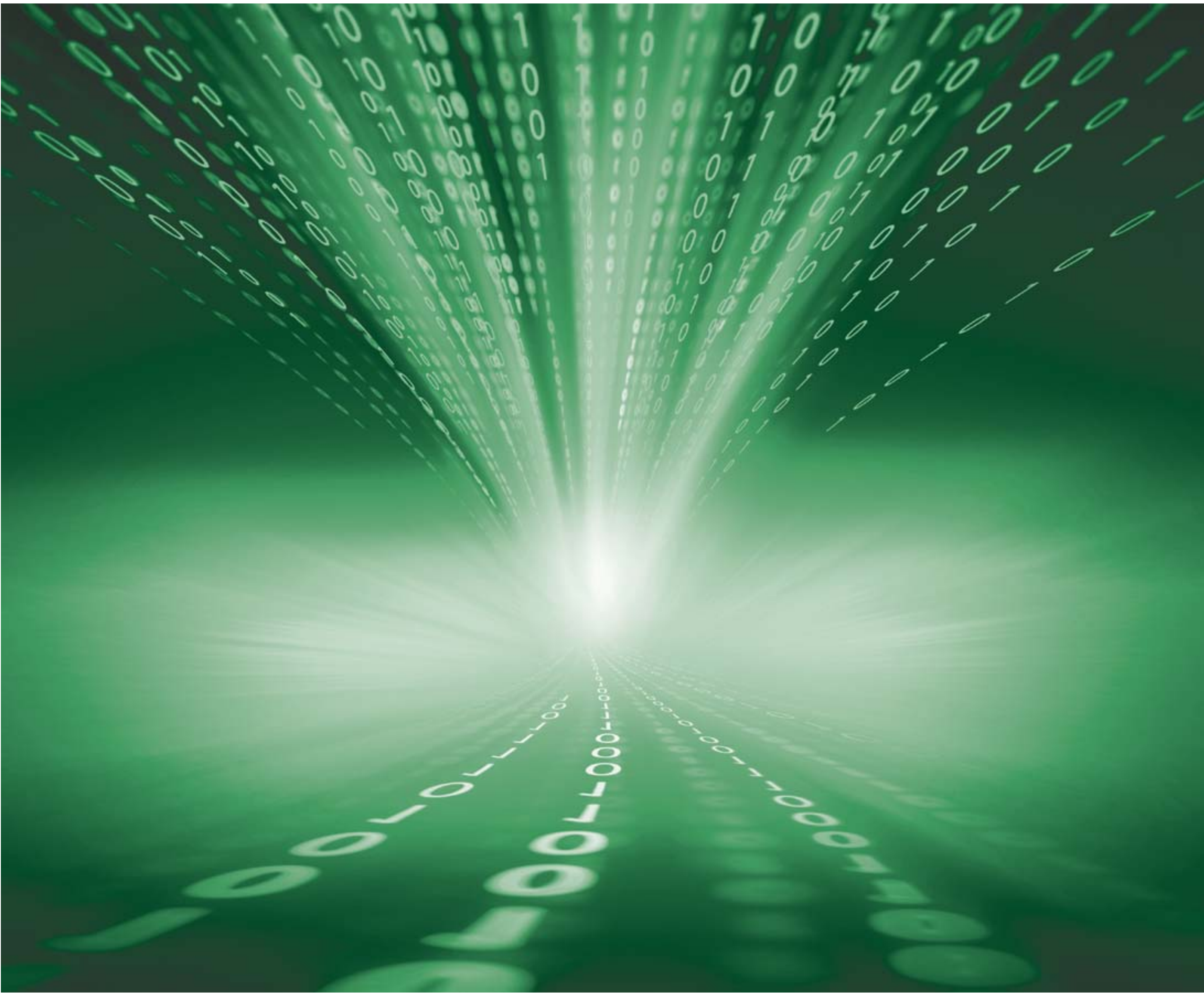
GEODE REPORT

Bringing Intelligence to the Grids

Case Studies



GEODE Working Group Smart Grids

November 2013

GEODE

The Voice of local Energy Distributors across Europe

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Foreword

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Smart Meters will be a central part of delivering a more efficient and reliable network. However, the real benefit comes from the Smart Grid that they enable. The ambitious targets for Smart Meter deployment across Europe are helping drive a revolution in the way we think about energy and the way we plan our investment in infrastructure. If successful, we have the potential for a truly smart network that enables a low carbon economy, giving security of supply in a way that is affordable for consumers.

Earlier this year, GEODE launched its major report on Smart Grid development "Bringing Intelligence to the Grids". The report was well received by the European Commission and all those opinion formers who attended its launch in Brussels.

Set out within this latest addition to GEODE's work on smart grids, are the case studies that have informed the thinking behind our earlier recommendations. These are the foundations of the Smart Grid development and show the successes of integrated and successful smart meter roll-out and the ways in which Smart Grids are beginning to support the sustainable, secure and affordable energy future.

From my own experience here in the UK, I know the transformational benefit that the Low Carbon Networks Fund has had by enabling innovation and reinvigorating the UK networks sector. The progress and learning here are being shared across our sector, for the whole industry and indeed globally through the UK annual Low Carbon Networks Fund Conference.

These new case studies are about the continued sharing of expert knowledge from across the GEODE membership. Here in the UK, innovation is being integrated into the business as usual, something that GEODE believes is essential for a successful Smart Grid across Europe.

I encourage you to read these GEODE reports from the DSO 'front line' as we work towards the smarter grid that we all want.

OVERVIEW

SMART METERS ROLL-OUT IN EUROPE

The Electricity Directive in the Third Energy Package, Directive 2009/72/EC[1], envisages the installation of Smart Meters for at least "80% of customers by 2020, subject to a cost-benefit assessment on long-term cost and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution".

Despite the ambitious plan for 80% market penetration of smart meters by 2020, the current figures, at the end of 2013, are still low, in particular in the newer European Member States, and shows that countries within Europe are at different stages and they are moving ahead at different speeds.

The Nordic countries Sweden and Finland are currently leading in the smart meter roll-out with 100% and close to 80% of meters installed respectively, next is Italy with over 95%. Norway is also well advanced.

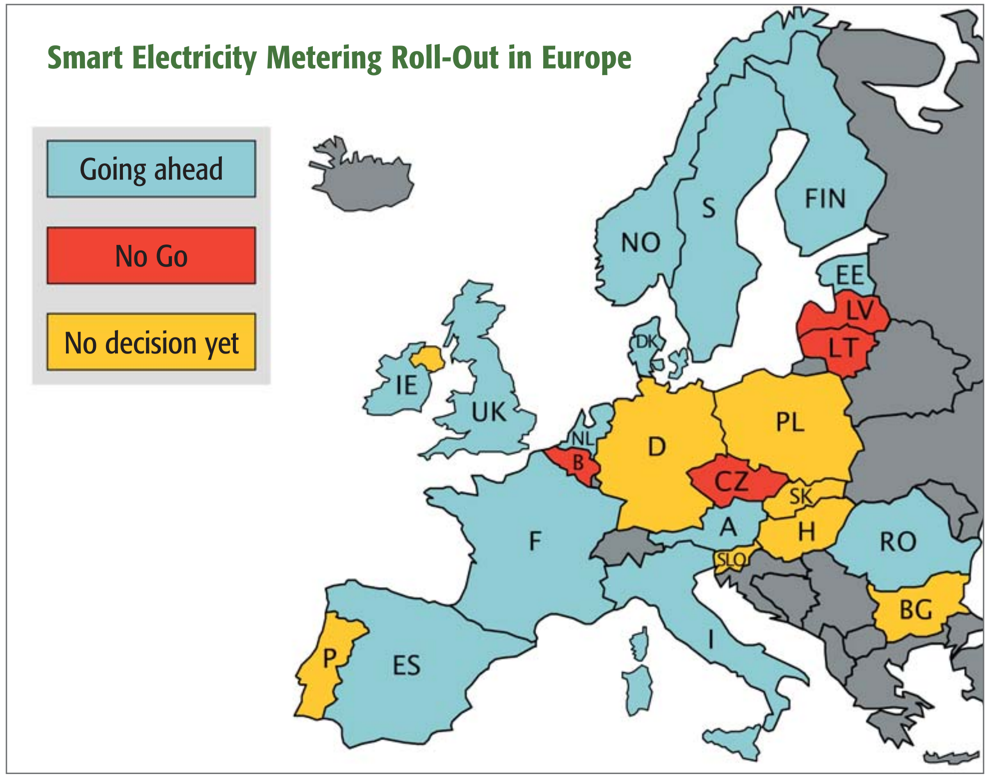
Other countries such as Spain, Austria, GB, Ireland, the Netherlands, France and Estonia are going ahead with the process and have already mandated the smart meter roll-out with a specified timetable. There are different deadlines in each country from 2017 to 2020.

In Denmark, the DSOs have rolled-out smart meters to 60% of customers without any legal decision, which is however expected to be taken shortly. The Netherlands should come up with a decision for a roll-out by the end of this year. In Germany no decision has been taken yet for a full roll-out.

Belgium has decided not to install smart meters based on a negative cost-benefit analysis, the same is the case in the Czech Republic.

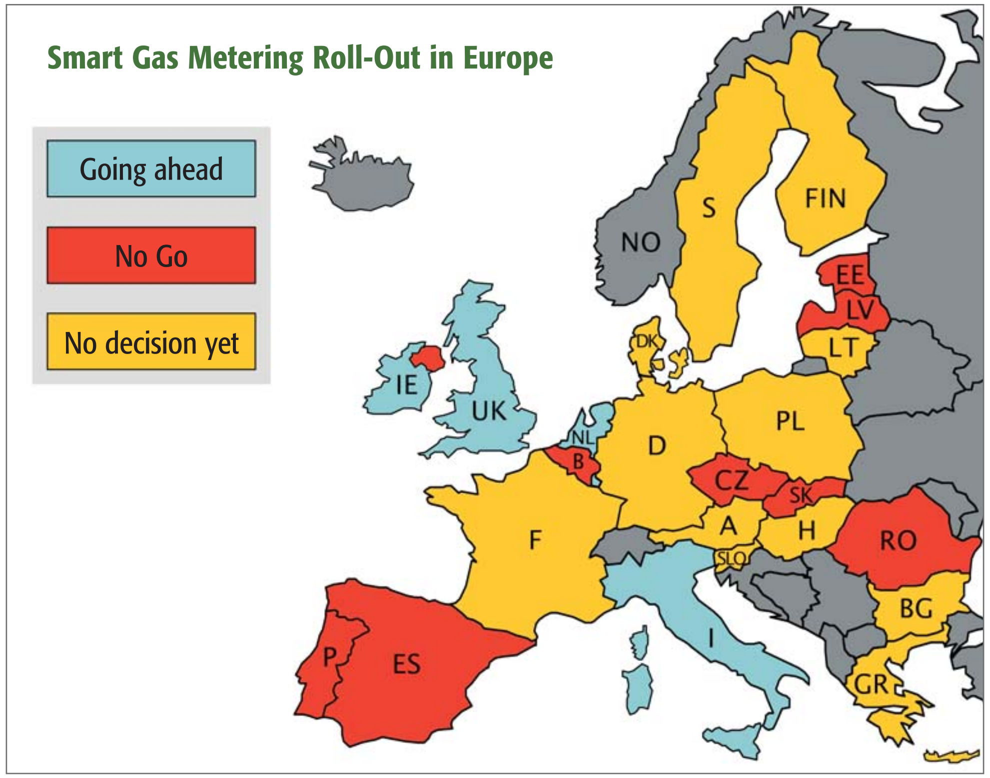
[1] Annex I, paragraph 2 Directive 2009/72/EC

If we consider gas, the market penetration across the European Union is still much lower. The Gas Directive[2] does not establish a specific deadline for the roll-out of smart meters. Nevertheless some countries have already decided on a mandatory roll-out. This is only the case in GB, Ireland, Italy and The Netherlands, while most of the others have not taken a decision yet.



Source: GEODE

[2] Annex I, paragraph 2 Directive 2009/73/EC



Source: GEODE

CASE STUDY 1

SMART METERS ROLL-OUT – THE NORDIC EXPERIENCE

Introduction

Modern smart electricity meter (picture Kamstrup)

This case study to the GEODE report "Bringing intelligence to the grid"[1] presents lessons learned about smart metering from a number of Swedish and Finnish DSOs. The Nordic countries, together with Italy, are frontrunners when it comes to smart meter installation and most electricity customers in Sweden and Finland have smart meters installed today. With this annex, GEODE hopes to share knowledge about the benefits as well as the challenges associated with smart meters, thereby enabling European regulators and other decision-makers to create favorable conditions for smart meter deployment in the rest of Europe.

The following aspects are described in the text:

- The roll-out
- DSO[2] benefits roll-out
- Customer benefits
- Costs and challenges
- Lessons learned - summary
- Facts and figures about the Swedish and Finnish electricity markets

[1] www.geode-eu.org
[2] Distribution System Operator

The roll-out

The meter manufacturers' marketing and sales activities exploded in Sweden after the decision for smart meter roll-out was made in 2003. Some companies decided to give priority to speedy implementation rather than analyzing the situation for best price, product and technology. The legal requirements at the time of implementation allowed little time for analyzing the possible return on investments as well as potential customer benefits. Some companies made **dedicated efforts to identify functions for the new meters that could add value,** while others went for the cheapest minimum functionality. Companies that waited for the implementation until the last minute (2009) generally got a better price as well as much improved technology. As of October 2012, a new Swedish law requires hourly readings for active customers, this clearly benefits those companies that bought meters with those functions during earlier roll-outs.

Smart meter roll-out (Source: Tekniska Verken i Linköping AB)

Today's smart meters are actually more computers than meters. Amongst other things, this means that they can be upgraded with new functions through their software. In order to utilize this advantage, it is important for the DSO to invest in meters that provide the most flexibility for updating in the future.

Many smaller DSOs decided to **cooperate during the purchasing process.** With more meters at stake for each deal, this had a significant effect on the final price for the meters. For many smaller DSOs, the purchasing cooperation was critical for the implementation of the smart metering reform.

Customer focus is key (Source: Mälarenergi AB)

In Sweden, the exchange of the meters was done by specially trained personnel, however without being formal licensed for electricity work. This made it possible to hire large numbers of unskilled personnel, train them and put them to work at much shorter notice than would have been the case if an electricity work license had been required. Training of the personnel is essential. This should not only include technical issues, but also “softer” skills such as customer relations training. There will always be customer issues, and how you address them will be crucial in determining if the project is a success or a failure. The way customer issues are handled will also very much influence the overall customer acceptance.

Customer information is essential in order to make the roll-out process as effective as possible. As the meter exchange can mean an annoyance for the customer (a power outage, having to take time off from work etc.), the DSOs must strive to minimize the number of visits to the customer’s premises. Most Swedish companies informed their customers through several different letters, starting weeks in advance before the meter exchange, and finally ending when the customer receive their first invoice based on monthly meter readings. This was completed with information on the web as well as having extra resources available at the DSO’s customer service centres.

Smart meter roll-out also involves many contacts with local housing companies, local government and administration. It is important to inform these actors at an early stage in the project and to maintain contact through the roll-out process. For the roll-out personnel, it is important to have knowledge about local conditions. Therefore, **using a local contractor** for the roll-out is in many cases preferable. This also helps to build local acceptance for the project. During the Swedish roll-out, about 3% of the customers needed more than one visit before the meter was properly installed and operational.

Although small in numbers, “the Swedish national organization for Electrical Hypersensitive” took a directly negative standpoint towards the smart meters, encouraging their members to refuse installation. In order to have a constructive dialogue with these groups of customers, many companies held special information meetings and gave particular attention to the various needs they presented. It is important to **respect the opinion** of interest groups, while at the same time applying the relevant laws that give the DSO the right to switch meters. A conflict with these kinds of organizations can severely hinder the roll-out process.

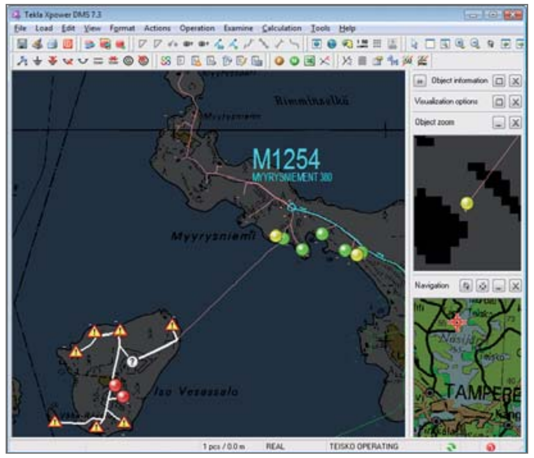
DSO benefits

Smart meters mean no more manual meter readings. This means **reduced cost as well as environmental gains** by not having to visit the customers by car. However, remote meter readings mean increased IT costs, which will be detailed later in this text. Remote reading makes normal business processes such as move in/out and supplier switching more efficient and faster to carry out. Remote on/off switching further reduces customer visits as well as limiting electricity usage on connection with no formal customer.

The DSO is responsible for the local electricity grid (Source: Tekniska Verken i Linköping AB)

The smart meter also **uses less energy** for its operation than the old mechanical ones. The new smart meters have **better metering precision** than the mechanical ones. This provides more correct usage information over time. It is also easier to detect faulty meters when the functioning of meters can be followed remotely. By collecting data from the smart meters as well as substations it is very easy to **locate electricity theft** as well as other kinds of unmeasured electricity usage. Outages are usually registered by the meter, enabling swift administration of outage compensation. It should be noted that the meters also detect outages from causes other than grid failures, such as the customer turning the main switch. Because of that, outages compensation still requires manual analysis.

As smart metering allows monthly billing based on actual energy usage rather than estimated, the new **electricity invoices are more easily understood by the customer.** This means less calls and questions for the DSO’s customer service as well as increased customer satisfaction.

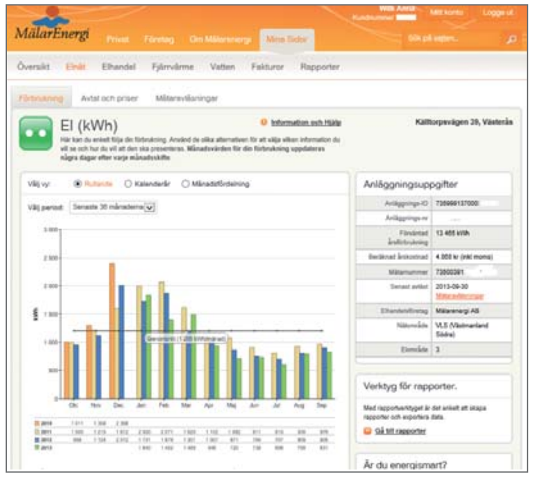


AMR-DMS system (Source: Mälarenergi AB)

The meter is the end point of the DSO's network. Remote access to the meters gives the DSOs more information about the status of the network. This increases the DSO's ability to monitor and control their network better, especially in low voltage networks. Using data from the smart meters in network fault situations (e.g. storms) shortens the interruption times for customers. During huge summer storms in 2010 and winter storms in 2011-2012 in Finland, several DSOs found smart metering to be **a very useful tool in fault detection and repair.** For example the possibility to contact a single meter to know whether electricity supply has been restored and detection of zero conductor faults gave the DSO increased benefits.

Remote metering within the balance settlement window (e.g. daily reading) improves the quality of national balance settlement, thus creating benefits to the electricity market. This also allows the DSO to measure network losses much more accurately than before.

Customer benefits



Example of a "My Pages" -function with energy and billing information (Source: Mälarenergi AB)

Smart meters allow **invoicing based on actual energy usage** rather than estimated usage, as it was the case with mechanical meters. This enables the electricity customer to settle his account with the DSO and supplier each month. This makes budgeting more accurate as well as using the consumption feedback for behavioral changes.

When implementing billing based on actual energy usage rather than estimates in Finland, several benefits were found. One of the most important benefits noticed was that electricity **bills are much easier to understand.** The content of customer enquiries towards the DSO have changed.

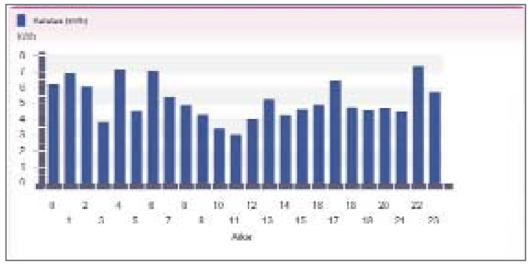
Customers are no longer asking help with reading the bill, but they are asking help for reducing energy usage. Also customers have been satisfied, that they don't have to pay for consumption in advance, but they only pay for what they use. Some customers found it difficult that electricity bill is bigger in winter time (electrical heating). The number of these customers was, however, very small (less than 1% of all customers), and alternative payment methods have been introduced for them. In general, the quality of meter readings and settlement has improved.

Renewable energy connected to the grid (Source: Bixia)

The smart meters are usually able to measure both consumption and generation. This makes the **introduction of micro-generation into the energy system much easier** than with mechanical meters. There has been a boom of small scale micro-generating customers in Sweden since the smart meter reform. Hourly metering allows **new innovative tariff structures** that encourage more efficient electricity usage enabling reduction of peaks in the distribution system. In the end, this reduces the usage of fossil based electricity generation which is extensively used today during peak hours. This also helps to optimize the distribution system, thus ultimately leading to lower customer prices.

Smart meters enable **improved outage information** to the customer as an outage can be located with better precision using information from the meters. This also makes it easier to locate failing components in the grid thereby reducing the time to fix the problem. In Finland several DSOs have introduced an SMS service. The DSO sends the customer an SMS if there is an interruption at the customer's consumption site. This has been found very useful, especially for customers with multiple consumption sites, e.g. summer house owners. Smart meters enable **advanced usage information** that can be communicated to the customer through many channels such as the internet, smartphones and in-home displays. One example of this kind of service is the mandatory DSO web-portal in Finland. The picture below shows an example of a portal of one Finnish DSO. This portal can be accessed by the customer via internet or a smart phone. The portal is protected with a customer specific password.

Smart metering makes it possible to introduce more sophisticated demand response services to customers. Hourly metering makes time of use tariffs possible even on an



Web portal of Finnish DSO giving the customer personalized information about her electricity usage (Source: Finnish Energy Industries)

hourly base, thus giving the customer the incentive to e.g. turn the water boiler automatically on during the cheapest hours of the day (via automation of course).

Remote disconnection and reconnection also benefits the customer. It gives the DSO the possibility to connect the electricity supply quicker in house move situations. When the electricity supply has been disconnected due to unpaid bills the customer gets a quicker and cheaper re-connection after the bills are paid.

To fully benefit from the reforms, and to be able to implement so called "Demand Response" activities[3], it is our belief that this should be made possible through a local open interface with the meter, and pricing information, steering activities etc. should be made available through other sources.

Costs and challenges

The costs for a smart meter including installation vary in the range from 170 to 250€ depending on the communication functionalities and the cost of installation work. For many customers, for example those living in small apartments with few options to save energy, **the payback period will be very long.**

Experience from existing installations in Sweden shows that the **communication between the meter and the metering system can be a challenge.** The absolute majority (99%) of meter readings are done without problems, but to reach the required 100% collected metering values within those 5 days in the beginning of each month requires a huge effort. Reporting of hourly metering data increases the cost 3 to 5 times. In Finland meter readings are collected daily and 100% should be achieved within 14 days after delivery. Over 99% is achievable with acceptable costs, but to get the last 1% within 14 days in every situation would increase the cost dramatically. **The Swedish experience is that the "clean up" process after the meter roll-out is 1-3 years before most communication problems with individual meters has been resolved.**

[3] Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time.

Some technical solutions for communication were working well in some grids, while not performing at all in other grids. The reason for this could be the different size of the grid and the geography of the grid, as there is a huge different between a city grid and a small countryside grid in the mountains. The background interference to the communications also varies which affects radio communication. It is also important to have interoperability between different communication systems allowing them to co-exist. Taking this into consideration, we strongly recommend that **regulators allow the DSOs to select a communication solution that fits their needs.** When it comes to communicating metering data, a contract with a telecom operator is usually needed. Unfortunately, many Telcos seem to use their contracts with the DSOs as a platform for building monopoly situations. Long contracts with high penalties for switching are examples of methods used. As DSOs we would like to see **more competition in the telecoms market in order to be able to lower the costs for data communication.** This will in the end benefit the electricity customer.

Using smart meters means an enormous increase in data that has to be properly handled by the DSO. This means **increased costs for collecting and maintaining metering data.** The increased costs for data handling are usually higher than the value of the efficiency gains created by not having to do manual readings. Therefore, reduced metering costs cannot on their own be used as an argument for smart meters.

Lessons learned - summary

- Dedicated efforts to find functions for the new meters can add value.
- Cooperation between DSOs during the purchasing process can lower the costs.
- Customer information during the roll-out process is the key to success.
- Using a contractor with local knowledge can benefit the roll-out process.
- Treat interest groups with respect.
- No more manual meter readings will mean reduced costs as well as environmental gains. However, the enormous increase of data that has to be properly handled by the DSO means some increased costs as well.
- Smart meters use less energy and have better metering precision than the old mechanical ones. They can also locate electricity theft and improve outage information.

- Smart meters allow invoices that are more easily understood by the customer than with estimated billing.
- A smart meter is a very useful tool in fault detection and repair.
- Smart meters make the introduction of micro-generation into the energy system easier.
- Hourly metering allows new innovative tariff structures.
- When comparing costs and benefits, it is obvious that the payback time will be very long.
- Communications between the meter and the metering system can be a challenge.
- It is important that regulators allow the DSOs to select a communication solution that fits their needs best.
- Better competition in the telecoms market is needed in order to lower the costs for data communication.

Facts and figures

SWEDEN

- The electricity market has been fully liberalized for competition since 1996.
- In connection with the deregulation, distribution companies were legally separated from suppliers. The level of separation depends on the size of the company.
- Grid tariffs are pre-approved by the authorities before entering into force.
- There is one Swedish TSO[4] (Svenska Kraftnät). One energy regulator (Energimarknadsinspektionen) regulates both TSO and DSOs.
- There are 150 DSOs and about 100 active suppliers on the market.
- In 2003, new legislation required monthly metering for all customers by the first of July 2009. This was implemented by the DSOs between 2003 and 2009.
- In 2012, a new law required that active customers should have hourly metering free of charge, enabling them to buy their electricity by the hour.

[4] Transmission System Operator

FINLAND

- The electricity market has been fully liberalized for competition for all customers since 1998.
- In 2004, the Finnish electricity market act was renewed. As a consequence, distribution companies have to be separated from other market functions. The level of separation depends on the size of the company.
- Regulator pre-sets the criteria for defining grid tariffs.
- There is one Finnish TSO (Fingrid). One energy regulator regulates both the TSO and the DSOs.
- There are 84 DSOs and about 30 active suppliers on the market.
- In 2009, new legislation required hourly metering for at least 80% of all customers by the end of 2013. This requirement has been met.
- In 2014, over 95% of all customers are expected to have their electricity consumption measured hourly and read daily.

CASE STUDY 2

SMART METERS ROLL-OUT – THE ITALIAN EXPERIENCE

Introduction

This case study to the GEODE report "Bringing intelligence to the Grid" describes the Italian smart meter roll-out and usage from the perspective of small local electricity distributors. Along with the Nordic countries Italy was among the first countries implementing a smart metering system. The roll-out process is almost successfully finished and Italy is now starting to develop tools and tariffs using the newly available information.

The following elements of the Italian smart meter system are described in this case study:
- The roll-out process
- DSO benefits
- Customer benefits
- Costs and challenges
- Facts and figures

Roll-out

In 2006 the national Authority for Electricity and Gas (AEEG[1]) released a new law mandating the replacement of all traditional meters for smart meters by the end of 2013. All smart meters have to be installed by the local DSO. The local authorities set the following goals for this measure:

for the customer:
- accurate billing based on the actual consumption
- use of various tariff models
- financial savings

for the electricity grid:
- possibility to avoid peak loads
- energy efficiency and CO^2 savings
- reduction of economic and technical losses

[1] Autorità per l'Energia Elettirca e il Gas, AEEG

In Italy the metering service is performed by DSOs who own the meters and are responsible for their installation, maintenance, reading and associated data management activities. **Metering tariffs** –separated from distribution tariffs or retail prices– cover investments and operational expenses related to the metering service came into force in 2004.

In Italy ENEL –the major energy company in Italy with a market share of more than 85% and 30 million customers– completed the whole process within only two years. The primary aim of the installation of new smart meters was to reduce power theft. This enabled ENEL to gain approximately 500,000 new customers. Along with the smart meter roll-out the Italian government also started promoting renewable energy with highly attractive incentives which has led to a massive electricity surplus in the south from wind and PV which needs to be transported to the major consumers in the north. Considering this fact, it can be easily understood why ENEL sees Smart Grids as means to achieving high-voltage load balancing and is completely focused on that issue.

About 150 DSOs operate in Italy and almost half of them in Northern Italy, namely South Tyrol and Trentino. In this case study we are referring to the experiences of those small local electricity companies as they are facing different challenges and have different expectations from the smart meter roll-out than ENEL.

For those small locally operating DSOs the smart meter roll-out started a few years later –in a purchasing cooperation with ENEL. This helped to reduce the final price for the smart meters but also made it difficult to order replacement parts in lower quantities. In Italy, the smart meter installation was done by the DSOs' staff and therefore the roll-out took some years –still some vacation houses are not fully switched to smart meters. Most DSOs created a set routine for the switching process, e.g. configuration, integration into GSM or PLC networks and customer communication. The switching process was subject to ongoing optimization resulting in final time of 20 minutes to change a traditional to a smart meter. It is notable that most of the time was spent installing the meter's back plate to the wall. Any future replacement of smart meters (e.g. due to technical issues) are expected to be done much faster.

Low voltage meters for households are usually connected via PLC to a concentrator in the MV/LV transfer and from there data is being transferred via copper, fiber or GSM to the main database.

Unfortunately PLC connections are not as reliable as copper or fiber connections and therefore a small proportion (2-3%) of smart meters remain without an uplink to the network.

It is planned to change all PLC and GSM communication lines to copper or fiber in the future to reduce maintenance costs, as well as creating an opportunity to offer additional services to the customer in the future.

Already we can see at this point that certain investments need to be made for the appropriate infrastructure such as communication lines and data storage. For Northern Italy this was neatly resolved by one of the local DSOs –AE Reti spa– building the appropriate infrastructure for remote reading of smart meters, data storage and then providing access for 3rd parties offering billing services.

DSO benefits

The main advantage is that manual meter readings are no longer needed. This means trained staff can concentrate fully on grid optimizations and are no longer needed for commercial issues. This is a crucial benefit for very small distributors with 5-15 employees where the whole staff needs to be technically trained and can now be allocated to specialized work only.

In Northern Italy one DSO takes care of the smart meter data handling resulting in lower data maintenance costs for all other participating companies. This has created a win-win situation as one data center has reached its optimal minimum size and other DSOs have access to this state-of-the-art infrastructure at low cost.

As energy theft was a problem for Italian DSOs, primarily in the North rather than the South, the smart meters also resolved an issue on the generation side. The local DSO is fully responsible for the integration of renewable energy and the legitimacy of the energy produced, e.g. PV power plants generating energy at night may be easily identified.

In addition to the 2006 mandate, the Authority has allowed higher tariffs for the DSO ensuring the financial viability of the necessary investments.

Smart meters are more effective at maintaining a maximum demand leading to more requests from customers to raise the allowed demand.

All changes regarding maximum allowable demand, energy supplier or activation / deactivation of a meter are done completely remotely, with only a very few operations needing to be done on-site.

Customer benefits

No more estimates of electricity consumption. The actual consumption will be charged. This leads to better budgeting and the identification of changes in energy consumption.

Because of the more transparent billing the DSO noticed less customer queries regarding their bills but more questions about how to save energy and how to use energy more efficiently.

Smart meters measure generation and consumption and are more accurate in measuring active and idle power. For that reason the generation of very small power plants can be easily measured.

Costs and challenges

Most of the small DSOs bought the technical equipment in purchasing cooperation with ENEL at a price of ca. 160€. A technician needed on average 20 minutes for the smart meter installation so the total switching costs are estimated to be approximately 180€ per meter.

As already mentioned above the whole remote meter reading process is carried out by one DSO. The data needed for additional billing to the energy supplier or consumer is provided by the DSO over defined (open) interfaces so different service companies may be hired to fulfill the billing process taking into account the different legal requirements. The whole process is offered as a service making it easy for smaller DSOs to control costs. Compared to the prior manual meter reading, these new costs are much lower. This combined with higher tariffs resulted in very low pay back times for smart meters.

The main future challenge for small DSOs in Italy is to analyze the data now available to more precisely forecast consumption and generation. For example AE Reti spa has already developed a PV simulation tool with a precision of +/- 2% for multiday forecasting. Just to note –AE Reti spa has a peak load in summer of 150 GW with 50 GW of this generated by PV.

The second major goal is developing, based on all the data, new customer tariffs –initially for medium voltage customers only. Together with experts on artificial intelligence, new pricing models are developed along with automatic identification of customers with certain characteristics which will be contacted directly.

Facts and figures

ITALY

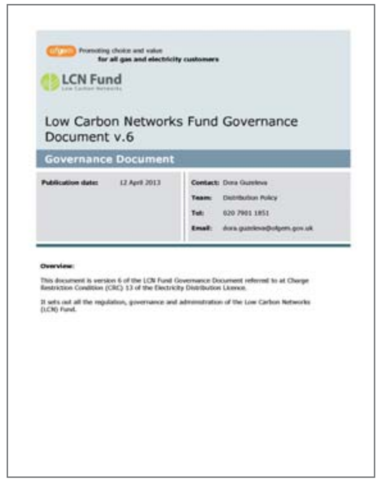
- The high voltage grid in Italy is fully operated by TERNA, a former ENEL division.
- There are approximately 150 DSOs on the market with ENEL having a market share of 85%. Almost half of the small local electricity distributors are situated in Northern Italy.
- The deadline for the deployment of smart meters was set for the end of 2013 and 100% of Italian customers are now equipped with them.
- As of 2012 Italy has the highest electricity price in Europe for industrial customers at 22,56 c€ (inclusive taxes).
- In 2012 the electricity demand in Italy was around 300 TWh; nearly a third came from Renewable Energy Sources (RES).
- Smart meters used for medium voltage customers and those measuring generation are read out at an hourly basis including a full load profile; those meters installed for low voltage customers are queried only once a month but also including a full load profile.

CASE STUDY 3

THE LOW CARBON NETWORKS FUND

Overview

As part of the Great Britain (GB) electricity distribution price control arrangements that run from 1 April 2010 to 31 March 2015, the GB regulator Ofgem established the Low Carbon Networks (LCN) Fund. The LCN Fund allows up to £500million support to projects sponsored by the distribution network operators (DNOs) to try out new technology, operating and commercial arrangements. The objective of the projects is to help all DNOs understand what they need to do to provide security of supply at value for money as GB moves to a low carbon economy.



Promoting choice and value for all gas and electricity customers

LCN Fund

Low Carbon Networks Fund Governance Document v.6

Governance Document

There are two tiers of funding which are available under the LCN Fund. The First Tier is designed to enable DNOs to recover a proportion of expenditure incurred on small scale projects. Under the Second Tier of the LCN Fund, the regulator facilitates an annual competition for an allocation of up to £64million to help fund a small number of flagship projects. In the first year, 4 projects were awarded Second Tier funding totalling £63.6million through the annual competition and 11 projects were registered under the First Tier. These projects involve the DNOs partnering with suppliers, generators, technology providers and other parties to explore how networks can facilitate the uptake of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management, as well as investigating the opportunities that the GB smart meter roll out will provide to network companies. As such the LCN Fund is providing valuable learning for the wider energy industry and other stakeholders.

Purpose

Ofgem's objective in designing the LCN Fund was to try to replicate the incentives on unregulated companies to innovate. Companies competing in unregulated markets that innovate successfully are able to capture the benefits of that innovation. It has been argued that regulated businesses –such as DNOs– may incur the costs if expenditure on innovation fails (as it may not be allowed by regulators). In addition DNOs may not be able to capture the full benefits of successful innovation as it could be fully or partially reclaimed by the regulator at subsequent price control reviews.

In the LCN Fund the regulator uses the discretionary reward to imitate the commercial benefits of innovation by rewarding DNOs for successful innovation. This is done by relating those rewards to the risks that DNO shareholders have borne (relative to customers) and the benefits associated with that innovation and any learning arising from it. This will not, typically, give rise to the same level of rewards that unregulated companies enjoy with successful innovation because under the LCN Fund DNOs will typically only fund 10 per cent of the expected costs with customers funding the other 90 per cent.

Structure

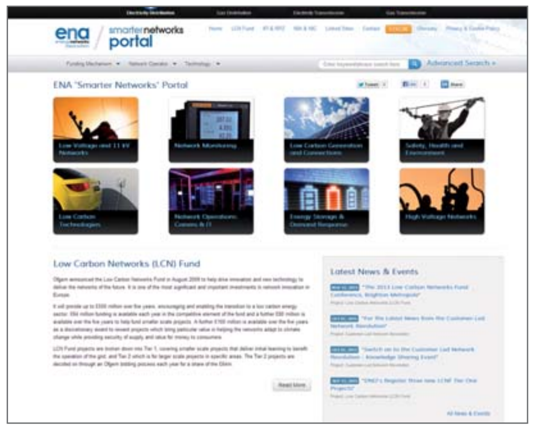
As previously stated the LCN Fund consists of two tiers. DNOs are able to use First Tier Funding to recover a proportion of expenditure incurred on small scale projects and to recover expenditure incurred to put in place the people, resources and processes to progress innovative projects. The total expenditure that a DNO can recover from First Tier Funding is subject to an annual limit.

The Second Tier Funding Mechanism provides total funding of up to £320million over the five years for a small number of significant "flagship" projects. The regulator holds an annual competition for project funding and DNOs compete against each other for an allocation of the funds. The annual process begins with DNOs putting forward outline project proposals in an initial screening process for the regulator to assess whether the proposals meet the LCN Fund requirements. This is then followed by the annual call for, and submission of, full proposals.

A discretionary reward fund worth £100million over the five year period enables the regulator to reward successful delivery and projects that bring particular value in helping the DNOs understand what investment, commercial arrangements and operating strategies they should be putting in place to provide security of supply at value for money for future network users, while doing all they can to tackle climate change.

Learning

A key feature of the LCN Fund is the requirement that learning gained from projects can be disseminated, in order that customers gain significant return on their funding through the roll-out of successful trials and the subsequent network savings and/or carbon benefits.



One of the ways in which the learning from LCN Fund projects is disseminated is via an annual conference. At this conference all DNOs present on a range of the projects they are progressing under the LCN Fund and are available for further questions and discussions. The conference is open to the public.

Another key means by which LCN Fund learning is shared is via the Smarter Networks Portal (SNP), an online repository for these innovative projects, focussing on:

- An overview of the technical and commercial coverage of current smart grid projects in GB.
- Identification of activity areas and gaps.
- An understanding of likely sources of Cost/Benefit data.
- Assistance to DNOs and other interested stakeholders in tracking progress of projects and promoting the sharing of information and learning.

The SNP can be accessed at **www.smarternetworks.org**

CASE STUDY 4

TELECOMMUNICATIONS FOR SMART GRIDS

Summary

The Grid itself is dumb: the Smart element is the Information & Communication Technologies (ICT) used to control the Grid. At the centre of ICT is 'Communications' –or to be precise in this context, 'telecommunications'.

Today, **telecommunications are essential for utility grid operations,** but as Smart Grids develop further, demand-side management and decentralized energy production mean that telecommunications will have to extend deeper into the networks. These developments are already recognised by European Union mandates M/441[1] and M/490[2] referring to Smart Meters and Smart Grids, and in Article 8.2 of the European Radio Spectrum Policy Programme RSPP)[3].

Gas Distribution Control Room

Telecommunication requirements of European utilities can be met using both radio and fixed telecommunications using a variety of technologies and standards. **Differences** in grid architectures, density, geographic coverage, amounts and different types of renewable energy to be integrated into the grid as well as varying demands in terms of resilience, security, latency, longevity, data rates, availability and criticality of communications determining which communications solution are optimal in technical terms for these different environments.

[1] European Commission Mandate M/441 for the standardization of smart metering functionalities and communication for usage in Europe for electricity, gas, heat and water applications, issued March 2009.
[2] European Commission Mandate M/490 on smart grid standardization issued to the European Standards Organisations (ESOs) in March 2011.
[3] Article 8.2 of Decision 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multi-annual radio spectrum policy programme.

Although some utility communication demands can readily be met by **commercial communications networks,** there are other more stringent demands which currently cannot be met by these networks. In these cases, utilities self-provide these telecommunications solutions, usually on dedicated networks; this is likely to be the case for the foreseeable future. Distribution System Operators (DSOs) must therefore retain the flexibility to self-provide telecoms systems where necessary to ensure resilient, secure and cost-effective telecommunications services to meet their specialized requirements.

Requirements for utility telecommunications networks differ from commercial telecommunications networks in a number of important ways:

- High availability
- High reliability
- Resilient architecture
- Mains power independence
- Low latency and stable asymmetry
- Cyber security to a high level
- Wide area geographic coverage
- Upload centric, supporting typical maximum bandwidth of 2Mbits/s
- Capable of supporting distributed control
- Longevity of support for technology

Some of these aspects present special challenges when involving radio based communications, especially where access to dedicated radio spectrum is required.

Fixed telecommunications networks

Utilities make use of extensive fixed telecommunications. Historically, this has been either copper cables leased from public telecommunications operators or their own copper 'pilot' cables laid alongside or within with the utility's own cables or pipelines. Then, in the same way as public telecommunications providers have progressively upgraded to fibreoptic cables, utilities have likewise made major investments installing fibreoptic cables alongside their own utility infrastructure.

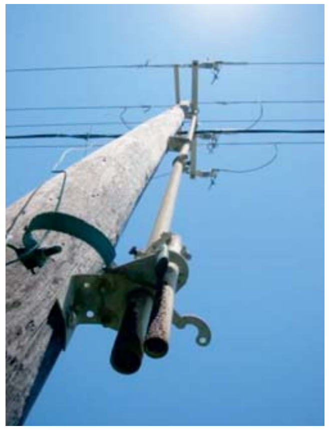
Utility Telecoms Tower

Spare capacity on any utility telecommunications infrastructure is usually commercialised in arrangements with other telecoms operators where a favourable regulatory environment exists to encourage this exploitation.

The electricity sector has access to a further telecommunications pathway in that relatively low rate signalling can be superimposed on the electricity network itself, providing a low cost mechanism to control their infrastructure in some circumstances (Power Line Communications – PLC).

Use of telecommunications networks

Radio-controlled switch on electricity pole-top



Manual switch on electricity pole

Electricity and gas transmission and distribution companies, together with water companies, use (wired and wireless) communication for Supervisory Control and Data Acquisition (SCADA) systems, distributed automation (remote monitoring and control), mobile voice communications and closed-circuit TV (CCTV) for security. Communication is also needed to support smart metering to monitor supply and consumption and to introduce dynamic tariffs. Smart meters will assist monitoring supply and quality as well as facilitate demand management. Electricity distribution companies also have a particularly demanding requirement for network protection –called teleprotection. These systems prevent damage to the infrastructure in case of faults on the network, and reduce the number of customers disconnected when faults do occur. With more complex and meshed electricity network architectures now being proposed to accommodate embedded distributed generation, comparison of the phase imbalance across the networks is being measured in real-time using devices called 'synchrophasors' which may create even more demanding telecommunications requirements.

The ambitious European goals ("20-20-20 goals") to reduce carbon emissions by means of extensive deployment of renewable energy technologies demand management and increased energy efficiency requires more extensive and trusted communications than previously needed. Additionally the smart meter roll-out obligation adds to the increasing communication demands faced by utilities in most European countries. Data privacy and data security concerns are also creating closer scrutiny of utility telecommunications facilities.

Radio monitoring of electricity substation

Given the growing importance and mission critical character of communications, many utilities consider that control over the communication medium is the most important criterion. The other decisive criterion when assessing communication options relates to technical telecom and application requirements (longevity of products and support, latency, availability, capacity/bandwidth).

It is in particular in the medium to lower voltage parts of the distribution grid that the future grid developments and the meter obligations require additional intensive and more trusted communication. This communication at the edges of the grid has the following characteristics:

- a large number of assets (including amongst others millions of smart meters);
- the assets are spread geographically throughout the service area of the DSOs;
- communication demands for bandwidth and availability are relatively low.

Radio communications networks

Monitoring point for underground gas plant

Although the bulk of core telecommunications functions are fulfilled by fixed networks, radio has always played a major part in utility telecommunications. Utilities use radio to monitor and control their networks, as well as for voice communications with their workforce. The attraction of radio for monitoring and control of the network is that it can be rapidly deployed and repaired if damaged. It is also independent of the infrastructure being controlled: if the telecoms cables are physically close to the infrastructure being controlled, storm or construction damage is likely to interrupt the telecoms service as well. A further benefit as systems migrate to Internet Protocol (IP) network infrastructure is that radio allows validation of redundant path routing, and resilience, which cannot be adequately tested and verified for 'cloud' type network services.

In order to be able to exercise the necessary control and functionality of the telecoms networks used to support their operations, most large utilities have maintained control over the telecoms networks supporting their infrastructure. In the case of radio systems, this usually requires access to suitable spectrum.

Licensed spectrum is a prerequisite for a private wireless network. In order to prevent a lock-in situation with an external licence holder the utility company needs to own the spectrum license, even if they outsource maintenance and management to a third party or even share the network with other critical national infrastructure operators. For this reason, utilities world-wide are seeking access to radio spectrum.

Spectrum proposals

Sub-station to connect wind farm with satellite and terrestrial radio monitoring

Because of the specialist nature of radio spectrum allocation, and the world-wide nature of its regulation, a dedicated organization has emerged to promote this activity. In association with the US Utility Telecoms Council (UTC), an autonomous European body, the European Utility Telecoms Council (EUTC) has emerged to promote this activity. Their willingness for access to a balanced portfolio of spectrum is summarized in Table 1 below. Because of the desirability of global harmonization of radio standards and frequency allocations, EUTC works closely with standardization and harmonization bodies, within Europe the European Telecommunications Standards Institute (ETSI) and the Committee of European Posts and Telecommunications Administrations (CEPT).

EUTC Spectrum Proposal

Europe - multiple small allocations within harmonised bands: • **VHF spectrum (50-200 MHz)** for resilient voice comms & distribution automation for rural and remote areas. [2 x 1 MHz] • **UHF spectrum (450-470 MHz)** for SCADA & automation. [2 x 3 MHz] • Lightly regulated or deregulated shared spectrum for smart meters and mesh networks (870-876 MHz). • **L-band region (1500 MHz)** for more data intensive smart grid, security and point-to-multipoint applications. [10 MHz] • **Public microwave & satellite bands (1.5-58 GHz)** for access to utilities' core fibre network or strategic resilient back-haul.

TABLE 1

Conclusion

Utiliy infrastructure is often in remote locations and harsh environments

Today, a modern car, train or aeroplane is a combination of a much simpler earlier product overlaid with a complex web of information and communications technologies to generate an advanced transportation product. Increasingly, these 'products' themselves now communicate with their surroundings to meet the needs of the 21st century. Thus, modern utility networks are becoming interactive intelligent two-way networks fulfilling requirements never foreseen when they were originally built. But to fulfill these expectations, advanced ICT systems need to be retrofitted; and at the heart of these ICT systems, there are 'communications'.

Because Utility Distribution Companies have widely differing network architectures, geographic challenges and regulatory frameworks, DSOs must have the freedom to determine the most appropriate ICT solutions to meet both theirs and their customers' needs in a secure, cost effective and reliable manner.

Where DSOs need to use dedicated radio systems to fulfil operational requirements, they require access to suitable and sufficient radio spectrum on a timely basis from the relevant telecoms regulators to meet their energy policy obligations.

CASE STUDY 5

THE NEW DATA EXCHANGE IN AUSTRIA

The new Customer Switching Process for Electricity and Gas

INTRODUCTION

With a new law going into effect in March 2011, a new fully automated electronic switching process for electricity and gas consumers was designed. The goal was to implement the new regulations from the Third EU-Energy Package to reduce the switching time from 4 weeks to 3 weeks, to simplify the switching process in general and to encourage customers to switch to new electricity and/or gas suppliers, since the switching rate in Austria is as low as approximately 1,2% per year.

From a technical standpoint the Austrian Power Clearing and Settlement GmbH (APCS) was responsible by law for the implementation of a decentralized data exchange platform and all market actors had to exchange their switching data using this platform in a secure and encrypted manner. The data is stored in separate systems with the market actors and not in a centralized database.

The Austrian National Regulatory Authority (NRA) was given the power to lay down the rules, defining the new switching process and the amount of time each process was allowed to take.

CHALLENGES OF THE NEW SWITCHING PROCESS

The central elements of the new switching process are a simple and quick switch from the old gas or electricity supplier to a new one. To achieve this the customer only needs to communicate with the new supplier.

In the new switching process the new supplier starts the process by sending the switching information to the old supplier and the DSO using the decentralized data exchange platform ENERGYlink. In order for the new supplier to find all the necessary switching information i.e. name and address of the customer, address of the installation, commitment period, terms and periods to end an existing contract, yearly consumption etc. the market actors exchange the necessary information via ENERGYlink. By using this closed system it is ensured that there are no direct data exchange between the market partners and a safe and secure system is maintained. At the same time all data exchanges are logged for further reference and analysis by the NRA.

Having implemented such a system it is clear that there is going to be very intensive data exchange between the new supplier, the old supplier and the DSOs using the decentralized data exchange platform ENERGYlink. The most important processes at the moment are:

- Identification of the network connection point
- Commitment period; terms and periods to end an existing contract
- Sending the certificate of authority
- The switching process itself
- Registration and deregistration
- End of supply
- Cancellation of processes

Alongside the new switching process it is also clear that new technologies and market models which are possibly coming together with smart metering and Smart Grids also have to be able to be accomodated by this new system.

In August 2013 a new legislation went into effect giving customers the possibility to switch suppliers online. This is done by adding an “online transfer” button next to the offers on online price comparison websites for electricity and gas. At the moment the new system and the way it is going to be implemented are under discussion with the NRA since there are a lot of legal questions that need to be addressed and resolved.

CHALLENGES FOR THE DSO

In Austria the DSO is the central point with all information regarding the customer. Therefore the **DSO plays a central role in the new switching process.** The DSO is the first source for the new supplier to gather all the information needed for the switching process i.e. name and address of the customer, address of the installation, yearly consumption etc. As mentioned above, the new supplier can ask for this information electronically and fully automated using ENERGYlink based on a certificate of authority issued by the customer. The DSO has a certain amount of time to answer to the requests of the new supplier depending on the kind of process.

CHALLENGES FOR THE SUPPLIER

The challenges for the supplier are similar to the ones for the DSO. For a successful switch from an existing supplier to a new one, the customer has to be able to end the existing contract and start a new one. To do this, the new supplier checks the commitment period, terms and periods to end the existing contract electronically and fully automated using ENERGYlink based on the certificate of authority issued by the customer.

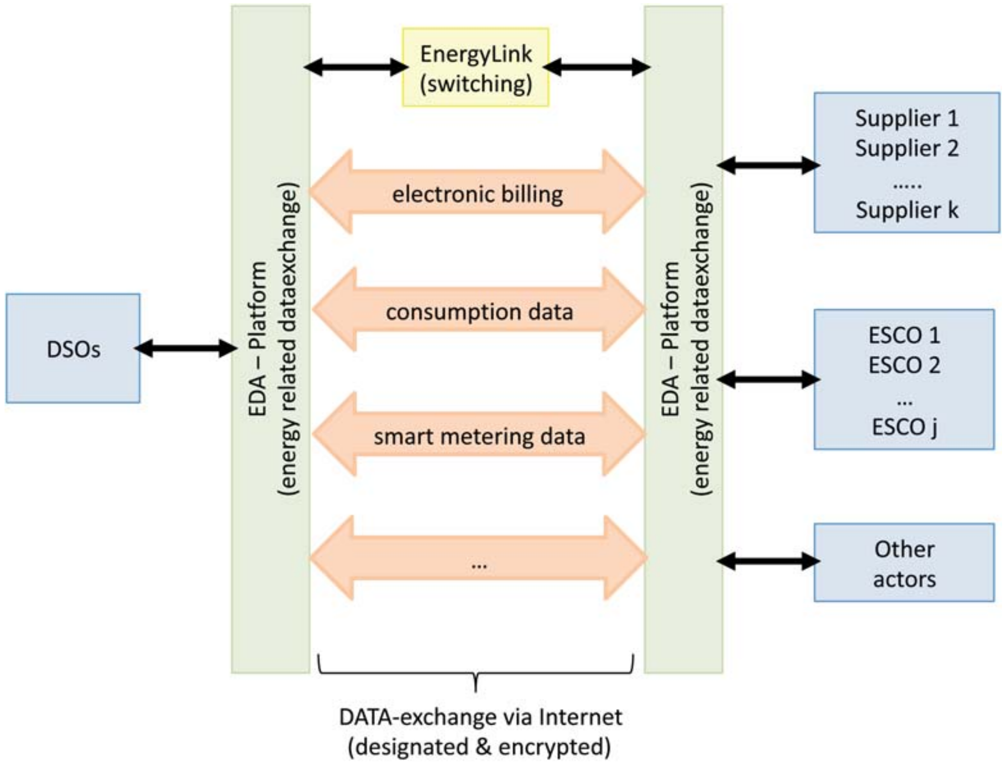
By the new legislation, also the legally binding period for contracts for household customers and small businesses was set to 1 year. After this year, household customers and small businesses can end their electricity and gas contracts by giving a 2 week notice and move on to a new supplier.

CHALLENGES FOR THE DECENTRALIZED DATA EXCHANGE PLATFORM ENERGYLINK BY APCS

APCS is responsible for the implementation of the data exchange platform ENERGYlink and has to guarantee that the data exchange between the market actors works flawlessly and without interruption and upholds the privacy and security of the exchanged data at the same time.

ENERGYlink records all the header information but not the contents of the exchanged data because the NRA is by law entitled to analyse the switching process. Thereby the NRA can analyse the duration of the processes and check if customers are able to switch within 3 weeks.

APCS also provides a “self storage” designed for suppliers and DSO which do not wish to implement the new switching process in their own systems due to the lack of the proper infrastructure and/or resources to implement and maintain such a complex switching system.



Source: Wiener Netze GmbH

The companies which use this system have to upload all the necessary data for the switching process so that every market actor can receive the correct data. The companies also have to update the data in the “self storage” frequently with their in-house data and vice versa which is done by using state of the art encryption and security.

The switching procedure is provided by APCS and the companies log on to the “self storage” using a web interface and can start, edit and handle the processes according to the regulations in a very cost effective way without implementing further systems.

Along with the presented duties to comply with the defined processes all market actors have to ensure the privacy and security of data.

TIME FRAME OF IMPLEMENTATION

In the past the Austrian electricity companies worked together extensively with NRA and APCS on defining the processes. It was planned that the new switching system should go into effect on January 2, 2013. Unfortunately, since there were disagreements regarding the publication of the new processes and some of the data exchange formats to be used, some software companies went ahead and used the formats which they thought were correct. Only after long and complicated negotiations were the market actors able to find a common understanding on the data exchange formats in June 2013.

Implementing new software is only one task. It is also necessary to test the new software with other market actors as well as train staff on how it works and how to use it.

LESSONS LEARNED

Defining and implementing such complex new processes is made more difficult if there is a fixed deadline by which the new system has to be set up and running, without taking into account the level of expertise of the actors involved.

Clearly there has to be a date when everything has to be ready but by defining such a date it is important to realize that it is crucial to develop a reliable and future oriented system where the solution itself stands in the foreground. Everybody involved has to make sure that the new software has no flaws or bugs as customers will be disappointed if the processes don't work properly and the NRA challenges suppliers or DSOs for not meeting deadlines.

It is also very important to spend enough time on the preparations such as finding the defining common language and understandings about the project goal and how to achieve it. Since there are a lot of different market actors involved (DSOs, suppliers, NRA, APCS, Ponton, software companies, etc.) it is also crucial to set aside enough time for testing and adapting of the software as well as for training the staff on how to use the new software.

Exchange of energy-related data (EDA) using Ponton

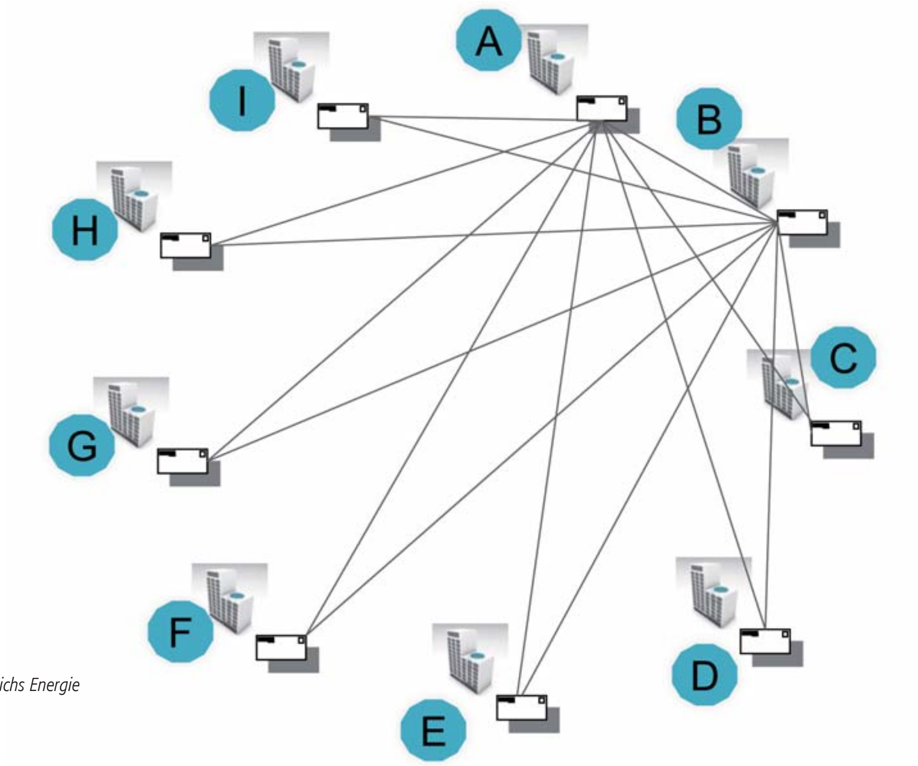
The Austrian legislator decided –as described above– to send all the information regarding the Austrian switching process via the decentralized data exchange ENERGYlink, provided by APCS to the market actors.

The Austrian electricity companies have been working for a year on a project called "Exchange of energy-related data" (EDA), with the emphasis on defining homogenous technologies for the communication of energy-related data among market actors. In regard to relevant security aspects, the communication with EDA is based on the ebXML standard which is used for every data exchange in this system.

WHY ARE WE DOING THIS?

The amount of data which has to be transferred electronically, standardized, secured and encrypted is increasing constantly and the number of market actors is going to increase as well as the number of data formats used.

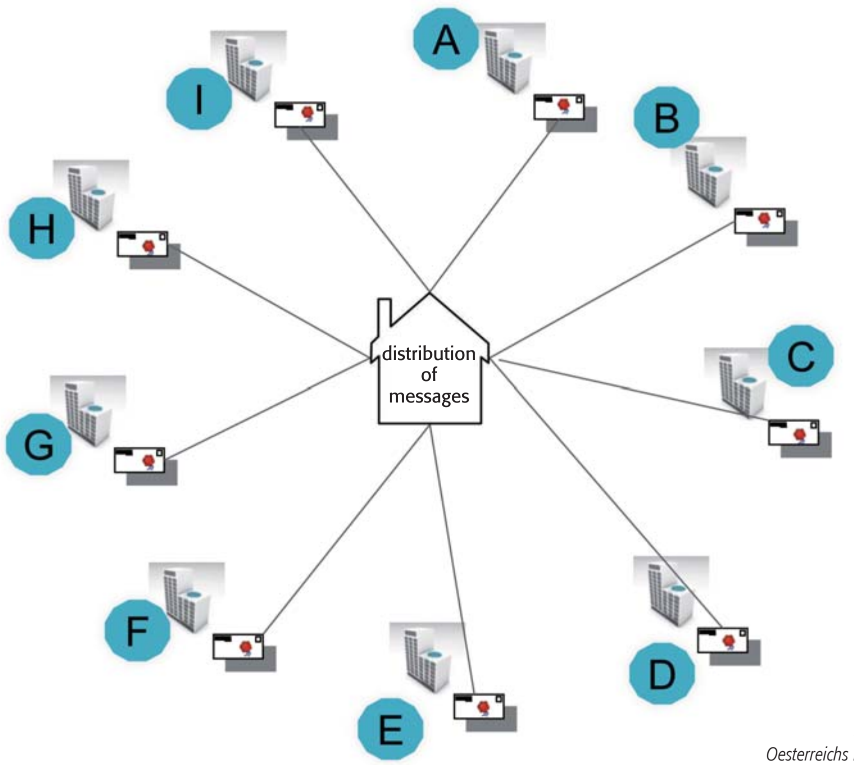
At the moment all market partners communicate bidirectionally using one individual channel to each market partner (peer-to-peer). This communication structure is illustrated in the following picture:



Source:
Oesterreichs Energie

With EDA this is going to change. The goal is to use one consistent platform of communication with proper messaging standards to reduce costs and to gain synergies. With this project, DSOs and suppliers will have an adequate, secure and cost effective way to exchange data in the future. EDA is open to all market actors as well as to different categories of energy.

The communication between the market actors goes through a central data hub provided by Oesterreichs Energie rather than peer-to-peer connections. The communication structure with EDA is illustrated in the following picture:



Source: Oesterreichs Energie

EDA is a complete solution for a simple and secure data exchange between the market actors and provides the following:

- Encrypted and signed transmission of the message
- Distribution of the messages to the market actor or ENERGYlink (for the switching process) and administration and distribution of the addresses of the market partners
- Acceptance of the message, decryption and checking of the signature

EDA will especially be used for the exchange of:

- Consumption data
- Smart metering data
- Electronic billing
- Data regarding the exemption of specific costs of green energy (vulnerable customers)
- Connection to ENERGYlink for the new switching process
- Prepared for the future…

At the moment about 90% of the customers are already or will be connected through their DSO or their supplier to EDA by the end of 2013. The rest will follow soon.

Acknowledgements

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Overview · Smart Meters roll-out in Europe

Carmen Gimeno, GEODE Secretary General

Case Study 1 · Smart Meters roll-out – the Nordic Experience

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Case Study 2 · Smart Meters roll-out – the Italian Experience

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Case Study 4 · Telecommunications for Smart Grids

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