

COMPARISON OF LIFE-CYCLE COSTS OF ENERGY METERING PROCESSES

Petri TRYGG
Tampere University of technology
Institute of Power Engineering
Finland
petri.trygg@tut.fi

Harri I. KULMALA
VTT
Industrial Systems
Finland
harri.kulmala@vtt.fi

Pertti JÄRVENTAUSTA
Tampere University of technology
Institute of Power Engineering
Finland
pertti.jarventausta@tut.fi

ABSTRACT

In this study, the basis of understanding and analyzing the business framework for measurement in competitive environment is created. Metering issues are currently discussed widely because investment decisions for automated meter reading (AMR) are currently under consideration in many European countries. The possibilities that new technology in the form of AMR offers can be studied more closely when cost structures of metering are more accurately known.

In this study life cycle costs for 11 different kind of metering activities are presented. These are combination of 5 different Finnish distribution companies' alternatives to carry out energy measurement. Results show that the nature of metering processes varies according to the way they are carried out. Cost structures show also the parts of organization that put efforts on energy information creation. New technology in form of Automated Meter Reading (AMR) can change the business processes and work in general inside organization. This factor should also be considered. AMR can also cause needs for additional features to fully benefit the investment.

INTRODUCTION

The aim of this study is to analyze the cost structures of different metering activities in distribution companies. There are many factors affecting the cost of metering and knowledge of understanding some of these factors is the results of the study. This paper presents the metering activities and real cost structures to increase understanding of different possibilities in organizing metering.

This study for five Finnish Distribution Network Operators (DNO) was conducted during 2005-2006. The data was collected from the companies' 2003-2004 accounting information. Method used is described more closely on next chapters.

Preliminary results of this study have already been presented in Cired 2005 conference as a single case study of a single company [1].

STUDY METHOD

Understanding the activity and cost structures is a crucial element in evaluating new ways of organizing business processes. Activity based costing (ABC) was applied to provide information on cost structure of energy

measurement business processes.

The aim of activity-based costing (ABC) is to determine the actual product cost by studying all activities under each process performed by resources. The idea of ABC is presented in Figure 1. Companies' processes can be described as activities at the selected level of details. In order to reach its goals, an ABC system should assign cost factors to cost-objects via resource and activity drivers. Both activity and resource drivers should be defined according to cost-objects' activity and resource use before this assignment is possible. [2, 3]

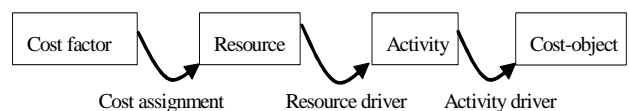


Figure 1. Assignment of cost factors to cost-objects.

Conducting activity and resource analyses needed to follow the procedure of Figure 1 is very complicated because of the time and cost requirements of these analyses. Therefore, a fast interview-based research method was applied in this study.

The study was conducted for five different Finnish DNOs. Companies present large and small utilities. Also the distribution area of the companies varies from small urban area with high customer density to large rural area with low customer density. Also comparison between in-house and outsourced processes can be made from the results of the analysis.

The metering function was divided into following processes for traditional or AMR meters:

- New measure assembly
- Annual reading
- Change reading
- Meter replacement
- Annual or period reading

These processes were selected as cost-objects, and costs for each of these were measured via resource analyses. These processes are presented more closely including some of the activities in next chapter.

The data for analyzing the processes was gathered from the following sources: the accounting systems of the utility, a vendor for measurement systems and equipment, and the personal of the measurement operation. The data of the accounting systems concerning the activities under

processes mentioned above was examined thoroughly. The information of the processes was put together and analyzed in a Microsoft Excel spreadsheet. The spreadsheet included the processes mentioned above and their costs each divided into material, direct labor costs, indirect labor costs, fixed labor costs, and capital costs.

METERING PROCESSES

This chapter describes the different processes studied.

1. Annual reading of traditional energy meter

The process covers systematic and planned manual readings of energy meters annually and on site. The reading is done by employee of the distribution company or its subcontractor.

The uncertainty in the process is caused by availability of readings. In some cases the customer cannot be reached and postcard for sending the reading is left on site. Card readings must be inserted into the system separately. This makes confusions in the amount of meter readings inserted in the systems. In Activity Based Costing (ABC) method the number of processes done is important. In some cases this was uncertain and estimations were used.

2. Change reading of traditional energy meter

When customer moves reading must be conducted to complete billing. This process is called change reading. Compared to annual reading the process has different phases. The main difference is, that it is always a single case reading. In some cases the customer informs the distribution company about the meter reading and visit on site is not required. The ratio of these varies according to companies. Also incorrect meter readings cause second visit to the metering site. In some cases the amount of these incorrect readings were known. This causes also uncertainty to the cost of the process.

3. Meter replacement

Meter replacement process includes activities done to change existing meter. Depending of the case the new meter is either traditional or AMR meter. The meter type has effect on the cost of the process. AMR meter present higher material cost due to more expensive meter. Some companies use maximum time for meters in network. This causes annually changing amount of meter replacements. Also miss functioning of the meters cause meter replacements. Due to becoming AMR investments some companies have suspended the annual meter replacements. This cause uncertainty to the process costs.

4. New meter assembly

The process covers establishments of new metering sites on network. Compared to meter replacement more indirect labor is required to establish metering site also to information systems. Meter cost is presented on the material cost and depends also on the type of the meter.

5. AMR meter reading

This process covers the Automated Meter Reading (AMR) activities. Compared to the annual reading process is automated so that the reading is done using telecommunication to acquire the correct reading. Annual reading and change reading are basically the same process and don't require significant extra work. Uncertainty to this process is caused by the fact that in all of the companies studied AMR was more or less on experimental level and processes were not as clear and well organized as in traditional meter reading. Only in one company the AMR meters were implemented under 63 A fuse size. This causes uncertainty in comparing traditional and AMR readings. Results of this single case study can be found from [1]. Usually mobile phone network or Power Line Communication (PLC) is used in telecommunication. In some cases also the combination is possible. Telecommunication provides new possibilities to interact with meter. The new possibilities can be utilized by developing meter's features.

RESULTS OF THE STUDY

In this chapter the life cycle costs for energy measurements for a 20- year-period is presented. To better compare the different options, annual reading is calculated to take place once in a year in both traditional and AMR reading. Technology makes it possible to increase the rate of reading to monthly and even daily reading. Increased rate of reading means additional costs from telecommunications.

In figure 2 the aim is to provide information of different kind of choices and their cost effect on total life cycle. From 5 different companies the result is 11 optional ways of producing metering function. This was done by calculating all the possible solutions when using the traditional / AMR reading and in-house / outsourced operations. Number in parenthesis presents company.

Parameters used in calculating the results are following:

- 20 year life cycle.
- One meter assembly in each life cycle cost.
- The results have been calculated to be more comparable by calculating annual reading once a year in to all of the processes.
- The rate of moving used is every 5th year. In 20 year life cycle this means 4 move readings

Figure 2 illustrates life cycle costs of the studied companies. Each company has been presented according to its different processes and simulated to be comparable by setting the rate of processes same.

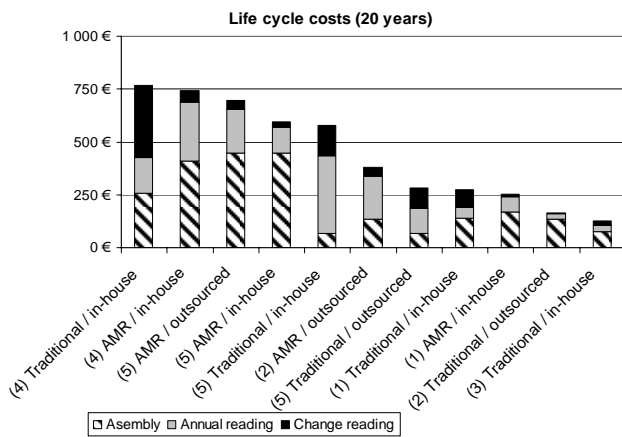


Figure 2. Life-cycle cost in different companies divided into different processes.

The cost variation in life cycle costs is quite high. In general can be said that neither the in-house/outsourced or the AMR/traditional processes are explaining factors when considering the total life cycle cost. This was verified with statistical TTest's. When studying the nature of the distribution area of different DNOs some explaining factors seem to be available. In this study higher customer density with smaller distribution area is reducing the total annual cost most efficiently. TTest show that dependency is very small as described in table 1. This means that the size distribution area combined with low customer density has impact on life cycle cost.

TTest compare statistical dependency of two groups (X_1 and X_2). The equation of performing TTest is:

$$t = (x_1 - x_2) / \sqrt{[(s_1^2/n_1) + (s_2^2/n_2)]}$$

Statistical difference can be seen with values under 1 %.

Table 1. TTest results on selected parameters of life-cycle costs in collected data.

Groups	Test 1	Test 2	Test 3
Group 1 (X_1)	In-house	Traditional	Urban
Gropu 2 (X_2)	Outsourced	AMR	Rural
TTest result	55,6 %	26,8 %	0,2 %

Further results show that meter assembly in AMR processes is the most significant cost factor. This is due to the more expensive meter. In future the price of the meter's is expected to decrease. In traditional metering process change reading process has higher cost affect that in AMR. This is due to the different nature of the annual and change reading process when considering traditional metering process. Annual reading is conducted as single task while annual reading is made cost efficient by its serial work nature. As a broader conclusion it can be said that in any processes the aim should be towards serial type of work when considering the cost efficiency.

When showing the different cost factors for figure 2 more

information of the cost structure is revealed. This information is presented in figure 3.

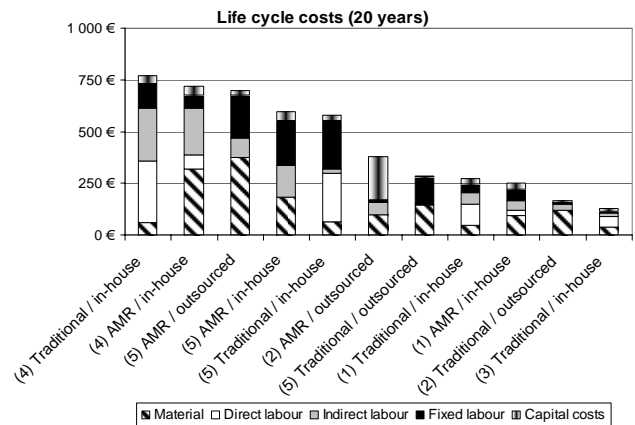


Figure 3. Life-cycle costs of the study presented in different cost factors with same parameters than in figure 2.

Figure 3 gives a good idea of the organisational work on metering. The amount of fixed labour can be seen as a black portion in the total costs. Also the proportion of meter cost can now be more easily seen as the material cost is mainly the cost of meter. Since the years of the data collected for this study some development in meter prices has occurred. This effect can be understood by looking the picture 4 and knowing the current price level of the AMR meters. In outsourced processes material cost is the cost for activities purchased from third party.

Figure 4 illustrates the results according to existing practice in the companies that are analyzed in this study. Difference is that annual readings are done monthly in AMR readings. This causes significant raise in the total costs.

When looking life cycle costs with real monthly rate of AMR reading the change is significant. The increase in the costs is large. This is one element of understanding AMR costs. The rate of reading affects the life-cycle costs. But as the rate of reading increases the rise of cost is not straight forwarded. A rule of a thumb is that when the amount of activities increases the cost for single activity decreases. Conclusion is that the rate of readings should be studied carefully with knowledge of the existing cost structure and possible new features installed to the AMR system. These factors give more benefit of increased reading costs.

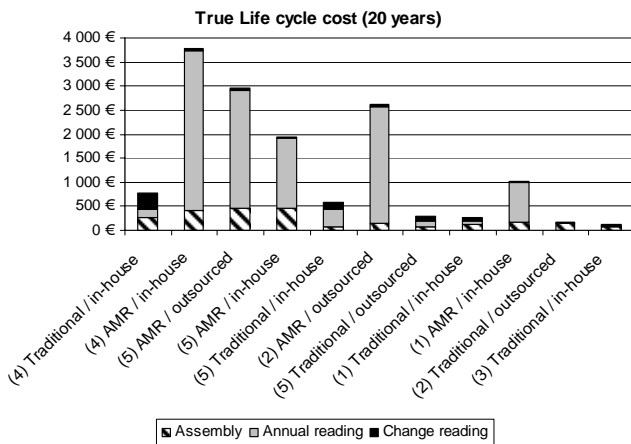


Figure 4. Affect of monthly rate of AMR into life cycle costs.

CONCLUSIONS AND DISCUSSION

The AMR investment may decrease the operational costs when implementation is made considering all the aspects of the effects to the metering costs. Decreasing costs also encourage studying new possibilities in way of organizing business processes in general. Outsourcing provides alternative solutions for cost management.

This challenge is also present with current Automatic Meter Reading (AMR) discussion with Nordic DNOs. AMR development not only causes heavy capital investments but also changes some of the business process structures. The challenge is to make choices that fit best for companies needs but also gets full potential of investment in use. Fully utilizing the investment also requires that organization adopts new models.

Other projects currently under study concentrate on developing additional features for AMR. AMR meter is a metering device and this provides multiple possibilities to develop new functions such as low voltage network monitoring. [7]

Combining technical and economical studies with business model creation is the key element of adopting AMR in different levels of business processes. Information and the technological change management causes challenges for the whole organization. Organization also faces decisions of outsourcing. This element also affects the final solution.

Also the costs effects of the new features should be carefully studied to better understand all of the dimensions in AMR. AMR affordability is depending e.g. on following issues:

- Planning and studying AMR implementation [5]
- The customer density and network structure of distribution company
- Good organizing of metering processes
- Rate of readings annually
- Rate of movings
- Additional features such as DSM [4], Power Quality monitoring [6] and network monitoring [7]

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