



Smart Grids in India

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To understand a smart grid's benefits and applications it is important to first understand the working of the system that is presently being used. In the current system, the end user measurements are mostly with billing in mind, and not control. The other measurements in the grid are few and limited. The sources of power are also restricted to conventional power plants like coal fired or hydro power plants. The tariff rates are flat and are not related to demand or supply.

Smart Grid is a nebulous term spanning various functionalities geared towards modernising the electricity grid. At its core, a smart grid utilises digital communications and control systems to monitor and control power flows, with the aim to make the power grid more resilient, efficient and cost effective. The basic objectives of smart grids are to enable informed participation by customers; accommodate all generation (solar, wind etc.) and storage options; enable new products, services, and markets; provide the power quality needed for the range of needs in a 21st century economy; optimise asset utilisation and operation efficiently; address disturbances through automated prevention, containment and restoration; and operate resiliently against all hazards. The various components and the interlinkages between them for implementation of a smart grid are shown in Fig 1.

Role of Renewable Energy

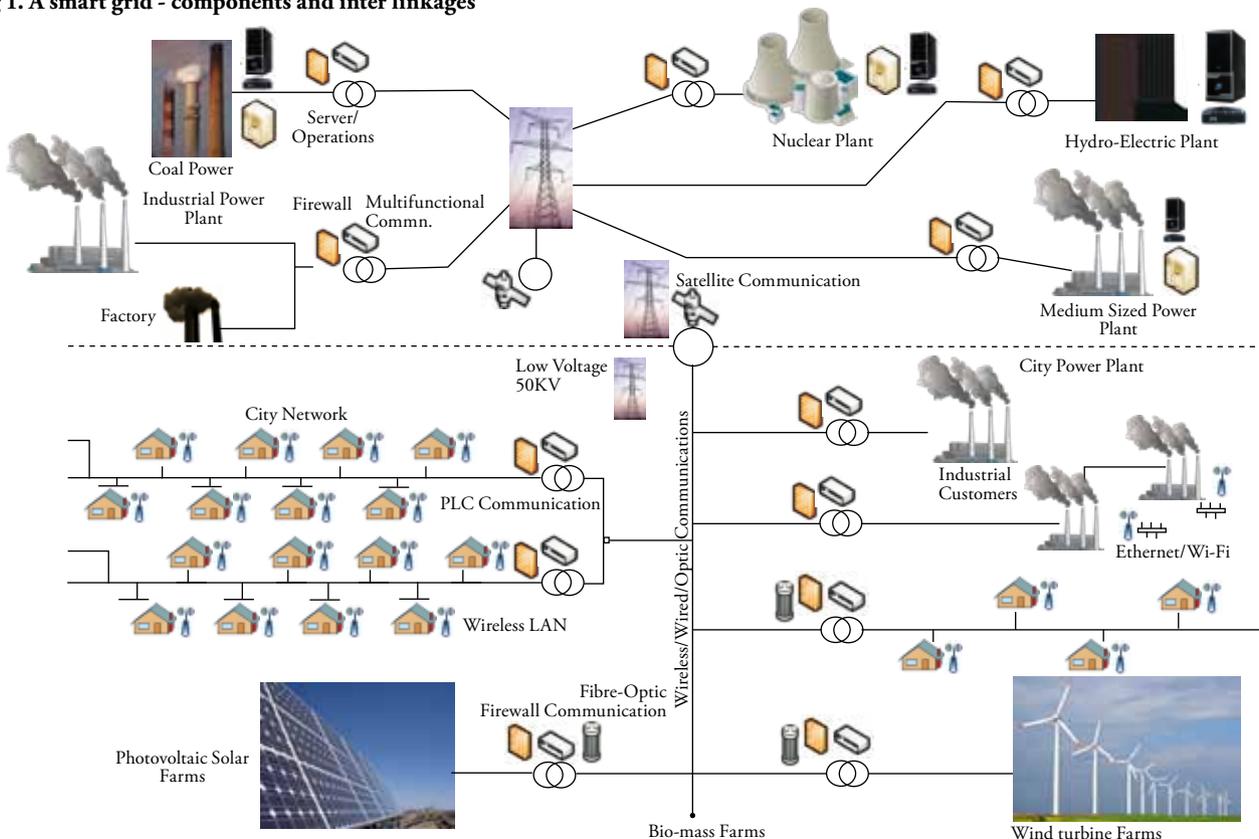
The above situation makes it imperative to harness the renewable energy resources wherever and whenever possible. Renewable energy (RE) is no longer 'alternate energy', but will increasingly become a key part of the solution to the nation's energy needs. In fact, a beginning has already been made and it is an important component of India's energy planning process now. It has the potential to resolve the decentralised energy needs of the remotest corner of the country.

Need for smart grids in India

According to the Ministry of Power, India's transmission and distribution losses are amongst the highest in the world, averaging 26 per cent of total electricity production, and as high as 62 per cent in some states. These losses do not include non-technical losses like theft etc.; if such losses are included, the average losses are as high as 50 per cent.

India loses money for every unit of electricity sold, since India has one of the weakest electric grids in the world. Some of the technical flaws in the Indian power grid are - it is a poorly planned distribution network, there is overloading of the system components, there is lack of reactive power support and regulation services, there is low metering

Fig 1. A smart grid - components and inter linkages



Smart grid efforts in India

Implementing organisation	Details
Bangalore Electricity Supply Company Limited (BESCOM), Bangalore, Karnataka	USD 100 million smart grid pilot project.
North Delhi Power Limited (NDPL), New Delhi	Collaboration with GE for smart grid.
Indian Institute of Technology Kharagpur (IITK) and Indian Institute of Technology Madras (IITM)	Collaboration with IBM for smart grid research.
Management Development Institute (MDI), Gurgaon, Haryana	Smart grid educational programme at the School of Energy Management.

efficiency and bill collection, etc.

India is venturing very fast into renewable energy (RE) resources like wind and solar. Solar has great potential in India with its average of 300 solar days per year. The government is also giving incentives for solar power generation in the form of subsidies for various solar applications; and has set a goal that solar should contribute 7 per cent of India's total power production by 2022. With such high targets, solar is going to play a key role in shaping the future of India's power sector.

A lacuna of renewable resources is that their supply can be intermittent i.e. the supply can only be harnessed during a particular part of the day, like day time for solar energy and windy conditions for harnessing wind energy, also these conditions cannot be controlled. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). Hence, the opportunities for building smart grids in India are immense, as a good electric supply is one of the key infrastructure requirements to support overall development.

Smart grid technologies

Smart metering/demand side management: Smart meters are microprocessor based devices that provide a two way communication capability. They help homeowners and the suppliers to manage the respective electricity usage and supply in a more efficient and cost effective manner. With the help of the information provided by such smart meters the power companies will have the capability to set up real time pricing systems for electricity.

Virtual power plants: The goal of virtual power plants (VPPs) (Fig 2) is to allow discrete energy resources (DERs) to access the energy market i.e. to feed the electricity grid constantly and reliably.

With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment.

Micro grids: A micro grid (Fig 3) is a cluster of local DERs and loads in such a way that an operation is possible within the grid or in independent mode. Usually it is connected at the low voltage level but sometimes also at the medium voltage level.

All these technologies can be used in India in different forms depending on the applications. Different algorithms can be used for the control of smart grids, VPPs etc.

Challenges and solutions

Policy and regulation: No defined standards and guidelines exist for the regulation of smart grid initiatives in India. The current policy and regulatory frameworks were typically designed to deal with the existing networks and utilities. With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment. The new framework will need to match the interests of the consumers with the interests of the utilities and suppliers to ensure that the societal goals are achieved at the lowest cost to the consumers.

Cost: If smart grids had made easy business sense, they would have been the norm everywhere. Cost is clearly one

Fig 2. A virtual power plant (VPP)

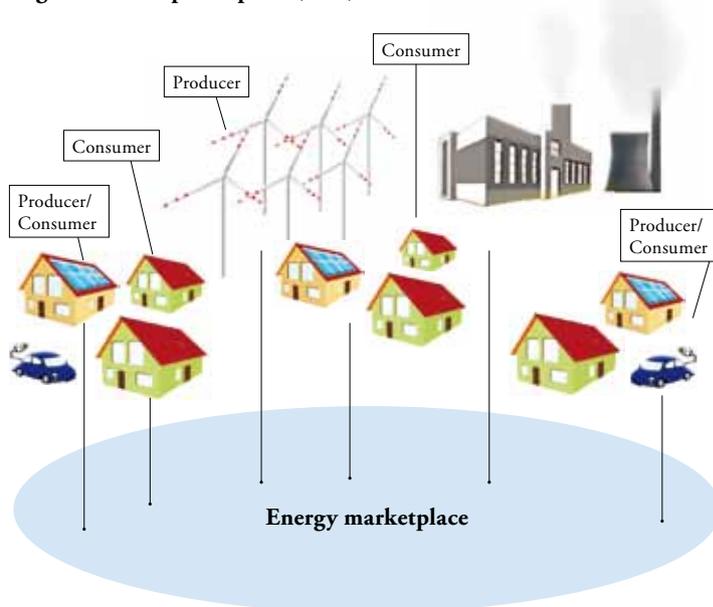


Fig 3. A micro grid



of the biggest hurdles in implementing smart grids. Some older equipment that cannot be retrofitted to be compatible with smart grid technologies will have to be replaced. This may present a problem for utilities and regulators since keeping equipment beyond its depreciated life minimises the capital cost to consumers. The early retirement of equipment may be an issue. Cost of implementing smart grids runs in crores of rupees. The benefits from smart grids are not just meter readings but include reduction in equipment failure, better quality of supply and greater use of green energy. It takes careful societal cost-benefit analysis, beyond return of investment calculations, to justify the use of a smart grid.

Lack of awareness

The level of understanding of consumers about how power is delivered to their homes is often low. So, before going forward and implementing smart grid concepts, the consumers should be made aware of what a smart grid is, how it can contribute to a low carbon economy and what benefits they as users can drive from smart grids. Therefore, consumers must also be made aware of their energy consumption pattern at home, offices, etc.; policy makers and regulators must be very clear about the future prospects of smart grids; and the utilities need to focus on the overall capabilities of smart grids rather than mere implementation of smart meters.

Cyber security and data privacy

With the transition from analogous to digital electricity infrastructure comes the challenge of communication security and data management. Since digital networks are more prone to malicious attacks from software hackers,

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security becomes a key issue. In addition to this, concerns on invasion of privacy and security of personal consumption data arise. The data collected from the consumption information could provide a significant insight into a consumer's behaviour and preferences. This valuable information could be abused, if correct protocols and security measures are not adhered to. These issues should be addressed in a transparent manner, to minimise any negative impact on a customer's perception. The systems should be designed with security as a priority and should be well protected against software hacking and other such malicious activities.

The way forward

It is very difficult to analyse the performance and benefits of smart grids without actually implementing them. Techno-commercial pilot projects can offer interesting potential demonstrations of various benefits of smart grids. Overall, the major elements of any such projects should include, developing a smart grid vision, conducting appropriate awareness to educate and develop a consensus, identifying viable funding options and implementing appropriate policy and regulatory actions to set common standards and encourage innovation.

In tandem with these actions, certain pilot projects could be implemented to demonstrate their commercial viability. Small and medium sized projects should be tried at both, the rural and urban level to decide upon an optimal solution, which can be implemented, on a larger scale.

It should be emphasised that any plan must be adaptable to the unique needs, cultural and political realities, and resource constraints of different regions, states and localities. Perhaps the gravest error at this early stage of smart grid development would be to adopt a rigid, top-down and 'one size fits all' approach to achieve a smart grid vision. In conclusion, if implemented appropriately, smart grids can provide a very green and optimal solution to India's energy needs. ❁

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