R&D Magazine

Vattenfall Research and Development Magazine • No 2, June 2010

THEME:
Smart Grids

VATTENFALL

Welcome to the

R&D Magazine

The R&D Magazine is Vattenfall's magazine about research and development within the Group. We want to give a comprehensive view of what Vattenfall is doing within R&D and a deeper view on one theme, to keep the readers up to date on advances in this particular area.

The theme for this edition is Smart Grids which is the next step in the evolution of today's electricity grids. In response to increasing electricity demand and stricter climate requirements, smart grids increase the efficiency of electricity transmission and distribution. This magazine will give you an insight into the work Vattenfall is pursuing within Smart Grids.

This edition also gives you a statement from Helmar Rendez, who recently moved from head of Vattenfall Group Strategies to a position as head of Business Unit Distribution in Business Group Central Europe.

In February 2009, Dutch Nuon and Vattenfall joined forces. We have talked to Chris Lappee, Head Technology & Engineering Services at Nuon, about the R&D work at Nuon and the differences from Vattenfall R&D before the merge.

As in previous issues, we also have the latest news briefing from all research programmes within Vattenfall R&D.

We hope you will enjoy reading the magazine!

Petra Sarközi is legally responsible for the R&D Magazine.

If you have any comments or questions about the R&D magazine, please contact the editors Markus Fischer and Sophie Nykvist:
rdmagazine@vattenfall.com

If you have any questions about the Smart Grids Programme, please contact Programme Manager Johan Söderbom:
johan.soderbom@vattenfall.com

Lars Strömberg, Vice President for Vattenfall Group R&D.
Petra Sarközi, responsible for communication of Vattenfall Group R&D.

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WHAT DOES VATTENFALL MEAN BY RESEARCH AND DEVELOPMENT AND WHY DO WE DO IT?

Vattenfall pursues research and development (R&D) as part of the business development of the Group. The aim is to meet the demands of customers, to reduce the environmental impact of our operations, to improve their efficiency and to contribute to our climate vision.

Vattenfall as an energy company and a system builder and operator has little or no competence in the manufacturing or production of technical equipment; instead we define our needs to the manufacturing market. Consequently, we do not develop new hardware or software products. Our ambition is to be an excellent user of technology that is mainly developed by others, notably equipment manufacturers, to provide our customers with clean electricity. To achieve this, we often work together with different suppliers, large and small, from the laboratory stage or in demonstration or pilot projects. In these projects, we develop know-how and provide the operator's perspective on, for example, the usability and maintainability of new systems.

Vattenfall's Group R&D programmes are organized in different areas:

- **Renewables**
- **Operational efficiency**
- **Nuclear energy**
- **Energy efficiency**
- **Carbon capture and storage**
- **New technologies**

Read more about Vattenfall R&D at **www.vattenfall.com**

Building the bridge to the future

Having moved on after more or less three years as head of Vattenfall Group Strategies to a position as head of Business Unit Distribution in Business Group Central Europe, I have been asked to sum up my view on the role of R&D in the Vattenfall group.

R&D is the scout of new technologies and models that shape our industry. It is also a tool to analyse change over time and give advice to our business colleagues. We have done this successfully so far, but to advance, we cannot rely on the rear view mirror. To take the lead in shaping the future, we must think outside the box – and we must act much faster.

The energy industry sees the dawn of a new era. In the near future, the energy mix will change dramatically. Vattenfall's task is to shape the bridge to the future.

As front-runners we must be fast. We should not count years, but weeks; instead of saying ten years, let us say 520 weeks.

Approximately 50 per cent of all power plants in Europe will be closed down within 20 years. This provides a fantastic opportunity to shape the future. To utilise it, we must think outside the box.

Here are some examples of changes that will come:

- Energy production will become much more decentralised.
- Consumers will become "prosumers" (producers AND consumers).
- E-mobility will play a significant role – in transport, as well as in energy storage.
- Other new ways for energy storage, such as load management – balanced supply and demand – will also be developed.

Smart networks will be needed to make all this living reality. Handling information is the key word. Like Cisco, all network companies will bring intelligence into the formerly "stupid" networks.

A lot of new players like Google or Bosch will enter into the energy sector – as well as some old players from other sectors, like oil companies and basic industries. There is a long list of new players in the market. We must discuss "outside the box" how to cope with this.

All technologies have different levels of maturity. Hydropower is a mature technology, where improved technology may help to squeeze out only a few final per cent. Land-based wind power, too, is already mature and off-shore is on its way to maturity. Bio-mass is fairly close to full maturity.

R&D on new technologies includes some new turbine technology, ocean energy, and some components of CCS technology. Lead times in these fields are some 260 or 520 weeks.

We must not re-invent everything ourselves, but share our own knowledge with universities and with some competitors, while also learning from them. Thus, we should have an open source attitude. Vattenfall will never construct wind turbines or develop ocean energy technology. We need networks to share knowledge, risks and funding.

Nuclear power is a cheap and almost CO_2-free means of electricity production, which will be needed in the future too. The third generation of nuclear plants is now being built, and we are thinking about the fourth generation. While optimising current plants we must think ahead, and envision new technologies that will come in the future. Therefore, together with the French energy company RDF, we have joined the Jules Horowitz Reactor (JHR) R&D Project. Some parts of the new technology can also be used in our old plants to further improve security and efficiency.

These are some ways in which we build the bridge to the future. I take this opportunity to wish good luck to the colleagues who continue the work with strategies and R&D. ■

Helmar Rendez

Research and development at Nuon

On the 23rd of February 2009, Dutch Nuon and the Swedish company Vattenfall announced that they joined forces to create a leading European energy company. Through joint investments, Vattenfall's acquisition of Nuon will accelerate the transition to climate-neutral operations by 2050.

Vattenfall and Nuon are global leaders in the development of CCS technology. Vattenfall and Nuon are, today, working together in a number of areas regarding research and development. Some examples are E-mobility, CCS and Smart Grids. The companies will work together with continuing developing projects like the CCS plant at Schwarze Pumpe in Germany (Vattenfall) and Buggenum in the Netherlands (Nuon). Collaboration in other areas is also in progress.

"The Technology & Engineering Services (T&ES) department within Nuon provides the technical input for the new-build projects and supports technical innovation and developments that take place within BG Benelux. Technical innovation and R&D are driven mainly by strategic objectives and business demand," says Chris Lappee, Head Technology & Engineering Services at Nuon.

T&ES consists of 15 engineers with a background in mainly mechanical and chemical engineering. Most of the activities of those engineers take place in projects based on proven technology, while the R&D work mainly is based on relationships with external partners. "T&ES is responsible for coordination with technology institutes such as KEMA (Dutch Technical Service Agreement (TSA)), ECN (Energy research centre of the Netherlands), TNO (Netherlands Organisation for Applied Scientific Research) and several Universities. Nuon is also a co-founder of the KEMA," says Chris Lappee. The amount of persons is quite small compared to Vattenfall, where there are about 200 employees working in this area. Before the acquisition of Nuon, Vattenfall had approximately 30,000 employees and Nuon roughly 10,000 employees.

A substantial part of the R&D work within Nuon is a pilot plant for Carbon Capture in Buggenum, which is planned to start July 2010 and the pilot project takes about 1,5 years. The behaviour system will be studied and the efficiency of the capture process will be optimised. Nuon is also working to develop combustion of hydrogen-rich syngas in DLN burners[1], co-firing of biomass in Hemweg and solar cells on foil. Some of these technologies are already commercial, but they are new for Nuon.

The R&D work connected to the energy transition strategy is performed in the areas of energy savings, renewable energy and clean fossil fuel. Energy saving activities are e-mobility, micro CHP[2] and smart meters. Examples within renewable energy are Helianthos[3], biomass co-firing and geothermal. Clean fossil fuels activities are towards next generation IGCC, torrefaction[4], enhancement of gas storages and demonstrating carbon dioxide capture. ■

About Nuon NV

Nuon is an energy company with more than three million consumers and corporate customers and over 10,000 employees in the Netherlands, Belgium and Germany.

Nuon is a producer and supplier of electricity, gas, heating and cooling and is an active energy trader in all major international markets. Nuon also provides other services and technological innovations. The company strives for a reliable, sustainable and affordable energy supply. With a turnover of 6.1 billion EUR in 2008, Nuon has a leading position in the Dutch energy market. The corporate shares were held by local and regional authorities. On the first of July 2008, Nuon was divided into one network operator (Alliander) and one production and supply company (Nuon). From that date, the two companies operate independently, but under one single holding company and one joint board.

[1] DLN (Dry-Low-NO_x) burners give significant reduction of NO_x emissions
[2] Micro Combined Heat and Power, electricity producing system where the "waste heat" is put in use
[3] A type of solar cell system
[4] A process were biomass properties are changed to obtain a better fuel quality

R&D, News in Brief

THERMAL TECHNOLOGY PROGRAMME

Cyclic operation of thermal power plants

Cyclic operation of power plants has become more common due to wind turbines and fluctuating electricity prices. It may result in new fatigue-related failures. This will be reviewed in a new project. The aim is to identify possible critical components, materials and operations as a consequence of increased number of start and stops.

Finished pre-study on fire and explosion risks

An increased use of biomass and waste might be associated with increased risks of fire and explosion in the whole fuel treatment chain, especially inside the plant. In a pre-study experience on storage, self-ignition, fire detection and extinction, explosion risks and measures and emissions have been summarized. Mechanisms of self-ignition have been studied and some guidelines on storage and fire detection and extinction are presented. These questions are now planned to be further investigated in a Swedish national R&D program within Brandforsk (The Swedish Fire Research Board).

Effects of co-combustion on electrostatic precipitators[1] (ESP)

A project has been completed regarding the impact of co-combustion of coal and biomass on the performance of electrostatic precipitators (in plants originally designed for coal combustion). The project includes a study of how negative impacts can be avoided or reduced.

A conclusion from the report is that 10% co-firing of biomass will not have a large impact on the ESP. At higher biomass shares, the ESP performance might be reduced, due to among other issues, fouling, lower sulphur content of the fuel and larger share of fine particles in the fly ash.

[1] Particulate collection device that removes particles from a flowing gas such as air) using the force of an induced electrostatic charge.

OCEAN ENERGY PROGRAMME

Environmental impacts caused by Electro Magnetic Fields (EMF)

A study concerning the potential environmental impacts caused by Electro Magnetic Fields (EMF) from AC (alternating current) and DC (direct current) cables and under water installations has been completed. The current knowledge about EMF is restricted to a few laboratory and field studies carried out for a number of marine animal taxa. Research results do not indicate that EMF from sub-sea power cables is a serious threat to the marine environment.

E-MOBILITY

Plug-in hybrids as providers of regulation power

An abstract from a diploma thesis work, sponsored by Vattenfall and carried out in the e-mobility field, was published in the scientific Journal of Energy Policy in the beginning of 2010. The study investigates how plug-in hybrid electric vehicles (PHEVs) can provide regulation power and the profits for the car owners that may be generated on the regulation power markets in Sweden and Germany. The result shows that profit can be generated on the German market, but not on the Swedish market. One explanation for this is that Germany has higher price levels for regulation power than Sweden.

WIND POWER

Modelling tool for proper assessment of wind resources

The aggressive expansion of wind power capacity means that sites with ideal wind conditions are in short supply. For this reason, complex sites with sloped terrain or forest areas are increasingly considered. Most of Vattenfall's onshore project sites in Sweden and United Kingdom fall into this category. Vattenfall is developing CFD (computational fluid dynamics) as a sophisticated wind modelling tool. The CFD models predict the spatial variation of mean wind speeds, turbulence, and wind shear levels and may, thus, be used for both estimating annual production and for mapping of severe conditions that would impose high fatigue loads and limit turbine lifetime.

The development of site analysis scripts continues in 2010 and we are planning a rollout of an operational wind resource assessment tool in 2011.

SUSTAINABLE CITIES

District-heating based cooling

A project in Berlin and Hamburg has been realized with the purpose to study the supply of cooling to office and residential buildings in summer time. The basic idea is to use heat from the district-heating network to produce cooling by the use of absorption chillers. A special concept has been developed to minimize the required equipment and installation work in order to offer the cooling for an attractive price.

Test runs have been carried out in Vattenfall office buildings in Berlin and Hamburg. The results are very promising and proved the suitability of the overall concept. The work continues and, parallel to this, the concept is also offered to other building societies.

SMART GRIDS

Vattenfall and ABB in unique Smart Grids cooperation

Vattenfall and ABB have announced a joint investment in a large demonstration project for smart electricity grids on the Swedish island of Gotland.

Vattenfall and ABB are planning a unique large-scale demonstration of most of the currently known technologies in one and the same place – the Swedish island of Gotland in the Baltic Sea. The demonstration project is planned to start in the autumn 2010 and last for four years.

Gotland is a distribution area that has all the right conditions for Smart Grids. The island is large enough to be represenataive for a normal distribution network including customer from large industries to private households. A substantial share of wind power is today connected to the distribution network and all customers have already smart meters installed.

Furthermore, Gotland's distribution operator GEAB, a subsidiary within Vattenfall, is in charge of keeping the island's electricity system in balance and the power supply at a stable frequency. All in all Gotland is an ideal place for testing both the technical solutions of the Smart Grid as well as the new services that will enable customers to participate more directly on the electricity market.

In this way, Smart Grids Gotland could become a scalable pilot plant, attracting interest from across the EU and demonstrating tomorrow's solutions. The pilot is expected to be supported by EU's SET plan (the Strategic Energy Technology Plan) with the task to develop and commercialize the technology.

More focus on Smart Grids

Until now, the push for carbon neutral operation has mainly been focused on the generation part in the electricity supply chain. In the future, however, the implementation of Smart Grids will become crucial to incorporate the increasing share of renewable energy sources that will be necessary to achieve the European Union's energy-climate goals.

ILLUSTRATION: KJELL ERIKSSON

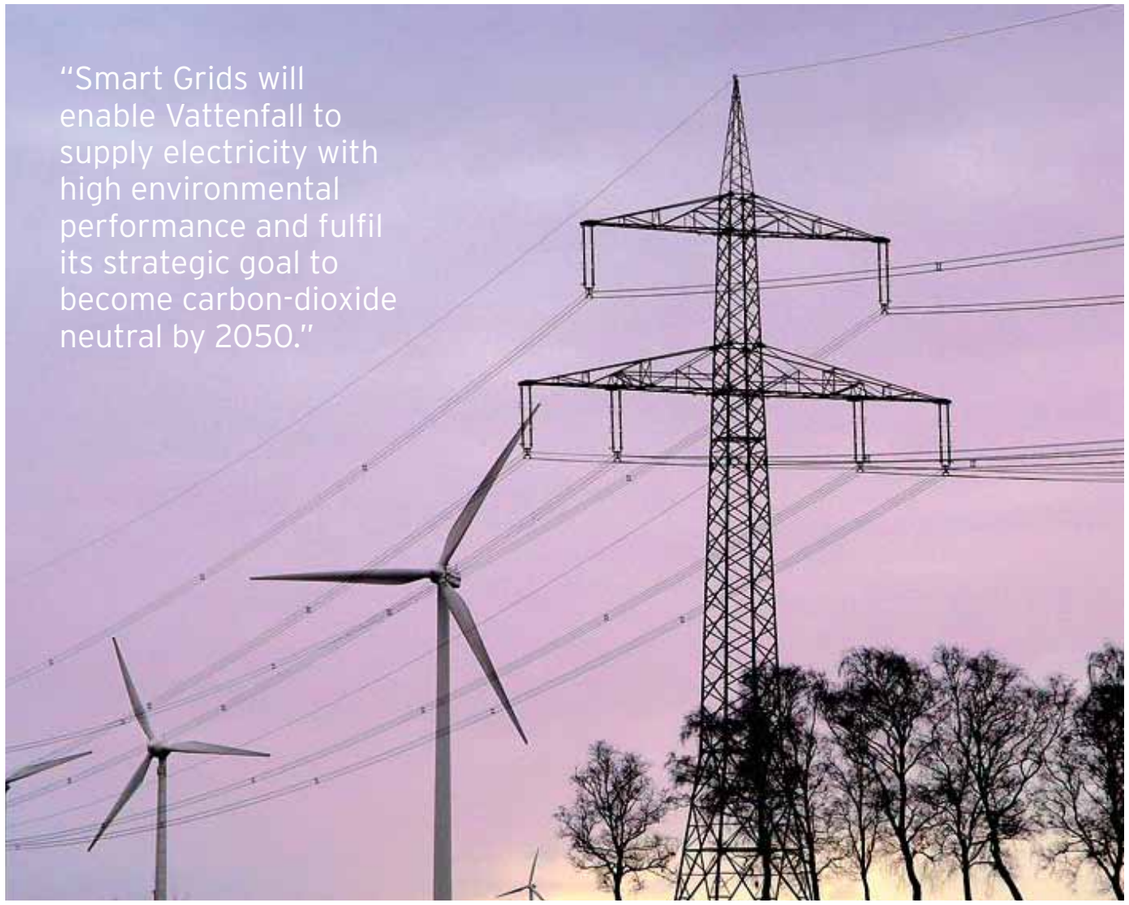
At present, there is intense activity concerning Smart Grids all over the world. A number of countries and regions are working hard with the development and introduction of Smart Grid technologies. Politicians, utilities and other stakeholders in the energy industry have all realised the importance of electricity systems that are better designed to integrate the rapidly growing share of renewable generation sources.

"To handle large amounts of renewable energy sources, such as wind and solar power, Vattenfall and other actors have to create a platform that can handle bi-directional flows of power and information between the market actors, while maintaining the harmonised and deregulated electricity market. This platform is the Smart Grid," says Johan Söderbom, Group R&D Programme Manager Smart Grids.

"Smart Grids will enable Vattenfall to supply electricity with high environmental performance and fulfil its strategic goal to become carbon-dioxide neutral by 2050. The future networks will be designed to enhance reliability and security and act as a platform for active customer participation on the electricity market."

Despite its name, Smart Grids is not just a technology that is implemented in the grid. The Smart Grid is rather an extensive concept that cuts across the entire value chain of Vattenfall. In an unbundled value chain, on a deregulated market, the benefits of Smart Grid investments will not arise in the grid where they are made. For example, providing for the connection of distributed energy resources to the grid will create profits for the generation unit owner or for an aggregator of such units.

"Given this reasoning, it is not possible to find one definition of Smart Grid that fits all of Vattenfall's markets. As a result, the Smart Grids R&D Programme develops common solutions, as well as local variations of the Smart Grid concept within Vattenfall," says Johan Söderbom.



Johan Söderbom, manager for Group R&D programme Smart Grids.

Although there is no single definition of Smart Grids, it is obvious that Smart Grids is a development and evolution of the present network, rather than a totally new network infrastructure. The structure or topology of the network, however, will change from a "hierarchic" tree structure, where electricity is transmitted and distributed from relatively few large-scale power plants to the consumers, to a "decentralized" structure that can accommodate a large amount of both small and large-scale renewable generation.

Furthermore, the Smart Grid will enable consumers to feed in and get credit for electricity production from small-scale household generation. A Smart Grid also entails solutions to facilitate for consumers to use electricity in a smarter way and with improved environmental performance, for example by the use of smart meters and solutions that make it possible to visualise and continuously adapt the electricity consumption to the production.

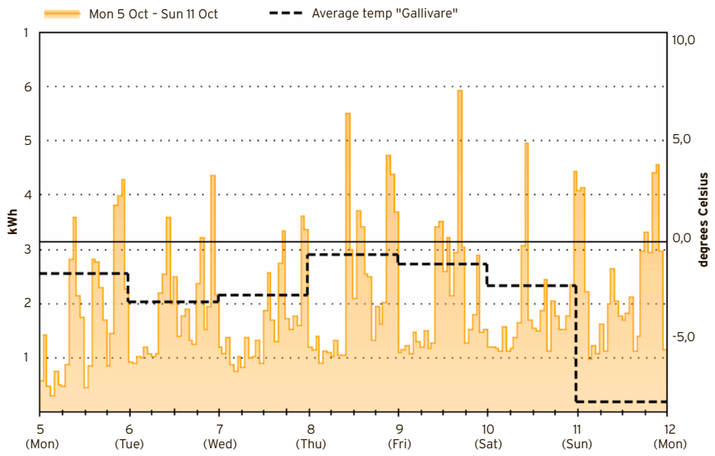
"As the dependence and importance of electricity will continue to increase, the networks have to be designed for maximal uptime and also support the transition to electric vehicles

The result is a more dynamic electricity system that utilises the generation sources and the transmission and distribution system in a more efficient way," says Johan Söderbom.

The main problem that Smart Grids have to tackle is to secure the balance between production and consumption and to guarantee the availability of high-quality electricity when the amount of intermittent generation sources increases. In order to counteract situations of under or overproduction, local energy storage solutions will be needed, as well as mechanisms and clear price incentives for consumers to use their electric equipment in a way that helps preventing overload situations. ■

Making the electricity consumption visible

Vattenfall has just carried out a large R&D project with the objective to evaluate real customers' interest in more advanced consumption services accessible through the Internet. The project, Customer Information Pilot (CIP), included a demonstration with 2,500 Vattenfall customers in Sweden who were keen to participate in the pilot.



Customers in the demo project could follow their electricity consumption directly on the Internet.

Customer interest in advanced consumption services through the Internet has been evaluated in a Customer Information Pilot, says project manager Monica Löf.

The interest for keeping track of the current electricity consumption is increasing, both among consumers and in society. As the last harsh winter led to very high electricity demand and temporary skyrocketing prices in the Nordic countries, a governmental inquiry was, for example, initiated in Sweden to explore the opportunities for hourly meter reading. The expectation is that consumers' awareness of their present consumption could lead to energy savings, beneficial both for consumers and for the climate. Today, all electricity customers in Sweden and most of the customers in Finland already have monthly reading of their electricity meters.

The goal of the CIP project, which started in 2008, was to test a web-based application, where customers would be able to log in and visualize high-resolution consumption statistics in graphs, tables and Excel. The customers were also presented with, for example, outage information, warning/messages regarding consumption deviations, they had easy access to Energy Experts, energy log for own registration, mailbox for support contact and Energy glossary, Frequently Asked Questions and Help pages.

"The project has given the opportunity both to evaluate customer interest in getting access to high-resolution consumption data and outage information and to carry out technical tests for Distribution Nordic, for example, in the area of data collection and distribution. In addition, setting up a requirement specification for a future roll-out was also part of the project," said project manager Monica Löf.

The pilot project received great response from the customers, as nearly 17% of respondents agreed to participate in the study. The participants gave mainly positive feedback, for example, they liked the features of the program and also understood how to use them. The web application proved to be user friendly for the private customer.

Another positive part of the pilot was that Distribution Nordic learned to manage the high-resolution data collected from the meters. The internal process for managing data and uploading hourly values once per day was improved greatly during the study.

"Overall, the pilot gave important input for the continued work. A requirement for successfully carrying out the pilot was the involvement of several important functions in Vattenfall, for example, Sales, Distribution and the Energy efficiency program," said Monica Löf.

The technical basis for developing advanced consumption services already exists in Sweden and Finland. The roll-out of Smart meters in Vattenfall started in Sweden 2002 and was finalized 2008 with 850,000 installed meters. In Finland, the roll-out started 2003 and also ended 2008 with 360,000 meters.

"The main goal of the Smart meter roll-out was to introduce billing that is based on actual consumption values. But the meters and communication infrastructure can provide more valuable information, which makes it possible to develop new services. Visualization of actual consumption on an hourly basis is today only available from some smaller companies," said Monica Löf. ■

"The main goal of the Smart meter roll-out was to introduce billing that is based on actual consumption values."

Producing your own electricity

Small-scale renewable electricity generation is expected to grow significantly in the future. This will have an impact both on the networks and the utilities' business models. Vattenfall has analyzed small-scale generation in a study.

Originally, most networks were designed to distribute electricity to a large number of customers from a limited number of large-scale production plants. An extensive introduction of small-scale production will be the contrary to this and will in the long-term perspective require a paradigm shift in network operation.

There is no general definition of small-scale production. In a recent study by Vattenfall, the following description was suggested:

"The term small-scale generation refers to generation units installed by customers who have a fuse level of, at most, 63 ampere, and produce electricity that can be fed in to the grid with a power capacity of maximum 43,5 kW. The amount of electricity taken out is larger than the amount of electricity fedin on a calendar year basis (net customer)."

So why this interest in small-scale production? The increasing attention to the international combat climate change issue and the growing interest for clean and renewable energy production is certainly one reason. From a customer point of view, small-scale production is attractive as a possible way to save money and become more self-sufficient, while at the same time contributing environmentally by producing one's own clean electricity.

Customers who use the possibility to produce their own electricity are often referred to as prosumers. Prosumers can consume electricity from the grid but also feed in electricity in the low-voltage power grid at times of surplus generation. They are often private persons or housing co-operatives with solar panels on the roof or small enterprises or farms with small wind power units.

In the southern parts of Germany, for example, the installation of solar panels has become increasingly popular. This photo-voltaic solar boom, however, has mainly been driven by the exceptionally high levels of state subsidies and has only small impact on the total electricity generation capacity. Apart from solar panels, there are also other micro-generators available on the market today, such as small-scale wind turbines and micro CHP[1]-systems (combined heat and power).

The penetration of small-scale generation on different markets is very dependent on laws and regulations for handling increased network costs. Another issue is regarding vulnerable networks area in the grid where voltage variations can be a problem. It is important to keep track of new installations and monitor the flows in areas identified as potentially vulnerable.

In a possible future scenario when small-scale generation is implemented on a broad scale, the network will have a role as a back-up system, as well as an electricity delivering system. In such a scenario, it is assumed that there has been a large break-through for small-scale production. This, in turn, will be highly dependent on governmental support even though the manufacturing cost for small-scale production is expected to decrease.

In the study of small-scale generation, Vattenfall also states that it is important to understand that each national market has their own set of regulations and also a particular economical development and network structure. This, in turn, means that each country has its own prerequisites for an introduction of small-scale production. ■

[1] Heat engine or a power station to simultaneously generate both electricity and useful heat.

Smart Grids will enable Vattenfall to supply electricity with high environmental performance and fulfil its strategic goal to become carbon-dioxide neutral by 2050.

ILLUSTRATION: ANNA BAUMGARTEN

FACTS: SMART GRIDS

What is a Smart Grid?
Smart grids is the next step in the evolution of today's electricity grids. They are intelligent electricity networks that can integrate the behavior and actions of all their users - generators, consumers and those that do both - in order to ensure an efficient, sustainable, economic and secure electricity supply. Smart grids functions bi-directionally, integrating customers on the electricity market and distributed, electricity generation, whether small- or large-scale. And in response to increasing electricity demand and stricter climate requirements, smart grids increase the efficiency of electricity transmission and distribution.

What is a smart meter?
A smart meter is an advanced electrical meter that measures consumption in more detail than a conventional meter and communicates that information via a network back to the local utility for monitoring and billing purposes. Smart meters can also measure production from small-scale electricity sources. Furthermore, they usually involve real-time or near real-time sensors, power outage notification, and power quality monitoring.

Possibilities with Smart Grids

- Allowing the seamless integration of renewable energy like wind, solar and ocean energy
- Enabling nationwide use of plug-in hybrid electrical vehicles
- Expansion of the small scale production market
- A more effective disturbance management and reliable electrical distribution
- Making large scale energy storage a reality
- Open up a new era of consumer choice
- Increase the customers awareness of their energy consumption
- Influence energy consumption by real-time pricing
- Makes it possible with two-way communication in support of distributed technologies and customer participation
- Web applications will enable customers to follow their energy consumption on an hourly or near to real-time basis

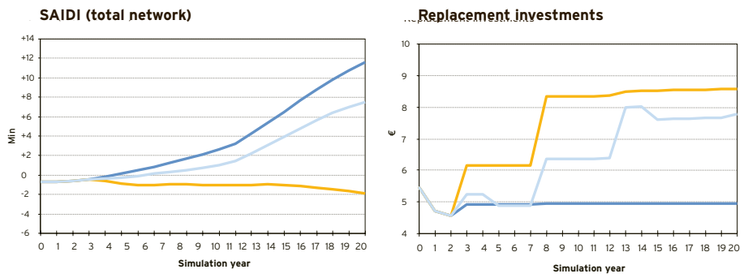
Today´s Grid and tomorrows´s Smart Grid

Characteristic	Today's Grid	Smart Grid
Customer participation	Many customers are only informed via the invoice	The customer is informed about their own consumption as well as the market situation
New products, services and markets	In best case an easy way to switch supplier	New users/usages of the electricity network create need for new range of products/services such as energy conservation products or local generation offers
Outage management	Difficult to get outage information	Automatically detects and respond to problems
Environmental advantages	Limited opportunities for the customer to act in an environmentally responsible way	Enable a more environmentally rational use of electricity and integration of renewable generation on all levels in the grid
Power quality	Focus on outage – slow respond to power quality issues	Faster respond and resolution of power quality issues
Electricity price	Limited possibility to influence	The customers have the opportunity to influence their consumption as well as entering more customised price programs

ILLUSTRATION: KJELL ERIKSSON

Strategic planning of the future network

In the coming years, Vattenfall's electricity networks will need substantial investments to increase capacity and upgrade the networks with future-proof Smart Grid functionality. Vattenfall is successfully using a software-based simulation tool called Asset Strategy Planning (ASP) in order to optimise these investments in its networks.



Asset Strategy Planning (ASP) is a software-based tool that facilitates strategic planning of network investments. The System Average Interruption Duration Index (SAIDI) and Replacement investments can for example be simulated.

The ASP tool was first implemented by Vattenfall Distribution Europe. Based on the positive German experiences, ASP is now being used also within Distribution Nordic in Sweden and Finland and a pilot study has recently been started in Poland.

Vattenfall's distribution networks are today valuable assets worth many billion euros. Until 2020, the reinforcement of the networks and implementation of Smart Grids technology will require several billion euros of further investments. This means that accurate long-term strategic planning of these investments is vital.

"The average age of the assets in the distribution network is increasing and a limited reinvestment budget must be prioritized in order to increase network quality and decrease costs. ASP is a long-term planning tool for evaluation of different investment strategies," says Thomas Schäfer at Distribution Europe.

By choosing different investment strategies, the ASP tool has the ability to simulate the ageing of large infrastructure asset groups, maintenance costs, reinvestment costs and its effect on network indices, such as customer interruptions or if energy is not supplied. The ASP tool also makes it possible to simulate the effect on the network indices and costs, as well as different topologies in the grid, such as using redundant transformers, mobile power equipment, fault sensors and remote controlled disconnectors.

"Alternative investment strategies can, for example, be whether to reduce or increase maintenance on different assets or whether to replace assets before or at end of life. This makes it possible to invest money in the most effective way, in other words with reduced investment costs and increased service level," says Thomas Schäfer.

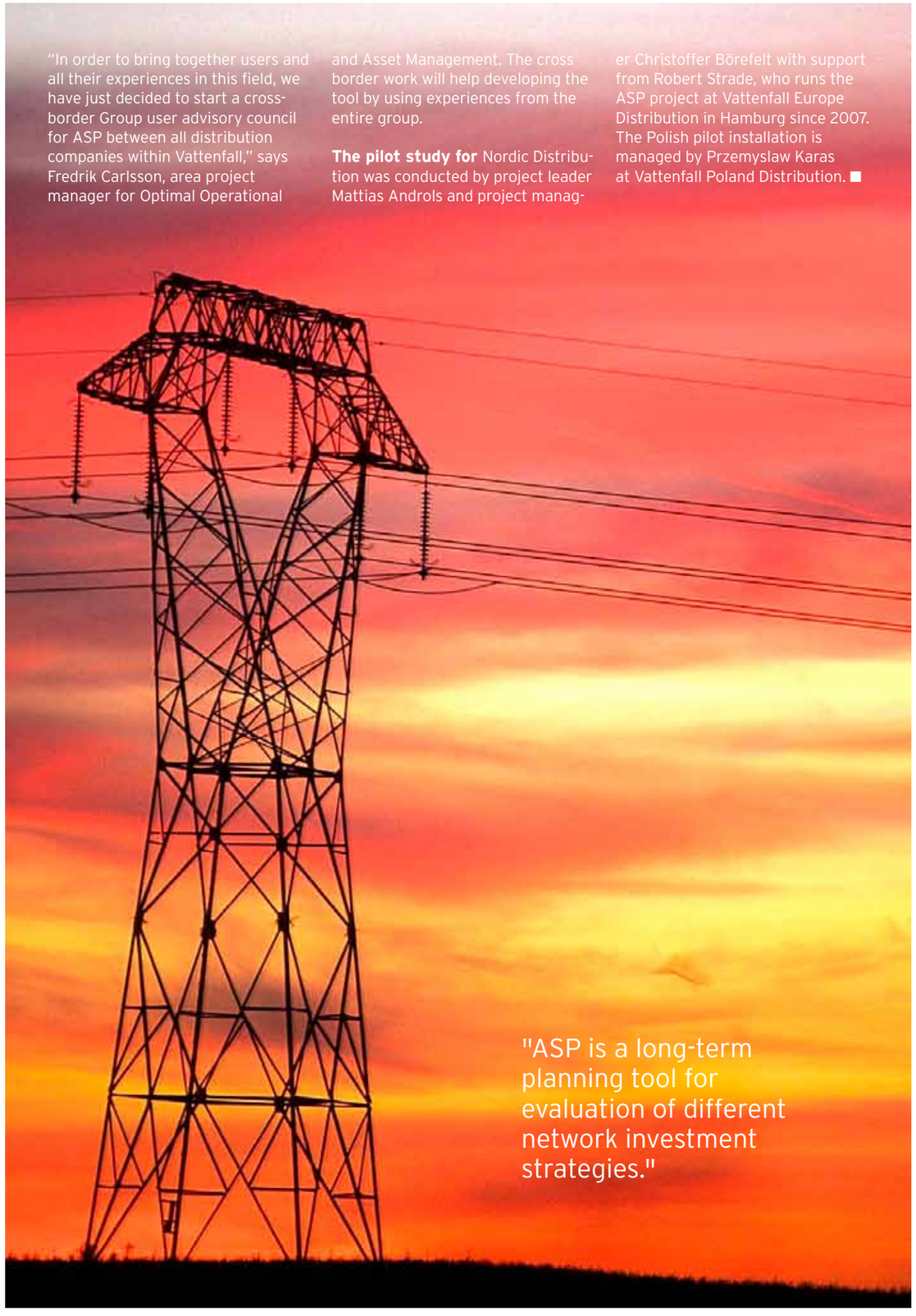
Based on the positive experiences of ASP in Germany, a pilot project was initiated in 2008 within the Group R&D programme Smart Grids to study the preconditions of implementing the ASP tool also within Distribution Nordic.

"The pilot project showed clearly that ASP could be a valuable tool also for Nordic Distribution who in September 2009 decided to implement the tool in the ordinary business and investment planning process. The implementation of the tool has received positive feedback from management and the plan is to use it to continuously support the investment planning process," says Hans Andersson, project manager at Nordic Distribution.

The interest for ASP has also spread to Distribution Europe in Poland, where a pilot project has now been started. This successful cross-border cooperation has resulted in a desire for a common forum for experience transfer.

"In order to bring together users and all their experiences in this field, we have just decided to start a cross-border Group user advisory council for ASP between all distribution companies within Vattenfall," says Fredrik Carlsson, area project manager for Optimal Operational and Asset Management. The cross border work will help developing the tool by using experiences from the entire group.

The pilot study for Nordic Distribution was conducted by project leader Mattias Androls and project manager Christoffer Börefelt with support from Robert Strade, who runs the ASP project at Vattenfall Europe Distribution in Hamburg since 2007. The Polish pilot installation is managed by Przemyslaw Karas at Vattenfall Poland Distribution. ■



Benefits for the distribution operators

The introduction of smart meters opens up a number of opportunities for DSO (Distribution System Operator). For example, it will be easier to detect interruptions in the electricity grid. Weak areas in the power grid with poor power quality will be easier to identify and correct. Before that, however, a great number of investments into the power grid will be required.

Before the introduction of smart metering, interruptions were mainly identified by customers' reactions to the operator. Smart meter equipment, however, makes it possible for the DSO to detect an outage and also to more precisely locate them in the network. In that way, an error will be faster to find and correct. Smart metering equipment also makes it possible to send data about the electricity load in the network. Getting information about high load areas, equipment in the network which needs reinforcement can quickly be located. In this way, investments will be more cost-efficient since you know where in the network an investment will give the best outcome.

Sensors integrated in the grid makes it possible to monitor power quality and, in some cases, respond automatically to them. Using such smart grid features of rapid sensing and automated self-healing of anomalies in the network promises to bring higher quality power and less downtime. Simultaneously, Smart Grid functionality will support power from intermittent power sources and distributed generation, which would, if unchecked, degrade power quality.

Another benefit with smart metering is the possibility for a more even customer consumption due to price differences between times of high load and low load electricity consumption. Price signals are sent out to customers as a response to high prices at high load times and customers will be more careful with their electricity consumption at high load times.

"Smart Metering will open a new world for the DSO's with less downtime, more effective investments and real-time communication with the customers, which has not been possible before", says Lars Garpetun, Vattenfall Distribution. ■

What is power quality?
The quality of electrical power may be described as a set of values of parameters, such as continuity of service, variation in voltage magnitude and frequency, and undesired disturbances of alternating currents.

Technical networks in the front-line of Smart Grids

The Smart Grid of tomorrow will look more like Internet 2.0 than like today's traditional electricity grids. Whereas traditional grids are designed to distribute power in one direction only, Smart Grids will have to manage a dynamic network of energy supply sources and demand spots by using cutting-edge IT and communication network technologies.

Smart Grids are much more than power network technology. In order to attain a more responsive electricity system that can manage a substantial share of renewable power sources, the future networks will increasingly incorporate new IT functionality. The Smart Grid will, for example, entail "intelligence" and overlaying IT network structures to monitor power flows and balance loads in a far more efficient way.

The main challenge in the future is to secure the balance between the electricity supply, which will vary over time, and the power demand on the market. For this reason, communication systems and dynamic pricing models that can contribute to active demand side participation have to be integrated in the system. A shortage of, for example, wind power has to be compensated by a balance power source, for example, electricity from hydropower or electricity storages, or by a reduction of the electricity consumption.

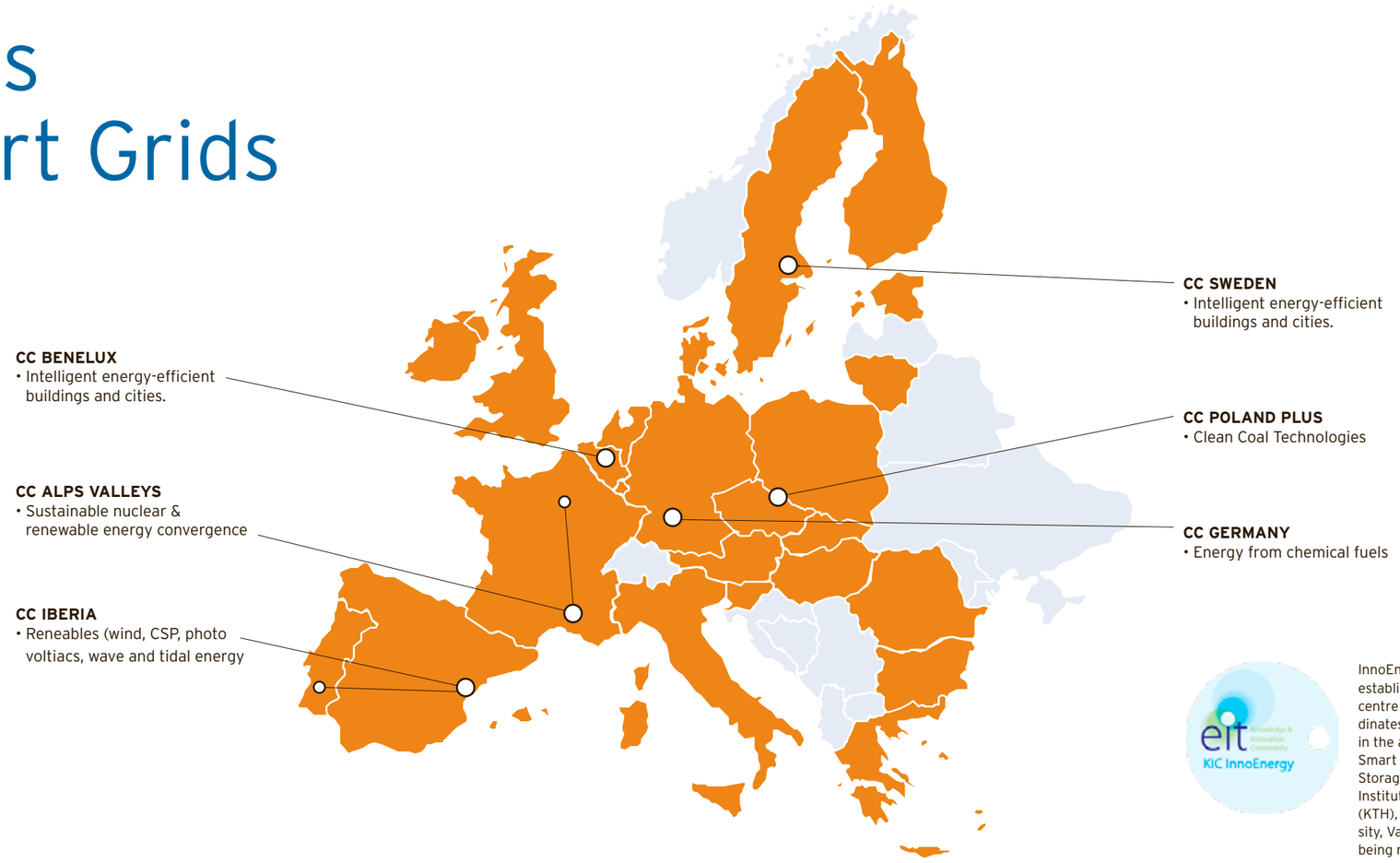
Smart meters and visualization of the present consumption is a key component in this equation. When electricity generation decreases, consumers will be encouraged to cut down or postpone their use of electrical appliances. Washing machines can, for example, be programmed to start at off-peak hours and electrical cars charged during the night when the price is low. A prerequisite for this are IT systems that can facilitate large-scale data collection and communication between consumers, network operators and electricity utilities.

Network monitoring and control is another Smart Grids area where a more powerful IT and communication network will increase efficiency and reliability. A large number of sensors in the network and its components will make it possible to quickly locate quality problems or outages. Downtime can be minimized or eliminated by self-healing functionality and automatic re-routing of power.

So there is no doubt that technical networks and IT systems are in the frontline of Smart Grids technology! ■

Vattenfall supports international Smart Grids initiatives

Smart Grids will help achieve sustainable development, not only on a local and national level, but also on an international level of the European Union's electricity and energy system. Vattenfall, therefore, actively supports and participates in a number of international Smart Grids initiatives and R&D projects.



InnoEnergy's newly established co-location centre Stockholm coordinates joint expertise in the area of European Smart Grids and Electric Storage, with The Royal Institute of Technology (KTH), Uppsala University, Vattenfall and ABB being main partners.

"Vattenfall is one of the founding members in EU´s Industrial Initiative on Smart Grids, 'The European Electricity Grid Initiative' (EEGI), with an expected funding of 2 billion euros until 2015. EEGI is one of three European Industry Initiatives that are important parts of the EU's Strategic Energy Technology (SET) Plan that has been designed to facilitate the process of coordination at regional, national and European levels," says Peter Söderström at Vattenfall Distribution Nordic.

The objective of the EEGI is to define a framework of a common research and large scale demonstration program to foster the development of Smart Grids, to identify the investments necessary for the development of an integrated European Smart Grid infrastructure and to highlight shared action plans covering the main steps of this development and standardization.

For Vattenfall, the involvement is an important step to continue position Northern Europe as an area at the cutting edge for electricity grid and market development. Specifically, EEGI will provide Vattenfall with a good platform for coming pilots in the Smart Grids area.

Active demand participation

Vattenfall also participates in ADDRESS (Active Distribution network with full integration of Demand and distributed energy RESourceS), another strategic R&D project within EU's Smart Grids European Technology Platform.

"Residential electricity consumption varies throughout the day in a consumer-specific pattern. If a large number of consumers are aggregated, the flexibility in their combined consumption and own generation – meaning "active demand" – may, for example, be used for load reduction in certain areas, says Stefan Melin at Vattenfall Research and Development.

"One of the objectives of ADDRESS is to design technical and business conditions for an aggregator to enable active participation of domestic and small commercial consumers in power system markets. This will be achieved by aggregating flexible demand and generation of equipment installed at consumer's premises, such as electrical appliances, distributed generation and energy storage."

ADDRESS is an Official Partner of EC Sustainable Energy Europe Campaign. The project consortium counts 25 participants from 11 European countries, including ENEL, EdF, ABB, Iberdrola, VTT and Vattenfall.

InnoEnergy co-location center

A new commitment for Vattenfall is InnoEnergy, a strongly integrated alliance of established players from the education, research and industry sectors. InnoEnergy operates through six co-location centres, regional hubs forming innovation eco-systems. The newly established co-location centre Stockholm coordinates InnoEnergy's joint expertise in the area of European Smart Grids and Electric Storage.

"InnoEnergy will enable us to further promote Smart Grids research and development activities in Sweden and also strengthen our international network to leading institutes and researchers," says Johan Söderbom, Vattenfall Group R&D programme manager for Smart Grids and responsible for Vattenfall's participations in InnoEnergy.

Vattenfall has also a strong involvement in EURELECTRIC, the Union of the Electric Industry. In addition to the fact that former CEO Lars G. Josefsson is, at present, President of EURELECTRIC, Vattenfall has representation in many working groups, for example, Per Hallberg who is Chairman of the Working Group Smart Grids (see separate article "Another Perspective"). ■

Torbjörn Wahlborg, Lars Strömberg and Johan Söderbom during opening ceremony at The Royal Institute of Technology in Stockholm.

ANOTHER PERSPECTIVE

Meeting EU's energy-climate challenge

Per Hallberg, Chairman of Eurelectric's Working Group Smart Grids

Upgrading the current European electricity grid with smarter technologies is one of the key priorities for the energy sector in order to meet the EU energy-climate legislative package with its 20-20-20 targets for the year 2020. Vattenfall's Per Hallberg is Chairman of Eurelectric's Working Group Smart Grids and knows what it will take to reach the goals of the triple targets.

The European Union has been moving towards deregulation of the electricity markets for the past decade. With the goal of creating a harmonized European energy market, the Union is also in the process of establishing a 'Trans-European Network' for electricity and gas.

"The main objective is to ensure the reliability and quality of energy supply, while integrating renewable energy sources (RES) into the system and increasing the efficiency of electricity transmission and distribution in order to limit the grid tariffs," says Per Hallberg.

The EU's triple commitment to reducing CO2 emissions by 20%, sourcing 20% of its total energy need from renewable sources and improving energy efficiency by 20%, all by 2020, represents a considerable challenge for the European energy sector.

For the electricity grid, the triple commitment is even more challenging as it means that approximately 35% of all electricity will be generated from renewable sources. In addition, more electricity applications will appear in the future, such as the electrical vehicles and heat pumps coming into use today.

"This will have a considerable impact on the electricity grid. However, as each country has its own power generation and network structure, there will be different solutions needed for different countries, different networks, and different parts of networks, which all have to accommodate the consequences of moving to a low carbon economy," says Per Hallberg.

The implementation of smart meters is one example of the differences in the development towards a smart grid. According to EU's third energy directive, all member countries have to guarantee that smart meters have been installed in at least 80% of their households by 2020, and 100% by 2022.

In Sweden, Finland and Italy, the implementation of smart meters has already been carried out, fully or to a large extent. In other countries, the issue of who will carry the cost for the smart meters rollout is mostly unsolved and the nationwide rollout of smart meters still remains.

"The EU commission has set up an advisory expert board, which will come up with recommendations for the implementation of smart meters within the next year. It is likely that these recommendations will eventually result in a fourth directive, which could mean that the distribution network operators (DSOs) will get the responsibility to install smart meters and also for collecting consumption data on, for example, an hourly basis. In this case, the cost would be included in the DSO's network tariffs. Other topics that could be a part of a future 4th directive are how to achieve an international retail market and how to increase transparency generally in the electricity sector".

The main driver for the development of Smart Grids is the ambition to increase the share of renewable energy sources. Per Hallberg foresees two main development trends for renewable generation:

"Electricity from renewable sources in Europe will come both from small-scale and large-scale wind and solar power generation, often supported by state subsidies. In addition to "household generation" from small-scale wind and solar generation, most countries and large utilities are now investing heavily in large-scale offshore and land-based wind farms."

"New Smart Grid technologies, a harmonization of national electricity markets and new trans-national transmission capacity will play important parts in the transition to a more flexible and efficient European energy and electricity system. Energy systems with a high proportion of renewable energy systems require a Smart Grid that can also help consumers and their electrical machinery and appliances to behave smarter," says Per Hallberg.