



ACCELERATING SDG 7 ACHIEVEMENT

POLICY BRIEF 25

BUILDING GLOBAL ENERGY INTERCONNECTION
(GEI) TO PROMOTE THE 2030 AGENDA FOR
SUSTAINABLE ENERGY DEVELOPMENT

7 AFFORDABLE AND
CLEAN ENERGY



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.

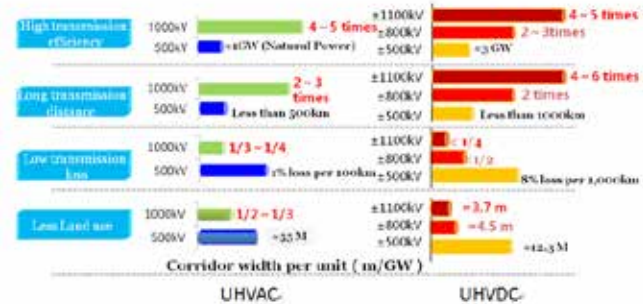
Among the various solutions to meet electricity demand, the centralized power grid offers an efficient and cost-effective way to achieve power access. For large-scale power transmission, ultra high voltage (UHV) technology can achieve long-distance power transmission with high efficiency, low losses 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, $\pm 800\text{kV}$ and $\pm 1100\text{kV}$ 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 $\pm 1100\text{kV}$ 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 health-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-Kurukshetra ± 800 kV 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/SDG7>.

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>.

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