

BENEFITS FROM SMART METER INVESTMENTS

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ABSTRACT

Vattenfall Distribution started already during 2003 to roll-out smart meters to all about 850.000 Private and SME customers with a fuse size up to 63A. The main reason was to implement an efficient solution to handle monthly billing based on actual consumption which was required from July 2009. The rollout decision was based on an original business case. After that, also additional business cases have been evaluated and implemented, here called extended business cases. This paper describes the achieved benefits, both financial and non-financial, from the Smart Meter rollout. The value to upgrade some of the Smart Meters with more advanced functionality is also described.

INTRODUCTION

Background

Vattenfall Distribution is a DSO in Sweden with about 850.000 private and SME customers in the grids. The legal requirements for billing have been yearly readings for customers with a fuse size equal or below 63A. These legal requirements were changed to monthly readings and monthly settlement in July 2009. As one of the first companies in Sweden, Vattenfall Distribution started already during 2003 to roll-out Smart Meters to all their customers. The main reason was to get a cost effective solution to collect monthly values as well as to increase the quality the data. The decision for Smart Meter rollout was based on an original business case for the Smart Meter investment. The rollout of Smart Meters was divided into three phases, called AMR 1, 2 and 3, in order to learn and gather experience from each phase. The reason was also to follow the technology development of Smart Meters and systems and to be able to select the best and most cost effective solution and supplier for each phase at the time. All three types of meters can handle hourly values even if this was not needed initially. AMR3, in the last phase, is a more advanced meter than AMR 1&2. AMR3 can e.g. handle metering events, not possible with AMR 1&2.

Original business cases for the Smart Meter investment were based on lower costs for collection of meter readings for monthly billing, supplier change and move out/in as well as improved customer support. Also reduction of non-technical network losses is included.

Extended business cases based on additional benefits from the Smart Meter investment have been developed after the decision for the Smart Meter rollout. This is now an ongoing process where more business cases are continuously evaluated and implemented.

Purpose and method

The purpose of the project is to:

- Evaluate **achieved benefits** based on the Smart Meter investment until today – both original and extended business cases
- Evaluate both **financial benefits** (realized cost reduction in kSEK/year) and **non financial benefits**:
 - Quality & Customer Satisfaction (Q&CSI);
 - Reduction of Environmental impact (Env);
 - Safety for customers and entrepreneurs (Safety).
- Evaluate **differences between AMR 1&2** (30% of the customers) **and AMR 3** (70% of the customers)

Each business case is summarized in the following format.

Business case	Meter capabilities		Financial benefits	Non Financial benefits		
	AMR 1&2	AMR 3	Realized kSEK/a	Q&CSI	Env	Safety
Described business case	Needed Smart Meter functionality (NO if lacking)		Realized value for BC	Estimated value (High/Medium/Low)		

Table 1: Method to evaluate and present the business cases

The evaluated business cases are grouped into three categories that described in the following chapters.

Business case
Original - Implemented
Monthly billing
Move in/out
Supplier change
Customer support
Non-technical network losses
Extended - Implemented
0-faults
Power outage - compensation to customers
Remote switch off/on
Presentation of daily/hourly values to customers
Extended - Evaluation/Pilot
Detect wrong fuse size
Optimize network losses - hourly values
Power outage - identify proactively
Power outage - remaining faults and restoration
Power quality
Network planning

Table 2: Overviews of business cases included in the paper

ORIGINAL BUSINESS CASE - IMPLEMENTED

The implemented original business cases are collection of meter readings for monthly billing, supplier change, move out/in. But there is also a major contribution from reduced non-technical network losses which was not originally foreseen to add such a high value. The total financial benefit for the original business cases is close to 70 MSEK (~7,8 MEUR) per year.

Business case: Meter readings

Smart Meters and systems automatically collect meter values at customer premises. Before Smart Meters, collection of meter values was done by manual readings, either by the customer or by field crew. Meter readings need to be collected every month by legislation to ensure correct billing. Meter values need also to be collected when a customer moves in and out as well as when a customer changes supplier.

The financial benefit from using Smart Meters is calculated based on the following two scenarios, where both scenarios show the situation after July 2009 when monthly readings are required:

1) Smart Meters – actual situation: The yearly cost consists of the internal process for metering and reporting when Smart Meters and systems are implemented. The yearly cost also includes the Smart Meter investment, which is based on the cost for interest on the investment and cost for depreciation over a 10-year period.

2) Manual readings – fictive scenario: The yearly cost consists of the internal process for metering and reporting using manual readings (without the Smart meters and system). The yearly cost also includes cost for manual readings. Monthly readings require 12 times more readings per year compared to yearly readings. Therefore, the cost per monthly reading is assumed to be 50% of the cost compared to yearly readings (conservative volume discount). Also the cost for spontaneous readings for supplier change and move out/in is assumed to be 20% lower due to the total higher volumes of manual readings.

The difference in yearly cost between using 1) Smart Meters and using 2) manual readings is summarized column 4 in the table below.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Monthly billing	Monthly values	Monthly values	7.600	High	High	Low
Move in/out	Monthly values	Monthly values	900	High	High	Low
Supplier change	Monthly values	Monthly values	500	High	High	Low
Customer support	Monthly values	Monthly values/ Events	Not quantified	High	Low	Low

Table 3: Results for four original business cases

The total financial benefit from the Smart Meter investment is estimated to be at least 9 MSEK (~1 MEUR) per year under the assumptions described previously. The largest part comes from monthly readings due to the high volumes. In practice it would have been impossible to use manual readings to collect monthly readings. So the comparison shall only be used as an indication showing that the Smart Meter investment is also financially better than using manual readings.

There are also non-financial benefits from using Smart Meters such as higher customer satisfaction due to exact invoices to customers and better meter data to handle customer requests and complaints. There is also improved environmental impact due to less driving by field services for manual readings as well as some increased safety due to reduced risk for traffic accidents.

Business case: Non-technical network losses

The Smart Meter investment and collection of monthly values has substantially reduced the cost for non-technical network losses. Using Smart Meters has improved the control of non-technical network losses caused by broken meters, thefts, faults in data quality, etc. Parallel to the rollout of Smart Meters and systems, there have also been other projects that have contributed to lower costs for non-technical network losses. A new billing system has been implemented; process improvements have been implemented as well as activities to increase the data quality.

The calculations of the financial benefit are based on the cost for network losses before and after Smart Meters were rolled out. It is assumed that the technical network losses are not affected, so the reduction comes for non-technical network losses. The contribution to non-financial benefits is judged to be low.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Network losses non-technical	Monthly values	Monthly values	58.000	Low	Low	Low

Table 4: Results for business case non technical network losses

It is difficult to quantify how much Smart Meters will contribute compared to other activities and projects. The assumption is that Smart Meters have contributed with a substantial part of the total cost reduction for non technical network losses in the order of 58 MSEK (~6,4 MEUR) per year.

EXTENDED BUSINESS CASES – IMPLEMENTED

There is continuous work ongoing to find new areas where the Smart Meter investment can add value. Currently there are four extended business cases implemented: zero-faults; remote switch off/on; power outage – correct compensation to customers; and presentation of daily and hourly values. The total financial benefit is up to 20 MSEK (~2,2 MEUR) per year.

Business case: Zero-faults

The voltage could be abnormal at the different phases when a zero-fault occurs. There can be a much higher voltage on one or two phases and a lower voltage on the others. High voltage can destroy electric equipment such as TV, PC etc. Freezers and refrigerator may not start if there is a low voltage and these may break and in the worst case cause a fire. So zero-faults are dangerous and may cause different types of failures in buildings, injuries to persons and broken equipment. There is about one zero-fault per week in average among Vattenfall's customers. Around 800 kSEK of compensation is paid every year to customers due to broken equipment caused by zero-faults. The Smart Meter can send events indicating zero-faults. The control centre has then the possibility to detect the risk for zero-faults early and take corrective action and inform the customer before a serious situation occurs. The possibility to detect zero-faults early depends on the situation. For example, degrading of a connector or a cable is possible to detect, but not if a cable is cut, so it is not possible to detect all zero-faults.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Zero-faults	NO	Events	0 - 150	High	Low	High

Table 5: Results for business case zero-faults

There is a rather limited financial benefit from zero-faults, estimated up to about 150 kSEK (~17 kEUR) per year. But the non-financial benefits are very important. Identifying the risk for zero-faults before they occur would give less costs and problems for both Vattenfall and customers. Benefits for both Customer satisfaction and Safety are thus considered to be high.

Business case: Remote switch off/on

When a customer moves out from an apartment the customer will terminate the electricity contract. (For houses/villas there is in practice always a new customer moving in.) If there is no new customer with a contract in the apartment there will be no customer paying for electricity. If a new customer moves in without notifying or if there is other electricity consumption in the apartment, no one can be charged for the electricity cost. To avoid that risk, the electricity is switched off when a customer moves out and no new customer is moving in. This is normally done by sending field crew to the premises to manually

switch of the electricity. Also for persons not paying their bills there may be a need to switch off the electricity. Using remote switch off/on will avoid sending field crew to the customer premise to switch off and on the electricity. The total yearly benefit is in the order of 14 to 20 MSEK (~1,6 to 2,2 MEUR) per year.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Remote switch off/on	NO	Remote on/off	14.000-20.000	High	High	Med

Table 6: Results for business case remote switch off/on

There will be substantial financial benefits for remote switch off/on since it is expensive to send out field crew. There are also non-financial benefits like improved safety for field service since they do not need to meet potentially upset customers, not uncommon in the case with bad payers. There is also an environmental benefit from less driving and less CO₂-emissions.

Business case: Power outage – correct compensation to customers

The Smart Meter can collect statistics and show what customers have been affected by a power outage and for what period. Without detailed information from Smart Meter about the power outage, you have to rely on customers calling in or information about affected areas with power outage without detailed information about individual customers. Therefore customers may have been compensated for a power outage even if they were not affected.

With power outage information from Smart Meters, only the affected customers will be compensated. This will in some cases save money for Vattenfall, but in other cases more customers may be compensated. In the latter case, the benefit will also be higher customer satisfaction due to correct compensation. The financial benefit varies at different times and is estimated to be up to 1 MSEK (~100 kEUR) per year.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Power outage - compensation to customers	NO	Events	0-1.000	Med	Low	Low

Table 7: Results for business case power outage - compensation

Business case: Presentation of daily and hourly values

Correct meter values via Smart Meters can be presented to customers via internet on a PC, smart phone, etc. This enables the customers to get a good overview of their energy consumption. Currently Vattenfall Distribution present daily values to customers. Also hourly values can be expected to be presented to the customers in the future.

Business case	Meter capabilities		Financial	Non Financial		
	AMR 1&2	AMR 3	kSEK/a	Q&CSI	Env	Safety
Presentation of daily/hourly	Daily/hourly values	Daily/hourly values	No financial results	High	Low	Low

Table 8: Results for business case daily/hourly values

There is no estimation of the financial benefit for presentation of daily and hourly values. But presentation of daily and hourly consumption will increase the customer satisfaction.

EXTENDED BUSINESS CASES – UNDER EVALUATION AND IN PILOTS

There are several additional extended business cases that are under evaluation and some are also in pilot phase.

Some of the extended business cases are not yet possible to implement since they require higher resolution of the consumption for all customers in the network area. Hourly metering is thus needed but that is not yet implemented for all private customers in Sweden. All three types of meters AMR 1, 2 and 3 of can handle hourly values.

For many of the extended business cases in the table below, there is also a need for more advanced functionality only available in AMR3 meters.

Business case	Description	AMR 1&2	AMR 3
Extended - Evaluation/Pilot			
Detect wrong fuse size	Detect customers who have too large a fuse compared to their contract. They may have changed to a larger fuse size without paying for it.	NO	Events
Optimize network losses - hourly values	Further reduction of network losses, using hourly values giving detailed information also about technical losses	Hourly values	Hourly values
Power outage - identify proactively	Identify where there is a power outage before customer via AMR-meters (last mile scada)	NO	Events
Power outage - remaining faults and restoration	Proactive fault tracing to find where the power outages are located and fixing faults - without calling customers	NO	Events/ping
Power quality	Detect power quality problems and optimize network investments	NO	Events
Network planning	Optimize investments, invest only where and when needed, defer investments	Hourly values	Hourly values/Events

Table 9: Overview of extended business cases under evaluation

VALUE OF UPGRADING AMR 1&2 TO MORE ADVANCED FUNCTIONALITY

Three of the extended business cases that are implemented require functionality that is only available in AMR 3 such as handling events and remote switch off/of. So currently it is not possible to implement these extended business cases for about 30% of the customers with AMR 1&2 meters. Also many of the extended business cases under evaluation and in pilots require AMR3 meters. The direct financial benefit from upgrading meter functionality for AMR 1&2 is almost 10 MSEK (~1,1 MEUR). However, the investment cost for upgrading meters is not taken into account and a complete business case need to be developed.

CONCLUSION

The Smart Meter investment has given a positive financial benefit according the original business case. The total financial benefit is close to 70 MSEK (~7,8 MEUR) on a yearly basis when comparing the reduced cost before and after the Smart Meter rollout. The contribution from meter readings using Smart Meters is about 9 MSEK (~1 MEUR). Reduction of non-technical network losses gives the major contribution with about 58 MSEK (~6,4 MEUR) on a yearly basis. This is very positive and such a high figure was not originally anticipated. The Smart Meter investment has also contributed to increased value from important non-financial benefits like Quality & Customer satisfaction, Reduction of environmental impact, and Safety.

Additional value from implemented extended business cases is up to 20 MSEK (~2,2 MEUR) per year.

The meter functionality in AMR 3 is more advanced and needed in most of the extended business cases. There is a potential of 10 MSEK (~1,1 MEUR) per year in upgrading AMR 1&2 to more advanced functionality.

The current Smart Meter investment will also continue to add more value since it can be used for future requirements without new major investments. According to a new legislation in Sweden in effect by October 2012, DSOs must provide hourly values for Private and SME customers who have selected an electricity contract based on hourly values, e.g. hourly spot price. This new requirement can thus be fulfilled with the current Smart Meter investment.

Also new large and important Smart Grid projects, e.g. Smart Grid Gotland and Grid4EU, require many real end-customers with Smart Meters.