



TRACKING **SDG 7**

THE ENERGY  
PROGRESS  
REPORT

2020



A joint report of the custodian agencies



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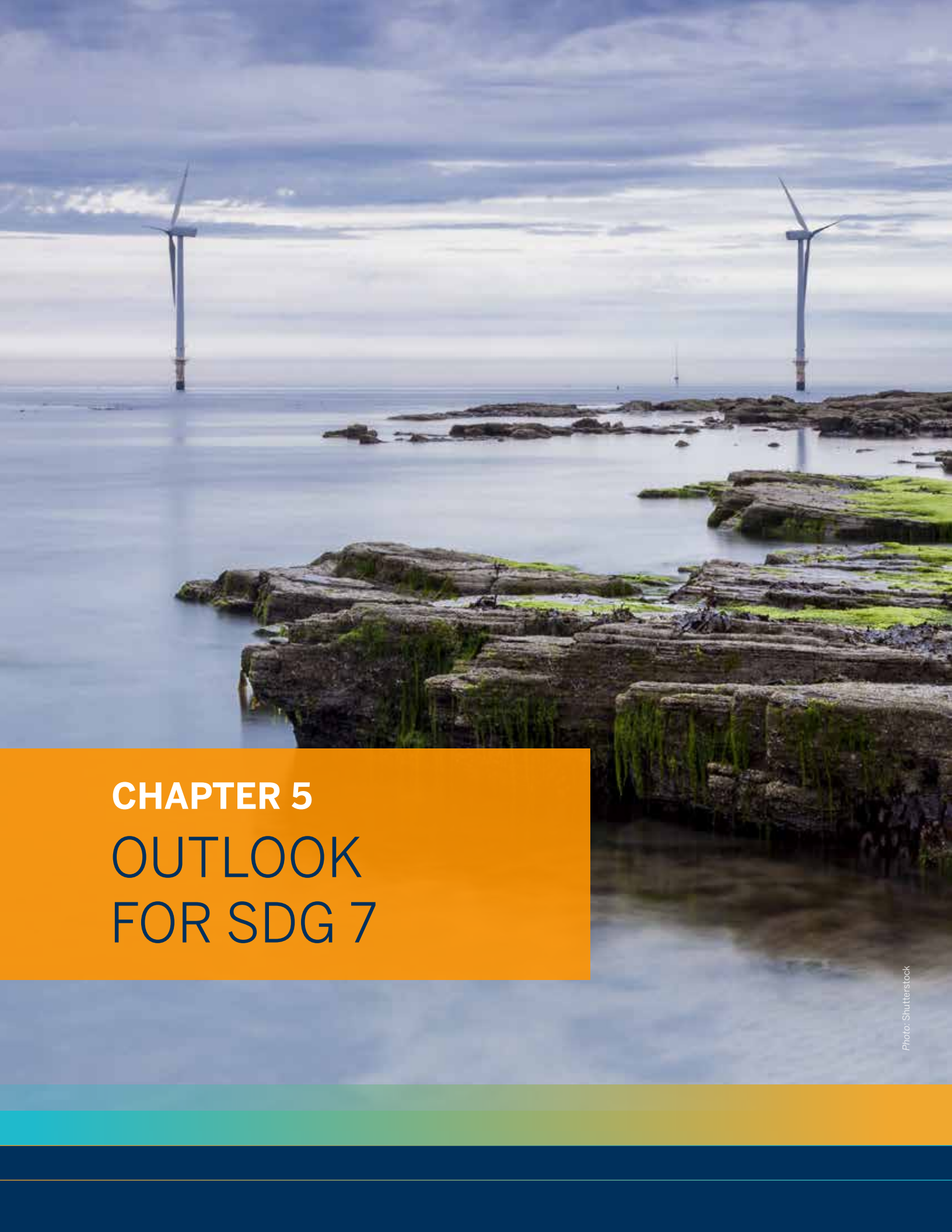
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A photograph of two offshore wind turbines in the ocean, viewed from a rocky coastline. The foreground shows layered, moss-covered rocks. The sky is overcast with grey clouds. The water is calm and blue-grey. The turbines are white with three blades each. A small boat is visible in the distance between the turbines.

# CHAPTER 5 OUTLOOK FOR SDG 7

# MAIN MESSAGES

- **Outlook for progress toward 2030:** At the current rate of progress, the world is not on track to achieve Sustainable Development Goal 7 (SDG 7). In this chapter, forward-looking scenarios are used to outline how the energy system could further support the achievement of global climate and sustainable development goals. The Stated Policies Scenario of the International Energy Agency (IEA) shows that current and planned policies will not be enough to meet the goals; in fact, under this scenario, none of the target is reached by 2030. IEA's Sustainable Development Scenario lays out a pathway to put the world's energy system on track to achieve the SDG targets most closely related to energy (those in SDG 3.9, SDG 7, and SDG 13).<sup>32</sup> For renewables, the Transforming Energy Scenario 2030 of the International Renewable Energy Agency (IRENA) also presents a possible way to achieve the goal of substantially increase renewable energy.
- **Outlook for access to electricity:** Recent progress was mixed, as is the outlook to 2030: under IEA's Stated Policies Scenario, around 620 million people would still lack access to electricity in 2030. Thanks to well-designed policies, the countries of Developing Asia are expected to expand electricity access to 98 percent of the region's population by 2030. In Sub-Saharan Africa, Ethiopia, Ghana, Kenya, Rwanda, Senegal, and South Africa should reach universal access. Nonetheless, without further efforts, 36 percent of the population of Sub-Saharan Africa would be without access in 2030 if current and planned policies are continued. Decentralization is an important part of the answer. IEA's most recent analysis of Africa demonstrates that decentralized solutions constitute the least-cost way of providing access to more than half of the population who must gain access by 2030 to meet the target. The challenge boils down to expanding access to those living close to the central grid, while deploying in parallel decentralized systems to connect those living farther away—particularly in countries where access is least advanced.
- **Outlook for access to clean cooking solutions:** If clean cooking remains low on the political agenda, 2.3 billion people in 2030 will still be relying on traditional uses of biomass, kerosene, or coal for cooking, according to IEA's Stated Policies Scenario, with dramatic consequences for the environment and for the health of women and children. The acute challenge in Developing Asia and Sub-Saharan Africa is to understand how cultural, economic, and social factors combine to slow progress. A possible path forward lies in building on successful policies implemented in countries such as Ethiopia, Ghana, and India, and on the innovations observed elsewhere, to support the deployment of clean fuels and technologies, notably liquefied petroleum gas (LPG), natural gas, improved biomass cookstoves and innovative, renewables-based electric stoves and alcohol stoves.
- **Outlook for renewable energy:** The IEA and IRENA scenarios both conclude that solar photovoltaic (PV) and wind will account for most renewables-based electricity generation by 2030. The IEA's Sustainable Development Scenario further shows that intensified policy support and cost reductions could push the share of modern renewables in total final energy consumption (TFEC) to 23 percent, in which case renewables would supply around 50 percent of electricity generation. In IRENA's Transforming Energy Scenario, the rise in renewables by 2030 is slightly higher, reaching 28 percent of TFEC and 57 percent of electricity generation. While renewables would climb to around 50 percent or more of electricity generation under both the IEA and IRENA scenarios, more dedicated efforts are needed to boost the penetration of renewables in transport and heating.

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<sup>32</sup> Most of this chapter is based on results from IEA's World Energy Model (IEA 2019e) and from analysis in the World Energy Outlook (IEA 2019a). Some of the geographical groupings in this chapter, unlike foregoing chapters, are those used in the World Energy Outlook. "Developing Asia" refers to non-OECD Asia

- **Outlook for energy efficiency:** Recent estimates indicate that annual improvements in global energy intensity is low for 2018 (1.3 percent) and 2019 (2.0 percent), moving the world further from achieving SDG 7.3. For example, the efficiency improvement in transport slowed in 2018, in large part because global consumer preferences shifted toward heavier SUVs. As a result, the new annual rate of improvement required from 2017 to 2030 to achieve the target would be over 3 percent, while IEA's Stated Policies Scenario shows that the expected improvement resulting from current and planned policies would only be around 2.3% annually from 2017 to 2030. With the right policies in place, IEA's Sustainable Development Scenario shows that an annual average rate of improvement of 3.6 percent between 2017 and 2030 is nonetheless possible. The building sector holds large potential for energy savings from efficiency improvements. It is the locus of more than 40 percent of the needed savings in energy demand by 2030 under the Sustainable Development Scenario, compared with the Stated Policies Scenario.
- **Additional investments and fuel savings:** IEA and IRENA's scenarios estimate that achieving SDG 7 would require annual investments by 2030 of around \$680 billion to renewable energy (IRENA and IEA scenarios), around \$45 billion going to energy access and \$625 billion to energy efficiency (IEA scenario). Furthermore, a redirection of investment from fossil fuels to renewables is necessary to unlock the capital needed to put the world back on track to a sustainable future. In total, savings of up to USD 220 billion per year in fossil fuels investment could be achieved under the Sustainable Development Scenario. IRENA's Transforming Energy Scenario suggests that USD 10 trillion would have to be redirected from fossil fuels and related infrastructure.
- **International public financial flows to developing countries in support of clean and renewable energy:** While the bulk of investment in the energy transition has and would continue to come from private sources, public finance will play a significant enabling role to spur investment. Tracking of progress toward SDG indicator 7.A.1 performed by IRENA and the Organisation for Economic Co-operation and Development (OECD) shows that international public financial flows to developing countries in support of clean and renewable energy have grown by around USD 1.6 billion per year since 2010, reaching USD 21.4 billion in 2017.<sup>33</sup> Although this increase in public financial flows to renewables is promising, only 12 percent of the flows reached the least-developed countries in 2017.
- **SDG 7 and emissions:** The energy system is strongly linked with greenhouse gas emissions, and the achievement of SDG 7 is critical to the attainment of SDG 13, which aims to slow climate change. Scenarios from both IEA and IRENA show that greater policy efforts in renewable energy and energy efficiency (complemented by several other technologies) account for most of the energy-related reductions in CO<sub>2</sub> emissions needed to realize the Paris Agreement.

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<sup>33</sup> The figures are drawn from the Renewable Energy Public Investments Database, a joint OECD/IRENA database on international financial flows to developing countries in support of clean and renewable energy. <https://www.irena.org/Statistics/View-Data-by-Topic/Finance-and-Investment/Renewable-Energy-Finance-Flows>

This chapter describes the results of global modeling exercises undertaken to determine whether current policy ambitions are sufficient to meet the SDG 7 targets, and to identify what additional actions might be needed. It also analyzes what investments are required to achieve the goals, including an update on SDG indicator 7.A.1 on international financial flows to developing countries in support of renewables. It finishes by highlighting the links between the energy system and emissions of greenhouse gases, suggesting that tackling both through well-guided actions will be critical to progress toward SDG 13. Scenarios for the various targets are taken from IEA's flagship publication, *World Energy Outlook* (IEA 2019a). With respect to the renewable energy target, scenarios are also derived from IRENA's *Global Renewables Outlook: Energy Transformation 2050* (IRENA 2020d).

IEA's Stated Policies Scenario (referred to in earlier IEA publications as the New Policies Scenario) reflects the impact of existing policy frameworks and announced policy intentions. Its utility is to hold up a mirror to the plans of today's policy makers and elucidate their consequences for energy use, emissions, and energy security. The policies covered by the scenario span a broad range, starting with Nationally Determined Contributions under the Paris Agreement. In practice, the bottom-up modeling implied by the scenario involves a great deal of detail at the sectoral level, including pricing policies, efficiency standards and schemes, electrification programs, and specific infrastructure projects.

IEA's normative Sustainable Development Scenario<sup>34</sup> describes an integrated least-cost pathway allowing the world's energy system to deliver on energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce the air pollution that causes deaths and illness (SDG 3.9); and to take effective action to combat climate change (SDG 13). This scenario takes the SDG outcomes as its point of departure, working backward to set out what would be needed to achieve those outcomes in a cost-effective way. By 2030, under this scenario, universal access to both electricity and clean cooking is achieved; modern renewables reach 23 percent of total final energy consumption, more than doubling today's share; energy efficiency aims of SDG target 7.3 are exceeded, with average annual improvements in global energy intensity accelerating to 3.8 percent annually between 2019 and 2030; and the global temperature increase over preindustrial levels is held well below 2°C.

Two IRENA scenarios sharpen the picture. IRENA has explored global energy development pathways to 2030 and 2050 from two perspectives. The first is an energy pathway shaped by current and planned policies (the Planned Energy Scenario); the second, a cleaner, climate-resilient pathway based largely on a more ambitious, yet achievable, uptake of renewable energy and energy efficiency measures (the Transforming Energy Scenario).<sup>35</sup>

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34 More information on the IEA Sustainable Development Scenario can be found at: <https://www.iea.org/reports/world-energy-model/sustainable-development-scenario>.

35 More information on the IRENA Transforming Energy Scenario can be found at: <https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020>.

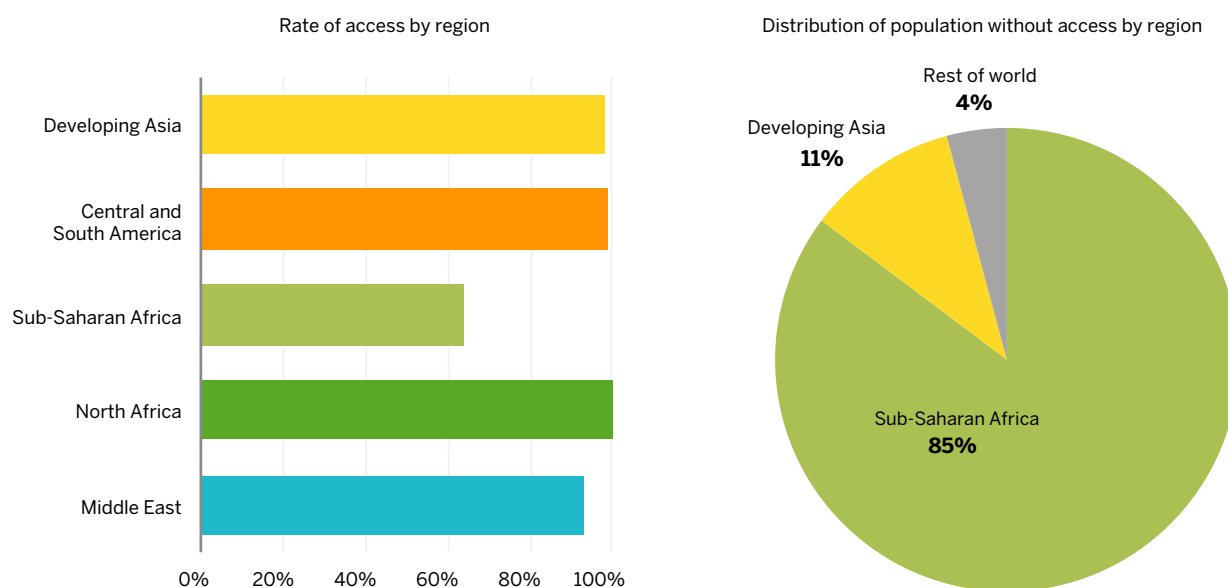
# THE OUTLOOK FOR ELECTRICITY ACCESS

## WHERE ARE WE HEADED?

Thanks to recent progress in several countries (chapter 2), the outlook for access to electricity indicates continued progress to 2030 but without achieving universal access. The number of people still lacking access to electricity in 2030 is expected to shrink under the current and planned policies mapped out in the Stated Policies Scenario to around 620 million (roughly 7 percent of the global population), 530 million of them in Sub-Saharan Africa. SDG target 7.1 remains within reach, and policies implemented in several countries have put them on track to achieve universal access, but the same cannot be said for many Sub-Saharan African countries.

Strong performance should put Developing (non-OECD) Asia on track to reach an access rate of 98 percent by 2030 (Figure 5.1). Bangladesh, India, Indonesia, and the Philippines are well on track to reach full access before 2030. Greater efforts are needed in Afghanistan or Mongolia, however, if the region is to achieve 100 percent access in 2030. Central and South America is projected to continue its steady progress, moving to 99 percent in 2030, with Haiti the only major country in the region to have a substantial unelectrified population.

**FIGURE 5.1 • Electricity access rates and distribution of population still lacking access in 2030, by region, under Stated Policies Scenario**



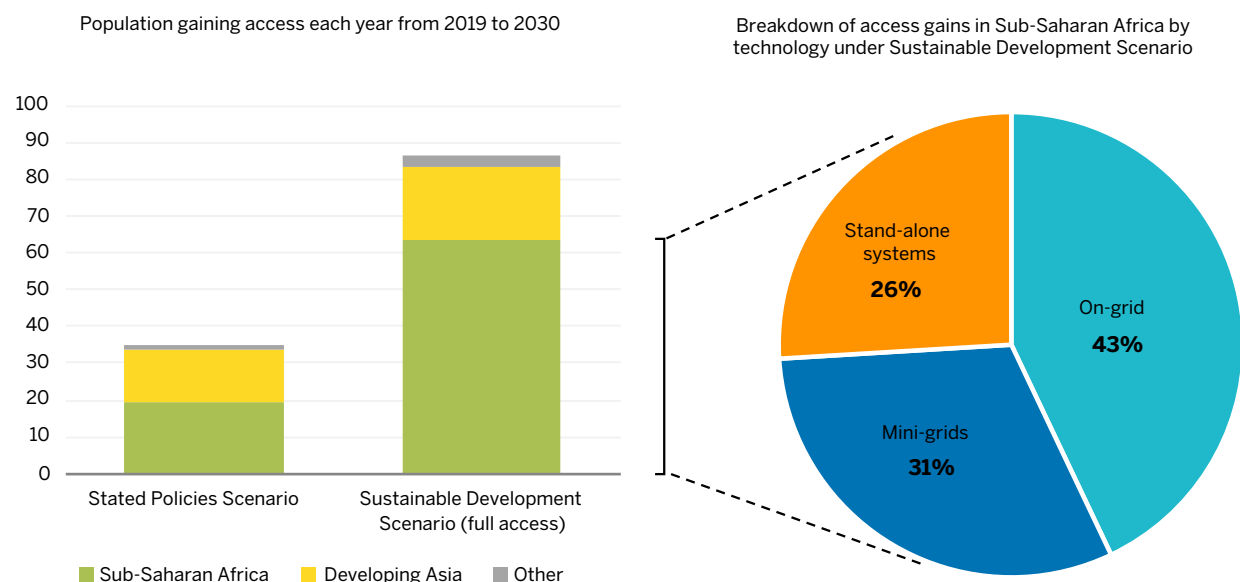
Source: IEA 2019a.

The situation is improving in Sub-Saharan Africa, where effective policies should allow Ethiopia, Ghana, Kenya, Rwanda, Senegal, and South Africa to reach full access by 2030 under the Stated Policies Scenario (IEA 2019b). For the region as a whole, the access rate is projected to rise to around 64 percent, though high rates of population growth mean that the number of people without access would still be about 530 million in 2030 under the Stated Policies Scenario. There would be almost 20 countries where less than half of the population has access, and 10 where less than one in four has access. Among the latter group are Chad, the Democratic Republic of Congo, Malawi, Niger, and Somalia. As a result, by 2030, 85 percent of the global population without access would be concentrated in the region. By 2040, that share would be more than 90 percent.

## HOW TO BRIDGE THE GAP

To bridge the gap and connect the remaining 620 million people projected by the Stated Policies Scenario to be without access in 2030, the connection rate would have to triple from its current level—to nearly 90 million a year between 2019 and 2030 (figure 5.2). Most of the acceleration would have to happen in Sub-Saharan Africa, as discussed in the previous paragraph. Certain countries would have to scale up efforts, notably the Democratic Republic of Congo, Niger, Nigeria, Sudan, and Uganda, which together are home to half of the regional population lacking access in 2030 under the Stated Policies Scenario.

**FIGURE 5.2 • Projected gains in access to electricity by region and technology, 2019–30**



Source: IEA 2019a, 2019b.

Policies that promote centralized and decentralized solutions in parallel are crucial to unlocking electricity access. Geospatial analysis developed by IEA identified decentralized systems as the least-cost option for more than half of the electricity connections (representing nearly 440 million people) that would have to be made in Sub-Saharan Africa if the region were to achieve universal access by 2030. Decentralized solutions (largely based on renewables) can be adapted to conditions in remote rural areas, where around 80 percent of the population without access in Africa would be concentrated in 2030.<sup>36</sup> If deployed carefully, such systems can complement the grid, providing energy services immediately and preparing the way for grid expansion in the future. Parallel efforts should be made to increase the central grid's density so as to connect nearby households and, where feasible, to extend it to reach large population centers. Capitalizing on the coverage of its main grid, Kenya implemented the Last Mile Connectivity Project, which has connected an average of one million households annually since 2015. Direct investment in the existing electricity network is also essential to improve and maintain energy services, increase trust in the central network, and raise the financial and operational performance of utilities.

Unlocking this potential for progress requires well-defined and transparent government planning that integrates all solutions, assesses the related investment needs, and provides clarity about the roles of all actors. Cross-sectoral planning and coordination to support the deployment of energy-efficient appliances and productive uses of energy will also be necessary. Several countries—among them Ethiopia, Ghana, Rwanda, and Senegal—developed comprehensive, long-term strategies of the sort needed to provide modern energy services to everyone in Sub-Saharan Africa in coming years.

<sup>36</sup> In collaboration with the KTH Royal Institute of Technology, IEA developed a geospatial model to identify optimal country-by-country electrification solutions, taking into account local geography, population density, technology costs, existing infrastructure, and resource availability. The analysis covered 44 countries of Sub-Saharan Africa, with a deep focus on 11: Angola, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal, South Africa, and Tanzania. Maps illustrating the results for the 11 focus countries can be found in the country profiles of the Africa Energy Outlook 2019 (IEA 2019b) and online at <https://www.iea.org/reports/africa-energy-outlook-2019>.



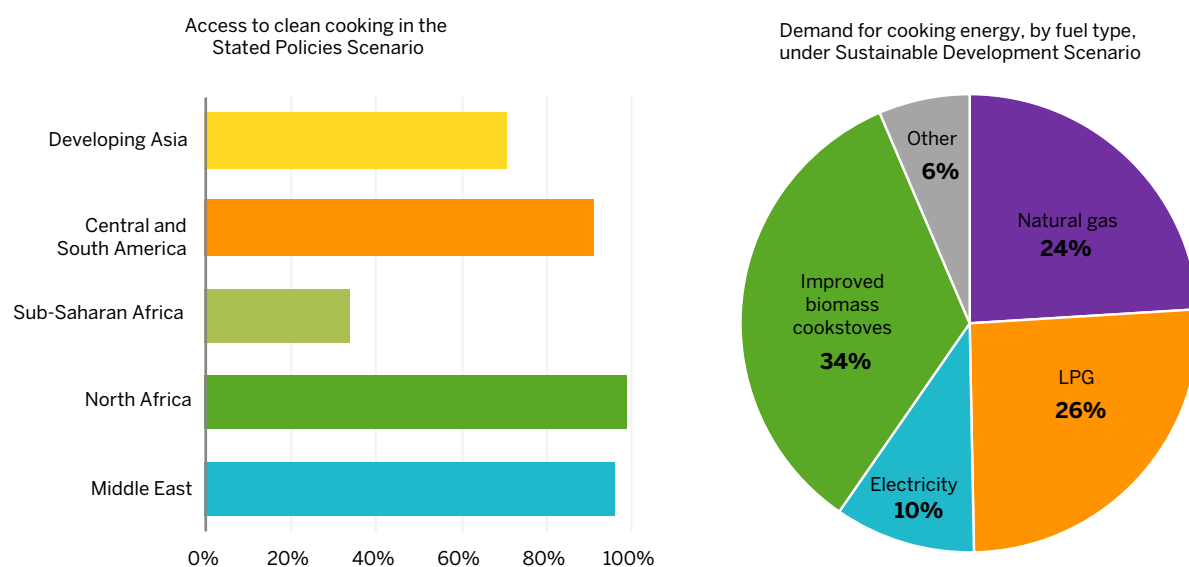
# THE OUTLOOK FOR ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES

## WHERE ARE WE HEADED?

The outlook for clean cooking is of the utmost concern; the world is far off track from achieving universal access to clean cooking solutions. In 2030, under the Stated Policies Scenario, 27 percent of the world's population would still be deprived of access to clean fuels and technologies for cooking. This means that, with population growth, around 2.3 billion people would still be relying on traditional uses of biomass, kerosene, or coal as their primary cooking fuel. It also means that premature deaths from household air pollution would remain roughly at today's level. Forest degradation, sometimes leading to outright deforestation, is yet another grave consequence of the unsustainable harvesting of fuelwood, chiefly for the production of charcoal to be used in cities.

In 2030, the population without access to clean cooking solutions is split almost equally between Developing Asia and Sub-Saharan Africa. In Developing Asia, the projected access rate in 2030 is 70 percent, leaving some 1.2 billion people without access (figure 5.3). Great progress is projected in India, which is expected to shrink the population without access to 500 million in 2030, achieving an access rate of 67 percent. This outcome is the result of the government's determination to promote clean cooking through the Pradhan Mantri Ujjwala Yojana (PMUY) scheme, which offers free LPG stoves and cylinders to women in poor households. The government is also extending and improving urban gas infrastructure.

**FIGURE 5.3 • Rates of access to clean cooking fuels and technologies in 2030**



Source: IEA 2019a.  
LPG = liquefied petroleum gas.

In Sub-Saharan Africa, greater efforts to reduce reliance on traditional uses of solid biomass for cooking would bring the rate of access to 34 percent by 2030. Nevertheless, because of rapid population growth, more than 970 million would remain without access in 2030. In some countries such as Ethiopia, Côte d'Ivoire, Ghana, Kenya, and Tanzania, ambitious policies will bend the curve and shrink the numbers without access, providing clean cooking solutions to around half of their population by 2030. For example, Ethiopia's government launched phase two of its National Biogas Program in 2017; the program aims to provide at least 180,000 people with biogas digesters by 2022.

## HOW TO BRIDGE THE GAP

Under the Sustainable Development Scenario, every household in the world would have access to clean cooking by 2030, an achievement that would require providing access to a total of 2.5 billion people. Clean cooking solutions cut household air pollution and improve health, particularly for women and children. In view of the stakes, efforts to deploy effective technologies need to be moved up on the international political agenda. Engaging with local women in the design, uptake, and sale of clean cookstoves is a key part of successful implementation.

How best to expand access to clean cooking depends on a variety of cultural and economic factors, notably the availability of resources and infrastructure. Under IEA's Sustainable Development Scenario, more than half of the population gains access through LPG in urban areas, while advanced cookstoves are a determining factor in rural areas. Other fuels—such as electricity, biogas, ethanol, and natural gas—also play a growing role in reaching universal access.

Providing access to clean cooking solutions for all by 2030 and action to mitigate climate change are complementary objectives. The dramatic acceleration in deployment of clean cooking solutions needed to reach universal access by 2030 requires all currently available and scalable fuels and technologies, with LPG and natural gas playing an important role in transitioning to decarbonized cooking solutions. While the range of uncertainty is high, analyses show that providing access to all and moving away from traditional uses of biomass could support the fight against climate change, considering the high levels of methane, black carbon, and nitrous oxide emissions resulting from incomplete combustion of biomass, as well as the associated deforestation (IEA 2018).

# THE OUTLOOK FOR RENEWABLE ENERGY

## WHERE ARE WE HEADED?

SDG target 7.2 envisions a substantial increase in the share of renewable energy in the energy mix. Although a quantitative objective is not specified, long-term scenarios charting various paths for the energy sector can assist in benchmarking progress. IEA's Stated Policies Scenario and IRENA's Planned Energy Scenario both plot where the world is headed under existing policy frameworks and stated policy plans.

The outlook for renewables under IEA's Stated Policies Scenario has been steadily improving in all regions in response to supportive policies and falling technology costs. The share of all renewables (including traditional uses of biomass) is projected to rise above 21 percent of TFEC by 2030, from 17 percent in 2017, while that of modern renewables would increase to 15.5 percent in 2030 from 10.5 percent in 2017.<sup>37</sup> IRENA's Planned Energy Scenario, by contrast, shows slightly higher growth in the share of modern renewables in TFEC—from 10 percent in 2017 to 17 percent in 2030.

The use of renewables to generate electricity has grown the fastest in recent years, and the various scenarios predict that will continue. According to IEA's Stated Policy Scenario, renewables-based generation is expected to overtake generation from coal in the mid-2020s and, by 2030, to account for 37 percent of all electricity generated. Of the renewable sources of electricity, solar PV is projected to grow by an average of 13 percent each year through 2030, putting it on a pathway to rival wind as the largest source of renewable-based generation. According to IRENA's Planned Energy Scenario, the supply of renewable electricity would reach 38 percent by 2030. Direct uses of renewables have not enjoyed the same level of policy support and cost reduction as the renewables used to generate electricity.<sup>38</sup> As a result, projected growth is slower for the direct uses of renewables such as biofuels, solid biomass, and solar thermal, with their shares in meeting demand for heat and transport fuels growing to 10 percent and 5 percent respectively by 2030, up from 8 percent and 3 percent in 2017, according to IEA.<sup>39</sup>

## HOW TO BRIDGE THE GAP

### *Insights from IEA's Sustainable Development Scenario*

The increases in the use of renewable energy that are likely to occur under current and stated policies fall short of what is required to achieve global goals for climate protection and sustainable development. IEA's Sustainable Development Scenario charts a path to achieve these goals, and renewables play a major role, with their use growing twice as fast as under current and stated policies. Under this more ambitious scenario, modern renewables are expected to reach nearly 23 percent of TFEC in 2030 (figure 5.4).

The share of renewables-based electricity generation increases most rapidly, doubling its current share to just under 50 percent by 2030, 11 percentage points higher than under the Stated Policies Scenario. The promising outlook for electricity generated from renewables is aided by strong policy support toward decarbonization of the power sector and continued declines in the cost of key technologies, notably solar PV, batteries, and wind. At the global level, electricity generation from renewable sources more than doubles from today's level to over 15,000 terawatt-hours (TWh) by 2030, more than triple the amount of electricity generated in the United States today from all sources.

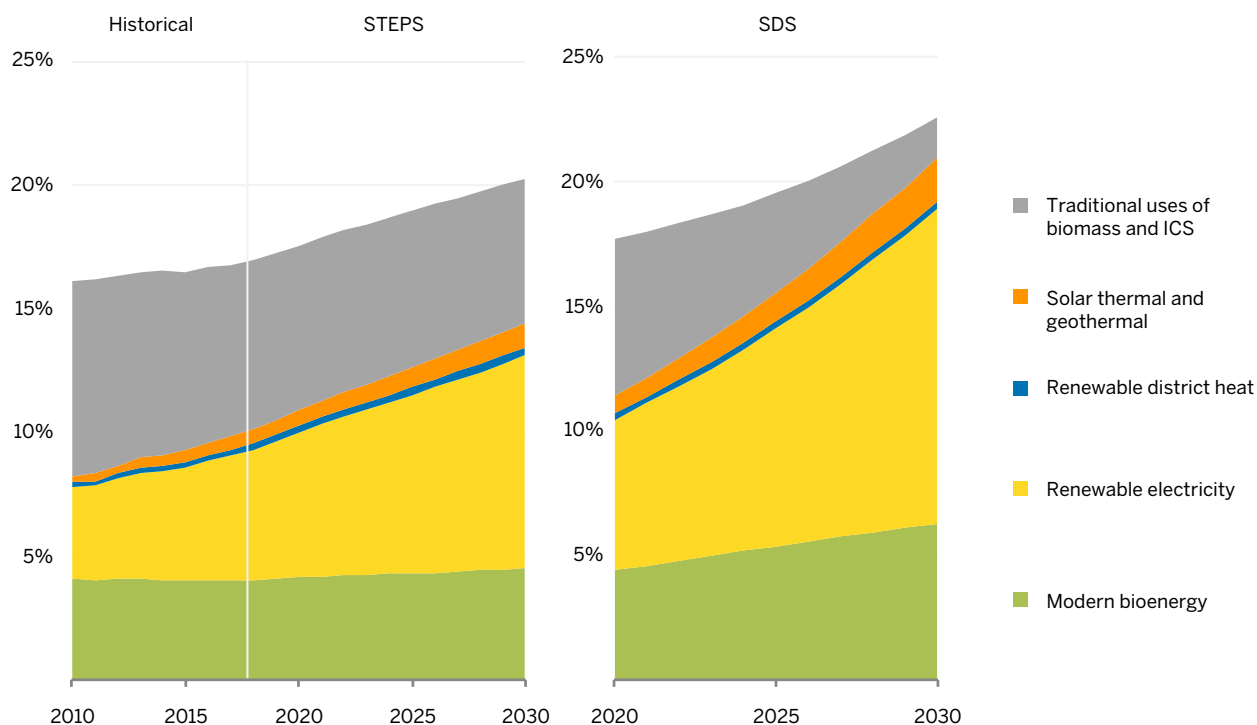
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37 Because traditional uses of biomass are linked with significant pollution and deforestation, and because the use of biomass for cooking must be scaled back to achieve other SDGs, this section focuses on modern renewables.

38 Renewable energy may be used in a relatively direct way to provide an energy service (such as solar power for heat) or indirectly from renewables-based electricity or renewables-based heat, which is then used to provide an energy service (such as to power heat pumps or electric vehicles, or to supply district heating).

39 "Heat" in this chapter refers to the amount of energy consumed to produce heat for industry, buildings, and other sectors. All of these will be referred to hereafter simply as "heat." They are not equivalent to heat as a final energy service, which refers to the energy available to end users to satisfy their needs, after taking into account transformation losses.

**FIGURE 5.4 • Share of modern renewables in total final energy consumption under the Stated Policies and Sustainable Development Scenarios, 2010–30**



Source: IEA 2019a.

Note: "Traditional uses of biomass" refers to the use of local solid biomass resources by low-income households that do not have access to modern cooking and heating fuels or technologies.

STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; ICS = Improved cookstoves.

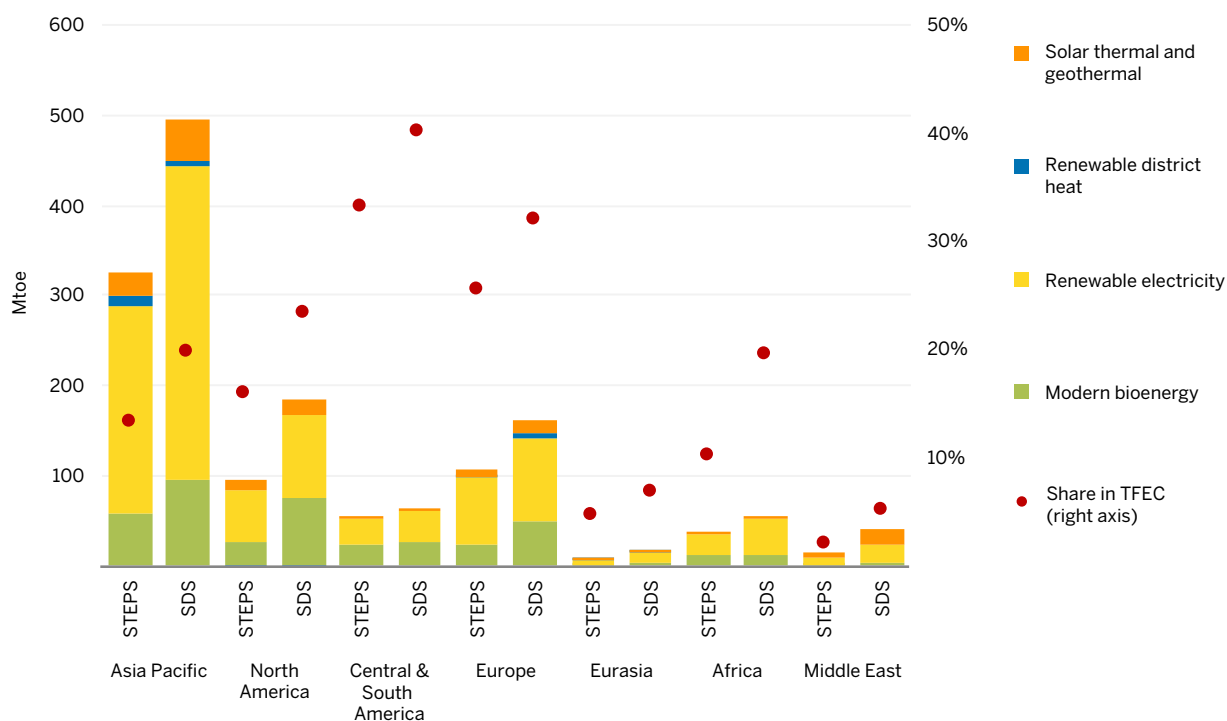
IEA's Sustainable Development Scenario also sees a greater electrification of energy use, with electricity meeting 23.7 percent of TFE in 2030, compared with 21.6 percent under the Stated Policies Scenario. Increased electrification of transport and heating complements the direct use of renewables in efforts to decarbonize energy use. Direct renewables, principally biofuels, increase to 10 percent their share of demand for transport-related energy; combined with growing electrification, renewables' share in transport rises to 12 percent. Although light-duty vehicles are on a pathway to decarbonization by 2030, challenges remain to decarbonize trucking, aviation, and shipping. The use of renewables to provide heat also grows considerably under the Sustainable Development Scenario, with the direct use of bioenergy, solar thermal, and geothermal energy expanding by an average of 3 percent annually to reach a combined share of 14 percent of total energy demand for heat in 2030. When the increased electrification of energy demand is factored in, the total share of renewables in heating rises to 19 percent by 2030.

The share of traditional uses of biomass falls to around 5 percent of TFE by 2030 under the Stated Policies Scenario. Under the Sustainable Development Scenario, traditional uses of biomass are completely phased out, as developing countries replace them with more modern and efficient fuels and technologies.

Across regions, variations in energy policy, socioeconomic trends, and natural-resource endowments result in differing growth trajectories for renewables. Developing economies account for two-thirds of the growth in electricity generation through 2030 under both the Stated Policies and Sustainable Development scenarios, with developing economies in Asia, led by China and India, representing half of the increase.

Under the Stated Policies Scenario, the outlook for electricity generation from renewable sources ranges from 9 percent in the Middle East and 16 percent in North Africa, at the low end, to well over 70 percent in Central and South America, where hydropower is the backbone of the power mix. Under the Sustainable Development Scenario, the share of renewable electricity generation increases in every region across the globe, approaching or surpassing half of all electricity generation by 2030 in several regions. Indonesia and other Southeast Asian economies see the most significant increase in the share of renewables in electricity generation under the Sustainable Development Scenario, led by growth in wind and solar PV.

**FIGURE 5.5 • Change in consumption of modern renewable energy, by region under the Stated Policies and Sustainable Development Scenarios, 2018-30**



Source: IEA 2019a.

Note: Modern bioenergy excludes traditional uses of biomass.

Mtoe = million tonnes of oil equivalent; STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; TFEC = total final energy consumption.

### Insights from IRENA's Transforming Energy Scenario

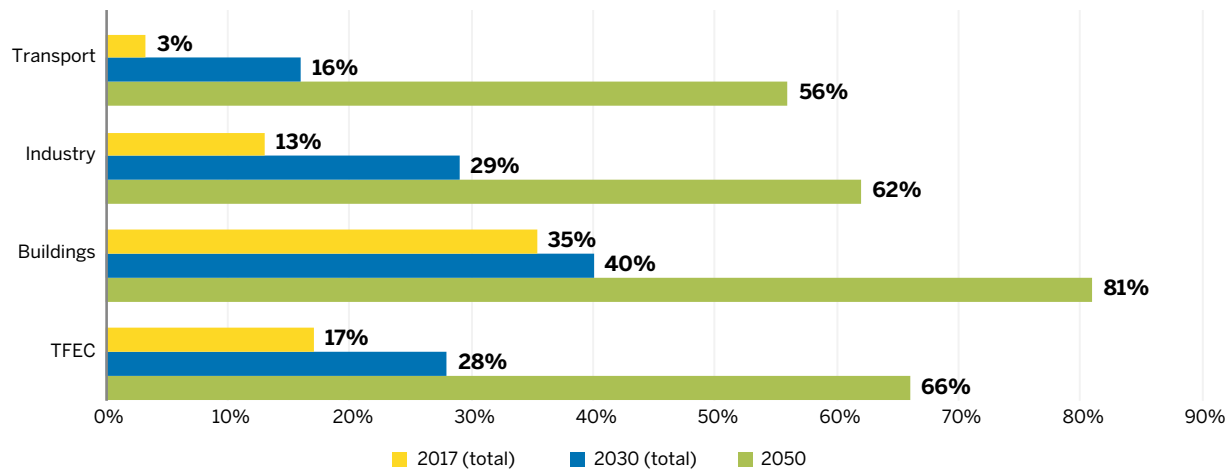
The increase in renewable energy use under IRENA's Planned Energy Scenario, a pathway set by current and planned policies, falls short of what is required to achieve global climate objectives and SDG 7. In it, the share of modern renewables would reach only 17 percent in 2030. By contrast, under the agency's more ambitious Transforming Energy Scenario for 2030, the share of modern renewable energy in TFEC would rise steeply, from around 10 percent in 2017 to 28 percent by 2030 (Figure 5.6). The increase would proceed from a combination of factors—chief among them significant growth in the supply of renewables-based electricity, increased electrification of end uses, greater direct use of renewable energy, and improved energy efficiency.

At a sectoral level, the buildings sector would show the highest share of renewable energy by 2030. Renewables would raise their share of TFEC from the 2017 levels of 35 percent (when traditional uses of biofuels are included) or 13 percent (excluding traditional uses of biofuels) to 40 percent by 2030 (with all traditional uses of biofuels phased out).

The next-largest renewables share would be in industry (including blast furnaces and coke ovens), where renewables would increase from a 13 percent share in 2017 to 29 percent by 2030 (of which 17 percent would be direct application of renewable energy, 11 percent electricity, and 1 percent district heat). The industrial sector offers great potential for improving efficiency through advances in industrial processes, demand-side management solutions, recycling of materials, and better waste management.

Transportation would have the lowest share of renewables in 2030 but the greatest growth, climbing to 16 percent of the sector's final energy consumption by 2030, from just 3 percent in 2017. Energy efficiency is as critical for the transport sector as for the previous two; it can be achieved through the adoption of low-carbon technologies, as well as through modal shifts—for example, to innovative mobility services such as car sharing, to public transport, or from airplanes to trains for short and medium-distance trips.

**FIGURE 5.6 • Share of renewable energy in total final energy consumption under IRENA's Transforming Energy Scenario, in total and by major end uses**



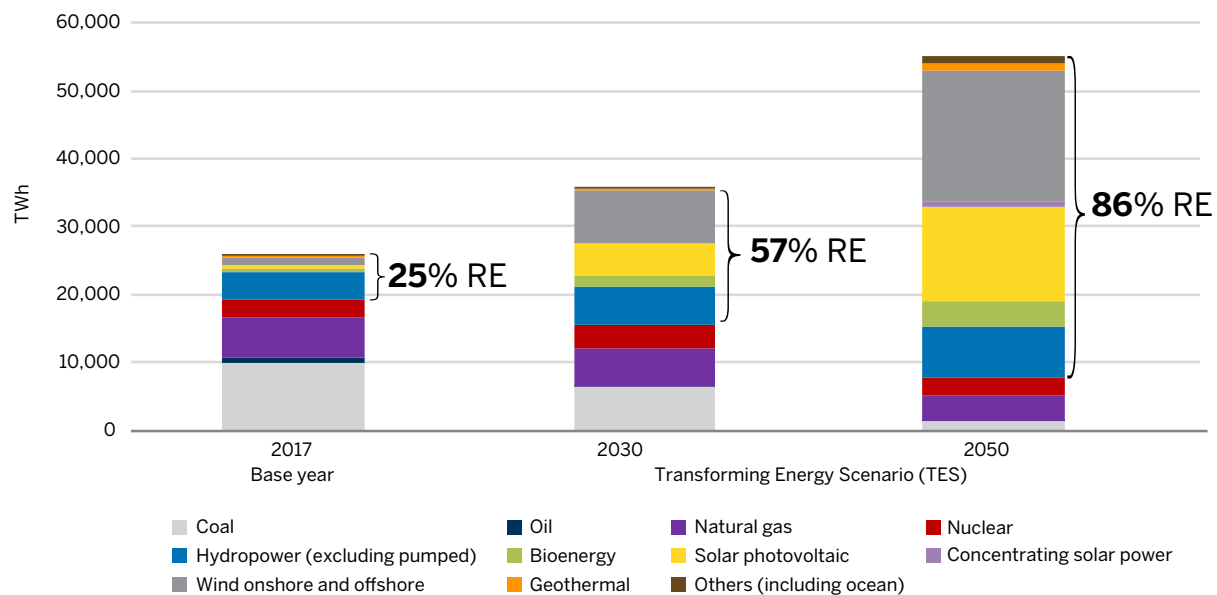
Source: IRENA 2020d.

Note: 2017 includes traditional uses of biofuels in the building sector and in TFEC. By 2030, all traditional uses of biofuels are phased out of the energy supply.

Scaling up electricity from renewables is a prerequisite for decarbonizing the world's energy system. Increasingly, electrification based on renewables is seen as a major solution, and the contribution of renewable electricity will be the single largest driver for change in the global energy transformation. IRENA's Transforming Energy Scenario sets a pathway to achieve, by 2030, a 57 percent share of renewables in the global power generation mix, up from 25 percent in 2017 (Figure 5.7). The role of electricity as an energy carrier will also increase, growing from a 20 percent share of TFEC to 29 percent share in the Transforming Energy Scenario in 2030, with gross electricity consumption increasing 50 percent between 2017 and 2030, from 25,600 TWh to 35,900 TWh.

Looking beyond 2030, IRENA's Transforming Energy Scenario also outlines a pathway to 2050 (figure 5.6). In it, electricity would become the central energy carrier, coming to account for nearly 50 percent of TFEC by 2050. Simultaneously, gross electricity consumption would more than double from 2016 levels to 55,000 TWh in 2050.

**FIGURE 5.7 • Share of modern renewables in electricity generation in 2017, 2030, and 2050**



Source: IRENA 2019

In this context, the most important synergy of the global energy transformation is the increasingly low cost of renewable power technologies, combined with wider adoption of electricity for end-use applications in transport and heat.

Among all power generation sources, wind and solar PV would dominate global electricity generation and capacity additions under IRENA's Transforming Energy Scenario. By 2030, one-third of the world's electricity would come from solar and wind power, increasing to almost 60 percent by 2050, with total installed wind and solar capacity exceeding 6,000 and 8,500 gigawatts, respectively, by 2050. However, while a 50 percent electricity share in TFEC is feasible by 2050, the other 50 percent, which cannot be electrified, must be decarbonized.

Each sector has options for decarbonization. The first option is energy efficiency, which includes advances in both technical efficiency and behavior. Energy efficiency would also contribute (together with renewables and electrification) to better energy intensity, predicted to increase by 3.2 percent each year through 2050 under the Transforming Energy Scenario.

Reduced consumption of fossil fuels is the second option. Under the Transforming Energy Scenario, fossil fuels retain a role in 2050, providing one-third of the energy supply. But global production of oil and coal would decline. Oil would largely be used in industry for petrochemicals, as well as in aviation and shipping. Coal would be used only in industry (7 percent of TFEC), mostly for steel production. Production of natural gas would grow through the mid-2020s, dropping by 2050 to two-thirds of the 2017 level. By 2050, natural gas would be the most widely used fossil fuel.

The third major decarbonization option involves indirect electrification (using hydrogen and synthetic fuels) and the direct use of renewables, including bioenergy. Both would increase significantly. Liquid biofuels, in particular, would play an important role in aviation and marine energy supply, and in providing heat for industrial processes. Hydrogen is also a promising energy carrier, complementing the direct use of electricity, which, under the Transforming Energy Scenario, has the potential to supply 11.1 exajoules of global energy demand by 2030 (of which 3.2 exajoules would be from renewable sources) and nearly 29 exajoules by 2050 (two-thirds from renewable sources). Other direct uses of renewables include geothermal and solar thermal heat; both of these heating technologies would contribute to the decarbonization of heat supply in industry.

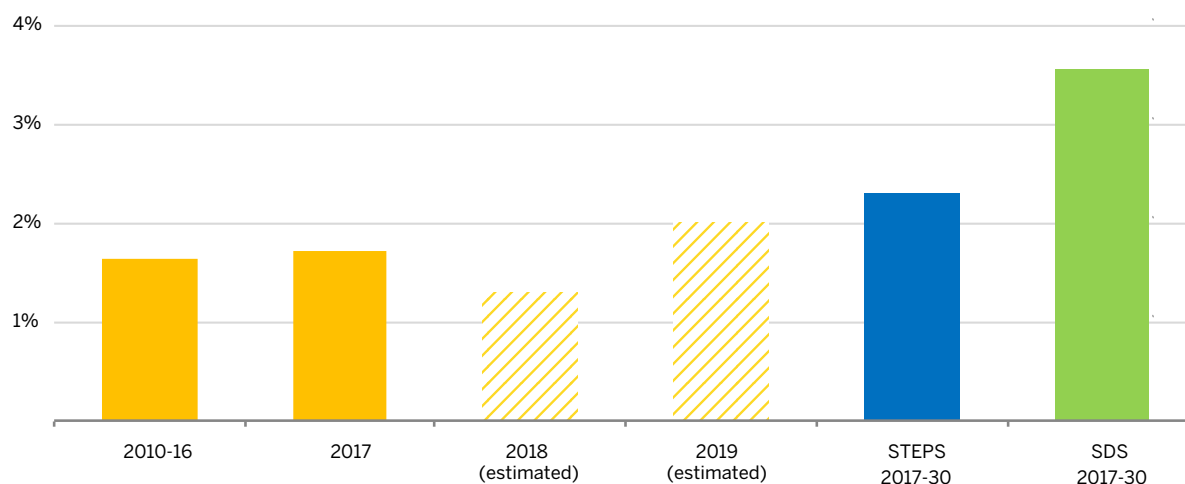
# THE OUTLOOK FOR ENERGY EFFICIENCY

Global energy intensity, measured by the ratio of primary energy demand to gross domestic product (GDP), is the key indicator used to gauge global progress on energy efficiency. Global energy intensity reached 120 tonnes of oil equivalent (toe) per thousand dollars (2010 PPP) of GDP in 2017, an improvement of only 1.7 percent over 2016. The slowdown means that to achieve SDG target 7.3 (which calls for a doubling of the rate of global energy intensity by 2030), annual improvements for 2018 forward would have to be around 3 percent, rather than the 2.6 percent originally required. Recent estimates show that the improvement for 2018 was even lower, at just 1.3 percent, pointing to a third consecutive year of slowdown in the rate of improvement. The slowdown likely reflects weaker implementation of energy efficiency policy and strong demand in energy-intensive economies and sectors. A clear example of the global slowdown in improvements can be seen in the transport sector, where heavier, less-fuel-efficient SUVs are increasing their market share, not only in the United States and Europe, but also in emerging nations such as China, India, and South Africa.

IEA's Stated Policies Scenario assumes an annual efficiency improvement of just 2.3 percent between 2017 and 2030, accompanied by a steady rise in global final energy consumption to more than 11,600 million tonnes of oil equivalent by 2030.

By contrast, energy efficiency is a cornerstone of IEA's Sustainable Development Scenario. The accelerated improvements in energy efficiency across all energy end uses under this scenario would cause global energy demand to peak by 2025, followed by a decline. The adoption of the measures outlined in the scenario translates to energy savings of 1,700 million tonnes of oil equivalent over the Stated Policies Scenario, overshooting SDG target 7.3. The annual 3.6 percent improvement in energy intensity under the Sustainable Development Scenario between 2017 and 2030 is obtained through a combination of well-implemented policies and regulations.

**FIGURE 5.8 • Average annual improvement in primary energy intensity under the Stated Policies and Sustainable Development scenarios, 2010–30**

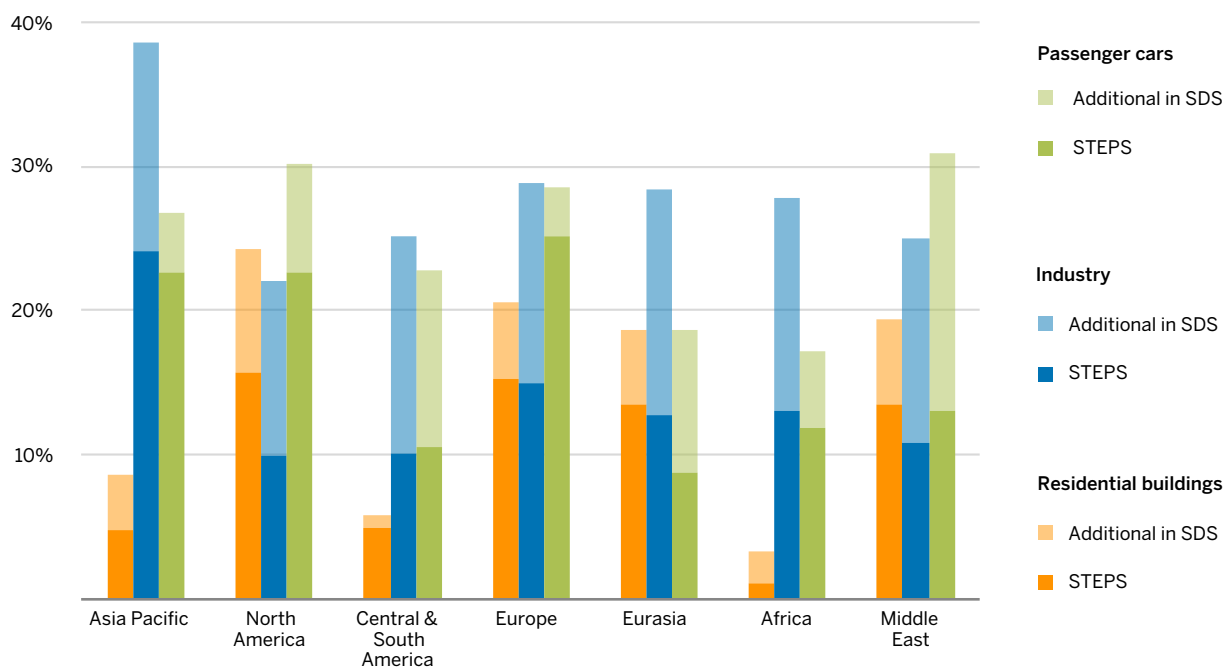


Source: IEA 2019a, 2020  
 STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.

More than 40 percent of the global savings in energy consumption achieved by 2030 under the Sustainable Development Scenario compared with the Stated Policies Scenario stem from the buildings sector, where building codes and energy efficiency standards for appliances and devices offer significant scope for improvement in most regions. Industry is the second-largest potential source of savings, representing around 30 percent of the global total. The gain would come from replacing outdated equipment, processes, and systems with more efficient versions. The remaining savings in energy consumption are attributed to transport, where stricter fuel-economy standards and emissions restrictions, combined with a variety of measures to accelerate the uptake of electric vehicles, could reduce global energy consumption by more than 20 percent by 2030.



**FIGURE 5.9 • Improvement in energy intensity by sector and region in the Stated Policies and Sustainable Development Scenarios, 2018–30**



Source: IEA 2019a.

STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.

To realize the Sustainable Development Scenario, the world has to exploit the full potential for efficiency improvements. Success will depend on a thorough understanding of global energy needs, as energy demand trends vary substantially from region to region, with sectors playing larger or smaller roles in country economies. There is no single solution to apply across the board. In every region, it is essential to start with the sectors where demand is high and room for improvement is greatest. For example, in Asia, the dominant sources of growth in energy demand is set to be industry and transport—these are the sectors that will require the greatest policy attention. In most parts of Africa, by contrast, efficient urban planning and strict building codes would help reduce the rapidly rising demand for energy. In North America and Europe, energy demand has been rising because of increased cooling needs in summer and heating needs in winter, attention should be paid to improving the efficiency of cooling and heating systems. Global commitment to achieve greater efficiency progress is nonetheless evident. At the United Nations Climate Action Summit in September 2019, 15 countries launched the Three Percent Club<sup>40</sup> and announced plans to work together to drive a 3 percent annual rate of improvement in global energy intensity.

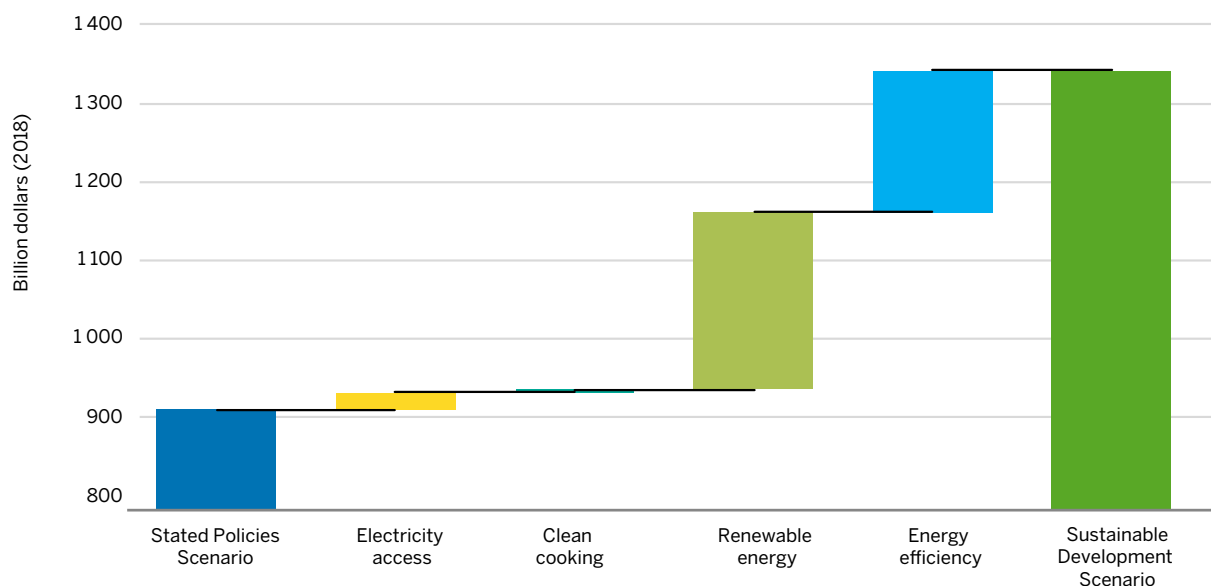
40 The Three Percent Club is a coalition of governments and supporting organizations committed to placing the world on a path to a 3 percent annual improvement in efficiency. The target was based on IEA's Efficient World Scenario, derived from the Sustainable Development Scenario. To support the member countries, the coalition leverages the combined global resources of the IEA, the SEforAll Energy Efficiency Accelerators and Hub, the Global Environment Facility, the UN Environment Programme, the European Bank for Reconstruction and Development, and the Energy Efficiency Global Alliance. Key industry partners commit to provide technical, financial, and project support to the participating countries, acting through the Energy Efficiency Global Alliance.

# INVESTMENT NEEDED TO ACHIEVE SDG 7

In the Sustainable Development Scenario, total energy sector investments needed to achieve all targets of SDG 7 are estimated to average USD 1.36 trillion per year between 2019 and 2030 (Figure 5.10) (IEA 2019a). To achieve universal access to energy would require investments of around USD 45 billion per year between 2019 and 2030. Of these investments, USD 40 billion would be required to attain universal access to electricity, or more than twice the amount observed in the Stated Policies Scenario. Significant scale-up of investment would be required in Sub-Saharan Africa, compared with that observed under current and planned policies, as it totals two-thirds of the additional investment in electricity access.

Providing access to clean cooking facilities to all the population now without access would require five times the investment spelled out in the Stated Policies Scenario, or almost USD 5 billion per year. Clean cooking needs to be placed higher on the political agenda so as to accelerate efforts to widen access and take advantage of the momentum achieved to date. The latest estimates (2017) show USD 32 million supporting access to clean cooking in high-impact countries: Afghanistan, Bangladesh, China, Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Democratic Republic of Korea, Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Philippines, Sudan, Tanzania, Uganda, and Viet Nam (SEforAll and CPI 2019). It is worth noting that total investment for access to clean cooking represents less than 2 percent of the total annual energy sector investment under the Sustainable Development Scenario.

**FIGURE 5.10 • Additional annual direct investment needed to meet SDG 7 targets, 2019–30**



Source: IEA 2019a.

Note: Investments under the Stated Policies Scenario include investment in the power sector and additional investments in end-use efficiency.

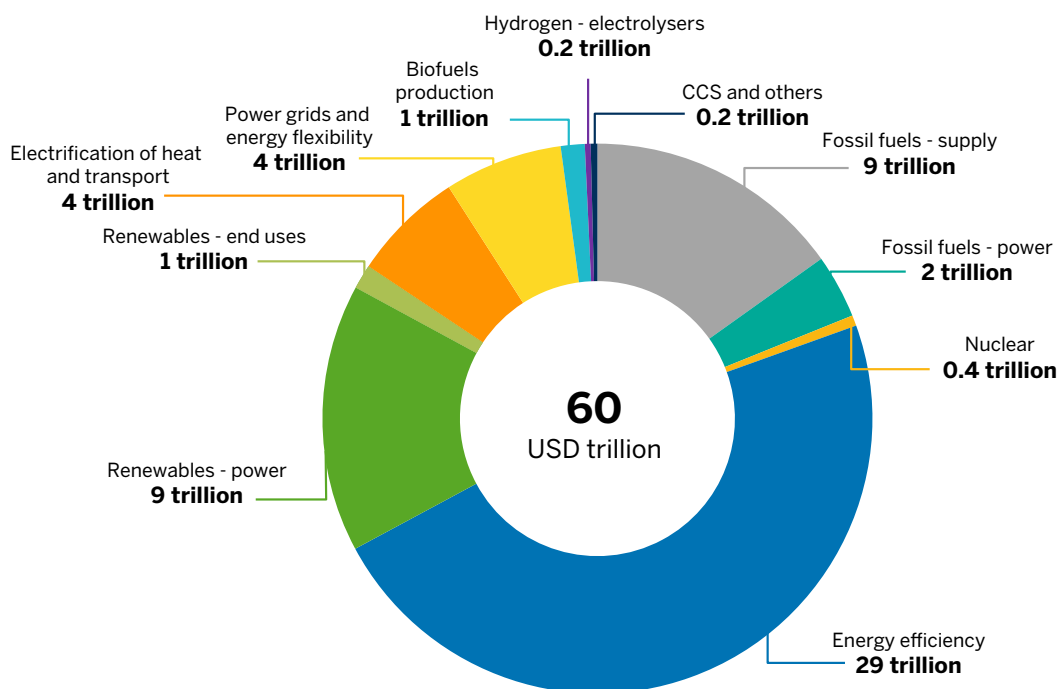
Under the Sustainable Development Scenario, the bulk of the investment required for meeting SDG 7 needs to go to renewable energy and end-use efficiency,<sup>41</sup> accounting for around USD 690 billion and USD 625 billion respectively. Compared to investments realized under current and planned policies, this represents an increase of almost USD 230 billion per year for renewables, principally going to renewables-based power, and of nearly USD 180 billion for efficiency, the greater part of it going to more efficient buildings and transport. These additional capital investments nonetheless conceal a different approach to financing compared with the Stated Policies Scenario; they could be achieved through

41 Renewable energy investments include investments in renewables power generation and grid integration costs. It also includes investments directly related to renewable energy capacity in industry and buildings end uses. Energy efficiency investments include those directly related to the efficiency of industry, buildings, and transport end uses.

a redirection of capital within the energy system. Indeed, the combination of lower energy use from efficiency investment alongside greater shares of renewables leads to a reduction of investments into fossil fuel of more than USD 220 billion per year, thereby demonstrating the economic viability of reaching the goals. All in all, the energy system would see additional annual investments limited to USD 210 billion to follow the pathway of the Sustainable Development Scenario relative to the Stated Policies Scenario.

Analysis performed for IRENA's Transforming Energy Scenario suggests that investments of nearly USD 10 trillion should be redirected from fossil fuels and related infrastructure to low-carbon technologies by 2030. Cumulative investments in the energy system over the period to 2030, including infrastructure and efficiency, would be reaching USD 60 trillion (Figure 5.11). Nearly USD 9.5 trillion of these investments would be needed to scale up renewable power generation capacity through 2030. In annual terms this would imply doubling of investments in renewable power generation capacity to USD 676 billion per year to 2030, compared with the USD 289 billion invested in 2018 (Frankfurt School–UNEP Centre/BNEF 2019). This would require a substantial investment. But leaving the energy system untransformed would be costlier. IRENA has estimated that between now and 2030, every additional dollar spent on the energy transformation would pay back between USD 2.5 and USD 7.5 in fuel savings, lower net energy subsidies, and reduced health externalities.

**FIGURE 5.11 • Cumulative investment in the energy system under the Transforming Energy Scenario, 2016–30**



Source: IRENA 2020d.  
CCS = carbon capture and storage.

Scaling-up of renewable energy investments requires coordinated action on multiple fronts. One recent initiative to coordinate action to mobilize renewable energy investment at the necessary scale is the Climate Investment Platform, an inclusive partnership of public and private stakeholders.<sup>42</sup> While the bulk of investment in the energy transition will need to come from private sources, public finance will play a significant enabling role to spur investment. Greater and more efficient risk-mitigation solutions by public institutions and financiers (including development finance institutions and multilateral development banks) can scale up investment, in particular in developing countries (IRENA 2020c). Included for the first time in Tracking SDG 7 is an overview of progress toward SDG indicator 7.A.1 on international public financial flows to developing countries in support of clean and renewable energy (box 5.1).

42 <https://www.climateinvestmentplatform.com/>.

## **BOX 5.1 • SDG INDICATOR 7.A.1 ON INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN AND RENEWABLE ENERGY**

SDG target 7.A envisions enhanced international cooperation to facilitate access to clean energy research and technology, including the enabling of investment in renewables, with SDG indicator 7.A.1 focusing on international public financial flows to developing countries in support of clean and renewable energy.

### ***Recent international public flows and trends***

Between 2000 and 2017, developing countries received a cumulative sum of USD 138.9 billion (2017 PPP) in financial flows in support of renewables. In 2017, these flows reached USD 21.4 billion—up 13 percent from 2016, twice the amount recorded in 2010, and a 15-fold increase since 2000, reflecting the rapidly intensifying focus on development aid for clean and renewable energy.

### ***Hydropower receives almost half of 2017 flows***

Of the accumulated USD 138.9 billion (2017 PPP) in support of renewables between 2000 and 2017, USD 64.5 billion went to hydropower projects, 27.8 billion to solar, USD 10.1 billion to wind, and USD 36.5 billion to other energy sources. After a few years of dominance by solar, hydropower was back to receiving the greatest share in 2017, at 46 percent, while solar projects received 19 percent, wind 7 percent, and geothermal 6 percent.

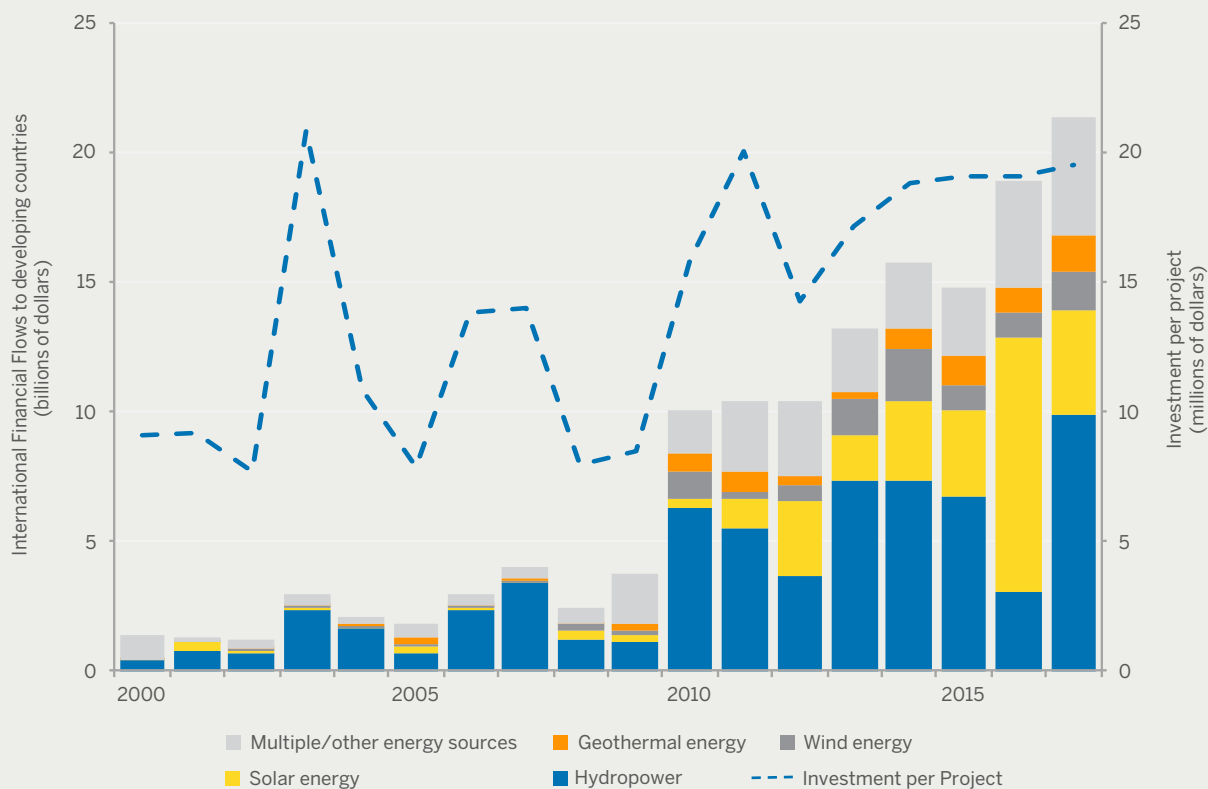
The scale of public investment projects also increased over the period, from an average of USD 10 million per project in 2000–09 to USD 19 million over the four years from 2014 to 2017. From 2016 to 2017, project scale grew the most for hydropower, with a two-fold increase from USD 53 million to USD 104 million per project. During the same period, the scale of solar projects decreased from USD 25 to 13 million per project, wind remained stable at USD 27 million per project, and geothermal inched up from USD 31 to 34 million per project.

### ***The least-developed countries receive only small shares of 2017 flows***

Although public financial flows grew after 2010 by an average of USD 1.6 billion per year, most of the growth was not targeted to those most in need—the least-developed countries. Between 2000 and 2017, only 20 percent of cumulative flows reached that set of countries. In 2017, the least-developed countries received USD 2.7 billion (12 percent of flows) and small island developing states less than USD 0.8 billion (4 percent of flows).

Out of 65 donors, four Asian donors committed 52 percent of the investments in 2017. The China Development Bank and the Export-Import Bank of China led with USD 9.0 billion, with an average of USD 651 million per project, followed by the Asian Development Bank (USD 1.1 billion) and the government of Japan (USD 1.0 billion).

**FIGURE B5.1.1 International financial flows to developing countries in support of clean and renewable energy (at 2017 prices and exchange rates)**



Source: Renewable Energy Public Investments Database.

Note: Figures in this box are drawn from the Renewable Energy Public Investments Database, a joint OECD/IRENA database on international financial flows to developing countries in support of clean and renewable energy (<https://www.irena.org/Statistics/View-Data-by-Topic/Finance-and-Investment/Renewable-Energy-Finance-Flows>).

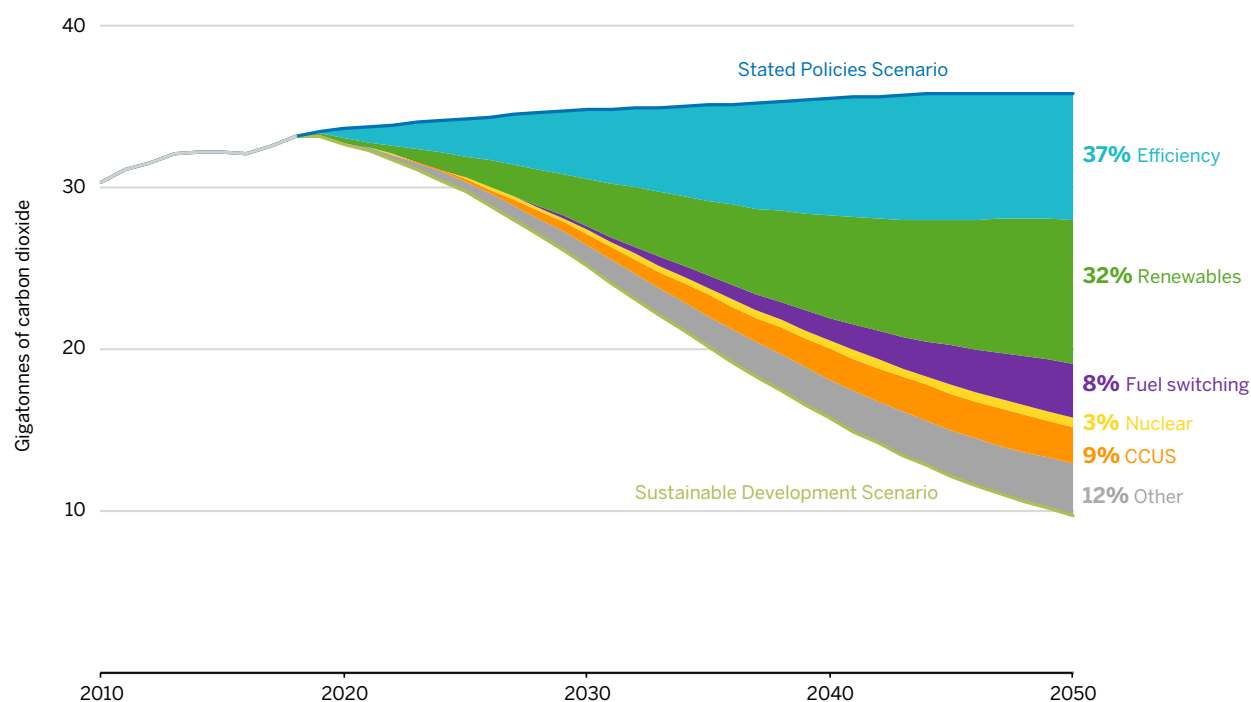
# SDG 7 AND REDUCTION OF EMISSIONS

The current energy system produces numerous greenhouse gases, making the energy sector responsible for around 75 percent of such emissions. Climate change mitigation is thus a mounting concern for the sector, and in 2020 countries will have to present revised and more ambitious commitments for the first time as a result of the Paris Agreement, which was adopted in 2015.

The reductions in CO<sub>2</sub> emissions needed to realize the Paris Agreement will require a deep transformation across the energy system. To understand the weight of each lever, the Sustainable Development Scenario assessed country-by-country pathways that could deliver these targets, depending on local policy preferences, costs, resources, and societal preferences. Efficiency and renewables would produce the greatest reductions, equivalent to 37 percent and 32 percent respectively of the additional efforts required in the Sustainable Development Scenario relative to the Stated Policies Scenario (Figure 5.12).

Energy efficiency is the primary “fuel” of choice in most regions owing to its cost-effectiveness; no pathway compatible with the Paris Agreement can afford to leave it aside. It can drastically reduce the fuel intensity of energy service demand in the buildings, industry, and transport end-use sectors. It is also central to reducing the peak load on the power grid, leading to a decrease of the peaking capacity, which is often associated with higher-cost and more-carbon-intensive technologies. While energy efficiency alone is insufficient, it is essential to attaining stable, energy-related CO<sub>2</sub> emissions below 30 gigatonnes by around 2040.

**FIGURE 5.12 • Additional reductions in CO<sub>2</sub> emissions by measure under the Sustainable Development Scenario relative to the Stated Policies Scenario**



Source: IEA 2019a.

Note: Reduced thermal losses in power generation account for 15 percent of efficiency improvements.

CCUS = carbon capture, utilization, and storage.

The second major contributor would be the increased deployment of renewables. Policies would be central to strengthening the competitiveness of renewable technologies relative to fossil fuel power plants, capitalizing on the cost reductions observed to date for solar and wind technologies. Measures supporting the integration of renewables into the energy system would complement cost reductions and tap into their huge potential. Any increase in renewables should nevertheless be accompanied by the phaseout of inefficient fossil fuel power plants to reduce the carbon intensity of power generation. The contribution of renewables could go further than power systems and targeted policies; their increased use for heating in industry and buildings as well as for transport (through advanced biofuels) would offer major benefits.

These two technologies alone—energy efficiency and renewables—could account for almost 70 percent of the effort needed to reach the targeted emissions pathway. Reaching sustainable development goals would also require a host of other technologies and policies, from carbon capture utilization and storage (CCUS) to hydrogen. There is no single or simple solution to reach the Sustainable Development Goals.

Similarly, IRENA's Transforming Energy Scenario shows that annual energy-related CO<sub>2</sub> emissions under current and planned policies (the Planned Energy Scenario) are expected to remain flat, at 33 gigatonnes of CO<sub>2</sub> per year in 2050. However, under the Transforming Energy Scenario, emissions would be reduced by 70 percent by 2050, with continued reductions thereafter, keeping the rise in global temperature to well below the 2°C climate goal. The Transforming Energy Scenario analysis shows that the accelerated deployment of renewables, combined with extensive electrification and increased energy efficiency, could achieve over 90 percent of the energy-related CO<sub>2</sub> emissions reductions needed by 2050. Electrification with renewable power is key in lowering energy-related carbon emissions, together comprising 60 percent of the mitigation potential. If the additional reductions from direct use of renewables are considered, the share increases to 75 percent, and to more than 90 percent when counting energy efficiency.

# CONCLUSION

Despite the great progress unlocked recently by innovative policies and technologies throughout the energy sector, the world is not on track to reach SDG 7 under current and planned policies. Efforts need to be scaled up across all goals so sufficient progress can be made. Providing universal access to energy requires a greatly accelerated pace of electricity connections in Sub-Saharan Africa. In parallel, access to clean cooking solutions needs to be placed much higher on political agendas in the developing and emerging world. Commercially viable renewables, especially for heat and transport, and renewed commitment to improving the coverage and stringency of efficiency regulations are urgently needed. It is increasingly realized that universal energy access targets are unlikely to be met without addressing the need for gender equality in energy access and in energy supply, whether in households or in businesses and energy companies.

A world on track to meet SDG 7 would deliver numerous socioeconomic benefits, which is why SDG 7 is central to achieving the other Sustainable Development Goals set out by the United Nations. In particular, energy and climate goals are interlinked and complementary. Pushing renewables and energy-efficient technologies across the energy system will play the main role in reducing greenhouse gas emissions as needed to meet the Paris Agreement.



# METHODOLOGY

## IEA METHODOLOGY

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and IEA analysis in the *World Energy Outlook* (WEO). A detailed documentation on the World Energy Model methodology can be found [here](#).

The 2019 edition of WEO featured a special look at Africa. IEA updated and expanded its analysis of the continent's energy outlook in this year's WEO. For the first time, models were developed for 11 selected Sub-Saharan countries, and these models were fed into the WEM. The country models enabled us to produce comprehensive, data-rich profiles for these countries and to draw implications for the continent as a whole.

### IEA scenarios

The analyses shown above are built on two main scenarios described below. [This page](#) contains further details about how these two scenarios are modeled:

- **Stated Policies Scenario:** The Stated Policies Scenario reflects the impact of existing policy frameworks and today's announced policy intentions. Its aim is to provide a detailed sense of the direction in which existing policy frameworks and today's policy ambitions would take the energy sector out to 2040. Previously known as the New Policies Scenario, it has been renamed in WEO 2019 to underline that it considers only specific policy initiatives that have already been announced. The policies assessed in the Stated Policies Scenario cover a broad spectrum. These include Nationally Determined Contributions under the Paris Agreement and much more besides. In practice, the bottom-up modeling effort in this scenario requires a lot of detail at the sectoral level, including pricing policies, efficiency standards and schemes, electrification programs, as well as specific infrastructure projects. You can find more information about this scenario [here](#).
- **Sustainable Development Scenario:** The Sustainable Development Scenario is a forward-looking, normative scenario, which describes an integrated, least-cost pathway for the world's energy system to deliver on energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce the household air pollution that causes deaths and illness (SDG 3.9); and to take effective action to combat climate change (SDG 13). It shows how the respective objectives can be reconciled, addressing potentially conflicting priorities so as to realize mutually supportive benefits. In this scenario, looking toward 2030, universal access to both electricity and clean cooking is achieved; modern renewables reach 21 percent of TFEC, more than doubling today's share; the energy efficiency aims set in SDG target 7.3 are exceeded in the Sustainable Development Scenario, with average annual improvements in global energy intensity accelerating to 3.4 percent annually to achieve critical energy sector objectives. You can find more information about this scenario [here](#).

### Methodology for access to electricity and access to clean cooking

The projections presented in the WEO and in this chapter focus on two elements of energy access: a household having access to electricity and to clean cooking facilities. These are measured separately. The IEA maintains databases on levels of national, urban, and rural electrification rates; for the proportion of the population without clean cooking access, the main sources are the World Health Organization (WHO) Household Energy Database and IEA's Energy Balances. Both databases are regularly updated and form the baseline for WEO energy access scenarios to 2040.

The projections shown in the Stated Policies Scenario take into account current and planned policies, recent progress, as well as population growth, economic growth, urbanization rate, and the availability and prices of different fuels. In the Sustainable Development Scenario, we identify least-cost technologies and fuels to reach universal access to both electricity and clean cooking facilities. For electricity access, this is done by incorporating a Geographic Information Systems model based on open-access geospatial data, with technology, energy prices, electricity access rates and demand projections from the WEM. This analysis has been developed in collaboration with the KTH Royal Institute of Technology, Division of Energy Systems Analysis (KTH-dESA) in Stockholm. For the Special Focus on Africa of WEO 2019 (IEA 2019b), IEA refined its geospatial estimation of the least-cost pathway toward universal access to electricity

by 2030, using latest WEM results and the latest version of the Open Source Spatial Electrification Tool (OnSSET) developed by KTH-dESA.<sup>43</sup> The results provide detailed coverage of 44 countries in Sub-Saharan Africa.

Further details about the IEA methodology for energy access projections are in [this document](#).

## METHODOLOGY FOR RENEWABLE ENERGY PROJECTIONS

The annual updates to WEO projections reflect the broadening and strengthening of policies over time, including for renewables. The projections of renewable electricity generation are derived in the renewables sub-module of the World Energy Model, which projects the future deployment of renewable sources for electricity generation and the investment needed. The deployment of renewables is based on an assessment of the potential and costs for each source (bioenergy, hydropower, photovoltaics, concentrating solar power, geothermal electricity, wind, and marine) in each of the 25 WEM regions. Our modeling, in all scenarios, incorporates a process of learning-by-doing that affects the costs. By including financial incentives for the use of renewables and nonfinancial barriers in each market, technical and social constraints as well as the value each technology brings to system in terms of energy, capacity, and flexibility, the model calculates deployment as well as the resulting investment needs on a yearly basis for each renewable source in each region.

## METHODOLOGY FOR ENERGY EFFICIENCY PROJECTIONS

The key energy efficiency indicator refers to GDP and total final energy demand.

Economic growth assumptions for the short to medium term are based largely on those prepared by the OECD, the International Monetary Fund, and the World Bank. Over the long term, growth in each WEM region is assumed to converge to an annual long-term rate. This is dependent on demographic and productivity trends, macroeconomic conditions, and the pace of technological change.

Total final energy demand is the sum of energy consumption for each end use in each final demand sector. In each subsector or end use, at least six types of energy are shown: coal, oil, gas, electricity, heat, and renewables. The main oil products—liquefied petroleum gas (LPG), naphtha, gasoline, kerosene, diesel, heavy fuel oil, and ethane—are modeled separately for each final demand sector.

In most of the equations, energy demand is a function of activity variables, which again are driven by:

- Socioeconomic variables: In all end-use sectors GDP and population are important drivers of sectoral activity variables that determine energy demand for each end use within each sector.
- End-user prices: Historical time-series data for coal, oil, gas, electricity, heat, and biomass prices within each sector are compiled based on IEA's Energy Prices and Taxes database and several external sources. End-user prices are then used as an explanatory variable influencing the demand for energy services.
- Technological parameters: e.g., recycling in industry, or material efficiency.

All 25 WEM regions for energy demand are modeled in considerable sectoral and end-use detail. Specifically:

- Industry is separated into six subsectors (with the chemicals sector disaggregated into six subcategories).
- Building energy demand is separated into residential and services buildings, which are then separated into six end uses. Within the residential sector, appliances energy demand is separated into four appliance types.
- Transport demand is separated into nine modes, with considerable detail for road transport.

## IRENA METHODOLOGY

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<sup>43</sup> For more details on the Open Source Spatial Electrification Tool, see [www.onsset.org](http://www.onsset.org); for the latest OnSSET methodology update refer to Korkovelos and others (2018).

## IRENA scenarios

IRENA's energy transformation scenarios outlined in this report were developed by the Renewable Energy Roadmaps (REmap) team at IRENA's Innovation and Technology Centre in Bonn. Since 2014, IRENA's REmap team<sup>44</sup> has produced a succession of roadmaps with ambitious, yet technically and economically feasible, pathways for deploying low-carbon technologies to create a clean, sustainable energy future at global, regional, and country levels.

The findings presented in this report are based on IRENA's 2020 flagship publication *Global Renewables Outlook: Energy Transformation 2050*. This report considers policy targets and developments through April 2019; any policy changes and targets announced since then are not considered in the present analysis.

- **The “Planned Energy Scenario”** is the primary reference case for IRENA's energy transformation study, providing a perspective on energy system developments based on governments' current energy plans and other planned targets and policies (as of April 2019), including Nationally Determined Contributions under the Paris Agreement unless the country has more recent climate and energy targets or plans.
- **The “Transforming Energy Scenario”** is IRENA's energy transformation pathway that describes an ambitious, yet realistic, energy transformation based largely on renewable energy sources and steadily improved energy efficiency (though not limited exclusively to these technologies). This pathway would set the energy system on the path needed to keep the rise in global temperatures to well below 2°C and toward 1.5°C during this century.

### Methodology for SDG indicator 7.A.1

This year's edition of Tracking SDG 7: The Energy Progress Report covers SDG indicator 7.A.1 for the first time. International financial flows to developing countries in support of clean and renewable energy comprise three categories of investment flows. Official development assistance (ODA) and other official flows (OOF) to developing countries together make up the public financial support that donors provide to developing countries for renewable energy. The additional flows (from the IRENA database) capture the flows to non-ODA recipients in developing regions and flows from countries and other public institutions not currently reporting to the OECD's Development Assistance Committee (DAC).

SDG indicator 7.A.1 is an indicator jointly produced by OECD and IRENA. The flows covered by the OECD are defined as the sum of official loans, grants, and equity investments that countries on DAC's list of ODA recipients receive from foreign governments and multilateral agencies for the purpose of clean energy research and development and renewable energy production (including in hybrid systems). These figures are extracted from the OECD/DAC Creditor Reporting System.

The flows covered by IRENA are defined as all additional loans, grants, and equity investments that developing countries (defined as countries in developing regions, as listed in the United Nations' M49 composition of regions) receive from all foreign governments, multilateral agencies, and other development finance institutions for the purpose of clean energy research and development and renewable energy production (including in hybrid systems). These additional flows cover the same technologies and other activities (research and development, technical assistance, etc.) as listed above and, to avoid duplication of data, exclude all flows extracted from the OECD/DAC Creditor Reporting System.

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44 <https://www.irena.org/remap>.

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