 85-90 per cent took the same amount of time as reaching the last 10-15 per cent. When assessing current levels of energy access, factors such as reliability and affordability should also be considered, rather than applying the traditional binary distinction between access and lack of access. (ESCAP, 2017)

Providing universal access to clean cooking by 2030 is an immense challenge. Given the low current achievement rates, the region is far from being on track to achieve universal access to clean cooking fuels and technology by 2030. On a more positive note, several Asia-Pacific countries have recently put forward clean cooking targets, and have conducted research on and expanded markets for clean cooking fuels and technologies. Indonesia led the world in its pace of increasing access through the expansion and promotion of LPG fuel and technology markets, resulting in a dramatic increase from a mere 2.4 per cent in 2000 to 56.6 per cent in 2014, while the Marshall Islands distributed efficient smokeless stoves to each household in the outer islands from 2014-2016, giving rural dwellers access to clean-cooking solutions. If these positive examples inspire emulation in the region, there may be some reason for optimism. But without a doubt, higher priority needs to be afforded to clean-cooking solutions.

### Interlinkages with other SDGs

Energy is intrinsically interconnected with the majority of the other SDGs. It is an essential enabler for poverty reduction, food security, health, education, water, and more. Indeed, 125 of 169 targets included in the SDGs are linked to energy. That is more than two-thirds of all targets. One such interlinkage of particular importance to the Asia-Pacific region is that of energy and air pollution. The increased consumption of energy, especially fossil fuels, has significant local and regional social and environmental consequences and costs. Air pollution is disrupting not just the health of people, but it is also adversely affecting the growth potential of entire cities and economies. Of the 1,622 global cities listed in the 2014 World Health Organization (WHO) Ambient (Outdoor) Air Pollution Database, Asia-Pacific cities represented 85 of the top 100 polluted cities. In 2015, more than half of the 4.2 million early deaths worldwide attributed to air pollution occurred in India and China. India and Bangladesh have suffered the steepest increases in air pollution since 2010 and have the highest concentration of particulates in the world. The interlinkage between energy and air pollution makes a shift to cleaner sources of energy and increased energy efficiency especially urgent in the Asia-Pacific region.

## Policy Implications

Achieving universal access to electricity in the Asia-Pacific region will require governments to maintain their commitments to sustain the current increase rates. The challenge of reaching the last mile puts a spotlight on off-grid solutions which require the respective authorities to put in place adequate regulation. Given the parallel continuous expansion of the main grid, provisions need to be put in place to ensure the potential integration of on-grid and off-grid infrastructure. In the case of the countries with continuously low access rates, most of which are located in the Pacific, additional efforts are required by both their respective governments and international development partners.

Several Asia-Pacific countries have recently put forward clean cooking targets, and conducted research on and expanded markets for clean cooking fuels and technologies. However, current efforts remain small in comparison to the scope of the problem, and the challenges are great. For the switch from traditional to clean cooking to take place, greater expansion and reliability of technology and fuel distribution networks is necessary, along with greater efforts to improve utility and affordability. Clean cooking must be better integrated into energy policy frameworks, and greater investment is needed to support the development of options that meet consumer needs and overcome barriers, such as cost and cultural preferences. Furthermore, increasing employment opportunities for women in rural areas raises the opportunity cost of gathering fuel for cooking. With value attributed to women's time, households are more likely to choose more efficient technologies with shorter cooking times and reduced fuel gathering requirements. Policies in support of clean cooking fuels and technologies would also help to reduce air pollution.

The targets of SDG 7 require more financial resources and ODA will remain relevant, especially for access to energy in the more remote areas where expensive storage technology will have to be part of the solution. For renewable energy and energy efficiency, the private and public sectors remain the most important source

of finance. Energy demand-related finance would need to grow significantly while energy supply-related finance would need to be geared towards cleaner sources. Governments have a central role in achieving SDG 7 and could affect investment flows by: facilitating additional revenue streams from investments; reducing risks; extending fiscal and non-fiscal incentives to investors; and providing more conducive legal frameworks for the business and technology choices of investors. Thus, public financing needs to be focused on creating the appropriate conditions for attracting private capital through de-risking transactions. To achieve true scale-up, which necessarily has to come from private sources, an adequate enabling policy framework needs to be put in place to facilitate access to commercial debt and equity.

Achieving SDG 7 also requires a mix of interventions for clean energy—energy market reform, carbon emissions pricing and fossil fuel subsidy reform—as well as effective methods for addressing the social aspects arising from diverging energy tariffs between urban and rural areas, and from fossil fuel subsidy reform. While governments will play key roles in the energy transition, greater coordination would be needed to plan and implement the transition. Governments would need to strengthen coordination among ministries and establish an enabling environment for the private sector. To promote investment, this enabling environment must be stable and based on consistent policy. In addition, policies and strategies based on evidence-based research would need to be developed, together with research institutions and innovative national and international organizations.

To embark on the most promising pathway for increasing energy efficiency, a good strategy is to first analyze the most impactful sector. The examples of the top performers in the region show that no single sector drives success alone. In all cases, countries acted on considerations of the size and impact of the sector in their particular context. With a regional sectoral fuel consumption in industry of more than 35 per cent, continued efforts to reduce the amount of energy used per unit of output is essential for Asia and the Pacific. The examples of the top performers indicate that this may be an area for quick wins, but this will imply also targeting the harder to reach small and medium sized enterprises which often make up a large share of industrial energy consumption. As the building sector is the second most consuming sector (a bit less than 25 per cent of TFC), energy efficiency regulation for buildings should be another priority. Given the lifespan of buildings, strong building performance standards and building codes will lock in performance for decades. Notably space heating and cooling will be an important challenge across the region. The third priority is the transport sector due to its fast growth in the recent past, which will likely only increase with the demands of a growing middle class. Moreover, tightening energy efficiency regulations regularly is important to provide incentives for continual improvement. Law makers should look not only at regulatory breadth (covering as many sectors as possible) but also at regulatory depth (strengthening requirements to drive performance further). This requires a common measurement framework, including monitoring and enforcement of existing standards.

## REFERENCES

ADB (2013), Energy Outlook for Asia and the Pacific, Manila. Available from: https://www.adb.org/publications/energy-outlook-asia-and-pacific-2013

ESCAP (2017a), Asia-Pacific Progress in Sustainable Energy, Bangkok. Available from: http://www.unescap.org/publications/asia-pacific-progress-sustainable-energy-global-tracking-framework-2017-regional

ESCAP (2017b), Regional Cooperation for Sustainable Energy in Asia and the Pacific, Bangkok. Available from: http://www.unescap.org/publications/regional-cooperation-sustainable-energy-asia-and-pacific

IEA (2017a), World Energy Outlook 2017, Paris. Available from: http://www.iea.org/weo2017/

IEA (2017b), Energy Efficiency 2017, Paris. Available from: https://www.iea.org/efficiency/

# POLICY BRIEF #20

## ACHIEVING SDG 7 IN THE UNECE REGION (CENTRAL ASIA, EUROPE AND NORTH AMERICA)

### Developed by

United Nations Economic Commission for Europe (UNECE)

### In collaboration with

The European Commission, European Investment Bank (EIB), FIA Foundation for the Automobile and Society, International Renewable Energy Agency (IRENA)

## KEY MESSAGES

### Status and progress towards achieving SDG 7 in the UNECE region

- Attainment of SDG 7 is falling short in the UNECE region. While many of the energy challenges in this region are similar to those found elsewhere in the world, the region has specific climatic, economic, environmental and political circumstances leading in parts of the region to inefficient use of energy, power cuts, increasing energy costs, and unsustainable and unaffordable heating in winter.
- Some countries export large quantities of fossil fuels and feature some of the world's highest levels of energy intensity. Many countries in the region have national incomes dependent on fossil energy, and large numbers of people whose livelihoods depend on it, which has implications for attainment of SDG 7 across the region.
- The UNECE region has achieved 100 per cent access to electrical power networks and 98 per cent access to clean cooking fuels, but there are significant quality and affordability challenges. Access to distributed generation sources or to alternative energy networks must be considered. The rate of progress in improving energy intensity is insufficient to meet the 2030 goal. Improvements in energy intensity in the region recently have been around -2 per cent per annum since 2012, while a rate of -2.6 per cent is required (UNECE 2017a).
- Annual renewable energy investments in the region need to more than double to achieve the 2030 target. The UNECE region has an increasing share of renewable energy in TFC, but certain sub-regions have low and declining investment rates (REN21 UNECE 2017).

### Priority actions:

- Reflect the full costs of energy production and use in energy prices, including externalities such as proper pricing of greenhouse gases, to enable sustainable management of energy resources and accelerated uptake of energy efficiency and clean energy technology.
- Rationalize the use of energy subsidies to remove market distortions while protecting vulnerable groups. Focus subsidies on overcoming short-term obstacles for the commercialization of efficient technology that can deliver national energy goals.
- Reduce market barriers to sustainable energy technology.
- Explore ways for energy suppliers to sell energy services rather than energy products to accelerate energy efficiency uptake; promote the creation of strong energy services companies.
- Develop sustainable frameworks to promote investment in renewable energy.
- Improve understanding of the interplay among efficient distribution networks, flexible fossil fuel plants and variable renewables.
- Provide support mechanisms to reduce the carbon intensity of the energy sector through worldwide deployment of high-efficiency/low emissions technologies with carbon capture and storage. Deploy best practices for monitoring and abating methane emissions; endorse and deploy the "Zero Routine Flaring by 2030" Initiative.
- Deploy the Framework Guidelines for Energy Efficiency Standards in Buildings and accelerate development of smart energy systems (UNECE 2017b) Pursue minimum energy performance standards in all sectors including testing and labelling.
- Adopt the United Nations Framework Classification as a tool to for sustainable resource management.
- Use UNECE as a forum for exchange, as a space for policy dialogue, and as a facilitator. Its knowledge platform provides opportunities to share information on technology, market design, transition processes and efficient pathways.

### Energy Access

Although the region has achieved universal household electrification in terms of physical access, aging infrastructure, a lack of supply diversity and increasing tariffs lead to poor power quality and, for some, energy poverty. This situation is particularly acute during the cold winter months in the Northern hemisphere, and disproportionately affects poor and rural populations. As a result, some consumers have reverted to local sources of solid fuels for cooking and heating, and others to electricity with off-grid diesel generators.

Human comfort and safety depend on substantial heating services in most UNECE countries, a reality not reflected in the statistics on electricity network access. A significant challenge exists to upgrade older, uninsulated housing stock with locked-in fossil fuel dependence. Low-income households throughout the UNECE region make trade-offs between heat, food, and other needs. A measurable proportion of households spend more than 10 per cent of their income on energy. Addressing greenhouse gas (GHG) emissions without improving energy efficiency would worsen energy poverty.

The region achieved 98 per cent access to clean fuels and technology for cooking in 2014, up from 95 per cent in 2000, but 23.3 million people[1] in remote regions still relied on traditional fuels for cooking in 2014. They mostly live in remote regions, and rely on locally-gathered firewood. The fuel typically is burnt in a controlled combustion wood stove or a traditional high mass combined space heater and/or cooking oven. Traditional stoves offer users reliable heat from low or no-cost local resources at reasonable efficiencies and are therefore a preferred option in situations where access to commercial energy sources is impractical or expensive.

### Energy Efficiency

The region reduced its energy intensity from 2012-14 by -2.0 per cent per annum, just below the global rate. Improving conversion efficiencies in fossil fuel power generation reduces inputs and emissions related to producing the same electrical output. In the UNECE region, average fossil fuel power plant efficiency improved from 36 per cent in 1990 to 41 per cent in 2014 mostly as a consequence of investment in high efficiency combined cycle gas-fired power plants (UNECE 2017a).

Most countries in the region have developed National Energy Efficiency Action Plans but there has been limited progress in improving energy efficiency. Improving building energy performance is slow, though there has been solid appliance efficiency progress in North America and the European Union. A largely untapped potential for improving industry energy productivity exists across the region. With the exception of the member countries of the European Union, vehicle fuel economy is not progressing.

### Renewable Energy

The UNECE region was the only region in the United Nations system to increase the share of renewable energy in TFC from 2012 to 2014 to 11 per cent (UNECE 2017a).. This outcome was driven by strong support mechanisms and increased application of market-based approaches, such as auctions, decreased installation costs, and increased awareness of the economics of renewable energy. The region is committed to further development of renewable energy based on cost-effective application of market-based approaches (dena 2017).

For the UNECE region as a whole, renewable energy from wind, solar, and geothermal accounted for only 1.6 per cent of TPES in 2014. If hydropower, biofuels and waste are included, this figure rises to 9 per cent, compared to a global share of 14 per cent. The numbers show that modern renewable energies are still lagging. Solar and wind power had a share of 2.1 per cent in TPES in Western and Central Europe, the highest share among UNECE sub-regions (UNECE 2017a).

## Policy Implications

There is no common view in the UNECE region of what sustainable energy is or how to attain it. Apart from the global challenges regarding the implementation of the 2030 Agenda and other pledges that countries have made, countries in the UNECE have divergent economic development, resource availability and energy mixes embedded in their national energy strategies. As a consequence, multiple national approaches and outcomes can be found. Choices must be economically and socially rational for each country and made in the broader context of the economy as a whole. The objective of integration of energy with other goals should be to enhance quality of life.

Existing infrastructure, including the physical, regulatory, policy, and organizational infrastructure of the energy industry, is shaping policy approaches and national energy decision making. There is evidence in the UNECE region of challenges in heating service affordability, reliability of aging systems and future resilience needs. Truly transforming the energy system will require a creative shift in policy and regulation to unleash innovation, investment, and improved energy productivity. Yet, in many countries in the region, the current political, regulatory, and industrial infrastructure is not yet ready for such a transformation as the existing energy system and players are broadly committed to current business models and approaches.

[1] 12 million from Southeast Europe, 2 million from Caucasus, 8 million from Central Asia (excluding Turkey), and 1.4 million from Eastern Europe (excluding Israel which has 100 per cent access rates) (see UNECE 2017).

### Challenges for the UNECE region

**Energy security concerns** These concerns impede improvements in technical, environmental, and economic efficiency, but can be interpreted in different ways. Some countries and sub-regions seek to promote energy independence or self-sufficiency while others strive for efficient integration of energy markets. Promoting mutually beneficial economic interdependence would accelerate attainment of the 2030 Agenda through integrative, nexus solutions that the notion of sustainable development offers. For energy, it is critical to think in terms of a wholly interconnected, complex system in which supply, demand, conversation, transport and transmission interact freely and flexibly.

**Fossil fuel dependency** Fossil fuels dominate the region's energy mix and underpin today's energy access and economic development. The locked-in dependency on fossil fuels is neglected in conversations about energy efficiency and renewable energy, which slows attainment of objectives. The TPES of UNECE countries is just over 80 per cent fossil energy. Less than half the fossil energy used to generate electricity is converted to usable energy, with the remainder lost during conversion. Even under a climate change scenario that meets a 2°C target, fossil energy will still represent a significant share of the energy mix in the region in 2050. The underlying tension between achieving SDG 7 and the impact on other SDGs is immediately apparent.

**Climate commitments** Given the region's dependence on fossil fuels, meeting the 2030 Agenda's climate objectives must be integrated with the remainder of the agenda to achieve the aspired decarbonization of the future energy system. Integrated solutions require clear understanding of the climate-related impacts of energy in connection with the development-related opportunities that energy represents. The two most relevant GHGs from the energy sector are carbon dioxide ($CO_2$), mainly from the combustion of fossil fuels, and methane ($CH_4$) emissions along the coal and gas value chains. The UNECE region is falling short on the relevant indicators for these emissions.

**Constrained optionality** Certain energy technologies (for example, carbon capture and storage, shale gas, investing in high efficiency low emission (HELE) technology, or nuclear power) are excluded in the formulation of some national sustainable energy strategies for reasons of public perception, politics, or imposed market distortions. There should be ways to discuss these options openly as they might offer options, particularly for a transition period, to improve the potential to meet the 2030 Agenda.

**Energy as a service, not energy as a commodity** The energy industry has succeeded in raising the quality of life around the world, most notably in the advanced economies but even in the developing world. The energy industry today is a commodity business, in which players earn returns by producing and selling more. And yet in some areas consumer energy services are inadequate. There is evidence in the UNECE region of challenges in energy efficiency, energy access, heating service affordability, reliability of aging systems and future resilience needs. What is needed for true sustainability is to re-conceive the energy industry as a complex of service industries. Such a reconfiguration would unleash innovation, investment, and improved energy productivity, as consumer needs rather than volume efficiency would be the driving force.

### Equitable access to modern energy services requires mobilizing adequate resources.

Ensuring physical and economic access to quality energy services requires investment throughout the energy value chain, from primary energy development to end use. Enabling investment requires that governments have long-term visions for providing sustainable energy services, and that they promulgate sustainable policies and regulations that allow producers and consumers to respond to a dynamically changing energy market. Such a vision should include provision of access to modern energy services for vulnerable groups as part of national poverty reduction strategies and social development policy.

### Improving energy efficiency is one of the most cost-effective options for meeting growing energy demand in most countries

Significant potential for improving energy efficiency exists in the UNECE region, but attempts to improve energy efficiency often fall short because of flawed national policy frameworks: policies that artificially lower energy prices encourage wasteful consumption; production and consumption subsidies distort markets; housing stocks are poorly managed; land use management is inefficient; new participants face barriers to entry; there are inadequate norms and standards; and the statistics and information to manage energy use and track progress are incomplete. In addition, there is often a lack of public awareness and education about the long-term economic and social benefits of action to improve energy efficiency and productivity.

### Renewable energy policies need to be redesigned

Renewable energy resources are gradually becoming cost-competitive in comparison to conventional resources. They offer a way to reduce the net carbon intensity of the energy sector, improve energy security, and encourage economic development. Integrating renewables into the global energy mix will be important as future energy systems are optimized both on- and off-grid. However, wider uptake of renewables requires addressing barriers to fair competition vis-à-vis conventional technology, without resorting to long-term subsidies, implementing stable long-term energy policy frameworks in a future energy system context, and deploying

innovative and targeted financial mechanisms. Policies should be designed in light of the economic circumstances (including existing infrastructure) and development challenges of countries with renewable energy potential.

## REFERENCES

Dena (Deutsche Energie-Agentur) (2017), "Status and perspectives for renewable energy development in the UNECE region", Berlin. Available online at: https://shop.dena.de/fileadmin/denashop/media/Downloads_Dateien/erneuerbare/9251_Status_and_perspectives_for_renewable_energy_development_in_the_UNECE_region.pdf

UNECE (United Nations Economic Commission for Europe) (2017a), "Global Tracking Framework: UNECE Progress in Sustainable Energy", UNECE Energy Series No. 49, 2017, United Nations, New York and Geneva, available online at: http://www.unece.org/fileadmin/DAM/energy/images/CSE/publications/Global_Tracking_Framework_-_UNECE_Progress_in_Sustainable_Energy.pdf

UNECE (2017b), "Framework guidelines for energy efficiency standards in buildings", ECE/ENERGY/GE.6/2017/4 , Geneva, available online at: http://www.unece.org/fileadmin/DAM/energy/se/pdfs/geee/geee4_Oct2017/ECE_ENERGY_GE.6_2017_4_EEBuildingGuidelines_final.pdf

REN21 (Renewable Energy Policy Network for the 21st century) and UNECE (2017), "UNECE Renewable Energy Status Report 2017", Paris, available online at:

UN Regional Commissions (2015),: "Joint Statement of the Executive Secretaries of the United Nations Regional Commissions for the 5th International Forum on Energy for Sustainable Development", Forum outcome document signed in Hammamet, Tunisia, 4-7 November 2014, available online at: http://www.unece.org/fileadmin/DAM/energy/se/pdfs/ee21/Forum_November_Tunisia/Joint_Statement_Fifth_International_Forum_Final_All.pdf

Ministers (2017), "Ministerial Statement of the 8th International Forum on Energy for Sustainable Development", Ministerial Declaration at the 8th International Forum on Energy for Sustainable Development, Astana, available online at: http://www.unece.org/fileadmin/DAM/energy/se/pp/eneff/8th_IFESD_Astana_2017/MinisterialStatment.pdf and http://www.unece.org/fileadmin/DAM/energy/se/pp/eneff/8th_IFESD_Astana_2017/ImplementingTheAstanaMinisterialDeclaration.pdf

# POLICY BRIEF #21

## ACHIEVING SDG 7 IN LATIN AMERICA AND THE CARIBBEAN

**Developed by**

United Nations Economic Commission for Latin America and the Caribbean (UNECLAC)

**In collaboration with**

IDB, FIA Foundation, IRENA and Federal University of Rio de Janeiro

## KEY MESSAGES

### Status in Latin American and the Caribbean and progress towards achieving SDG 7

- If recent trends continue, the energy goals set for 2030 are unlikely to be met, except in the case of access to electricity. Countries vary greatly in terms of how far they are from attaining the targets, and efforts will need to be concentrated more on those with the furthest to go.
- The number of people without access to electricity fell from 44 million in 2000 to 18 million in 2014. In urban areas, coverage in 2014 was 99 per cent while in rural areas it reached over 88 per cent. If current growth rates are maintained and if additional resources are provided for the countries with the largest deficits (Haiti, Nicaragua, Guatemala, Honduras, Bolivia, and Guyana), the target could be attained by 2030.
- Access to modern energy sources for cooking has been improving, and was up to 86.5 per cent in 2014, but over 84 million people still lacked access as of 2014. Annual rates of expansion have declined in recent years, and at current rates of progress (roughly 0.5 per cent per year), the SDG 7 target is unachievable.
- The Latin America and the Caribbean region has the lowest energy intensity in the world. However, it also has the lowest annual rates of improvement (approximately 0.5 per cent per year on average between 1990 and 2010). Although the energy intensity indicator has been trending down, driven mainly by efficiency gains in the industrial sector, at the pace of progress (which dropped to 0.3 per cent between 2012 and 2014) it will be impossible to achieve the target set for 2030.
- Renewable energy sources are widely used in the region, representing 27.2 per cent of total final energy consumption (TFC) in 2014; modern renewable energies represented 22.9 per cent of TFC in 2014. There has been a slight downward trend in both indicators, which could be reversed with more non-conventional renewable energy and hydroelectric plants, and stronger policies for sustainable use of firewood.

### Priority actions

- Generate suitable institutional and regulatory frameworks for attracting the investment needed to universalize access to electricity and develop human and organizational capacities to distribute it efficiently. To reduce costs for low-income households, introduce social rates, energy efficiency programmes and carefully targeted subsidies.
- Implement government policies that encourage the development of renewable energies, and are sustainable over time.
- Mainstream non-conventional renewable energy technologies such as wind and solar in policies, programmes and projects to improve energy access, particularly in rural areas, with clear rules and transparent procedures to attract the large-scale investments needed.
- Intensify national programmes to promote the use of efficient and clean wood-burning stoves, with emphasis on environmental care, protection of people's health and respect for the socio-cultural contexts in which families live their lives. Promote the gradual replacement of traditional biomass fuels for cooking and heating with modern energy sources.
- Strengthen the institutional and regulatory frameworks for energy efficiency and boost national capacities regarding statistical information and indicators.
- Draw up national energy efficiency plans that define targets and instruments, and provide the resources needed to implement them.
- Promote greater rationalization of the transport sector, incorporating cleaner and more efficient technologies, multimodality and greater use of renewable energies.

## Access to electricity and the Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a global call to action to adopt measures aimed at ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity. Energy plays a key role in nearly all the major challenges and opportunities facing the world today. Consequently, for these objectives to be achievable and for the world to develop in a sustainable manner, it will be necessary to ensure access to affordable, reliable, sustainable and modern energy services, while reducing greenhouse gas emissions and the carbon footprint of the energy sector. It is for this reason that SDG 7 defined a set of energy targets for 2030, which represent an important step in efforts by the United Nations to focus on social, environmental, economic and regulatory challenges, which are related both to each other and to the production, distribution and access to services that depend on energy supply.

Access to clean, modern and sustainable energy is crucial for promoting improvements in people's health, the production of goods and services, employment, security, climate change and household livelihoods. In this connection, there is increasing evidence linking socioeconomic benefits with access to a reliable and affordable electricity supply. Electric power provides lighting, heating, cooling, motive power and transportation, among other services. Thanks to the modernization of these services and their availability to all people, especially the poor, new employment and income opportunities are generated, the quality of education and health services is improved, agriculture systems become more productive, and poverty is alleviated.

Similarly, the sustained adoption of clean and affordable energy sources for cooking can improve the wellbeing of millions of people, reducing the harmful effects on health (particularly among women and children) caused by burning traditional solid fuels (such as firewood, charcoal or agricultural waste) for cooking in the home. Avoiding use of these fuels generates additional benefits by enabling savings in time that would otherwise be used in gathering or buying solid cooking fuels, thus allowing children to spend more time studying and enabling women to generate livelihoods and incomes through other productive activities.

It is universally acknowledged that current approaches to energy are not sustainable in economic, environmental or social terms, given world population growth and the burgeoning demand for energy services. Consequently, there is a need to move towards more sustainable energy systems, in which both the greater use of renewable energy and a significantly more efficient use of fossil fuel based energy sources have important roles to play and are not mutually exclusive. This means focusing the debate on the essential role of energy in the global sustainable development agenda, while at the same time emphasizing the need to protect the environment (paying special attention to the harmful environmental impact of conventional energy use) and promoting the conservation of non-renewable resources.

The promotion of energy efficiency cuts across the four dimensions of sustainability, since it positively impacts the productivity and competitiveness of economies, reduces investment needs in the energy industry, has positive effects on the external sector of a country's economy, makes supply more secure, reduces household energy bills, facilitates access to new and modern energy sources, promotes technological improvement, mitigates harmful effects on the environment and contributes to the conservation of non-renewable energy (thus increasing its future availability). As a result, greater energy efficiency has a positive impact on most SDGs.

### Access to Energy

In Latin America and the Caribbean, major efforts are being made to universalize access to electricity. The deficit has been reduced progressively (from 8.3 per cent in 2000 to 3 per cent in 2014); and, although most of the areas that are still without electricity are the hardest to reach (mainly in rural zones, which in 2014 had coverage of 89.6 per cent), the goal of extending coverage to 100 per cent of homes by 2030 could be achieved if current rates of expansion are maintained. Nonetheless, this encouraging prospect is marred by a significant lag in the Caribbean sub-region (81.9 per cent access as of 2014), where rates of increase in electricity coverage have faltered in recent years. The situation in Haiti (with 38 per cent coverage) largely explains the low level of this indicator for the Caribbean sub-region generally, since 6.5 million without access to electricity live in that country. Despite the enormous momentum that has been given to rural electrification over the last 25 years (an increase of more than 30 per cent), over 14 million rural inhabitants of Latin America and the Caribbean still had no electricity service in 2014. This deficit is explained by access difficulties and the higher costs of electrification in remote rural areas. ( IADB, 2014 )

In countries such as Guyana, Honduras and Nicaragua, where more than 10 per cent of the population does not have access to electricity, coverage has been expanding at annual rates above 1.3 per cent, so the goal will be achieved if the effort is maintained. The other countries with the largest coverage deficits (particularly Guatemala, Haiti and the Plurinational State of Bolivia) need to make additional efforts to attain rates close to 100 per cent by 2030. As a general conclusion, if efforts are targeted on countries with the least coverage, there is a reasonable chance that the region as a whole will achieve the target set in SDG 7 by 2030.

The indicator of access to modern energy sources for cooking has improved (from 78.1 per cent in 2000 to 86.5 per cent in 2014), driven by urbanization processes and the progressive replacement

of traditional solid fuels by liquefied petroleum gas (LPG), vigorous expansion of electricity and, in some countries, the intensive use of natural gas in domestic consumption. In recent years, however, annual rates of expansion have declined; and if these rates are maintained at their current values (roughly 0.5 per cent per year), the region will be unable to attain the target set in SDG 7 by 2030. There is also a larger deficit in Caribbean countries, although that sub-region is doing its utmost to close the gap, as shown in annual rates of coverage increase above those of Latin America and the Caribbean as a whole. As is the case with the region generally, however, the pace of expansion is slackening; but even if the current annual rates (approximately 0.6 per cent) were to be sustained, the sub-region would be a long way from attaining the relevant targets by 2030. ( OLADE, 2017)

The global figures on access to modern energy sources for cooking conceal great heterogeneity, with a large group of countries enjoying 100 per cent access or very close to that, alongside a group of countries in which less than half of their respective populations have access to these sources (Guatemala, Haiti, Honduras and Nicaragua). In general, the countries with the largest deficits are making strenuous efforts to close the gap, as exemplified by El Salvador, Paraguay and Peru, which have annual average growth rates above 1.6 per cent. (IEA, 2017) Nonetheless, countries that start from very low levels will be unable to meet the established targets even if their rates of expansion double. Here again, the situation in Haiti deserves special consideration (only 9 per cent access). The very poor socioeconomic conditions in which the vast majority of the population lives means that firewood and charcoal are the main energy sources for cooking in nearly all households. In short, if the region as a whole is to attain the targets set in this area, a major additional effort will be needed; and this also includes addressing the socio-cultural issues present in several countries, which play a key role in maintaining the use of firewood as a cooking fuel.

### Energy efficiency

The Latin America and the Caribbean region has the lowest energy-intensity in the world, but also the lowest rates of improvement (approximately 0.5 per cent per year on average in 1990-2010). Although the energy-intensity indicator for the Caribbean is currently approaching the region-wide level, the sub-region started from a higher range of energy intensity, so its average annual rates of improvement have surpassed those of the region as a whole. Moderate rates of efficiency gain have been compounded by an actual decrease in efficiency levels in recent years, which dropped to around 0.3 per cent per year in the 2012-2014 biennium. (GTF, 2017)

Improvements in energy efficiency in the region have essentially been achieved by reducing the use of firewood and replacing it with more efficient sources such as gas, supported by a vigorous expansion of electricity and the adoption of energy efficiency programmes, with the industrial sector contributing the most to reducing energy intensity. The efficiency of electric power generation has increased significantly from 33 per cent in 1990 to 40 per cent in 2014, thanks to major increases in the thermal efficiency of natural gas-fired power generation and, to a lesser extent, coal and oil-fired thermal power plants. Against this, electricity and gas transmission and distribution losses remain at relatively high levels.

If the faltering trend in the global rate of improvement in energy efficiency is not reversed, the region will be unable to achieve the target of doubling the average value recorded in 1990-2010. Thus, achieving this target poses a major challenge for the region, since energy intensity must not be reduced at the expense of people's quality of life or the productivity of economic sectors. Energy efficiency must play a leading role, by helping to decouple economic growth from energy consumption and raising population comfort levels, with the minimum possible energy consumption.

### Renewable energy

The region's large share of renewable sources (27.2 per cent) in its total final energy consumption places it well above the world average (17.3 per cent as of 2014). This significant share of renewables is mainly due to the traditionally dynamic development of hydropower in the region, in conjunction with the vigorous programme to promote the use of biofuels implemented in several countries, and abundant forestry resources (which explain the high rate of consumption of modern and traditional solid biofuels). If the analysis is limited to modern renewable energies, the region is ranked first worldwide, with a 22.9 per cent share as of 2014. The Caribbean subregion's use of modern renewable energies is well below the regional average; but it is encouraging to note that many Caribbean countries are promoting greater use of renewables, owing to their multiple economic advantages, protection of the ecosystem, modernization of the sector and the benefits in terms of supply resilience offered by the new technologies. (ECLAC, 2017)

Notwithstanding these auspicious figures, the trend of the respective shares has been slightly downward in recent years. One of the causes of this trend, which is also evident in the other developing regions, is the substitution of traditional biomass consumption for modern fuels (such as gas), in both residential and industrial uses. The most recent data reflect great momentum in the development of non-conventional renewable energies and also hydroelectric sources, which suggest that this trend can be reversed in the short term. Based on the above and given the qualitative specification of the SDG target for this area, the region faces the challenge of reversing the downward trend, aiming to raise the overall share of renewables above 30 per cent and continuing to expand the use of modern renewable energy sources.

## Policy implications/recommendations

The results presented here constitute a wake-up call to redouble efforts on several fronts, including an increase in funding, bolder policy commitments and a willingness to adopt new technologies on a broader scale. The great heterogeneity among the countries of the region in energy matters implies the search must be for solutions that are appropriate to the specifics of each case, depending on their socioeconomic characteristics, the degree of development of their energy infrastructure, and the geographical conditions and the technologies available to address the challenges facing their energy systems. Nonetheless, a number of general energy policy guidelines can be identified that are appropriate to the situation of most countries.

The bulk of the electricity access deficit is found in the poorest settlements and remote places that are difficult to reach and where new connections are generally more expensive. Achieving universal access to electricity will require a major and permanent flow of economic resources from either public or private funds, from multilateral banks or from international cooperation. To enable this, it is crucial that the respective governments put appropriate institutional and regulatory frameworks in place and develop human and organizational capacities to make sure the resources in question are allocated efficiently. The mainstreaming of non-conventional renewable energy technologies in policies, programmes and projects for energy access, particularly in rural areas, are playing an important role in the process of expanding electricity coverage; everything suggests that this should be intensified. An approach that combines the development of rural electrification with the general provision of educational and health services as part of an integrated SDG agenda can help give the final push in this area.

In general, the region has challenges in terms of the affordability and quality of the electricity service. The heavy burden of energy bills relative to income among the most vulnerable sectors of the population requires specific policies for these sectors. These should include a wide range of instruments that enable low-income households to access electricity consumption under advantageous conditions—such as the introduction of social rates, promotion of energy efficiency both to improve housing conditions and to make it easier to acquire efficient electrical equipment, and programmes to regularize illegal connections.

Efficient resource allocation requires moving towards convergence between energy prices and production costs. The use of subsidies as public policy instruments must be done through mechanisms that ensure they benefit the target populations. Such targeting determines not only the potential impact on poor households, but also possibilities for reasonably limiting the consumption-decision distortions that stem from subsidies, and for redirecting resources to other priority uses.

Policies implemented in the last few years have contributed to the formation of more renewable power generation mixes, through the development of large-scale hydroelectric projects and the incorporation of non-conventional renewables such as wind and solar energy. To achieve the desired results, it is imperative that these policies be made sustainable through time, by becoming consolidated. In addition, stable institutional and regulatory frameworks will be needed, with clear rules and transparent procedures, to attract the large-scale investments (both public and private) needed to increase the share of renewable energy sources. The transport sector offers great opportunities for increasing the use of renewables. A comprehensive approach to the problem could yield major benefits for sustainable development.

Everything indicates that traditional biomass will continue to play a prominent role for cooking and heating in several countries of the region. In this context, and alongside efforts to continue improving access to modern energy sources for cooking, the implementation of national programmes to promote the use of efficient and clean wood-burning stoves should be intensified, with emphasis on environmental care, protection of people's health and respect for the socio-cultural contexts in which families live their lives. Experience shows that the programmes that are most likely to succeed are those that encourage direct and conscious participation by the beneficiaries, rely on the communities' technical skills and stimulate the innovative capacity of their organizations, and mainstream gender in the processes of developing, designing and implementing technology.

To be able to develop energy efficiency, countries need consolidated regulatory and organizational frameworks, trained technical teams and well-oiled and robust funding mechanisms that enable them to sustain their activities through time. Only in this context can energy efficiency become a permanent component of energy policies and form a substantial part of energy-sector planning.

The region has significant experience in the development of energy-efficiency programmes and projects, and also in the implementation of technical standards. Nonetheless, the lack of a comprehensive approach to the issue often results in inefficiencies and the squandering of resources. In this situation, national energy efficiency plans that set targets and provide instruments to attain them can help break down the barriers to such an approach and boost the development of market mechanisms that facilitate private-sector participation—through energy service companies (ESCOs) for example.

Adequate monitoring of such plans requires a sound base of energy statistics and a set of specific and methodologically consistent

indicators. It would be useful to improve and expand data collection and processing and develop useful-energy balances to facilitate the evaluation of the programmes.

It is crucial to boost the development of energy efficiency standards for electrical equipment and appliances, with the aim of generating energy labelling systems that inform users and thus encourage rational purchase decisions. Similarly, minimum energy-efficiency standards need to be promoted, to gradually eliminate the least energy-efficient equipment and appliances from the market.

## REFERENCES

ECLAC (Economic Commission for Latin America and the Caribbean) (2017), Avances en materia de energías sostenibles en América Latina y el Caribe. Resultados del Marco de Seguimiento Mundial, informe de 2017, LC/TS.2017/119, Santiago, Chile.

IADB (2014), Study on the Development of the Renewable Energy Market in Latin America and, the Caribbean. OVE/WP-02/14, September 2014

IEA (2017), Energy Access Outlook 2017

IEA & WORLD BANK (2017), "Global Tracking Framework: Progress Towards Sustainable Energy—GTF 2017"

IRENA (2017), Renewable Energy Statistics

OLADE (Latinamerican Energy Organization) (2017), Anuario Estadísticas Energéticas 2017

# POLICY BRIEF #22

## ACHIEVING SDG 7 IN ARAB REGION

**Developed by**

United Nations Economic and Social Commission for West Asia (UNESCWA)

**In collaboration with**

FIA Foundation and IRENA

## KEY MESSAGES

### Status of the Arab region and progress towards achieving SDG 7

- The development of sustainable energy systems is a crucial priority for all economies across the Arab region, especially to meet the expectations of their overwhelmingly young populations for economic opportunities and improving living standards.
- Overall, access to electricity is close to universal in cities across the Arab region but remains fixed at approximately 80 per cent in rural areas, with a total of around 36 million people lacking access to electricity in 2014. Planned and unplanned service disruptions in many countries in the region are a challenge for electricity users, irrespective of the urban–rural divide or income disparities. In some areas, war, regional instability and mass migration also present significant challenges in providing energy access to millions of people.
- Overall, the share of the Arab region's population using clean cooking fuels and technologies has risen continuously since the 2000s, and stood at 88 per cent in 2014, with intra-regional differences ranging from close to 100 per cent access in the Gulf Cooperation Council (GCC) economies and the Mashreq, to less than 40 per cent in the Arab LDCs.
- While the Arab region has historically not been one of the most energy-intensive regions in the world, it has been the only one to have no reduction in its energy intensity over the past 25 years, while energy consumption has more than doubled since 1990. Residential and service sectors combined accounted for at least two-thirds of total annual electricity consumption in the region, of which around 73 per cent was consumed by the residential sector alone. A recent study by the World Bank estimated the potential savings from energy efficiency at 21 per cent of projected TPES in the Middle East and North African countries by 2025.
- Despite a considerable potential for use of modern renewable energy technologies, such as wind and solar power, renewable energy still plays a marginal role in most Arab countries, at 4 per cent of TFC in 2014, including biomass. Its overall low contribution to the energy mix reflects the region's globally unparalleled reliance on non-renewable sources. However, over two-thirds of the region's consumption of renewable energy is based on biomass, accounted for by a small number of countries whose primarily rural populations continue to use biomass.

### Priority actions

- Develop and implement suitable policies and institutional frameworks to boost energy efficiency measures and practices, and to address the various barriers preventing progress in energy efficiency and renewable energy deployment, including inadequate market and energy pricing incentives.
- Build institutional capacity, transparency and accountability, monitoring and data collection systems, dissemination and information-sharing between institutions and a stronger role for science and research.
- Strengthen local governance and communication between government, financial institutions and the public and private sectors, and reinforce the role of civil society and stakeholder engagement.
- Enforce proactive and integrated policies that manage natural resources more sustainably, especially the water-energy-food nexus.
- Develop a more rational use of the region's fossil fuel resources by boosting their productivity and optimizing their inputs into the energy mix in conjunction with renewable energy.

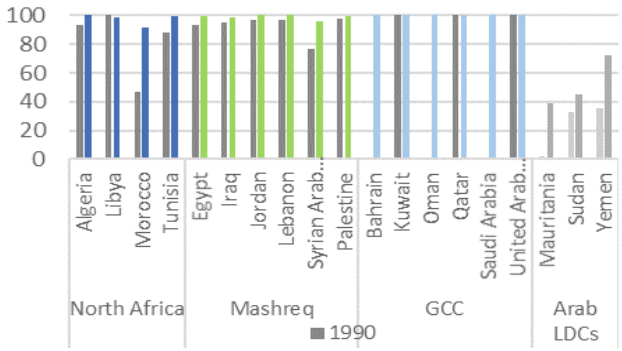
Enhance interregional Arab cooperation and trade and develop local manufacturing of renewable energy technologies components.

## Energy Access

Access to electricity, as well as to clean cooking fuels and technologies, is now near-universal in North Africa, the Mashreq and the Gulf Cooperation Council[1] —an impressive achievement, allowing the Arab region to stand out from other regions with a high share of developing economies.

Figure 22.1

**Share of population with electricity access in the Arab region, 1990 and 2014 ( per cent)[2]**




Despite very positive developments in electricity access since the 1990s, some significant gaps in access to energy remain in the Arab region. Overall, access to electricity is close to universal in cities across the Arab region but remains fixed at approximately 80 per cent in rural areas, with a total of around 36 million Arabs who did not have any access to electricity in 2014, primarily in the Arab LDCs, and small numbers of people without electricity access in North Africa and the Mashreq.[3]

Planned and unplanned service disruptions, on the other hand, are a challenge for electricity users, irrespective of the urban–rural divide or indeed income divide.

War and regional instability present the Arab region with the separate challenge of supplying modern energy access—among other essential services—to a rapidly increasing number of people, with highly detrimental effects on energy access and the environment. Mass migration imposes tremendous material and logistical challenges for host countries and communities, while it deprives millions of refugees of secure access to energy, in addition to other essential services such as clean water, sewerage, food and health care.

Through its multifaceted links to different fields of socioeconomic development, the lack of access to energy is a major stumbling block for national development efforts in the Arab LDCs.

Access to other energy services is also essential to support health, education, water and other infrastructure facilities, and to power economic activities, including agriculture in rural areas.

Access to these other energy services to meet other basic human needs should be the focus of the next steps of insuring universal energy access.

One of the key challenges the Arab region faces as a whole is whether primary energy and electricity should remain what has been effectively a "public good" supplied at low cost by the State to all of its citizens, or whether the region's emerging economies will need to redefine the way energy is used and supplied within their domestic markets, based on a system that reflects the real costs, but at the same time protects the most vulnerable segments of society and includes mitigation measures for those with low to medium amounts of income.

### Energy Efficiency

While the Arab region has historically not been one of the most energy-intensive regions in the world, it has been the only one to achieve no decrease in its energy intensity over the past 25 years.[4]

Reductions in energy intensity in the Arab region have lagged significantly behind those in other regions. Between 2000 and 2014, global energy intensity fell by around 1 per cent annually, 2 per cent per year since 2010, while the average intensity in Arab countries rose by around 1 per cent during the 2000s and has since been largely stagnant.[5]

Energy intensity rates differ considerably across the Arab region. Energy net exporters drive the regional trend in rising energy intensity, having based their historical industrial growth on fossil fuels and energy-intensive industries. Net energy importers have seen fairly low and falling energy-intensity rates.

[1] The Arab region here includes North Africa (Algeria, Morocco, Libya, Tunisia) Mashreq (Egypt, Iraq, Jordan, Lebanon, Palestine, Syria), GCC (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates), LDC (Mauritania, Sudan and Yemen).

[2] World Bank (2017): Global Tracking Framework 2017: Progress Towards Sustainable Energy

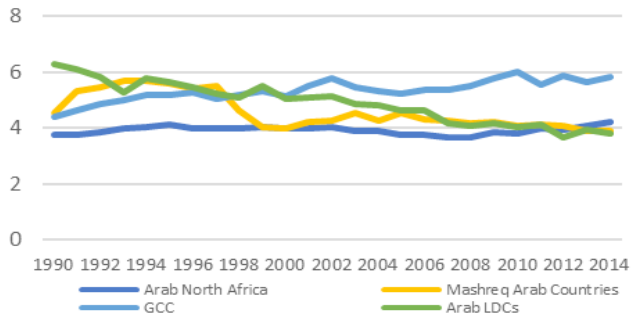
[3] UN ESCWA (2017) Arab Region Progress in Sustainable Energy—Global Tracking Framework Regional Report

[4] UN ESCWA (2017) Arab Region Progress in Sustainable Energy—Global Tracking Framework Regional Report

[5] World Bank (2017): Global Tracking Framework 2017: Progress Towards Sustainable Energy

Figure 22.2

**Energy intensity in the Arab region by sub region, 1990–2014 (MJ/2011 PPP US$)[6]**




Taking the region's aggregate data, we see a moderate trend in more recent years towards falling energy-intensity levels in agriculture and transport, with declining intensity rates in industry in some economies. Transport remains by far the most energy-intensive sector in the Arab region, however, followed by industry and agriculture.

On a regional aggregate level, transport is more fuel-intensive than in any other region of the world reflecting on the one hand the increasing mobility of many Arab economies' populations, along with progress in a number of social development indicators, such as access to education and health care, and rising income levels. On the other hand, many Arab countries' socioeconomic development models have been built around the concept of cheap, personal transport, with a significant lag in the availability of public transport systems, which are inadequate in many Arab cities, suburbs and the countryside. In addition, a significant number of the road transport vehicles, whether for passengers or freight, are in aging fleets, which contributes to worsening energy performance in this sector. Policy priority should focus on promoting public transport with cleaner energy sources and stringent rules about pollutant emissions from all types of vehicles. A comprehensive review and redesign of the transportation system in each Arab country may be needed to properly address this sector.

Residential and service sectors account for a growing share of the Arab region's energy consumption. They are both large final user groups of electricity, which makes them important driving forces behind electricity demand, in addition to the demand from related sectors that consume primary energy and electricity, water and food. The two sectors combined accounted for at least two-thirds of total annual electricity consumption in the region, of which around 73 per cent was consumed by the residential sector alone.[7] Furthermore, all forecasts indicate that electricity demand in these two sectors is set to rise considerably in the near future. Rising pressure for food production has also driven significant efforts to increase the energy efficiency of the agricultural sector. The dispersed nature of agriculture, with many small farms spread across geographic conditions and outside the reach of centralized urban policymaking and legislation, complicates the implementation of energy-efficiency measures in agriculture, while most financial markets in the Arab region lack financial products particularly suited to the needs of farmers.

Very low, subsidized prices for energy, electricity and water, combined with a lack of energy-efficiency regulations in different economic sectors, have resulted in large increases in per capita water and electricity consumption over time throughout the Arab region.

Where economies and living standards have been growing, market incentives to conserve energy have been lagging significantly behind. Measures that help increase energy efficiency and therefore energy productivity, particularly on the regulatory side, have in many parts of the Arab region been sketchy and piecemeal. Even in high-income countries in the Arab region, policy focus and hands-on reform efforts differ markedly between countries, with historical priority having been given to fast-rising development and quick improvements in living standards. The typical market structure of the energy industry in the Arab region further affects incentives for energy efficiency. In the absence of corrective measures, this will lead to a loss in revenues, slowing down of development efforts, increasing vulnerability to international energy price fluctuations and a weakened energy situation across the region.

A recent study from the World Bank estimates the potential for savings from energy efficiency at 21 per cent of projected total primary energy supply in Middle East and North African countries by 2025. Nearly three-quarters of these savings are from greater efficiency in end-use sectors, including industry, residential, commercial users, transport and public services.[8]

Therefore, there is a need to work towards a change of scale in achieving energy efficiency in the building sector (residential and non-residential) and appliances and commercial equipment. Earnestly, and rapidly, improving energy efficiency will increase energy productivity in the region and contribute to its economic and social development.

### Renewable Energy

Renewable energy is still a largely untapped resource in the Arab region, despite recent efforts in several Arab countries to boost renewable energy contributions in their energy mix. In 2014, renewable energy, including biomass, accounted for some 4 per cent of the region's final energy consumption, with similar trends

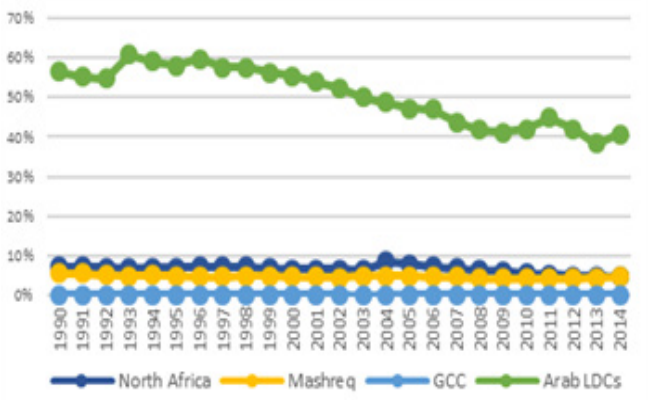
[6] World Bank (2017): Global Tracking Framework 2017: Progress Towards Sustainable Energy

[7] Based on published figures in the Statistical Bulletin of the Arab Union of Electricity, 25th issue—2016

[8] World Bank (2016): Delivering Energy Efficiency in the Middle East and North Africa

continuing up to now despite the implementation of successful renewable energy projects in some Arab countries. This contrasts with the considerable potential for renewable energy, in particular modern technologies such as wind and solar power, offered by the region's favourable geography and climate conditions.

**Figure 22.3: Share of renewable energy in total final energy consumption in the Arab region by sub-region 1990–2014[9]**




Over two-thirds of the region's consumption of renewable energy is based on biomass, accounted for by a small number of countries whose primarily rural populations continue to use biomass.

In most parts of the Arab region, conventional fossil fuels have for many decades underpinned the systematic expansion of modern energy access, leading to near-universal access rates of electricity and clean cooking fuels.

Some of the key challenges hindering more accelerated penetration of renewable energy include the absence of targeted policy initiatives, as well as the prevalence of state-owned energy utilities and widespread use of fossil-fuel subsidies, which have traditionally discouraged the use of new non-fossil fuel-based technologies. However, this rationale has started to change in recent years in some parts of the region. The share of modern renewable energy stabilized in 2012–14 and has since increased in several leading countries in the region. Renewable energy costs have been also falling dramatically, making investments, particularly in wind and solar power, more attractive, with some of the lowest auction results obtained in the region for solar PV, as well as competitive prices for wind technologies.

Although the Arab region is still at an early stage of investing in renewable energy technologies, there is potential for strong growth over the next decade, in particular for solar energy. Nonetheless, there are still policy and regulatory obstacles hindering a more accelerated deployment of renewable energy. On the other hand, new initiatives such as competitive auctions and public–private partnerships have been successfully implemented in several countries in the region, and hold considerable potential for the future of the energy sector. Such business models could be considered in other parts of the region.

While the Arab region's recent trend in solar and wind energy deployment is currently driven by only a few countries, more dedicated policies to establish these technologies could substantially increase their level of deployment over the coming decades. This includes allowing markets to establish a business case for alternative technologies. In a market that remains dominated by fossil fuels—more than any other region—this will require more systematic reform to open up utility sectors.

Also, many energy services can be directly provided by dedicated renewable energy (RE) systems, without the need for producing electricity as an intermediary step. Mature renewable energy solutions exist for thermal applications, whether for domestic, commercial, recreational, industrial or agricultural uses, and offer much more efficient solutions for providing these services than renewable energy electricity generation.

Grid-connected individual systems, mainly PV, can offer an immediate and cost-effective alternative for increasing power generation capacities in the Arab region. These types of systems can be deployed gradually, with a high participation from energy consumers in covering their costs, offering an additional relief to state budgets.

Micro-, mini- and off-grid renewable energy options can also offer a cost-effective alternative for improving access to energy services in remote areas.

Developing such renewable energy small-scale applications will require the implementation of enabling tools and measures, through specific and appropriate dissemination and financing mechanisms that need to be developed based on each country's conditions.

Enhancing regional integration, collaboration and trade among the Arab countries and take benefit of each country specific comparative advantage to develop local manufacturing of RE components which would boost deployment of RE in the energy mix.

### Interlinkages with other SDGs

"Energy is crucial for achieving almost all of the Sustainable Development Goals, from its role in the eradication of poverty through advancements in health, education, water supply and industrialization, to combating climate change."[10]

Progress in sustainable energy can no longer be seen as separate from other socioeconomic development goals in the Arab region.

[9] World Bank (2017): Global Tracking Framework 2017: Progress Towards Sustainable Energy

[10] Report of the Secretary General on Progress towards the Sustainable Development Goals, E/2016/75*

The fragile natural resource balance in many parts of the region, coupled with rapid and rising economic expectations by the region's young and increasingly educated populations, means that managing the natural assets of Arab countries has to take centre stage in ensuring that future generations can lead stable and successful lives.

Energy is crucially interconnected with a whole range of other factors for developmental success. It plays a major role in ensuring the security of water and food supplies, and in enabling key development goals such as universalizing access to modern health services and education, gender equality and women's empowerment, the creation of sustainable living spaces, technology innovation, and critical progress in mitigation of, and adaptation to, climate change.

## Policy implications and recommendations

Efficient natural resource governance and policy should play a pivotal role in driving the Arab region's energy transition. Existing market mechanisms provide insufficient incentives for a change in production and consumption patterns in the region. Future efficiency savings resulting from near-term policy changes can provide significant reductions in the rate of growth in energy demand, and near-term financial savings as well. Over the longer term, such changes can provide significant savings to national economies and reduction of deadweight loss to economies through resource waste.

### Initiating proactive policymaking approach towards sustainable energy in the Arab region

This could involve the following:

- **Strengthening the links between sustainable energy, environmental management, and social and economic development goals.** This includes a more rational use of the region's valuable fossil fuel resources, as well as exploitation of the economic potential of energy alternatives, in particular renewable energy, and reinforcement of legislative settings that promote sustainable consumption and production patterns.
- **Using innovative policy approaches**. The increased deployment of renewable energy in the Arab region in recent years illustrates the positive learning curve in Arab countries that have experienced positive progress in the deployment of renewables. Public–private partnerships in this context are becoming an increasingly attractive solution for Arab countries aiming to attract private finance for sustainable energy projects whilst retaining a public hand in energy projects.
- **Ensuring that new policies, plans and targets are stringent and mandatory**. This is of particular importance in contexts where various economic interests are involved, such as in regulatory efforts to improve energy efficiency.
- **Effective government communication and strategy-making**. Ultimately, the most effective way of promoting a positive energy transition is through the creation of complementary policies among different government bodies that integrate individual policy changes, such as in areas of regulation with a wider policy strategy that targets the most efficient use and management. Such policies are those which promote energy efficiency and renewable energy in the national interest, embracing new legislation and regulation from different ministries in coordination with each other, including by: identifying the full cost of a business-as-usual scenario; consulting rather than just informing; and using quantifiable goals and targets that help the public understand progress. A participatory approach involving all stakeholders implicated in each targeted area is a major condition for a successful implementation of the developed policies and regulations.
- **Building institutional capacity, transparency and accountability** requires: effective and credible institutions with sufficient access to information and data; skilled human resources and professionalization of the public sector; clear institutional mandates to design, implement and monitor policies; reinforced local governance and the role of cities; greater use of existing competence by strengthening of communication channels between government institutions, financial institutions and public and private companies; and strengthening civil society institutions that are able to communicate with their constituencies far more credibly than government institutions. These efforts will require the development of suitable institutional frameworks and effective implementation instruments with the mobilization of adequate financial and human resources necessary to reinforce, or create, the appropriate structures and meet the associated challenges.

### Restructuring domestic energy and water-pricing.

The Arab region's slowly changing pricing environment for energy may yet prove to be one of the most important structural drivers for a gradual improvement in energy efficiency. Wider energy and utility market regulation and liberalization remains one of the most important areas for further development in the Arab region over the coming decades. However, ongoing experiences show that it is highly recommended that the reforms be implemented gradually and accompanied by mitigating measures for the segments of society that will be negatively affected by these reforms, along with a well-designed communication campaign explaining the need for such price restructuring.

**Preparing financial markets.**

Access to finance is a key factor in determining market uptake of more sustainable energy technologies. Several financing solutions have been demonstrated to drive clean energy deployment in the Arab region, illustrating the diversity of options that can work in different circumstances. These include: microcredits for small-scale applications, especially in the off-grid segment; implementation of certain energy efficiency measures; international sources of funding, with an increase in initiatives linked to clean energy development in developing countries; and locally oriented, national policies and financial instruments specific to each individual country. Arab states may also need to review their existing instruments for implementing sustainable energy solutions and consider certain experiences in the region involving the development of public, or public-private partnership, structures with a certain *critical size*, allowing the mobilization of the required financial and human resources to manage the sustainable energy solutions implementation processes and meet associated challenges.

**Strengthening information quality and awareness-creation.**

Policy trends, and their macroeconomic, social and environmental impacts, need to be monitored through pertinent macro policy indicators that are based on reliable energy and socioeconomic data. These indicators are essential in evaluating the effectiveness of the designed policies at attaining the broad national goals set for the sustainable energy transition. In addition, access to information plays a pivotal role in government and business decisions to invest in and favour one technology over another and in guiding final consumer behaviour. Progress in improving information access in the Arab region will rely on a number of factors, including: data collection and dissemination; information-sharing between institutions; communicating with final consumers; re-prioritizing sustainable energy use and environmental consciousness in the public discourse; and a stronger role for science, research and Media and depoliticizing data.

In the longer term, achieving sustainable development goals, including in the area of energy, will require a degree of data dissemination and media reporting, empowering civil society members to present their interests and help governments to assess society's preferences.

## REFERENCES

UN ESCWA (2017) Arab Region Progress in Sustainable Energy—Global Tracking Framework Regional Report. https://www.unescwa.org/publications/gtf-regional-report-arab-region-progress-sustainable-energy

World Bank (2017): Global Tracking Framework 2017: Progress Towards Sustainable Energy. http://www.se4all.org/sites/default/files/eegp17- 01_gtf_full_report_final_for_web_posting_0402. pdf.

UN ESCWA (2015): Urbanization and Sustainable Development in the Arab Region, Social Development Bulletin, Vol. 5, No.4

https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/social-development-bulletin-urbanization-sustainable-development-arab-region-english.pdf

UN ESCWA (2015) Analysis of Energy Policy Trends in the Arab Region

https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/l1500568.pdf

UN Regional Commissions (2015): Joint Statement of the Executive Secretaries of the United Nations Regional Commissions for the 5th International Forum on Energy for Sustainable Development. Hammamet, Tunisia, 4-7 November 2014: http://css.escwa.org.lb/SDPD/3539/JointStatement.pdf

Report of the Secretary General on Progress towards the Sustainable Development Goals, E/2016/75*

https://unstats.un.org/sdgs/files/report/2016/secretary-general-sdg-report-2016--EN.pdf

Delivering Energy Efficiency in the Middle East and North Africa, World Bank (2016), http://documents.banquemondiale.org/curated/fr/642001476342367832/pdf/109023-WP-P148222-PUBLIC-DeliveringEEinMENAMayEN.pdf

# POLICY BRIEF #23

## ACHIEVING SDG 7 IN LDCS, LLDCS AND SIDS


### Developed by

Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and the Small Island Developing States (UN OHRLLS) and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)

### In collaboration with

UNCTAD, UNIDO, UNECA, UNECLAC, UNESCWA, IRENA and FIA Foundation

## KEY MESSAGES

### Status of LDCs, LLDCs and SIDS and progress towards achieving SDG 7

- LDCs, LLDCs and SIDS consist of 91 countries with a total population of about 1.1 billion. Access to energy in these vulnerable countries remains a major challenge.
- About half of the people in the world without electricity live in LDCs. In 2016, the proportion of the population in LDCs with access to electricity was 44.8 per cent. In LLDCs it was 53.1 per cent, and SIDS it was 76.3 per cent. This data hides disparities between countries and regions, as well as urban and rural areas, and some countries are trailing way behind, with an access rate as low as 7.6 per cent.
- Ending energy poverty in vulnerable countries and ensuring that no country or person is left behind has to become a priority for all stakeholders in order to achieve the 2030 Agenda.
- Each country's transition to a sustainable energy sector involves a unique mix of resource opportunities and challenges. National plans and policies should be designed for the particular needs and resources of each country, with a mix of grid, mini-grid and off-grid solutions.
- All vulnerable countries face inefficiencies in power utilities, which impact their operations and financial viability, and deter the private investments needed to improve generating capacity, and transmission and distributions systems.

### Priority actions

- To achieve the global goals on energy in LDCs, LLDCs and SIDS it will be essential to act fast to create enabling environments for private sector investment and to promote attractive project pipelines. This will require well-functioning institutions, and policy and regulatory reforms to help build credibility with investors and effectively scale up private investment, leveraging public resources for country-level implementation.
- Development Finance Institutions (DFIs) and development partners should increase the funding allocated to sustainable energy in LDCs, LLDCs and SIDS as this will have an impact across different sectors, including most of the SDGs, accelerating poverty eradication, structural transformation, and reducing vulnerability to fluctuating global energy prices.
- Moving a project from initial plan to bankable project requires significant time and human and capital resources (to prepare feasibility studies, environmental impact assessments, and permits). Vulnerable countries need more targeted support from their partners for project preparation to fast-track progress.
- Enhance integration of regional/cross border energy infrastructure and institutions to ensure economies of scale and lower the unit cost of energy generation.
- Create cross-sectoral linkages between sustainable energy and other development priorities (e.g., clean water, gender equality, improved education, access to healthcare, and climate change) to engage multi-stakeholder partnerships to support an energy transition, and to increase development finance flows that have the potential for higher impact and harmonized planning.
- Lack of maturity in energy access markets and underdeveloped financial markets in vulnerable countries mean that DFIs will have to play larger role in catalysing energy access investment in vulnerable countries.
- Ensure that the national energy policies take into consideration the energy demand profile of the poorest people, and ensure access to affordable energy. The positive development impacts of sustainable energy can be broadest by targeting the poorest people, who would normally not benefit from modern energy. The focus should not only be on promoting minimum access to households, but also on productive uses and economic development, with a gradual shift towards self-sustaining systems promoting economic development that is transformative and inclusive. These two different types of end-use demand are mutually supportive.

## Vulnerable Countries and the Sustainable Development Goals

### Electricity access and achieving SDG 7 in vulnerable countries

Sustainable energy,[1] encompassing its three dimensions of access, efficiency, and renewable energy, is a key development enabler for many SDGs. Despite the potential that sustainable energy has for development, many vulnerable countries, including the least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing states (SIDS), still face daunting challenges in achieving SDG 7.

Together the LDCs, LLDCs and SIDS consist of 91 countries with a total population of about 1.1 billion. Access to energy remains a major challenge for them. In 2016, the proportion of population with access to electricity in LDCs was 44.8 per cent; in LLDCs it was 53.1 per cent, and in SIDS it was 76.3 per cent. However, this data hides huge disparities between countries; some trail way behind with an access rate as low as 7.6 per cent. It is also important to stress that the portion of the population without electricity overlaps with the portion in acute poverty, as they are not able to utilize the benefits of modern energy to improve their health, education, income generation and overall social and economic development. Furthermore, there are wide disparities between urban and rural areas, with urban areas having access rates that are substantially higher than the rural areas.

The three groups of countries, LDCs, LLDCs and SIDS, all face a different set of energy challenges, and the progress achieved so far depends on which pillar—access, efficiency or renewables—is being measured. However, none of the vulnerable countries can afford to focus on only one of the pillars; all three areas must be pursued at once to achieve accelerated energy transition.

This policy brief will identify how vulnerable countries are progressing towards achieving SDG 7 and what is needed to accelerate their energy transition.

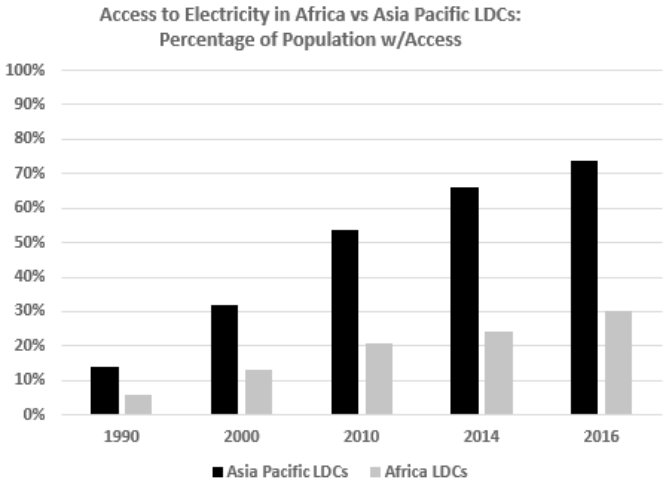
### Current energy access status and main challenges in LDCs, LLDCs and SIDS

The 47 least developed countries (LDCs) represent the poorest and weakest segment of the international community and thus are the battleground on which the 2030 Agenda will be won or lost. The LDCs have a long way to go to achieve universal access to modern energy by 2030. While the average global electrification rate reached 87.4 per cent in 2016, the average access to electricity across LDCs hovered as low as 44.8 per cent, and 540.9 million of the world's 1 billion people without electricity live in LDCs. There has been progress in LDCs in recent years, but while access to electricity increased faster between 2000 and 2016 than in the previous decade, the expansion rate is still far from what is needed to achieve universal energy access by 2030. Expanding access has been hindered by high connection costs, unreliable or unavailable grid electricity, low population density (especially in rural areas), high leakage rates, high operational costs that pose challenges for utilities and consumers ability to pay, low demand from productive users, and lack of investment.

The electricity access situation in the LDCs also varies by region. In 2016, the Asia Pacific LDCs reached an average electrification rate of 73.6 per cent, while the rate in African LDCs was much lower at 30 per cent (as shown in the figure 23.1). Among the Asia Pacific LDCs, expansion of electrification and deployment of renewable energy systems in Bhutan, Tuvalu, Afghanistan, Cambodia, Nepal, and Lao People's Democratic Republic have led to notable expansion of access. In some LDCs where significant gains have been made, government engagement and buy-in have been driving forces.

Figure 23.1

**Access to Electricity in Africa v. Asia LDCs: Percentage of Population w/Access**




Within the LDCs, access to electricity tends to be far greater in urban areas than in rural areas. In 2016, on average, 75 per cent of the urban population had electricity access, compared with only 31 per cent of rural populations, and access is expanding only slightly

[1] The term sustainable energy in this policy brief encompasses access to three forms of energy, each of which provides distinct but essential benefits for economic and social development: less polluting household energy for cooking and heating, including from improved cookstoves with traditional solid biomass fuels, from liquid and gaseous fuels such as kerosene and LPG, or energy from renewable energy sources such as solar; electricity for powering appliances and lights in households and public facilities such as health clinics, schools, and government offices; and mechanical power from either electricity or other energy sources that improve the productivity of labour.

faster in rural areas. With a significant portion (68 per cent) of the LDC population living in rural areas and a steep urban-rural electrification gap, closing this gap in LDCs will require a higher level of investment in infrastructure, including a combination of off-grid / mini-grid and decentralized grid-connected solutions to reach more remote populations. The gap between urban and rural populations is more extreme in African LDCs, where 64.6 per cent of urban populations but only 14.4 per cent of rural populations have electricity, than in Asia Pacific LDCs, where 94.2 per cent of urban and 63.9 per cent of rural populations had access to electricity by 2016.

The 32 **landlocked developing countries (LLDCs),** with a total population of 478 million, face development challenges related to their geographical disadvantages: lack of direct territorial access to the sea, and remoteness and isolation from world markets. Investment in energy infrastructure, along with information and communications technology, underpins the ability of LLDCs to structurally transform their economies, and therefore is a key priority for all landlocked developing countries. While the average proportion of population with access to electricity rose from 33 per cent in 2000 to 53.1per cent in 2016, wide disparities between urban and rural areas exist in LLDCs. Furthermore, at least two-thirds of the population relies on biomass for cooking, underscoring the urgent need for improved access to clean and modern cooking energy.

**Small island developing states (SIDS)** face additional geographic barriers to economic as well as sustainable energy development. SIDS generally rely heavily on imported fossil fuels for both transport and electricity generation, while their remoteness poses logistical and financial challenges to trade. This reliance makes them highly vulnerable to fluctuations in global oil prices and increases their cost of doing business. Most SIDS rely on widespread use of oil-based generators for electricity, but with small, dispersed populations, the grid does not reach the majority of inhabitants in many islands. At the same time, SIDS have the potential to access several renewable energy sources, such as solar, wind, geothermal and tidal power. Hence, SIDS have the prospects to be forerunners in switching to renewable energy by adopting national renewable energy strategies, building the enabling environment, scaling up existing initiatives, establishing new partnerships, adopting new technologies and gaining better access to financing.

With respect to sustainable energy, across LDCs the share of traditional and modern renewables in total final energy consumption (TFEC) was 67.8 per cent, which is significantly higher than the global average of 17.5 per cent in 2015. However, this is largely due to the use of traditional biomass, which has negative health, gender, and environmental consequences. In terms of renewable energy use, the average proportion of renewable energy in the total final energy consumption is 53 per cent for the LLDCs. In seven of these countries the proportion of renewable energy in final consumption is very small, accounting for less than 10 per cent, which shows that there is still great potential to promote greater use of renewable energy sources.

Improving energy efficiency is also a priority for all vulnerable countries, and most of them have only experienced small improvements. One crucial factor in increasing energy efficiency is the improvement of transmission and distribution systems. Improving energy intensity in these countries would make them more attractive for private sector activity, but greater private sector involvement and technological innovation is a necessity for driving such improvements.

In addition, all vulnerable countries face serious operational inefficiencies of power utilities, which need to be addressed as they impact significantly on the financial viability of these utilities. These inefficiencies reduce expected cash flows and deter private funding from going to power generation and distribution.

### Leaving no one behind—are we on track to achieving SDG 7 in vulnerable countries?

Achieving universal access to modern energy globally is critically dependent on achieving it in vulnerable countries. But for most of them, achieving SDG 7 by 2030 will be an enormous challenge. Despite progress in recent years, only four of the 47 LDCs could achieve universal access to electricity by 2030 without an acceleration of the rate of increase in access, while only seven more could do so even if they doubled their current rate of progress. In nearly a quarter of the LDCs, by contrast, achieving universal access by 2030 would require the number of persons gaining access annually to be 10 times higher in the coming years than over the past decade.

The vulnerable countries with the least resources often also pay a considerably higher price for each kWh. The average electricity rate in across LDC capitals is at US 22.4¢/kWh, compared to the rates of developed countries such as the United States (10.08¢/kWh, commercial 2016). Electricity rates in LDC countries range from US 5.7¢/kWh (Bhutan) to US 96¢/kWh (Solomon Islands). The significant variation is partly due to the energy mix, with countries highly dependent on imported fossil fuels having the highest rates.

Despite the vast challenges ahead, significant progress has been made in many countries. Vulnerable countries are increasingly incorporating access to reliable, affordable and renewable energy into their national development strategies and are making continuous efforts towards implementing their plans. Many success stories exist already, including the examples discussed below.

Many SIDS are emerging as frontrunners in the pursuit of renewables-based energy systems. Several SIDS have included in their national plans ambitious targets on increasing the share of renewable energy in their power mix. Samoa, for example, set a target of achieving 100 per cent renewable energy by 2025 in its Nationally Determined Contributions under the Paris Agreement. To contribute to this target, Samoa recently signed a project on Improving the Performance and Reliability of RE Power Systems, which was funded through the Global Environment Facility (GEF) with US$ 6 million and US$ 46million co-financing by the Government of Samoa.

In Burkina Faso, the government aims to meet 100 per cent of electricity needs in urban areas and 40 per cent in rural areas with reliable and affordable electricity by 2025. Significant efforts are under way to achieve this, and the largest solar power plant in West Africa was inaugurated in Burkina Faso in 2017. This 33 MW power plant, located in Zagtouli, has 129,600 solar panels on a surface of 60 hectares.

Bangladesh has made considerable progress in electricity access in recent years. The major sources of renewable energy in Bangladesh are solar and wind energy. The innovative financing model for Solar Home Systems has led to rapid expansion of their use and over 4.5 million Solar Home Systems have been installed. The energy output from solar increased from 51 to 212 GWh between 2010 and 2014. The coastal areas in Bangladesh also provide good opportunities for wind-powered pumping and electricity generation.

The Economic Community of West African States (ECOWAS) has demonstrated the added value of sub-regional cooperation, by creating the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) and implementing a comprehensive sub-regional policy process which resulted in the adoption of regional renewable energy, energy efficiency and energy access targets by 2030. Under the coordination of ECREEE, all member states developed national action plans on renewable energy, energy efficiency and energy access. In the partnership with DFIs and investors, sustainable energy investment prospectuses were developed. ECREEE has become an important vehicle for ensuring equal and accelerated progress (nobody is left behind), as well as harmonization of donor activities. Currently, other regions have also started advancing similar sub-regional initiatives.

These success stories are clear signs that achieving rapid progress in the energy sector is possible. The historic Paris Agreement on climate change, has shaped recent year's developments, which together with the price decreases in renewable energy and new technical innovations, have paved the way for a brighter future. With strong national leadership, multi-stakeholder partnerships and increased access to finance, vulnerable countries will be able to accelerate their progress in providing access to modern energy.

However, considering the long up-front times of energy investments and the current pace, it is uncertain whether SDG 7 can be attained by 2030 in many vulnerable countries. The uptake of sustainable energy investments continues to be hindered by a broad range of interrelated barriers (e.g., policy, technical, financial, institutional, capacity, knowledge, awareness).

Moreover, in many LDCs, LLDCs and SIDS the inability of the private sector to supply quality sustainable energy products and services at competitive prices has become a major bottleneck. Often the domestic manufacturing and services sectors are weakly developed and market demand remains underserved by international suppliers and supply chains due to high market entry costs and risks. This situation has led to a mismatch between the increasing demands for specialized services and equipment on the one hand and the limited capacities of the domestic sector to meet them. Despite enabling policies and targets this leads in some cases to a stagnating market, where sustainable energy investment is only ad-hoc or without the perspective of scaling-up. The lack of viable business, operation and maintenance models calls into question the long-term sustainability of decentralized renewable energy projects in various developing countries (e.g., mini-grids in SIDS or Sub-Sahara Africa).

### How to accelerate energy transition in vulnerable countries and policy recommendations

Sustainable growth, advancing development, and improving livelihoods can only be achieved with efficient use and distribution of modern energy. Access to, and dissemination of, affordable, reliable, and renewable energy and related technologies should be made a priority; this will be critically important on the path towards sustainable development and ending extreme poverty. Each country's transition to a sustainable energy sector involves a unique mix of resource opportunities and challenges, and national plans and policies should be designed for the unique needs and resources of each country with the necessary mix of grid, mini-grid and off-grid solutions.

To accelerate the energy transition, LDCs, LLDCs and SIDS and their development partners need to focus on: 1) creating and enforcing predictable and coherent demand and supply oriented policies and regulatory frameworks, 2) unlocking investment in the energy sector, including through tailored de-risking and financial instruments, 3) addressing currently limited funds and human capacity in policy development and the project planning stage, 4) improving technology transfer and strengthening domestic R&D on adapted solutions, 5) enhancing regional cooperation, 6) engaging and building multi-stakeholder partnerships to support the energy transition, and 7) considering options for building energy systems catering to the demands of the "bottom of the pyramid".

To accelerate progress, a holistic approach, which addresses all the above mentioned issues simultaneously, is needed. This will require multi-stakeholder partnerships involving many different stakeholders with individual comparative advantages. A **national plan for energy transition** that brings together DFIs, bilateral donors, the private sector and national stakeholders, and aligns energy sector budget allocations to support energy access investments is needed.

It is equally important to enact **regulatory reforms** that are consistent and predictable for DFIs and the private sector to adhere to, thereby boosting investor confidence and unlocking financial flows. A national investment prospectus can also support countries in making rapid progress, through: identification of gaps; clear, ambitious and realistic goals; risk assessment and management; prioritization of actions; and communication/sharing of information with the general public on the investment prospectus. It is also important to create **cross-sectoral linkages between sustainable energy and other development priorities** (e.g., clean water, gender equality, improved education, access to health care, and climate change) to increase development finance flows that have the potential for higher impact and harmonized planning. In particular, policymakers should aim to establish the energy-transformation nexus, creating a virtuous circle between energy and structural transformation.

Additional sources of financing and tailored programmes for vulnerable countries are key for accelerating progress. It is the responsibility of LDC, LLDC and SIDS governments to take necessary actions to shift funding priorities and design enabling policies to promote investments in the energy sector. Similarly, DFIs, development partners and the private sector will have to play a large role in providing the capital, mitigating risk, and building the market for high quality and affordable energy products. These actors can play a role in unlocking investment in vulnerable countries. However, the lack of maturity in energy access markets and underdeveloped financial markets mean that **public finance institutions will have to play larger role in catalysing energy access investment in vulnerable countries**.

One of the main constraints for vulnerable countries in accessing funds is **weak project preparation, implementation and monitoring capacities.** Financial and human resources required for building robust project pipelines are considerable, from enhancing project preparation capacities to defining the roles of the public and private sectors and deploying financing models that encourage blended finance. A sustainable business model needs to take into account ownership structure, communities, understanding of requirements for funding, capacity, technology, financial models, environmental and market analysis, etc. Many project developers in LDCs, LLDCs and SIDS find that having the technical capacity and/or connections is not sufficient to develop a bankable, financially viable project. The shortage of funds to undertake this critical preparation work further hampers the preparation of bankable project concepts in these countries. **Vulnerable countries will need further support in preparing bankable projects**, and development partners should provide targeted support in this area.

Many LDCs, LLDCs and SIDS that have made impressive strides in their energy access have had **a strong local institution or so-called "local champion"** to work in tandem with DFIs and take the lead in the development and implementation of the national energy plan and subsequent programmes with a clear, transparent and well-managed approach. One good example is the Alternative Energy Promotion Centre in Nepal.

To make the shift towards sustainable energy and climate technologies sustainable and a win-win situation for vulnerable countries, there is a need to **strengthen technology transfer and the absorption and innovation capacities of the domestic private sector**. Apart from demand-creating support, a strong emphasis on supply side is needed (e.g., incubation services, tailored grant and loan financing for entrepreneurs, R&D on adapted technologies, cluster building, innovation networks linking industry with applied research, and South-South and North-South business partnerships).

To reach economies of scale, there is a need to strengthen **sub-regional cooperation and capacities in the sustainable energy sector.** Some of the barriers (e.g., capacity-building, policy, knowledge and data, infrastructure building, investment and business promotion) can be addressed more effectively (and cost-effectively) through regional or sub-regional exchanges, methodologies and tools. In this context, regional sustainable energy centres, owned by the regional economic communities, can play an important role in setting priorities, coordinating complex policy implementation processes, and creating synergies between country and donor activities. Such centres can complement and support the activities of DFIs, regional power pools and regulatory authorities.

A greater effort is needed to strengthen **synergies between access, energy efficiency and renewable energy.** A fragmented approach to the three SDG 7 targets is an obstacle to building linkages to other key SDGs such as health, food, water, gender and productive and community uses. A well-performing and efficient energy system strengthens the opportunity to provide energy access to those now deprived of affordable and reliable energy. Provision of modern energy access, including electricity and clean cooking fuels, will also: develop productive capacities and accelerate economic growth; provide better health outcomes through reductions in both indoor and outdoor air pollution, and greater provision and access to quality health services; raise education standards; and help mitigate the impacts of climate change. In fact, there are very

few areas in the sustainable development agenda where sustainable energy will not play a significant role.

Going forward, national energy policies need to take into consideration the **energy demand profile of the poorest people** and ensure their access to affordable energy. The positive development impacts of sustainable energy can be expanded the most by targeting the poorest people, the so-called "bottom of the pyramid", who usually do not benefit from modern energy. Bottom-up planning will enable a realistic understanding of the technologies needed and the scales on which they are required. This will allow bringing the right financing tools to best address the challenges and needs of the poorest people. The distributed generation solutions often require smaller project portfolios and may require different sets of aggregation tools and early-risk capital.

At the same time, the focus should not be on just promoting minimum access for households, but also on transformational energy access, which supports productive uses, structural transformation and economic development, through a gradual shift towards self-sustaining systems **promoting economic development that is transformative and inclusive**.

## REFERENCES

OHRLLS, (2017) Promoting Investment for Energy Access in Least Developed Countries

Available on line at: http://unohrlls.org/custom-content/uploads/2017/10/Promo-Energy_10_10_2017_FINAL_LowResF.pdf

UNCTAD (2017) The Least Developed Countries Report 2017—Transformational Energy Access

Available on line at: http://unctad.org/en/PublicationsLibrary/ldcr2017_en.pdf

Practical Action (2017), Poor People's Energy Outlook 2017

Available online at: https://policy.practicalaction.org/policy-themes/energy/poor-peoples-energy-outlook/poor-people-s-energy-outlook-2017

Asian Development Bank (2016) ADB Approves $15.2 Million Solar Project for Solomon Islands. Retrieved from Asian Development Bank Website.

World Bank (2017) Burkina Faso: $80 Million to Diversify Electricity Supply http://www.worldbank.org/en/news/press-release/2017/06/08/burkina-faso-80-million-to-diversify-electricity-supply

Various documents of the Global Network of Regional Sustainable Energy Centers, www.se4allntwork.org

http://www.ws.undp.org/content/samoa/en/home/presscenter/pressreleases/2017/10/31/samoa-is-ready-to-impress-with-launch-of-large-scale-renewable-energy-project.html

http://www.ecowapp.org/en/news/official-commissioning-zagtouli-solar-power-station-burkina-faso

IEA, IRENA, UNSD, WB, WHO, 2018, SDG 7 Tracking: The Global Energy Progress Report. A Joint Report of the Custodian Agencies.

# POLICY BRIEF #24

## ENERGY SECTOR TRANSFORMATION: DECENTRALIZED RENEWABLE ENERGY FOR UNIVERSAL ENERGY ACCESS

## Developed by

Federal Ministry for Economic Cooperation and Development (BMZ), Germany,* Ministry of Foreign Affairs of the Netherlands, International Renewable Energy Agency (IRENA) and World Bank

## In collaboration with

Ministry of Energy of Kenya, Nepal Alternative Energy Promotion Centre, The European Commission, IEA, HIVOS, SNV, Schneider Electric, SELCO and University of Bergen

* Represented by the Division for Energy; Infrastructure; Raw Materials and the Division for 2030 Agenda for Sustainable Development; Reducing Poverty and Inequality at the Federal Ministry for Economic Cooperation and Development (BMZ), Germany.

## Key Messages

### Status of the energy sector transformation and progress towards achieving SDG 7.1.1

- The deployment of decentralized renewable energy is fuelling a disruptive transformation of the energy sector. The rapid growth of decentralized renewable energy technologies changes the structure of the energy sector towards a multi-actor set-up in which large utilities interact with self-producing consumers and mini-utilities.
- Accelerating the deployment of decentralized renewable energy will drive energy solutions that are more in line with people's needs, in particular those who prioritize energy services with major development co-benefits. The focus of energy access is therefore not just wires and poles, but quality supply that supports local economic activities.
- Renewable energy distributed through the grid (27 per cent) as well as through mini-grids and off-grid installations (3 per cent) have provided power to 30 per cent of the people who have gained access since 2000. To achieve universal energy access by 2030, this share will need to increase significantly. For over 70 per cent of those who gain access in rural areas, decentralized systems based on renewable energy will be the most cost-effective solution (IEA, 2017).
- This, in turn, will drive a deeper systematic transformation of the energy sector. Business as usual governance of the energy sector will not be able to mobilize the full potential of renewable energy for electricity access. Comprehensive regulatory, legal and financial frameworks will need to enable a decentralized and proactive citizen-oriented organization of the energy sector with high shares of renewable energy.

### Priority actions over the next four years and toward 2030

- Countries with a large energy access deficit will need to introduce mini-grid and off-grid renewables in national electrification plans, in addition to on-grid capacity, to enable a decentralized organization of the energy sector with clear energy access development targets. It is also important for these countries to recognize and address existing shortcomings in the regulatory, financial and administrative frameworks for renewables, in particular for mini-grid and off-grid renewables, based on reliable data regarding energy services.
- The financial landscape needs to shift towards unlocking local and community-driven financing available from the private sector to generate, distribute and sell decentralized renewable energy, especially in remote areas. For governments, this translates into a changing role from a direct provider of energy access to a facilitator of energy access, and introducing clear investment frameworks tailored to different renewable solutions, cost-reflective tariff settings, and dedicated funding facilities.
- The focus of energy planning and monitoring should move from least-cost energy supply, to value maximization approach, where energy services address people's needs and unlock the co-benefits in areas related to other SDGs, such as education, food security and socioeconomic development. Only with inclusive planning and monitoring processes, as well as high quality data and adequate legal and financial frameworks, will countries set the right path for a deeper transformation towards low carbon development pathways. The international community will thus need to refine the instruments for multi-stakeholder participatory planning and monitoring of SDG 7.
- Without the proper human resources, it will be impossible to achieve a long-lasting, equitable transformative change in energy access. Going forward, it will be critical to strengthen the role of people throughout the entire energy supply chain—from producers to users. Capacity-building and training will become essential components of any successful project aimed at enhancing energy access through decentralized renewable energy.

## Preface

*We acknowledge the inputs done in Policy Brief 1 on ensuring universal access to electricity. This policy brief discusses universal access to electricity in the context of the disruptive transformation of the energy sector fuelled by the deployment of decentralized renewable energy. The brief focuses on the regulatory framework necessary for the wider roll out of decentralized renewable energy. Although we recognize other energy forms such as transport, clean cooking, heating and cooling, this policy brief´s primary focus is on the electricity sector, as we see this sector as the key for an energy sector transformation within the framework of the Paris Agreement and the NDCs. In this policy brief decentralized renewable energy is recognized as renewable energy (solar, wind, small hydro) distributed both through the grid and through mini-grids and off-grid installations.*

### Current Status of Energy Sector Transformation

The energy sector is evolving rapidly and undergoing a disruptive transformation fuelled by decentralized renewable electricity generation. Since 2012, new generating capacity driven by renewables has exceeded that of non-renewables by a widening margin (IRENA, 2017a). Similarly, renewable energies have had a positive impact on the provision of electricity access. Out of the people who have gained access since 2000, 27 per cent have been reached through on-grid renewables, and 3 per cent through mini-grid and off-grid renewables (IEA, 2017).

The positive contribution of renewables to electricity access reflects a change in the energy sector. Public programmes and community level initiatives have traditionally been the key actors in this sector. More recently, private sector actors have emerged to provide electricity access by associating renewables with end-user services, ranging from solar irrigation pumps to stand-alone home systems More than 100 international companies are now providing stand-alone solar lanterns and solar home system kits targeted at those without modern electricity access.

Governments have been instrumental in the engagement of the private sector by implementing dedicated policy and regulatory frameworks to support renewable energies. Recently, governments have been attempting to mobilize market-based mechanisms (such as result based financing and auctions) to improve the effectiveness of financial support, address market failures, leverage capital, and support market development in the long term. Sierra Leone, for example, has recently announced auctions for mini-grid projects and electrification of health centres.

The international community has been similarly instrumental in putting renewables on the international agenda, including through the dedicated focus on renewable energy within SDG 7. Instruments for monitoring SDG 7 have been refined to allow for the tracking of renewable sources for electricity access. For example, the Multi-Tier Framework (MTF) redefines the measurement of access to energy, acknowledging the incremental energy access benefits provided by both the grid and off-grid energy technologies (Bhatia, Angelou, 2015, see Policy Brief #8 on energy-poverty-inequalities interlinkages).

### Energy sector transformation—what role can decentralized renewables play for universal energy access?

Business as usual governance of the energy sector will not be able to achieve universal energy access, in particular with regard to renewable energy. Since large scale on-grid energy production can be less cost effective for providing access in rural areas, mini-grid and off-grid renewable energy systems are essential to achieving universal access by 2030 in the most cost- and time-efficient manner. Since most of the people who will gain access live in rural areas, the share of mini-grid and off-grid renewable energy (38 per cent) for energy access needs to be higher than the on-grid renewables share (23 per cent) (IEA, 2017). In addition, timely access to energy would mitigate the opportunity costs associated with better livelihoods and economic prosperity, which are fundamental aspects to achieve other SDGs (see Box 1).

### Barriers to a deeper and systematic energy sector transformation

The move towards a decentralized organization of the energy supply with a high share of renewables challenges the structure of the existing energy sector. A range of policy, regulatory and financial barriers are still in place that impede a deeper and systematic energy sector transformation in line with universal energy access by 2030 and the long-term objectives of the Paris Agreement.

Regulatory Indicators for Sustainable Energy (RISE) show that all energy access deficit countries have developed regulatory provisions for renewables. Taking a closer look at regulations, however, it seems as if these countries are still some steps away from a coherent and integrated energy access development scenario through renewables. For example, very few of these countries have regulations that clarify interconnection procedures for the main electricity grid reaching a mini-grid, which is a very important investment consideration for mini-grids (RISE—World Bank 2017). Only 40 per cent of countries have a grid code that includes variability of RE, 36 per cent of countries have transmission pricing rules for RE, 14 per cent of countries have plant forecast rules for RE generation, and only 8 per cent of countries have power exchange rules for balancing areas, which is an important consideration for feasibility of grid-connected RE projects (RISE—World Bank, 2017).

In addition, out of the ten highest access deficit countries, only

Box 24.1:

**Interlinkages with other SDGs**

Although governments have stressed the integrated, indivisible and interlinked nature of the SDGs, important interactions and interdependencies are generally not explicit in the description of the goals or their associated targets. Implementation of Agenda 2030 and the SDGs requires comprehensive national sustainable development strategies that factor in all the SDGs and their interlinkages. The range of relevant interlinkages with SDG 7 includes: Energy, Poverty and Inequalities (SDGs 1, 10); Food, Water and Energy (SDGs 2, 6, and Nexus-Approaches), Good Health (SDG 3), Gender Equality (SDG 5), Decent work and economic growth (SDG 8), Industry, innovation and infrastructure (SDG9), Energy and Education (SDG 4), Life on land (SDG15) and Sustainable cities (SDG 11). Some recommendations include integrated planning and programming, breaking down silos and interdisciplinary research (Lay and Prediger 2016, Mc Collum et al., 2017) as well as specific policy options for interlinkages between SDG 7 and SDGs 1, 2, 3, 6, 8, 13 (Nilsson et al., 2016)

**Poverty reduction (SDG 1)**

No country has gone from poverty to prosperity without providing energy in line with people's needs. Sustainable energy available in the right amount, at the right time, and at the right place, and affordable for all segments of society, can offer major social and economic benefits. Renewables have the potential to supply electricity directly in line with end-user demand, ranging from solar irrigation pumps to off-grid renewable energy solutions for healthcare facilities. With the development of local skills, the deployment of decentralized energy can create employment in assembling, distributing, installing and maintaining equipment. Electricity is also essential for economic sectors—agriculture, tourism, commerce, and industry—to thrive and create income-generating opportunities. (IRENA, 2017a).

**Climate Action (SDG 13)**

The framework conditions for delivering universal access to energy are defined by the Paris Agreement, which seeks to promote low-emission, resilient development pathways that limit the temperature rise to well below 2°C, ideally at 1.5°C. To achieve the temperature targets outlined in the Paris Agreement, all countries need to decarbonize their energy systems through an up-scaling of renewables and energy efficiency. Renewable energy systems contribute to climate change mitigation by replacing or avoiding fossil fuel based energy services. About 70 per cent of Nationally Determined Contributions (NDCs) to the Paris Agreement therefore mention the need to expand or strengthen renewables in their country's energy mix time (Stephan et al., 2016; REN21, 2016). The energy sector also needs to increase its resilience and adapt to the effects of climate change; and in addition can be an important contributor to climate change adaption.

**Peace and justice, strong institutions (SDG 16)**

To "ensure universal access to affordable, reliable and modern energy services" (SDG 7.1) through the promotion of renewable energies, requires conducive political and legal framework conditions for the energy sector, including effective, accountable and transparent institutions at all levels (SDG 16.6), rule of law and access to justice (SDG 16.3) and responsive, inclusive and participatory decision-making (SDG 16.7).

three countries (Bangladesh, India and Tanzania) have developed comprehensive frameworks for mini-grids. 41 out of 55 RISE access deficit countries, mainly in Sub-Saharan Africa, are lagging behind in the provision of enabling policies for off-grid solutions: they neither provide confidence for private investors, nor champion public sector solar uptake. Only 23 access deficit countries have financing facilities available for mini-grid and/or stand alone home systems.

Over the last years, finance commitments for small-scale electricity projects have still been minimal compared to large-scale investments. Between 2013 and 2014, finance commitments for electricity in the 20 countries representing 80 per cent of the global energy access deficit were at least US$ 19.4 billion a year on average. Almost all finance commitments were dedicated to large-scale solutions including two-thirds from renewables and one-third based on fossil fuels (SEforALL, 2017). This implies a continuing bias toward funding large-scale infrastructure projects and a need for more targeted and refined strategies to address structural issues related to the organization of the energy sector.

## Policy Implications/Recommendations

### Energy access deficit countries—Integrated and holistic planning for a deep transformation

Countries with a high energy access deficit will need to focus on enabling a deep transformation of the energy sector to scale up decentralized renewables for universal energy access. As a first step, this would mean to introduce next to on-grid capacity, mini-grid and off-grid renewables into their national electrification plans. Energy access development scenarios should focus on satisfying the current and future needs of various population groups, especially women, youth, and the poor, and establish pathways for increasing consumption and demand over time. This requires dynamic energy access planning that allows for the co-existence and integration of different technologies and system-sizes over time (Sareen, 2017). The planning should be the result of cross-sectoral consultation with various stakeholders, including the local private sector and civil society organizations, as well as relevant ministries (health, education, water and agriculture) and subnational governments. Planning needs to be bottom-up and gender-sensitive. Such holistic electrification planning will provide guidance to the public and private sector, as well as development banks and donors, to collaborate, mobilize and work to direct resources towards off-grid and grid-based electrification options (IRENA, 2017b). This approach will avoid duplication of efforts (from off-grid and on-grid sectors) and will also mitigate the risk of stranded assets of off-grid systems (if and when the grid arrives).

### Tailoring regulatory frameworks to accelerate deployment

Equally important, countries with high energy access deficits will need to address outstanding shortcomings in the policy and regulatory frameworks for distributed renewable energy. This includes developing comprehensive support frameworks for decentralized renewables and creating an equal playing field by removing key barriers for energy access through renewable energy deployment. Streamlined regulatory requirements can reduce development costs, which will allow a balance between reliability and affordability for the actors participating in the market. Adoption of standards is also critical for distributing high-quality products that do not breach the trust of end-users in off-grid renewable solutions. A common approach to facilitate various regulatory requirements is to establish a single-window clearance facility hosted by a rural electrification agency or similar body (IRENA, 2016c). A tailored approach to tariff regulation has a strong influence on the viability and sustainability of mini-grids, in addition to effective participation of the private sector. This is crucial when countries attempt to move towards market-based mechanisms for renewables support. For many governments this may imply a shift from being a direct financier of energy access (e.g., through state-owned utilities) to being an energy access facilitator, creating incentives and a level playing field for a number of technologies and service providers to co-exist and serve different segments of the grid and off-grid markets. Effective policy and regulatory reforms are also needed to unlock domestic commercial finance, including by raising awareness and capacity-building among local institutions. This, in turn, will require enabling regulatory frameworks from the national to the local level, as well as effective multi-level governance where solutions can be defined, sufficiently funded and implemented.

### Flourishing investment in renewables—The key for a deeper sector transformation

The continuing bias towards funding large-scale infrastructure projects will not achieve the necessary financing amounts to contribute to universal energy access. Instead, the focus needs to shift towards attracting funding for small scale low-carbon climate resilient infrastructure projects by the (local) private sector. For this, certainty and clarity within the legal framework and legal enforcement through rule of law are important issues for investors to address. Clear licensing and regulatory guidelines tailored to different renewable solutions should be in place. The traditional approach of uniform national tariffs needs to give way to differentiation between centralized and decentralized grid power to allow for cost recovery. Industrial bulk consumption, self-consumption and the application of distributed storage can yield benefits for both end-users and the power system as a whole. Therefore, regulation should actively promote self-consumption by adopting a cost-reflective design for retail tariffs, and subsidy systems should be reviewed to promote greater equity between grid and non-grid connected households. Finally, governments

can also take concrete financing measures by i) cooperating with regional and global funding facilities to attract early-stage capital, ii) using tools, such as guarantees, to encourage commercial bank lending, iii) developing dedicated funding facilities for specific needs, and iv) creating favourable fiscal regimes (e.g., eliminating custom duty barriers for renewables). Integrating renewable energy and access targets, as concretely as possible, in a country's NDC and in its national energy and economic planning will give policy certainty, enhance the predictability of investors and support a transformation funded by commercial banks, among other investors.

### Integrating productive use of electricity in the project life cycle

The inclusion and adequate integration of productive use in project planning and implementation is pivotal for greater economic growth, productivity, and employment. Productive use cannot be an afterthought and should be an integral part of the energy access strategy. Several renewable energy technologies have emerged as economically viable and environmentally friendly options, which if suitably adopted can meet the growing energy needs of industry, and particularly of small and medium-sized enterprises (SMEs).

### International community—Guiding the way for a deep transformation

Analysis of the current status of access at the multilateral level, together with identification of gaps, will ensure a more timely and effective process for reaching energy transformation goals. Common methodologies and tools are also needed to assess the energy sector and develop roadmaps for a transformation maximizing the potential of the sector to meet climate and development goals. Similarly, the monitoring of SDG 7 will need to integrate the characteristics of on-grid renewables, as well as mini-grid and off-grid renewable energies, to track the dynamics and integrated nature of energy access development going forward. There is a need for a multilateral supported approach paving the way for an energy sector transformation and maximizing the potential of renewable energy deployment to achieve development goals such as energy access, as well as the Paris Agreement, at the same time. Only with inclusive planning and monitoring processes, high quality data, adequate legal and judicial frameworks, and effective, accountable and transparent institutions countries will set the right course for a deep transformation to meet the "leave no one behind" principle of the agenda 2030.

Effective institutions and administrations at all levels facilitate the development and implementation of policies on renewables and improve citizen-oriented energy supply as part of public service delivery. To increase the availability and the use of data for planning, statistical systems need to be strengthened through training of its members who are in a position to influence, introduce or modify policies that will positively impact national energy access.

### Civil society—Voicing the interests of people and communities

To increase the uptake of decentralized renewable energy, including for the last mile, civil society organizations (CSOs) can support national governments and the international community first and foremost by voicing the interests of people and communities, with a focus on household energy consumption as well as productive and community use of energy. Governments need to be proactive in creating these spaces of inclusion and allowing these voices to influence their planning and decision-making. Next, CSOs can support policymakers with concrete suggestions for finance, energy and nexus policies and regulations, making sure policy and implementation is connected to the needs of communities and making sure they are sustainable and operational in the long term. CSOs can increasingly work alongside the private sector as key partners, to support and challenge them to reach the last mile. Finally, CSOs can lead by example, by developing inspiring and daring new solutions, using a multi-stakeholder communication approach.

## REFERENCES

Bhatia, M.; Angelou, N (2015), Beyond Connections: Energy Access Redefined. ESMAP Technical Report; 008/15, World Bank, Washington, DC https://openknowledge.worldbank.org/handle/10986/24368 License: CC BY 3.0 IGO

IEA (International Energy Agency) (2017), Energy Access Outlook 2017

IRENA (2016), Policies and regulations for private sector renewable energy mini-grids, Abu Dhabi

IRENA (2017a), Rethinking energy: Accelerating the energy transition, Abu Dhabi

IRENA (2017b), Accelerating Off-grid Renewable Energy: Key Findings and Recommendations from IOREC 2016, Abu Dhabi

REN21 (Renewable Energy Policy Network for the 21st Century) (2016), Renewables 2016 Global Status Report, www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report_REN21.pdf, 30 Jan 2018

Sareen, S., (2017), Energy distribution trajectories in two Western Indian states: Comparative politics and sectoral dynamics. Energy Research & Social Science.

SEforALL (2017), Energizing Finance—Scaling and Refining Finance in Countries with Large Energy Access Gaps, 2017, Washington DC

Stephan, B., et al. (2016), What Place for Renewables in the INDCs?, www.worldfuturecouncil.org/inc/ uploads/2016/03/WFC_2016_What_Place_for_Renewables_in_the_INDCs.pdf, 30 Jan 2018.

World Bank, 2017 Regulatory indicators for sustainable energy: a global scorecard for policymakers, http://rise.esmap.org, Washington, D.C.: World Bank Group. 2017International Council for Science (ICSU), 'A Guide to SDG Interactions' (particularly pp. 127-169 on SDG 7), Nilsson et al. (2016) https://www.icsu.org/cms/2017/05/SDGs-Guide-to-Interactions.pdf

# POLICY BRIEF #25

## BUILDING GLOBAL ENERGY INTERCONNECTION (GEI) TO PROMOTE THE 2030 AGENDA FOR SUSTAINABLE ENERGY DEVELOPMENT


### Developed by

Global Energy Interconnection Development and Cooperation Organization (GEIDCO) and Renewable Energy Institute (REI)

### In collaboration with

Association of Power Utilities of Africa (APUA), International Hydropower Association (IHA) and Green Grid Alliance (GGA)

## KEY MESSAGES

### Status of global energy interconnection (GEI) and progress towards achieving SDG 7

- The world has seen a steady improvement of electrification, but there are still 1 billion people globally with no electricity access (WB, 2018), over 90 per cent of them in sub-Saharan Africa, Asia and Latin America.
- Global energy interconnection (GEI) is a vision of globally interconnected power grids, which can become a platform for large-scale development, transmission and consumption of clean, renewable energy worldwide. Ultra high voltage technology (UHV) can support long-distance power transmission with high efficiency, low losses, and stability, allowing electricity generated from clean energy to be sent to people currently without access to electricity, or using electricity supplied by fossil fuels. A 'Smart Grid' uses advanced technologies to monitor and control the whole system.
- The installed capacity of solar and wind power increased dramatically from 2000 to 2016. In 2016, about 86 per cent of increased energy demand in the European Union was met by renewable energy (EEA, 2017). In at least 30 countries around the world, renewable energy already contributes more than 20 per cent of energy supply (REN21, 2017), and many countries have set targets for increasing renewable energy levels. For instance, the European Union has set the target of meeting 20 per cent of all electricity demand by renewable energy by 2020 (UNECE, 2017).
- Clean energy resources are not evenly distributed around the world, and may be located far from major consumption centres. If those resources can be used to generate clean power in bulk, which can then be transmitted over long distances to address the geographical mismatch of renewable energy resource centres and load centres, there will be significant cost reductions in utilizing renewable energy. GEI is a cost-effective mean of achieving an optimized renewable energy allocation by combining Smart Grid and UHV technologies through grid interconnection (expansion). GEI enables countries to balance electricity demand and supply by means of import and export of renewable energy. Excessive electricity generated from clean energy can be traded (after satisfying local demand) to remote regions or countries, with minor losses, and economic benefits for both the sending and receiving sides.
- A "GEI Action Plan to Promote the 2030 Agenda for Sustainable Development" was released in November 2017, together with the United Nations (GEIDCO, 2017).

### Priority actions over the next four years

- Incorporate GEI into energy development strategies and planning, where appropriate, as an important effort to implement the 2030 Agenda and the Paris Agreement. Encourage a wide range of cooperation in areas of planning, research, technical innovation, international investment, project construction and international electricity trade under the framework of GEI.
- Conduct power grid study and planning at the global level based on local, country or regional power grid planning, taking into account global renewable resources distribution and electricity demands. Develop new business models to attract multi-stakeholder investors to build power grid infrastructure.
- Carry out concerted actions to accelerate power grid interconnection, and disseminate successful experiences of UHV transmission plus Smart Grid technologies for transmitting bulk renewable power over thousands of kilometers.
- Put in place policies and action plans to encourage renewable energy development and utilization on a global level, and promote power transmission across countries or regions, on the basis of win-win cooperation and shared benefits.

## GEI and the Sustainable Development Goals

Energy utilization is the key element for sustainable development. The target to "ensure access to affordable, reliable, sustainable and modern energy for all" is included in the SDGs as SDG 7 (UN, 2017).

Global Energy Interconnection (GEI) is a means to optimize the utilization of clean energy and transmission in a bulk way. It aims to achieve the replacement of fossil fuels by renewable energy in electricity generation, and then, replacement of fossil fuels by renewable electricity in energy consumption. That will increase the electrification level for end users and limit the use of fossil fuel as an industrial energy source.

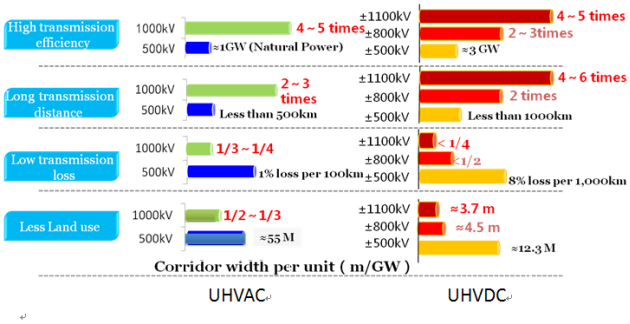
Among the various solutions to meet electricity demand, the centralized power grid offers an efficient and cost-effective way to achieve power access. For large-scale power transmission, ultra high voltage (UHV) technology can achieve long-distance power transmission with high efficiency, low losses and more stability. Through UHV transmission, consumers can get access to the cheapest generators from a larger set than in a local system with few power plants. The more efficient generating plants can be better utilized as they can supply a wider set of consumers and therefore be less vulnerable to local dips in demand (IEC, 2017).

GEI is a vision of globally interconnected power grids, and a platform for large-scale development, transmission and consumption of clean energy worldwide. GEI transmits electricity generated from clean energy to load areas suffering from pollution caused by fossil fuels, as well as to some areas without electricity access or affected by electricity shortages.

The three pillars of GEI are the Smart Grid, UHV transmission and clean energy. The UHV technology, composed of 1000kV alternating current (AC) power transmission, ±800kV and ±1100kV direct current (DC) power transmission, is able to transmit bulk power across thousands of kilometres with high efficiency, low loss and high security. The transmission distance is 2 to 3 times that of the regular high voltage lines, and the capacity of the UHV transmission is 4 to 5 times larger than regular high voltage transmission (IEC, 2017). Thus, the UHV technology is a significant innovation for the electric power industry. The Smart Grid, relying on advanced smart technologies, serves as the "brain" to monitor and control the whole system, ensuring flexible integration of various clean energy sources and electric devices, and operation, transmission, distribution and storage in a coordinated manner. The voltage of transmission systems has been increased from a low level up to 500kV, then to 1000kV for AC systems; UHV DC voltage started from 500kV and has reached +/- 1100kV in the recent decade (MPS, 2016).

Figure 25.1

**A comparison of the advantages of UHV (AC and DC) vs. High voltage transmission in terms of capability, transmission distance, loss and occupied land area**




A comparison of the advantages of UHV (AC and DC) vs. High voltage transmission in terms of capability, transmission distance, loss and occupied land area, as shown above.

Besides SDG 7, many other SDGs will benefit from GEI, including mitigation of climate change, removing heath-detrimental air pollution, supporting sustainable production and consumption, reducing poverty, and promoting gender equality.

### Current status of GEI

The world is rich in clean energy resources but the distribution is not even, nor does it fit demand. In Asia, Europe and Africa, 85 per cent of the hydro, wind and solar resources are located in an energy belt from North Africa to the Far East of Russia via Central Asia, at an angle of 45 degrees to the equator (GEIDCO, 2017). However, major load centres are concentrated in East Asia, South Asia, Europe and Southern Africa. Most of the areas rich in clean energy resources are far away from load centres. GEI is designed to promote clean energy development, optimize energy supply, and make better use of clean energy worldwide by re-allocating resources to consumers by UHV electricity transmission.

Technically, the Smart Grid technology, based on measuring, control, and information technologies has been well developed and applied in some parts of the world. It allows for large-scale integration of all types of users, and intermittent energy sources such as wind and solar power. Clean energy generation is making continuous progress thanks to technical breakthroughs, the application of new materials and support mechanisms. The efficiency of photovoltaic (PV) systems has reached 20 per cent. Wind turbines with capacity of 8MW have been put into operation, and 9.5MW wind turbine has been successfully developed. The UHV technology has become more mature, and the distance of UHV AC and DC transmission can reach 1500 kilometres and 6000 kilometres respectively (GEIDCO, 2017). Some key technologies, such as UHV submarine

cables, high-speed DC switches, are being developed, and technical breakthroughs are expected in the near future.

GEI is a cost effective solution. The average cost of wind and PV generation worldwide has declined by 30 per cent and 75 per cent respectively in the past 5 years (GEIDCO, 2017). The international bid-winning prices of PV projects in the United Arab Emirates (expected to be in operation in 2019) and Chile (to be in operation in 2021) have dropped to US 2.4 cents (Reuters, 2017) and US 2.9 cents (BN, 2016) per kilowatt-hour respectively. It is estimated that by 2025, the prices of power generation from wind and solar, will be lower than power prices from fossil fuels (BEIS, 2016). The declining cost of clean energy makes it possible to supply clean electricity to more people through long distance transmission by GEI.

GEI can make full use of the differences of time zones, seasons, resources and prices between countries and regions, to maximize economic benefits through interconnections. For example, if the hydro power in Central Africa and the solar power in North Africa are transmitted to Europe with UHV DC transmission, the total cost would be US 7 cents to US 9 cents per kilowatt-hour, about US 7 cents lower than the average PV generation in Europe. The connection is beneficial to both sides. African countries can increase income by selling extra electricity, while Europe can reduce its purchase costs by importing cheaper electricity. With GEI, long-distance electricity trading can be realized.

### Status of power grid interconnection

Power grid interconnection is a trend in the power sector. Interconnection can enhance the efficiency of resource utilization. Large power grids are regarded as more economic, more secure and more reliable than small ones. The demand for power interconnection is much greater than before, due to the increasing number of new energy sources integrated into the power grid, such as wind, solar, geothermal power, etc. Several large-scale transnational interconnected power grids exist nowadays, supplying electricity for billions of people.

In India, the Champa-KurukshetraI ±800kV UHV DC project is under construction (Alstom, 2015), which will transmit power for people without electricity access. In Brazil, the Belo Monte Phase I UHV DC project was put into operation in 2017, which provides hydropower to areas more than 1000 kilometers away. China's clean energy has been developing at high speed, and bulk clean energy in the west is transmitted to the eastern areas via UHV transmission lines.

In Europe, a European power grid has been in operation for years, consisting of several well-connected national grids. Substantial electricity is traded between countries each year. The interconnected grids strongly support the development and allocation of clean energy throughout Europe. In Asia, Africa and North America, there are also several transnational power grids, such as the Gulf grid, Southern Africa grid, US-Canada grid, which all greatly contribute to power supply.

The necessity, feasibility, and affordability of GEI have been extensively discussed over the past two years. Several MOUs to promote the development of GEI in various regions of the world have been signed by United Nations bodies, such as UN-DESA, UN-ESCAP, UN-ECLAC, as well as SE for ALL. In particular, the Global Energy Interconnection Action Plan to Promote the 2030 Agenda for Sustainable Development was released in November 2017 at United Nations headquarters in New York. It is envisioned that more efforts will be made to complete the transnational and transcontinental power grid planning by 2020. In the long run, with the large deployment of clean energy, concerted actions can be taken to improve domestic interconnection, cross-country interconnection, and finally major intercontinental power transmission corridors, which may provide for global availability of clean electricity for all.

### Are we on track to achieve SDG 7 through building GEI?

The share of clean energy in primary energy consumption is expected to rise to 35 per cent by 2030, up by 16 per cent over 2015, and 10 per cent higher than the business as usual scenario (GEIDCO, 2017). With the clean energy in the energy mix on the rise, it is estimated that by building GEI, the installed capacity of clean energy can be expected to be 2.5 times that of 2014, reaching 5.3 TW in 2030 (GEIDCO, 2017). This will make high capacity and long distance clean energy integration and transmission more desirable.

It is anticipated that upgrading national, transnational or even wider power grids will be accelerated in the future, which will supply modern and sustainable energy services for more people.

### How to fill the gap to build GEI for promoting SDG 7

In order to promote the development, allocation and consumption of clean energy globally, it is crucial to build and strengthen the backbone grids of each country, and domestic power grid connections, as well as transnational and transregional grid interconnections, for the optimized development and utilization of clean energy resources in each continent.

Figure 25.2

**Overall layout of global energy interconnection (GEIDCO, 2017)**


For the purpose of building GEI, effective cooperation is required among governments, enterprises and other social stakeholders and parties, in order to promote concerted action in planning, construction, trade, operation and technology standardization.

In order to build GEI, innovative business models, multi-level investment and financing mechanisms, and high-efficiency investment and financing supporting systems are essential. Interlinkages with other Sustainable Development Goals.

Building GEI not only contributes to SDG 7 but also to many of the other SDGs, including those on ending poverty, combating climate change, gender equality, and sustainable industrialization and innovation.

By providing sustainable energy to poverty-stricken areas, GEI would make it possible for the poor to have access to education, work and infrastructure for industrial activities, which would generate more opportunities to increase income, end poverty and narrow the regional gap. Countries in Asia, Africa and South America could sell clean energy to developed countries, thus transforming resources advantages to economic benefits.

## Policy implications

### Policies to promote modern energy system through GEI

Modern energy system feature large-scale clean energy development, distribution and utilization. This requires enabling polices, clear objectives and road maps, and active implementation.

Currently, governmental policy support for clean energy development is uneven and sometimes insufficient. To achieve global allocation of renewable energy there need to be effective, transparent and clear-targeted government policies, removing policy barriers and creating a favourable policy environment to support the deployment of clean energy.

To promote universal clean energy access, energy transmission and distribution options can be improved through Global Energy Interconnection. Dissemination of information about GEI can encourage governments to formulate policies that support its development.

In order to extend grid connection to the regional and global level, comprehensive power planning at the global level would be needed to optimize grid inter-connectivity and operations worldwide and promote integration of clean energy resources.

This process should take into account global renewable resource distributions as well as distribution of demand in space and time. International cooperation is needed, involving governments, international organizations, the private sector and civil society.

### Policies to enhance international technical cooperation

Building GEI requires continuous development of clean energy technologies, including power grids with lower costs and higher reliability, and technologies to operate electrical devices in extreme conditions of cold or heat. New R&D activities call for cooperation among manufacturers and research institutes, and support from governments through mechanisms and incentives for technology innovation.

### Policies to encourage international investment and trade

Energy interconnections require an increase in financing from various financial sources, including multilateral and bilateral development banks, governments, bilateral development assistance and the private sector. Policies can be put in place to provide a safe, effective and win-win investment environment. And new business models need to be developed to attract multi-stakeholder investors to build GEI infrastructure.

Connecting national electricity grids requires cross-border electric power trading mechanisms, such as taxes, transmission pricing and dispute mediation to achieve efficient collaboration in global power exchange.

## REFERENCES

Alstom (2015), "Alstom successfully delivers 1st 800 kV HVDC transformer for India's Champa-Kurukshetra Phase 1 Project", available online at http://www.alstom.com/press-centre/2015

BEIS (Department for Business, Energy & Industrial Strategy) (2016), "Electricity Generation Cost report, Department for Business, Energy & Industrial Strategy"

BN (Bloomberg News) (2016), "Solar Sold in Chile at Lowest Ever, Half Price of Coal", available online at https://www.bloomberg.com

EEA (European Environment Agency) (2017), "Renewables accounted

for vast majority of new EU power capacity in 2016", available online at https://www.eea.europa.eu/highlights/renewables-accounted-for-vast-majority

EEA (European Environment Agency) (2017),"Renewable energy in Europe"

GEIDCO (Global Energy Interconnection Development and Corporation Organization) (2017), "Global Energy Interconnection Action Plan to. Promote the 2030 Agenda for Sustainable Development," available online at http: //www.geidco.org/html/zt1101/down/data05_en.pdf

IEC (International Electrotechnical Commission) (2017),"Global energy interconnection," White Paper

MPS (Modern Power Systems) (2016), "World's first 1100 kV DC line will be constructed in China", available online at http://www.modernpowersystems.com/features/featureworlds-first-1100-kv-dc-line-will-be-constructed-in-china-4991040/

REN21 (Renewable Energy Policy Network for the 21st Century) (2017),"Renewables Global Futures Report", available online at http://www.ren21.net/Portals/0/documents/activities/gfr/REN21_GFR_2013.pdf

Reuters (2017), "Abu Dhabi closes $872 million financing for world's largest solar plant", available online at https://www.reuters.com

UN (United Nations) (2017)," SUSTAINABLE DEVELOPMENT GOAL 7," available online at https://sustainabledevelopment.un.org/SDG 7

UNECE (United Nations Economic Commission for Europe) (2017), "Renewable energy-Moving towards a low carbon economy", available online at https://ec.europa.eu/energy/en/topics/renewable-energy

UNECE (United Nations Economic Commission for Europe) (2017),"Global Tracking Framework: UNECE Progress in Sustainable Energy"

WB (World Bank) (2018), available online at http://www.worldbank.org/en/topic/energy

# POLICY BRIEF #26

## ENERGY PATHWAYS TOWARD SUSTAINABLE FUTURES TO 2050 AND BEYOND


### Developed by

International Institute for Applied Systems Analysis (IIASA)

### In collaboration with

International Energy Agency (IEA) and International Renewable Energy Agency (IRENA)

## KEY MESSAGES

### Progress on energy pathways to achievement of SDG 7 and beyond

- The SDG 7 targets for 2030 (universal access to affordable, reliable and modern energy services; increase substantially the share of renewable energy; and double the global rate of improvement in energy efficiency) were based on the recommendations of the Secretary-General's Advisory Group on Energy and Climate Change (AGECC) and the six sustainable development pathways developed b for the Global Energy Assessment (GEA, 2012), as well as on other research, particularly the work of the International Energy Agency (IEA) on access. These are ambitious goals, but achievable with appropriate policy frameworks and institutional support.
- There are other pathways in more recent literature that would meet some of the SDG 7 targets by 2030, including scenarios by the IEA and International Renewable Energy Agency (IRENA), and some of the community pathways developed for the International Panel for Climate Change (IPCC). The new scenarios, as well as the original GEA pathways, extend the sustainability transformation into the future beyond 2030. The sustainable energy pathways show it is possible to harmonize human need for greater energy services without transcending planetary boundaries.
- Reduction of energy intensity is central to the achievement of sustainable energy futures across a wide range of pathways presented in the literature. Appropriate policies for vigorous efficiency improvments are essential, not just on the supply side but especially in end uses. A number of studies indicate that, based on the second law of thermodynamics, the potential for efficiency improvement is huge, because the current efficiency might be on the order of only a few per cent.
- The world is on a good track to achieve increasing shares of renewable energy and also great progress has been made in reducing energy intensity and access. However, we are far from doubling the rate of energy intensity improvement as well as achieving sustainable energy access for all. Thus, these two targets need additional efforts and strong support to be achieved.

### Priority actions

- Increase energy investments to around US$ 2.5 trillion per year until 2030, with further increases beyond that. This will require new models of de-risking that can attract the capital needed.
- Investments in science, technology and innovation need to complement deployment and diffusion in order to reduce costs and make the transition to sustainable energy affordable.
- Energy policies and regulations should be integrated and reliable to support long-term investments. They should also consider multiple benefits and potential synergies with other SDGs to decrease the costs of the transformation.
- New behaviours and the emergence of sustainable social norms and values are central to the energy transformation toward sustainable future. Digitalization can be a great facilitator of this transformation.
- The future transformation needs to take place at a much higher rate of change than observed in the past. This requires disruptive thinking in terms of the imagined futures and the complementary disruptive policy interventions.

## Sustainable Energy Pathways and the SDGs

### The Role of Pathways in SDG 7

Energy was one of the first areas in which researchers applied methods of systems analyses to develop scenarios and pathways of future developments—including work by Shell, the World Energy Council, the International Energy Agency (IEA), the Energy Modeling Forum, and the International Institute for Applied Systems Analysis (IIASA). Both narrative and quantitative energy pathways were developed early on, including variants leading to sustainable futures. The pathways in the literature clearly show energy as key for human development.

However, the Millennium Development Goals (MDGs) did not include an energy goal, even though energy is essential for development. Consequently, the Global Energy Assessment (GEA, 2012) brought together about 500 authors and reviewers across the world to provide comprehensive, science-based perspectives on sustainable energy futures, quantitative pathways, and the policies needed so they could be achieved.

In 2010, the United Nations SG's High-Level Advisory Group on Energy and Climate Change (AGECC, 2010) called on the UN system and its member states to commit themselves to two complementary goals: 1. Ensure universal access to modern energy services and 2. Reduce global energy intensity by 40 per cent, all by 2030. Successful adoption of these measures was estimated to reduce global energy intensity by about 2.5 per cent per year, approximately double the historical rate. A third target—to double the share of renewables in final energy to 30 percent, also by 2030—was added later as the need to increase substantially the share of renewable energy. The three targets were based on six sustainable development pathways developed in GEA, as well as other research, particularly work by IEA on access and by IRENA on renewable energy. In 2011 the Vienna Energy Forum (VEF, 2011) confirmed the three targets, and they were also later adopted by United Nations Energy and the United Nations SG's High-Level Group on Sustainable Energy for All.

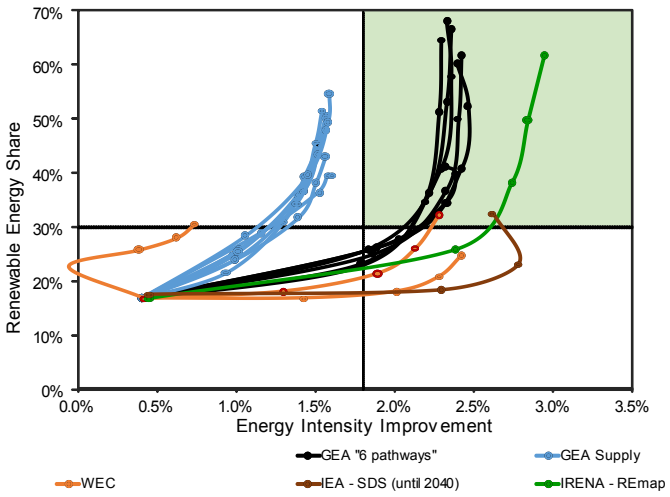
Thus, there was strong evidence-based knowledge on which SDG 7 was rooted. The three goals adopted in 2015 by the United Nations General Assembly closely mirrored the original AGECC and VEF formulations. There are also many other pathways in the more recent literature, including scenarios developed for the IPCC, which meet the SDG 7 targets by 2030.

### Are we on track to achieving the SDG 7 targets?

The world is on a good track to achieve increasing shares of renewable energy, and also great progress has been made in reducing energy intensity. However, we are far from doubling the rate of energy intensity improvement, or achieving sustainable energy access for all (see Policy Brief 1). Thus, these two targets need additional efforts and strong support to be achieved. A key question is whether the ambitious SDG 7 goals can be achieved through incremental improvements or if they require transformational change. This question is important for the roadmaps to 2030 and even more for sustainable pathways that go beyond that.

Figure 26.1

**Renewable energy shares and energy intensity improvements to 2050 in 10 year steps. Green quadrant indicates SDG targets for renewable energy share and energy intensity improvement. Six GEA sustainability, IRENA Remap and IEA SDS scenarios are shown that clearly fulfil the two SDG 7 targets. All GEA pathways fulfil the third target of universal access to energy services. It also displays recent pathways from the literature. Please note that the RE shares refer to the net increase, i.e., by accounting for decreases in traditional biomass. For instance, the IEA SDS meets the clean cooking goal, which dramatically reduces traditional biomass, thus the gross increase in modern renewables is actually higher than shown by displayed shares. (Sources: based on data from Riahi et al., 2012, IRENA, 2017, IEA, 2017 and WEC, 2017)**




### Energy transformation beyond 2030

The more recent scenarios, as well as the original GEA pathways, extend projections for the sustainability transformation into the future beyond 2030, and show that energy continues to be key to achieving a sustainable future for people and life-supporting functions of the planet. The sustainable energy pathways show that it is possible to meet human needs for greater energy services without transcending planetary boundaries.

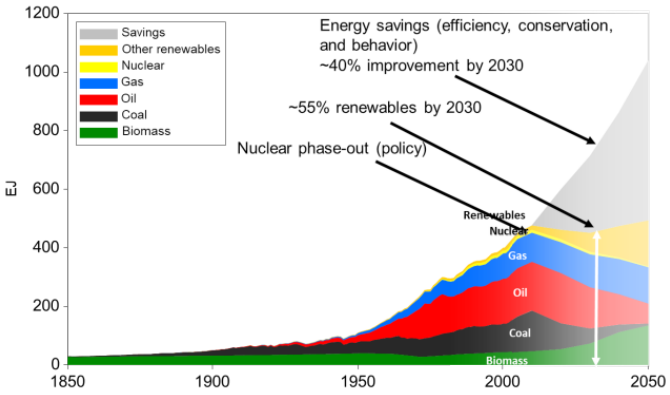
Recent literature abounds with questions about the ultimate limit for renewables, particularly whether they can provide for all energy needs. Exceedingly high contributions of renewables are conceivable, with the caveat that this needs to occur in conjunction with efficiency improvements and sustainable behaviours,

especially in end use.

One of the six GEA pathways emphasises a future where renewable energy sources will play a particularly important role. In this pathway (see Figure 2) by 2030 the renewable share increases to more than 55 per cent primar energy use and continues to grow toward the middle of the century. In conjunction with this large role for renewables, energy efficiency improvements avoid almost 40 per cent of potential demand, especially in end use. Efficiency is the largest "source of energy" in the six pathways.

Figure 26.2

**Global energy requirements in one of the six GEA pathways that informed SDG 7 targets. This pathway emphasises the role of renewables, while others in the set of six pathways show higher roles of fossils and nuclear. All fulfil the three SDG 7 targets and also SDG 13 and many other dimensions of sustainable futures. (Source: based on Riahi et al., 2012)**



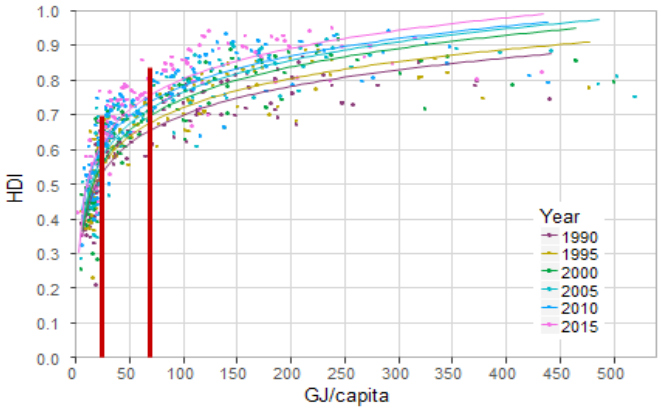

Reduction of energy intensity is central to the achievement of sustainable energy futures across a wide range of pathways presented in the literature. A reasonable question to ask is whether this is feasible both in the short and the long run. In both cases vigorous policies are essential, not just on the supply side but especially in end uses.

A number of studies indicate that, based on the second law of thermodynamics, the potential for efficiency improvement is huge, since the current efficiency might be on the order of only a few percent (Nakicenovic et al., 1996). Realization of this potential in practice is another story (cf. Banerjee et al., 2012).

Another perspective is given in a energy per capita and human development index (see Figure 3). With development, ever less energy is required to achieve high levels of the index. With further progress, it can be expected to decrease even further. In fact, current average per capita energy needs are in the range of about 80 per cent of the index, meaning that total energy will not need to increase much more in the future. However, inadequate distribution must be improved, and those excluded need to be served to afford them a decent life.

Figure 26.3

**Per capita energy is shown with the human development index (HDI) indicating that after an initial rapid increase the improvements of HDI start to level off at high levels of per capita energy. Current average per capita global final energy is about 70GJ/capita, achieving values in excess of 80 per cent HDI index. (Source: based on Steinberger and Roberts, 2010)**




There are many energy pathways in the literature, well over a thousand. Many pursue sustainable energy futures. Across the scenarios, the roles of different energy sources, as well as the role of efficiency, are varied. GEA pathways, in general, and the six related to SDG 7 portray possible futures with a large share of nuclear, as well as futures with continued reliance of fossil energy, but all six achieve the three SDG 7 goals.

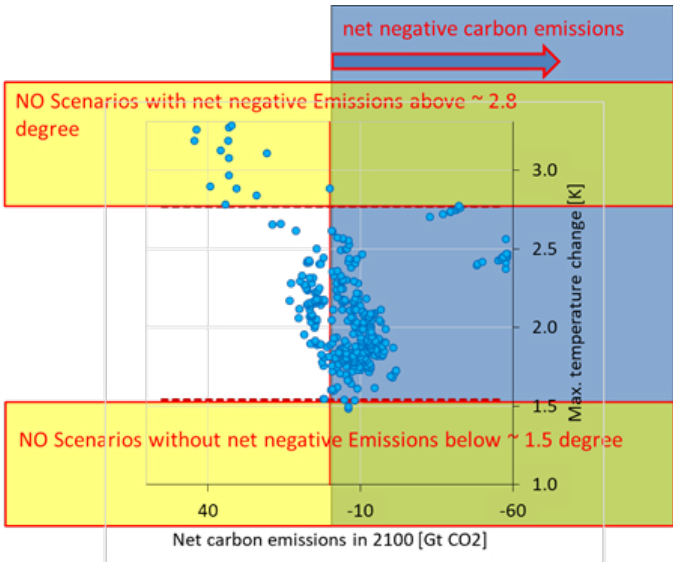
## Interlinkages with other SDGs

### SDG 13

Many of the scenarios in the literature are related to achieving SDG 13, namely stabilizing emissions to reduce global warming below 2°C compared to preindustrial levels. One of the major constraints for sustainable energy pathways is the global carbon budget. For stabilizing at below 2°C about 600 to 800 billion tons of $CO_2$ can be emitted and for 1.5°C only 200 billion tons or so. This budget will be exhausted in no time with current energy-related annual emissions of some 36 billion tons $CO_2$ per year.

Figure 26.4

**Emissions pathways in the literature indicate for low climate stabilization levels, say between 1.5 and about 2.7°C stabilization, a very high share of pathways have huge net-negative emissions by 2100. (Data Source: IAMC AR5 Scenario Database, 2014)**




One of the ways forward to reach climate goals is with huge efficiency improvements and increases of renewables as shown in the GEA pathway in Figure 4. The other ways are to continue the reliance on fossil energy in conjunction with carbon capture and storage. Nuclear is also an option in pathways that assume public acceptance and resolution of the proliferation challenges. In all cases, the pathways (including from recent literature and the GEA), indicate that net-negative emissions would be required to achieve SDG 13 with stabilization at below 2°C. The lower the stabilization level, the higher the need will be for net-negative emissions in order to stay within the remaining carbon budget—assuming nothing else changes. Afforestation is an obvious option for achieving net negative emissions. Another is sustainable use of biomass in conjunction with carbon capture and storage. However, carbon removed from the atmosphere would need to be stored in reservoirs that are virtually leakage-proof over a time scale of thousand years or more. The need for net-negative emissions will have important implications for the energy sector; if they are required for a sustainable future both carbon capture and sustainable biomass will need to be scaled-up and deployed at a large scale as soon as possible.

### SDG 15

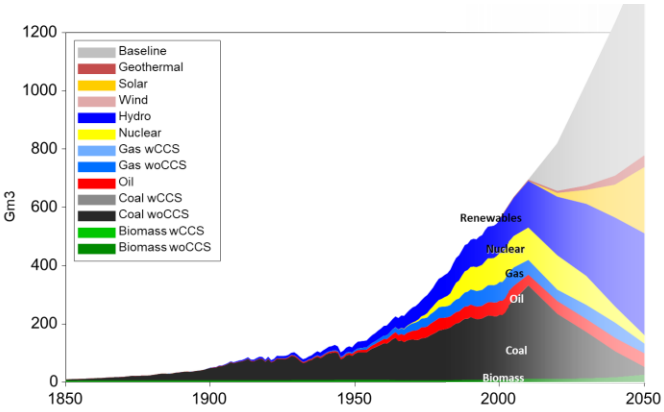
Energy is essential for food security, as it provides motive power, production of fertilisers, food processing and transport. An important connection between projected energy pathways and SDG 15 relates to the impacts of energy on land use, and potential conflicts between land use for energy and food. This is not only related to biomass as an energy source. Other potential conflicts relate to renewables and fossil energy, especially with respect to air and water pollution.

### SDG 6

The energy sector is responsible for about 15 per cent of global water withdrawals, mainly for cooling of thermoelectric power plants (IEA, 2012). Thus, there is a strong connection to SDG 6 on water. The GEA pathways shown in Figure 5 with high shares of renewables do not pose a huge challenge for water withdrawals averaged for the world, but may do so in some arid areas using hydropower, which are likely to see increased negative impacts with continued climate change. However, other GEA pathways that rely more on fossil fuels and carbon capture and storage need ever-increasing water withdrawals. This is one of many cases of possible trade-offs and synergies among the SDGs.

Figure 26.5

Water withdrawals for the GEA pathway with high share of renewables indicating that water demand shifts from coal as its share in energy declines toward renewables, including hydropower.



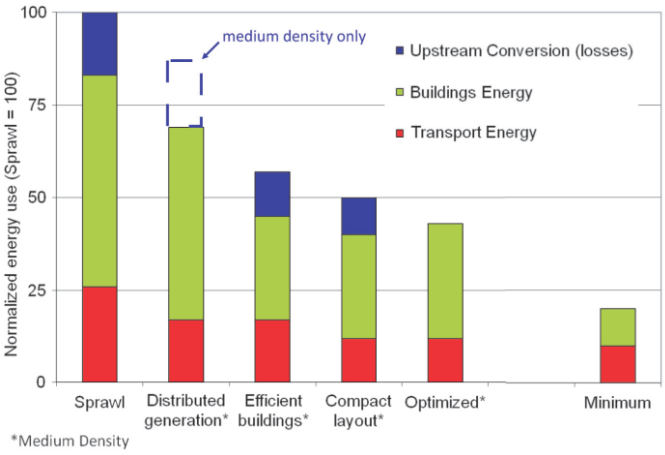

Source: based on Fricko et al., 2017

**SDG 11**

Another great challenge is the rapid urbanization in the world (relating to SDG 11). In the highly-developed countries of the world, most of population lives in urban areas or within urban sprawl. Globally, just over half of the people live in urban areas, mostly in small to medium-sized cities. This share is likely to rise to about two-thirds by 2050.

Figure 26.6

**Model simulations for a 'synthetic' city with 20,000 inhabitants suggest improvement potentials of at least a factor of two each from buildings that are more energy-efficient and from a more compact urban form, with energy system optimization through distributed generation and resulting cogeneration of electricity, heat, and air conditioning adding another 10–15 per cent improvement in urban energy use. (Source: Grubler et al., 2012)**




Without vigorous energy-efficiency improvement of cities, energy demand will continue to increase with increasing urbanization in the world. Cities can have very high levels of efficiency assuming, for example, there are sustainable developments such as "closed metabolism" systems with full recycling (circular economy) and "urban mining" of wastes, and more collective transportation infrastructure.

## Policy implications and recommendations

Stimulate additional energy investments: Energy investments need to increase to US$ 2.5 trillion per year by 2030, with further increases beyond that. These investments should also provide substantial savings in operation costs and positive externalities so that they would be cost-effective in the long term. Attracting capital is a major challenge, because most investment today is oriented toward high yields in the short term rather than sustainable gains in the long run. In particular the high up-front investment needs require new models of de-risking and a reliable regulatory and policy framework.

Science, Technology and Innovation: Vigorous investment in Science, Technology and Innovation (STI) needs to complement deployment and diffusion. STI and deployment of new technologies offer opportunities for learning by doing, and rapid decreases in costs that can make the transformation to a sustainable energy future affordable. This has to be embedded in a facilitating environment along the whole value chain that is rewarding to innovators.

Design energy policies that seek synergies to shield against severe distributional consequences of the energy transformation: Energy policies should consider multiple benefits and potential synergies with other SDGs. This would also decrease the costs of the transformation. Integrated policy frameworks and new institutions are required for achieving the synergies across SDGs. Sustainable policies are a must, because volatility of regulatory mechanisms blocks long-term investments. Strongly negative distributional effects have to be avoided in order keep acceptance high for the energy transformation. For instance, recycling of carbon revenues could offer an option to compensate for disproportionally high costs on the poor.

Enable and support behavioural changes: New behaviours and emergence of sustainable social norms and values are central to the energy transformation toward a sustainable future. This includes a shift in focus towards the demand side, with an emphasis efficient services rather than increased energy use—'negawatts instead of megawatts' needs to become a new credo. Digitalization can be a great facilitator in this regard. Moreover, the right incentive structures—such as real time pricing—need to be in place in order to trigger these types of behavioural changes.

Accelerate transformation and avoid lock-ins in old path dependencies: The future transformation needs to take place at a much higher rate of change than observed in the past. This requires disruptive thinking in terms of the imagined futures and the complementary disruptive policy interventions. For instance, coal based electricity generation without the use of CCS will have to be phased out well before the end of its technical lifetime. Also, the current rate of change in the transport sector towards emission-free vehicles is much too slow and bears the risk of creating technology lock-ins. Rapid transformation of the energy system offers a window of opportunity for developing countries to leapfrog toward sustainable futures.

## References

AGECC, UN (2010), "The Secretary-General's Advisory Group on Energy and Climate Change (AGECC) Energy for a Sustainable Future Report and Recommendations." New York, April 28 2010.

Banerjee, R., Y. Cong, D. Gielen, G. Jannuzzi, F. Maréchal, A. T. McKane, M. A. Rosen, D. van Es and E. Worrell (2012), Chapter 8—Energy End Use: Industry. In Global Energy Assessment—Toward a Sustainable Future, Cambridge University Press, Cambridge,

UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, 513-574. Fricko, O., S. Parkinson. N. Johnson, M. Strubegger, M.T.H. van Vliet and K. Riahi (2017), Energy Sector Adaptation in Response to Water Scarcity. In: IIASA Institutional Evaluation 2017, 27 February-1 March 2017, International Institute for Applied Systems Analysis, Laxenburg, Austria.

GEA (2012), Global Energy Assessment—Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria.

Grubler, A., X. Bai, T. Buettner, S. Dhakal, D. J. Fisk, T. Ichinose, J. E. Keirstead, G. Sammer, D. Satterthwaite, N. B. Schulz, N. Shah, J. Steinberger and H. Weisz (2012), Chapter 18—Urban Energy Systems. In Global Energy Assessment—Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, 1307-1400.

IAMC AR5 Scenario Database (2014), available at: https://secure.iiasa.ac.at/web-apps/ene/AR5DB/

International Energy Agency (IEA) (2012), World Energy Outlook 2012. OECD/IEA, Paris, France.

International Energy Agency (IEA) (2017), World Energy Outlook 2017. OECD/IEA, Paris, France.

IRENA (2017), Perspectives for the Energy Transition investment needs for a low-carbon energy system. Chapter 3, REmap Scenario.

Nakicenovic, N., P.-V. Gilli and R.Kurz (1996), v Regional and global exergy and energy efficiencies, Energy, Vol .21, Iss. 3, , Pages 223-237.

Riahi, K., F. Dentener, D. Gielen, A. Grubler, J. Jewell, Z. Klimont, V. Krey, D. McCollum, S. Pachauri, S. Rao, B. van Ruijven, D. P. van Vuuren and C. Wilson (2012), Chapter 17—Energy Pathways for Sustainable Development. In Global Energy Assessment—Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, pp. 1203-1306. Steinberger, J. and T. Roberts (2010), From constraint to sufficiency: The decoupling of energy and carbon from human needs, 1975–2005, in Ecological Economics, Vol. 70, Iss. 2, 425-433.

VEF (2011), Summary Report on the Vienna Energy Forum 2011—Energy for All—Time for Action. 21—23 June 2011, Vienna, Austria.

WEC (2016), World Energy Scenarios 2016. World Energy Council. London, UK.

# POLICY BRIEF #27

## INDICATORS AND DATA FOR ENERGY FOR SUSTAINABLE DEVELOPMENT


### Developed by

United Nations Economic Commission for Europe (UNECE)

### In collaboration with

IEA, World Bank, WHO, UNECA, UNECLAC, UNESCAP, UNESCWA

## KEY MESSAGES

### Status of indicators and data and progress towards achievement of SDG 7

- Tracking of progress towards achieving SDG 7 shows that i) current approaches on indicators could be refined, and ii) capacities to collect relevant data need enhancement. Adopting international methodologies for statistics and indicators is a prerequisite for improved analytical quality, global coverage, and comparability.
- Current indicators are derived from the existing data gathering and reporting infrastructure. In order to enhance policies that accelerate the energy transition, it will be necessary to adapt the existing indicators for energy access, energy efficiency, and renewable energy. It will also be necessary to develop new indicators for the future system and to develop capacities to collect, analyse, track and report the new data and indicators. New indicators should embrace nexus areas of water, food, and climate, track investments in clean energy, and address other forms of energy.
- Decision makers would be better informed with a broader range of forward-looking indicators that cut across the 2030 Agenda. Considering a broader concept of "energy for sustainable development" would measure progress towards all energy-related SDGs to reflect cross-cutting interconnections among the SDGs.

### Priority Actions

- On energy access, the SDG 7 indicators relate to how many people have access to electricity and to clean cooking fuels and technologies. Complementary indicators could address challenges of affordability, reliability, quality of access, access to heating services, and access to other kinds of energy.
- Energy efficiency is commonly measured by energy intensity (the energy needed to produce one unit of economic output). Other useful indicators could be energy productivity (the ratio of GDP to total primary energy supply (TPES)), and the efficiency with which primary energy resources are transformed into useable energy at the point of consumption.
- For renewable energy, the SDG 7 indicator is the share of renewable energy in TFC. Further indicators of progress would be: the share of renewable energy in TPES, renewable energy generating capacity, and investments in renewable energy. Indicators related to renewable energy should distinguish between traditional biomass and modern renewable energy, as these have very different social, economic and environmental implications.
- Reinforce and adequately resource energy statistics programmes that monitor and report comprehensive energy data, and integrate fully with other economic and social national statistical efforts.
- Ensure that full energy balances are produced regularly and in a timely fashion by governments, and international methodologies are adopted to ensure data comparability.
- Develop appropriate indicators for the system of the future, adapt existing data gathering systems, and build required capacities to collect and analyse data—then track and report on both data and indicators.
- Develop new indicators that embrace nexus areas on water, food, climate, investments in clean energy, and other forms of energy.
- Strengthen analytical capacity concerning interactions involving energy and climate, especially the water-food-energy nexus, in order to support innovative sustainable policy approaches to address these multidisciplinary, energy-related issues.
- Develop specialized national energy data observatories to centralize the consolidation, processing and analysis of energy-related data and indicators.

## Adapting and Complementing the SDG 7 Indicators

### Energy Access

Energy is essential for sustainable development and poverty eradication. In 2015 about 2.8 billion people had no access to modern energy services and over 1.1 billion did not have electricity (World Bank and IEA 2018).The SDG 7 indicators for energy access are the shares of population with physical access to electricity and the shares of population with access to clean cooking fuels and technology. However, even in countries with 100 per cent or near 100 per cent physical access to electricity, many people are challenged by issues of affordability, quality of access, and quality of service. Additional indicators that would address these challenges include affordability and reliability of electricity access (UNECE 2017).

For both electrification and cooking, the World Bank has developed a Multi-Tier Framework methodology that is a measure of energy access covering seven quality dimensions (including affordability and reliability) and places households in one of five tiers of access (as opposed to the traditional binary measure). The methodology, based on surveys, picks up deficiencies in service that are relevant even outside of the high access deficit countries. A first Global Energy Access Survey is under way in 15 high access deficit countries. The survey and analysis will apply this approach systematically on a large scale (World Bank 2017).

In cold climates, affordability and service quality of heating services (not electricity) are particular challenges with the lock-in of older, fossil fuel based heat infrastructure and poor insulation. Complementary indicators to show progress in this area would be heat demand, affordability of heating, and quality of heating services.

### Energy Efficiency

A commonly used measure for energy efficiency is energy intensity, although the two are not equivalent. Energy intensity, in itself, does not reflect differing economic structures, availability of resources, activity levels or climatic drivers for energy use. It is an indication of how much energy is needed to produce one unit of economic output: a lower ratio indicates that less energy is used to produce one unit of output. The SDG 7 indicator is the rate of growth in energy intensity measured as the ratio of TPES to GDP, with the latter measured in a way designed to avoid distortions caused by exchange rate fluctuations.

An alternative to energy intensity is its mathematical inverse, energy productivity. Energy productivity has the positive connotation of improving productivity, whereas energy intensity has the negative connotation of having to stop using so much energy. Most governments are more motivated to improve their country's social wellbeing, economic productivity and environmental impacts than to "save energy". Intuitively, people adopt concepts more willingly when improvement leads to an increase in value rather than a decrease. The recommended complementary indicator is therefore energy productivity (absolute, not the rate of growth) measured as the ratio of GDP to total primary energy supply.

Several national and international initiatives are developing end use indicators to track progress on energy efficiency across sectors. (There is currently inadequate data to calculate energy productivity at the sub-sector level.) End use indicators may be more or less disaggregated depending on the data availability, and require both energy and "activity" data from outside the energy statistics domain that make the data collection challenge greater. While methodologies have been developed internationally, outside of the OECD and a handful of larger countries, there is little good data on energy outputs, particularly in the transportation sector (vehicle-kilometres travelled) or building sector(square metres of area). Without the ability to drill down into the sectoral and sub-sectoral level, the diagnosis of energy efficiency challenges remains quite rough. Solving this issue will require the adoption of common methodologies and a concerted cross-sectoral data gathering effort, as often the missing information will have to come from the energy-using sector rather than from the energy sector itself.

Other indicators for energy efficiency relate to the production, transmission, and distribution of electricity, and the efficiency with which primary energy resources are transformed into useable energy at the point of consumption. Efficiency in electricity generation, measured as primary energy used for electricity production divided by delivered electricity, would provide a useful measure of supply side efficiency. The Global Tracking Framework reports on supply side efficiency, with thermal generation efficiency, and transmission and distribution losses, (using IEA data) as complementary indicators (World Bank and IEA 2017, 2018).

### Renewable Energy

The SDG 7 indicator for renewable energy is the share of renewable energy in total final consumption (TFC). Measuring renewable energy as a share of energy is an indicator of progress in: reducing global greenhouse gas (GHG) emissions and local pollution sources; a country's progress in developing and utilizing available resources sustainably; and improving sustainability over the entire energy value chain. Measurement of renewable energy as a share of TFC can be useful, but it ignores the 6-8 per cent transmission losses that are incurred through the transmission and distribution network. A second option is an indicator expressing renewable energy as a share of TPES, but this measurement ignores losses incurred in the combustion of fossil fuels. While both indicators have their advantages, it is important to understand primary

energy options and their implications. Both indicators can be used, but they must be interpreted carefully. A third option would be an indicator that could account for exergy, or entropy. In this case, renewable energy's contribution is evaluated with respect to total primary energy requirements (TPER), based on the primary energy required to provide its equivalent input to the energy system. This indicator would reflect the real contribution of renewable energy to reducing GHG emissions and displacing non-renewable energy sources.

Further indicators of progress on renewable energy would be renewable energy generating capacity additions, and investments in renewable energy capacity. Tracking investments in renewable energy capacity provides further insight into the success of developing renewable energy.

All of the indicators related to renewable energy should distinguish between use of traditional biomass and modern renewable energy.

#### SDG targets 7A and 7B

SDG 7 targets 7A and B need to be monitored closely with appropriate indicators to track mobilization of funding, investment in energy efficiency, and foreign direct investment in infrastructure and technology.

## Recommendations for Energy Indicators in addition to SDG 7

In order to inform policies to accelerate the transition to an energy system that can support sustainable development, it will be necessary to: develop appropriate indicators adapted to the system of the future; adapt existing data gathering systems; and build the required capacities to collect, analyse, track and report new data and indicators. The total set of indicators should be comprehensive but focused so that clear and accurate messages emerge for decision makers.

At a minimum, new indicators should: embrace the nexus areas with water, food, and climate; track investments in clean energy; and enlarge the chosen energy indicators to include other forms of energy. The 2018 global tracking report includes a special chapter addressing nexus issues (World Bank and IEA 2018). For energy, it is critical to think in terms of a wholly interconnected, complex system, in which supply, demand, conversion, and transport/transmission interact freely and flexibly to deliver affordable energy services to customers. This perspective applies within regions and sub-regions, and also between regions and economic sectors.

Indicators to track energy for sustainable development in addition to those for SDG 7 show that increased efforts are required throughout the energy system. Attaining the objectives of the 2030 Agenda will require full engagement of the private sector to transform energy. As a consequence, it is essential to monitor progress on energy for sustainable development in ways that reflect the cross-cutting interconnections among the SDGs and that involve the private sector in more integrated ways.

Given that world's share of fossil fuels in TPES is 80 per cent and will likely remain above 50 per cent in the coming decades, the transition to a clean, affordable and low-carbon energy system will require solutions for the use of fossil fuels. To track progress towards this objective, the share of fossil fuels in the energy system could be one additional indicator to measure progress towards a low-carbon future. Other indicators could include the efficiency of fossil fuel based power generation and methane ($CH_4$) emissions along the energy value chain. To assess whether targets linked to SDG 13 on climate can be achieved, it would be useful to provide information on the GHG and/or $CO_2$ intensity of TPES and TFC, and carbon dioxide ($CO_2$) emissions from fossil combustion. This information is available from the IEA (UNECE 2017)

The data gathering and reporting infrastructure that exists today has emerged and evolved over many years, and changes and improvements to this system require extensive consultation, adaptation, and capacity development support. This process is ongoing, but will take more time to realize in practice. Tracking important pillars, such as the carbon intensity of energy or per capita carbon emissions, is difficult because of missing data or differences in reporting approaches.

A number of new paradigms have emerged from recent analyses regarding indicators for the future, whether related to quality of service or holistic systems analysis. There is merit in considering what indicators would point to a future in which energy for sustainable development is assured. Once a concise set of indicators has been identified, it will be necessary to establish new data gathering infrastructure. The tables annexed to this policy brief set forth a broad range of possible indicators of energy for sustainable development.

#### Transforming energy from a commodity business to a service business

The energy industry has succeeded in raising the quality of life around the world through the provision of energy services, most notably in the advanced economies, but access and affordability challenges remain. It was noted above that affordability should be included in the measure of energy access. That perspective considers kWh units sold and bought as a share of household budgets. New approaches from a services perspective will allow those without access to energy to leapfrog over existing technology and systems and benefit from innovation and falling technology costs. Current indicators will not capture that shift.

Changing the energy industry to a service configuration involves changing the business model of a utility (or service provider) to

one that maximizes the margins between the revenues received for services provided (for example, indoor comfort or mobility) and the costs of providing those services (through, for example, efficiency investments). Realising the potential for this will require careful reconsideration of, and readiness to revisit, the existing regulatory, policy, technical, and organizational infrastructure of energy systems. These are the types of considerations that a more complete set of indicators would be able to inform. There should be an engaged and continuing conversation about what changes are requires, the relevant indicators that would point to progress, and the data (and sources) that would be needed to populate the indicators.

## REFERENCES

International Energy Agency (IEA) (2014); "Energy Efficiency Indicators: Fundamentals on Statistics", available online at: http://www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-fundamentals-on-statistics---.html

IEA (2014); "Energy Efficiency Indicators: Essentials for Policy Making", available online at: http://www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-essentials-for-policy-making.html

IEA (2017), "Tracking Clean Energy Progress", Energy Technology Perspectives 2017 Excerpt. IEA/OECD, Paris.

United Nations Department of Economic and Social Affairs (UN DESA) (2018),"International Recommendations on Energy Statistics",, New York, available online at:https://unstats.un.org/UNSD/energy/ires/default.htm

United Nations Economic Commission for Europe (UNECE) (2017), "Global Tracking Framework: UNECE Progress in Sustainable Energy", UNECE Energy Series No. 49, 2017, United Nations, New York and Geneva, available online at: https://www.unece.org/fileadmin/DAM/energy/images/CSE/publications/Global_Tracking_Framework_-_UNECE_Progress_in_Sustainable_Energy.pdf

United Nations Economic Commission for West Asia (UN ESCWA) (2017), "Arab Region Progress in Sustainable Energy—Global Tracking Framework Regional Report", available online at: https://www.unescwa.org/publications/gtf-regional-report-arab-region-progress-sustainable-energy

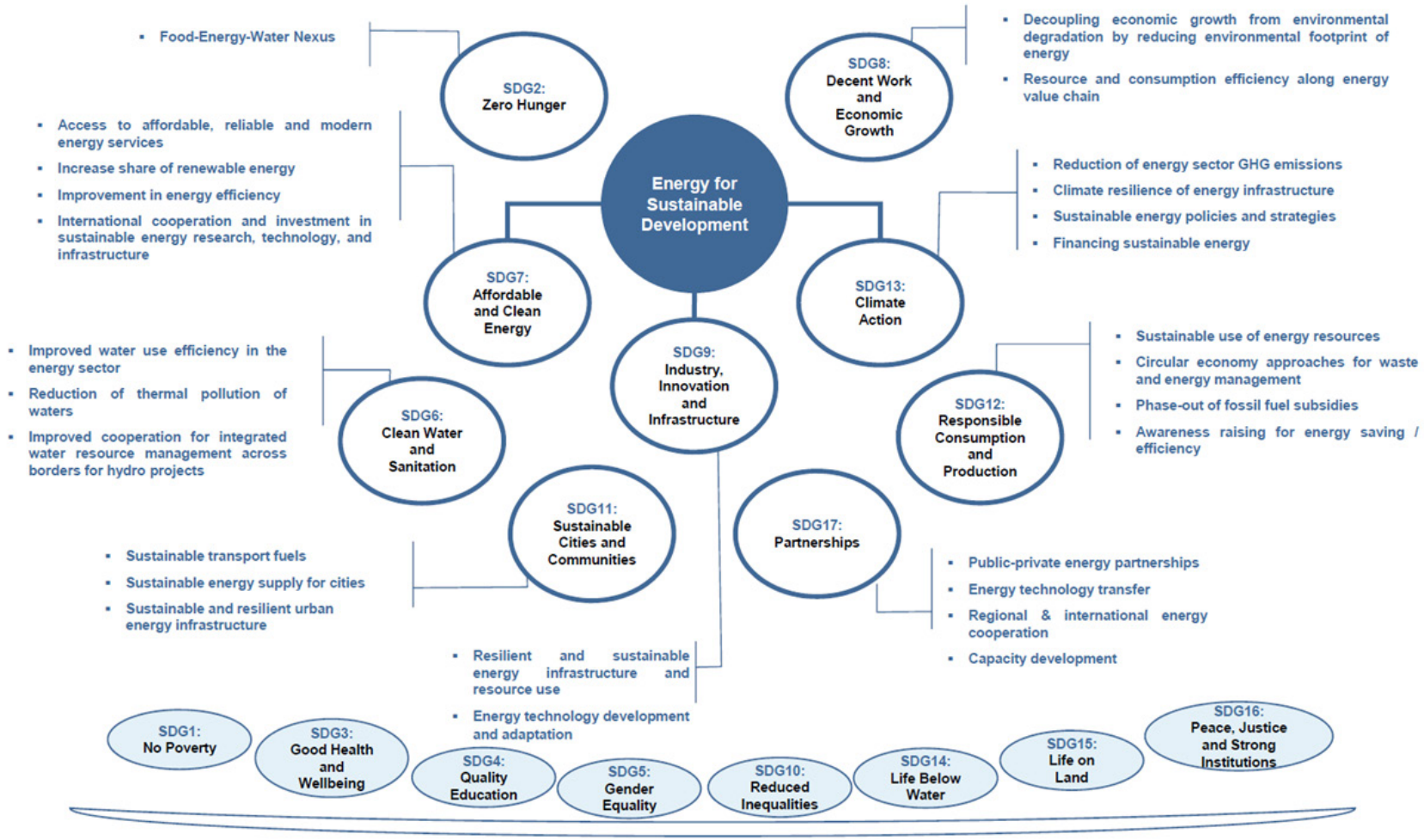
World Bank (2017), "Multi-Tier Framework for Measuring Energy Access", available online at: https://www.esmap.org/node/55526.

World Bank and International Energy Agency (IEA) (2017): "Global Tracking Framework 2017", available online at:

World Bank and IEA (2018): "Global Tracking Framework 2018", available online at: http://gtf.esmap.org/downloads

Figure 27.1

**Contribution of Energy to the 2030 Agenda for Sustainable Development**




Source: UNECE (2017). *Global Tracking Framework: UNECE Progress in Sustainable Energy*.

## Possible Indicators Considered for Energy for Sustainable Development

**(Bold Red: SDG 7 current indicators; Bold Blue: Recommended complementary indicators; Black: indicators considered but not recommended)**

| Pillars | Suggested Indicators (or areas for indicator formulation) |
|---|---|
| ENERGY | |
| Energy Access | • **7.1.1 Proportion of Population with Primary Reliance on Clean Cooking Fuels and Technology**<br>• **7.1.2 Proportion of Population with Access to Electricity**<br>• **Affordability, expressed as share of household income spent on energy**<br>Suggested areas to formulate additional indicators:<br>• **Reliability and quality of electricity access**<br>– Number of hours of access to electricity per day (outage rates)<br>– Technical quality (frequency, voltage)<br>– Number of turnoffs by type of consumer<br>– Number of households with access to main grid<br>– Time required to fix disruptions<br>– Number of households with generators<br>– Loss of GDP through interrupted supply (VOLL)<br>– Transmission losses<br>• **Energy Poverty, encompassing access to and quality of heating and cooling** |
| Renewable Energy | • **7.2.1 Renewable Energy Share in Total Final Energy Consumption (TFC)**<br>• **Share of modern / traditional renewable energy in TFC**<br>• **Share of renewable energy in Total Primary Energy Supply (TPES)**<br>• **Additions of renewable energy installed capacity (installed and rated)**<br>• **Investments in renewable energy**<br>• Share of renewable energy in bus-bar energy (e.g., post combustion but pre transmission and distribution losses)<br>• Installed reliable renewable energy capacity per capita<br>• Renewable energy by type of output (electricity, liquids, heat)<br>• Ratio of renewable energy (capacity, production/consumption) to total electricity (capacity, production/consumption)<br>• Share of renewable energy expressed in terms of Total Primary Energy Requirements (TPER, *i.e.*, taking into account the actual non-renewable primary energy required to provide the same final RE).<br>• Number of people with access to RE<br>• Terms of access of renewable producers to networks<br>• Share of renewable energy in installed reliable capacity (versus generation)<br>• Cost of producing 1kWh from solar PV / Wind /other renewable energy (under consideration of distribution losses with a view towards improving the network)<br>• Installed energy storage (batteries (including EV's), pumped storage, phase change materials, other technologies |

| Pillars | Suggested Indicators (or areas for indicator formulation) |
|---|---|
| **Energy Efficiency** | • **7.3.1 Energy Intensity Measured in Terms of TPES to GDP (MJ/USD**<br>• **Energy Productivity Measured in Terms of GDP to TPES (USD/MJ)**<br>• **Supply side efficiency in electricity generation**<br>• Ratio of TFEC to GDP (MJ/USD)<br>• Compound annual growth rate, or CAGR of TFC as well as of TPES<br>• Transmission losses<br>• Ratio of TPES to TFC net of imports and exports<br>• For SDG indicator 7.a.1: Replace "USD invested in energy efficiency" with "USD invested divided by energy saved over the life of the investment"<br>• Price elasticities of energy demand and supply<br>• Spend by governments on energy efficiency (through grants, concessionary finance etc.).<br>Sector-specific Indicators (industry, transport, buildings) required disaggregated data<br>• Energy use in buildings (kWh per $m^2$ of used space)<br>• Efficiency measured as the amount of energy needed to provide demanded energy services<br>Sector-specific Physical Energy Intensity Indicators<br>• Specific energy consumption defined as the amount of energy to produce a tonne of steel |
| **Other Energy Sources** | • **Share of fossil fuel in TPES**<br>• **Efficiency of fossil fuels in generation**<br>• Methane emissions along the value chain<br>• Share of nuclear in TPES<br>• Cost comparison of unsubsidized renewable energy with unsubsidized fossil<br>• Bringing it all together, Fuel Mix in TPES; Fuel mix in Electric Generating Capacity; TFC by end-use |
| **NEXUS** | |
| **Climate** | • **CO2 emissions from fossil fuel combustion (total and per capita) per TPES and per TFC**<br>• **GHG emissions of energy sector** |
| **Water** | • Clean water treatment (sanitation, desalination volumes and efficiency, …)<br>• Water resource depletion (aquifer), intermittent energy supply<br>• Fracking and water use, chemical pollutions<br>• Water cooling systems in the energy world (evaporation losses, thermal losses through cooling)<br>• Transfer of water (system to system, transboundary), hydro, agriculture<br>• Impacts of large hydro development<br>• International water resource management<br>• Thermal pollution in rivers / impact of water cooling systems in energy generation |

| Pillars | Suggested Indicators (or areas for indicator formulation) |
|---|---|
| **Land** | • Land intensity of renewable energy (wind, solar, biomass)<br>• Deforestation caused by use of traditional biomass<br>Suggested areas to formulate additional indicators:<br>– Land management in cities<br>– International land management |
| **Food** | • Food waste for biofuels / compost<br>• Fertiliser production<br>• Energy embodied in food exports / imports |
| **Environment** | • Energy use per passenger miles<br>Suggested areas to formulate additional indicators:<br>– Air quality / health / exposure; Health impacts of household air pollution<br>– Waste as resource: Recycling; waste to energy |
| **Socioeconomic** | • Energy poverty / affordability: household money spent on energy<br>Suggested areas to formulate additional indicators:<br>– Quality of building codes (does it cover humidity, indoor air quality)<br>– Embodied energy in materials and structures (cement, steel, use)<br>– Economic value added of energy exports (benefits in the receiving country)<br>– Corruption index associated for PPP energy<br>– Number of hours spent by households gathering fuelwood |

## Possible Indicators for different elements of the energy system

| System Element | Insights | Potential Indicators |
|---|---|---|
| **Consumer service quality** | There is a need to move beyond simple notions of 'access' and 'energy poverty' to real metrics for end use service quality, entitlement and access in households and businesses, while accommodating diversity in resources, expectations and needs. Importantly how these contribute to SDG outcome goals. | Systematic tracking of:<br>• Achieved end-use service quality against basic welfare norms.<br>• Affordability of end use service quality (the cost of the service attained rather than the unit price of energy) |
| **End-use efficiency** | There is a need to move beyond naïve energy intensity to real energy efficiency indicators, with a concatenated structure of indicators that also highlight structure and activity within households and businesses. | Systematic tracking of:<br>• Changes in household size, occupancy, and efficiency of key end use applications in households.<br>• Changes in economic structure, end use efficiency and value added in industry and commerce.<br>• Changes in modal and vehicle structure, activity and end use efficiency in transport. |
| **Distributed cost-reflective utilities** | There is a need to identify how utilities can better incentivize consumer demand responsiveness and end-use efficiency as T&D utilities shift from being energy distributors to become capacity managers of diverse central and distributed energy producers. | Systematic tracking of:<br>• Changes in the actual performance of central supply systems, distributed and end-use energy, within competent life cycle analytical frameworks. |
| **Supply system innovation and sustainability** | There is a need to understand how supply side policies and practices can evolve a more sustainable and economically efficient supply system. | Systematic tracking of:<br>• Changes in supply system value and performance within competent life cycle analytical frameworks. |
| **Resource sustainability** | There is a need to understand how diversifying the resource mix, economic trade, and managing environmental nexus impacts can enable a more resilient and sustainable energy system. | Systematic tracking of:<br>1. Metrics for separate and integrated resource (energy water, land, and air) system resilience.<br>2. Changes in resource (energy water, land, and air) system value and performance within competent life cycle analytical frameworks.<br>3. Metrics for nexus dynamics. |

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