2016 IEEE International Forum on Smart Grids for Smart Cities

Topic: General Overview and Conclusions

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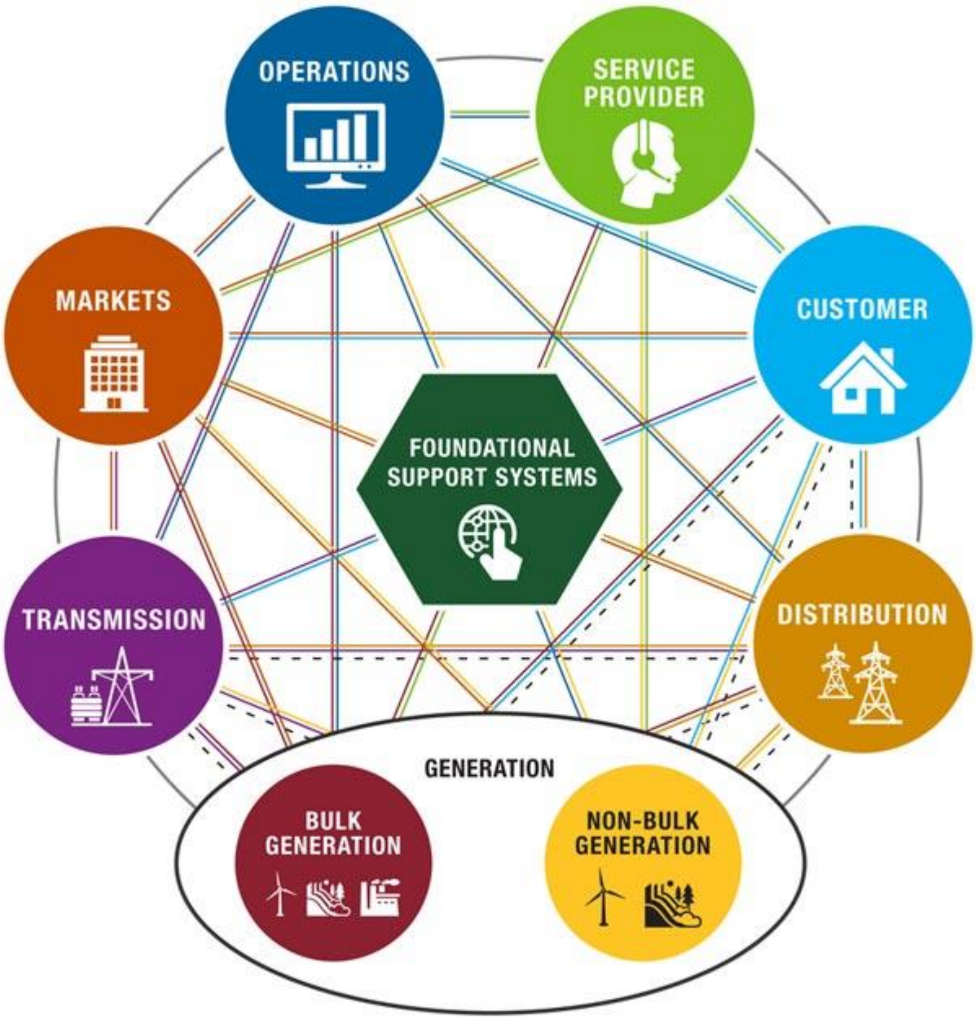

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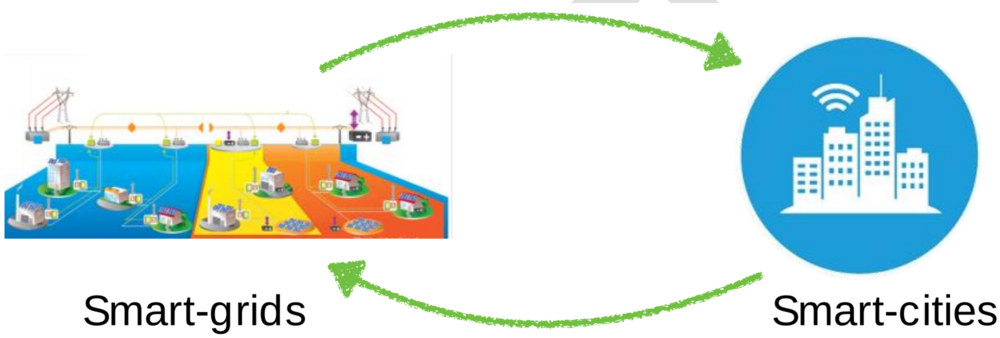
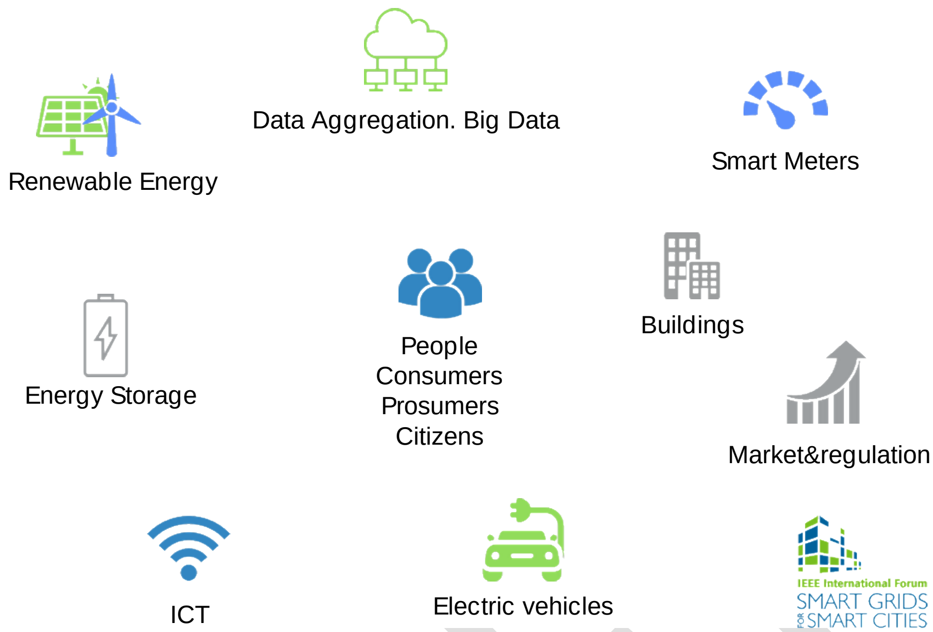
1. Introduction

The notion of a smart-city is at the moment a vague, all-encompassing concept. Depending on the background of the person whom is providing the definition, a smart-city could be linked to education, smart health, smart retail, IoT, smart homes, smart mobility, smart buildings and homes, or any other technical or social ambitions. In the same note, electrical engineers and researchers will argue that there is a direct mutual-enabling link between the developments in the smart electrical grid and some of the objectives of a smart-city.



For the past few years, smart grids have been the main topic of fervent research and development at both industrial and academic level. They are expected to be the enablers of a high penetration of renewable energy, facilitate the wide adoption of electrical vehicles, increase the awareness and the involvement of the end-user in the energy scene, and altogether contribute to create a sustainable lifestyle for the eco-aware 21st century citizen. However, all these prospected transformations also bring with them numerous challenges and opportunities.

In order to address some of these questions, the 2016 IEEE International Forum Smart Grids for Smart Cities, gathered in Paris a forum of experts from the energy, telecommunications, and computing sectors each providing a unique international perspective on technology, applications, standards and policy pertaining to Smart Grids as Enablers for Smart Cities



2. Game changers

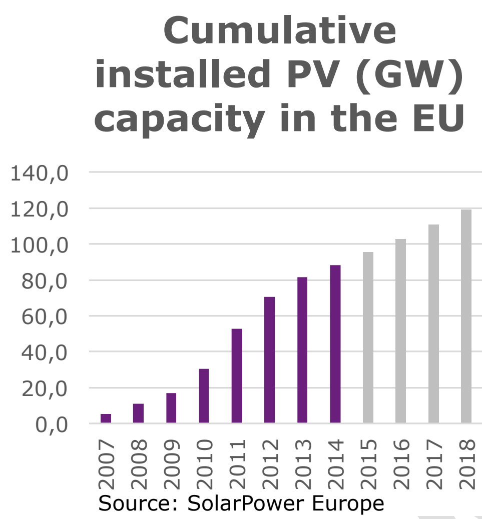
Throughout the two days of technical presentations and project-testimonies, featuring, among others, prominent actors from academia, utilities and companies, IEEE societies, and EU institutions, it became clear that there are several game-changers in the field that require a rather urgent redefinition of the existing electrical infrastructure. New policies, and business-models are required in order for the evolution of the smart-grid-cities symbiont to be able to keep up with the technological advancements.

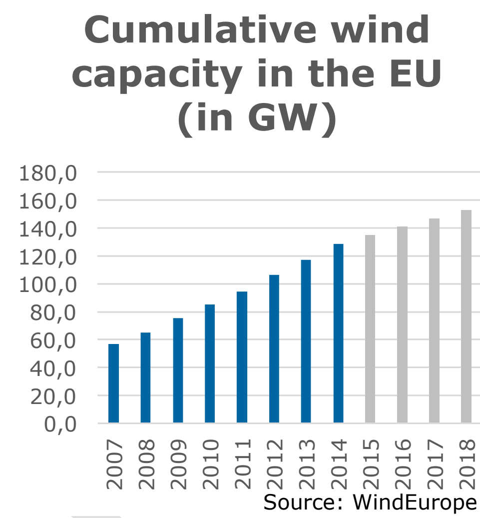
2.1 Renewable energy

Renewable energy has been on a continuously increasing trend for the past decade. Photovoltaic installations reached 97 GW in 2015, meanwhile wind turbines installations reached 142 GW, and the trend is expected to continue also in the next years.

While until recently renewable energy amounted only to a small amount in the overall energy mix, this large scale adoption cannot be ignored anymore. For example, In Denmark, 56% of the energy production came from wind in September 2016.

The large penetration of renewables brings a lot of challenges to the electrical grid. Firstly, there are the technical challenges. The current infrastructure of the electrical grid was designed so that generation will always follow consumption. However, this approach cannot operate in a system where renewable energy represents the majority of the generators. Also on the technical side, since the majority of the renewable generators are connected at the distribution level, this raises problems regarding inverted power flows, i.e., from the distribution level to the transmission level. This in turn causes issues regarding power quality and security (overvoltages, fault protection and reconfiguration, etc.).





Besides the technical challenges there are also business and policy challenges. As the layers of the classical grid, i.e., transmission down to distribution and finally to the end consumer, are starting to blend between them, it is becoming very uncertain which will be in the future the role of the DSO and which will be the role of the TSO. One of the key points of discussion during the two days was the need of a redefinition of the concept of DSO and TSO and how they will fit in the future smart-grid.

2.2 Smart meters

Smart meters and their possible applications were discussed to great lengths in several occasions, and, given their massive rollout from the past years, they are certainly becoming a reality. In Europe, more than 200 million smart meters are expected to be deployed before 2020, i.e., the equivalent of ~80% of the consumers. At the present moment in Italy, 38, out of the 61 million clients are equipped with smart meters. Meanwhile, France is in the process of deploying 35 million meters and on the other side of the ocean, USA is planning to role 65 million units.

The smart meters bring new possible services for both the consumer as well as for the utility company.

New possible services for the consumer:

- invoices based on real consumption

- facilitate interface with the market
- contribute to the energy transition
- facilitate active demand and the implementation of flexibility
- helps consumers to save energy

New possible services for *smartening* the operation of the network:

- fault location by pinging the meter
- monitoring of medium voltage network (fault indicators will be connected through the smart meters to control centers)
- low voltage networks monitoring
- optimization of investments: help selecting the phase to connect the customer.
- monitoring of power quality
- act remotely on the network
- detect congestions
- reduction of non-technical losses

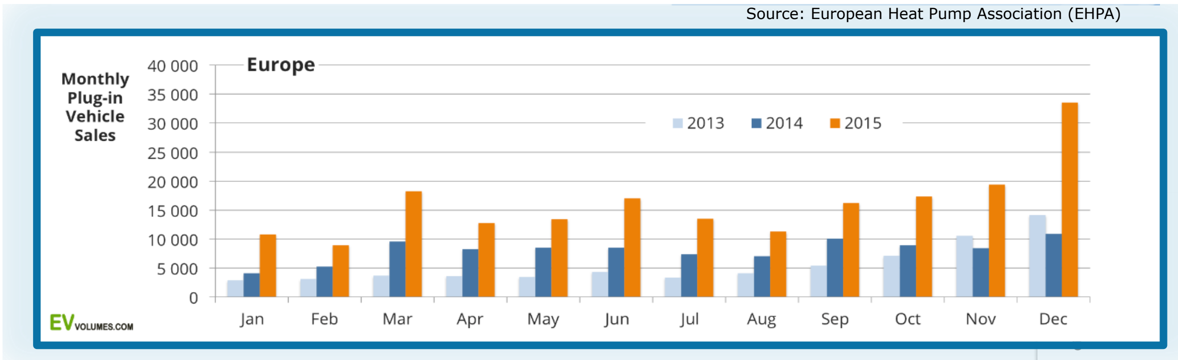
According to the testimony of Michele Salaris, the Head of Network Technology for ENEL, Italy, after the introduction of the smart meters, ENEL saw a 400 million euros/year saving in costs.

However, while the future prospects of smart-meters applications look very promising there are also still some challenges and concerns regarding them. Given the very large number of deployed units, the problem of data collection and analytics is not a trivial one; and it might provide a new interesting direction for future business cases at the DSO level. Data confidentiality and cybersecurity are still fueling the skepticism of some of the actors in the field, and they will also open the field for new businesses and applications.

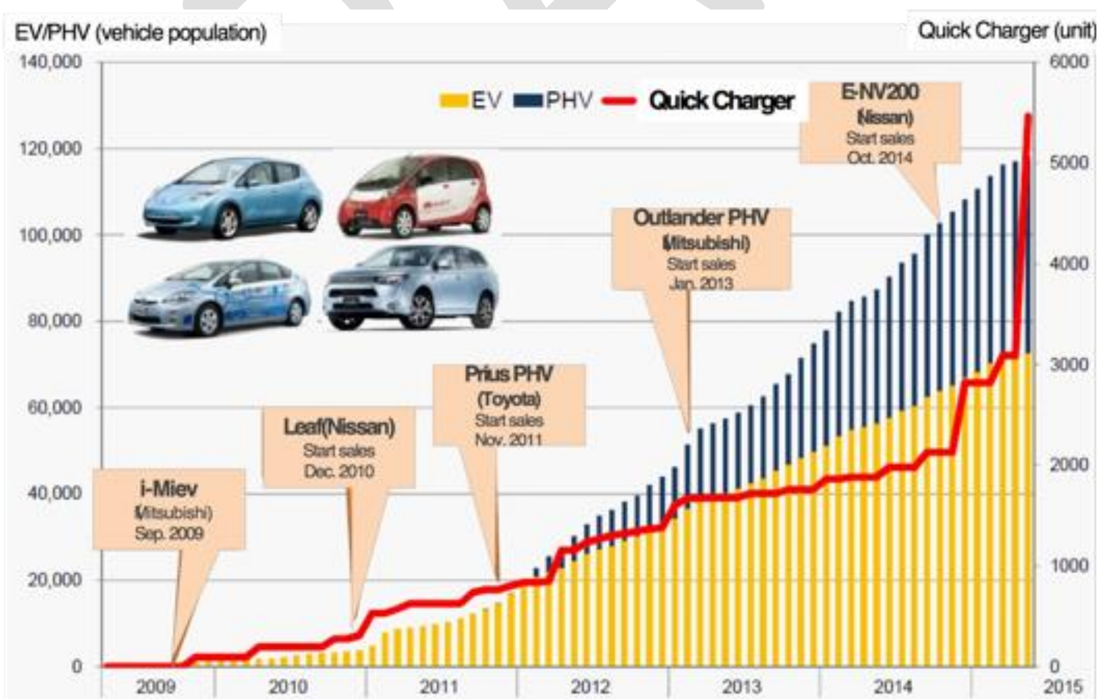
Another issue of concern for the utility company, is the life cycle of the meters and the associated costs regarding replacement when the units become obsolete.

2.3 Electric vehicles

If renewable energy and smart meters are undeniably starting to establish their role in the future smart grids, the things are not so clear regarding the role and impact of the electric vehicles. This is mainly due to the fact that unlike renewables, which have been around for several decades, the electric vehicle industry is just starting to catch up. In Europe, the sales of electric vehicle have increased from year to year, and the infrastructure is starting to be deployed accordingly. For example France is planning to install 7 million charging stations before 2030. Similar trends were presented for the case of Japan, which aims by 2030 to have a share of 50-70% of electric vehicles in the transportation mix.



However, according to some of the speakers, electric vehicles are still not a business case, and they are currently on an ascending trend due to government incentives. Various such programs are in place throughout Europe. For example, in France, 5000 euros are discounted from the purchase of an electric vehicle. In the same not, Germany offers a 5 years tax exemption for electric vehicles, and similar programs are currently running in Japan. In the case of Italy, where there is no government involvement, there are almost zero electric vehicles, thus proving the point regarding the need of new business models.



Even though the EV wave is just starting to rise, its impact on the the electrical grid can be comparable to that of the renewable energy, and it has the involved actors on the edge.

Everyone acknowledges the potential of the EV as distributed energy storage and the advantages that this could bring to the operation of the grid, but nobody has a clear plan on how this should be handled.

Given the massive increase in the load that the EV will bring, DSOs will be forced to upgrade their networks in order to accommodate the new peak demands or they will need to find other solutions, e.g., microgrids, virtual power plants, adding “smart-hardware” to the network, demand response, etc. However, at the moment there is no clear consensus on what is be the best way to move forward. Questions like: “where should public chargers be connected and what will be their impact? what type of chargers to use in different situation (home/ fast chargers/ public chargers)? who should be responsible of installing these chargers and how should they be operated?” are at the moment subject only to academic research, but it is an urgent need for them to be addressed at the practical level. Therefore, a stronger interaction between the DSOs, business innovators, local administrations, and the EV manufacturers is required in only to address these issues as soon as possible.

3 General overview

3.1 Technology is up to the challenge

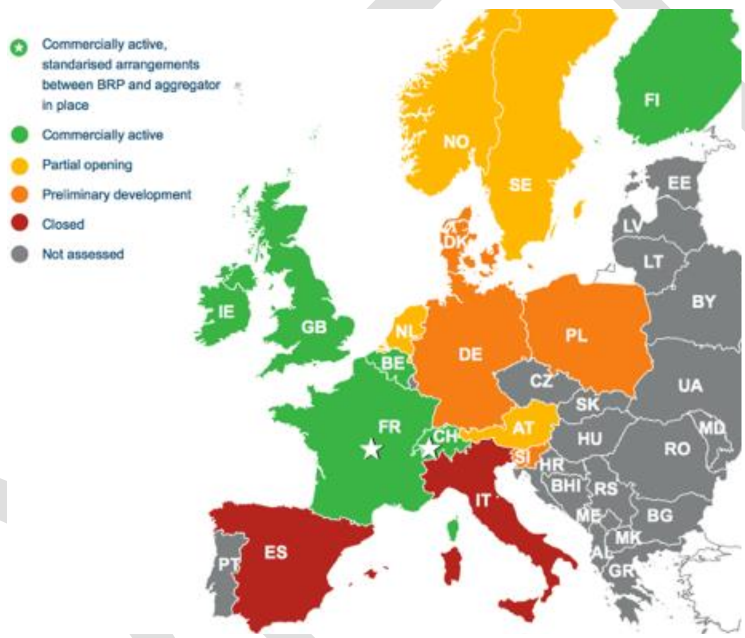
The general conclusion at the end of all the discussions was that it is not technology that is lacking in dealing with the challenges brought by the transition towards a smarter grid. Numerous examples and pilot projects in various countries were mentioned during the two days of presentations. Among these we mention:

- pilot projects experimenting with distributed renewable energy
- energy storage
- smart metering
- user involvement (GreenLys, NiceGrid, Freiburg Smart Green City, ZAE - Toulouse)
- holistic approaches to energy and sustainable design (Singapore, Shangai Lingang)
- EV to VPP in Japan
- smart cities (TianJin eco-city)

Overall, at the end of 2014, there were 495 running projects in Europe involving 1700 different organisations.

The invited speakers representing industry (Schneider & GE) showed futuristic concepts encapsulating connected objects, data analytics, infrastructure, datacenters, etc. Among the industry representatives, the consensus was clear: “we have the technology to move forward”.

A similar sentiment was expressed when analyzing the situation in USA: renewables and storage are getting cheaper, technology is there, and customers and 3rd parties want to get involved.



3.2 What is missing?

While technology is ready to tackle the challenges of smart-grids, the same thing cannot be said about the business side. Apparently, the big culprit for the slow development of the smart-grid is the lack of business models, as it requires several stakeholders to be aligned and they need to collaborate in order to find an economical interest. Also, the structure of the policies and laws at the local as well as at international level as well as the lack of standards and architectures is also a big issue.

A clear example in this sense was presented for the case of demand side response in Europe. As the map shows demand response in Europe is far from reaching its full potential. Even though some of the presented study cases showed that 1 GW of flexibility for 50h on the German market would result in 169 million euros in benefit for the society, such strategies are not being implemented at the moment because they come into conflict with the established business and legal dimension.

Also, a full understanding of the needs of the end user is required in order to be able to design a user-first smart grid; one that has to be about comfort and services and not about electricity. New business models that move away from just selling kWh are required, as this approach is not foreseen to continue for a long time.

Several ideas were mentioned as possible starting points for a more visionary business environment that could tackle some of the dead-locks that slow the evolution of the smart grids.

A first suggestion proposes a closer inter-DSO collaboration. Collaboration that goes beyond secret data, and in which DSOs share knowledge between them, thus creating a collective learning process about best practices regarding structure, design, reliability, etc. This process could go further and data collected from the DSOs can be used for creating representative models and tools needed for planning and validating different solutions. These tools could help researchers and innovators in designing and evaluating the impact of new business models. Such an initiative is underway from the EU Joint Research Center, and preliminary studies show that DSOs are willing to participate in such scenarios.

Secondly, closer collaboration between DSOs and TSOs is mandatory. As mentioned earlier, the concept of DSO and TSO, as well as maybe other stakeholders, might need to be redefined in the near future and this cannot happen without getting together all the parties involved.