FACT SHEET

Smart grid

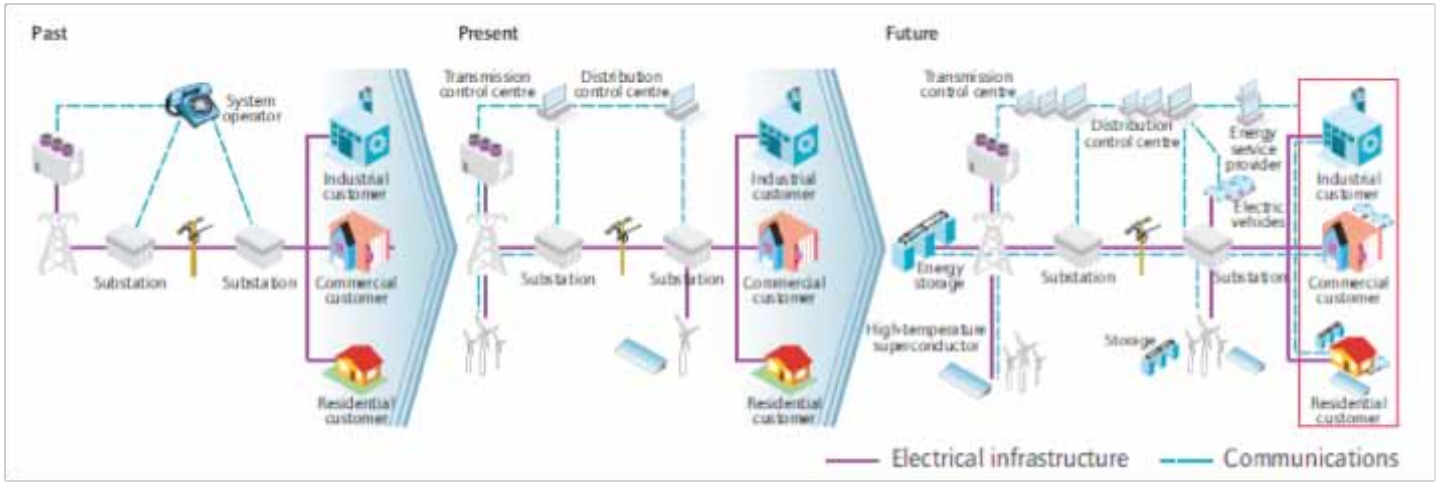
Key point

- ***The smart grid allows small- and medium-scale suppliers and individuals to generate and distribute power in addition to the conventional utility companies.***

Smart grid explained

The smart grid, according to *Technology Roadmap: Smart Grids*, is "an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users."[1] The smart grid coordinates the needs and capabilities of all energy producers, grid operators, end users and electricity market providers to control all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability.[2]

Figure 1: Smarter electricity system



Source: International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

The technologies associated with the smart grid serve to deliver power from producers to end users. Although many of the individual technologies are mature, further experience is required to integrate all the technologies into one comprehensive smart grid system through their application in a large-scale demonstration project. The individual technology areas that make up the smart grid's hardware, systems and software include wide-area monitoring and control, information and communication technology integration, renewable and distributed generation integration, transmission enhancement, distribution grid management, advance metering, energy storage systems, electric vehicle charging infrastructure and customer side systems. They are used to assist in managing electricity consumption at the industrial and commercial levels and include smart appliances, routers, in-home displays and energy management systems.[3]

[1] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

[2] ibid.

[3] ibid.

Infrastructure has a long life span which can be more than 30 to 50 years. Once an infrastructure is developed, in general, it is locked in. Thus, the design and construction of new infrastructure should take into account the eco-efficient technological innovations, such as smart grid technology, and lifestyle changes that will take place over the next 30 to 50 years.

Strengths of the smart grid

- **Provides potential for large scale deployment and distribution of locally generated renewable energy:** Volatile fuel prices and growing demands for energy will make countries look for renewable energy sources. But existing conventional electricity infrastructure, as it is, will not be able to accommodate the deployment of new sources of energy. However, smart grid technologies can maximize the use of existing electricity infrastructure through improved monitoring and management systems, while more energy-efficient infrastructure is strategically deployed.[4]
- **Provides the opportunity for the wide-scale introduction of electric vehicles and plug-in hybrid electric vehicles:** Smart grids allow cars to be charged when demand is low or during certain times of the day when renewable energy production is high (for instance, solar energy production is high during the day time). Smart grids also enable electric vehicles to be charged at a residence or at a designated charging station.
- **Provides resilience to disturbances, attacks and natural disasters:** Not only can smart grids ensure the supply of a reliable, stable and better quality of energy, it can also be programmed to supply energy during emergency situations from its energy storage facilities.[5] The batteries of electric vehicles also store energy and feed energy back into the grid during times of emergencies, such as black outs and natural disasters.[6]
- **Encapsulates central and localized power distribution:** One of the primary benefits of the smart grid is the way it transforms the power supply and distribution system from a centralized one to a less centralized one, enabling small-scale suppliers and individuals, or "prosumers", to generate and distribute energy alongside conventional utility companies.
- **Lowers utility use and bills and enables informed participation by customers:** The real-time, two-way digital communication channels (supply and demand control) made possible through the smart meter and information and communication technology allow consumers to control and manage the way they use energy. This directly impacts the users' utility bills. For instance, the smart electrical appliances connected to the smart meter can be switched on and off according to the electricity demand at a certain time. This also allows consumers to choose the type of energy they want to use, such as solar, geothermal or wind energy. It additionally enables utility operators to manage the supply, such as during peak hours.
- **Promotes energy and operating efficiency:** There is tremendous capacity to reduce the energy losses experienced in the transmission and distribution system. Because the energy generation, distribution and consumption can be managed better through a smart grid, it improves energy efficiency.[7] It also helps countries save money that can be redirected, for instance, to social programmes, such as job creation, health care and education. For example, in the United States, the interruption of power and blackouts cost the nation US$150 billion annually.[8]
- **Creates new opportunities for technology development in electrical appliances, energy products and energy services:** According to the International Energy Agency, while technological advancement in smart grid technology is progressing, there are still many technologies that have not reached maturity. This includes electric vehicle charging infrastructure and renewable and distributed generation integration, which include battery storage technology.[9]

[4] ibid.

[5] ibid.

[6] ibid.

[7] According to the ESCAP *Guideline for Strengthening Energy Efficiency Planning and Management in Asia and the Pacific*, less than 5 per cent of the energy in fossil fuels is delivered as lighting service and 60 per cent of the energy in the fossil fuel is lost because the power plant is constrained by the second law of thermodynamics.

[8] United States of America, *The Smart Grid: An Introduction* (Washington, D.C., Department of Energy, 2008). Available from http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_SG_Book_Single_Pages%281%29.pdf (accessed 12 March 2012).

[9] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf (accessed 3 October 2011).

- **Improves the climate change mitigation potential:** The development of a smart grid can be a major driver for countries to achieve the global goal of 50 per cent CO_2 emission reduction by 2050. According to the International Energy Agency's, Energy Technology Perspective 2010 BLUE map scenario, smart grids have the potential to contribute directly and indirectly to reducing between 0.9 and 2.2 gigatonnes of CO_2 annually by 2050, compared with the baseline scenario.[10] This is because it will facilitate the introduction of renewable energy and increase energy efficiency leading to energy security and new opportunities for economic development.

Challenges to introducing the smart grid

- **Lack of policy and market uncertainty:** The various technologies and infrastructure comprising the smart grid system require different levels of investment according to the maturity of the individual technologies, and the application of these technologies in demonstration projects requires even greater levels of investment. Thus, investors need policy and market certainty to make long-term investment plans.
- **Regulation barriers:** The electricity sector, especially the transmission and distribution systems, is generally a monopoly.[11] However, smart grids enable a wide variety of parties, including individuals and small to medium-sized entities, to enter the market. These include entities for renewable energy production. Regulatory barriers need to be removed and incentives schemes need to be provided to facilitate these new entrants.
- **Lack of investment towards research, development and demonstration:** In addition to investment in R&D for smart technologies that are still in the developing stage, it is equally important to undertake large-scale demonstration projects of the smart grid to test the application of technologies, infrastructure and services as a total system. The International Energy Agency estimates that current public research, development and deployment spending on smart grids is US$539 million annually. However, according to the International Energy Agency's BLUE map scenario, investments need to reach US$5.6 billion to US$11.2 billion annually to halve CO_2 emissions by 2050 compared to 2007 levels.[12] Thus, governments will need to lead and provide sufficient public funds to support this research, development and deployment process. At the same time, governments need to form partnerships and also attract investments from the private sector.
- **Lack of human resources:** To prepare for the large-scale deployment of a smart grid, appropriate training to build the capacity in human resources will be required. Without an able workforce with the appropriate skills and knowledge, smart grids will not be deployed and operated effectively.

Implementing strategies

Integrate smart grid strategies into national policy frameworks: Smart grid development will require strong government commitment and national vision. Short-, medium- and long-term goals and targets need to be set and integrated into national sector policies for science and technology, ICT, infrastructure, energy, innovation, finance, industry and climate change, just to name a few. Because of the smart grid's capacity for energy efficiency, the goals and targets for its development should also be integrated into national energy and energy efficiency policy frameworks.

Develop national smart grid roadmaps, which are crucial for planning and implementing smart grid technologies: A national smart grid vision needs to be formed by the government – stating what is to be achieved and how the technologies should be used. A matching investment plan and timeline of activities, such as government-supported demonstration activities, need to be devised. This process will contribute to creating an enabling policy environment. The development of the smart grid system also requires collaboration with and investment from the private sector and other partners. It will be important to have a plan that maps out how all actors will be engaged.

[10] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part1.pdf (accessed 1 March 2012).

[11] ibid.

[12] International Energy Agency, *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050* (Paris, 2010). Available from www.iea.org/Textbase/nppdf/free/2010/etp2010_part2.pdf (accessed 1 March 2012).

Ensure that regulations and standards enforce quality control and uniformity among the different technologies and infrastructure: Governments should take the lead in creating standards that ensure quality control and uniformity among the technologies and infrastructure as one system. The standards should be compatible with the existing infrastructure.

The introduction of the smart grid also involves the transformation of the market. Regulatory changes need to ensure that all actors involved in electricity generation, transmission and distribution as well as the consumers will benefit and share the cost burden – with consideration of the distributional and equity issues. For instance, a policy option may be the application of a dynamic pricing scheme involving smart metering,[13] although there has been controversy over this scheme in some parts of the world, including health and data privacy issues.

Regulatory barriers associated with smart grid technology and infrastructure must be removed from the current electricity system. New regulations must promote the market entrance of medium- and small-scale electricity generators and "prosumers".

Other regulatory issues include assessing and then enabling the appropriate level of investments that will be required to support infrastructure development. The regulatory environment will need to be attractive enough to draw investment and generate returns on that investment. Because ICT will be the central tool for operating the smart grid, regulatory changes will be necessary to ensure cyber security. Lastly, the technology development will herald in the need for new regulator options.[14]

Financing smart grids

Public funding will be crucial for smart grid development at the national level. Governments will need to provide credible and stable signals through medium- to long-term policy frameworks to invigorate private sector confidence, which leads to investment. At the same time, governments will need to couple innovative financing schemes and incentives focused on the private sector, such as a feed-in tariff, to increase the share of renewable energy sources, which will be a vital component for smart grid efficiency. Such incentives as tax rebates, loan guarantees and low interest loans can spur investment. Incentives must also be extended to consumers because they will bear the financial cost for new technologies and appliances.

Opportunities in Asia and the Pacific

Although the electrification coverage has improved in developing countries, many still do not have adequate power infrastructure nor enjoy a stable energy supply. Further investment is required to improve their energy supply, including the infrastructure needed to access energy. The introduction of a smart grid system may be progressive at this time for many developing countries, but they can proceed with the construction of the power infrastructure now, keeping in mind the possibilities of smart grid technology integration in the future once there is more experience with large-scale projects in industrialized countries. At the least, the smart grid system can be deployed as an option for rural electrification by adopting small remote systems that are not connected to the centralized electricity infrastructure but can provide electricity to households and communities. At a later stage, community grids can be connected to the national system.[15]

Trends in smart grid development

The following table highlights the current status of smart grid systems in four of the eleven countries in the Asia-Pacific region that have either a demonstration smart grid system or are deploying a system: Australia, China, Japan and the Republic of Korea. (Elsewhere, Brazil, France, Germany, Italy, Spain, the United Kingdom and the United States have also introduced this system.)

[13] The smart metering allows a two-way flow of information between the customers and utilities on the electricity price as well as the time and amount of the electricity consumption.

[14] International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/Papers/2011/SmartGrids_roadmap.pdf (accessed 3 October 2011).

[15] ibid.

Table 1: Selected national smart grid demonstration and deployment efforts in Asia and the Pacific

Australia	The Australian Government announced an A$100 million *Smart Grid, Smart City* initiative in 2009 to deliver a commercial-scale smart grid demonstration project.
China	The Chinese Government developed a large, long-term stimulus plan to invest in water systems, rural infrastructure and power grids, including a substantial investment in smart grids. Smart grids are seen as a way to reduce energy consumption, increase the efficiency of the electricity network and mange electricity generation from renewable technologies. China's State Grid Corporation outlined plans in 2010 for a pilot smart grid programme that maps out deployment to 2030. Smart grid investments will reach at least US$96 billion by 2020.
Japan	The Federation of the Electric Companies of Japan is developing a smart grid that incorporates solar power generation by 2020, with government investment of more than US$100 million. The Government announced a national smart metering initiative, and large utilities have announced smart grid programmes.
Republic of Korea	The Korean Government launched a 64.5 billion won approx. US$ 57.8 million pilot programme on Jeju Island in partnership with the industry sector. The pilot programme consists of a fully integrated smart grid system for 6,000 households, wind farms and four distributional lines. The Government announced plans to implement smart grids nationwide by 2030.

Source: Extracted from the International Energy Agency, *Technology Roadmap: Smart Grids* (Paris, 2011). Available from www.iea.org/Papers/2011/SmartGrids_roadmap.pdf (accessed 3 October 2011).

Further reading

Technology Roadmap: Smart Grids (Paris, International Energy Agency, 2011). Available from www.iea.org/papers/2011/smartgrids_roadmap.pdf