



## **POLICY BRIEF #25**

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

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This document is a part of a series of Policy Briefs being developed to support SDG7 review at the UN High-Level Political Forum to be held in July 2018. The objective is to inform intergovernmental discussions by providing substantive inputs on SDG7 and its interlinkages with other SDGs prepared through inclusive multi-stakeholder consultation processes. The development of these Policy Briefs is coordinated under the auspices of the Ad Hoc Informal Multi-stakeholder Technical Group of Advisors on SDG7.

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## **KEY MESSAGES**

### **Status of GEI and progress towards achieving SDG 7**

- The world has seen a steady improvement of electrification, but there are still 1 billion people with no electricity access all over the world by 2014, over 90% of the population without electricity access live in sub-Saharan Africa, Asia and Latin America.
- The installed capacity of solar and wind power have been increased dramatically from 2000 to 2016. Since 2014, the renewable energy started to meet the increment of global energy demands. In 2016, about 86% of energy demands increased in EU was met by renewable energy. At the national level, in at least 30 countries around the world, renewable energy have already contributed more than 20% of energy supply. National renewable energy markets grow rapidly in the coming decade and beyond, and countries have set various targets for increasing the shares of renewable energy. For instance, EU has set the target of meeting 20% of all electricity demand by renewable energy by 2020.
- The significant cost reduction of utilizing renewable energy makes it possible to develop bulk clean power for people without access to electricity and people with electricity supply from fossil fuels. The geographical mismatch of renewable energy resource centers and load centers leads to the demand for large-scale electricity power transmission over thousands of kilometers in order to achieve a globally optimized allocation of renewable energy for all.
- GEI is a cost-effective mean of achieving an optimized renewable energy allocation by combining the Smart Grid and UHV technologies through grid interconnection (expansion). GEI enable countries to balance electricity demand and supply by means of import and export of renewable energy. Excessive clean electricity generated from clean energy satisfies local demands and can be traded to remote regions or countries with minor losses and economic benefits for both sending and receiving sides.
- “GEI Action Plan to Promote the 2030 Agenda for Sustainable Development” has been released in November 2017, together with the UN.

### **Priority actions over the next four years**

- Incorporate GEI in the energy development strategies and planning, where appropriate, as an important effort to implement the 2030 Agenda and the Paris Agreement.
- Conduct power grid study and planning at the global level based on local, country or regional power grid planning, taking into account the global renewable resources distribution and electricity demands.
- Disseminate successful experiences of UHV transmission plus smart grid, transmitting bulk renewable power over thousands of kilometers.
- Carry out concerted actions to accelerate power grid interconnection, and improve universal access to electricity, energy efficiency, and enhance technology innovation and capacity building.
- Put in place policies and action plans to encourage renewable energy development and utilization on global level, and promote power transmission across countries or regions, on the basis of international cooperation and win-win benefit.

### **Priority actions towards 2030**

- Promote modern energy system that features large scale development, transmission of clean energy worldwide. In this regard, disseminate information of GEI and encourage governments to formulate policies that support the development of GEI.
- Develop new business models to attract multi-stakeholder investors to build power grid infrastructure. A fair electricity trading model through interconnected power grid is needed so as to provide open, clear, and affordable prices and mechanism for population without electricity.
- 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.

## GEI and the Sustainable Development Goals

Energy utilization is a key element for sustainable development. For the first time, the target to "ensure access to affordable, reliable, sustainable and modern energy for all" is included in SDGs as the SDG7.

GEI, Global Energy Interconnection is a mean to improve the utilization of clean energy and transmission. It aims to achieve the replacement of fossil fuel in electricity generation by renewable energy, and then, replacement of fossil fuels by renewable electricity in other sectors. That will increase the electrification level for end users and reduce the use of fuel fossil as an industrial energy source.

Among the various solutions to meet electricity demand, the integrated power grid is one of the most efficient and cost effective way to achieve power access. For large-scale power transmission, high voltage level, namely UHV technology, is essential to achieve long-distance power transmission with high efficiency, low loss and 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 most efficient generating plants may be better utilized as they can supply a wider set of consumers and therefor being less vulnerable to local dips in demand.

Global Energy Interconnection, or GEI, is a visions 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 where such resources are rich, to load areas today suffering from pollution caused by fossil fuel consumption, as well as to people currently without electricity access.

The three pillars of GEI are Smart Grid, Ultra High Voltage (UHV) Power Grid 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 transmissions, is able to transmit bulk power in the order of 10 Giga-watts across thousands of kilometers 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 the regular high voltage transmission. Thus, the UHV technology is a significant innovation for the electric power industry. 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 the operation, transmission, distribution and storage in a coordinated manner. In brief, GEI is a systematic combination of "Smart Grid", "UHV" and "Clean Energy".

The voltage of transmission systems has been increased from low level to 500kV, then to 1000kV for AC system; HVDC voltage started from 500kV and has reached  $\pm 1100\text{kV}$  in the recent decade.



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 contributing to SDG7, many other SDGs will benefit from building GEI, including the mitigation of climate change, removing health detrimental air pollution, supporting sustainable production and consumption, reducing poverty, and promoting gender equality, etc.

### Current status of GEI

The world is rich in clean energy resource but the distribution is not even in space and time, nor does it always fit demand. In Asia, Europe and Africa, 85% 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. However, major load centers are concentrated in East Asia, South Asia, Europe and Southern Africa. In brief, many of the areas rich in clean energy resources are far away from load centers. GEI intends to promote clean energy development, optimizing energy supply, making good 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 widely applied. The power grid is more flexible and economic, adapted to the 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 the technical breakthrough and the application of new materials. The efficiency of the photovoltaic technologies has reached 20%. Wind turbines with capacity around 10 MW have been put into operation. The UHV technology has become mature, and the distance of the UHVAC and DC transmission can reach 1500 kilometers and 6000 kilometers respectively. Some key technologies, such as UHV submarine cables, high-speed DC switches, are being developed, and technical break-throughs 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% and 75%

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respectively in the past 5 years. The international bid-winning price of PV and wind projects where resources are good are now repeatedly in the order of 2 US¢ per kWh. In growing parts of the world renewable electricity is outcompeting fossil based power. With better interconnections it is possible to supply clean electricity to more people.

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 connected, low cost and stable power may be provided to Africa and Europe. With GEI, global electricity trade can be realized, which will become the dominant form of global energy trade.

### **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 in general more economic, more secure and more reliable than small ones. The benefits of power interconnections are much greater than before due to the increasing low-cost wind- and solar power being connected to the grid. Several large-scale transnational interconnected power grids supplying electricity for billions of people have demonstrated the reliability of the technologies involved.

In India, the Champa-Kurukshetra 800kV UHV DC project is under construction, 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 hydro power 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 is 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. UHV is considered as an important option for renewable energy integration and intercontinental transmission in future.

In Asia, Africa and North America, there are also several transnational power grids, such as the Gulf grid, Southern Africa grid, the US-Canada grid, which all greatly contribute to power supply.

The desirability, feasibility, and affordability of GEI have been extensively discussed during the past two years. Several MOUs to promote the development of GEI in various regions of the world, have been signed by UN bodies, such as UN-DESA, UN-ESCAP, UN-ECLAC, as well as SE4ALL. In particular, the *Global Energy Interconnection Action Plan to Promote the 2030 Agenda for Sustainable Development* was released on

November, 2017 at the UN 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 inter-connection, cross-countries 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?**

In 2014, the population without electricity was around 1 billion and the electrification rate was 85%. It has been 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. The population without electricity access may be reduced to less than 500 million and electrification rate may increase to 94%, up by 9% compared to 2014.

The share of clean energy in primary energy consumption can be raised to 35% by 2030, up by 16% over 2015, and 10% higher than the business as usual scenario.

It is anticipated that upgrading national, transnational or even wider power grid, especially upgrading the distribution grids in rural areas, will be accelerated in the future, which will supply modern and sustainable energy services for all.

### **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 connection as well as trans-national and trans-regional grid interconnection, for the optimized development and utilization of clean energy resources in each continent.

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, multilevel investment & financing mechanism, and high-efficient investment & financing supporting system are essential and need to be improved.

## **Interlinkage with other Sustainable Development Goals**

Building GEI not only contribute SDG 7 but also to many of the other SDGs, including those on ending poverty, combating climate change, gender equality, and sustainable industrialization & innovation.

### **Ending Poverty, inequity and regional disparities**

By providing sustainable energy to remote and poverty-stricken areas, GEI makes it possible for the poor to have

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access to education, work and infrastructure for industrial activities, which will generate more opportunities to increase income, end poverty and narrow the regional gap. Countries in Asia, Africa and South America may sell clean energy to developed countries, thus transforming resources advantages to economic benefits.

### **Climate change**

Based on Independent National Determined Contribution (INDC), greenhouse gas emission will reach 55 billion tons in 2030, far more than the 40 billion tons goal set in Paris Agreement. With GEI, CO<sub>2</sub> emission will reach peak before 2030, while the energy-related CO<sub>2</sub> emissions will be 26.7 billion tons, down by 17% than that of 2014. The total greenhouse emissions will be below 40 billion tons, fulfilling the pledges made in Paris Agreement, and pave the way for achieving zero emission of global greenhouse gases and limiting the global average temperature rise to below 2 degrees Centigrade in the 2nd half of this century.

### **Policies to promote modern energy system**

Enact polices to increase the rate of access to electricity, set clear objectives and road maps, and actively promote the implementation.

Promote modern energy system that features large scale development, and transmission of clean energy worldwide. In this regard, disseminate information of GEI and encourage governments to formulate policies that support the development of GEI.

Policies should be put in place to optimize grid inter-connectivity and operation worldwide, and promote access of all kinds of centralized and distributed clean energy resources.

In order to extend grid connection to regional and global level, a comprehensive power planning at global level is crucial. This process should take into account global renewable resource distributions well as distribution of demand in space and time. International cooperation is needed involving governments, international organizations, and the private sector.

Governmental policy support for clean energy development is uneven and sometimes insufficient. To achieve global allocation of renewable energy needs effective, transparent and clear-targeted government policies, removing barriers and creating favorable policy environment to support the deployment of clean energy and to accelerate energy interconnection.

### **Policies to enhance international technical cooperation**

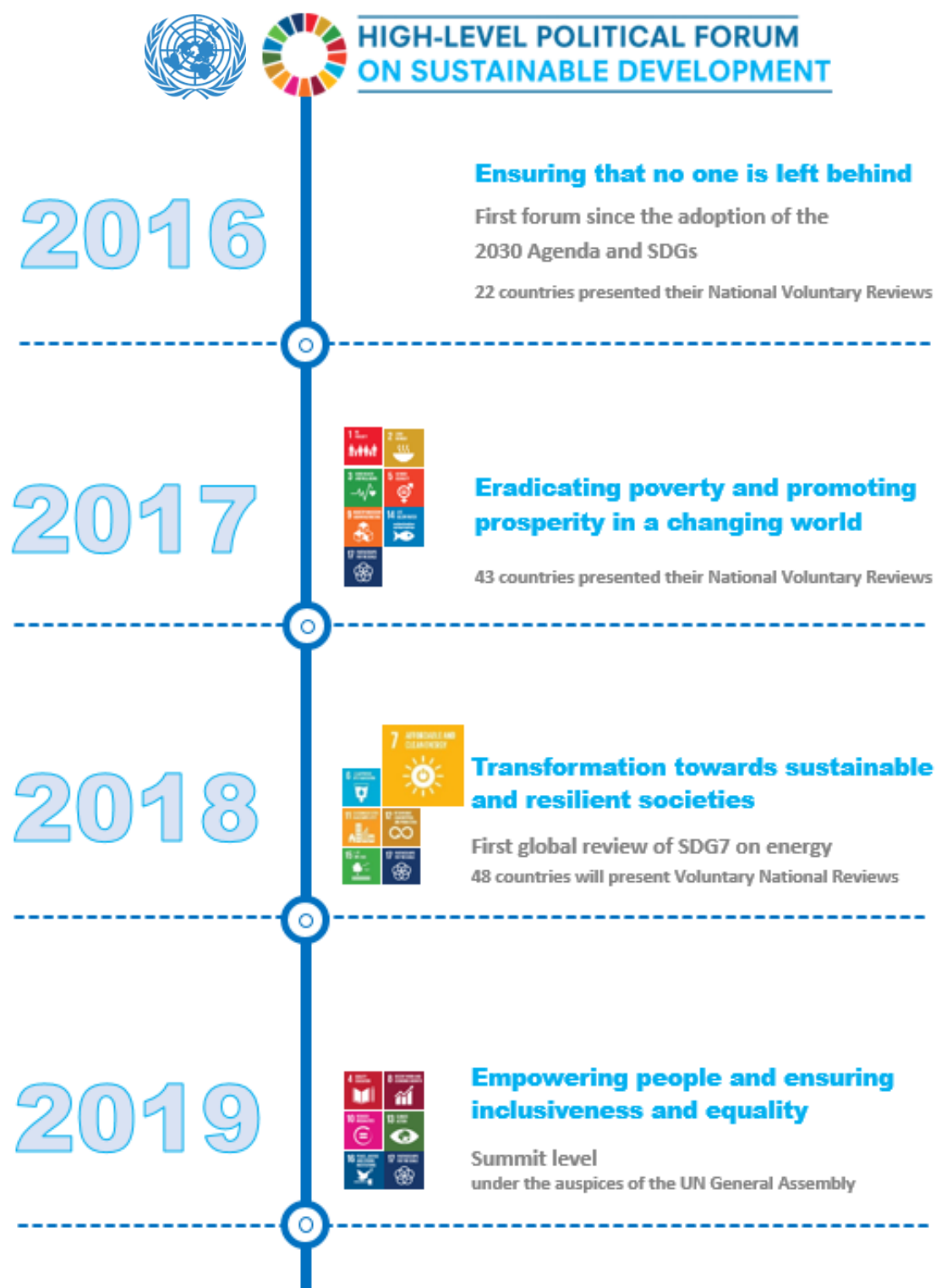
Building GEI needs continuous development of clean energy technologies, including power grids of lower costs and higher reliability and technologies to operate electrical devices in extreme condition (eg. extreme cold or extreme hot conditions). New R&D activities call for cooperation among

manufactures, research institutes, talent tanks, and support from governments.

### **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 should 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 power grid infrastructure.

Connecting national electricity grids requires cross-border electric power trading mechanisms. The mechanism should include tax, transmission costs and dispute mediation to achieve efficient collaboration in global power exchange.



For further information, please contact:  
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