MARKET OPPORTUNITIES IN THE SMART GRID SECTOR IN FINLAND 2016

Photo: ABB

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FOREWORD:

CREATING THE FUTURE ENERGY MARKET

Finland provides an excellent R&D and testbed environment for Smart Grid technologies.

We have a number of competitive advantages supporting this business area: very strong ICT and energy sectors, a highly skilled workforce in several technology subdomains, and last but not least, an electricity system that already uses smart grid functionalities.

THE FINNISH ELECTRICITY SYSTEM IS CALLED SMART GRID 2.0 FOR A GOOD REASON.

Finland was, for example, one of the first countries in the world to adopt remote meters that register electricity consumption data on an hourly basis. These smart meters are capable of receiving and sending load control commands. Services for the utilization of smart energy data are developed in a practical testing environment in which real-life user experiences play an integral part.

FINLAND WAS ONE OF THE FIRST COUNTRIES IN THE WORLD TO ADOPT REMOTE METERS THAT REGISTER ELECTRICITY CONSUMPTION DATA ON AN HOURLY BASIS.

This report aims to introduce the Smart Grid business area and the business potential and investment opportunities it provides in Finland. It describes the current value chain as well as the expected changes and upcoming business opportunities these changes may create.

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BUSINESS/MARKET OPPORTUNITIES

- Finland provides a great R&D environment and testbed for companies offering Smart Grid technology from distribution automation to home integration of intelligent devices. Both ends are strong in Finland.
- With the help of Finnish companies, energy meter and device suppliers can transform into intelligent systems and network supplies
- The role of the ICT sector in smart grids is growing. As Finland has leading expertise in both areas, software and IoT companies can find lucrative partnering opportunities in Finland in seeking to resolve problems in bigger markets
- The Finnish Smart Grid ecosystem attracts pioneers and industry leaders.

WHY FINLAND

- The Finnish electricity system is among the leading systems in Europe and even globally.
- The Finnish electricity market has been interconnected with the Nordic market since the 1990s. Being open and transparent in many aspects, the market offers a flexible platform for different operators.
- Finnish network operators have developed state-of-the-art operational processes. Internationally compared, asset management in Finland is on a very high level.
- Distribution network operators, such as **Elenia, Caruna** and **Helen,** are pioneering companies in implementing Smart Grid technologies in their businesses. **Fortum** has also been one of the key players in developing new services for the Finnish energy sector.
- Finland was one of the first countries in the world to adopt remote meters that register electricity consumption data on an hourly basis.
- Today, national regulation is strongly steering the interests of operators and resulting investment plans.
- Finland is expected to see a rapid increase in PV installations.
- Finnish customers are quick to adopt new technologies. In the future, potential can be seen, for instance, in mobile-based energy applications.
- Smart Grids are increasingly utilizing telecommunication technologies. Thereby, this competence basis is extremely valuable.
- Several industrial companies, such as **ABB, Alstom Grid, Landis Gyr** and **Aidon,** have research and development units in Finland
- The Finnish Electricity system is well-operated, maintained and documented, forming an ideal test-bed for tomorrow's Smart Grid solutions.

KEY DRIVERS FOR SMART GRIDS

There are various drivers for Smart Grid development. In Finland, stricter requirements for service reliability and system resilience have created demand for smart applications, such as self-healing grids and local micro grid solutions.

However, there are other measures currently being taken to improve reliability, which somewhat compete with Smart Grid based solutions. In the optimal case, such solutions will complement each other depending on the circumstances.

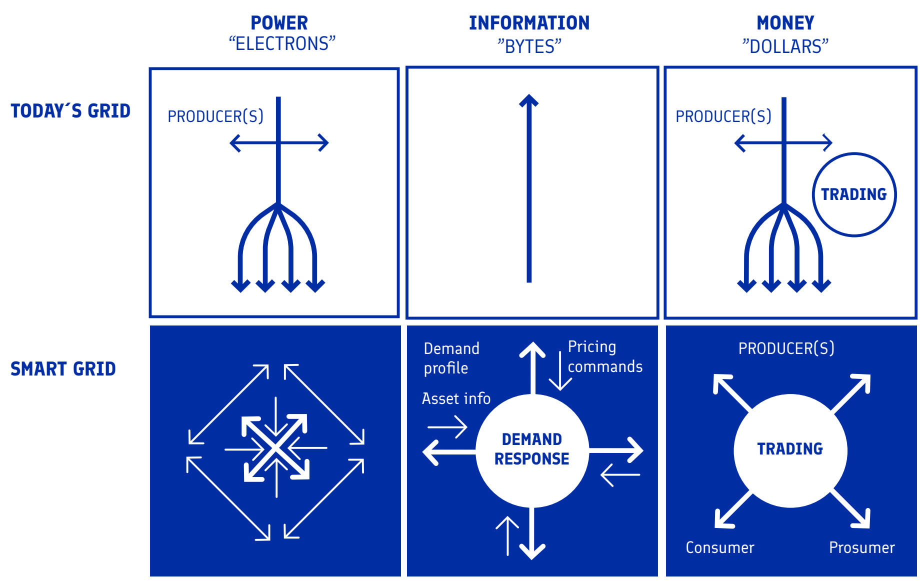
MARKETS AND REGULATORY FRAMEWORK IN FINLAND

The prevailing market environment and regulations play crucial roles in deploying Smart Grid technologies, especially through network utilities' asset management and investment planning. Market structures have been liberalized in the whole of Europe and it has probably gone furthest in Finland.

As the liberalization process has opened energy generation and customer supply to competition, energy production is no longer run as monopolies. Electricity transmission and distribution, however, occur through natural, regulated monopolies as there is no socio-economic reason to build parallel transmission or distribution networks.

Over the last decades, regulation has focused particularly on cost-efficiency and the need for reducing customer electricity prices. This has, for example, given rise to methods for calculating allowable profits from electric network assets. The methods have been further developed to weigh out the network operator's level of service, resulting in how reliability and quality indices affect the allowable profit. These changes have highlighted the need for better asset management among utilities.

SMART GRID CHANGES THE ENERGY MARKET STRUCTURE



Smart grid environment change as illustrated in national SGEM research program by CLEEN.

The severe winter storms experienced in the last years have clearly steered interest towards securing service reliability in extreme conditions even further. At the same time, discussion on socio-economic aspects has been raised.

ENTERING A NEW ERA – INTRODUCING SMART GRID 2.0

The Finnish electricity system has often been called Smart Grid 1.0, referring to the Smart Grid functionalities that are already implemented in the infrastructure.

However, there are several aspects justifying the term Smart Grid 2.0 for the Finnish electricity system. It is from many points of view already among the leading systems in Europe and even on the global level. There are several active players driving the development further, which makes the system constantly evolve in many aspects.

HIGH LEVEL OF NETWORK AUTOMATION

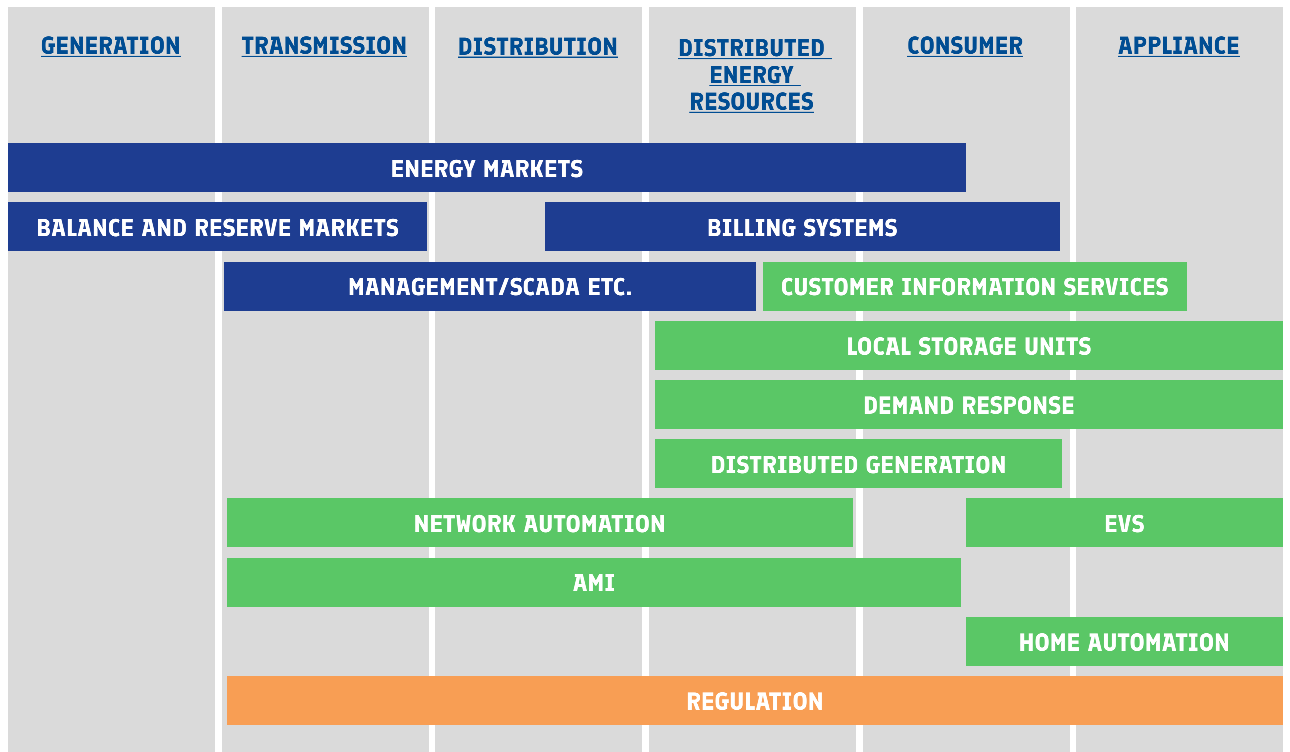
The Finnish energy system is characterized by advanced distribution automation. As Finland is a sparsely populated country, there has been a need to develop automation as far as possible. This means, for example, wide use of equipment like intelligent protection relays at primary substations, tariff control systems, remote controlled switches and distribution management systems. On the ICT system side, management of the distribution process via SCADA (Supervisory Control and Data Acquisition) and DMS (Distribution Management System) systems as well as use of NIS (Network Information System) systems for network planning and asset management are very advanced in Finland. As a part of NIS development, for instance, hourly load profiles for customers have been implemented to support network calculations and planning.

THE FINNISH ELECTRICITY SYSTEM IS AMONG THE LEADING SMART GRID SYSTEMS IN EUROPE – OR EVEN GLOBALLY.

The application areas of the advanced network automation include, for instance, accurate fault location, fault isolation and service restoration, improved service reliability and optimized network topology.

A SMART GRID VALUE CHAIN

A Smart Grid value chain can be composed in different ways. The following figure presents one simplied version. Currently, a new domain Distributed Energy Resources (DER) is seen between distribution and actual customers. DER includes small-scale energy production, storage units and controllable loads.



Simplified Smart Grid value chain. The blue boxes indicate more traditional actions, whereas the green boxes refer to issues araising in smart grids. Regulation overlooks the whole electricity transfer chain.

DEPLOYMENT OF SMART METERS

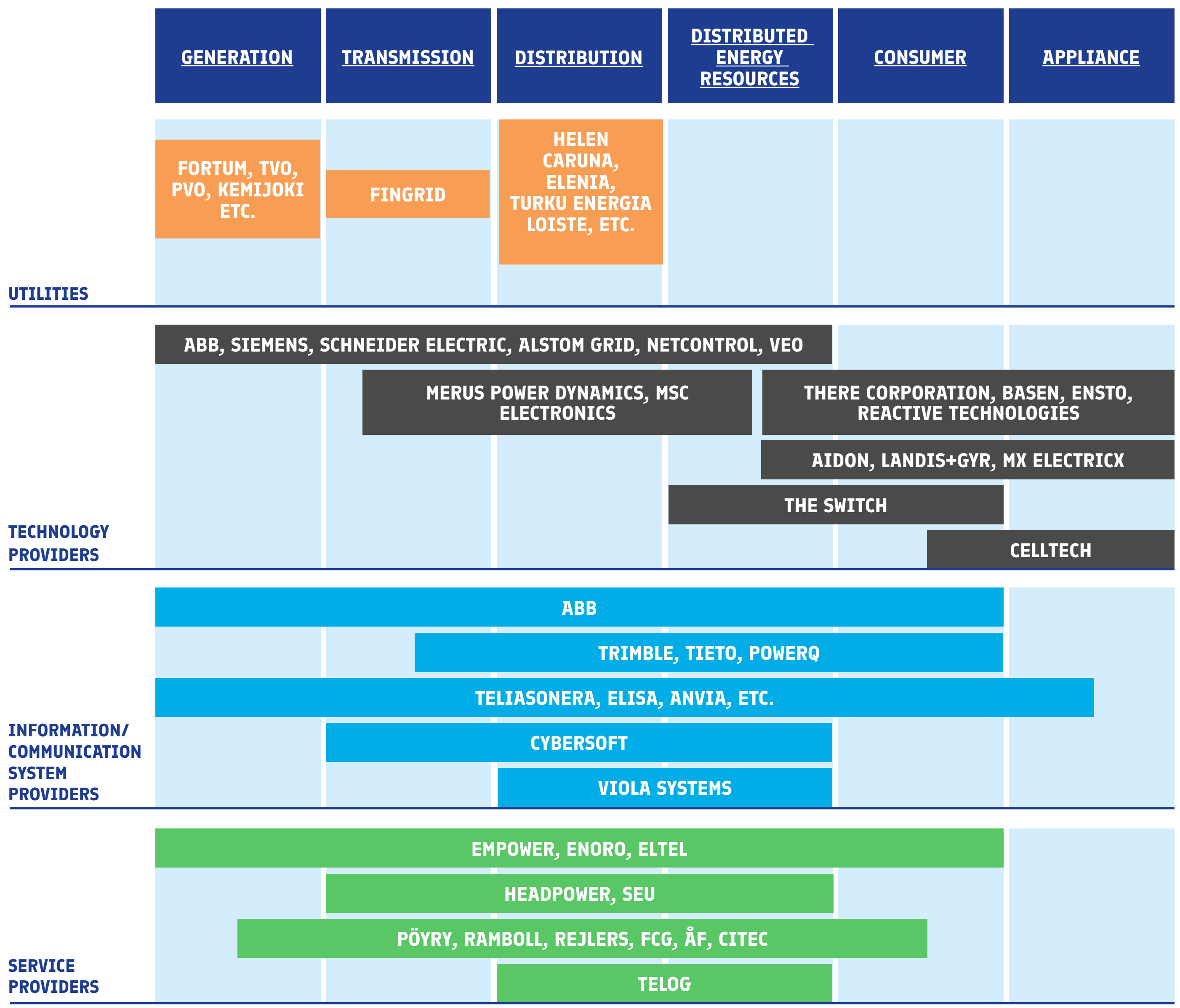
Finland has been a forerunner in smart meters and related AMR (Automatic Meter Reading) systems. This has led to many achievements, such as improved energy use information for customers, improved load profiling, real-time billing, and remote control and monitoring, as well as improved efficiency for reading the meters. The following figure shows the overall status in Europe as presented by SmartRegions project's European Landscale Report11. It showcases the dynamic movers in terms of smart meter regulation and implementation, placing Finland as a frontrunner. Besides the typical meter functions, AMR systems are used for improving monitoring and control at the LV grid level. They have especially been applied for managing faults in the LV network. With the help of AMR systems, faults can also be located in LV grids where traditional network automation is not present. Thereby, AMR systems can be thought to extend network automation on the LV level.

Most importantly, smart meters can provide a smart customer interface with two-directional communication, thus enabling better customer involvement in Smart Grids. This is an important basis for further Smart Grid development.

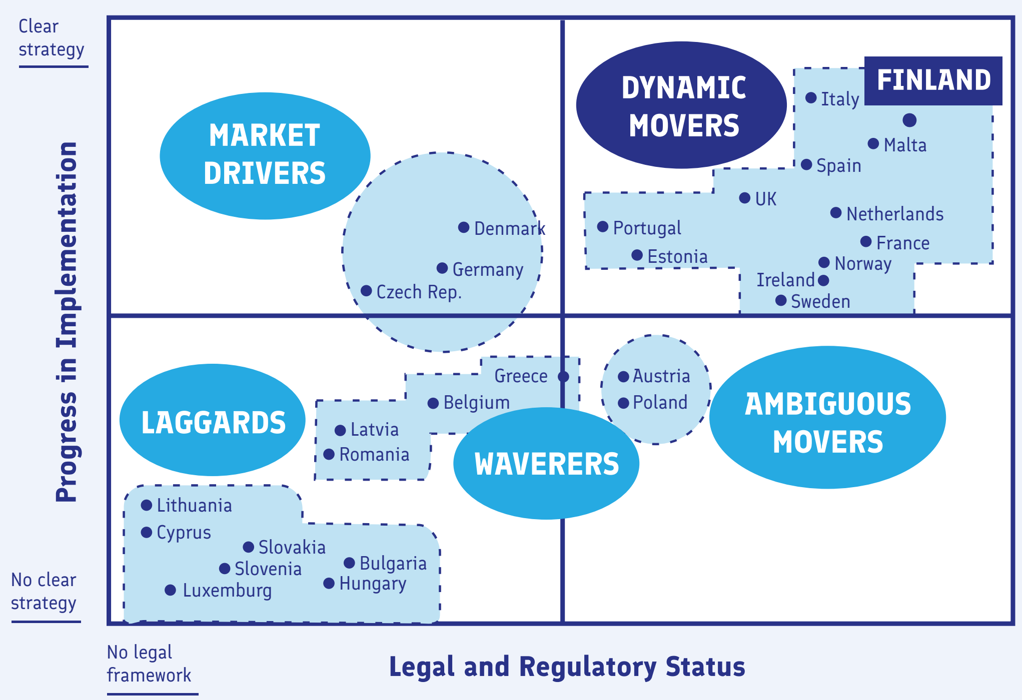
OPEN ENERGY MARKET

Finland is part of the Nordic electricity market and its exchange Nord Pool. Nord Pool offers a market place for different electricity products and markets. The Finnish electricity market has been interconnected with the Nordic market since the 1990s. The Finnish market is in many aspects open and transparent and offers a flexible platform for different operators.

SMART GRID VALUE CHAIN WITH SOME RELEVANT FINNISH PLAYERS



STATUS OF REGULATION AND IMPLEMENTATION FOR SMART METERS IN EUROPE



Source: SmartRegions project: European Landscape Report 2012.

MAIN SMART GRID COMPETENCES IN FINLAND

Finland has a long history in developing distribution automation technologies, such as protection relays, distribution management systems and electricity meters. There is also strong expertise in manufacturing more traditional equipment, such as transformers, generators, electric motors and cables. Newer competence has been found especially in power electronic based converters.

Finland has also further competence in FACTS (Flexible AC transmission systems) and related technologies, such as compensation or HVDC (high voltage DC) systems. These technologies are increasingly applied in distribution networks as well, which offers new possibilities for downscaling the concepts.

Finnish network operators have also taken their operational processes to a very advanced level. Compared internationally, asset management in Finland is highly effective. This means, for instance, condition monitoring methods, maintenance methods, crew management, etc.

Finland has a strong background as a leading country in telecommunications. As Smart Grids are increasingly utilizing telecom technologies, this competence basis is extremely valuable.

FINNISH NETWORK OPERATORS HAVE DEVELOPED THEIR OPERATIONAL PROCESSES TO A VERY ADVANCED LEVEL. INTERNATIONALLY, ASSET MANAGEMENT IN FINLAND IS HIGHLY EFFECTIVE.

DEVELOPMENT TRENDS

The need for improving service reliability is currently one of the major development drivers of the Finnish electricity system as regulatory authorities have taken into account the operational performance indices of network operators. Regulation principles are established as part of the national decision-making.

Thereby, it can be said that regulation is strongly steering the interests of operators and their investment plans. In many cases, the network operators optimize their actions according to prevailing regulations. Manufacturers and service providers obviously need to follow this development and adjust their offerings accordingly.

NATIONAL REGULATION IS STRONGLY STEERING THE INTERESTS OF OPERATORS AND RESULTING INVESTMENT PLANS.

More drivers appear from continuously changing circumstances. At the moment, the need for cleaner energy production and transportation is a hot topic. There is also a need for improved flexibility and controllability of electricity systems, which in part contributes to the need for further developing energy storage solutions and demand response systems. Customers are becoming more and more aware and interested in their own energy use. Open data type approaches can also be expected to grow.

The following subchapters discuss different development trends and their meanings in terms of FDI investments.

RELIABILITY IMPROVEMENT NEEDS

Severe winter storms experienced in December 2011 led to a national discussion on service reliability, as well as the role of the electricity as a critical infrastructure. As a result, the requirements against interruptions were tightened. At the same time, regulators have focused more on service level indices and the calculation of allowable profit based on the network assets.

So far, the stricter requirements have been addressed with increasing cabling of distribution networks, both on the medium and low voltage levels. New cabling technologies have been brought in, for instance, from Sweden where similar development has taken place. The stated requirements aim for an improved situation by 2028. Thereby, it can be seen that extensive cabling projects will be developed in the coming years and there may be possibilities for new actors as well. These possibilities can relate to practical contracting, excavations, etc. but also to materials and equipment related to cabling, for instance, cables, lead-in equipment or drilling equipment. It can also be stated that all techniques for operating, monitoring and maintaining cable networks will see a clear increase in the coming years. For instance, efficient methodologies for locating cable faults can become a high-demand service. Similarly, the need for reactive power compensation systems and their competence is likely to rise.

The latest discussions have indicated an increasing interest in finding solutions other than cabling to meet reliability requirements. Especially, local microgrid solutions using local power generation, storage units, controllable loads, etc. have been proposed. It has been stated that reliability improvements could be achieved with such actions, with more sound impacts from the socio-economic perspective.

At the moment, cabling still seems to be the prevailing solution. However interest in local solutions is rising. It can be expected that both solutions will be increasingly applied in the near future.

SMALL-SCALE RENEWABLE GENERATION

The trend towards renewable distributed generation systems on a small scale is very strong in Europe. In Finland, energy production is and has been fairly distributed for a long time: Our energy production mix includes for example, hydropower, wind power and small bio-based units, as well as increasingly popular heat pumps and photovoltaic systems.

As small-scale renewable production is volatile by nature, this trend sets new requirements for the grid. As the balance between energy production and consumption must be maintained at all times, the grid must be more flexible than before in order to keep the system resilient.

One of the main challenges brought by distributed generation is linked to managing voltage levels in low voltage networks, although generally speaking, the Finnish LV network is fairly sturdy.

Apart from these issues, safety aspects are another common concern for small-scale electricity generation. Wide-scale problems may occur, for example, if a local generation unit disturbs network protection. An unplanned voltage peak could cause local hazards in certain parts of the network. Another risk area is improper installation or documentation related to the distributed generation units.

Finland is expected to see a rapid increase in photovoltaic systems (PV). On an annual energy yield level Finland is surprisingly close to conditions in Northern Germany, where PV has become very popular.

FINLAND IS EXPECTED TO SEE A RAPID INCREASE IN PV INSTALLATIONS AS WELL.

Wide application of PV in Finland would require development of seasonal energy storages. Seasonal storage systems could also be seen as a highly attractive possibility for foreign system suppliers and investors. However, mature and viable technologies for solving the issue are still lacking.

In any case, the amount of small-scale generation, especially PV, is expected to grow and there will be potential in importing system solutions, installation techniques and other know-how from European countries where more development has already taken place. The cold conditions and snow may present a problem for some systems but they can also offer an opportunity to develop the solutions further in extreme conditions.

RISE OF INTELLIGENCE IN SMART GRID FUNCTIONALITIES

One major trend is that intelligence is expanding rapidly to the electricity networks. While traditional intelligence has been on the substation level in the form of SCADA systems, it is now increasingly applied to LV networks and the customer side.

One example of this is widely deployed smart meters. The next generation of the meters will bring ICT and Smart Grid technologies closer together which will enable entirely new functionalities. For example, Landis+Gyr is developing the next generation of smart meters in Finland.

There is some intelligence gap between the electricity distribution process and individual customers. The LV network level has not been intelligent so far. Now, smart meter solutions are closing the gap from the customer side, but there is still a gap visible on the secondary substation side. Smart transformer stations are currently being developed to overcome this.

There are many aspects of the intelligence of the electricity networks. Low cost wireless sensors can improve network monitoring and fault location. It increases communication between all components of the grid and enables connecting them with different bandwidths depending on the application. Beyond technical solutions, it also means increased availability of energy data. The data can, for instance, be processed with data mining techniques or statistically in order to find the most essential information.

In addition, intelligence means better visualization of information gathered. This can be offered for individual customers and utility operators, as well as contractors in the field.

A MORE INVOLVED CUSTOMER

Another major trend is that individual customers will become more involved and integrated in the Smart Grid. Customer involvement has long been one of the major gaps for efficient Smart Grids. This involvement has taken place rather naturally, for instance, with customer-level PV installations, feed-in tariffs, electric vehicles, etc. drivers which have required attention, from the user side. These days, customers are more aware of their own energy use.

Finnish customers use lot of energy and are highly aware of energy efficiency aspects. Finnish customers are also quick to adopt new technologies. As circumstances evolve, potential can be seen in mobile-based customer energy applications and other uses.

Photo: ABB

BUSINESS OPPORTUNITIES AND INVESTMENT DRIVERS

OPEN ENERGY DATA AND RELATED POSSIBILITIES

Open data is currently coming to the energy data sector as well. Based on experiences from other sectors, a rapid increase in related applications is expected. There are still some major obstacles relating to legislation, data ownership, privacy issues, etc. However, the benefits of more open use of data and especially of combining Smart Grid data with other data sources are obvious when considering improved energy efficiency.

Smart grid and more generally energy related data is increasingly available from smart meters, protection relays, sensors distributed in the network, EV charging stations, PV inverters, etc. This data can be quite accurate depending on its source. Combining such data with data from other sources can provide many new possibilities. Some examples of suitable data sets include:

- Data from telecommunication systems
- Building automation systems
- Weather data and forecasts
- Customer behaviour data
- Traffic data
- Infrastructures such as heat, water, gas, etc.
- Building registers
- Statistics

A more open energy data sector creates new possibilities for small actors and start-ups, as well as for other sectors where this kind of change has already taken place. In practise, many new solutions could be made by adapting open data applications from other sectors.

ACTIVATING THE CUSTOMER

Currently, there are new opportunities appearing in the area of customer energy data. On the most basic level, this means providing individual customers with information on their own energy use. Just by visualizing energy use and putting it into an easily accessible format can translate into interesting opportunities. Studies have shown that just making daily energy usage information visible to customers will reduce energy usage significantly.

As a further example, energy efficiency and a green image have not yet been taken up by social media. Adding some competition and peer benchmarking with friends could go a long way to promote energy efficiency. We can expect to see some of that in near future.

A MORE ADVANCED STEP IS TO DEVELOP CUSTOMER LEVEL ENERGY MANAGEMENT AND TO PROVIDE REAL VALUE FOR INDIVIDUAL CUSTOMERS BY MEANS OF ECONOMIC OPTIMIZATION.

A more advanced step is to develop customer-level energy management and to provide real value for individual customers by means of economic optimization. This will be highlighted in the foreseeable future as the amount of small-scale generation, customer-level energy storages, electric vehicles and controllable loads increase among customers. The optimal use of such resources can offer customers economic benefits.

Further, by aggregating active customers into bigger entities, they can jointly offer services and gain economic benefits from different energy markets as well. Efficient customer interface is a basic requisite for forming such entities. Aggregator operation is discussed in more detail in the next chapter.

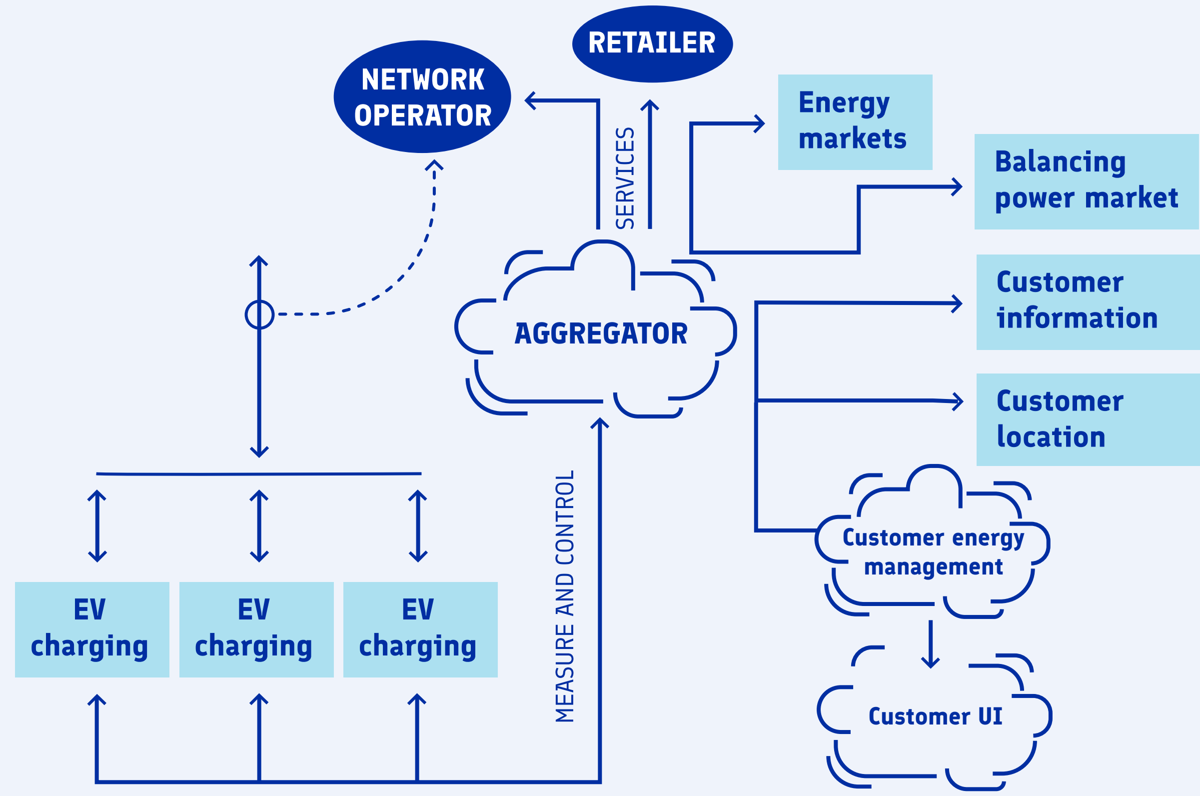
OPPORTUNITIES IN DEMAND RESPONSE OPERATOR BUSINESSES

One specific opportunity can be seen in implementing wide-scale demand response operator businesses in Finland. A demand response operator, which practically is nearly equal to term aggregator, can act as a service provider for energy markets, as well as for individual customers and balancing/reserving services. Depending on the circumstances, a demand response operator can also offer ancillary service for local network operators, for instance, voltage control, power quality improvement or power flow management.

The demand response operator's role is new to the current energy value chain. There is an ongoing discussion on the EU the level regarding the aggregator's role. Finland actively promotes an open, transparent and market-driven model which enables the entry of new players into the Smart Grid ecosystem.

The economic potential of demand response operators can be significant; however, it needs to be collected from small entities and thus efficient management of data and controls is a requisite.

EXAMPLE OF AGGREGATOR'S OPERATIONAL FIELD



SERVICE PROVIDERS ON DIFFERENT SYSTEM LEVELS

The smart grid environment will open up possibilities for new kinds of service providers who can be active at different levels of the system. These providers can serve various players in the smart grid value chain and optimally they serve many types of demands at the same time. For example, the aggregator business logics described in the previous chapter can be based on serving multiple purposes simultaneously.

New service provider businesses are likely to be built around energy data applications. Currently, a national data hub is being developed with the idea of putting all measurement data into one location and handing it over to appropriate parties. This replaces many separate interfaces and direct information exchange arrangements with one solution that all actors will be using. The data hub will also form an interesting environment to enable new applications. Structure, as well as general principles for data management, make it difficult to get an accurate estimate of the actual impacts at this point.

It is also possible that energy could transform into a side product of other services. This can apply especially to customer-level energy management. For example, customer energy management features may be integrated into home automation systems, access control systems or electric vehicle charging systems.

COMMUNICATION, ICT AND IOT

Emerging Smart Grid technologies always require efficient communication and management of data. The amount of measurements and controls available in the networks will increase continuously. This alone means more measurement data and control signals will flow across network levels and its components. Another fact is that network components will become better able to measure network status with higher sample rates. For instance, protection relays and smart meters can already measure high density data which could be used for
detailed network performance analysis. Currently, there are some gaps in bringing such high density historical data up to utility systems. An even further step is using high density data for real-time control purposes.

Another trend is that data is increasingly aggregated on low network hierarchy levels and only the essential parts are transmitted to utility control systems. This reduces the need for data transfer and thereby addresses the challenges described above without endangering data accuracy for the most critical events. It is clear that this development will lead to a need for a data aggregation point and improved intelligence for aggregation. Suitable solutions could be adapted from other sectors, especially telecommunication systems.

One concrete example is the location of data aggregation points. So far, these kinds of functions have been located at smart secondary substations

(MV/LV transformers). However, if devices on the LV level are connected via mobile connections, data aggregation points could be integrated into mobile data links. This means that the aggregation should follow the actual data flow path instead of the traditional electricity flow.

A lot of new development is taking place in the communications sector, opening up many new possibilities. Seeking to offer wireless wideband everywhere, 5G technology focuses quite strongly on Smart Grid applications. For Smart Grid applications, it is essential to bring 5G to rural areas where there are not yet fixed wideband connections.

Also, fibre broadband connections are currently being built around Finland in order to cover even the most remote areas. This can increasingly bring fast fibre connections to substations and secondary substations. The components on the LV grid level and the customer level – such as smart metering – can still rely on wireless technologies. On the other hand, in some countries it is a standard solution to use customer broadband connections also for smart meter data. Such solutions could easily be brought to Finland as well. It could be considered whether there are also new possibilities beyond this issue.

The Internet of Things (IoT) thinking can change the smart grid control chain significantly, especially by expanding intelligence to customers and appliances. While there is currently a certain intelligence gap at the smart meter interface, IoT technologies could enable easy expansion of intelligence to smart devices. In the IoT world, for instance, a washing machine could be controlled wirelessly for demand response purposes.

CYBER SECURITY

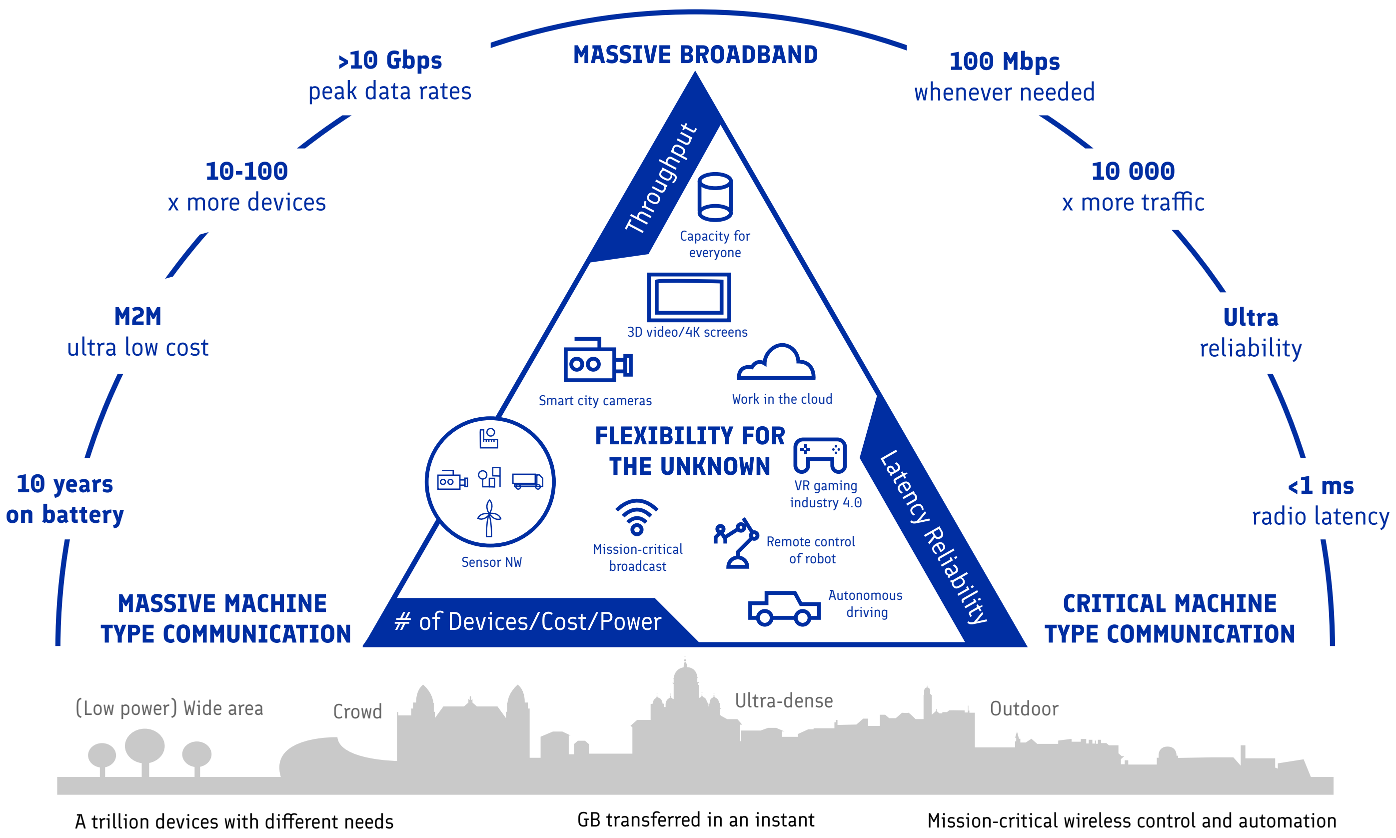
As has been noted in most of the previous chapters, the main opportunities for new businesses in the Smart Grid sector utilize increasingly ICT and various possibilities of more open energy data. There are obvious security and privacy concerns in this development.

The table below shows classifications of different Smart Grid applications and their criticality.

Generally, smart grid cyber security concerns can be divided into consumer data and critical infrastructure related issues. When it comes to consumer data, the main concerns are related to data ownership, privacy, anonymity. Smart meter data and its utilization, for instance, need to be assessed against these concerns. Applying more open data approaches for the energy sector will further highlight these needs.

Another domain is the critical infrastructure perspective and system resilience against various threats. These can include different cyber attacks, hacking, service blockings, etc. Clearly, the most severe threats

Photo: ABB



5G coverage according to area and application.

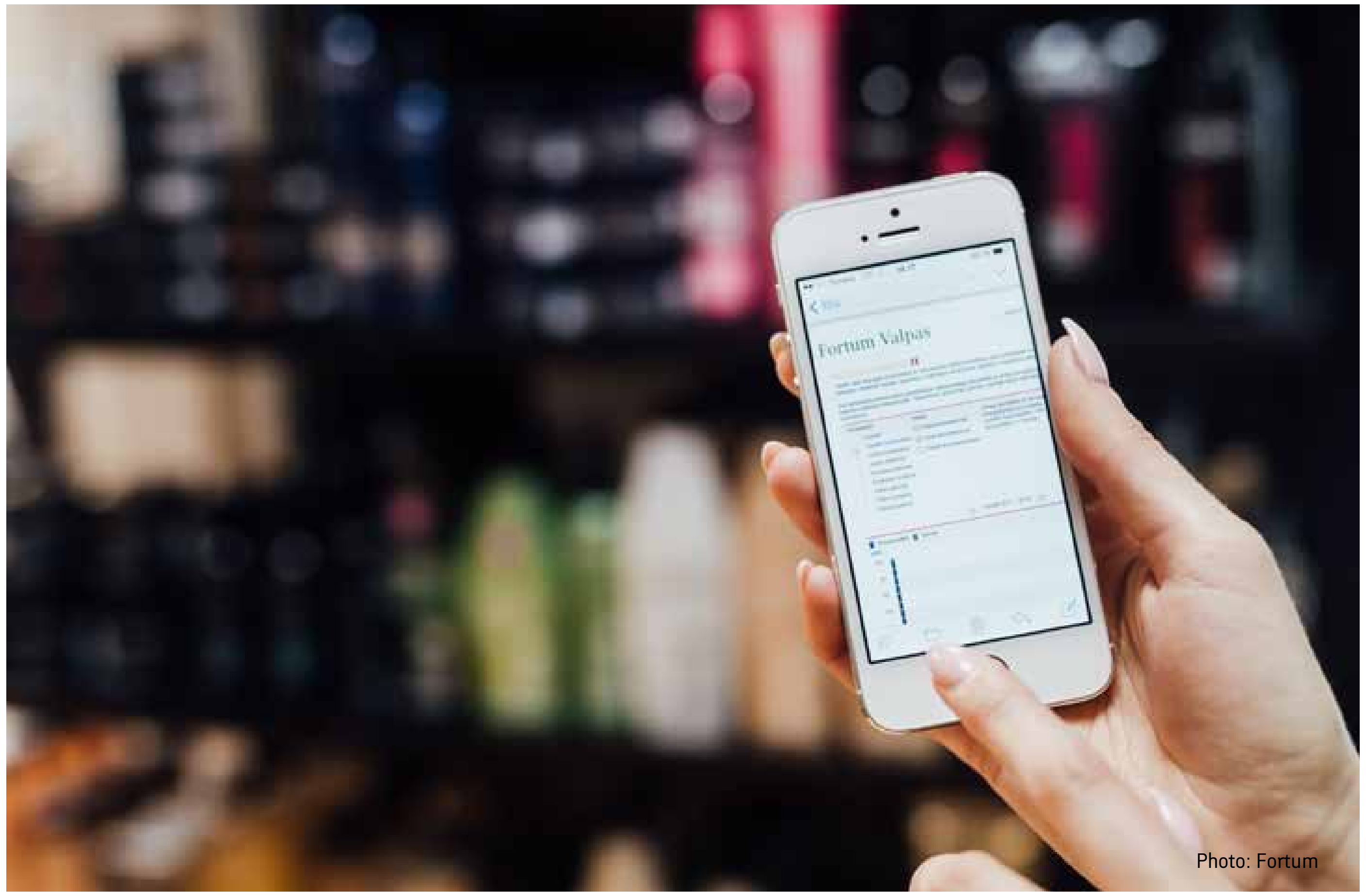


Photo: Fortum

are at transmission system level where it could even be possible to bring the national system down with cyber actions. On the other hand, these systems are normally built to be extremely safe and are always kept isolated from public networks. They represent the most crucial part, for instance, in the case of wide-scale cyber attacks. On the level of distribution networks, it may be difficult to cause system-wide impacts, but there could be severe damage caused particularly to specific customers, such as data centres or communication systems. On the distribution network level, there are also more points from which the ICT system could be accessed for cyber attack purposes. There are many different protocols, interfaces, communication channels, etc. where the suitable point could be found.

Many parties, for instance NERC13, have forecasted that the consequences of cyber security will increase rapidly in the electricity network business.

COMPETENCE BANK

Smart Grid competence is on a high level in Finland. We have university educated experts with experience in industry and network utilities. Several industrial companies, such as ABB, Alstom Grid and Wärtsilä, have world-leading research and development units located in Finland. Transmission network operator Fingrid, is a leader in operating and planning their networks, is also active on the European level. Distribution network operators, such as Elenia, Caruna and Helen, are among the most advanced utilities with operational implementation of Smart Grid technologies. Further, Finnish distribution network operators have developed effective asset maintenance schemes utilizing, for instance, condition-based maintenance thinking.

At the same time, Finland has a strong background in telecommunications and ICT systems. Nokia has been a leader in the development of mobile communications and has created a huge pool of communication specialists. Today, many of them are currently open to new challenges, so there is a move to engage them and capture their expertise for Smart Grid development. The newly revamped Nokia is currently globally active in developing 5G technologies which offer many promising prospects for the smart grid field.

Finland has also excellent competence in cyber security, especially by F-Secure, and other actors. Cyber security is becoming essential for Smart Grids, for both customer data privacy, and for an electricity system as critical infrastructure which the public is increasingly dependent on. This 'competence bank' can be a significant driver for foreign investers to set up business units or research centres in Finland.

CLASSIFICATION OF SMART GRID CYBER SECURITY ASPECTS

	Smart Grid System/ Application	System/Application Definition	Information and Infrastructure Security Requirements	Application Security Requirements
CRITICAL INFRA-STRUCTURE DOMAIN	Power Markets	Commodity-based energy markets necessary to balance supply and demand for energy	Integrity; Availability; Authentication; Confidentiality	Integrity; Non-Repudiation
	Wide Area Measurement, Protection, and Control (WAMPAC)	The set of applications and systems that collectively provide Phasor-Measurement-Unit-based wide-area monitoring (state estimation), protection, and control	Integrity; Availability; Authentication; Confidentiality	Integrity; Availability
	Energy Management Systems (EMS)	The set of applications and systems used to control bulk power system generation and transmission	Integrity; Availability; Authentication	Integrity
	Distribution Management System (DMS)	Utility IT information systems capable of integrating and analyzing real-time electric distribution data to manage voltage and power at the distribution level	Integrity; Availability; Authentication	Integrity; Availability
CONSUMER DATA DOMAIN	Advanced Metering Infrastructures (AMI)	Systems deployed to provide two-way communication to customer power meters, enabling more granular management of energy pricing, usage, and renewable energy generation	Integrity; Authentication; Confidentiality	Integrity; Non-Repudiation

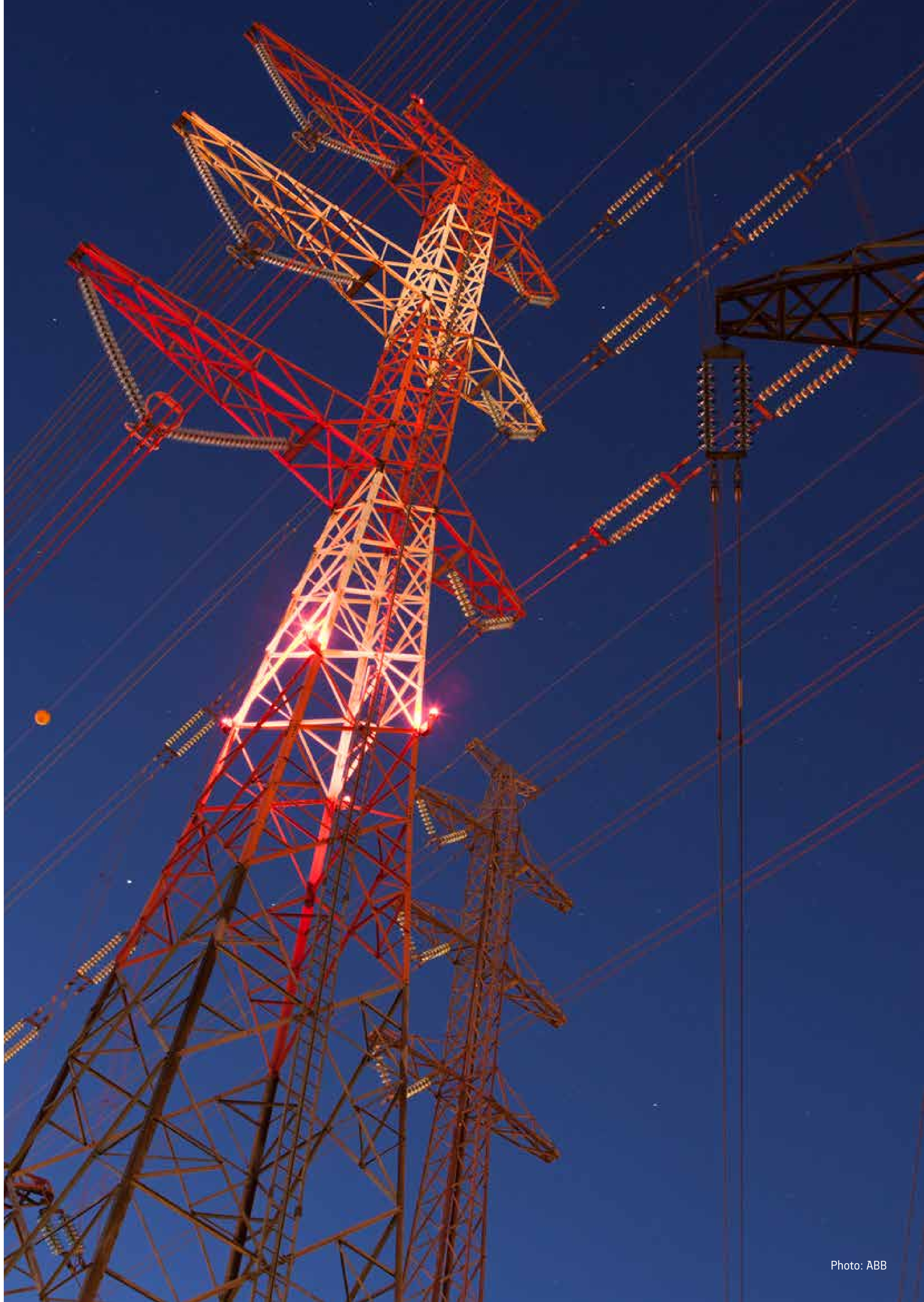


Photo: ABB

INTERNATIONAL PERSPECTIVES

COMPARISON WITH GERMANY AND SWEDEN

There are certain differences in smart grid drivers in different countries. For instance, when comparing Finland with Germany and Sweden, there are some clear differences. Development in Finland is driven by improving service reliability and improving system resilience against various threats. In addition, Finnish drivers include market-oriented development and improved asset management methods. In Germany, the main driver is the integration of renewable energy resources, especially on the small-scale level. Other drivers related to the same issues include environmental aspects and dependency on government incentives. Development in Germany seeks to improve energy and system efficiency.

In Sweden, a lot of attention has been on customer participation, market effectiveness, etc. Sweden has seen similar development in the area of optimal asset management as Finland has. System efficiency is a driver for Finland as well.

The following table presents the TOP-5 drivers for utilizing smart grid technologies in Finland, Germany and Sweden. These data are from IEA ISGAN studies.

FINLAND	GERMANY	SWEDEN
Reliability improvements	Renewable energy standards or targets	System efficiency improvements
Enabling new products, services, and markets	Environmental advantages	Enabling customer choice and participation
Optimizing asset utilization	Energy efficiency improvements	Enabling new products, services, and markets
Enhanced power system resiliency to natural and human threats	System efficiency improvements	Renewable energy standards or targets
Power restoration improvements	Reliability improvements	Optimizing asset utilization

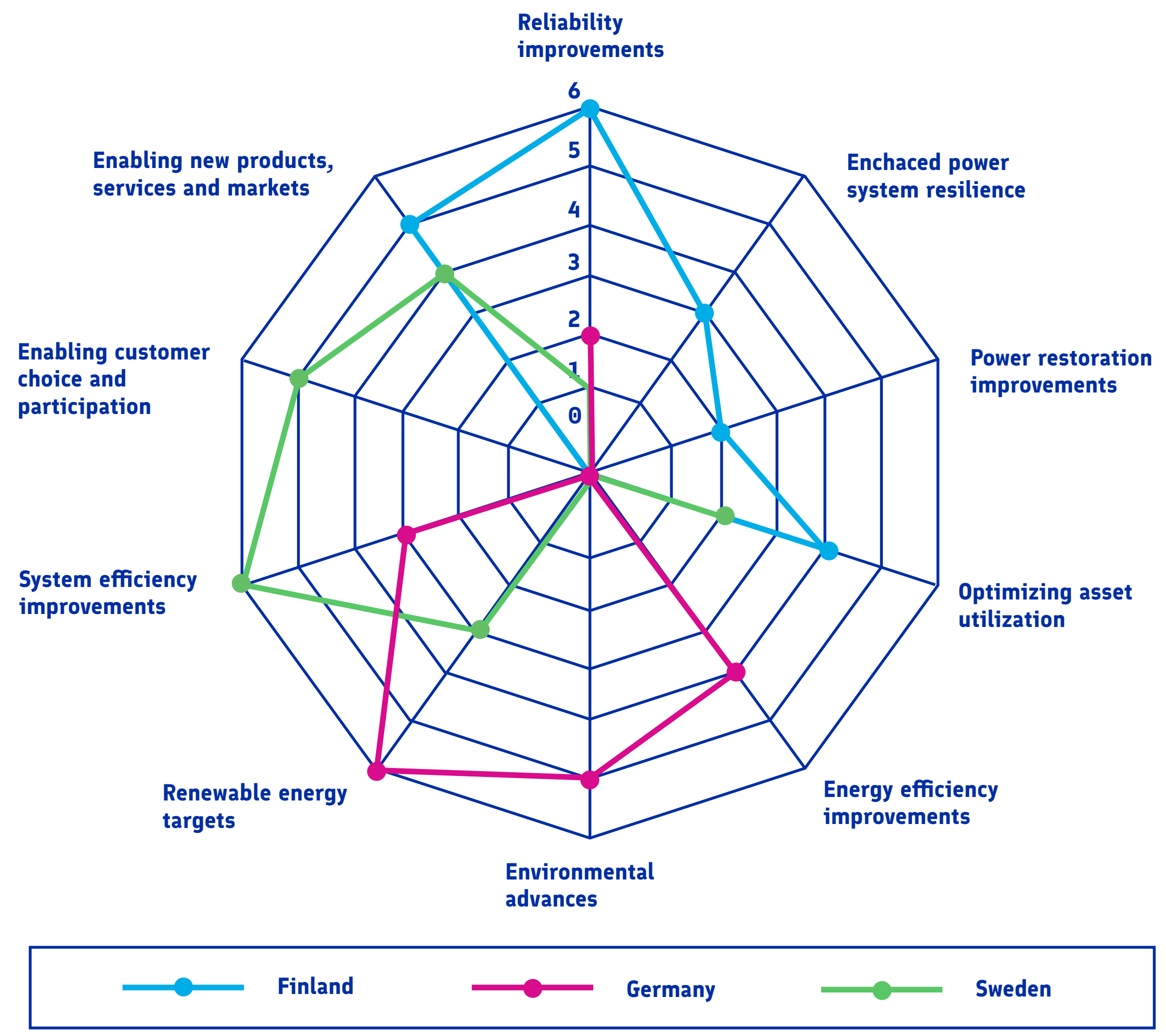
These priorities are often driven by political decisions, such as implementing feed-in tariffs for renewable energy or for requiring improved service reliability. The priorities are extended by improved asset by means of regulation but also national funding instruments and other national-level strategic alignments. Affecting the main priorities can be time-consuming and become more of a political process. However, continuous discussion is taking place around the alignments and their implementations in Finland, as well as in other European countries.

For the purposes of comparisons with Germany and Sweden, country profiles have been created for main Smart Grid drivers, and for the technological potentials.

Such profiling shows clearly the priorities of each country. These priorities are the direct outcome of the prevailing circumstances and of higher level decision-making. For Finland, the political decisions taken to reduce lengthy interruptions to the networks has been a factor leading in this direction. Similarly, decisions taken in Germany have resulted in the promotion of renewable energy resources as a priority.

This information can be highly valuable for foreign actors considering their presence in Europe. Whereas Germany is commonly seen as a living lab for PV installations, Finland can be seen as more focused on reliability and resilience. Looking globally, reliability and resilience are exactly the issues being considered at the moment in developing countries like India.

SMART GRID DRIVER PROFILES FOR FINLAND, GERMANY AND SWEDEN



CONCLUSIONS

THE FINNISH ENERGY SYSTEM IS ONE OF THE MOST ADVANCED IN THE WORLD – IT IS CALLED SMART GRID 2.0 FOR A REASON. A PLETHORA OF SMART GRID FUNCTIONALITIES ARE ALREADY IN REGULAR USE THAT INCLUDE REMOTE METERS THAT ARE NOW FOUND IN NEARLY EVERY FINNISH HOUSEHOLD.

Improving the service reliability of the national electricity system has been a major driver for development in Finland. This has resulted in a high level of overall automation in energy distribution. Tomorrow's energy technologies can already be developed and tested in Finland today.

We have the largest energy cluster in the Nordic countries located in the city of Vaasa, with an annual turnover of 4.4 billion Euros. Industry leaders like ABB, Wärtsilä and Vacon have their roots in the long tradition and competences of the Finnish energy sector. Our start-up boosted ecosystem attracts energy pioneers. Several industrial companies, such as ABB, Alstom Grid, Landis+Gyr and Aidon, have significant R&D units in Finland.

The Finnish electricity market has been open and interconnected with the Nordic market since the 1990s. In many aspects the Finnish market is transparent and offers a flexible platform for different operators. The Finnish electricity system is well-operated, maintained and documented, forming an ideal testbed for tomorrow's smart grid solutions.

Finnish network operators have also developed their operational processes. Asset management in general in Finland is on very high level. National regulation strongly steers the interests of operators and resulting investment plans.

Currently in smart grid, there are new opportunities related to customer energy data, such as applications for customer-level energy management and economic optimization of energy consumption. Finland is a forerunner in implementing smart meters and AMR systems. This has made possible many achievements, such as advanced energy use information for customers, improved load profiling, real-time billing, remote control and monitoring, and improved efficiency for practical reading of the meters. Hence, the ecosystem forms an ideal testbed for a variety of service providers.

FINLAND'S SMART GRID 2.0 OFFERS A UNIQUE R&D ECOSYSTEM THAT COMBINES A STRONG ENERGY CLUSTER, EXPERIENCED ICT TALENT AND A LIBERAL ENERGY MARKET

FINLAND IS IN THE FOREFRONT OF SHAPING THE FUTURE ENERGY MARKETS.

Furthermore, the applications for customer energy data will be needed when the amount of small-scale generation, customer-level energy storage, electric vehicles and controllable loads will increase among customers. In the long run, **integration of electricity, heat and water metering** will create further business opportunities. As ICT plays a crucial role in the global energy industry the world-leading ICT talent in Finland can be utilized in developing future solutions for the energy markets.

One specific opportunity is the implementation of the **wide-scale demand response operator business** in Finland. A demand response operator, which practically equals to term aggregator, can act as a service provider for energy markets and balance/reserve services, as well as for the individual customer.

Photo: Fortum

Photo: ABB

Photo: ABB

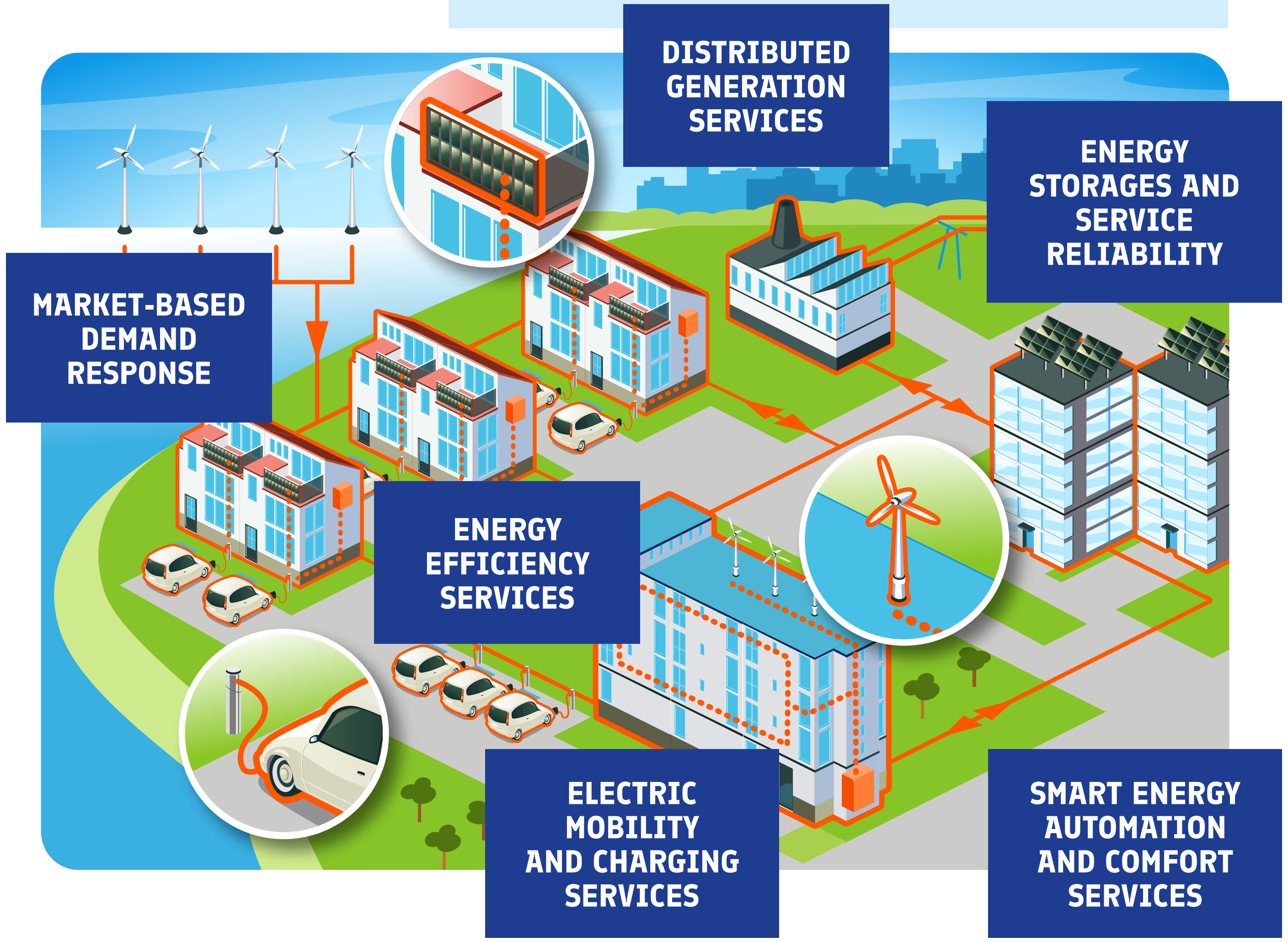
Photo: Fortum

TESTBED ENVIRONMENTS

The Finnish electricity system can offer a high-level test environment with most of the latest technologies already implemented. Our system is well operated, maintained and documented. Our best candidate for such testbed thinking is **the Kalasatama area in Helsinki.** The Sundom pilot area is also under development in Vaasa. A further plan for a pilot area in the Åland islands is currently being developed.

KALASATAMA AREA IN HELSINKI

- Former port area in Helsinki
- 10,000 jobs and homes for about 18,000 residents by 2030
- Model area for a smart power grid
  - local production of renewable energy
  - infrastructure for electric vechicles
  - energy storage
  - energy-efficient building automation
  - demand response management



THE FINNISH ELECTRICITY SYSTEM IS WELL OPERATED, MAINTAINED AND DOCUMENTED, FORMING AN IDEAL TESTBED FOR TOMORROW'S SMART GRID SOLUTIONS.


Photo: ABB

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