



Customer Spotlight

Hafslund Nett Reinvents Smart Metering with a Wide Area Mesh Network

Sponsored by: Wirepas and Aidon

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September 2017

INTRODUCTION

Hafslund Nett, headquartered in Norway, owns and operates the regional power grid in Akershus, Oslo, and Østfold. This covers a population of about 1.5 million people. Hafslund Nett owns and operates the distribution network in 35 communes and delivers power all the way to customers' homes in these areas. Hafslund Nett owns one of Europe's most state-of-the-art operations centers that manages, monitors, and optimizes the operation of Hafslund's power grid.

After a few years of discussions and pilots, the Norwegian regulator finally mandated the rollout of electricity smart meters. By January 1, 2019, all consumers will need to have a smart meter installed. DSOs (distribution system operators) are responsible for the installation, which aims to provide consumers with better information about their consumption and to enable new energy related services resulting in a much more efficient and transparent use and management of the distribution grid infrastructure.

To prepare for the deployment and to evaluate different devices and communication technologies, Hafslund Nett embarked on a series of tests in 2014. The objective was to optimize the investment related to the rollout and implement a secure and cost-efficient infrastructure capable of achieving a 99.9% minimum level of reliability.

Solution Snapshot

Organization: Hafslund Nett is a Norwegian utility that owns and operates the regional power grid in Akershus, Oslo, and Østfold, serving a population of about 1.5 million people. The company has about 700,000 connected customers.

Operational challenge: According to Norwegian regulations, all electricity consumers will need to have a smart meter by January 1, 2019. The mandate requires rich functionalities and a high level of performance to allow hourly metering and settlement. Every morning, at 7 o'clock, all data needs to be centrally available.

Solution: Hafslund is deploying a smart metering infrastructure from Aidon, including head-end systems and devices (Aidon Energy Service Devices) with an automated multihop mesh network designed by Wirepas.

Project duration: Full-scale rollout of power meters started in August 2016 and will be completed by the end of 2018. About 37% of the 700,000 meters have been deployed so far. Between 1,000 and 1,400 meters (peaking at 1,700) are installed daily, six days a week.

Benefits: Accuracy of consumption measures, network operation cost reductions, and the ability to use aggregated data from the smart meters to improve grid operations.

The full-scale rollout of 700,000 power meters started in August 2016 and will be completed by the end of 2018. At present about 37% of meters have been installed. The full project cost (including the cost of personnel involved in the deployment) is estimated to be NOK 2.1 billion (about \$250 million).

"Our new smart metering system, combined with reinvestments in the grid, will enable Hafslund Nett to achieve its strategic priority of being the most efficient grid company in Norway," said Steinar Drange, project leader for the technical solution in Hafslund Nett's smart meter project.

IMPLEMENTING SMART METERS IN THE IOT ERA

Smart meters have been in operation for more than a decade. Sweden was the first European country to indirectly mandate them, while Italy is already preparing for the second full rollout. Norway had the opportunity to observe the benefits of smart meter technology and, most importantly, the lessons learned by the pioneers. In the meantime, metering and communications technologies have evolved alongside the increasing appeal and maturity of utility-grade IoT, adding functionalities that had not been considered in previous projects. This is the context in which Hafslund Nett conceived its smart meter project, selecting a fit-for-purpose communication technology approach that is in sync with IoT requirements and providing as much transparency and control as possible at the lowest possible cost during installation and operations.

HAFSLUND NETT'S PROJECT FUNDAMENTALS

Hafslund Nett has been looking into smart metering for the past 10 years, but the current project was conceived in 2014 and started in 2015. The first steps were the selection of the meters with head-end systems and the related communication, together with the creation of the central IT infrastructure and the appropriate interfaces with company applications.

The core of the new smart metering consists of Aidon Energy Service Devices (smart meters), Aidon's head-end system for the collection and management of the data from the smart meters, and a communication solution for data delivery powered by Wirepas.

PLC, cellular, and radio were considered and evaluated to handle meter data communication. Hafslund Nett was looking for an effective and future-proof solution. The cost of the alternative solutions was also assessed. Considering the network topology, the location of the meters, the frequency of data collection, and the overall system performance, the final decision was to adopt radio communication – and more specifically wireless mesh.

REINVENTING SMART METER NETWORK OPERATIONS

The selection of the right smart meter communications technology strategy that meets current and future demand is fundamental to the success of smart metering operations. The electricity meters are powered, meaning that energy efficiency is not a primary concern on a per metering point basis unlike for many IoT devices including heat cost allocators and gas and water meters. However, when looking at the total power budget for the entire communications system, including infrastructure, then total energy consumption levels can vary significantly for different communications technologies. Meter location is a critical aspect. The density of their distribution, and even more their placement in basements and deep indoors, can be a challenge for the communication network.

Compared with most known smart metering rollouts, the connectivity solution adopted by Hafslund Nett has radically changed the network logic. It introduces the approach of autonomous

decentralized networks and network management by eliminating investment in specific communication network devices and additional infrastructure equipment, thanks to an innovative approach in which part of the meters (so-called "master meters") act as concentrators. These master meters – there will be around 8,000 to 9,000 in total – use a mobile communication channel to convey data to the head-end system.

Each meter is a node in the self-organized network. No routers, repeaters, or additional network infrastructure are needed. No network configuration is required. A simple radio chip in the meter and the connectivity software handle data transmission and network configuration. Scalability is ensured as the network adapts itself and configures on the fly while more meters are deployed. Reliability is therefore increased. If a node (smart meter) fails, messages are automatically rerouted and communication load is rebalanced. In other terms, the network is self-healing with instant rerouting. Interferences are managed by dynamically changing the communication channel, and physical obstacles are handled with the system rerouting itself locally and retransmitting lost data. Upgrades can easily be remotely executed and new types of devices can easily be added.

"For our smart metering project, we adopted a technological approach which is very different from what was done by other European utilities," said Drange. "Once the rollout of the 700,000 metering points is completed, it will be one of the largest single mesh networks ever deployed."

SELECTING THE RIGHT SUPPLIERS FOR A FUTURE-PROOF SMART METERING SOLUTION

Smart metering requires high reliability, scalability, and optimization of life-time costs. The infrastructure is deployed to remain in operation for about 15 years, so selecting future-proof technologies with reasonable total cost of ownership, as well as the related suppliers, is critical.

Hafslund Nett went through an extensive review before selecting the Aidon solution combined with Wirepas connectivity. According to Hafslund Nett, Aidon's proposal was economically competitive and, most importantly, was considered a future-oriented and technically superior solution. The solution was found to be designed for the future and would provide Hafslund Nett with the requested advanced smart grid functionalities as laid out in the proposal. The wireless communication platform meets the need for flexibility and performance required for future developments, the head-end solution enables multiple configuration options, and it is IPv6 compliant.

RELIABILITY, FLEXIBILITY, AND INNOVATION AT WORK

Hafslund Nett strongly believes that its smart metering deployment will be a game changer for the way the grid is operated: the solution will allow Hafslund Nett to get more information about the state of its network, enabling efficient and reliable operation of its grid.

The rollout of smart meters is still underway and only some of the expected benefits have been realized so far. Key takeaways are:

- **Reliable and secure data collection.** The smart metering technologies adopted are capable of delivering a high level of operational resiliency and cybersecurity. The performances achieved so far are aligned with expectations, and 99.9% minimum reliability has been confirmed. Every day the hourly data is collected from the meter. Cybersecurity and data protection are enabled by proven industry-standard cryptographic algorithms.
- **Flexibility to meet future needs.** Once the rollout is completed, Hafslund Nett will be able to move from the basic functionalities requested for metering operations to more complex

grid operation needs, such as power quality management or to enable customer-facing new services including smart homes. The technologies selected can easily manage functionality upgrades and secure over-the-air (OTA) updates. Hafslund Nett focused on making sure the system is modular and updateable in all parts.

- **Investment and operation cost optimization.** Due to the adoption of Aidon technology and Wirepas connectivity, the meters (both master and slave) are the communications infrastructure. This means that no extra communication devices are required and this significantly reduces investment, installation, and operation costs. Maintenance is also simplified, and hence costs. The connectivity itself doesn't have any recurring fees, enabling significant savings over the life time of the meter (though there is the cost of the cellular connection from master meters to the head-end system).
- **Innovation at the edge.** Hafslund Nett's smart metering solution is conceived to move at the edge activities that are normally managed by a centralized network management solution. Hafslund Nett's meter network is autonomous and decentralized, capable of dynamically and locally healing failures, at meter level.

SUCCESSFULLY EXECUTE A SMART METERING PROJECT

A smart meter rollout is a complex and multiyear project, and Hafslund Nett planned and organized its rollout carefully. Project phasing is critical. Before moving to the actual rollout, a pilot phase was carried out to test both the technologies and the processes to execute the installation. The latter is as critical as the technical pilot. Logistics are dependent on the execution program. Each activity needs to be performed correctly and installers need to be trained. The cost of deployment can easily spiral out of control if installers are not able to correctly replace the meter in one single visit.

The technical pilot was fundamental to evaluate communication performance in a real environment. Being one of the first implementations of its kind, there were some complexities mainly related to deep indoor meter localization and interferences. However, thanks to the decentralized network management approach, the tuning is left to the meters themselves, avoiding the need for central configuration. The quality of frequency and time domain decisions for optimal performance and reliability is proven to be much higher than with centralized control. Data security is a must for the entire smart metering project. End-to-end security by design needs to be part of the project, not only to comply with regulatory obligations but also to establish and maintain customer trust.

Customer communication campaigns need to be prepared and executed before and during meter installation, and Hafslund Nett has yet to encounter any significant customer issues.

Finally, an important lesson learned by Hafslund Nett is related to the collaboration with the selected partners. Establishing a collaborative approach and creating mutual trust is key to successfully overcoming any unforeseen problems. It is also essential to work together to make the most of any future opportunities.

WHAT'S NEXT FOR HAFSLUND: COMPLETE THE PROJECT AND MOVE TO THE FOREFRONT OF GRID OPERATION INNOVATION

The smart metering project is due to be completed by the end of 2018, when all 700,000 meters will be in operation. Up to July 2017, about 250,000 meters had been installed and the project is progressing according to plan.

But Hafslund Nett is aware that the value of the data collected from the meters goes beyond the pure metering activities, and it is now focusing on fully exploiting the value of data collected.

While progressing with the installation, the company is building a data lake where smart meters and other data from grid devices will be integrated. Algorithms and engines are being developed to analyze the data and access the information to understand the condition of the network. Power quality measurement is obviously on the agenda, and is in a pilot phase on a subset of the meters: a single algorithm downloaded in the meter, for instance, measures the level of variation from the norm and, if it is above 7%, sends a message that can be passed to consumers as a "notification" or the trigger to look deeper into the specific local grid situation. Smart home and prosumer grid applications will also be evaluated.

"The new smart metering solution is an important step in bringing our company to the next stage of smart grid implementation – a stage in which value is created by the availability of integrated and reliable data," said Drange.

METHODOLOGY

The project and company information included in this document was obtained from multiple sources, and most importantly from direct interviews with Hafslund Nett executives by IDC analysts.

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