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Electromobility between grid connection and renewable power generation (Smart Grid)

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Abstract

Today's grids are capable of covering peak loads throughout the day; yet, at night, utilization is low. In order to master the energy turnaround, more efficient and intelligent power grids must be developed. These so-called Smart Grids balance the fluctuating power generation of wind power plants and photo-voltaic plants in a better manner. An important aspect of this situation is the establishment of an area wide charging infrastructure and the integration of existing units such as heat pumps, electric hot water boilers, night storage heaters, refrigerators and freezers for Smart Homes, as well as the integration of intelligent buildings and plants to create Smart Buildings.

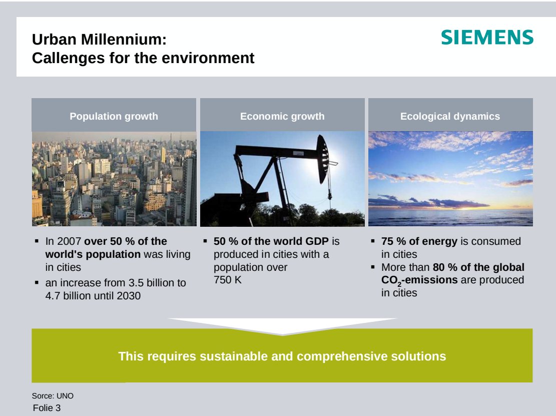
Important Smart Grid elements are not only intelligent meters (Smart Meters) in the households of the consumers, but also distributed generation via virtual power plants that bundle numerous small on-site generation plants. In this case, such a power plant can operate in a manner similar to a large scale provider on the energy market and can sell its generated power at standard market conditions. In a Smart Grid, electric vehicles store excess energy and feed the energy back during peak load times. Intelligent control systems determine the optimal charging and discharging cycle.

Evaluation of the results from the joint project IRENE (integration of renewable energies and electromobility) together with the "Allgäuer Überlandwerk" (a regional interurban utility), the Wildpoldsried community and the project AMIS of the "Energie AG Oberösterreich" (energy provider in Upper Austria) show that the approach is feasible. An essential step when developing an intelligent infrastructure is to create common industrial standards so that different technologies can interact with each other on a uniform infrastructure. With this in mind, Siemens as the consortium leader of the EU project Green eMotion stepped into the work of defining the framework for electromobility in Europe with more than 40 partners. The main focus is on recommendations for uniform standards as well as proof of interoperability of different technologies, resulting in efficient and reliable energy utilization strategies.

Keywords: Smart grid, infrastructure, communication

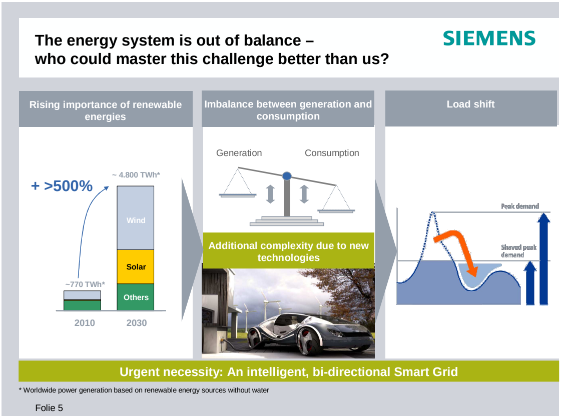
1 Introduction

Experts assume that the worldwide demand for electrical energy will climb two-thirds by 2030. The main drivers behind this development are world population growth from the current seven billion to almost nine billion in the next twenty years and the associated urbanization taking place all over the world. According to a recent study from the consulting company Frost & Sullivan, in 2025 more than 60 percent of the world's population will live in cities. And these cities will require 75 percent of the electricity produced worldwide, and will be responsible for 80 percent of the global CO2 emissions. As a result, the battle against climate change must be fought and won in cities. Suitable infrastructure plays a decisive role – infrastructure that makes more efficient use of energy and resources. For road traffic, the increasing electrification of automobiles is a ray of hope. Just as the electric vehicle is revolutionizing the automobile industry, electromobility is changing the context of energy generation, storage and distribution, IT and communications technologies, and mobility itself. Also included in the equation is renewable power, such as from wind, hydro and solar.



2 Renewable energy production requires new networks

When, for example, wind energy facilities without respective storage capacity are integrated in a supply network, the installed capacity at a supply level of 20 percent – which corresponds to the situation in Germany in 2010 – cannot be further increased. At the same time, the complementary coal and gas power plants have to be stepped down, in some cases all the way to zero capacity, in a short amount of time, and just as quickly powered up to full capacity. Studies show that European-wide total consumption, depending on expansion scenarios for wind power stations, fluctuates between 25 percent and 230 percent of the average output [1]. Without the deployment of storage facilities and efficient and intelligent distribution networks, supply cannot be ensured. The Boston Consulting Group concludes that the capacity of the available storage (water, compressed air, cold, batteries, etc.) will have to be quadrupled by 2025 in order to guarantee the security of supply.

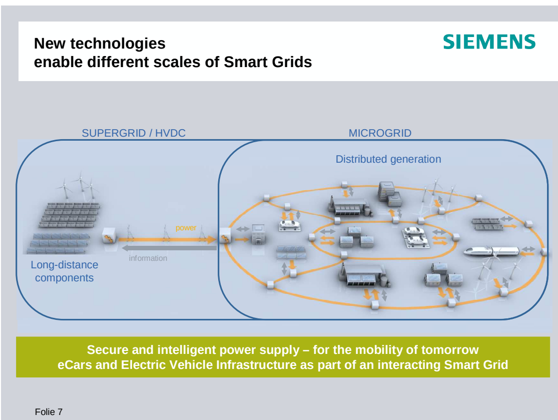


Of course, today's setup – the generation-follows-load principle of the supply network with its top-down structure, storage of energy by producers, and the use of primary energy holders like gas, coal, etc. – is turned on its head. Renewable energies operate according to the load-follows-generation principle. Joint industry standards are indispensable for the expansion of an intelligent infrastructure, so that different technologies can interact with one another uniformly. Producers, burden and storage in the network need to be integrated into a functioning overall system. Experience gained in the IRENE (Integration of Renewable Energies and Electromobility) project together with Allgäuer Überlandwerk (a regional interurban utility) and the municipality of Wildpoldsried, and in the AMIS project from Energie AG Oberösterreich (utility in Upper Austria), speaks for the feasibility of the approach. In these projects, an extensive storage infrastructure for electric vehicles can be integrated equally as well as existing household appliances such as heat pumps, electrical water heaters and night storage heaters, refrigerators and freezers (smart homes). Intelligent buildings and facilities with their air conditioning and heating systems (smart buildings) can also be included.
The result is a virtual power plant with networked and distributed power producers, which act as a

large energy provider in the market and sell the energy supplied at the usual market prices. In the meantime, energy supplier and distributor Energie AG has installed meters in more than 20,000 households. As a result, in every third household large consumers can be controlled by the network via a so-called power shift module. By the end of this year, the number of installed meters will climb to 100,000. With these meters Energie AG can switch its consumers' loads, which correspond to 260 megawatts or about a third of Energie AG's power plant capacity. Those who consume during off-peak hours pay a lower price per kilowatt-hour.

3 Stable networks by means of electromobility

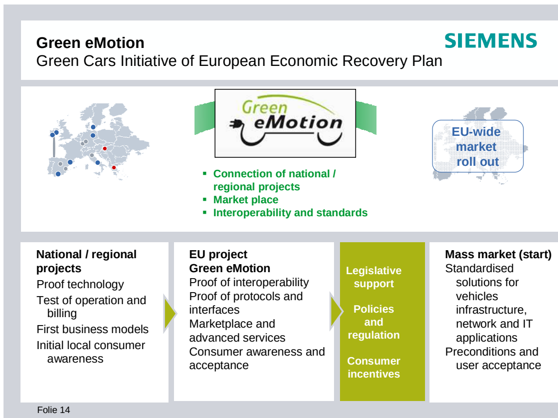
It is possible to stabilize the German supply network with just 250,000 electric vehicles with an average battery capacity of 15 to 20 kWh. The vehicles absorb peak loads of between 4 and 8 GW. To connect an electric car to the network, all a household needs is three-phase connection with 32 amps and a smart charging station. With intelligent loading in off-peak times and feedback during peak times, no additional power plants would be necessary. Norms for loading and feedback have yet to be addressed. The intelligent integration of electric vehicles in the supply network requires the use of advanced communications technologies to exchange and optimize price information, status and loading times, the number of connected vehicles, planned departure times, charging capacity, etc.



4 European Electromobility marketplace within Green eMotion

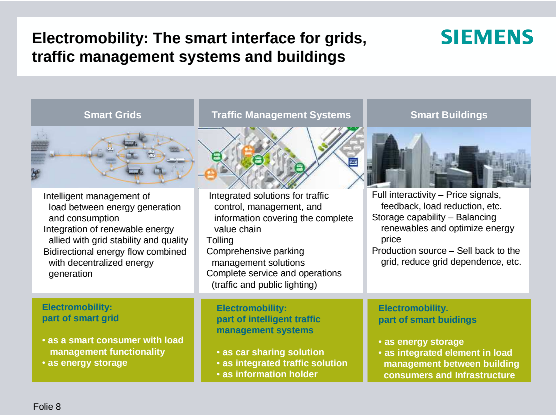
The EU project Green eMotion was initiated to develop and demonstrate uniform, European-wide processes, standards and IT solutions for electromobility. With Siemens as the consortium leader, 43 companies and institutions – from infrastructure suppliers and automobile manufacturers up to universities and cities – are participating in Green eMotion. In the final stages, the twelve demo regions involved in the project will together have more than 10,000 charging stations.

Standardization is a prerequisite for simple and cross-border access to charging infrastructure and the associated services all across the European Union. Special considerations in individual demo regions include battery swapping, charging with direct current and integration in intelligent electricity networks. Further considerations include cross-border travel with electric vehicles and trials with different pay systems and business models. An important task is the design and the testing of a common European marketplace, similar to the roaming services of mobile telephone providers, which will serve as a European data hub.



5 The Siemens integrated approach

The sum of this information opens up the possibility for many new applications, such as a comparison of energy requirements with availability. Smart grid solutions combined with intelligent traffic control prepare electricity networks for the requirements of electromobility. In this way, environmentally friendly electric cars can be optimally integrated in intelligent electricity networks, and via traffic control they can be guided to vacant charging stations. Siemens takes a view of the entire value added chain, starting with electric vehicles and their components all the way to charging technology and electricity networks (smart grid). The company also considers systems for operation, such as electric load distribution, fleet management, traffic and parking management, billing, mission planning, service, etc.



Acknowledgments

List acknowledgments here if appropriate.

References

[1] Matthias Popp, *Speicherbedarf bei einer Stromversorgung mit erneuerbaren Energien/Storage Needs for Power Supply with Renewable Energies*, Springer Verlag, 2010

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