THE SOCIO-ECONOMIC BASED DRIVERS FOR EFFICIENT ENERGY CONSUMPTION AND SMART GRIDS

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Abstract: The electric power grid infrastructure that has served us so well for so long is rapidly running up against its limitations and needs to be optimized. Long-term drivers in the energy market are the cause of a current systematic optimization of the energy system. In this article the current position of the smart grid, the issues surrounding it, the challenges ahead, the countless opportunities it presents, and the benefits we all stand to gain by its adoption are discussed. There is a massive challenge to put the global energy system on a sustainable basis to offer less impact on the environment and CO_2 emission control. Energy networks and grids have to become more efficient, flexible, reliable, green and decentralized. To address all these drivers, new technologies, public policies, economic incentives and regulations are fundamental to bring the smart grid to full implementation. The transformation from a centralized, producer-controlled network to one that is less centralized and more consumer-interactive is proposed. This empowers consumers to become active participants in their energy choices to a degree never before possible and offers a two-way visibility and control of energy consumption.

1 INTRODUCTION

It is a big task to accomplish, but it is a task that must be done. Equally critical to the success of this effort is the education of all interested members of the public as to the nature, challenges and opportunities surrounding the smart grid and its implementation. It is intended to primarily address to the public the existence of, and benefits derived from, a smarter grids and what the application of such intelligence means for the globe and citizens.

The risks associated with relying on an often overloaded grid grow in size, scale and complexity every day. From challenges like power system security to those global in nature such as climate change, the near-term agenda is formidable.

There are in fact two timelines for the grid transformations to keep in mind:

The short-term promise – offers “a smarter grid” for valuable technologies that can be deployed within the very near future or are already deployed today. A smarter grid will function more efficiently, enabling it to deliver the level of service we have come to expect more affordably in an era of rising costs, while also offering considerable societal benefits such as less impact on our environment.

The long-term promise – represents a grid remarkable in its intelligence and impressive in its scope, although it is universally considered to be a decade or more from realization.

A smarter grid applies technologies, tools and techniques available now to bring knowledge to power – knowledge capable of making the grid work far more efficiently by:

- Ensuring its reliability and monitoring
- Maintaining its affordability
- Reinforcing the global competitiveness
- Accommodating renewable and traditional energy sources
- Potentially reducing the carbon footprint
- Allowing for best ideas and innovations.

Full implementation of the smart grid will evolve over time. Further in future, with the appropriate application of ingenious ideas, advanced technology, entrepreneurial energy and political will, there will come a time when the dream for smart grid comes true.

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2 BACKGROUND

The many hazards associated with operating the 20th century grid in the 21st century is of high concern. Even as demand has skyrocketed, there has been chronic underinvestment in getting energy where it needs to go through transmission and distribution, further limiting grid efficiency and reliability. As a result, system constraints worsen at a time when outages and power quality issues are estimated to cost more than hundreds of million dollars each year (Wijayatunga, 2004). In short, the grid is struggling to keep up.

Based on 20th century design requirements and having matured in an era when expanding the grid has the only option and visibility within the system, the grid has historically had a single mission, i.e., keeping the lights on. It was not simply a primary concern when the existing grid was designed to consider the energy efficiency, reliability, security, and environmental issues (Detchon, 2009).

EFFICIENCY: If the grid were just 5% more efficient, the energy savings would equate to permanently eliminating the fuel and greenhouse gas emissions from 53 million cars. Consider this, replacing just an incandescent bulb with a compact fluorescent bulb; the country would conserve enough energy to light millions of homes and save a fortune annually.

RELIABILITY: There have been few massive blackouts over the past 40 years. More blackouts and brownouts are occurring due to the slow response times of mechanical switches, a lack of automated analytics, and “poor visibility” – a “lack of situational awareness” on the part of grid operators. In many areas the only way a utility company knows there is an outage is when a customer calls to report it. This issue of blackouts has far broader implications than simply waiting for the lights to come on. Imagine plant production stopped, perishable food spoiling, traffic lights dark, and credit card transactions rendered inoperable. Such are the effects of even a short regional blackout.

SECURITY: The grid’s centralized structure leave it open to attack. In fact, the interdependencies of various grid components can bring about a domino effect – a cascading series of failures that could bring the nation’s banking, communications, traffic, and security systems among others to a complete standstill.

CLIMATE CHANGE: From food safety to personal health, a compromised environment threatens us all. To reduce the carbon footprint and stake a claim to global environmental leadership, clean, renewable sources of energy like solar, wind and geothermal must be integrated into the grid. However, without appropriate enabling technologies linking them to the grid, their potential will not be fully realized.

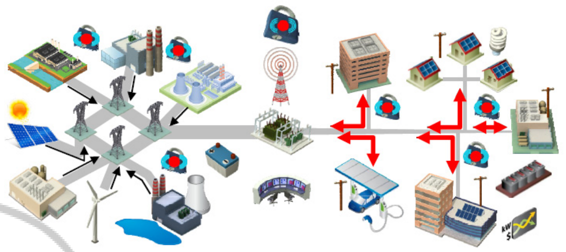

Figure 1: Smart grid power system (Gellings, 2011).

This all comes in to the preparation for an electric system that is cleaner and more efficient, reliable, resilient and responsive – a smarter grid (Figure 1).

3 THE SMART GRID

The electric industry is poised to make the transformation from a centralized, producer-controlled network to one that is less centralized and more consumer-interactive. The move to a smarter grid promises a new business model and relationship with all stakeholders, involving and affecting utilities, regulators, energy service providers, technology and automation vendors and all consumers of electric power.

A smarter grid makes this transformation possible by bringing the philosophies, concepts, technologies and the industry’s best ideas for grid modernization to achieve their full potential. It may surprise you to know that many of these ideas are already in operation.

Smart grids will increase the possibilities of distributed generation, bringing generation closer to those it serves (think: solar panels on your roof). The shorter the distance from generation to consumption, the more efficient, economical and “green” it may be. Distributed generation is the use of small-scale power generation technologies located close to the load being served, capable of lowering costs, improving reliability, reducing emissions and expanding energy options. An automated, widely distributed energy delivery network will be characterized by a two-way flow of electricity and information that will be capable of monitoring everything from power plants to customer preferences to individual appliances. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level. It will empower consumers to become active participants in their energy choices to a degree never before possible and it will offer a two-way visibility and control of energy usage (Figure 2).

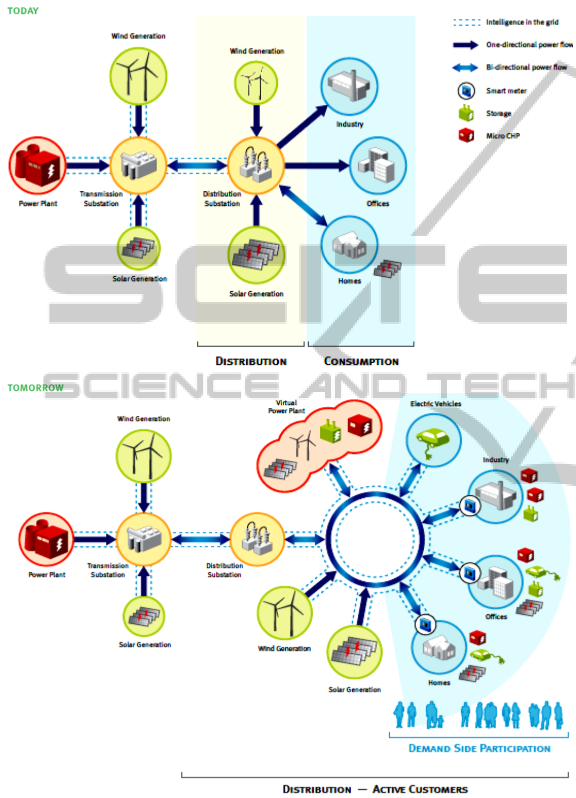

Figure 2: The smart grid in operation (Lorenz, 2010).

While supply and demand is a bedrock concept in virtually all other industries, it is one with which the current grid struggles mightily because, as noted, electricity must be consumed the moment it is generated. Without being able to ascertain demand precisely, at a given time, having the 'right' supply available to deal with every contingency is problematic at best. This is particularly true during episodes of peak demand, those times of greatest need for electricity during a particular period.

In making real-time grid response a reality, a smarter grid makes it possible to reduce the high cost of meeting peak demand. It gives grid operators far greater visibility into the system enabling them to control loads in a way that minimizes the need for traditional peak capacity that may eventually eliminate the use of existing peaker plants or build new ones.

3.1 A Grid Transformation and Complexities

Until relatively recently, the utility operations are not necessarily well positioned for integrated strategic initiatives like the smart grid although they have collectively and forcefully advocated in the past on issues such as security and climate change.

With growing consensus around the crucial need for smart grid deployment, the cultures of these entities are now changing dramatically. Thanks to these and other efforts, many regulators are moving toward new regulations designed to incentivize utility investment in the smart grid. Among these are dynamic pricing, selling energy back to the grid, and policies that guarantee utilities cost recovery and/or favourable depreciation on new smart grid investments and legacy systems made obsolete by the switch to "smart meters" and other smart grid investments.

One of the reasons the electric industry has been slow to take advantage of common technology standards – which would speed smart grid adoption – is a lack of agreement on what those standards should be and who should issue them.

Fortunately, the agendas of utilities, regulators and automation vendors are rapidly aligning and movement toward identifying and adopting smart grid standards is gaining velocity.

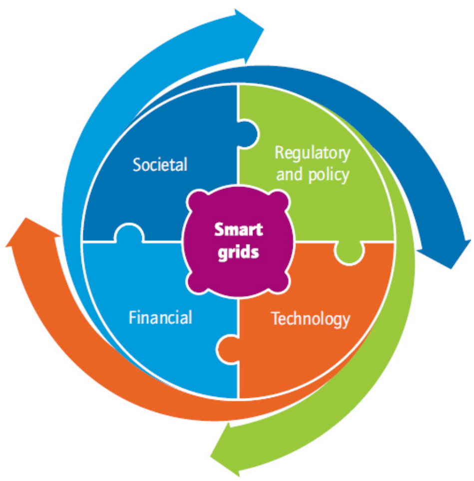

Figure 3: Smart grid roadmap programs (Tanaka, 2011).

It is underway to develop a common interface between Societal, Financial, Technology, Regulatory and policy aspects of the smart grid to further create a basic platform and roadmap (Figure 3).

3.2 A Look at the Current and Future Initiatives

A smarter grid is taking shape by bringing new initiatives and platforms in place. At present, there are no fully fledged smart grids anywhere in the world, beyond small-scale pilot projects. Smart grids will be rolled out globally over the next 20-30 years, but rates of development will differ from region to region, and from country to country (KEMA, 2009).

The nation of Malta (population 400,000) is about to become the world's first smart grid island. IBM is building the island's national smart grid network, which will consist of 250,000 smart meters placed in homes around the country. The network will allow Malta's national utilities to perform remote monitoring, meter-reading, and management of the network. Utilities can then use information collected from these tools to adjust electricity pricing based on the time of day. Island residents will also have the opportunity to track their energy usage online. The socioeconomic impacts of this initiative, given the historical water and energy constraints of the island, are quite obvious. Therefore, the smart grid projects are not restricted to technologies and the advancement of "hardware", but also include the socio-economic and policy oriented aspects of the energy system.

The European Commission recently launched an ambitious Energy Infrastructure Package that promises to deliver the hardware aspects of a smart grid (Giordano, 2011). In Europe, over €5.5 billion has been invested in about 300 smart grid projects during the last decade.

A recent report by Pike Research forecasts that during the period from 2010 to 2020, cumulative European investment in smart grid technologies will reach €56.5 billion, with transmission counting for 37% of the total amount. The report also suggests that by 2020 almost 240 million smart meters will have been deployed in Europe.

According to the International Energy Agency (IEA), Europe requires investments of €1.5 trillion over 2007-2030 to renew the electrical system from generation to transmission and distribution. This figure includes investments for smart grid implementation and for maintaining and expanding the current electricity system.

4 CONCLUSIONS

The smart grid transforms the current grid to one that functions more cooperatively, responsively and organically that would ultimately enables:

- Allowing the seamless integration of renewable energy sources
- Leading in a new era of consumer choice
- Making large-scale energy storage a reality
- Enabling nationwide use of plug-in hybrid electric vehicles.

The global market for energy demand is growing rapidly and energy production being still quite dependent on rough materials whose price is continuously increasing makes indispensable development of smart grids an important element to reduce the gap or, at least, to optimize the production capacity.

The policy makers should allow for the best ideas to prove themselves. Smart grid efforts are well underway on several key fronts, from forward-thinking utilities to decision making organizations.

New technologies and public policies, economic incentives and regulations are aligning to bring the smart grid to full implementation. Its success is imperative to the economic growth and vitality of our future. Of course, it is an ongoing attempt to bring a clearer understanding of the need for immediate and concerted actions in the transformation of electrical grid working as an enabling engine for our economy, our environment and our future.

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REFERENCES

Wijayatunga, P., 2004. Assessment of economic impact of electricity supply interruptions in the Sri Lanka industrial sector. *Energy Conversion and Management*.

Detchon, R., 2009. The national clean energy smart grid: An economic, environmental, and national security imperative. *EFC*.

Gellings, C., 2011. Estimating the costs and benefits of the smart grid. *EPRI*.

Lorenz, G., 2010. 10 steps to smart grids. *EURELECTRIC*.

Tanaka, N., 2011. Technology roadmap for smart grids. *IEA*.

KEMA, 2009. Smart Grid Project Evaluation Metrics. *GridWise Alliance*.

Giordano, V., 2011. Smart grid projects in Europe. *JRC*.