

Smart energy – How to become smart consumers

Consumers are key players in **lowering carbon emissions** from the electricity system. We are all consumers, so we must ask ourselves how we can contribute to smart energy usage and how this will affect our daily lives. **Utilities are in for a radical change.**

► **GLOBAL WARMING** and the need to decarbonize operations top today's business agenda. This article presents a vision of how this may affect the individual consumer, and also of the transformation facing the utility industry.

Salvatore is sitting at the airport waiting for his flight when he receives an e-mail alert on his smartphone from his energy service provider. The alert informs him that back home in Italy critical peak pricing for electricity will come into effect in four hours.

It is summer 2015. European utility-market liberalization has created fierce competition among energy service providers. Regulators have increased the pressure on energy companies to achieve substantial changes in the consumption behavior for both residential and commercial customers. The target for electricity generation from renewable energy sources has been raised to 40 percent by 2030. The opening of the European utility market has resulted in further consolidation, with a number of pan-European players in the segments of electricity generation, distribution, and retail. Electricity distribution networks are undergoing a fundamental transformation into an integrated "European Smart Grid."

What does all this mean for Salvatore? Motivated to make a personal contribution to global sustainability (and of course driven by financial incentives), Salvatore has recently signed a new contract providing a "best peak rate" for his house in the greater Rome area.

Electricity consumption has risen substantially in Southern and Western Europe during July and August, primarily due to air-conditioning systems and plug-in hybrid electric vehicles. Energy service providers across Europe have introduced tariffs with sharply higher prices during peak-demand hours and incentives for customers who are willing to reduce consumption during those times.

Salvatore is a businessman and a father with two small children. He understands and accepts that global warming must be

limited, and that everyone has to pitch in to make it happen. But he is neither a technology freak nor interested in investing a lot of time in managing his own and his family's energy consumption.

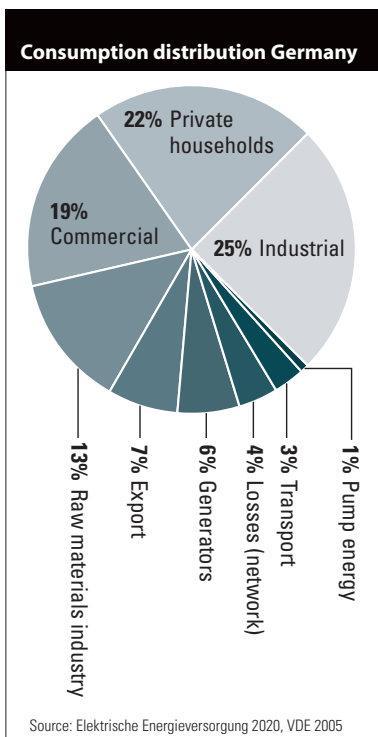
Therefore, he was happy when his energy service provider offered him a best peak rate for the electricity supply to his house that includes a remote control option for his air-conditioning system, in return for a reduced price during critical peak demand times. During peak demand, his provider manages his air-conditioning system remotely to reduce its energy consumption. This typically results in a temperature increase of 2–3°C in Salvatore's home, which his family finds acceptable. Consumers have the option of overriding the remote air-conditioning control, but this is expensive, and everyone in the family understands and accepts the fact.

Back to the airport. While Salvatore is reading e-mails on his smartphone, he decides to take a look at the electricity microgeneration unit at his summer house in Sicily. By clicking an icon on his mobile's touch screen, he opens a web page showing that his solar panels are delivering 6kW of electricity into the network. A quick check of the current market price for microgenerated electricity reveals that he might come out of the critical peak price with a bit of extra revenue.

The scenario with Salvatore might, of course, not be typical in 2015, but it is becoming obvious that all of us as consumers will have to play an active role in the reduction of greenhouse gases.

This means, first, that we need to understand how we consume energy today. Second, we need to learn how to use energy more efficiently, and how to change our consumption so that our interests balance with the needs of a low-carbon energy system. Achieving this requires incentives for good behavior and punishment for wrong behavior. It will take some of our valuable time; it will add complexity to our life; and it might mean some loss of comfort. But it has to happen.

Technology will help. Whatever future





applications look like, they must be based on precise measurements of consumption, real-time communication, and smart tools in order to help all of us – including the non-technical – become responsible energy citizens.

SMART ELECTRICITY NETWORKS

Smart consumers cannot save the planet if they cannot interact with a smart electricity network. Therefore, a key element is the transformation of today's electricity networks into smart grids. The large-scale integration of electricity generation from renewable energy sources (and other developments such as the need to support electric vehicles) will dramatically change the operating conditions for electricity networks.

A substantial amount of electricity will be generated at remote locations all over the network such as Salvatore's photovoltaic-powered summer house, rather than at central power plants. Also, the energy Salvatore saves by participating in his provider's peak pricing program can be seen as "virtual generation" in this context.

Distributed generation will, however, affect the direction of electricity flow in the network, allowing it to flow back and forth. As well, the supply from many renewable energy sources is unsteady; for example, varying with weather conditions. Because no large-scale storage systems presently exist, electricity generated from wind also needs to be sold when the wind is blowing. Demand-side management not only means reduced peak demand, but also ensures that demand follows generation to

some extent. The consequence of these mechanisms is an increasing volatility in the electricity system, with a corresponding risk of blackouts.

In order to address these challenges, the electricity networks will have to become more internet-like. The internet has been built as a robust network with distributed resources and intelligence, and different options for routing information from source to destination. The Smart Grid idea applies the same concepts to electricity networks, such as virtual power plants or microgrids. Virtual power plants consist of geographically distributed generators managed as one power plant. Microgrids are parts of the electricity network that can be isolated and supply enough energy for the consumers connected to the microgrid. Such setups will secure the robustness of future electricity networks and avoid blackouts.

SMART COMMUNICATIONS

The best internet-like concepts and distributed intelligence do not help if network nodes cannot communicate with each other and with control centers. Communication networks connecting all electricity network nodes playing an active role in the Smart Grid will be the nerve systems of our future electricity networks.

But demands on the communication networks will be high. The networks will have to handle diverse types of traffic, from control signals that must travel long distances in virtually no time (e.g., to isolate line faults) to broadband connectivity providing video surveillance of mission-

► critical assets. The communication networks must not fail under any circumstance; otherwise the electricity network will fail. Redundancy and security aspects are crucial. Also, these networks must partly operate under harsh conditions and must not, for example, be affected by electromagnetic interferences. Utilities undertaking such substantial investments might also consider offering Salvatore broadband services to his summer house, to leverage their investments.

Salvatore, his family, and his electrical appliances are active participants in the Smart Grid, implying that communication with him, his family, and the devices they use is an integral part of the grid's nerve system.

Central to this integration is smart metering. Digital meters will provide the data needed for Salvatore and his family to understand how they consume energy and how they can change their behavior. Again, real-time communication solutions will give him feedback and relevant information through appropriate applications, using the media and devices he and his family prefer, or which are available in a specific situation. Most suitable for Salvatore might be his smartphone, while his children might prefer to use their gaming console, and his parents would only look at a stylish display in an oak housing that matches their furniture. Whatever applications, media, and devices are best, they need to communicate in real time with the energy meter and other equipment such as electrical appliances or microgenerators to collect data for a meaningful feedback loop.

Smart meters will be a key sensor for the Smart Grid, collecting valuable measurement data about the "health status" of the electricity network (e.g., short interruptions, and over or under voltages), thereby enhancing network operations. Collecting all this critical data is of no use if it cannot be communicated in real time, reliably, securely, and independently from the status of the electricity network.

SMART MARKETS AND NEW PLAYERS

What does all this mean for the utility markets and their stakeholders?

Utility market models, with their established players and contractual relationships, will change. Experience from the telecommunication markets has shown that market liberalization changes the game board. While creating challenges for established market players, it also unlocks impressive creativity to find new business

models, new ways of working, and new approaches to consumers. New participants will enter the markets, consumers among them.

The decarbonization of the electricity system will have to be reflected in market models. For example, the need to balance consumer and energy-system interests will require a mediator role to collect requests from different players in the electricity system, and gather the contribution offers from consumers to balance the system. Dedicated communication and automation services must be provided, and tightly integrated electricity and communication networks must be operated.

Which role will today's energy service providers take? They already have the relationship with consumers; they hold both the carrot (in terms of financial and other incentives) and the stick (e.g., peak pricing) to influence our behavior. Will they also offer us advanced communication, information, and automation services related to energy consumption and generation (and possibly even beyond) in order to help us manage the complexity of our future energy life? Will new players enter the scene?

Which role will distribution system operators take? They will, of course, continue to provide the electricity logistics, connecting generators with consumers in the new smart-energy world. But will they also operate the tightly integrated electricity and communication networks of the future? Many operators have already identified the operation of their telecommunication networks as mission-critical but not as core business, and consequently have outsourced these operations to reduce costs.

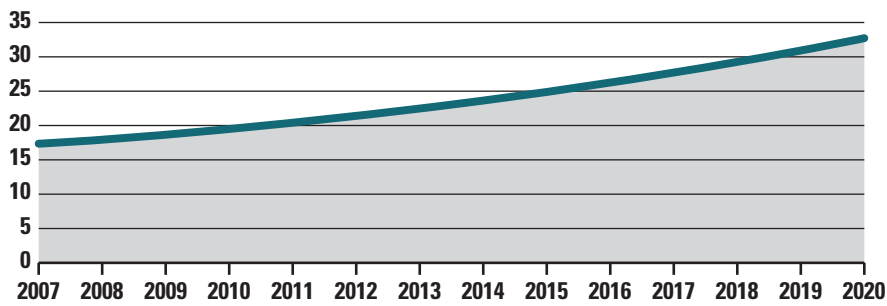
Which role will telecommunication network operators play? Will they provide communication services for smart grids? Will they provide the communication services used by energy service providers to influence our energy consumption?

New market models are on the verge of evolving, and it is still early to predict how the utility markets will develop in light of liberalization and decarbonization. The situation creates as many uncertainties and threats as it holds opportunities – for existing and new players.

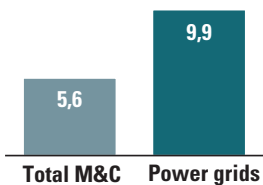
INVESTMENT OPPORTUNITIES

Investment in smart grids is expected to be in the range of up to 6 percent of utility company turnovers, which could add up to EUR 1 billion by 2030 in Europe alone. However, it can only take place if regula-

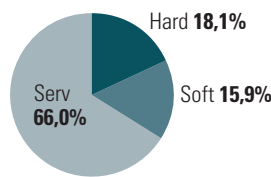
European monitoring and control market for power grids
Market value (Bn €)



Growth perspectives
(2007–2020 annual rate)



Percent of hardware, software and services, 2007



Source: EC DGINFSO – SMART 2007/047

tion creates clarity on harmonized European business models and market rules, which is not yet the case. Also, the business case for such investment is complicated and difficult to address, as it only holds if benefits for both utilities and society are factored into the equation. The benefits for utilities expand across the value chain, but are not distributed in the same way as the investment needed. These challenges must be resolved to facilitate the investment needed to decarbonize the electricity system.

Back to Salvatore. His way of living with electricity changed significantly between 2009 and 2015. It is much more complicated, because the days when he just plugged in his appliances and ignored the energy they consumed are long gone. In 2015, he is an “energy citizen,” consuming and generating electricity, balancing his own interest with the interest of the system. Yes, it involves a loss of comfort, but he finds it manageable with the help of automation, enhanced applications, and communications. And his carbon footprint looks much better in 2015 than it did in 2009, also thanks to sophisticated communication networks operating in the background, tightly integrated with electricity networks.

Market liberalization and new market models can represent a threat to existing market players but represent opportunities as well. It is now time for those existing players, the players from related industry

segments (such as telecommunications), and potential new players (perhaps in the area of value-added services) to understand their desired positions, to develop strategies, and to start pilot programs to build experience.

From a consumer perspective, we all have to contribute to decarbonizing the way we consume energy. We can succeed if provided with suitable support from the utility markets and its technologies – and have fun doing it, too! ●

AUTHOR



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