SEAS-NVE: End to End Smart Metering Solution

![seas-nve logo]

Svinninge, Denmark

End to End Smart Metering Solution

Beyond Billing: How SEAS-NVE Uses Smart Meters to Manage their Low Voltage Grid

SEAS-NVE issued a bid with the intent to replace its aging meter infrastructure. Four years later, 390,000 NES (Networked Energy Services) smart meters had been deployed by NES's partner, Eltel Networks. Under the leadership of Eltel Networks, as many as 2,000 meters were installed on peak days and those same meters were up and running, communicating with greater than 99.7% reliability on the same day. SEAS-NVE was pleased to be able to achieve full deployment with a customer complaint rate that was as low as 0.5% - ten times better than their expected target.

Like many utilities, SEAS-NVE deployed smart meters to improve their billing system. However, after the billing process was fully operational, SEAS-NVE moved beyond using the smart meters as billing devices and now sees them as smart grid devices that convey power quality (voltage, frequency, and power factors) and analytics to evaluate grid health.

This is a case study about what SEAS-NVE is doing with the grid data they collect from smart meters that allows them to move beyond billing and better monitor power quality, outages and manage energy efficiency on their low voltage grid.

How the NES Solution Works at SEAS-NVE

The NES System is a three-tier grid management system. The NES smart meter has advanced features for load profiling, power quality measurements, remote load control, remote disconnect, and maximum power limiting. The NES smart meters for SEAS-NVE were provisioned at the factory to support SEAS-NVE demands and arrived ready for installation.

The meter communicates with a control node, the data concentrator. Data Concentrators collect data from the meters, aggregates the data, and sends it back, in bulk, to the NES System Software. They can send alarm data, such as outage detection events, to NES System Software whenever an event occurs. In the SEAS-NVE installation, meters are managed per hour, such that hours are saved in a load profile registers and the profile is read four times per day. An hour after the profile is read, the information is made available for customers to be able to check their usage, which is updated four times per day.

NES System Software is the system management software that communicates with the Data Concentrators to provide infrastructure management, device management, event management, and data collection. SEAS-NVE uses the system management software to add and remove meter functionality, for example, to adapt an existing meter for use with a solar panels. SEAS-NVE communicates with the NES smart meters through device management software. This allows them to load new firmware and commands into the system without visiting the field. Event management lets SEAS-NVE track loss of meter communication, power outages, and meter tampering. Data collection is used to manage load profiles and power quality information.

Scheduling the power quality measurements on a different cycle than billing data allows utility managers to review history and troubleshoot the grid when problems are reported, rather than forcing them to sift through a mountain of billing data. This decreases the time and cost of conducting analysis in the field and keeps the focus on reliable service to users of the grid. A great example of this is how SEAS-NVE is responding to a 10x growth in solar panel deployments since the beginning of 2012.

Troubleshooting Solar Panels and Power Quality Challenges

As a leading utility in Denmark, solar panels and renewable energy have always figured into the equation of the SEAS-NVE grid. The difference today is the sheer amount of solar installed. At the start of 2012, there were approximately 100 solar installations on the SEAS-NVE grid; within a year it increased to 3,526, and continues to grow each year. Because smart meters were already an accepted device on the grid, SEAS-NVE did not have to make over 3,500 customer visits for each installation. Instead, SEAS-NVE was able to re-program meters remotely - a current savings

of approximately 6 million Danish Crowns or as much as 570 million Danish Crowns if each of their 390,000 residents installed solar.

Once the panels are producing power, the customer can check their meter and see how much power they generated for themselves and how much they provided to the grid. To date, the solar customers have been able to freely transmit their production onto the grid. Another area where the NES smart meters have been beneficial to SEAS-NVE with this explosion in solar panels has been in the ability of the NES System Software to monitor the grid to make sure the voltage levels are within acceptable ranges. In the past, most voltage quality investigations have been the result of customer complaints; for example, when customers experience dimming or flickering of lights and equipment failure. Before smart meters, the utility would respond to the complaint by sending linemen to the location to obtain initial readings and to identify the severity of the fluctuations. If the linemen could not immediately find the problem, they would install power quality recording devices at the customer's point of common coupling, inside the customer's location, and at various sites along the circuit that serves the customer location. Voltage readings are recorded over a given time, which is mostly determined by the frequency of malfunctions.

By setting a series of alarms and events within their NES System Software, SEAS-NVE can now monitor and identify voltage quality problems at the same time as the customer, or even before the customer experiences any significant equipment malfunctions or failures. The event log records the occurrence of meter events and fault conditions that are selected to be logged. The date and time of each event occurrence is included in the log. The meter provides power quality measurements for the following: Voltage (RMS) sag (under voltage), Voltage (RMS) swell (over voltage), Over-current (RMS), Power Outages, Frequency, Phase Loss, and Total Harmonic Distortion (THD). By recording these events, SEAS-NVE can better deliver the correct voltage level to each customer's house. By collecting and analyzing events, and being prepared to monitor the grid where voltage levels have been exceeded, SEAS-NVE can meet their obligation to customers and regulatory mandates.

Responding to Outages

The SEAS-NVE installation has established a series of alarms that notify the utility when the power is out at points in the grid. This means that the utility can begin predicting issues before the customers call. Knowing when an area is down gives the utility the advantage of isolating the problem; once the outage is identified, SEAS-NVE can begin the tasks to restore power, thus avoiding damages from surges, a lengthy loss of power, reduced outages, and an understanding of the usage in the area where the power failed. SEAS-NVE also has the power to differentiate failures as utility problems or customer-created problems.

Understanding patterns has become a part of SEAS-NVE post-power outage activity. When the power is out, there is now a detailed consumption pattern available for review and a better understanding of what failed, and why. With this information available, SEAS-NVE can see how their grid has failed, but they also can see when customers have exceeded energy limits and caused an outage, as well. Maintenance costs under the NES system have proved advantageous for SEAS-NVE across the board. Maintenance costs under the old system averaged in the 6 million

Danish Crowns range. Current maintenance costs, under the NES system, have been reduced to as little as 1.5 million Danish Crowns.

"I couldn't imagine living without smart meters," said Bo Danielsen, Head of Smart Metering/Smart Grid, SEAS-NVE-NVE. "It's now completely normal. No one in my department could imagine living without them now."

SEAS-NVE's Role in Reducing Energy Consumption

SEAS-NVE knows that educating the consumer is an obligation of the utility and has worked hard to keep communication open. By working so closely with energy consumers, SEAS-NVE continues to strive to find new ways for customers to both save money and to use energy more efficiently - which is not only good for Denmark, but will help meet European carbon emissions targets.

To date, SEAS-NVE has engaged customer contact through their web portal, marketing contests and frequent interaction. In an interesting turn of events, SEAS-NVE conducted a study of current energy usage by engaging their customers in a monthly contest to save energy. After it was announced, approximately 40,000 customers enrolled and customers who participated saved 17% energy usage - well above the 5-8% energy savings predicted by industry experts. Moving forward, SEAS-NVE wants to continue to improve energy consumption by choice.

SEAS-NVE has proven that giving its customers visibility into their own energy usage is a valuable tool in convincing them to make changes. Now that they have taken steps to make headway into this "basic" function, they see all kinds of new future services that could be offered to continue to improve customer satisfaction and build value.

"If you can't get people to change their consumption, you won't see a change in meeting current carbon emissions targets," said Bo Danielsen at SEAS-NVE-NVE. "Studies have shown that by raising awareness and giving people logical consumption data, they can start to use energy more intelligently. As a utility company, this is our societal responsibility." 390,000 NES smart meters.
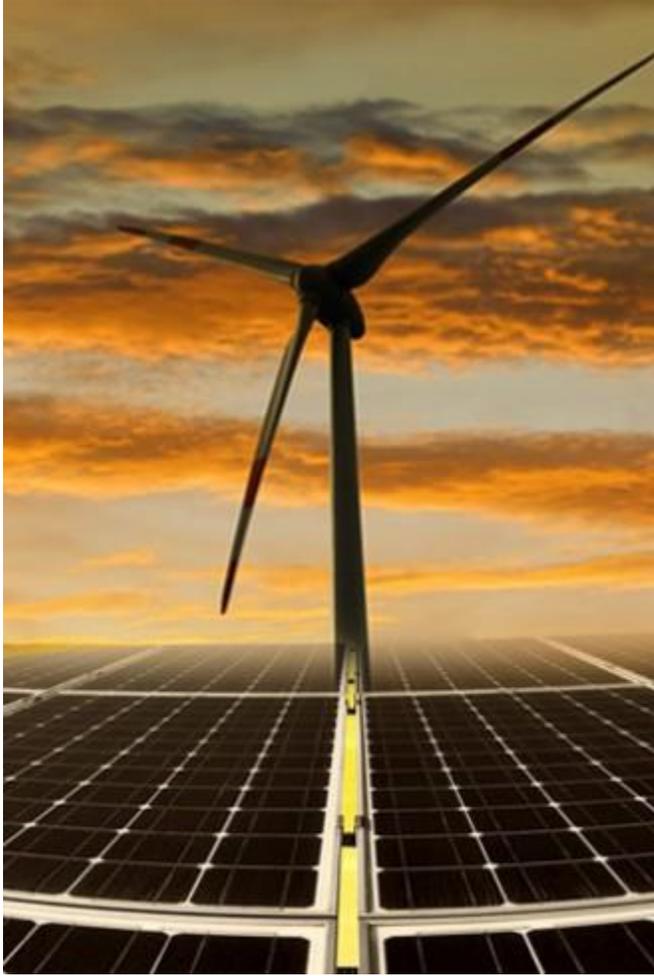
Outcomes / Benefits:

• Outstanding system reliability and performance.

• Load profile data has helped customers better manage and reduce their energy usage.

• Power quality data allows utility managers to better monitor and troubleshoot problems in the grid.

• Enabled integration of solar generation within the low voltage network.

• Utility managers get alarms notifying them of grid problems.

• Reduced network maintenance costs.

Time frame 2008 - ongoing