Smart Grid

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Abstract

The development and implementation of a smart grid for power supply is one of the pressing issues in modern energy economy, given high national priority and massive investments, although the entire subject is still in its infancy stage. The smart grid delivers electricity from producers to consumers using two-way digital technology, and allows control of appliances in the consumers' houses and of machines in factories to save energy, while reducing costs and increasing reliability and transparency. Such a modern electricity network is promoted by many governments as a way of handling energy independence, global warming and security of supply. Smart meters are part of the smart grid, but do not themselves constitute a smart grid. A smart grid includes an intelligent monitoring system that keeps track of all the electricity that flows in the system. It could incorporate the use of super-conducting transmission lines to reduce losses, as well as the ability to integrate electricity from alternative sources such as solar and wind. When electricity cost is low, the smart grid can offer the customer to run intensive consumption household appliances, such as washing machines, or processes in plants that operate at flexible hours. On the other hand, smart grid at peak hours can, in coordination with the client, turn off selected appliances and machines to reduce demand.

In principle, the smart grid is an upgrade of the common electricity grids that operate mostly to provide one-way power from several major power plants to a large number of consumers. This upgrade is expressed in the ability to operate in conditions of uncertainty in order to route the power supply in an optimal way that responds to a wide variety of situations, to encourage users in off-peak hours and charge premium rates from consumers who use energy during peak hours. The key to this capability is fast, accurate and two-way transmission of information between all parts of the grid. Situations that require fast response can occur at all parts of the grid – at the chain of production, transmission and

consumption. The source of the event could be in the environment (sudden cloudiness that decreases solar power, or a very hot day that increases the demand for air conditioning), in parts of the grid itself (sudden failures, the need for proactive maintenance) or in the demand (work hours compared to hours of rest).

Several countries have devoted significant efforts to the issue of smart grid and it is possible to learn from their experience. Italy is considered the most advanced of the European countries with the Telegestore[1] project that was completed in 2005. This project is considered the first on commercial-scale for residential buildings and saves about 500 million euros per year with an investment of approximately 2.1 billion euros. In the U.S., the city of Austin in Texas replaced one third of the meters in its area with smart meters and has about 200,000 units that are interconnected by a communications network.[2] The city of Boulder in Colorado completed the first phase in installing a smart grid throughout the city.[3] A similar project was conducted in Ontario, Canada.[4]

Smart grid will bring many benefits to Israel's energy economy, including optimal production of electricity and combining storage while reducing the need for it, a natural integration of decentralized producers - in particular from renewable energy sources, efficient planning of power consumption to reduce consumer costs, and security of supply. The network will enable metering and monitoring, consumption management and many other benefits, the most important of which is a reduction of total consumption and intelligent exploitation of energy resources. The expected applications and services in the short term are mainly in the field of optimization, resources and providing information to consumers; however, it is difficult at present to imagine the full range of related innovations that will be developed, as it happened following the creation of the Internet network.

The smart grid does not have to be based on a hierarchical structure that characterizes the conventional grid of "from the manufacturer to the consumer". It is reasonable to expect

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[1] The NETL Modern Grid Initiative - Powering our 21st-Century Economy: Modern Grid Benefits, Conducted by National Energy Technology Laboratory for the U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, August 2007

[2] "Building for the future: Interview with Andres Carvallo, CIO — Austin Energy Utility". *Next Generation Power and Energy* (GDS Publishing Ltd.) (244). http://nextgenpe.com/currentissue/article.asp?art=273073&issue=244.

[3] "Building for the future: Interview with Andres Carvallo, CIO — Austin Energy Utility". *Next Generation Power and Energy* (GDS Publishing Ltd.) (244). http://nextgenpe.com/currentissue/article.asp?art=273073&issue=244.

[4] "Building for the future: Interview with Andres Carvallo, CIO — Austin Energy Utility". *Next Generation Power and Energy* (GDS Publishing Ltd.) (244). http://nextgenpe.com/currentissue/article.asp?art=273073&issue=244.

that it would be a matrix structure based on interconnected clusters, each in itself constituting a smart grid for its own producers and consumers, similar to communication networks or the Internet. For example, the smart grid could be at the city level, integrated into a national grid, or at the plant level, integrated into the urban grid. The physical infrastructure - transmission and distribution lines - requires innovations and the introduction of disciplines that do not exist today in the standard power supply grid - speedy switching, direct or alternating current with synchronization, coordination and transmission of information on the same network or on an attached network, developing applications for operators and consumers and enabling control of the systems. Data transfer, communication and control – all require a universal protocol for communication and grid management, communications equipment, metering and consumption control.

The Smart Grid subject is still in its infancy, both in Israel and the world, but is clearly of national importance. Israel has much to contribute in this field, both as a leader in various technology areas and in particular in ICT, and because of its ability to serve as a testing field, being an energy "island".

The cost of the smart grid is quite high. According to estimates, turning the entire grid into a smart one will cost billions of dollars. It is possible and probably desirable to perform the process gradually. IEC has already started the project of smart metering of 6,000 large consumers that are responsible for half of the national electricity consumption, and this could be extended later to all 2.5 million domestic consumers with an estimated cost of $500 per consumer. The savings achieved by energy efficiency could serve as a lever to finance the entire project.

Recommendations:

(1) An action plan to implement a smart grid in Israel should be prepared. One proposed way is to formulate this plan in a work group of experts who can work in parallel with groups in the U.S. and Europe. There is an immediate need to bring to the discussion table parties that do not consider the power system as part of their natural playground, for example, ICT people.
(2) A policy must be set and objectives have to be mapped out: the course of action is not necessarily the same when the objective is maximal efficiency in electricity consumption, compared with full supply of all consumption at any time or introducing maximum renewable energy into the electricity sector. As part of the policy, the desired benefits should be defined, and then the business model has to be determined, as well as the processes and the technology from which the expected costs and the expected added value will be derived.
(3) Implementing the smart grid should start at the consumer side. This is worthwhile and practical since the basic infrastructure is simple and exists already. Smart Metering should be installed nationwide since its benefits have been proven and it constitutes an essential infrastructure for the smart grid. It is possible to create clusters of regional smart grids in areas with high profitability. These clusters will be interconnected later on, and be connected to the national grid. With consumption of more than 4-5 MW, many plants will benefit from self-production of electricity, especially if they could use cogeneration. (For this purpose, the regulator must ensure that the price of natural gas will be maintained).
(4) Standards should be set – with international coordination – for the components of the smart grid, such as smart meters. A universal communication protocol for communications and grid management, communications equipment, metering and control of consumption is required.
(5) Appropriate personnel should be trained to operate the smart grid. The required profile is a combination of energy and telecommunications engineers.
(6) Israel has a national interest in maximizing the use of renewable energies. The smart grid should be designed with suitable flexibility so as to be able to absorb maximum electricity produced from solar and wind energy.
(7) As this is an international mission, it is recommended to act mainly through international cooperation, in order to maximize the relative advantages of the various countries in various fields, and achieve the maximum benefits at possible low-cost.

(8) Whereas the development of Israel moves in the high-tech direction and electricity consumers in this area need reliable and available electricity, at a very high quality and reasonable prices (but higher than other consumers), it is recommended to give priority to these consumers, in collaboration with all relevant parties, regarding the implementation of a smart grid.