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MASTER THESIS:

Electrical consumption dilemma - All we need is a new metering system?

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Abstract

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Electricity consumption are increasing, as our society keeps on growing. Due to climate changes and human impacts, it is clearly that we need to slow down this trend. One of the most important activity that each consumer can contribute due to this matter is to reduce our usage. This addresses a dilemma, in which human activity and realization of the need to change within consumption is a crucial factor in order to achieve effective usage.

The European commission has reached out to the advanced metering systems (AMS) as part of a solution. Advanced metering systems (AMS) is a system that provide consumers and supplies information on real time consumption. EU aimed to equip at least 80% of all consumers with smart metering before 2020.

Norway have followed this footstep as well, and according to NVE regulations §4-5 (42) advance metering system will be install for all electricity consumers in Norway by 1. January 2019 (42)

It seems to exist a strong faith in AMS within public organs, and the aim of this thesis is to explore AMS technology and views of it at a consumer's level. The research has focus on consumer groups within manufacturing companies and household. The scientific ambition of the research is to contribute to an understanding of our mindset, our attitudes towards the environment, AMS technology and energy consumptions. Another scientific ambition is to be a contribution for future research within energy and consumption field.

The chosen method for this thesis is quantitative method. The main reason for the chosen method is because quantitative method represents larger crowd, and it contribute to form a basis for a systematic review of the consumers' attitude towards AMS smart metering.

The results reveals that it does not seems to exist as much faith as it may have been taken account for in AMS within consumers. However, these findings are subject to changes in the future. Findings reveals a common motivational factor due to changes within consumption as economic benefits. This benefit seems to be a driven factor in both groups of consumers.

The research concludes that comparing to the metering system that exist today, AMS smart meter is an important investment that suits for the future. However, it does not necessary means that AMS itself can lead to less electricity consumption. In order to reduce consumption, require an interaction of human actions and technology development.

Terminology

SSB	Statistics Norway
TWh	Terawatt Hour
GWh	Gigawatt Hour
KWh	Kilowatt Hour
NVE	The Norwegian Water Resources and Energy Directorate
IEA	International Energy Agency
DSO	Distribution System Operators
CO2	Carbon Dioxide
AMS	Advanced metering systems
EMS	Energy Management System
ISO	International Organization for Standardization
WWF	World Wide Fund for Nature
UN	United Nations
EU	European Union
TU	Teknisk Ukeblad – Technical Magazine
NRK	Norsk rikskringkasting AS - Norwegian Broadcasting Corporation

Table of contents

Abstract I
Terminology III
Figure List VI
Table List: VIII
Equation: VIII
Chapter 1: Introduction 1
1.1 Introduction of Chapter 1 1
1.2 Background 1
1.3 Purpose and research Question 2
1.4 Limitations of the research 3
1.5 Structure of the thesis 5
Chapter 2: Method 6
2.1 Introduction of chapter 2 6
2.2 Qualitative method and Quantitative method 6
2.3 Method view 7
2.4 Which method for this thesis and why? 10
2.5 Validity and Reliability 12
2.5.1 Validity and reliability of the thesis 12
Chapter 3: Theory 13
3.1 Introduction of chapter 3 13
3.2 The Power market in Norway 13
3.3 Production and consumption of energy in Norway 14
3.3.1 Electric Production in Norway 15
3.3.2 Hydro power 17
3.3.3 Wind Power 18
3.3.4 Thermal Power 20
3.3.5 Consumption of electricity in Norway 20
3.3.6 Consumption of electricity from power intensive manufacturing industries 21
3.3.7 Consumption of electricity from household 24
3.3.8 Export and Import of electricity in Norway 25
3.4 The political debate and the climate targets 26
3.4.1 European Union (EU) climate targets 27
3.4.2 International commitment and the Kyoto Protocol 28

3.4.3 Norwegian climate targets and commitment....29
3.5 Advance metering system (AMS)....31
3.5.1 Advance metering system technology....31
3.5.2 Implementation of AMS technology....35
3.5.3 Benefits of AMS....36
3.5.4 Challenges of AMS....38
3.6 Energy management and manufacturing industry....41
3.6.1 Management system within manufacturing....42
3.6.2 Energy management system....43
3.6.3 Implementation and certification of energy management system....45
3.7 Environment and human psychology....49
3.7.1 Environmental psychology....50
3.7.2 The interaction between climate changes and Human activities....53
3.7.3 Encouraging Environmental behavior....56
3.8 Organization behavior changes....59
Chapter 4 Data collections and Analysis....61
4.1 Introduction of chapter 4....61
4.2 Data collection approaches....62
4.3 Evaluation of data collection and quality....63
4.3.1 Information that were provided to informers....63
4.3.2 The amount of responds....64
4.3.3 The reasons for dropout....65
4.3.4 The quality of answers and possible bias....66
4.4 Data results and analysis....67
4.4.1 Data results and analysis from private household....67
4.4.2 Data results from manufacturing companies....75
Chapter 5 Discussion....81
5.1 Introduction of chapter 5....81
5.2 Why should we have AMS smart meter?....81
5.2.1 Why should Household have AMS smart meter?....83
5.2.2 Why should Manufacturing companies have AMS smart meter?....89
5.2.3 Society expectations....96
Chapter 6: Conclusion – All we need is a new metering system?....98
Future Work....100
References List....101
Appendices....108

Appendix 1 1

Appendix 2 3

Figure List

Figure 1: The system view. Sources: Arbnor and Bjerke, 2009 (11), page 53 8
Figure 2: The Analytical view. Sources: Arbnor and Bjerke, 2009 (11), page 52 9
Figure 3: The Actor view, Sources: Arbnor and Bjerke, 2009 (11), page 54 9
Figure 4: The different between explanatory and understand knowledge. Arbnor and Bjerke, 2009 (11), page 51 10
Figure 5: Overview of the Power Market in Norway. Sources: Segtnan 2011, page 3 (13) 13
Figure 6: Electricity production 2014 by type. Sources: Statistics Norway (19) 16
Figure 7: Hydro power plant. Sources EDF energy (20) 17
Figure 8: A wind turbine system. Sources: statskraft about wind power, 2010 (23) 18
Figure 9: Wind power system. Sources: National instrument. Introduction to a Wind Power System (24) 19
Figure 10: Wind Power Production time Line (sources: SSB, 19, 26) Made by author. 19
Figure 11: Thermal power production from different energy sources in 2009 in percentages. Sources SSB report no 2/2011 (26) 20
Figure 12: Total consumption of electricity in GWh. Sources: Statistics Norway, Electricity, 2014 (19) 21
Figure 13: Power consumption in power intensive industry in 2009, Sources SSB report no 2/2011 (26) 22
Figure 14: Monthly electricity use in Norway. 1993 to 2013. Sources: Report No 69/2013. By NVE. (28) 23
Figure 15: Private Household and agriculture electricity consumption in 2014 by group in percentage. Sources: Statistics Norway: Electricity, 2014 (19) 24
Figure 16: Export of electricity from Norway to other countries in 2009 in percentage. Sources: SSB report no 2/2011 (26) 25
Figure 17: Import of electricity to Norway from other countries in 2009 in percentage. Sources: SSB report no 2/2011 (26) 26
Figure 18: Distribution operator's responsibility. Sources: About AMS by NVE (48). Made by Author. 32
Figure 19: System value chain. Sources: Segtnan, 2011 (13) 33
Figure 20: Possible central system solution, adapted from Aidon 2011, sources: Segtnan, 2011 (13, page 46) 35
Figure 21: Installation processes of smart electricity meters in EU Member States by 2020. Sources: EU report, 2015 (55) 36
Figure 22: Todays metering system comparing to smart meter system (AMS). Sources: Report about smart metering by Gerwen, Jaarsma, Wilhite and KEMA. (58) 38
Figure 23: Energy management system model, sources Norwegian Environment Agency (67) 44
Figure 24: Energy management system model. Sources: ENOVA guidelines: Energy Management, 2012 (63) 46
Figure 25: Energy management system information flow, sources Enova, Interaction between people, technology and organization (71) 47
Figure 26: Energy management requires cooperation, Sources: The Norwegian Environment Agency (67) 48

Figure 27: ISO 50001 Certificates in Norway 2014. Sources: ISO standard (74) 49
Figure 28: The invisible triangle. Sources: Tony Cassidy, 2013 (75) 52
Figure 29: Prediction of average temperature and precipitation from the year of 1986 – 2005 comparing to 2081 – 2100. Sources IPCC report 2014. (77) 54
Figure 30: Human and Psychological Dimensions of Climate Change. Sources Psychology's Contributions to Understanding and Addressing Global Climate Change (78) 55
Figure 31: Systematic approach due to environmental behavior. Inspired by Linda Steg and Charles Vlek, 2008 (80). Made by author. 57
Figure 32: The total response rate in percentage. Made by Author. 64
Figure 33: Response rate divided in target groups. Made by Author. 64
Figure 34: Response rate within target groups. Made by Author. 65
Figure 35: Question no 15 - What type of resident are you living in? Made by Author. 67
Figure 36: Question no 16 - How much electricity do you use in a year? Made by Author. 68
Figure 37: Question no 17 - Were you aware of NVE regulations regarding smart meters?.....68
Figure 38: Question no 18 - Do you have AMS meter installed in your home today? Made by author. 69
Figure 39: Question no 19 - How often do you read of your electricity meter? By author. 69
Figure 40: Question no 20 - Do you think AMS meter might have reducing effect on electricity consumption? By Author. 70
Figure 41: Question no 21 - Do you think AMS meters can lead you to reflect on your own electricity usage? By author. 70
Figure 42: Question no 22 - Do you think that AMS meters might have reducing effect on climate emission? By Author. 71
Figure 43: Question no 23 - Do you think you are going to implement energy-saving action because of AMS meters? By Author. 72
Figure 44: Question no 24 - Assumed that you are going to implement energy savings actions, in what extent will be main reason for that? Results for all options combined in percentage. By Author. 73
Figure 45: Question no 24 - Option 1 - Of Economical Consideration? By Author. 73
Figure 46: Question no 24. Option 2 - Of Environmental Considerations? By Author. 74
Figure 47: Question no 24. Option 3 - Of Conscientious or moral considerations? By Author. 74
Figure 48: Question no 25 - What do you think is the main reason for peoples to not implement energy-saving actions? By Author. 75
Figure 49: Question no 3 - How much electricity do your company uses in a year? By Author. 76
Figure 50: Question no 4 - Did your company implemented any kind of energy- saving actions? By Author. 77
Figure 51: Question no 6 - what type of benefits did your company gain with energy savings actions? By Author. 77
Figure 52: Question no 8 - Would your company considered to gain ISO 50001 certification? By Author. 78
Figure 53: Question no 10 - Do you think AMS meter might have reducing effect on your company's electricity consumption? By Author. 79
Figure 54: Question no 11 - Do you think AMS meters can lead you to reflect on your own electricity usage? By Author. 79
Figure 55: Question no 13 - Do you think that AMS meters might have reducing effect on climate emission? By Author. 80
Figure 56: The impacts of AMS smart meter within household and manufacturing companies. By Author 82
Figure 57: AMS smart metering benefits for household. By Author. 83

Figure 58: The contrary of economic benefits and its challenges. By Author. 85
Figure 59: AMS smart metering and human interactions lead to environmental benefits. By Author. 86
Figure 60: Approaches to achieve environmental benefits. Inspired by Gardner and stern, 2002 (81). Made by author. 88
Figure 61: AMS smart metering as a tool in an energy management system benefits within manufacturing companies. By Author. 91
Figure 62: Energy savings actions and decisions makers within household. By Author. 92
Figure 63: Energy savings actions and decisions makers within Manufacturing. By Author. 93

Table List:

Table 1: Structure of the Thesis. By Author. 5
Table 2: Key categories of research. Sources: Elis and Levy, 2008 (8) 6
Table 3: Electricity production from 2012 – 2014 in GWh. Sources: Statistics Norway (19) 15
Table 4: Electricity production 2014 by type in GWh. Sources: Statistics Norway (19) 16
Table 5: Risk assessment of scenarios. Sources: Sintef, 2012 (60) 39
Table 6: General psychological barriers Sources: Robert Gifford, 2011 (77) 56
Table 7: Conclusion Table, By author. 99

Equation:

Equation 1: Lewin equation: Human and environment. (76) 50

Chapter 1: Introduction

1.1 Introduction of Chapter 1

The aim of this chapter is to explain why I have chosen smart metering system as my topic, and the purpose of the research.

This chapter will provide background and the research questions of the master thesis. Limitations are unavoidable in researches. However, one should know and acknowledge limitations. Limitations of the research are provided in this chapter, in order to present the objectives and limitations of the research.

1.2 Background

Electricity is one of the most important elements of modern life. It is necessary for lighting, air condition, hot water, production etc.

Overall, electricity provides great comfort to our needs, and most people just cannot think of a life without electricity. Despite the importance of electricity, we usually do not reflect on our own usage. As consumers, we just need it to be available.

The main sources of electricity in Norway comes from hydropower, which is an environmental friendly and renewable energy source (3). Despite being almost 100 percent renewable, there are environmental impacts associate with electricity production and transmission. Impacts such as, greenhouse gas emission and different ecological impacts. These impacts are relating to climate changes, and other environmental impacts.

The focuses around climate changes and human impacts has emerged over the past years. As a part of the Kyoto protocol, Norway has planned to reduce the global greenhouse gas emissions to 30 percent of Norway's 1990 emissions by 2020. The goal is to be carbon neutral by 2050. (4)

According to statistics Norway (SSB), the total energy usage in Norway has increased approximately 3 percent from 2011 to 2012. The total energy usage is 220 TWh, which is one of the highest usage level registered. (1) The trends predict that electricity consumption will continue to increase.

Due to climate changes and human impacts to the environment, there are different areas that need attention, and energy consumptions is one of the main concern. While trends predict that electricity consumption will continue to increase, and we do need to reverse this trend. Obviously, we are facing an electricity consumption dilemma and the question is how can this be resolve?

The European commission has reached out to the advanced metering systems (AMS), other definition is smart electricity meters as a part of the solution. Advanced metering systems (AMS) is a system that provide consumers and supplies information of real time consumption. (5)

AMS is expect to be a tool that contribute to better knowledge of usage, and consumer's opportunity to adapt electricity usage. According to the European commission report in 2014, the expected average energy savings of having a smart meter system are 3 percent. (5)

This thesis is about electricity usage in Norway, with focus on manufacturing and household as consumer groups. The research concentrate about the technology of AMS, and its benefits to manufacturing and household groups.

I have worked at Agder Energy Nett AS from 2011 – 2013, it was where I have first learned about the AMS metering system. Although I did not work directly with the project, I have found the technology very interesting. It seems to exist a strong faith in AMS system, which is one of the main motivation for me to choose this as my topic.

1.3 Purpose and research Question

The human impacts of the environment have been one of major focus over the past years due to climate changes. There are several discussions and researches about how to reduce emissions and consumptions. There are arguments about the need to invest and develop technologies that can reduces climate changes. However, technologies and equipment cannot help us alone. We need to look at our overall attitudes against the environment.

According to NVE, The Norwegian smart grid center and IEA (International Energy Agency), smart metering system is a system that will provide information to consumers, which will contribute to reduce consumption, peak demand and stabilizes the electric system.

The AMS smart metering system represents an energy revolution that contribute to less emission. These statements about AMS smart metering system is one of the reasons for my research questions, because the research questions in this thesis are related to how consumers will reacts to the received information. Will we change our behavior due to information that we get from the AMS system?

The research in this thesis focuses on existing facts, statements, theories and psychological behavior towards the environment. The purpose of this research is to gain knowledge about the technology of AMS and concentrate about consumers' attitude.

The research questions are the following:

- Does AMS smart meter contribute to reflect on own usage as a manufacturing organization?

- Does AMS smart meter lead us to reflect on our own usage as individual?

- Are there different perceptions between individuals and organization, when it comes to energy savings incentives?

- Assumed that smart meter (AMS) can contribute to energy management as a control tool or and technology, what are the benefits of it within manufacturing aspect?

In order to answer these questions, the following objectives and actions were developed:

Objectives factors:

- Evaluate the AMS technologies such as an informative technology at a consumers level.
- Evaluate the effect of AMS technology, and the possible psychological behavior from consumers.
- Evaluate benefits from advanced metering systems (AMS) as a part of Energy management system.

Actions:

- Analyze literatures, reports etc. for AMS technologies.
- Analyze literatures, reports etc. about human's psychologies, behavior, changes of attitudes and technologies.
- Analyze method and empires collected through quantitative method.

The practical aim of this research is to study the technology of AMS smart meter and its challenges, in contribution to reduce the global greenhouse gas emissions.

The scientific ambition of the research is to contribute to an understanding of our mindset, our attitudes towards the environment, technology development and energy consumptions. From my point of view, it is important to gain knowledge in this area, in order to evaluate improvements and gain benefits of the technology within manufacturing aspect.

1.4 Limitations of the research

As mentioned, the aim of this research is to gain knowledge of AMS and its technologies. The research concentrate about the consumers attitudes towards the received information from AMS system, and evaluate this matter towards manufacturing process. It is important to stance that the research is not intend as guidelines of how to reduce energy consumptions.

Due to the limitations of time and resources, it was not possible to include all type of electricity consumer groups. The research questions were based on views from consumers as individual, and organization, therefor it is appropriate for this research to concentrate about household and manufacturing industries as consumer groups.

In the beginning of the research, I did not have much knowledge of smart metering system. Therefore, I had to read up on the topics before I could design a questionnaire draft. I believe it is important to have good knowledge of the topic, to be able to design relevance questions.

During the research, I have gained knowledge about AMS system through different websites and report at nve.no; sintef.no; stortinget.no etc. Documents and literatures about this subject has become extensive. However, I have limit it to what I thought were most relevance to mine research questions.

As a researcher in this project, I have tried to be as objective as possible. However, due to the relevance of mine research questions, mine data collections cannot be completely objective, because of the choices and priorities I have done during the collection process.

This thesis is not intended as a guidance or a full description of AMS technologies, because the research does not represent all policies and expert of the topic. AMS system are not installed in all homes and businesses, and for that reason not all data of energy usages are available. During data collection, it seems to be low knowledge about AMS metering system among consumers. Therefor it is important to notice that the results in this research might change in the future, when all AMS smart metering system are installed.

The aim of the research is to studies the links between the technology and its challenges such as psychological behavior regarding to AMS technologies. Despites limitations, I do hope that my work will be a contribution for future research.

1.5 Structure of the thesis

This thesis is a scientific report and I have followed NTNU Gjøvik's guidelines for master thesis. (6)

The thesis structure is described by table 1:

Chapter 1	Introduction	Introduction chapter introduces the thesis background, purpose and the research questions. This chapter also presented the limitation of the research and the structure of the thesis.
Chapter 2	Method	The second chapter is a method chapter. In this chapter, I have described which method that was used, and how chosen method proceeded in order to answer the research questions.
Chapter 3	Theory	Chapter 3 will present theories that are relevance in order to answer the research questions. The theories that are provided in this chapter are the following: Information's about electrical productions in Norway and consumers' groups, AMS smart metering, energy management system, environmental psychological theories and changes within organization.
Chapter 4	Data collection and analysis	In this chapter, the aim is to provide information about how data was collected and an analysis of collected data.
Chapter 5	Discussion	The discussion chapter includes discussion of existing theories and findings in data collection.
Chapter 6	Conclusion	This chapter introduces the conclusion based on collected data and theories.
Future Work	Future work	Future work provide a recommendation for future researches within consumption, benefits and the before/after effect of AMS smart metering system.
References		List of references and literatures that were used in this research.
Appendices		Relevance documents such as: Presentation formal and questionnaires.

Table 1: Structure of the Thesis. By Author.

Chapter 2: Method

2.1 Introduction of chapter 2

The aim of this chapter is to present the chosen method for the thesis, and reasons for chosen method. This chapter will explain the meaning of methodologies and the importance of methods.

In addition, this chapter will provide an overview of how the chosen methods can be link to research questions, and how to answer the research questions based on chosen methods.

At last, this chapter will also provide the importance of validity and reliability in research, and the validity and reliability of the thesis itself.

2.2 Qualitative method and Quantitative method

There are several different approaches and methods within research. The main aim of these are to be able to resolve and answer specific problems. Burns, 2008 (7) states that there are many approaches and methods in order to answer the research questions.

According to Burns 2008 page 5, ''*Research is a process of systematic enquiry or investigation into a specific problem or issue that leads to new or improved knowledge*'' (7)

Table 2 described a summarize and key overview of different approaches.

Approach	Most common type of data	Stage of problem	Categories of Theory
Experimental	Quantitative	Evaluation	Testing or revising
Causal-comparative	Quantitative	Evaluation	Testing or revising
Historical	Quantitative or Qualitative	Description	Testing or revising
Developmental	Quantitative and qualitative	Description	Building or revising
Correlational	Quantitative	Description	Testing
Case study	Qualitative	Exploration	Building or revising
Grounded theory	Qualitative	Exploration	Building
Ethnography	Qualitative	Descriptive	Building
Action research	Quantitative and qualitative	Applied exploration	Building or revising

Table 2: Key categories of research. Sources: Elis and Levy, 2008 (8)

As table 2 illustrated, there are many different approaches and types of data within researches, but each represent different stage of problems. Therefore, one can argue that the chosen approach depends largely on the problem.

Leady and Ormrod, 2004 (9) described the research methodology in page 12 as the following:

''the general approach the researcher takes in carrying out the research project; to some extent, this approach dictates the particular tools the researcher selects''

In other to choose an appropriate approach for the research, it is important to know the different between research tool and research methodologies. Leady and Ormrod, 2004 (9) argued that while the research tool is a specific mechanism or strategy, the research methodologies is a chosen approach that includes different tools.

In this thesis, I have first considered two methods types in order to answer research questions. The methods of interest were qualitative and quantitative methods.

Leady and Ormrod, 2004 (9) described qualitative method as an approach that gives a deeper and complete understanding of the phenomenon. Data collections in qualitative method can be done through observations, interviews, objects, written documents etc.

Leady and Ormrod, 2004 (9) also mentioned that qualitative research could be characterize by an emerging design, which means that data are often influenced by new data. The limitations of data collections here are only based on the researcher's open mindedness and creativity. The data collection in this approach needs to be examine from different angle to give a rich and meaningful picture of a complex research. Which indicate that collections and examination of data within this approach often takes a great deal of time.

Leady and Ormrod, 2004 (9) consider the quantitative method as a descriptive research. The descriptive research describes the situation as it is. The data collection in this approach can be done through observations, sampling, interview, surveys and more. However, it is important to notice that quantitative approach is systematic and structured, and usually used to describe phenomena, not intended to change it.

The different between these two approaches according to Keith F Punch, 2013 (10) in page 4 as the following:

- *''Quantitative data – Data in the form of numbers (or measurements)''*
- *''Qualitative data – Data not in form of numbers''*
- *''Quantitative research is empirical research where the data are in form of numbers.''*
- *''Qualitative research is empirical research where the data are not in form of number''*

As we can see, each approaches have different type of data collection and analyzes methods. Leady and Ormrod, 2004 (9) suggested that despite the different in data and approach, one should choses the approach that can best answered the research question.

2.3 Method view

According to Arbnor and Bjerke, 2009 (11), methodology is not just a mode of thinking. It is also a mode of acting. Understanding methodologies provide knowledge about previous researches, and how to develop it for future research.

Arbnor and Bjerke, 2009 (11), framework stance that there is a link between the researcher belief about reality and the subject of the research question. The authors argued that methodology is not about following footsteps of methods in previous researches design, and refer to methodological views as ''opinion'' about what is the really meaning of methods. (11)

The choice of methods is often based on the research's own understanding of reality. Another important factor is to think and reflects critically, through this statement: ''*to think and to reflect critically means philosophically to develop alternative ways to think about and to look at things''.* Arbnor and Bjerke, 2009 (11), page 23.

Arbnor and Bjerke, 2009 (11), have formulated three different methodological views that determine the reality of the research.

- **The system view:**

According to this view, reality are fill with facts. Facts create the system and therefore cannot be separate from each other. This view, also known as system theory, which is about how different system can work together and how to understand their relationships.

Figure 1 illustrated this view below:

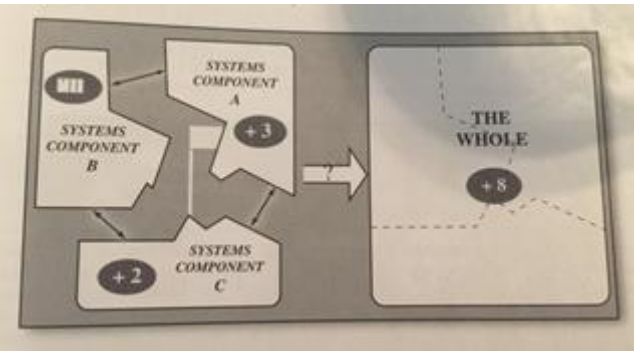

Figure 1: The system view. Sources: Arbnor and Bjerke, 2009 (11), page 53

The ambition of the system is to develop and make the system picture better. The most common asked question in this view is ''*How*'', because the aim is usually to seek finality and gain an understanding of the system.

- **The Analytical view:**

The analytical view is the oldest of the three views and had its origin in classic analytical philosophy. According to this view, reality is fill with facts and has summative characters.

Figure 2 illustrated this view below:

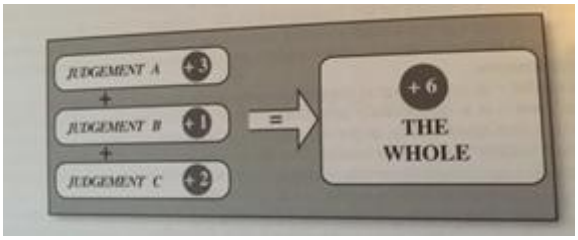

Figure 2: The Analytical view. Sources: Arbnor and Bjerke, 2009 (11), page 52

In the analytical view, reality are explained by seeking causal relations, patterns etc. In order words, this view is an approach that involves '' cause and effect''. The most common research question in this view starts with ''*why''.* The research built on existing theory in order to answer the research question.

- **The Actor view:**

The actor view is about assumptions that exist through a social construction. This view are very different from the system and analytical view, because reality here relies on the common belief.
This view is illustrated by figure 3:

Figure 3: The Actor view, Sources: Arbnor and Bjerke, 2009 (11), page 54

The social construction as illustrated in figure 4 above shows reality as combination of meaning. These meaning are created by people and can be changed, because meaning are subject to change. According to Arbnor and Bjerke, 2009 (11), the reality in this view is considered as subjective understanding, which are expressed through social constructs.

There are significant different between the analytical, system view and the actor view.

The differences between these method views are illustrated by figure 4:

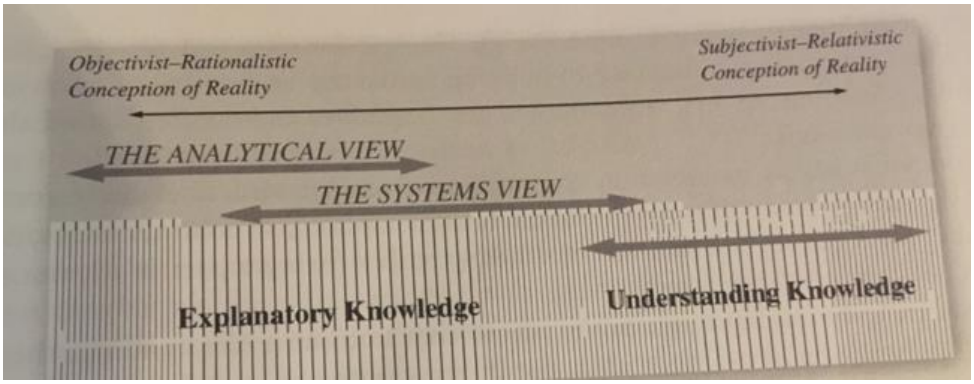

Figure 4: The different between explanatory and understand knowledge. Arbnor and Bjerke, 2009 (11), page 51

Based on figure 4 from Arbnor and Bjerke, 2009 (11), the differences between these views can be summarize as the following:

The analytical view: main purpose of this view is to explain reality. Reality in this view are based on summarizing of individual facts.

The system view: The aim of this view is either to explain or improve understanding of the research. Reality in this view are based on several facts in a systematic way. The facts in this view cannot be separates from one another such as in the analytical view. Understanding through this view are often refer as representative understanding.

The actor view: The aim of this view is to understand reality. Reality in this view are based on social construction. The knowledge here depends on individuals. Understanding in this view are called constitutive understanding.

2.4 Which method for this thesis and why?

In this thesis, I have tried to be as objective as possible and so does my choice of method. Leady and Ormrod, 2004 (9) suggested in page 105 that the best way of doing research is to involve both quantitative and qualitative methods into the research. However, due to the limit of time and resources, one should choose the most appropriate method.

In order to answer the research in a most valid way, this thesis will consist of several tools and quantitative method.

Reviews of chosen method, and why I have chosen it are the following:

- The method View:

The chosen method view is the analytical view. As mentioned above, analytical view relies on causal relations or pattern that explains reality.

Based on research questions:

- Does AMS smart meter contribute to reflect on own usage as a manufacturing organization?

- Does AMS smart meter leads us to reflect on our own usage as individual?

- Are there different perceptions between individuals and organization, when it comes to energy savings incentives?

- Assumed that smart meter (AMS) can contribute to energy management as a control tool/technology, what are the benefits of it within manufacturing aspect?

Due to these questions, we need to base our reality view on a summering of facts.

The research is are built on existing theory that AMS smart metering will reduces energy consumption by making information available to consumers. So based on Arbnor and Bjerke, 2009 (11) theory, I feel that this method view is the most appropriate for the research.

- Literature study:

In order to do a valid and reliable research, literature study is important as part of the planning process. As mentioned earlier, I did not have a lot of knowledge and experience in AMS project, and doing literature study on the subject is important for me to gain knowledge.

The literature reviews about AMS smart meter are through websites from the Norwegian government, nve.no, sintef.no etc. As mentioned, there are different documents and literatures about this subject, I have limit it to what I found were most relevant to research questions.

- Quantitative method:

In order to answer the research questions in this thesis, I believe that quantitative method is a better choice than the qualitative method. Quantitative method represents a larger crowd, and provide data from consumer's levels.

As mentioned in chapter one, one of the limitation is that AMS smart meter system are not installed for all consumers. Therefor the actual energy consumption is not possible to collect in order to compare before and after scenarios. The aim here is to seek facts and to test the statement about reduction of energy consumptions.

According to Leady and Ormrod, 2004 (9) quantitative researches seek for explanations and predictions. The aim is to develop generalizations by conformations or validations to the theory.

The data collection in this thesis focuses on surveys and questionnaire about AMS smart metering system at a consumer's level. Data collections provides statistics that can help to answer the research questions. According to Burns, 2008 (7) statistics and research methods can contribute to better decision making and effective planning for the process.

Leady and Ormrod, 2004 (9) states that survey in quantitative is specific because it was built upon existing theories. The research does relate to this statement, as the existing theories

are about consumer behavior are subject to changes due to installations of AMS smart metering system.

2.5 Validity and Reliability

Validity and reliability are two terms that often used in research that relate to measurement. According to Leady and Ormrod, 2004 (9) these two terms have impacts on the quality of data in the research and the conclusion of the research. The importance of being valid and reliable in research is crucial due to the quality of the research, and as basic for future research.

Leady and Ormrod, 2004 (9) describe validity in page 28 as the following: ''*The validity of a measurement instrument is the extent to which the instrument measures what it is intended to measure''.* Which indicates that the chosen data collection must be relevant and intended to answer the research question in order to be valid.

Leady and Ormrod, 2004 (9) define reliability in page 29 as the following: *''Reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured hasn't changed''*. This statement means that reliability in research are based on the reliability of data results and possible bias.

2.5.1 Validity and reliability of the thesis

The Journal of Business & Economic Research by Carrie Williams (12) states that:

''Although each approach seeks to validate sensory knowledge as truth, neither is absolute in its form'' (12, page 70)

This statement indicates that although research methods and approaches main aim is to seek the ''truth'', none is complete in its form to do so.

As a role of a researcher, I have been as objective as possible. During the planning of the research, I have evaluated difference types of approaches, and its relevance to the research questions. The chosen method, approaches and data materials in this thesis were evaluate and chosen carefully, due to validity and reliability.

Validity and reliability in data collection are important, in order to give accurate answer to the research question. Therefore, good quality in data collection are crucial for this thesis based on valid and reliable factors.

However, it is important to notices that despite having good quality data collection. Due to its relevance to the thesis research question, mine data collections cannot be completely objective, because of the choices and priorities I have done during the collection process.

Chapter 3: Theory

3.1 Introduction of chapter 3

This chapter provide an introduction of energy usage and production in Norway, the focus is electricity energy. This chapter will explain what AMS system is, including its benefits and challenges. The chapter also include the EU and Norwegian Energy directorate (NVE) guidelines regarding to the AMS project.

With the research questions in mind, it is appropriate to provide knowledge of energy management system and environmental psychology aspect in this chapter as well.

3.2 The Power market in Norway

This chapter provide a brief description of the Norwegian power market and supplier in order to provide knowledge of this matter.

The Norwegian power market consist of different groups, some are public participants and some are from private segment. The power system is divided in monopoly groups and open market actors.

An illustration of the Norwegian power market is provided in figure 5:

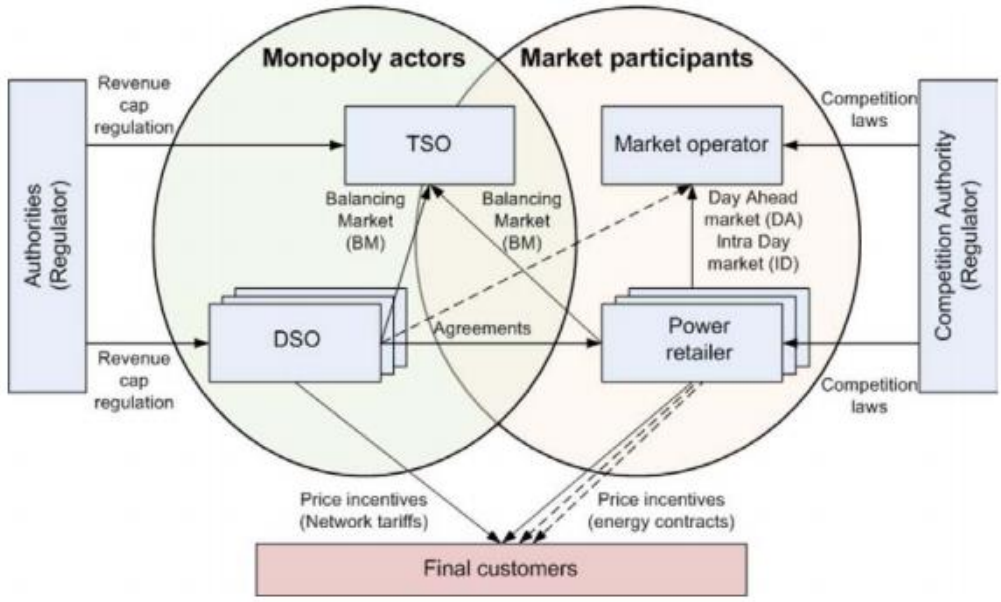

Figure 5: Overview of the Power Market in Norway. Sources: Segtnan 2011, page 3 (13)

Based on figure 5, definitions of each of these groups are the following:

Final Customers: Final customers represent all groups of electricity consumers. Electrical consumers in Norway usually receive 2 different types of contracts and settlements for electricity. One is for the network. The tariffs for the network, comes from the DSO, which stands on the monopoly side. The other settlements are from the suppliers, which are from an open market. Customers are free to choose which supplier to use, but they cannot choose which network to use as it relies on the location of the electric grid system. (13)

Distribution System Operators (DSO): DSO are the ones that distribute the electricity to the consumers. DSO are the owner of the local grids and monopolies in their respective regions. As monopolies, they are obligated to supply customers in their areas and they are responsible for the quality and the metering system. (13)

The Transmission System Operator (TSO): TSO are defined as Statnett in Norway. They are responsible for about 11 000 km power lines as main grid system and are responsible to develop the transmission grid for the whole country. They are also responsible for international grid connections and the total system safety. (13) (14)

The Market Operator: This Group defines as Nord Pool, which means the Nordic power exchange market. This group operates the power market and trades electrical power. (13) (15)

Power retailers: This group can be defines as power suppliers. This group are the final steps of electrical sales between the grid and the end user. They also trade electrical power through Nord Pool. (13)

The Competition Authority: This group can be defines as government or policies that regulates the power market. (13)

Authorities: This group are defines as Norwegian water resources and energy directorate, in shorter definition NVE. NVE are government sector that regulates the power sector. (13) (16)

3.3 Production and consumption of energy in Norway

This chapter provide information about energy production and consumption in Norway based on information from SSB and Norwegian Water Resources and Energy Directorate.

The total energy usage in 2012 was 220 TWh, the usage increased by 3 percent from 2011. This was the second highest energy consumption registered in Norway (1). Total energy usage in this term includes all types of energy.

In household and service sector, the consumption of energy has increased the most with 6 percent from 2011 to 2012. The main usage here in this group are heating and remain rom temperatures. (1)

According to SSB, the main reason for the high usage was due to the cold weather in 2011 to 2012. (1) Generally the temperature in 2012 was about 1, 4 degrees higher than 2011, however 2012 was still 0, 4 degrees higher the ‘’normal temperature’’ (1)

The total energy usage in 2014 was 211 TWh. This was 3 percent lower than 2013, and 4 percent lower than 2012(1, 14). SSB explained that the main cause for decreasing in usage is because of the high temperature in 2014 (14). Most of energy consumptions comes from heating and remain temperatures in cold season. According to the Norwegian meteorological institute (18) 2014 was recorded as the warmest year since 1900 with a temperature that were 2, 2 degrees above the normal temperatures.

According to SSB (1) electricity energy within household and service sector stands for 70 percent of energy usage. In manufacturing industries, the electricity usage makes up about 60 percent of energy usage. From 2011 to 2012, electrical usage has increased by 3,5 percent and SSB argued that one of the reason for this is because of the electrical prices were approximately 19 kwh/øre lower in 2012 than in 2011. (1)

Based on information above, it can be summarized that electricity consumption can vary from one year to another. The consumptions reason of electricity depends largely on temperatures and the prices of electricity. The lower electricity prices, the more consumers would rather use heat pumps or electrical heaters than other heating products.

The research questions are based from a consumers' point of view, both as organization and individuals, therefor it is appropriate to take to accounts electrical consumptions from household and manufacturing industries as they represent each of their respectively segments.

Presentations of electricity production methods and consumption are provided in the next chapters.

3.3.1 Electric Production in Norway

The production of electric energy in 2014 was total 142 TWh, and 96% of the production was from hydropower. (19)

Table 3 below provide electricity production in detailed numbers:

Production, total		
2012	2013	2014
147 716	133 975	141 967

Table 3: Electricity production from 2012 – 2014 in GWh. Sources: Statistics Norway (19)

As we can see from the table 3, the electricity production in 2014 has increased by 6 percent compared to 2013. However, understandable 2012 had the highest production of total 147,7 TWh, due to the high-energy consumption, that was mention in chapter 3.3.

		2014
Hydro power production	Thermal power production	Wind power production
136 181	3 570	2 217

Table 4: Electricity production 2014 by type in GWh. Sources: Statistics Norway (19)

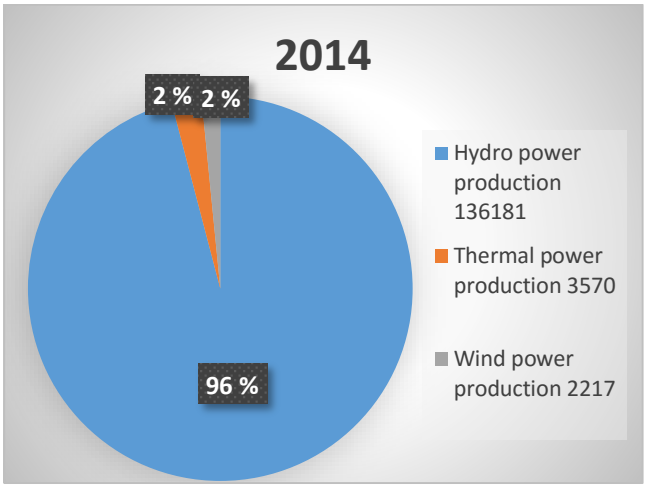

Figure 6: Electricity production 2014 by type. Sources: Statistics Norway (19)

In Norway, the main energy for electric comes from Hydro energy. Based on report from SSB, in 2014, 96% of the electricity production was from hydropower. The detailed number of electricity production in GWh by type are shown in table 4 and illustrated by figure 6.

3.3.2 Hydro power

Hydropower is a renewable energy production that depend on water. Electricity provided through hydropower can be call Hydroelectric. How Hydropower can provide electricity to consumers are illustrated by figure 7:

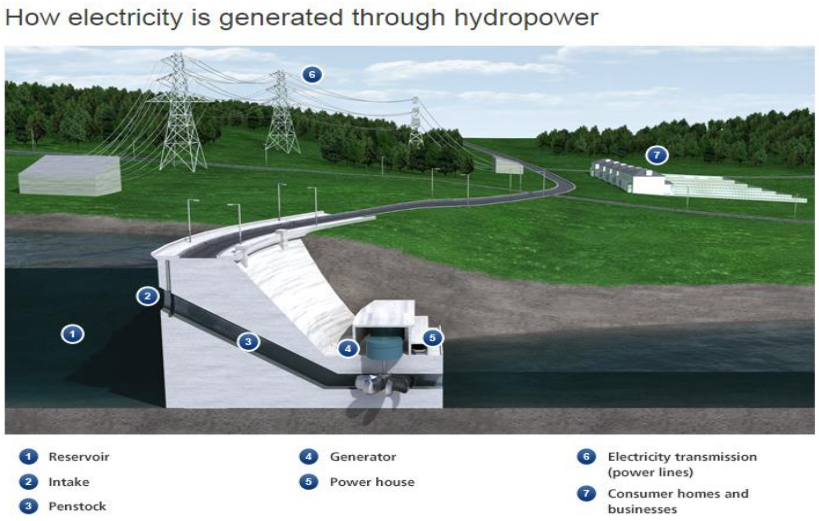

Figure 7: Hydro power plant. Sources EDF energy (20)

As we can see from figure 7. The first step to create power is to have a reservoir fill with water, the water run through a generator transmit to the powerhouse. The power is then transfer to the powerlines and to consumers homes and businesses.

Electricity generation depend on water, and therefor can vary in periodes, as its depends on rainfall and reservoirs.

According to statkraft (3) hydro power produces 1/6 of electricity on a global basis. Hydropower does not produce any air pollutants, and considered as one of the best power generation technology when it comes to greenhouses gases aspects.

Hydropower provide the highest energy efficiency rate and because of its reservoirs, hydropower can be use in longer period, as well as backup energy when other renewable energy is not available. That is why this type of electricity generation are considered as renewable and environmental friendly.

According to statkraft (3) Norway, have close to 50 percent of the reservoir capacity in Europe.

However, Hydropower does affects the environmental through river systems when it comes to rivers flow pattern, which also affects fish and biodiversity. According to WWF report by Dr. Collier (21) and the UN report, 2003 (22) the changes in river flows can have consequences both for the ecosystem and its users such as fishes and humans.

3.3.3 Wind Power

Wind power is an electricity production that considered as environmental friendly. Power generated from wind does not produces any pollution.

Power that generates from wind power comes from wind turbines. Wind turbines produces electricity by convert the energy from the wind into electrical power.

The major components of a wind pumps system include:

1. Tower
2. Foundation
3. Rotor
4. High-speed gear box
5. Safety systems
6. Generator

A wind turbine system are illustrated in figure 8:

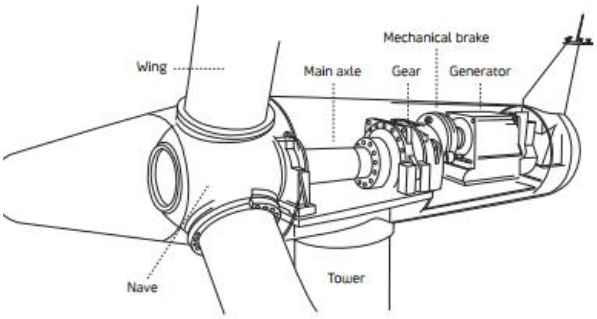

Figure 8: A wind turbine system. Sources: statskraft about wind power, 2010 (23)

How the wind turbine system generated electricity are illustrated by figure 9:

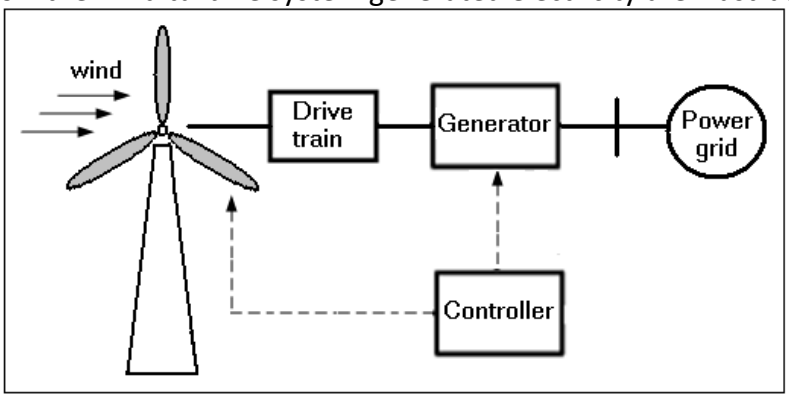

Figure 9: Wind power system. Sources: National instrument. Introduction to a Wind Power System (24)

Despite being one of the environmental sources of energy, wind power requires impacts to nature due to construction of wind turbines. According to the report about Environmental impact of wind energy (25), wind turbines may have negative consequences for wildlife such as birds and bats. However, wind power has miner impacts on nature than most other types of electricity production.

According to SSB report no 2/2011(26) wind power production are on the rise in Norway, in 1993 the production was 7 GWh, and in 2009 it has increased to 981 GWh. The latest measurement is 2217 GWh in 2014. (19). The time line is illustrated in figure 10:

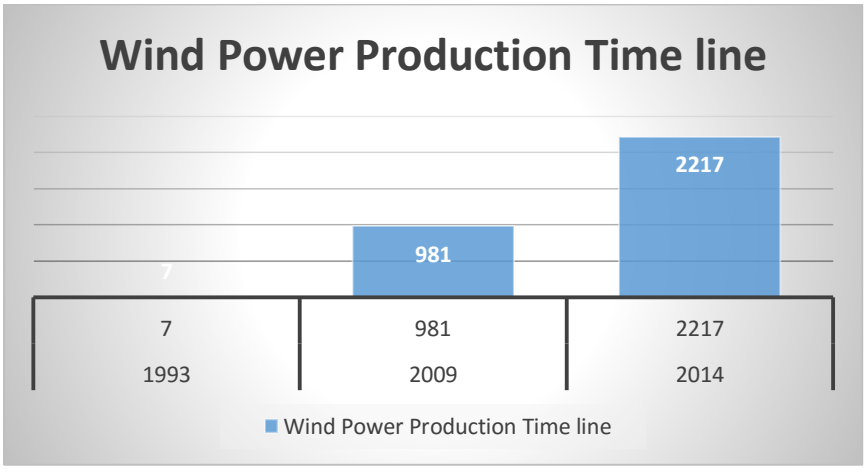

Figure 10: Wind Power Production time Line (sources: SSB, 19, 26) Made by author.

According to statkraft (23), Norway are one of the countries that have the best available wind resources in Europe. However, wind power production represents just a small amount of the total electricity production in Norway.

3.3.4 Thermal Power

Thermal Power are energy that generates by temperatures mainly by heating. There are several types of thermal power plants. In Norway, the main sources of thermal power comes from nature gasses, coal, biomasses and other types of wastes.

Energy resources that comes from biomass releases CO2 emissions. However, its status remains as renewable because plants and trees binds CO2 as they grow. Overall, this type of energy production in Norway does not considered as environmental friendly or renewable because the sources such as gas, other wastes and coal releases pollutions and are not renewable energy sources.

According to SSB report the total heat power production in 2009 was 4,7 TWh (26). In 2014, thermal power production was registered at 3,6 TWh. So based on the reported numbers, we can see that the production of this type of energy are relatively constant from years to years.

Based on the report from SSB (26) Most of thermal powers comes from natural gas, 4 percent comes from biomass such as woods. 2 percent of thermal powers comes from municipal waste and others types of wastes made up about 4 percent of thermal powers.

The figure below illustrated how thermal power are produces from various energy sources in percentages.

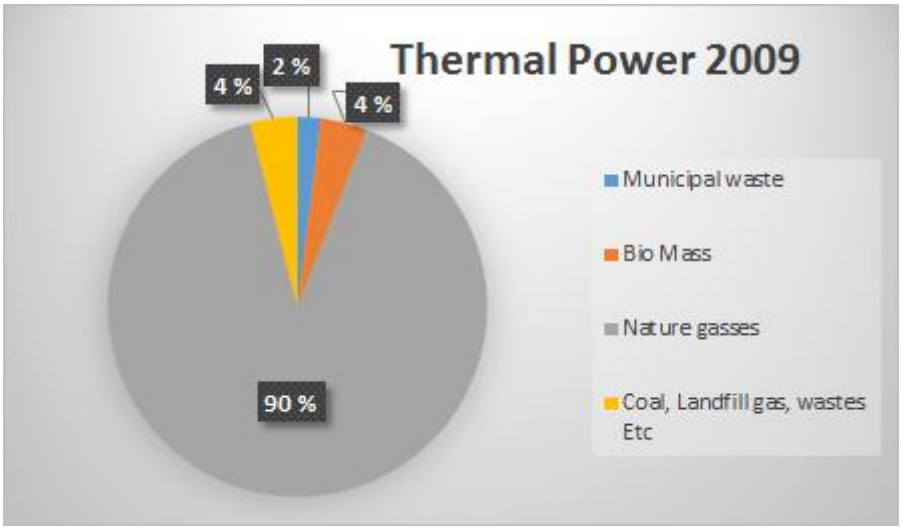

Figure 11: Thermal power production from different energy sources in 2009 in percentages. Sources SSB report no 2/2011 (26)

3.3.5 Consumption of electricity in Norway

This chapter present the electric consumption in Norway. The totaled electric consumption in Norway are 117,1 TWh in 2014. (19)

The consumers groups are the following:

- Power intensive manufacturing industries: 35362 GWh

- Mining and extraction: 7196 GWh
- Manufacturing excluding power intensive manufacturing: 7761 GWh
- Various supply and remidiation activities: 2095 GWh
- Transportation and storage: 1659 GWh
- Construction and other services: 24101 GWh
- Private households and agriculture: 38882 GWh

Figure 12 illustrated the consumption of electricity divided by each groups.

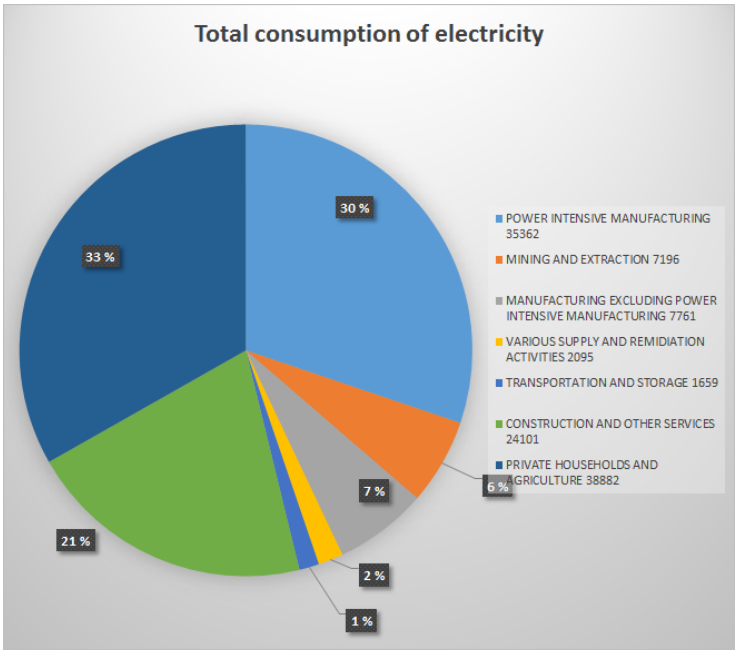

Figure 12: Total consumption of electricity in GWh. Sources: Statistics Norway, Electricity, 2014 (19)

3.3.6 Consumption of electricity from power intensive manufacturing industries

Power intensive manufacturing industry are one of the largest electricity consumers in the country, beside household.

Based on the Standard Industrial Classification (27) Power intensive manufacturing industry main groups are the following:

- Manufacture of pulp, paper and paperboard (paper and pulp)
- Production of chemical raw materials
- Production of iron, steel and ferroalloys
- Production of non-ferrous metals

The figure below illustrated the electricity consumptions of each group in this section.

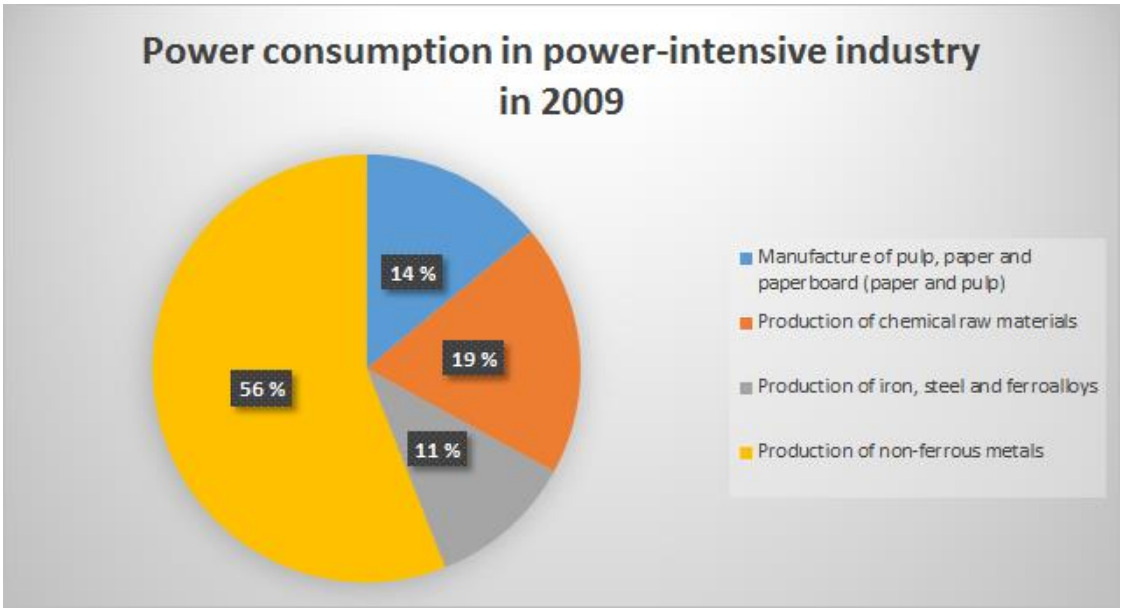

Figure 13: Power consumption in power intensive industry in 2009, Sources SSB report no 2/2011 (26)

For many manufacturing company, electricity is important because it represent a large input factor within the production.

However, the electrical consumptions do not largely depend on temperatures as it does in household. The electricity consumption here depends on electrical prices.

Another factor that are important due to electrical consumptions in this type of industry is international economic conditions, import/exchange rates and metals prices because their products compete in an international marked. (26) (28)

Electrical usage in power-intensive industry are more stable than other groups of consumers and therefor, easier to manage in order to use it more effectively.

Figure 14 illustrated the monthly usage electricity within household and other groups comparing to power-intensive industries.

The figure shows that while consumptions from household and other consumers groups varies from 4 TWh in the summer months to 12 TWh in the winter months, the power - intensive industries have a more stable usage that varies from 2,5 to 3 TWh. (28)

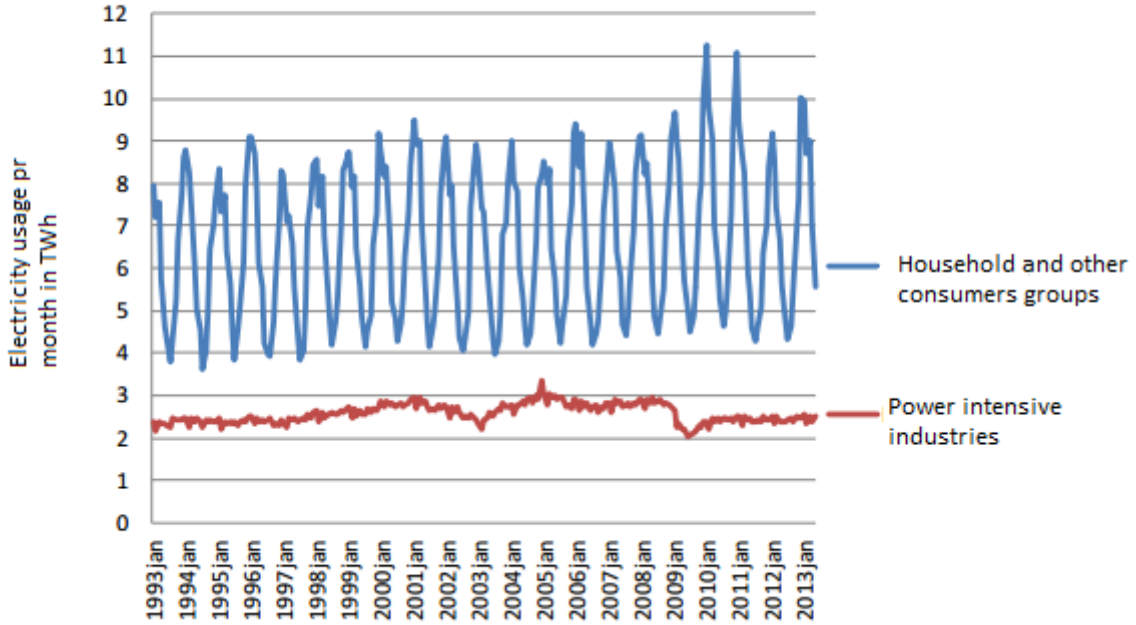

Figure 14: Monthly electricity use in Norway. 1993 to 2013. Sources: Report No 69/2013. By NVE. (28)

Major changes and requirements of consumption within this group will create difficult challenges for the power grid in several places in the country. The main reason for that is power-intensive industries represents a high proportion of electrical consumptions in Norway and this group of consumers have a higher electricity requirement. (28)

According to NVE report (28) many companies choses to close down their production processes in a short period of time due to critical power situations. The purpose of such short stops is to reduce the peak load of the power grid and to reduce electricity consumption in the most strained periods. These episodes have reportedly happened during the winter months in from 2009 to 2010, and winter months from 2010 to 2011.

During shut down, companies may sell the power that they have purchased at a fixed price to the power market for higher spot prices. Hydro exercised this option during the winter months from 2010 to 2011, and according to NVE report (28), this action may have contributed to keep the electricity prices lower this winter season comparing to the winter season the year before.

Despite the opportunity to compensate during production shutdown, not all companies have the ability to shut down their production processes. This option varies largely from companies to companies depends on the manufacturing materials. For example, the metal manufacturing industries does not have the ability to shut down their production for more than a few hours at the time. The reason for this is risks of destroying metal materials. (28)

Many companies strived in order to use electricity effectively. Enova, NVE and Innovation Norway are public organs that can help companies economically in order to achieve the

ultimate usage of electricity and energy. Enova reported that they have compensate companies overall in Norway, with around 1 billion in order to implemented more effective energy consumptions methods. This has results around total 4 TWh in energy savings, and most of it comes from power-intensive manufacturing industries. However, there are still potentials in many areas, when it comes to achieving a more effective usage of electricity. (28)

3.3.7 Consumption of electricity from household

Private households and agriculture represent about 38882 GWh of electricity usages in 2014. The main groups under this section are define as the following:

- Agriculture, forestry and Fishing
- Hot-houses
- Private Household
- Cottages and holiday houses

The figure below illustrates how much each groups represented for the total consumption of 38,8 TWh in 2014.

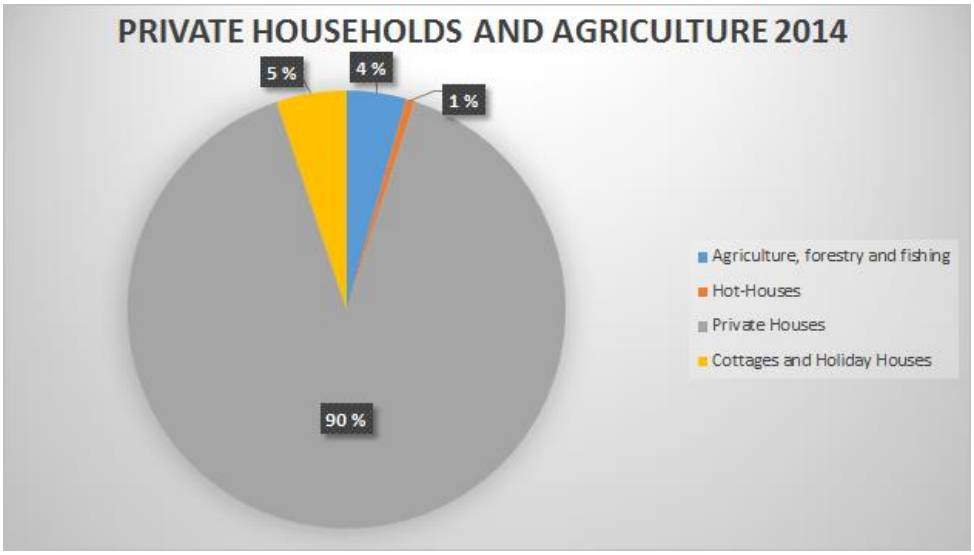

Figure 15: Private Household and agriculture electricity consumption in 2014 by group in percentage. Sources: Statistics Norway: Electricity, 2014 (19)

As we can see from the reported numbers and figure 15, private household dominates the total usage here in this group by 90 percent, and around 33 percent of the total energy consumptions. As household continues to increases, the demand will also increases

This group differ from the power-intensive manufacturing industries by the way they use electricity. According to SSB about energy consumption in households (29), the main heating sources for about 73 percent of household is based on electricity, and there for electricity consumptions in this group depends largely on temperature. Electrical prices play a role in

consumptions tendency as well. Many consumers prefer to use other types of heating sources rather than electricity if the prices were higher (29)

This group of consumers is an important target group due to the research question, as the questions are mainly based on from a consumer's point of view.

3.3.8 Export and Import of electricity in Norway

As mentioned above, the main electricity production in Norway are from hydropower. Producing power through hydropower can vary in periods, as its depends on rainfall and reservoirs. In other Scandinavian countries, electricity are produces by wind powers, nuclear and coal power etc.

In some periods of need, Norway may export and import electricity to other countries through the Nordic market.

The figures below illustrated how much Norway export and import to other countries in 2009 by percentage.

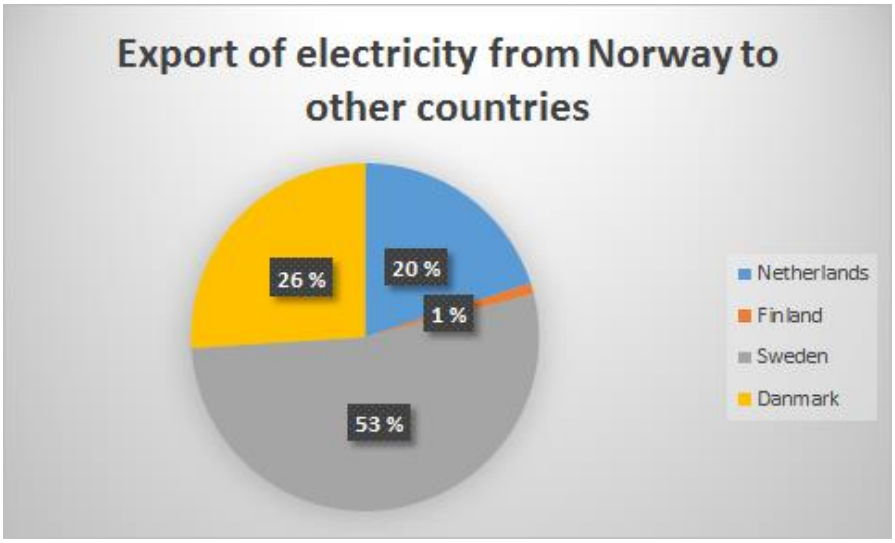

Figure 16: Export of electricity from Norway to other countries in 2009 in percentage. Sources: SSB report no 2/2011 (26)

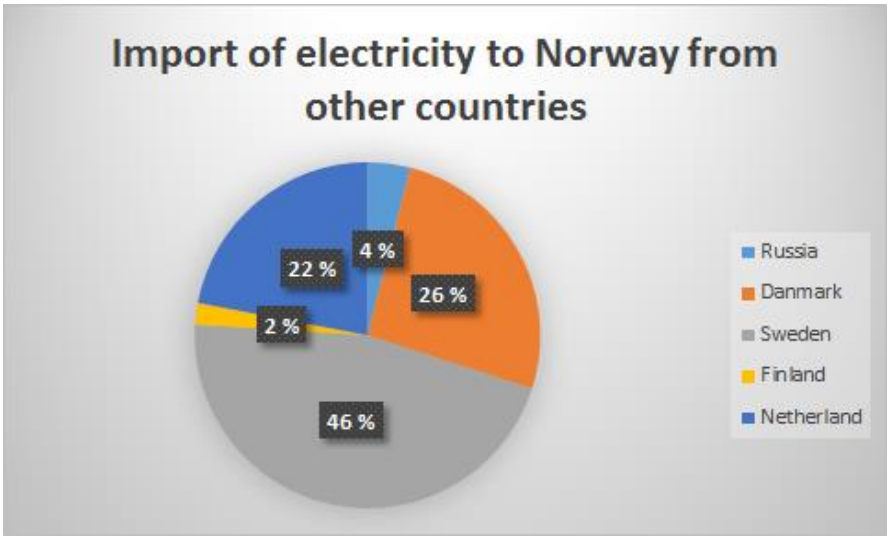

Figure 17: Import of electricity to Norway from other countries in 2009 in percentage. Sources: SSB report no 2/2011 (26)

In 2014, Norway exports a total 21,9 TWh and imported a total 6,3 TWh (19). As we can see, Norway does benefit from having reservoirs and power that generates from hydropower. However, in times of need Norway does import as well, in order to answer the demands in the marked.

3.4 The political debate and the climate targets

In Norway, electricity is available in most places. We are constantly surround by electric infrastructures that we use in our daily life, without considering what type of impacts it brings to the environment and climate. Such as electricity infrastructures, it is just ''there'' to fulfilled our need.

Energy consumptions dilemma and its impacts to the environment has received significant political attention over the past century. The main issues are increasing electrical consumption. It was claimed that the existed electrical grid would not be able to supply this type of increasing usage in the near future. The Norwegian Parliament representative proposal in document 8:18 (2012 – 2013) (30) remind us about the importance of electricity and argues that all major social tasks depends entirely on a strong power grid. It is important to focus on development in this area in order to have the capacity to supply the whole country. This reminder is understandable, as we can see that if electricity infrastructure would cease to function, it would have major consequences for our daily life.

In 40 years from now, energy usage can be in a completely different scenario than what we can predict today. The report from the Parliament about energy plan, value creation, supply security and environment NOU 2012:9 (31) claims that energy usage towards 2050 relies on the technologies development in the area and general trends in our society. The general trends that we see today are significant population growth, centralization and increasing demand of energy. We need to find solutions to have a more efficient energy usage, in order to achieve a sustainable energy supply and environment consideration. Smart meter (AMS)

technology mentioned in this report as an important initiative for a more efficient energy usage in the future.

The focus on climate changes and human impacts has emerged over the past years and as a part of the Kyoto protocol, Norway has plan to reduce the global greenhouse gas emissions to 30 percent of Norway's 1990 emissions by 2020. The goal is to be carbon neutral by 2050. (4).

Another climate policy in Norway was set through the EU directives guidelines for the Norwegian energy and climate policy. The report from the Parliament about energy plan, value creation, supply security and environment NOU 2012:9 (31) states that climate policy has impacts for energy usage, energy usage has impacts on the fulfillment of climate policies. The report mentioned that the guidelines from the EU directives are not always well adapted to the Norwegian conditions. Therefore, there is constantly political debate within this subject. Despite these issues, international organs and national organs seems to be united about climate policies and its importance, in order to achieve the climate targets that were set.

The goal of this chapter is not about to evaluate the AMS smart meter technologies with the political debate, but about knowledge of the visions and ideas that policy actors have for this technology. This chapter will consist of information about the Norwegian and European Union (EU) climate targets, international climate targets and shortly about Kyoto protocol. The goal here is to gain knowledge of the smart technology in society, which can contribute to answer the research questions.

3.4.1 European Union (EU) climate targets

According IPCC report (77) global greenhouse gas emission contributes to temperature rise causing climate changes. Climate changes and its impacts will cause serious and irreversible consequences to the world that we are living in today.

The European Union has focuses on a joint fulfillment on international level, have taken many initiatives since 1991 (32). The focus has been to promote electricity from renewable energy, commitments to reduce CO2 emissions and taxations of energy products. The EU states that it is important that actions require from both member states and EU in order to achieve to goals that have been set. Especially the targets that were agreed on through the Kyoto Protocol. (32)

The EU has set several targets until 2050 for reducing greenhouse gas emission. The key targets are the following (33)

Targets for 2020:

- Greenhouse gas emission reduces by 20 % from 1990.
- Increasing renewable energy by 20 %
- Energy efficiency increase by 20 %

Targets for 2030:

- Greenhouse gas emission reduces by 40 % from 1990.
- Increasing renewable energy by at least 27 %
- Energy efficiency increase by 27 %

The ambition for 2050 are to be able to reduce greenhouse gas in EU by 80% from 1990 level and the low-carbon transition is affordable and feasible.

The report by the European environment Agency (EEA) ''Trends and projection in Europe 2015'' (35) informs that the greenhouse gas emission in Europe has decreased by 19,8 percent from 1990 to 2013 which was very close to the targets that were set for 2020. The report predict that the total reduction of emissions may reach to 24 percent below 1990 levels by 2020.

Energy efficient is a very important factor due to climate change and EU has focuses on this matter in all theirs targets. The directives 2006/32/EC, Annex 3, new directive November 2012 (34) states that:

''The Union is facing unprecedented challenges resulting from increased dependence on energy imports and scarce energy resources, and the need to limit climate change and to overcome the economic crisis. Energy efficiency is a valuable means to address these challenges. It improves the Union's security of supply by reducing primary energy consumption and decreasing energy imports. It helps to reduce greenhouse gas emissions in a cost-effective way and thereby to mitigate climate change''

Smart metering system (AMS) were mentioned as a tool to achieve the 2020 targets by contributing to overall energy efficiency, the predicted average energy savings by using smart metering are around 3 %. (34) (5)

The aim for electrical efficiency of 2020 is that at least 80% of the electricity consumers shall be equipped with smart metering system according to the Directives 2009/72/EC and 2009/73/EC. (36) (37)

3.4.2 International commitment and the Kyoto Protocol

The Kyoto protocol was first agreed in Kyoto, Japan 11.dec 1997. This protocol is an international agreement for emission reduction. The agreement focuses on the responsibility for the climate change from developed countries. Under the concept of *''Common but differentiated responsibilities''* It was claimed that the high levels of GHG emissions are a result from industrial activity and therefore, therefor places a heavier responsibility on develop Nations. The detailed on the agreement and implementation of the protocol were adopted at COP 7 in Marrakesh, Morocco (38). The first commitment period last from 2008 to 2012.

The emission targets for the first commitment period are the following:

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous Oxide (N2O)
- Hydrofluorocarbons (HFCs)

- Perfluorocarbons (PFCs)
- Sulphur Hexafluoride (SF6)

The first commitment period, 37 countries agreed upon to reduce GHG emission to an average 5 percent against 1990. The second commitment in 2012 period was in Doha, Qatar and countries has committed to reduce GHG emission by at least 18 percent below 1990 level from period 2013 to 2020. (38)
In order to prohibit global warming below 2 degree Celsius and climate change by 2020, the UN discuss and negotiate at a COP21 convention, also known as the Paris climate conference. (39)
The main target for the agreement states by the UN are the following:

"The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change" (39)

The Paris agreement will be available for signature on the 22.april 2016 in New York, and will be valid 30 days after 55 countries that are accounted for at least 55% global emission have deposited their ratification.

3.4.3 Norwegian climate targets and commitment

According to the Norwegian Parliament report no 13, 2014 –2015 (40) the government have set important targets for Norway's contribution for the climate policy nationally and internationally. The report informs that in 2013, Norway's emissions was measured to 53,9 million ton CO2, which was 3,7 percent over the 1990 levels. The petroleum industry stands for 26 percent of the emission. However, increasing of emissions in 2013 was also due to several fields in production.

The report claims that the emission in the future will depends on many factors such as technology, population, economic etc. They predict that technology development will contribute to lower emission for all sectors in the future. (40)

Norway has committed to several climate agreements internationally through the Kyoto protocol and the EU climate program. Norwegian government claim that the corporation with EU and international countries will contribute to a joint fulfillment of climate targets for Norway and EU. (41)

The press release from the government about a new and more ambitious climate policy for Norway states that:

''The EU is our most important collaborator and partner. A joint fulfilment with the EU allows for a more efficient climate policy and will give more predictable conditions for Norwegian businesses, says Minister of Finance Siv Jensen'' (41)

Under the second Kyoto protocol, Norway has committed to reducing emissions of greenhouse gas to 30 percent by 2020 compared to the 1990 levels. (41)

The government has also proposed that Norway by 2030 will reduces greenhouse gas emission by at least 40 percent compared to 1990 levels through a joint climate solution with the EU. (41)

Norway's climate policies focus on the following area: (41)

- Reduced emissions in the transport sector
- Development of low-emission technologies in industry and clean production technology
- CO2 capture and storage
- Strengthen Norway's role as a supplier of renewable energy
- Environmentally friendly shipping

Norway climate policies are defined largely after the EU policy targets. The EU has mentioned smart metering system (AMS) as a tool and technology that contribute to effective energy usage. Another reason for the focus on AMS in Norway and EU is about to maintain a secure supply of electricity.

According to NVE regulation §4-5, all electricity consumers will get a smart metering system by 1. January 2019. (42)

The responsibly for this installations are on companies that operates and distribute network in their respective regions (defined as DSO, see chapter 3.2), most of them would most likely start the installation process by the end of 2015.

The NOU 1998:11 Energy and power balance 2020 (43) states that the main concern for electricity consumptions depends largely on the consumers in the society. The usage of electricity will continue to increase unless the society put in a joint effort to avoid these issues.

Consumers behavior and consumption tendency are linked together. Therefore, it is important to give consumers a better overview of their electricity consumption, and cost in order to gain electricity efficiency. According to the Committee for the NOU report, the advanced metering seems to be relevant tools in order to resolve the increasing consumption issues. This technology will provide remote reading of electric consumption and gives direct information to consumers. The committee points out user's flexibility as one of the benefits of this technology. (43)

The NOU 1998 (43) states in the report that in order to keep the electricity consumptions on consumers consciousness, the smart metering device or system should be display in a place that emphasizes the consumers' consciousness of their own electricity consumption. The technology for smart metering system provide to consumers their real time usage of electricity, so consumers are able to adapt usage based on electrical prices, weather condition etc.

The benefits that NOU 1998 (43) expresses and confirmed by proposals from parliament in document no 138 (2002 – 2003) (44) is the consumers ability to control the consumption easier, economic benefits for the consumers as they can chose to use more electricity in hours that have lower electrical rate than other, more reflection due to the environment due to usage. The technology contributes positive environmental impact such as less need for grid investments and blasted capacity of electricity. Overall, the consumers and the society can gain smarter consumptions.

However, the benefits above does raised a few questions that are relevance to the research questions. The thesis will discuss this matter further under chapter 5 - Discussion.

3.5 Advance metering system (AMS)

Advance metering system (AMS) or smart metering system are a tool that can contribute to efficiency consumption of electricity according to EU. The Directives 2009/72/EC (36) and 2009/73/EC (37) aimed to equip at least 80% of all consumers with smart metering before 2020. Due to the NVE regulations §4-5 (42), advance metering system will be installed for all electricity consumers in Norway by 1. January 2019.

The main purpose to install smart metering system is to be able to have real time data of consumptions from the consumers. This matter involves about 2,7 million electrical meter in the Norway. NVE states that the technology will give customer the opportunity to save energy and contribute to a more secure electrical supply. NVE considered this regulation as futuristic and in a direction towards a future of smart grids system. (45) (46)

According to the IEA report (47), Smart grid definition are explained by the following:

''Smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users'' – IEA report, page 6 *(47)*

This thesis will only briefly define the term smart grid, but will not describe deeply about smart grid, because it is not relevance to the research questions.

Public instance describes several benefits of having an AMS system, and due to the amount of consumers that smart metering will have impacts on. Clearly, demonstrate that AMS smart meter system does not only represent itself from a technology point of view, but it also represents a strong social aspect. Smart metering will be in the future a large part of modern lives. The question is: Will we pay more attention to it than the meter system that we have today?

The aim of this chapter is to present the technology aspect of the advance meter system (AMS), implementations process and what benefits we can gain of such metering system.

3.5.1 Advance metering system technology

The NVE regulations state that the distribution operators (DSO) are responsible for installations of the AMS metering system. Being responsible for installations means that they have distribution rights to the metering system, as it is their property. Despite being

responsible for the solutions, NVE mentioned that customers are free to choose which supplier they would like to use due to management and information services regarding to the AMS system. (48)

The different responsibility areas are illustrated by the figure below:

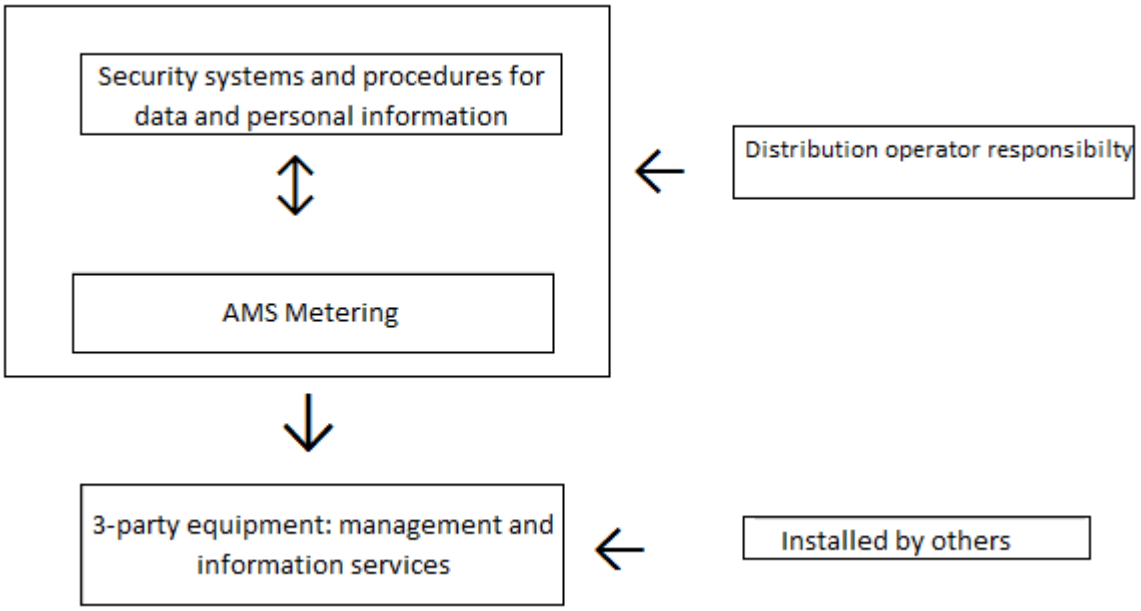

Figure 18: Distribution operator's responsibility. Sources: About AMS by NVE (48). Made by Author.

The technology of the advance metering system involves several technological solutions. This chapter aims to introduce this as a general typical smart metering system.

NVE states that AMS meter includes two-way communication between the meter and the distribution company (DSO). This system should provide customers with current information about their consumption and instant prices for electricity. (48)

According to the LCA studies Assessing the Environmental Costs and Benefits of Households Electricity Consumption Management by Ida Lund Segtnan (13) the smart metering system technology can be generalized and summarize into a general description of the system illustrated by the figure below:

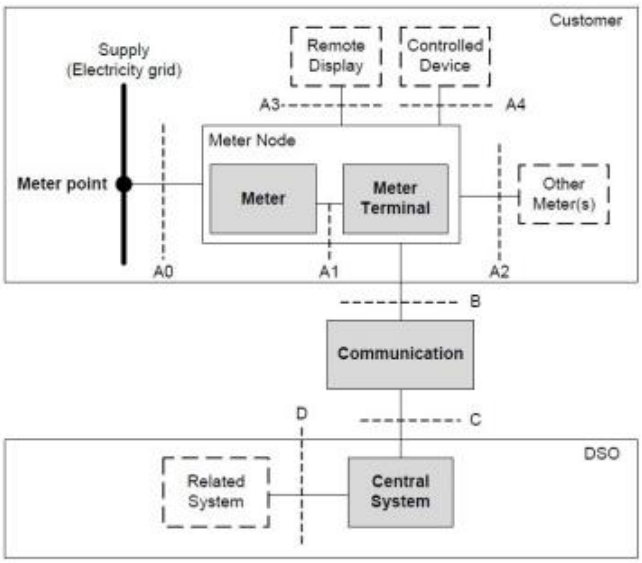

Figure 19: System value chain. Sources: Segtnan, 2011 (13)

The grey boxes in the figure are subsystems that are necessary for the system of smart metering. (13) According to the LCA study (13), the basic AMS technology are the following:

- Meter node: Electronic meter
- Communication system
- The central system

Meter Node: The electronic meter

The meter node includes several equipment. In this thesis, the meter node can be defining as an electrical meter. Electrical meter is an equipment that is necessary in order to measure the consumption of electricity. The meter that exist today in most homes and industries are mechanical and do not have two- ways communication between consumers and the distributions operators. Consumers must read and report to the distributions operators or their power supplier company in order to receive correct settlement for their consumptions. (13) (50)

AMS meter should have communication function and standards that gives the distribution operators (DSO), electricity supplier and the consumers live update of electricity usage. (42) According to NVE regulations §4-2, b (42) the function requirements for the meter are remote control opportunity and communication function that can communicate with external equipment. According to NVE document no 7- 2011, the distribution operators (DSO) stands for the total economic and installations responsibility of AMS meter. (49)

The European Smart Metering Alliance (ESMA) (50) report defines the AMS metering as the following:

- *"Automatic processing, transfer, management and utilization of metering data*
- *Automatic management of meters*

- *2-way data communication with meters*
- *Provides meaningful and timely consumption information to the relevant actors and their systems, including the energy consumer*
- *Supports services that improve the energy efficiency of the energy consumption and the energy system (generation, transmission, distribution and especially endues)'' (50, page 9)*

The distribution operators (DSO) would most likely buy the meter from supplies that produces these products. The Norwegian electro committee have suggested the distribution operators to use their standard in order to meet the requirement from the regulations, this standard are electrical metering equipment NEK IEC 62052(51). However, the DSO according to the regulations stands free to choose their types of meter. As long as the chosen meter system are considered as most cost-effective and meet functional requirements of the regulation. (49). This thesis does not focus on which types of AMS meter are the best among supplies. The aim here is to provide the function requirements in order to provide knowledge of such technology.

The Communication system:

The communication system is a system that enables two-way communication from AMS meter. The system should provide data to the electrical supplier or operator distribution by hour or by request.

Document no 1-2011 from NVE (52, page 17) summarizes the most relevant communication carries for AMS technology and the distribution operator. The communications are the following:

- Internet, PLC - Power Line Communication
- Radio - General packet radio service
- GPRS
- Fiber

NVE states that they do not want to regulate which communication carries that shall be use. NVE assumes that the chosen solution from the distribution operators has functions that meet the functional requirements that have been set. (52). When it comes to communication system between AMS meter and external devices, NVE suggested IP solution to be the communication carrier for this matter. (52).

The central system

The central system is a system that distribution operators have due to the information receiving from AMS meter. This system can be describe as a servers or hub, and can be use due to customer service tasks, billing systems etc. The central system depends largely on how and what requires from such system.

According to LCA study Assessing the Environmental Costs and Benefits of Households Electricity Consumption Management by Ida Lund Segtnan (13) a Central system can be illustrate and adapt from Aidon 2011.

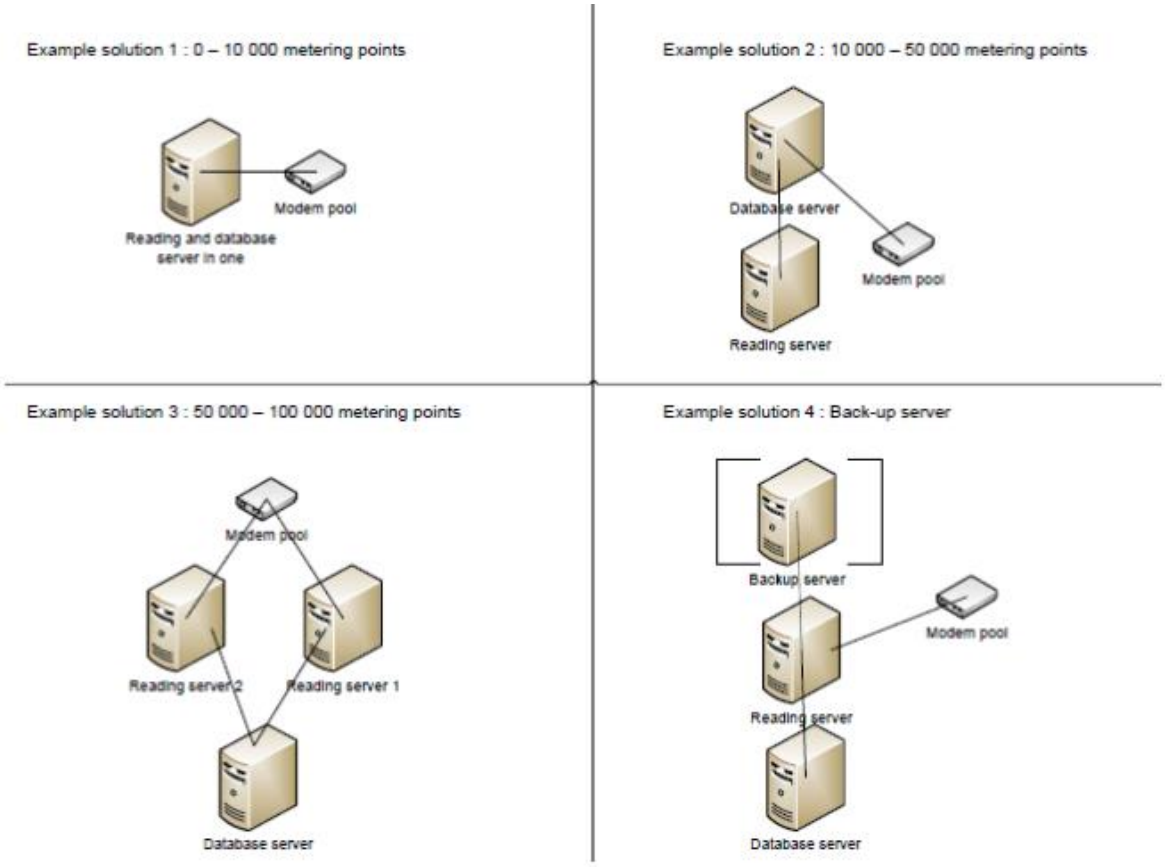

Figure 20: Possible central system solution, adapted from Aidon 2011, sources: Segtnan, 2011 (13, page 46)

As figure 20 illustrated, there are several system solutions for the central system. It largely depends on the requirements that the distribution operator (DSO) have sets from such system.

According to NVE requirement in document 7-2011 about §4-3 (49), the distribution operators are responsible for the total quality of the measurement data and storage of data. Therefor a central system should be a reliable and a stable solution due to these requirements'.

Despite the DSO are responsible for data quality, NVE suggested in the report 51- 2015, (85) that all data gathered in one central data hub. NVE refer this data hub as Elhub (54). NVE has imposed statnett to develop Elhub for data exchange purpose. Benefits of Elhub are to contribute to effective flow in supplier marked, and more defined lines between monopolies and private, in favor for the consumers (54).

3.5.2 Implementation of AMS technology

The Directives 2009/72/EC (36) and 2009/73/EC (37) aimed to equip at least 80% of all consumers with smart metering before 2020. According to the EU report 2015 (55) Finland, Italy and Sweden have in advanced started with implementation of the smart meter. The total installed meters are close to 45 million meters. However, many other members of the

state are still in different stages of the implementation. Some had trouble to implement the technology and some experienced positive feedback. The report informs that:

''Although enthusiasm for smart electricity metering is not uniform across the EU, a majority of Member States still intend to proceed with large-scale deployment by 2020.''(55)

The figure below illustrates different process for the EU member states.

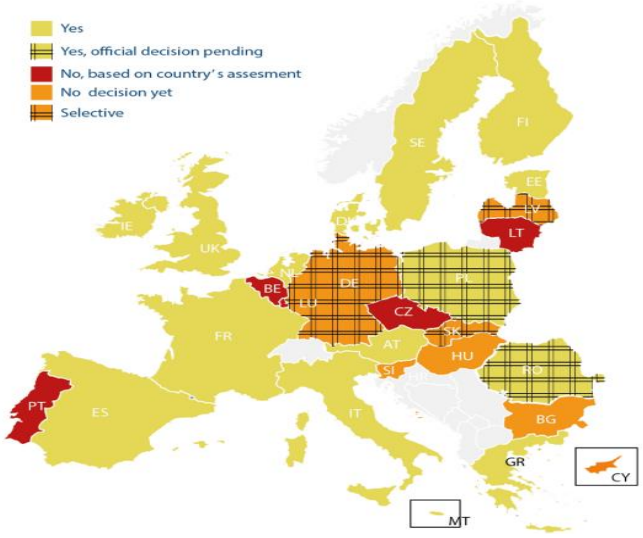

Figure 21: Installation processes of smart electricity meters in EU Member States by 2020. Sources: EU report, 2015 (55)

Norway is not a member of the EU, but Norway have adopted the EU directories due to climate agreement. NVE regulations §4-5 (42) states that advance metering system will be installed for all electricity consumers in Norway by 1. January 2019 (42) Some household and companies already have installed the AMS meter system. According to regulations §3-3 (56) two -ways communicated meters are already installed for consumers that have above 100 000 kWh per year.

According to the report from NVE 2015 (53), about status and implementations of AMS meter, 81 distribution operators have reported about their plan and status for implementation of the AMS meter. These operators represent about 2,5million meter node. The cost of installation is estimate to be about 3 787 kr per meter node. The total cost for the project are estimate to be about 10 billion kr.

The distribution operators are responsible for the implementation and based on the regulations time line, the implementation according to NVE (48) should start by the end of 2015. Based on the regulations, distribution operators stand free to choose their timeline of implementation of AMS meter as long as they meet the deadline of 1.jan 2019. (48)

3.5.3 Benefits of AMS

According to NVE, smart metering registered real time data of consumptions from the consumers. The consumers will have the opportunities to update their usage due to the

electrical prices. NVE states that the benefits of such meter is to provide faster, correct and better fundament for the customer's electrical settlements. (48)

As mentioned in chapter 3.4.1 about the technology of the smart meter system. The main different comparing to the standards meter is that the smart meter has a two-way communication system. This technology opens up for several opportunities that provide more controls and monitoring of electrical usage. Solutions for energy saving can be for example Apps on mobile phones, monitoring devices etc. All developed technology from such system can contribute to energy savings from the consumer's side. (48)

The main reason for AMS technology according to NVE is about innovation and contribute to a sustainable electricity consumption for the future. (45) (46)

According to several political documents, environmental benefits are often mentioned as important factors when it comes to AMS meter installation, and a future towards smart grid system. Document NOU 9/2012 (31) argues that effective energy usage in a long-term aspect contribute to a sustainable energy production that will have positive impacts on the environment.

AMS meter technology as mentioned earlier, opens up for several opportunities in the technological world for example APPS on mobile phones, monitor devices, remote devices etc. This matter contributes to new business opportunity for many technology and IT department and provide positive social impact. (48)

NVE argues that smart metering will contribute to reduction of electrical consumption, and revers the dilemma that we are having today with increasing consumption by giving each of us the opportunity to manage and change our consumption behavior by ourselves. The tariffs for peak time load may rise, and lower tariffs for times that usage are less. Many cost conscious consumers may use electricity in times that the price are lower, which contributes to less overload capacity and consumers can achieve better economical profits. An interview of water resources and energy director Per Sanderud with NRK (84) state that the network tariffs represent a large part of the total electricity settlement, and it should be made beneficial for consumers that are willing to move consumption from peak time hours to other times of the day in order to avoid blast capacity. (84). This matter also was also discussed in NOU from 1998:11. (43).

EU also enhanced this matter, and according to the EU report states the following:

''The Commission's benchmarking report expects that smart metering will lead to substantial cost savings in the longer run: the average consumer can reduce their energy costs by around 3%, while some types of consumers could reduce them by up to 10%.'' (55)

The implementation of smart meter in USA indicate that the possible energy saving can be around 6 –12 %. (55), (57). Finland concludes that the average saving is about 1- 2 %, Sweden reports that they expected a range of 1 –3 % energy saving. EU report (55) informs that the amount of energy saving can varies because of different types of standards that have been set.

The metering system that most users have today requires that users have to read of the meter in period such as monthly or yearly and report it in to the distribution operator or the electricity supplier.

The figure below illustrates how todays metering system works, comparing to AMS meter:

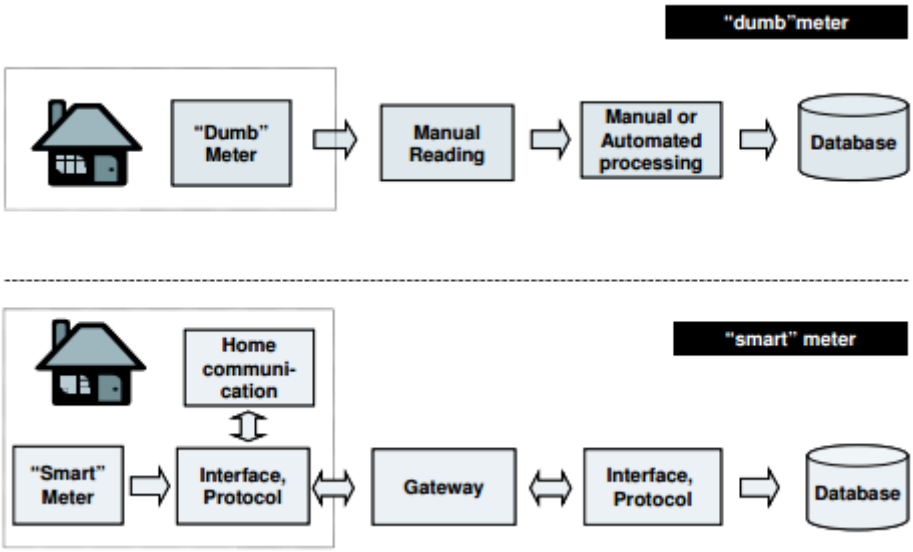

Figure 22: Todays metering system comparing to smart meter system (AMS). Sources: Report about smart metering by Gerwen, Jaarsma, Wilhite and KEMA. (58)

Today many of us uses smart phones, computer and clouds services as a part of daily life. Smart metering comparing to today's metering system is an innovated move towards a smart future. NVE descries AMS meter as step in to ''Digitization of power industry'' (45)

AMS meter appears to be a simple technology that contribute to more information but requires less effort from the consumers. The technology gives the consumers opportunity to manage their own usage and therefor contribute to positive impacts for the environment. The smart metering system is introducing as smart tool, in order to meet the climate targets that have been sets. NVE states that AMS is a correct direction toward a future of smart grids, this matter was also confirmed by the parliament document no 14 (2011 – 2012) (59)

3.5.4 Challenges of AMS

Despite the benefits mentioned in chapter 3.5.3, there some challenges due to the AMS meter.

The challenge that distributor operator is facing are the process of replacing old meter by smart meter. AMS meter requires other types of data communications and collection method. According to NVE regulations mentioned in document 7-2011 § 4- 3(49) Distribution operators are responsible for the total system such as storage and measurement quality.

Sintef have done an overall risk assessment for the general AMS technology (60). The events that can occurred that Sintef considered to be at highest risk are the following:

- Unwanted disconnection among several customers
- Software Error
- Central system error or hacked data
- Not reliable server, unfaithful employee misuses knowledge and / or legitimate accesses

The reasons that these events are considered to be at highest risk, is because of the consequences of it. One of the main consequence that Sintef enhances involve large costs for repair and or replacement of technical equipment. The most critical scenario is disconnection among several customers at the same time. (60)

Table 5 describe scenarios that Sintef states as highest risk and the most likely ness for that scenario to happens. (60)

Scenario	Seriousness, from 1 - 5, (where 5 is catastrophic)	Most likely to happens, from 1 - 5, (where 5 is catastrophic)	Risk assessment
Large number of AMS out of operation at once	4	3	12
Customer manipulate measurement data	2	2	4
Internal threats - disloyalty among staff	5	3	15
Targeted attacks on power supply	5	3	15
Unfortunate consequences of third party access	3	2	6

Table 5: Risk assessment of scenarios. Sources: Sintef, 2012 (60)

NVE report no 77/2015 (53), states that the cost of installation are estimate about 3 787 kr per meter node. The total cost for the project are estimate to be about 10 billion kr. There is an discussion about the cost and investment especially for consumer that have over 100 000 KWh usage per year, this can be seen in the hearing document 7 –2011 (49)

The document 7-2011 (49) gives impression that these facilities involves complicated and high cost construction. These facilities already have two-ways communications meter installed, but many may does not meet the AMS requirement that were set, especially requirement that involves third party connection. AMS adaption through the regulations that were been set will not increase its advantage for either the customer, supplier or the distribution operator. Meter exist in this segment already have integrated monitor devices and control of usage for many years, and effective solutions have been covered for this segment. Statnett argues in the document that customer in this segment already have a necessary system similar to AMS solution, and a third party requirement should not be

necessary in this type of segment. Hafslund confirmed this matter in the document, as they believe that a development with full AMS function as the regularities require for all type of consumer are expensive and unnecessary (49, Page 22). NVE states in the report that, under special condition, distributor operator or consumer can send in an application for exceptions, regulates by §4-2 (49)

However, EU argues that in order to achieve energy savings to its fullest potential, the meter system depends largely on the function of it. This matter was conformed according to EU report (55). The commission states:

" The extent of energy saving can depend heavily on the functionality of smart meters "(55)

As we can see back in chapter 3.3.6, intensive industry stands for about 30 % of consumptions in Norway, an eventual reduction of electricity usage in this segment will have a significant impact for the power system.

Another challenge around AMS metering is about how the government have intended to introduce the smart metering to the market. According to EU report, Finland promoted smart metering as a government legislation. Sweden in other hands, promoted the smart meter by the government in response to the consumers concerns (55). In Norway, it seems to be little promoting to consumers for the AMS meter besides a few information pages.

Questions about the cost of investment in AMS meter, and whom this settlement should go to are discus in varies report and article. The NVE regulations (48) states that the distributor operators are responsible for the cost and implementation of smart metering. In other term, according to the EU report, most distributor operator can recoup their investment in AMS metering through higher tariffs for consumers. The EU report (55) states the following:

"According to the Commission's benchmarking report, in the vast majority of Member States where deployment of smart meters has been approved, the DSOs that install them will be allowed to recoup their costs, either partially or fully, through higher network tariffs for consumers" (55)

An interview with Eimund Nygaard, CEO at LYSE AS in an article from TU states that he assumed that the total cost of AMS meter most likely to be more than 10 billion kroner. The main reason for this is the costs to maintain the system, which will require much more than the standard meter system that we have today. (61)

Document no 138 (2002 – 2003) (48) and NOU 1998- 11 (43) argued that one of the benefits for consumers are economic benefits. As they can choose to use more electricity in hours that have lower electrical rate than other does. NRK interview with NVE' s water resources and energy director Per Sanderud (84) confirm that DSO tariff regulations from 2019 will increase during peak time hours such as afternoons, after most household consumers come home from work.

This indicate that in peak time, the tariff most likely will be much higher than other times of the day, and consumers that do not have the ability to avoid usage in these peak time hours would risk much higher settlement than others. Due to this, United Kingdom (62) have

argued that the economic benefits of smart metering are aimed to the energy suppliers, especially in areas that have uncompetitive energy markets. Raised of tariffs and smart metering does not benefits vulnerable consumers. (55) (62)

The smart metering in technological term is just a tool, a device. The benefits that can gain from a tool depends on how we choses to use the tool. As we can understand, the intended assumption of energy savings comes from how consumers uses the information that they receive. Document no 138 (2002- 2003) (48) pointed out that event if consumers receive information about their consumption, does not necessarily mean that all consumers will have any action about their consumption. Energy savings action from a consumer point of view, which requires a psychological understanding. This matter is further investigated in chapter 3.7.

3.6 Energy management and manufacturing industry

Manufacturing industries depend on a sustainable production process, and electricity is one of important elements for the whole production process.

Electricity within manufacturing industries stands for a large part of the total cost of production. In order for an organization to have a sustainable production, requires a solid management system for the production process. The management system for the production process should also include an energy management system in order to save energy and cost.

There are several types of manufacturing industries. This thesis focuses on the power-intensive industry. As we can see earlier on chapter 3.3.6, power- intensive manufacturing industry stands for a high share of electricity usage in Norway (19). An eventual electricity savings in this segment would have significance impact for the environment, society and the organization. The benefits of electricity reduction for the environment is to avoid peak time load, blast electricity capacity and the need to construct new grid system would be reduced. The benefits of electricity reduction for the organization is the ability to save cost, stable production line and gain economical profit.

According to NVE report, much have been done in order to gain more effective energy consumption in this segment. Enova have reported that they have compensate companies overall in Norway, with around 1 billion in order to implemented more effective energy consumptions methods. This has results around 4 TWh in energy savings total, and most of it comes from power-intensive manufacturing industries. However, there are still potentials in many areas when it comes to more effective usage of electricity (28) Mc Kinsey have done an analyses research for NVE in 2009, and the research concluded that there is a potential economic benefits for organization that reduces energy consumption with an amount of 12 TWh.(28)

Enova states that when energy management have been including as a part of the management system, it contributes to continuous improvement, reduced energy cost and gain a better climate financial statements. (63)

In organizations, energy savings initiatives come often from managements through the decided management system and routines. Due to the research about smart meter within manufacturing industries and the research questions, it seems appropriate to include and link smart meter to energy management system. In this chapter, energy management system (EMS) are introduces through research and Enova guideline in order to provide knowledge in this segment.

3.6.1 Management system within manufacturing

Manufacturing organization are facing a constant need for improvements due to changes in the marked, requirements of the government and increasing of competitions.

In early days, the focus was mostly about mass production, the concern was more about quantity rather than quality. Today, most manufacturing organization focuses on the process, total quality of the product, cost performance and management system in order to compete with the global market. Due to constant changes and high competition in the market, organizations are force to seek ways to increase the efficiency in all levels. Organizations must consider steps and strategies that can help them to work effectively without wasting time and resources. Researchers has developed many theories within these issues such as the Toyota ways of lean leadership. There are several researchers and theories about management system. The aim of this chapter is to provide general knowledge of management system and limit this to into a general description.

The overall management system started out with the managers in the organization. According to Strategic management by Charles Hill Gareth and Jones Melissa (64), managers are groups of peoples that makes decision in the organization. There are several different types of managers within an organization. The amount of managers depends on the need and size of the organization. However, the aim of the organization and its managers is all about making strategic goals and decisions that contribute to gain profit and provide customers need. (64)

International Organization for Standardization (ISO) defines the management system as the following:

''Management system describes the set of procedures an organization needs to follow in order to meet its objectives.'' (65)

In other words, the aim of the management system is to provide the organization with targets, strategies, routines and standards in order to achieve better results. The system should clearly describe and provide important information to employers and managers. The management system should also provide information about what employer's tasks and responsibility are in the organization.

ISO *(65)* summarizes the benefits of a successful management system as:

- *''More efficient use of resources*
- *Improved risk management*

- *Increased customer satisfaction as services and products consistently deliver what they promise.''*

This thesis focuses on electricity consumption, and in what extend a smart metering can benefit organizations. As we know, electricity is a critical element of the production process, and a large part of the total production cost. It is reasonable that energy savings process should be include in a management system. The thesis focuses on AMS (smart metering) and its benefits to manufacturing aspect. Smart metering can be understood as a tool to achieve energy savings incentives. From an organization point of view, energy savings tool such as smart metering should be include in an energy management system. Knowledge of energy management system are provided in the chapter below.

3.6.2 Energy management system

Due to the research questions, it seems appropriate to include energy management in order to answer these questions.

The main different between understand consumption from a individuals point of view, versus an organization point of view are simply that in a household, consumer can chooses to reduces usage or not, in an organization there are often routines and management systems to follow due to this matter. However, it is important to notice that human as private or managers makes both point of view and decisions.

The relationship between energy consumption and management strategy was not an interesting topic to top management in early days. The realization of the need to make energy a part of the strategic decision does not start before around the 80s. (66)

Turner, 2007 (66) have states the following about why organization have been focuses on the environment as a part of the management system:

'' Business, industry and government organizations have all been under tremendous economic and environmental pressures in the last few years. Being economically competitive in the global marketplace and meeting increasing environmental standards to reduce air and water pollution have been the major driving factors in most of the recent operational cost and capital cost investment decisions for all organizations. Energy management has been an important tool to help organizations meet these critical objectives for their short-term survival and long-term success'' (66, page 2)

Turner 2007 gives impression that organizations should include energy management as a part of their management system due to the overall pressure and competitions. According to Turner, 2007 energy management is cost effective and it is important due to our national security, environment and economic productivity. (28)

The Norwegian Environment Agency argues that the main reasons to implement energy management into management system with the following benefits (67):

- Climate changes and increasing energy consumptions requires energy efficiency initiatives such as energy management.

- Competitive advantage
- Cost savings
- Great opportunities for financial support and technological progress by Enova and innovation Norway
- Regulatory requirements, laws, directives and authorizations

The regulatory that the Norwegian Environment Agency means here are the following (68) (67):

- §2, section 3: Technologies solutions that can provide information about current and future usage should be include preventing and limiting pollution.
- §16: The law here opens for regulatory that involve reducing pollution and effective usage of energy.

According to Norsk Energy (69), Norwegian industry have most likely lost 1,5 billion by not having knowledge about the organizations energy usage. Norsk Energy states that: *''Energy management is essential to maintain a profitable and competitive business''* (69)

Enova have also confirmed similar benefits of having an energy management system, especially within efficiency of operations and cost savings. Enova argues that the potential cost savings are about 5 –10 % during the first year. (63)

The management system model developed by Deming is a known model that can be use in energy management (70). The Norwegian Environment Agency has used this model to describe the energy management system. The model is based on a circle of Plan – Do – Check – Act that are illustrated by the figure below: (67)

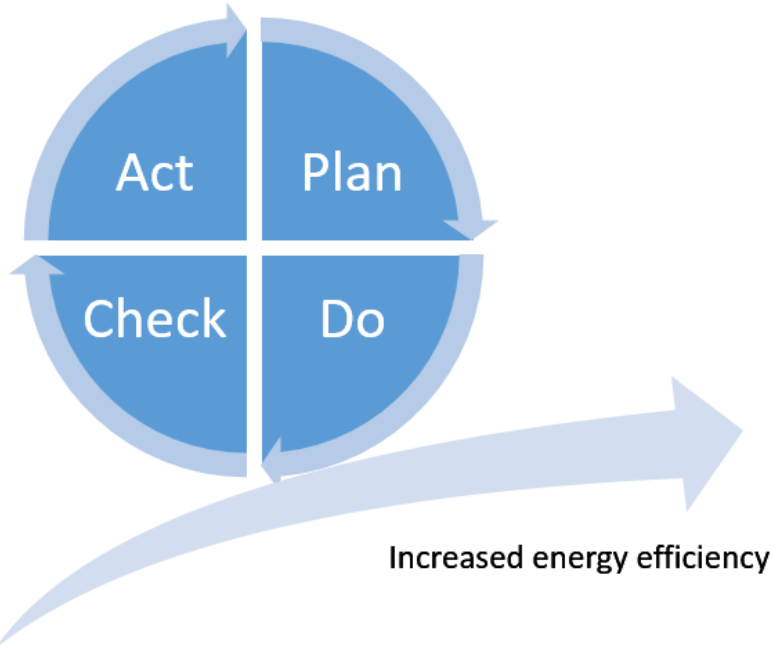

Figure 23: Energy management system model, sources Norwegian Environment Agency (67)

The Norwegian Environment Agency (67) describes the energy management system as a systematic, purposeful that based on continuous efforts to improve energy efficiency in the organization. Such as the figure above illustrated, the system should consist of an act, plan check and do in a never-ending circle of continual improvement.

According to Enova (63), energy system management is not just about establish a system. In order for the energy management to work requires human activities, support in the management group, a clear define goal and foundation. How this system can be implemented are describe in the next chapter.

3.6.3 Implementation and certification of energy management system

Energy management system according to Enova is not a complicated system. The system is based on a model as mentioned above with a circle of plan, do, check and act. If the organization already have a solid management system as a foundation, implementation of energy factor in the management system will be an easy process. (63)

Enova summarizes the most important element for the energy management system are the following (63):

- Goal setting
- Organize organization and clear defined roles.
- Information of energy usage
- Plan to achieve the set goal
- Control of energy usage
- Evaluation of process in order to achieve continuous improvement
- Simple sets of routines and standards to follow

The Enova elements for energy management are illustrated by the figure below:

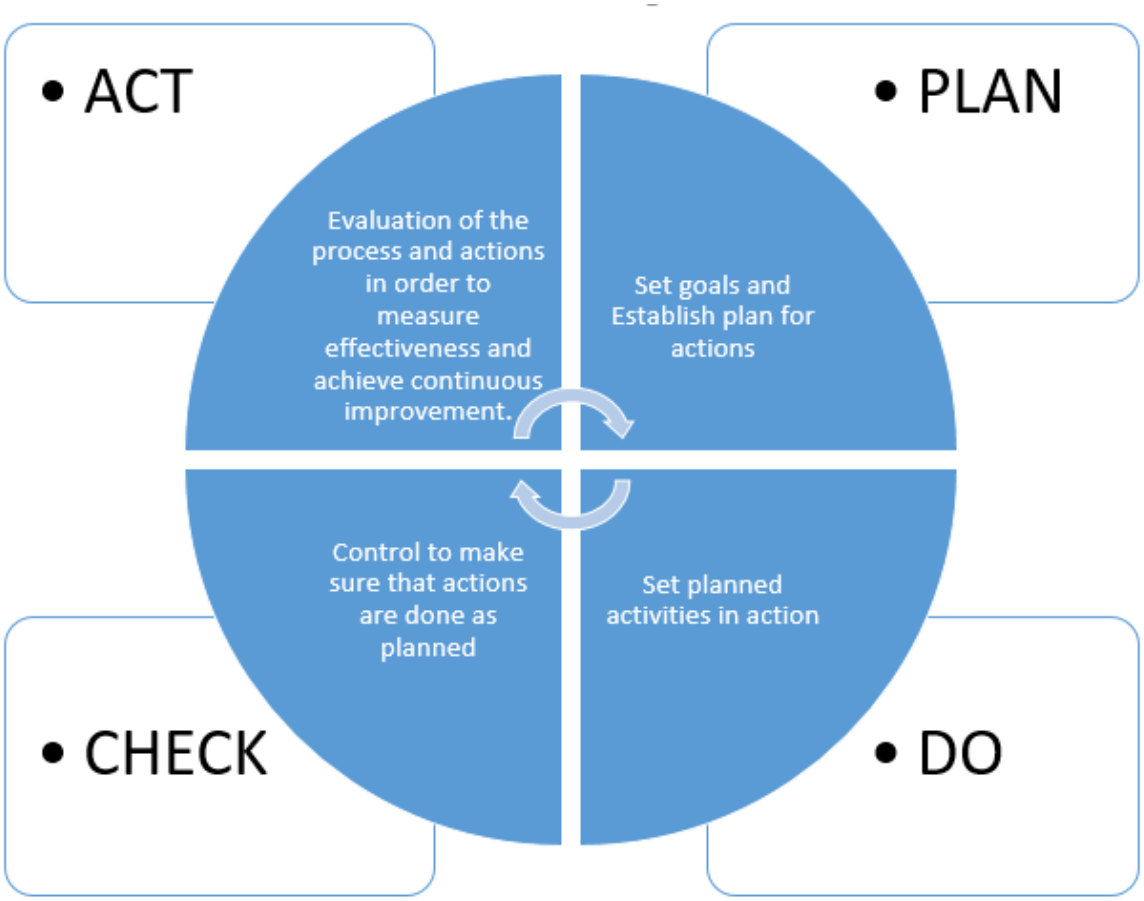

Figure 24: Energy management system model. Sources: ENOVA guidelines: Energy Management, 2012 (63)

The most common problem due to implementation of a new management system is lack of information and understanding of expectations in different levels of management. This matter is illustrated by figure 25 below:

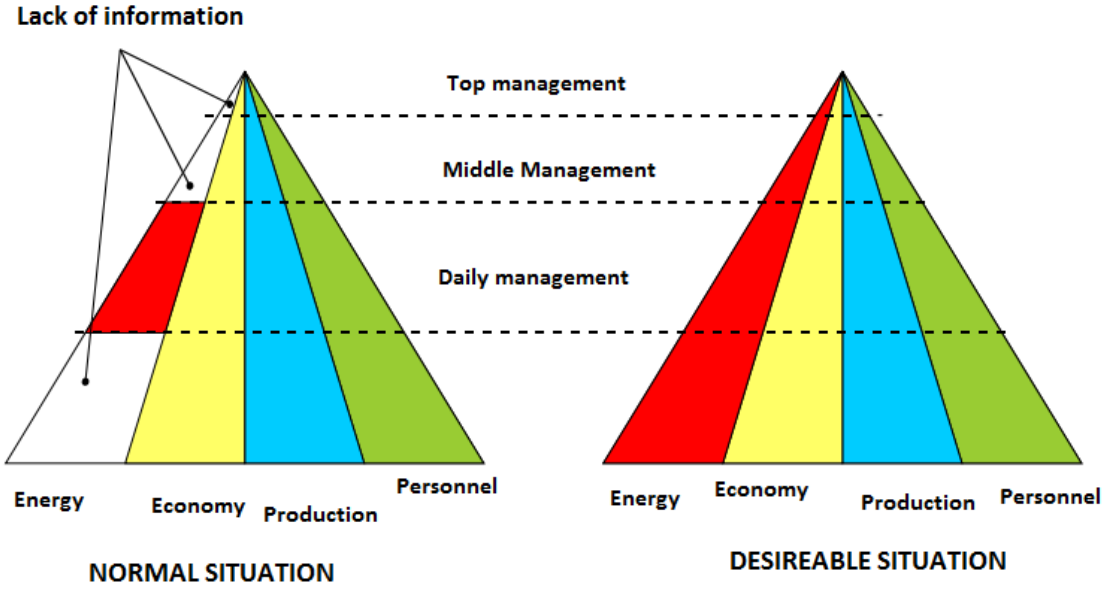

Figure 25: Energy management system information flow, sources Enova, Interaction between people, technology and organization (71)

It is important that the management system involve understanding and willingness to implement the system into the organization from every aspect of the organization, especially from top managers.

According to Training and development by Craig Eric Schneider, 1994 (72) page 51, a major misconception is that top management may grasp new system quickly and believe in their importance, but they did not change their behavior pattern. Which causes difficulties for middle managers and other organs in the organization. Schneider, 1994 (72) describes a situation where implementation of new techniques fails to implementation because of these issues.

The situation that Schneider, 1994 (72) describes where about workers that have learned about new techniques and eager to apply them in order to achieve better quality. However, higher quality does have an impact on their delivery goals. Top managers expected the workers to deliver qualities that have been set, but not at the expense of the delivery goals. This situation has put middle manager in a '' squeeze''. The workers began to lose interest of quality techniques and as the results; there were no changes at all when it comes to quality improvements.

This situation gives impression that, in order to implement a new system, new techniques requires a cooperation from every hold in the organization. The Norwegian directorate mentioned this matter as well in their description of energy management. This matter is illustrated by figure 26:

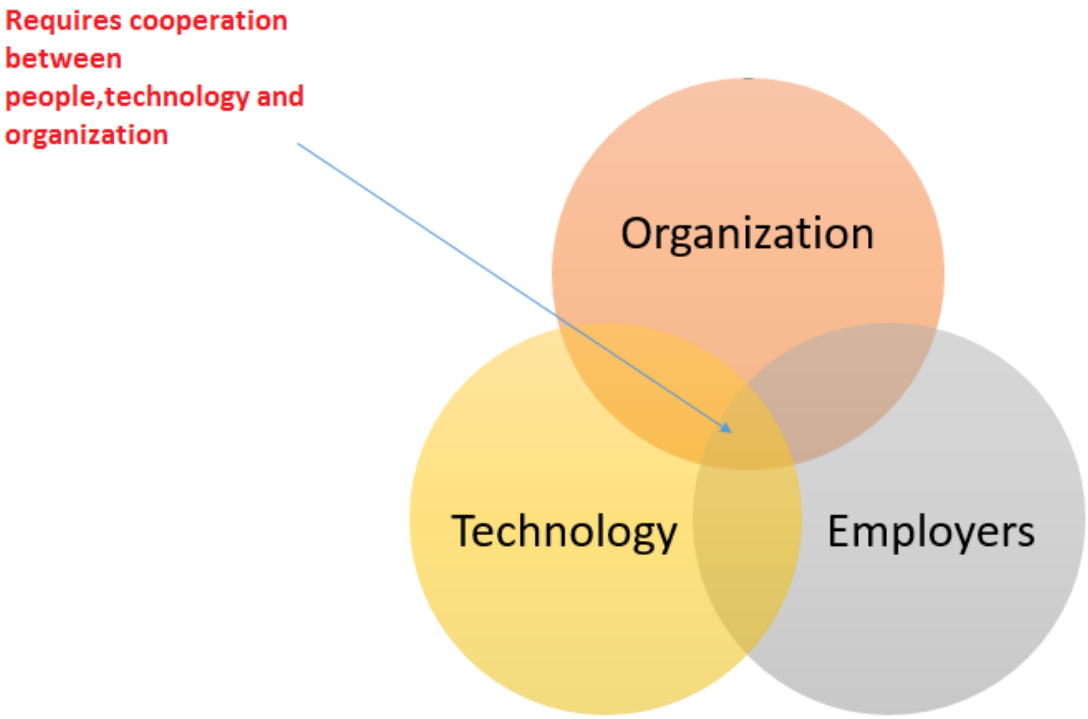

Figure 26: Energy management requires cooperation, Sources: The Norwegian Environment Agency (67)

Figure 26 illustrated that in order for the energy management to work successfully, requires cooperation from different hold. This matter involves organization itself such as managers, employers and the available technology.

All organization can choose to implemented and certificate energy management system as they wish. It is not a requirement be law in Norway. ISO standards are standards that many organizations chose to use, as it provides necessary requirement, guidance and specifications for the processes or system organization wish to use or implemented. The most important standards set for energy management system are the following (71):

- ISO 50001: Energy management system
- ISO 14001: Environmental management
- ISO 9001: Quality management system

The total amount for certifications are 1 609 294 worldwide in 2014 and ISO 50001 energy management system have 324 148 certified organizations (73). Due to the regularities about emissions, most organization recognize the purpose of such certifications although it is not a requirement in Norway. Despite the certification for ISO standards is not require by law, the amount of organizations that has certified has increased. According to ISO standard (74), there are 19 organizations that are certified for ISO 50001 in Norway in 2014 and the trend is increasing.

The evolution of ISO 50001 certificates in Norway are illustrated by figure 27 below:

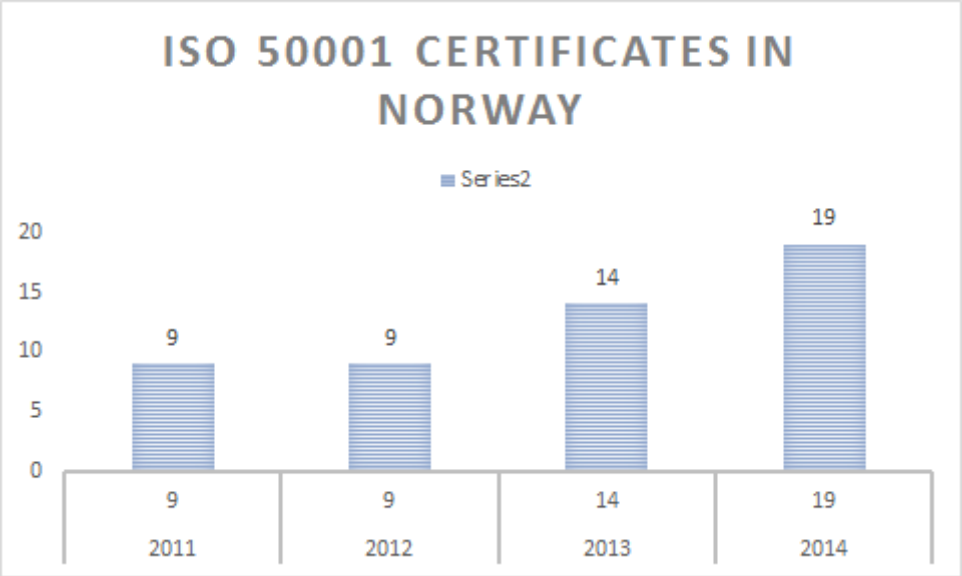

Figure 27: ISO 50001 Certificates in Norway 2014. Sources: ISO standard (74)

The figure above illustrated the process of certification of ISO 50001 in Norway. We can see that it is increasing but, comparing to Germany that have 3402 certified ISO 50001 organizations, Norway still have a long way to go due to ISO 50001 certifications.

It gives impression that in order to achieve a successful energy management system the most essential factor comes from human interaction together with the technology that are available.

Smart metering is just a device, a technology that gives information. Energy management system requires energy control, it is assumed in this thesis that smart metering could be an appropriate tool in order to achieve such requirement. Smart metering in manufacturing organization can be a helpful tool in the process of implementation of energy management system as well.

3.7 Environment and human psychology

As mentioned, manufacturing industries depend on a sustainable production process in order to minimize negative impacts on the environment, natural resources and achieve energy effectiveness. The term sustainable manufacturing are popular, and most manufacturing organizations strive to achieve this. Several management systems, methods and researches claims that sustainable manufacturing can be achieve through them. This thesis does not favor which processes or methods are the best in order to achieve sustainable manufacturing.

From my point of view, sustainable manufacturing is not just about to produce more sustainable products itself, but the total manufacturing processes are sustainable. This thesis focuses on electricity, which is one of important elements for the whole production process.

In order to gain energy effectiveness, one must know how, and have a plan to achieve this. As we can see from figure 26, energy management system requires corporations between technology and human interactions, both as individuals and organizational. Due to the

research questions, that consist of about consumers own reflection of usage. In order to answer these questions, we need include a psychological understanding, and this chapter will provide knowledge in this area.

This chapter consist a general understanding of environmental psychology and organization reactions due to changes.

3.7.1 Environmental psychology

Environmental psychology studies the links between individual's behavior, experience and the impact it has on the natural environment. Environmental psychology an introduction, 2012, by Linda Steg, Agnes E. van den Berg, Judith I. M. de Groot (76) define environmental psychology as:

'' The discipline that studies the interplay between individuals and their built and natural environment. '' (76, page2)

Researchers have several definitions to environmental psychology. However, the most important aspect of the definition is about the interactions between human and environment.

This field of psychology studies is not a new concept. It been studied for a long time but did not receive a special field before the late 1960s. The original rots of environmental psychology come from the following roots:

- The psychological Roots
- The Architectural Roots
- The geographical Roots
- Other researches of its inspirations. (75)

Steg, berg and Groot, 2012 (76) Informs that Egon Brunswick (1903 – 1955) was one of the first psychologist whom paid attention to the field, and argued that physical environment can affect the subconscious psychological processes. (76)

Steg, berg and Groot, 2012 (76) added that Kurt Lewin (1890 – 1947) shared the same view as Brunswick statements, but his focuses were mainly based on the human behavior patterns and social influences instead of physical environment.

Lewin states that the following:

'' *Behavior is a function of the person and the environment''.* (76)

Lewin developed an important equation due to environment psychology:

$$B = \int (P, E)$$

Equation 1: Lewin equation: Human and environment. (76)

Functions of the equation can be explained as the following:

B is the behavior, P is the person and E is the environment. The equations states that the behavior is a function of a person in their environment. (75) (76)

The P in Lewins equation consist 3 areas of research that are important in order to explain the way people responds to the environment. It can be summarized as the following:

1. Environment perception: This involves how a person actually perceive the environment that they are living in. In context with the interaction of social and psychical elements.
2. Environment appreciation: This factor involves emotional or evaluations of how a person actually feels about their environment.
3. Environmental personality: The natural personality in order to reflect different responds to different environment.

(75)

Historically, Environmental Psychology in the late 1940s and 50s had a more systematic research in focus. The researches had focuses about how individuals perceive their environment, and their reaction to their physical environment. The studies of environment factors were defined as architecture psychology. Within these researches, environment have large impacts on the human performance and behavior. Questions were often about how homes, offices etc. could be construct in order to achieve best effect on human performance. (76)

In times, the researchers within this field have developed towards a focuses about effects of human behavior patterns to the environmental resources. The main reason for that is the focuses on climate changes, and the need to understand in order to change behavior patterns. (76)

Overall, the concept of environmental psychology can be described as: The environment has impacts on humans, as well as humans have impacts on environment.

According to Cassidy, 2013 (75) Vietch and Arkkelin (1995) have identified four major historical trends and six theoretical themes due to environmental psychological.

The historical trends are the following:

- Geographical determinism: This can be explained as the geographical environment influences the behavior. Behavior that occurs here are because of the experience the individuals have due to the area they are living. Behavior towards example rains and season changes are largely geographical based.

- Ecological biology: This approach can be simply explained as the human behavior as instinctual. For example, the instinct to survives, food, water etc.

- Behaviorism: This approach is about the interactions of environment and behavior. Two different types of behaviors are important due to this approach. One is about the physical impacts of the environment due to human's behavior, the other one is about the impacts of human behavior due to the environment.

- Gestalt psychology: The Gestalt approach is based on the assumption that the '' *the whole is greater than the sum of its parts*'' (75, page 15). In psychological meaning, it

can be explain as the meaning of experience individuals have. An understanding of this approach are illustrated by the figure below:

Figure 28: The invisible triangle. Sources: Tony Cassidy, 2013 (75)

Figure 28 shows us the overlaid triangle, but there are no evidence of it in the real world. Gestalt explained the ''Phenomic'' world that determined behavior. In order words, gestalt approach can be explained as a sum of the whole, which includes physical or socials experience that make up the environment.

There are several theories in this field. However, according to Cassidy, 2013 (75) there are none unified theories about the subject, which were supported by Vietch and Arkkelin, 1995. Cassidy, 2013 (75) suggested four categories within environmental psychology theories:

- *''Theories that look inward*
- *Theories that look Outward*
- *The role of cognition and appraisal*
- *Theories that assume interactions.''*

Due to the time limit, it is impossible to discuss all the theories available in environmental psychology research. Due to the research questions, that focuses on the understanding of impact of human's behavior towards the environment. This matter require knowledge that about interactions between the human's behavior and environment. Therefor theories that assume interactions are more appropriate due to the research questions.

According to Cassidy, 2013 (75) there are at least 3 different forms of theories that assumes interactions. These theories have developed out of Lewins integral B=f(P,E). These theories can be summarized as the following:

- Interactionism: This theory refers to a system where the persons and environment are seen as separate parts. Each part interacts with one another through different forms.
- Transnationalism: This theory is usually associate with a model of stress. The theory emphasis the interdependence of person and environment where additive effects are not acceptable as explanatory models. The theories focus on the interactions

between the person and environment in a chain or sequence of a developing process.

- Organismic Theories: This Theory focuses on the complexity of person and environment relationships as well as their interdependence. The model in this theory includes the person and environment as interdependence, together with social factors in a complex process. Overall, this theory reflects on the interactions of both person and environment, which can be related to Lewin theories.

In order to answer the research questions, we must gain understand the interactions of the environment and person. In this term, human behavior and impacts to the environment. The next chapter will provide a closer look into the impact of human activities due to the environment.

3.7.2 The interaction between climate changes and Human activities

Our climate is changing, which cause extreme weather conditions. The fact of climate changes can be described as the atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

The IPCC report in 2014 (77) have warned us that carbon emissions have soared in the last decade and are now growing at almost double the previous rate. The main cause for this problem because of human being activities.

The IPCC report states the following:

''Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems'' (77, page 22)

The IPCC report gives impression that, if we do not stop the emissions of greenhouse gases, it will cause further warming and changes in the climate system. The projected climate changes impacts are: the ocean will continue to warm and rise. It is likely that the artic sea ice cover will continue to shrink and the global volume will further decrease. (77)

The impact of climate changes is illustrated by the figure below:

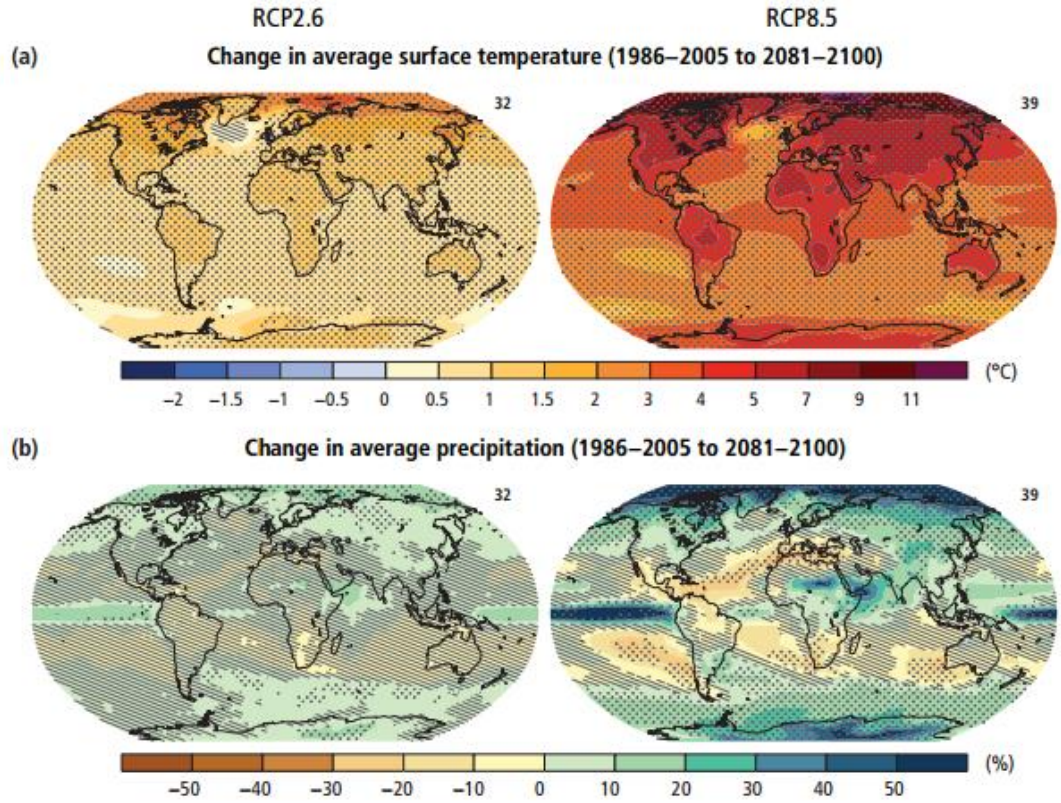

Figure 29: Prediction of average temperature and precipitation from the year of 1986 – 2005 comparing to 2081 – 2100. Sources IPCC report 2014. (77)

The report analysis found that rapid actions could help limit the global warning (77)

As mentioned, the consumption of electric are increasing. We can state that people are addicted to electric, and all production process depends on electricity.

As the IPCC report (77) states, climate changes bare based on human actions. As we can learn from environmental psychology theories. Human behavior does have impacts on the environment, which make these issues a common problem. The common problem in this terms means behavior that are repeat by many individuals, that causes impacts on the environment.

An article about Psychology's Contributions to Understanding and Addressing Global Climate Change (78) developed a model due to this matter that are illustrate by the figure below:

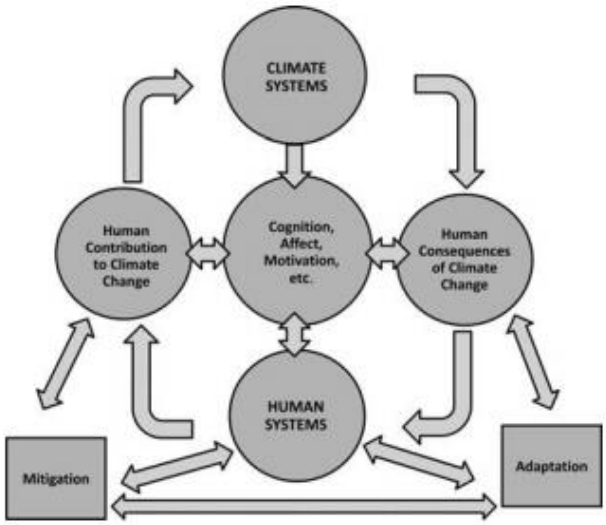

Figure 30: Human and Psychological Dimensions of Climate Change. Sources Psychology's Contributions to Understanding and Addressing Global Climate Change (78)

The model in figure 30, illustrated the human system, the climate system, and their interactions to one another. The left side illustrated the humans affect to environment through activities and consumptions. The human's system in the figure illustrated the psychologies of humans in terms of understanding of climate changes, responses and psychological motivations. The right side illustrated the consequence of climate system from a both psychological and social point of view.

The article about Psychology's Contributions to Understanding and Addressing Global Climate Change (78) explained the figure through the following statements:

'' The direct and indirect impacts of these psychological processes on many of the elements shown in the figure illustrate that human dimensions of climate change are inherently psychological and social, and that psychology can offer knowledge and concepts that can help explain the human understanding, causes, and consequences of climate change as well as inform responses to it and help make them more effective. '' (78)

The research questions of this thesis are about the consumers own reflection of usage, and the benefits of AMS within manufacturing organization.

In order to achieve benefits of the AMS system, it requires a corporation of the technology of AMS and human's actions. Therefore, we need to gain knowledge of how to encourage environmental behavior. This matter is introduced by the next chapters.

3.7.3 Encouraging Environmental behavior

Encouraging environment behavior requires changes of the current behavior. In other to change, one should know what type of limitations that exist. Robert Gifford, 2011 (79) suggested several types of psychological barriers that can limit behavior change. The barriers that Gifford suggested are the following:

- Limited cognition
- Ideologies
- Comparisons with others
- Sunk costs
- Discredence
- Perceived risks
- Limited behavior

These barriers are explained by table 6:

General psychological barrier	Specific manifestation
Limited cognition	Ancient brain Ignorance Environmental numbness Uncertainty Judgmental discounting Optimism bias Perceived behavioral control/ self-efficacy
Ideologies	Worldviews Suprahuman powers Technosalvation System justification
Comparisons with others	Social comparison Social norms and networks Perceived inequity
Sunk costs	Financial investments Behavioral momentum Conflicting values, goals, and aspirations
Discredence	Mistrust Perceived program inadequacy Denial Reactance
Perceived risks	Functional Physical Financial Social Psychological Temporal
Limited behavior	Tokenism Rebound effect

Table 6: General psychological barriers Sources: Robert Gifford, 2011 (77)

Robert Gifford, 2011 (77) suggested five essential strategies that could help to overcome the general barriers. These strategies are summarized as the following:

- Analyzes and defined possible barriers.
- Creating better ways to introduces information to consumers
- Improve understanding of technologies and policies in order to limit climate change.
- Design and gain more knowledge about carbon related behavior such as energy usage.
- In corporation with different instance such as government, consumers and technical expert.

Linda Steg and Charles Vlek, 2008 (80), suggested a quite similar approach in a systematic way in order to encourage pro-environmental behavior. This system approach is illustrated by figure 31:

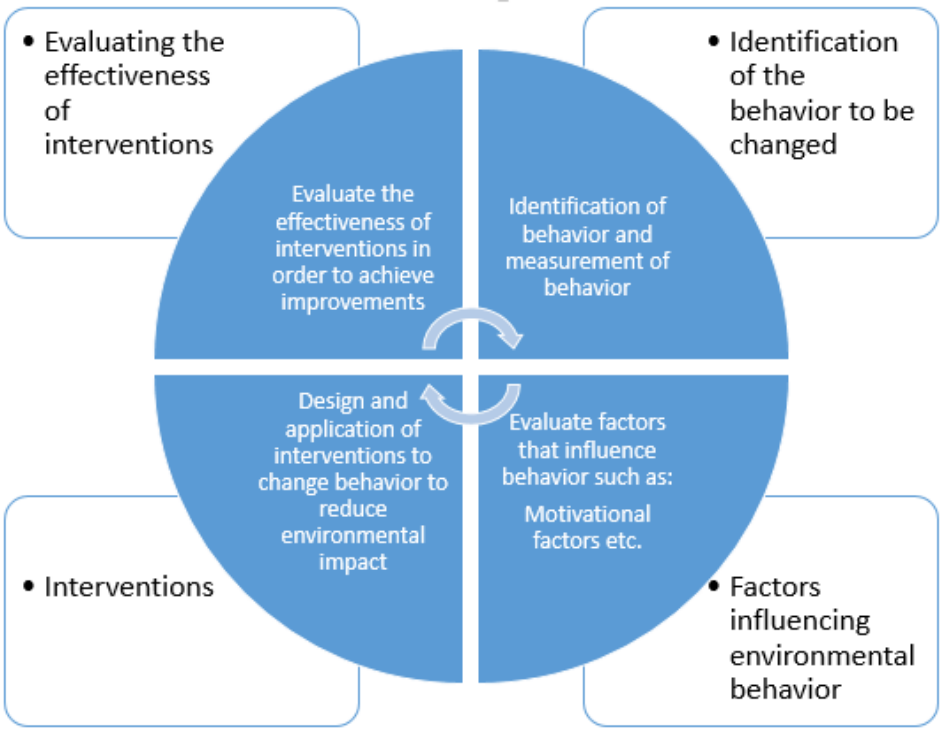

Figure 31: Systematic approach due to environmental behavior. Inspired by Linda Steg and Charles Vlek, 2008 (80). Made by author.

Figure 31 illustrated that in order to achieve change in behavior in favor for the environment the actions requires are identifying, evaluate exist factors, design and applicate changes and evaluation in order for future improvement.

Both approaches suggested to identified possible factors or barriers exist in order to create changes within this matter. The thesis is about own reflection of usage and some of barriers that may exist can be inspired by Robert Gifford, 2011 (79) with the following:

- Ignorance: This barrier consists of not knowing that a problem exists, and not knowing what to do when become aware of the problem.

- Environmental Numbness: This means when a human finds themselves numb when hearing about one thing to often. For example, climate change, energy usage etc. Most people become less aware of the problem, which lead to unwilling ness to change of behavior.

- System justification: This means when humans find themselves in a current comfort situation it is difficult to require change in behavior. Humans would justify their behavior in order not to change.

- Mistrust: Trust is very important factor when it comes to change of behavior. Mistrust may occur when a person feels that the information from them have been misused such as stolen emails, personal information, lies from unprofessional scientists or politics.

- Denial: This means that for some other reasons, a person is in denial of a problem. Some may denial that climate change is happening or that one's roles does not matter when it comes to climate change.

There can be more barriers, but in this thesis I have limit this to the barriers that I have considered appropriate to the research questions.

According to Gardner and Stern, 2002 (81), global climate problem is considered as a common problem that occurs due to human behavior. As we have learned from chapter 3.7.1 about environment psychology, there is many theories within this subject. Gardner and stern describes environmental psychology in a broad overview and suggested 4 solution approaches due to climate changes. The four approach can be summarized as:

- Religious and moral approaches: This approach focuses on change in beliefs, point of views and values.

- Educational and interventions: This approach focuses on providing information and encouragement to change attitude. The focuses in this approach are information strategies and change of behavior through feedback, reminders, modelling, prompts and commitment.

- Society incentives: This approach focuses on change in society's incentives in order to achieve changes in behavior. This matter can be achieving from all society aspect like taxes and subsidies. The focuses here are about making environmental responsibilities convenient as well rewarding, if it is possible.

- Community management strategies: This approach focuses on the local resources as common resources. The approach takes stance in environmental changes in the local areas and not as states or national levels. In other words, this approach focuses on change in a small geographic area and the resources and pollution that exist within this area.

Gardner and stern, 2002 (81) argues that these four solutions are not effective to use alone in solving the global environmental problems. In order for the solutions to be most effective,

requires effort from at least all or most of these solutions. Gardner and stern, 2002 (81) believes that each of these solutions have their pros and cons, but if used combined they may supplement and strengthen their advantages.

As we can understand human psychology are very complex, and there is many different factors that can affect behavior change. The most important thing that we have learned is to investigate what behavior that needs to be change, and what kind factors and strategies that can help to achieve the target.

3.8 Organization behavior changes

Smart metering (AMS) as mentioned is just a tool that provide information. Energy savings actions comes from consumers through development of the technology and behavior changes in a systematic way. As we can learn from chapter 3.6.2, in order to save energy and have control over consumption, theories recommended to included energy management system into the management system.

In order to implement energy management system or a new tool such as smart metering requires changes within the organization. The process of changes within organization are quite similar to implemented change in human behavior. It is a very complex process, especially for those who are involved in the actual change. Change processes is difficult to understand for researchers, and it is unlikely that any one can be able to give a complete overview of the research on changes within organizations. The theories on the topic seems endless.

Smart metering and energy savings incentive in an organization can be define as an idea. Based on Rørvik, 2007 (82) theories about translation and change. During idea implementation, something happens to both the idea and the organization. Through Rørvik, 2007 (82) theory, we may gain knowledge about consequence that can occurs when an idea such as energy savings incentive by using smart metering are put into practice and applied.

Rørvik, 2007 (82), argues that when ideas are adopted into an organization, it may have several outcomes such as disagreement, actual changes, or a compensation between old and new concept. The theory about an idea journey into practical approach can be define as a virus. Defining idea as a virus clearly is just a metaphor, but it gives us an understanding within this matter. Rørvik, 2007 (82) explained that similar to virus, an idea can go to different process and have different results.

Rørvik, 2007 (82), suggested the following properties that a virus have that are similar to management ideas:

- Host and infection: The first step is establishment of the idea within a host. The host will then spread the ''idea virus'' on to other hosts. This matter can be understood as, if a person or manager is convinced the effectiveness of the idea, it is most likely that they will contribute to spreading the idea to the organization.
- Incubation time: As a result, to this intrusion, it may trigger defense mechanism. One of it are called incubation time. This means that it may takes long time before one can see the affect and actual changes in forms of structure, activities and routines.

- Immunity: The defense system may aim to get rid of the ''idea virus'' through developing immunity. This may be a consequence of several failure of change, which have causes the organization to become resistant to changes.
- Mutation: Other defense mechanism here is developing mutation where the ''idea virus'' mutated in order to blend in with the current organization culture and identity.
- Activation and deactivation mode: The defense system can become immune with the system. However, some times the virus tend to stay in active/passive mode. Sometimes symptoms are there and sometimes it is not.

Due to research question about what benefits, Smart metering (AMS) are for manufacturing organization. Within manufacturing aspect, one can consider smart metering as a tool for an energy management system, or a step closer to establish such management system in order to reduce energy consumption.

The idea of using smart metering to save energy, and the consequence that may occurs are closely connected with the research questions, and the theory provided seems useful in order to answer the research questions

Chapter 4 Data collections and Analysis

4.1 Introduction of chapter 4

This chapter will present the collected data for the thesis. The chosen method for this thesis is quantitative method. The main reason for the chosen method is because quantitative method represents larger crowd, and can provide data from a consumer's level. Based on the research questions, I believe that quantitative is an appropriate choice in order to answer them.

According to Leady and Ormrod, 2004 (9), there are several strategies within quantitative method. The chosen approach for this thesis are survey research. Leady and Ormrod, 2004 (9) informs that survey research is used frequently in researches, and it is quite simple in design.

Leady and Ormrod, 2004 (9), states the following about survey research:

"Survey research involves acquiring information about one or more groups of people, about their characteristics, opinion, attitudes or previous experience – by asking them questions and tabulating their answers. " (9) page 183

The thesis does relate to this statement, because the aim of the thesis is to gain knowledge of opinion and attitudes due to AMS smart metering.

The research questions are the following:

- Does AMS smart meter contribute to reflect on own usage as a manufacturing organization?

- Does AMS smart meter leads us to reflect on our own usage as individual?

- Are there different perceptions between individuals and organization, when it comes to energy savings incentives?

- Assumed that smart meter (AMS) can contribute to energy management as a control tool/technology, what are the benefits of it within manufacturing aspect?

The main purpose of this chapter is to provide data results in order to answer the research questions. This chapter will present the results from the questionnaire survey and analysis of the answers.

In addition, an evaluation of the data collection methods and data quality are present, in order to provide the quality of data, and limitations that occurred during the data collections process. Personally, I believe that it is important to evaluate the data collection process in order to gain knowledge and improve for future reference.

The next chapters will provide how data collections were collect, which groups represent the data, and chosen collection techniques.

4.2 Data collection approaches

The aim of this thesis as mentioned is to gain knowledge of opinion and attitudes due to AMS smart metering. Public organs as we have learned from chapter 3.3 states that AMS smart metering will contribute to lower electrical consumptions. This is one of the main motivational factors for this thesis and reason for data collection. Through surveys research the aim is to seek facts through large amount of population, and to be able to test statements about AMS smart metering benefits from public organs.

It is important to notice that survey research provide the ''truth'' at the moment, but does not represent the ''truth'' for eternally. Leady and Ormrod, 2004 (9), states that:

''Survey research captures a fleeting moment in time, much as a camera takes a single frame photograph of an ongoing activity.'' ,(9) page 184

People's descriptions often represent at a moment in time, and can be subject to changes. Leady and Ormrod, 2004 (9), states that people description of their attitudes and opinion are often construct at the same moment they receive the question. It is often that people do not think about the specific issues until they have been asked, so answers may be colored by recent events, or what they think most people wants the hear.

In survey research, the research is based on a set of questions given to willing participants. When all data are collected, responses are summarized as percentage, frequency or statistics.

According to Leady and Ormrod, 2004 (9), there are several techniques due to survey research. The typical techniques are the following:

- Face to face interview
- Telephone interview
- Written questionnaire
- Using the internet

This thesis consists a set of questions given to different groups of peoples both as private and within manufacturing companies. The research questions are based on opinion from both private and manufacturing aspect that is why it is relevant to include both groups to represent the data collection.

The techniques that were used, in order to gain data were short telephone interviews based on questionnaires and by using the internet. Through NTNUs student license for questionnaire program, a survey was created through a program called Quest back essentials (83). A survey created in this program can be send to volunteers by a simple link or emails, which made it easier to use and to spread around. It is also easy for peoples to answer and simple to use.

Because answers can be affect by what people think most people wants to hear, anonymous answers were considered as an important factor in seek of the ''truth''. The responses collected in this process were treated confidentially, and all invited groups were informed that their answers are anonymous and will not be link back to them.

4.3 Evaluation of data collection and quality

The data collection was done through different techniques, as mentioned I have done short telephone interviews based on questionnaires, and by using the internet to spread the link from Questback program (83). The focus groups for questionnaires were electrical consumers within private household and manufacturing companies.

The totaled invitations were 50, where 25 invitations were sent to private house hold and 25 invitations were sent to manufacturing companies. For data collection from private house hold data collections, I have used Questback program to spread the questionnaire link among peoples through internet and emails.

The data collection from manufacturing companies were a bit more complicated. As the target group were manufacturing companies. In order to send invitations to the correct group, I have done websites search to find which companies that goes under manufacturing. Through NVE report about power intensive companies (28), there were information's about companies that goes under manufacturing, which were helpful during the search for manufacturing companies. The data collection technique for this group were short telephone interviews, and email questionnaire link from quest back.

This chapter introduces evaluation of the collection process and quality of data. It is important to evaluate this matter, due to future improvements and describe limitation of the research in a more detailed term.

The evaluation of data collection process and quality consist of the following factors:

- Information that were provided to informers
- The amount of responds
- The reasons for dropout
- The quality of answers and possible bias

These factors will be presented and evaluate in the following chapters.

4.3.1 Information that were provided to informers

In order to gain most replies and encourage people to answer the questions. There was a brief presentation of myself and the purpose of the research before the questionnaires. Personally, it seems important to provide the purpose of the research, in order to gain the interest of the survey.

The techniques that were used are short telephone interviews, internet through emails and spread the quest back link.

For telephone interviews, I presented brief about myself, the purpose of the phone call and the purpose of the research. For the survey through quest back on internet, introduction was placed on the first page before the survey. There was also addition information about AMS smart metering before relevance questions. The brief presentation and information's that were provided to informers can be seen in appendix 1 and 2.

4.3.2 The amount of responds

The totaled amount of invitations was 50. The totaled replies were 34, which indicates a total replies percentage of 68 percent. The total dropout rate stands for 32 percentage of the totaled invite of 50. This matter are illustrated by figure 32.

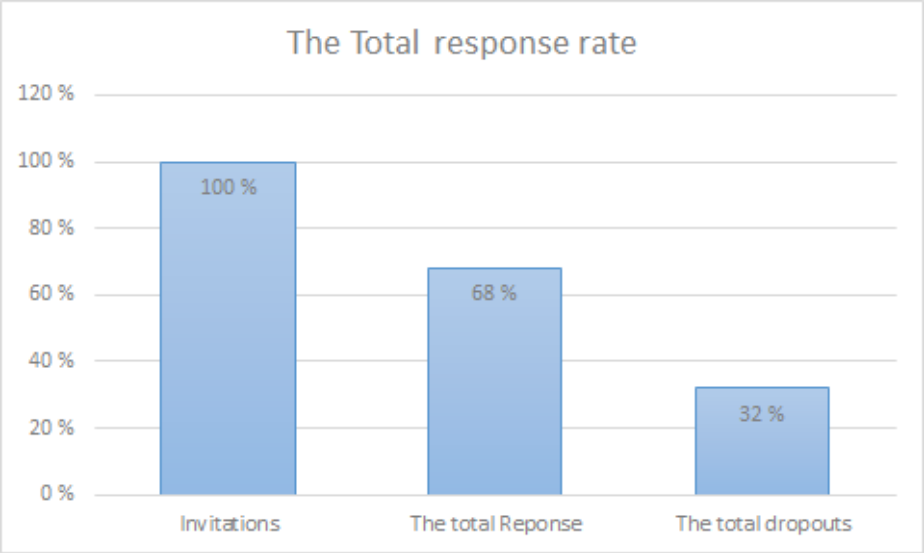

Figure 32: The total response rate in percentage. Made by Author.

The totaled replies from private household makes 68 percentage of the totaled replies of 34 and manufacturing companies represent about 32 percentage of the totaled replies of 34. These numbers are illustrated by figure 33.

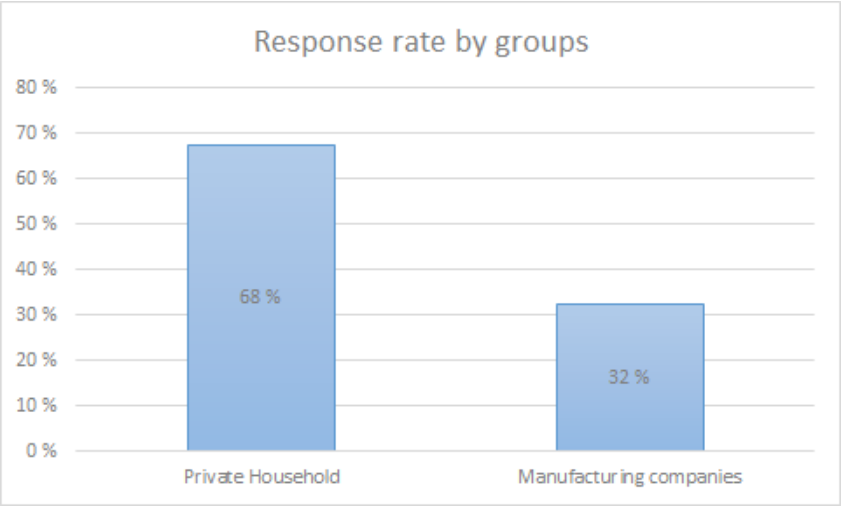

Figure 33: Response rate divided in target groups. Made by Author.

The questionnaire was separated into two different target groups. Where 25 invitations were sent to private household, and 25 invitations were sent to manufacturing companies. Under consideration of the amount that were sent to different target groups. The calculated response rate for private household were 92 percent of totaled 25 invite, and the totaled response rate for manufacturing companies were 44 percent of totaled 25 invite. Figure 34 illustrated the response rate within target groups.

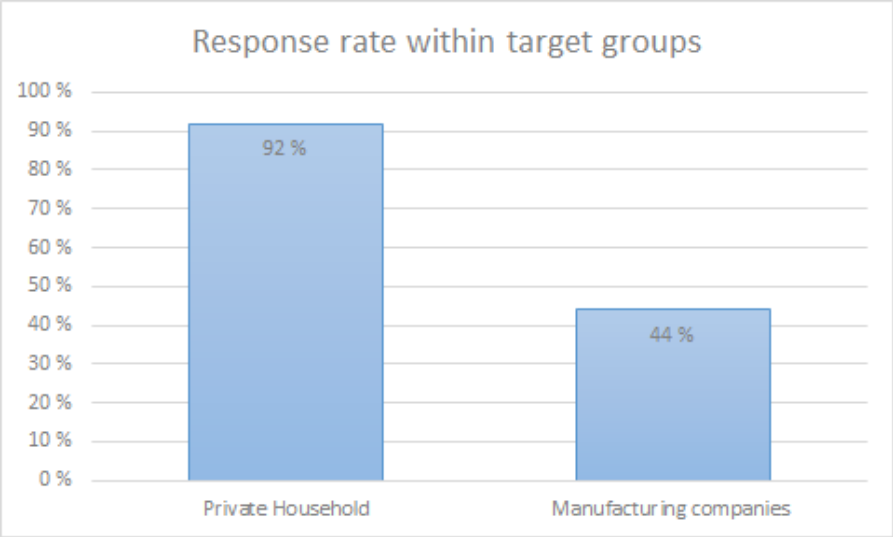

Figure 34: Response rate within target groups. Made by Author.

The totaled response rate is important in order to generalize the answers that represent the target groups in the research. Due to dropout rates, we must ask questions about why some people in greater extent than others has failed to respond.

The totaled response that obtained was slightly lower than what I had hope, but it is not surprising. According to Leady and Ormrod, 2004 (9) questionnaires often have low return rate due to different reasons, so one should not expected to achieve 100 percentage of respond rate. However, it is important to gain knowledge of why drop out occurs, asking ourselves: are there room for improvements? The evaluation of dropout will be introducing in the next chapter.

4.3.3 The reasons for dropout

The totaled responds rate were 68 percent, which indicates 32 percent as dropout. As mentioned, the totaled response rate was slightly lower than what I had hope for. Study supervisor, Stig Ottosson advised me that the totaled invite for quantitative survey research should be around 20 to 25, and have a respond rate of approximate 70 percent. With the totaled responds rate of 68 percent, I do feel comfortable with the respond rate. However, I did hope for a larger numbers of replies.

We can divide the responds into two groups, illustrated by figure 34. As we have learned from figure 34, the statistic measurement shows that the amount responds within private household were much higher than manufacturing companies. Which lead to questions about why there are different rate in responds within the two groups, and what is the reasons for dropout in responds?

The assumption of why dropouts happened can be summarizes as the following factors:

- Did not bother to answer the questionnaire?
- Lack of knowledge within the subject?

- Those who did not responded, think that the research purpose is unimportant or boring?
- Confidential treatment did not reach to informers?
- Weaknesses in the distribution and collection of the questionnaire?
- Errors and weaknesses of the questionnaire?

It is difficult to know for sure, which of these factors may have significant meaning to the dropout rate.

During collection, I have received feedbacks from some dropouts that they do not have knowledge of the subject, and therefor does not feel comfortable to answer the questionnaires. One can only assume that the factor that could have affected the respond rate significantly is knowledge within the subject.

Another factor that may affected the respond rate is distribution and collection of the questionnaire, especially within manufacturing companies. Most of the invitations were sent by emails; the risk that exist here is that emails invitation were blocked as spam emails. The weakness of distribution here is that questionnaires did not reach through to the informers.

However, I have tried to compensate this matter by using phone calls in order to gain responds rate. Although, short telephone interviews did actually gained more responds than emails within manufacturing companies. There were challenges here as well due to that informers did not have the time for answer, or do not want to answer questionnaires. The assumptions here is that the subject were considered as unimportant, not interesting enough, or that confidential treatment were not clear enough to informers.

4.3.4 The quality of answers and possible bias

As mentioned earlier, it is important to notice that survey research represent the ‘’truth’’ at the moment, it does not represent ‘’truth’’ for eternally. AMS smart metering are not installed in all homes and companies, so the opinion of this matter may subject to changes when the project are finalized in 2019.

Leady and Ormrod, 2004 (9) argued that drawback of survey research is that the people participants in the study may not be representative for the subject. There are often misunderstanding of questions in survey research, and follow-up information are often not possible due to large sample. We can most likely define this matter as one of possible bias in this research. Follow-up investigation are not possible either, due to the confidential treatment in this research. This research has chosen to focuses on two main groups of electricity consumption, therefor it is important to notice that the eventual generalization does not necessary covers all electricity consumption groups in Norway.

Due to the knowledge of possible bias that can appear, I have decided to design questionnaire as easy as possible for readers. The questionnaires were designed with Norwegian language as short, clearly and consist in order to avoid misunderstanding.

The questionnaires consist of questions, in addition information about AMS smart metering in order to gain informers knowledge within the subject. Questionnaires includes both yes and no answers, and ratting scales to define behavior and attitudes of AMS smart metering.

The total quality of answers from the study are considered as good as it can be. It is possible to form a basis for a systematic review of the consumers' attitude towards AMS smart metering. However, the represented groups in this research does not covers all electrical consumption groups. Another important notice is that the low respond rate within manufacturing companies provided large standard deviation, in order to generalized answers within this group of electrical consumption.

4.4 Data results and analysis

This chapter consist of the results from survey research and an analysis of results. The results presented in this chapter are based on questions that are most relevance to the research questions. The appendixes 2 will provide the complete sets of questions.

As mentioned, the research focuses on two main electrical consumption groups, which are household, and manufacturing companies. The survey was designed firstly to ask if informers are answering as private or as manufacturing companies. After group definition, the questionnaires were split into different sets of questions to adapt these different groups. The main aim of definition is to avoid irrelevance questions to informers.

The selected results of survey research will be present in the following chapters.

4.4.1 Data results and analysis from private household

In order to gain knowledge of what type of resident within household are responding to the research, there is a question with residential choices within household group.

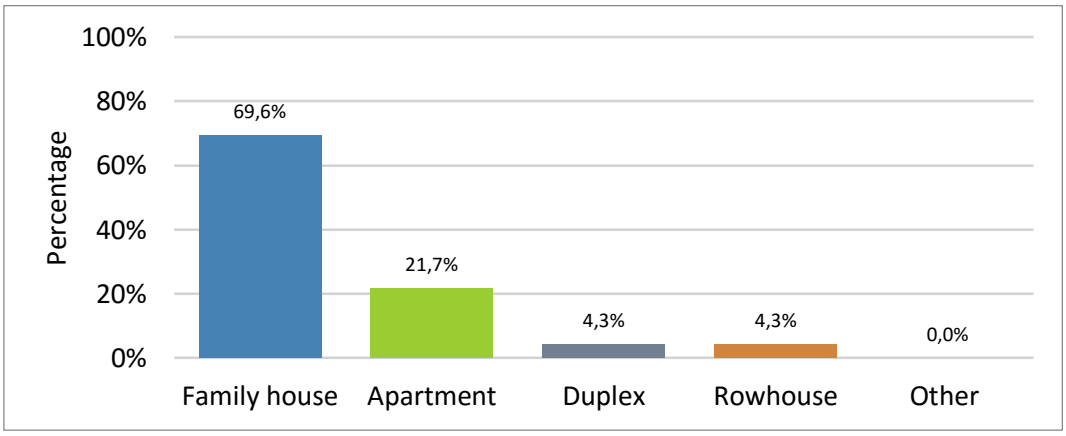

Figure 35: Question no 15 - What type of resident are you living in? Made by Author.

As we can learn from this, most responders are currently living in what we can defined as family houses. Which indicates that the household may contain an amount of at least two persons.

In order to learn if the responder have knowledge about their own electricity consumption, question no 16 were about how much electricity they use in a year. The purpose of the

question is not about the consumption amount it self, but to test if there is knowledge of self-consumption.

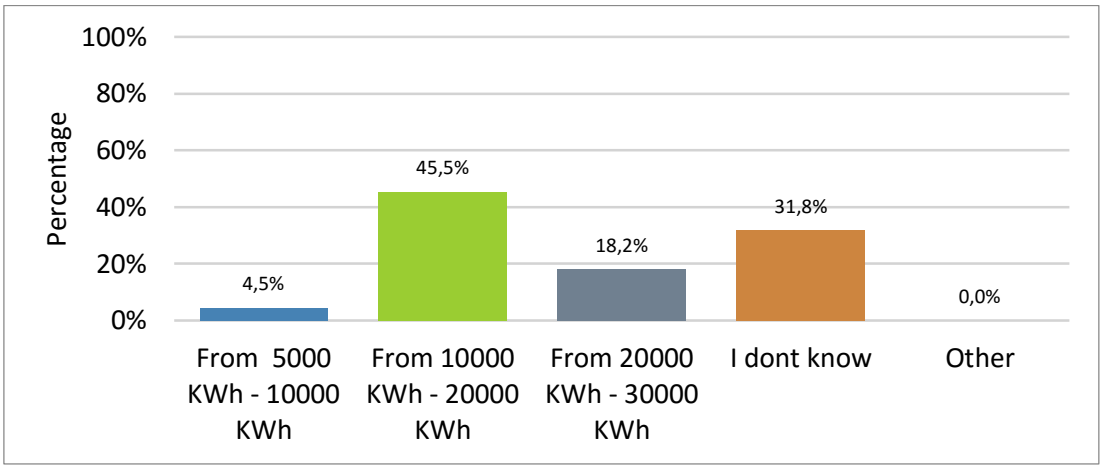

Figure 36: Question no 16 - How much electricity do you use in a year? Made by Author.

The answers here indicate that about 70 percent of respondents have knowledge of their electricity consumption and the amount of KWh per year. However, it is interesting to notice that there were almost 32 percent of respondents that answers they do not know how much KWh they use in a year. Which indicates that the amount of people that do not know how much electricity they use are quite high among this group of consumers.

Before the next question, the survey informs to responder about NVE regulations and AMS smart meters and explained briefly what AMS smart meter are. NVE regulation that was informed to responder were about AMS smart metering will be installed in all homes and companies by January 2019. The question no 17 intention is to gain knowledge about if responder did know about this regulation.

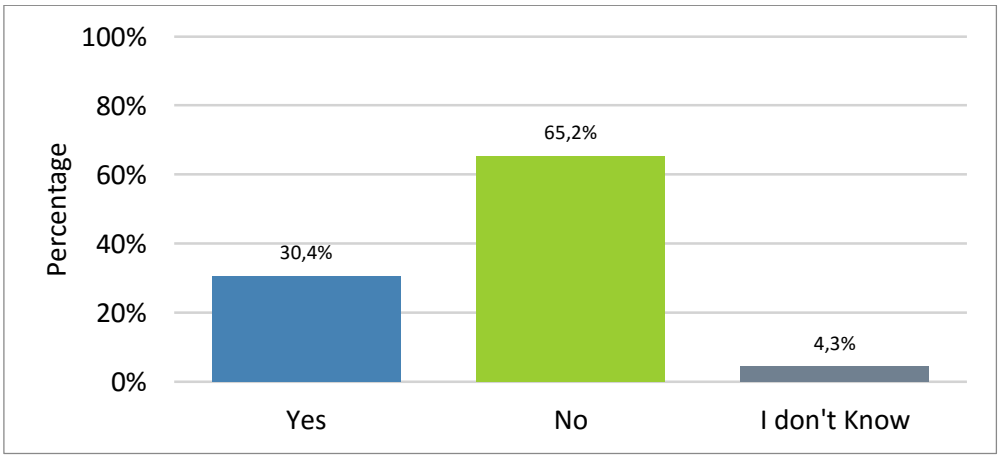

Figure 37: Question no 17 - Were you aware of NVE regulations regarding smart meters?

The percentage that answers no in this question indicates that a large amount of household did not know of the NVE regulations of AMS smart metering.

Some of household and companies do have AMS smart metering system installed already, so the intention of question no 18 is to gain knowledge of how many already have the AMS smart metering system installed.

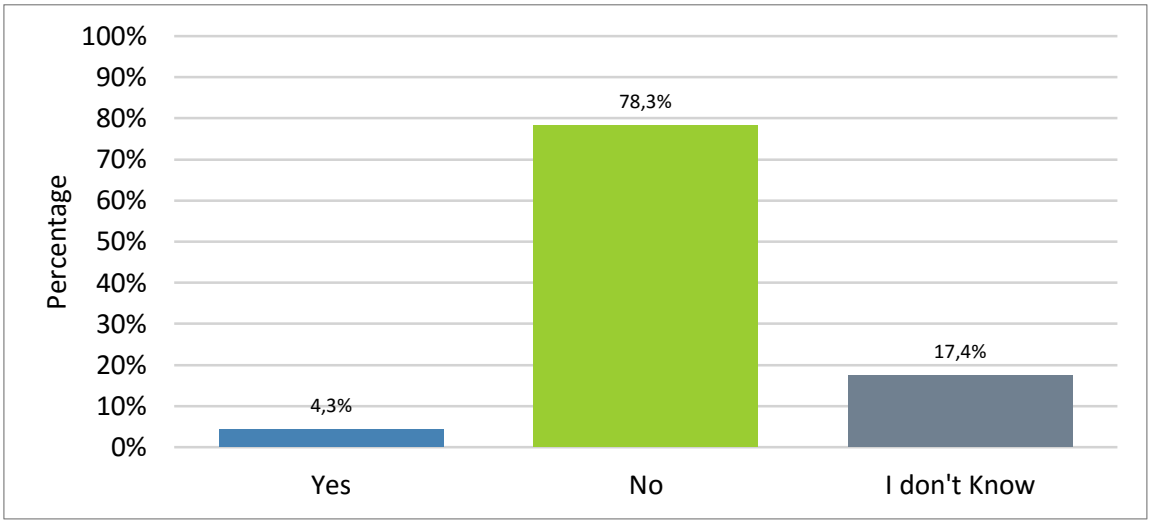

Figure 38: Question no 18 - Do you have AMS meter installed in your home today? Made by author.

The rate that answers ''no'' to this question, gives impression that the majorities within household groups do not possess AMS smart metering yet. Assuming that those that answers ''no'' only have a standard mechanical electricity meter system. The next question no 19 were only given to those that answers ''no'' to the previous question.

The question is about how often does you read of your meter? The intension here is to gain knowledge of frequency of meter reading, regarding to the accurate of the electricity settlements. However, another intension of this question is to gain knowledge of how often responders' actually pay attention to their electricity consumption.

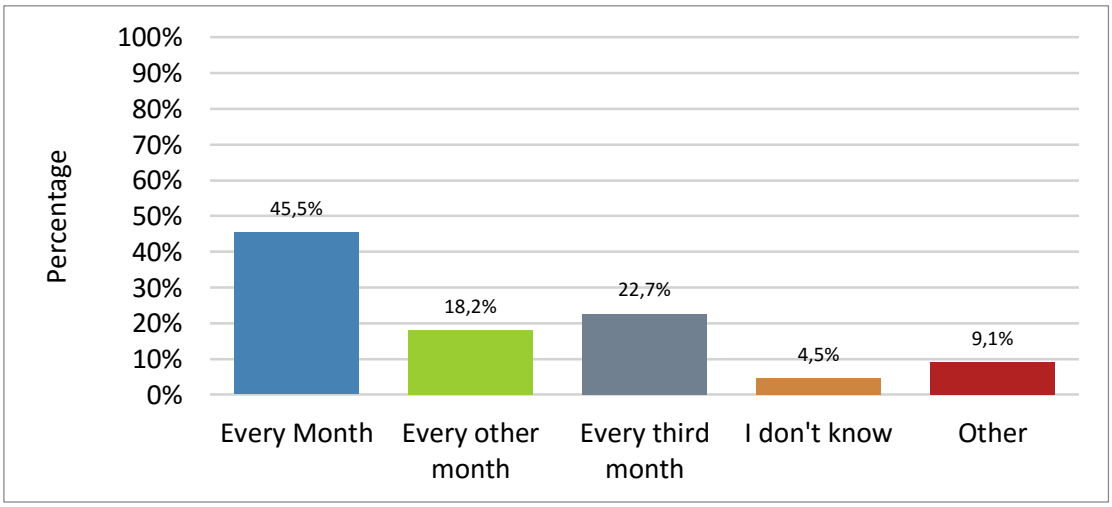

Figure 39: Question no 19 - How often do you read of your electricity meter? By author.

The next questions provided to responders was directly connected with the research question: Does AMS smart meter leads us to reflect on our own usage as individual?

The first question in this matter is question no 20 about if responder think that AMS meter can have a reducing effect on their consumption. The main intension here is to gain knowledge about if responded actually believe in AMS smart metering system as a tool for reducing electricity consumption.

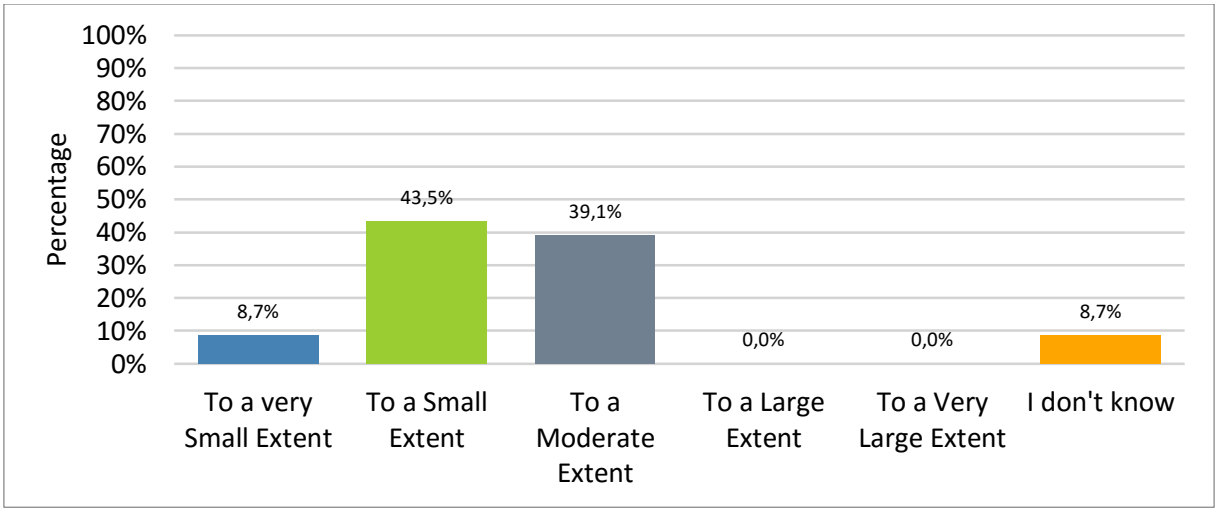

Figure 40: Question no 20 - Do you think AMS meter might have reducing effect on electricity consumption? By Author.

The responds in this question indicates that the majorities of responders think that AMS smart metering system will have a reducing effect on electricity consumption within a small extent. For those whom believe in such effect are just to a moderate extent.

The next question was more directly linked to the research question: Does AMS smart meter leads us to reflect on our own usage as individual?

The main aim of this question is to gain knowledge about if AMS smart meter would cause electrical consumers to reflect on their own usage more.

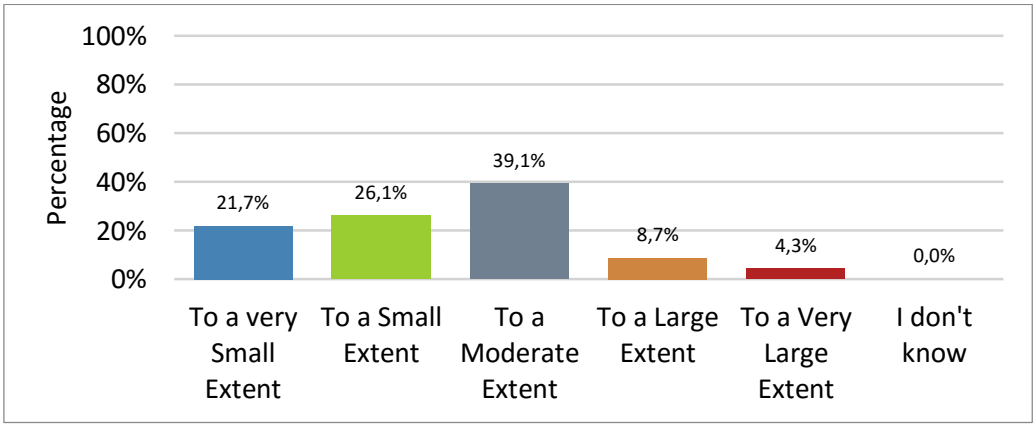

Figure 41: Question no 21 - Do you think AMS meters can lead you to reflect on your own electricity usage? By author.

The responds in this answer indicates almost 50 percent of responders believe it would lead to own usage reflection in a very small or small extent. The other majorities think that AMS smart meter would only lead them to reflect on their own usage in a moderate extent.

According to public organs, one of the main benefits for AMS smart meter is about its positive effect on climate emission. The next question aimed to ask if consumers does share this idea. The next question was asked if the responder think that AMS meter have a reducing effect on climate emission.

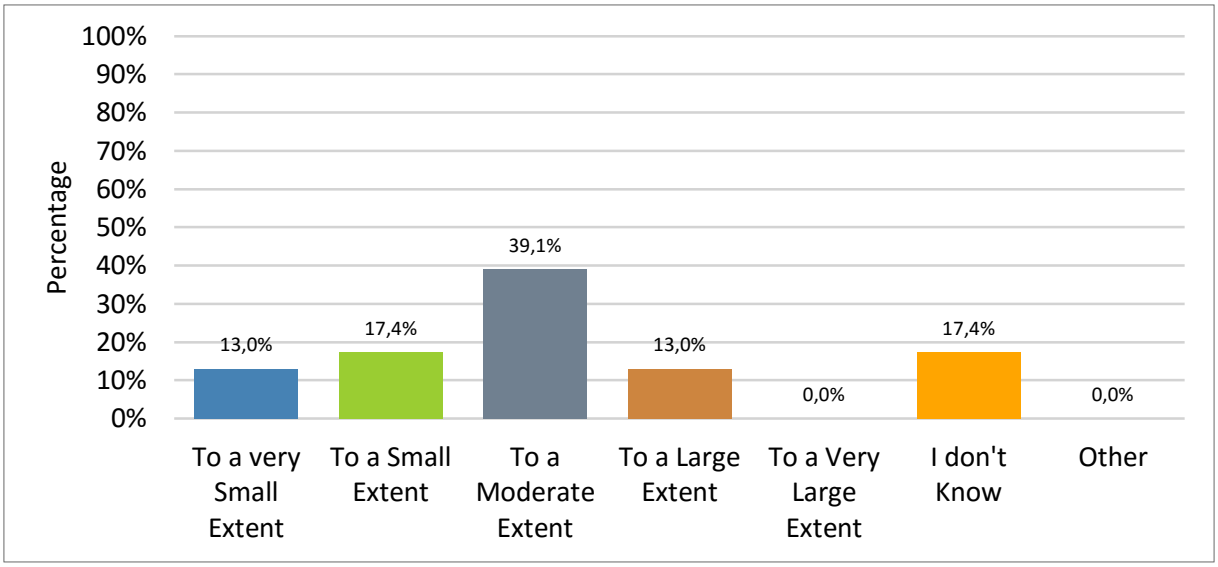

Figure 42: Question no 22 - Do you think that AMS meters might have reducing effect on climate emission? By Author.

The answers in this question indicate that almost 30 percent of respondent think that AMS contribution to the environment in a low extent. The other majorities think that AMS contribution to the environment to a moderate extent.

The next question is about if the consumers would implement energy savings action because of the AMS smart meter? Public organs argued that when tool as AMS smart meter are provide, many would implement energy savings action due to this. Question no 23, aimed to test this statement.

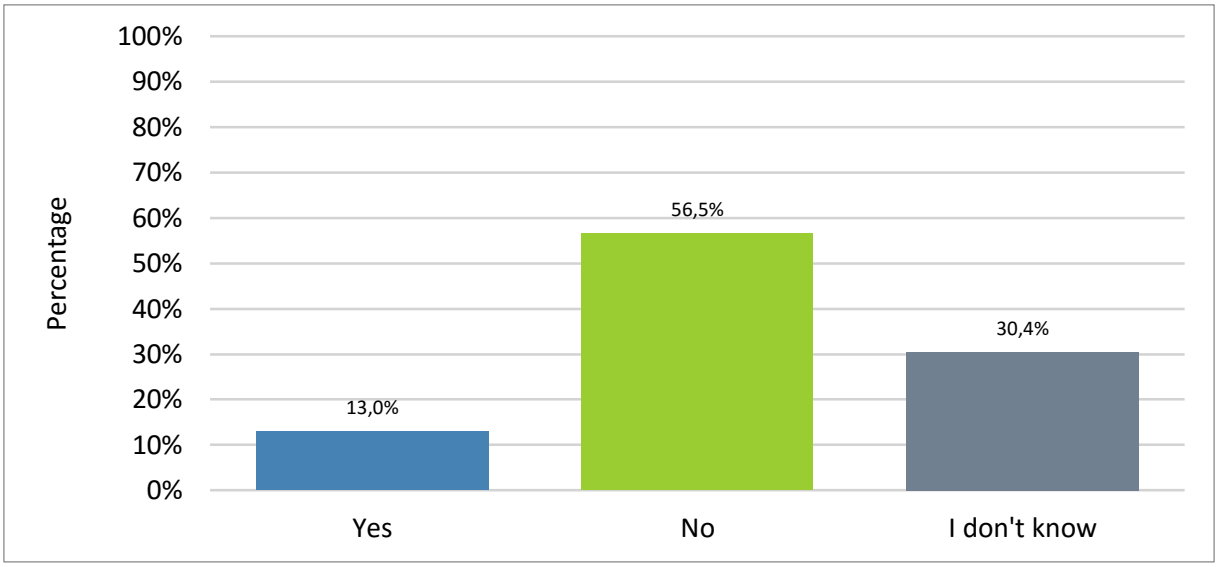

Figure 43: Question no 23 - Do you think you are going to implement energy-saving action because of AMS meters? By Author.

Answers in this question indicates that most responders would most likely not implement energy savings action on basis of AMS smart metering. What we can learned from the answers is technical tool may often not be enough by itself. However, 30 percent of responders were not sure about this matter. The uncertainty factor here are interesting as the actual results can be swing both ways in the future.

The next question is about what would be the main motivational factor to implemented energy savings action. Question no 24: Assumed that you are going to implement energy savings actions, in what extent will be main reason for that?

There are possible to choose several options with the following factors in the question:

- Economical motivational factors
- Environmental motivational factors
- Conscientious or moral as motivational factors
- Other types of motivational factors

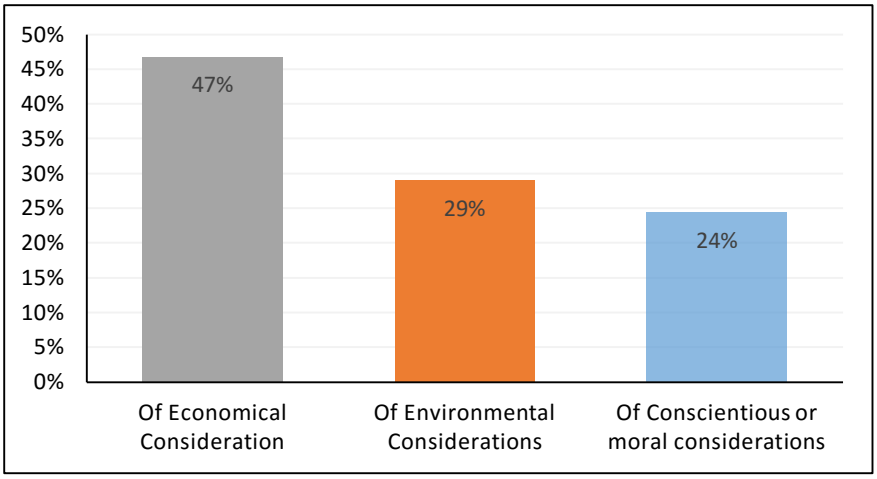

Figure 44: Question no 24 - Assumed that you are going to implement energy savings actions, in what extent will be main reason for that? Results for all options combined in percentage. By Author.

In the next figures, each of the options are illustrate by the extent grade.

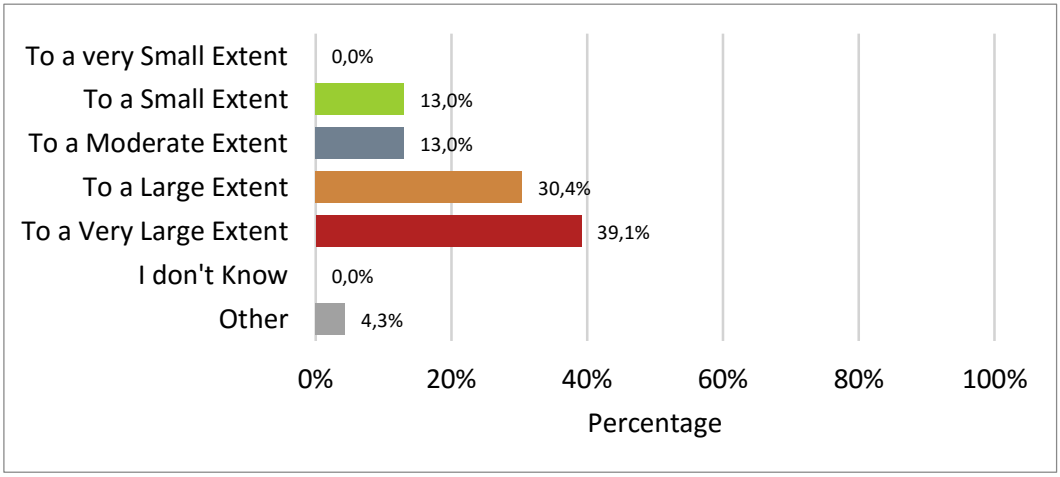

Figure 45: Question no 24 - Option 1 - Of Economical Consideration? By Author.

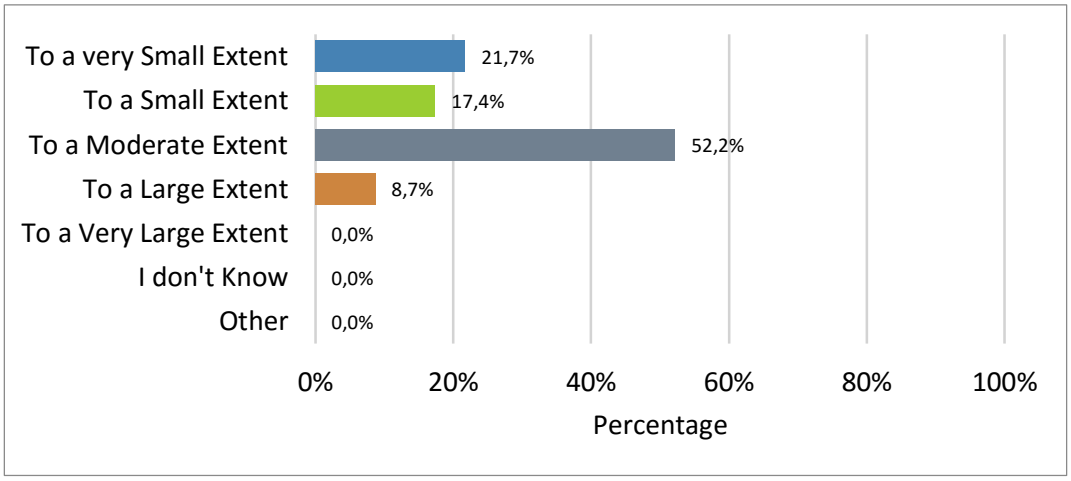

Figure 46: Question no 24. Option 2 - Of Environmental Considerations? By Author.

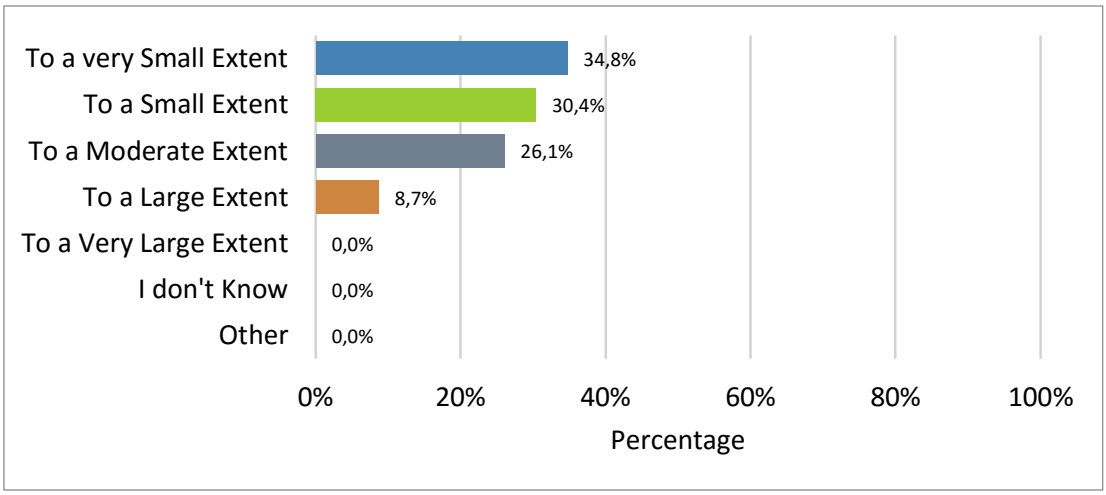

Figure 47: Question no 24. Option 3 - Of Conscientious or moral considerations? By Author.

This summarizing of answer here indicates that economical consideration have a high rate for energy savings incentives. However, environmental and personals morals or conscientious represent a part as well.

We already learned from the answer above that economy is a major motivational factor. The last question is about what would be the main reason for not implemented energy savings actions. The intention here is to gain knowledge of why people do not want to reduce their consumptions.

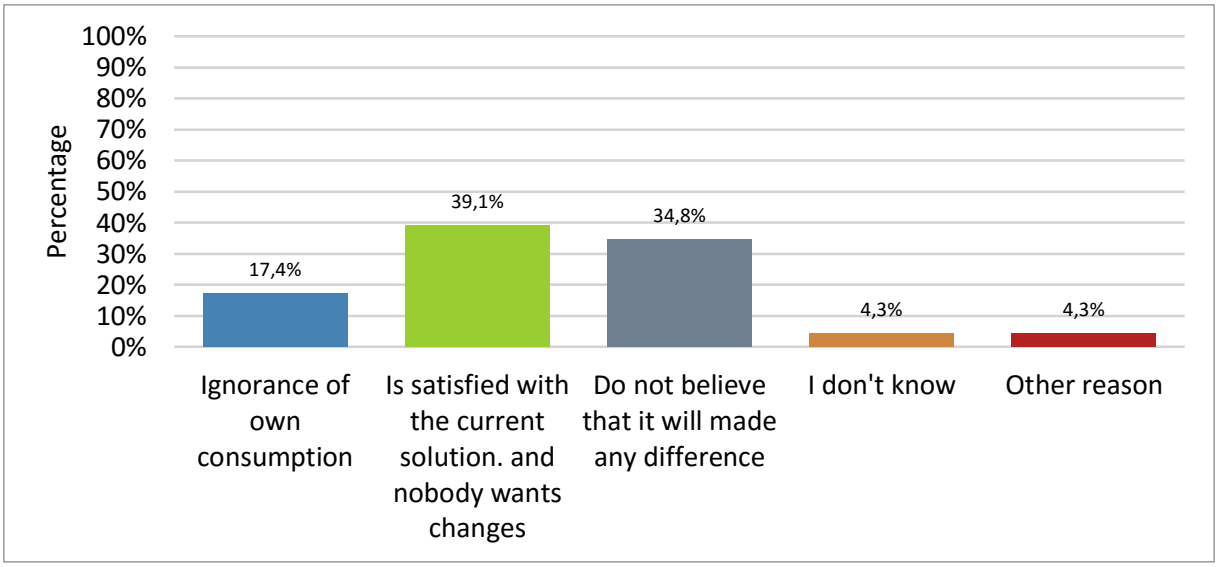

Figure 48: Question no 25 - What do you think is the main reason for peoples to not implement energy-saving actions? By Author.

There might be many reasons for not implemented energy savings actions. The options in this question were shorten down to factors about ignorance, do not want changes and do not believe in changes. Based on the answer, the majorities are satisfied with the solution that they have today, and just do not wants changes. The other majorities answer indicates that they do not believe in changes would results in any different.

The main reason for not implemented energy savings does not seems to surround by ignorance of own consumption. The majorities of answers in this question indicates that most electrical consumers are happy with the usage and settlements that they are receiving today, and that they do not see the point of energy savings incentives.

4.4.2 Data results from manufacturing companies

The data collection within manufacturing companies' focuses on companies that qualifies under the terms of energy intensive manufacturing companies. So the expected of usage per year should be over 100 000 KWh a year for this group of responders.

In order to learn if the responder have knowledge about their own electricity consumption, question no 3 were asked about how much electricity they use in a year. The purpose of the question is not about the consumption amount it self, but to test if there is knowledge of self-consumption.

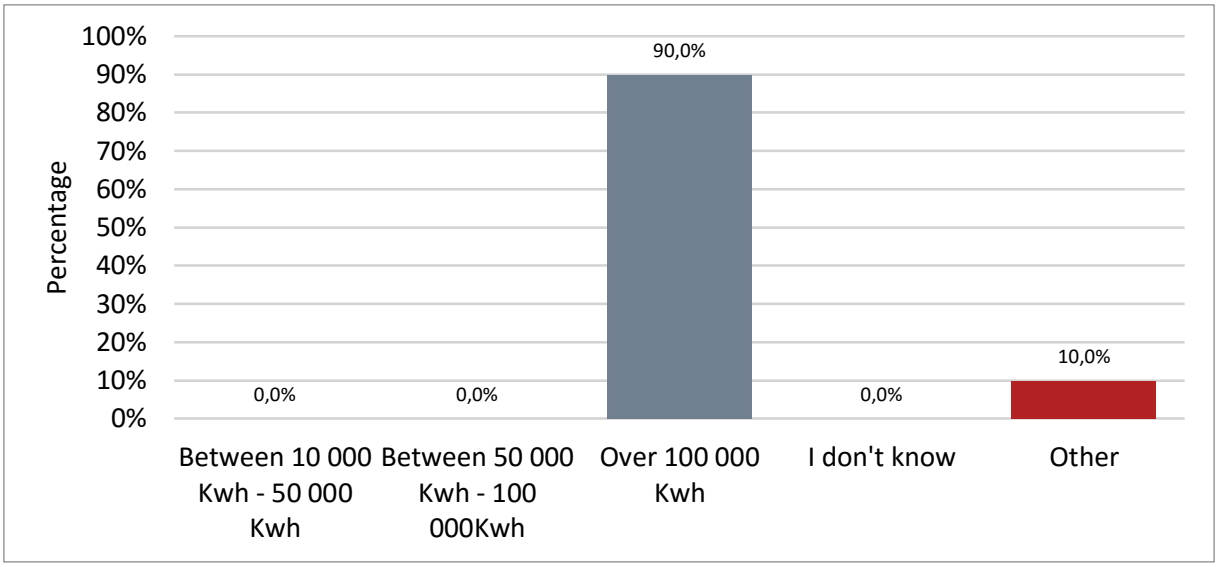

Figure 49: Question no 3 - How much electricity do your company uses in a year? By Author.

The answers in this question indicates that most companies that were asked have a usage over 100 000 KWh a year. Some have wrote the correct amount on ''other'' option. The reason for this maybe is to provide knowledge, or there are errors in the existing options. However, it seems like most responder in this group have good knowledge of their electricity usage.

There was a question about if the company already have installed AMS smart meter, the responds from this matter indicates that none of responder have AMS smart meter installed. An important notice and possible bias in this matter is that companies may not know for sure what AMS smart meter is, or the different of the metering system they have today comparing to AMS smart meter.

The next question is about if the company have implemented energy-savings action and what benefits they have gained from it. Energy-savings action in this term mean all kind of action regarding to energy – savings incentives.

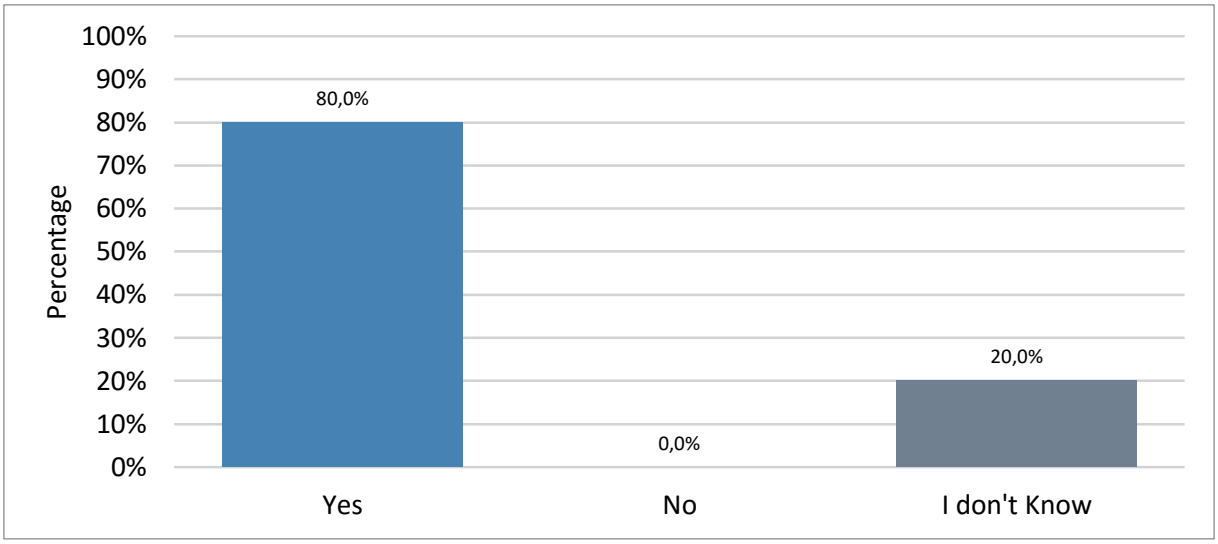

Figure 50: Question no 4 - Did your company implemented any kind of energy- saving actions? By Author.

The answers in this question indicates that most company have some sort of energy saving action implemented in their company guidelines, routines etc.

The aim of the next question is to gain knowledge of what type of benefits companies have gained from having energy-saving actions. There are several benefits within this matter, so the option that were provided to responders were summarized in to the following groups: economic, competitive advantage, stability in productions and better reputations. It was possible to select several actions at the same time.

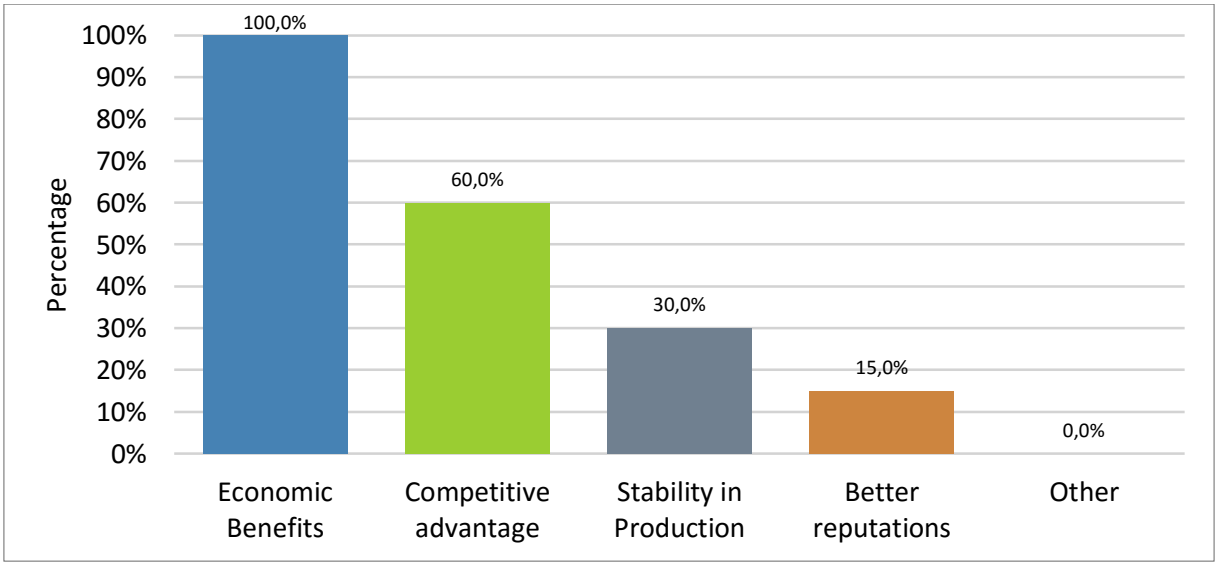

Figure 51: Question no 6 - what type of benefits did your company gain with energy savings actions? By Author.

The answers in this question indicates that economic benefits considered as a main benefit. It is understandable because electricity is a one of the mandatory cost within production.

Therefore, by implemented actions to reduce electrical usage could have significant meaning to the total cost of production.

Companies were asked if they were ISO 50001 certificated (energy management certification) Due to the responds rate of this question, none of the responder have this type of certification. However, the next question is about if the responder in this group aim to achieve such certification.

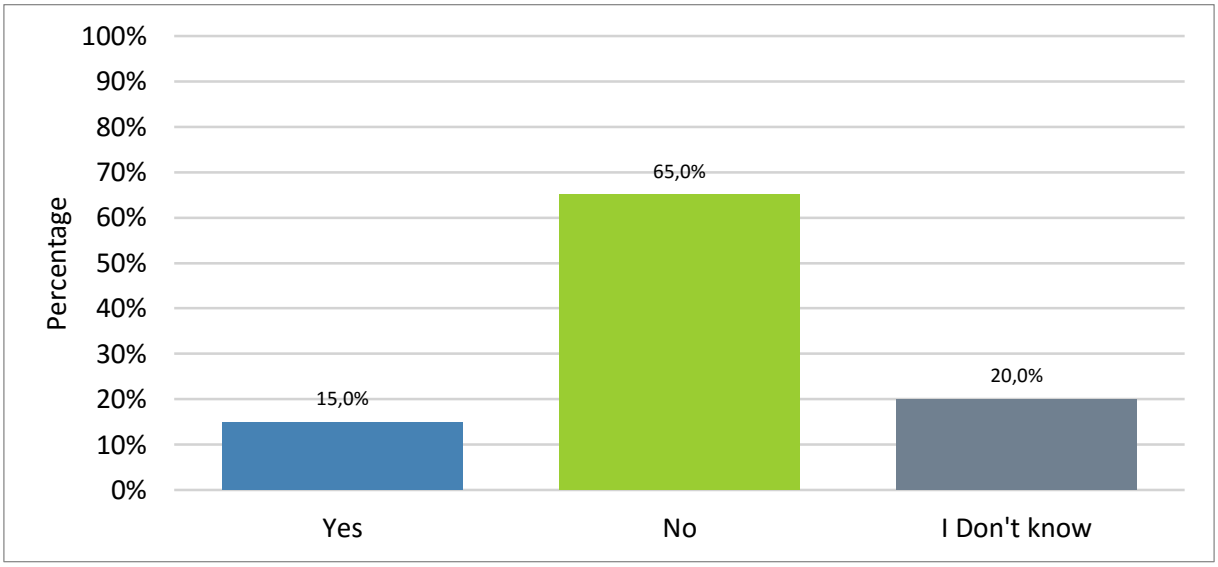

Figure 52: Question no 8 - Would your company considered to gain ISO 50001 certification? By Author.

It seems to be little interest to gain ISO 50001 certification, which is an interesting phenomena. As we can see most responder answers earlier, that they have implemented energy-savings action, but the interest of having energy management certification does not stand on a high priorities list.

The next questions are quite similar to the question that were asked private household group and it is directly connected with the research question: Does AMS smart meter contribute to reflect on own usage as a manufacturing organization?

Question no 10 is about if manufacturing companies believe that AMS smart meter could have a reducing effect on electricity consumption.

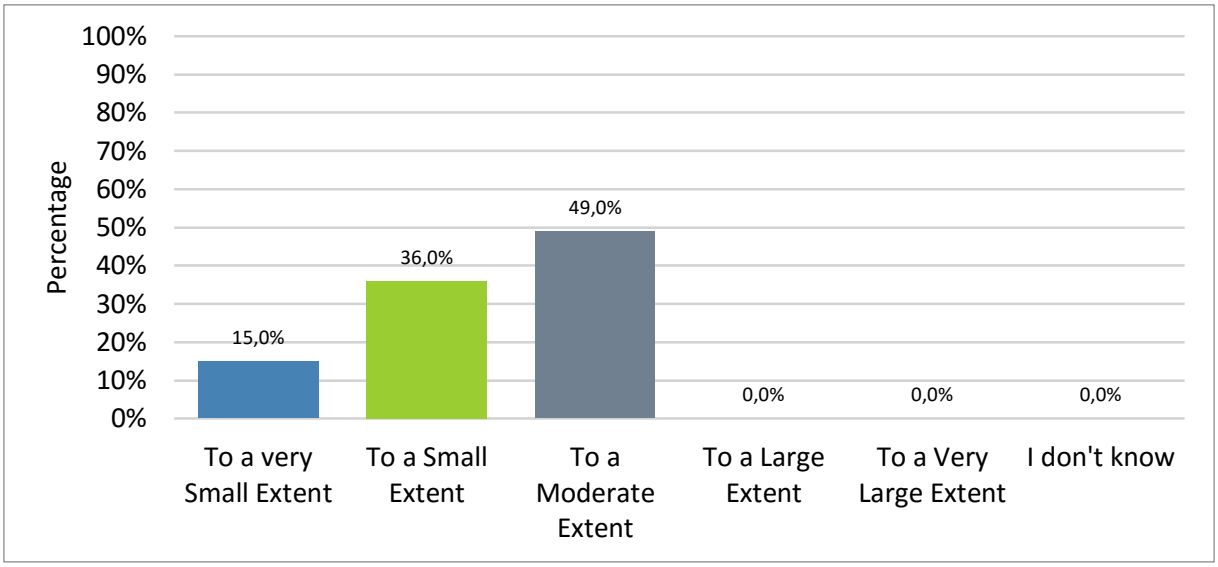

Figure 53: Question no 10 - Do you think AMS meter might have reducing effect on your company's electricity consumption? By Author.

Answers in this question indicates that most companies do not in large extent believe that AMS smart meter would have impact on their electricity consumption.

The next question was directly link to the research questions and it is about whether AMS smart meter would lead them to reflect on their own consumption.

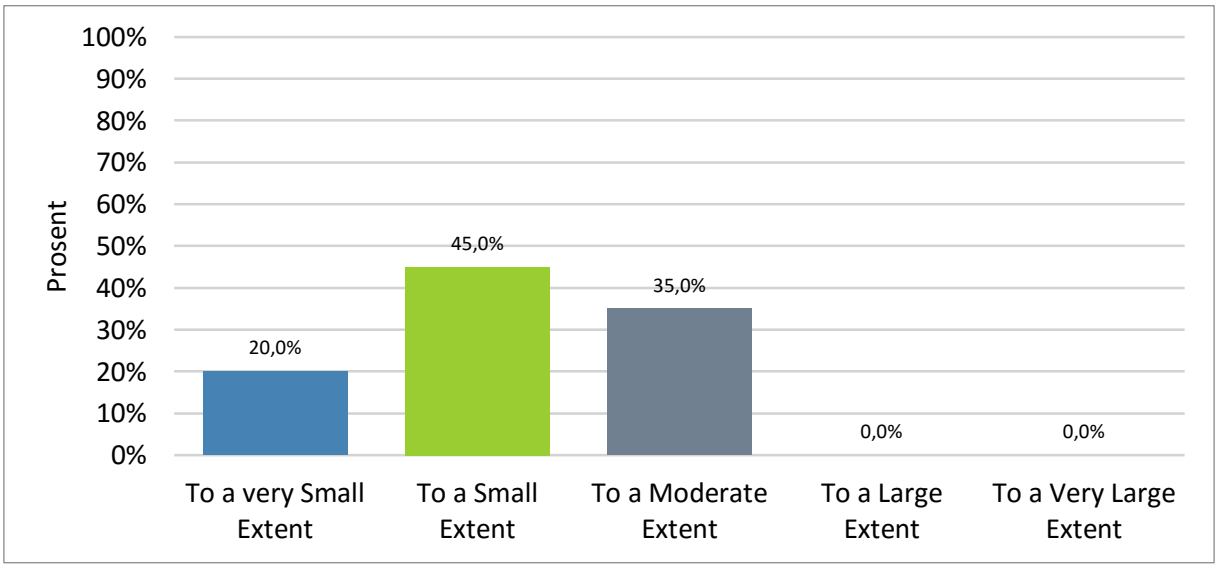

Figure 54: Question no 11 - Do you think AMS meters can lead you to reflect on your own electricity usage? By Author.

Answers in this question indicates that most responder do not believe in large extent that AMS smart meter system would lead them to reflect on their own consumption.

The next question is about if the responder in this group believe, that AMS smart meter might have impact on reducing climate emission.

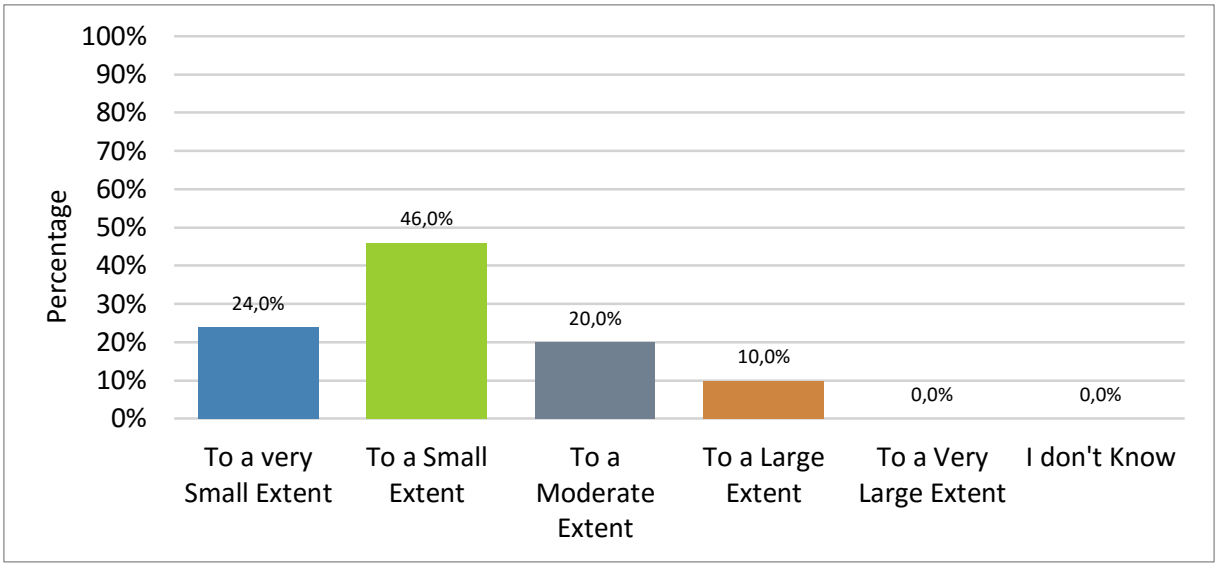

Figure 55: Question no 13 - Do you think that AMS meters might have reducing effect on climate emission? By Author.

Answers in this question indicates that the percentage of this matter is quite low, and there are few that believes that AMS smart metering would lead to reducing effect on climate emission. If it does, the chances are limit to a small or moderate extent.

Chapter 5 Discussion

5.1 Introduction of chapter 5

Electricity is an important element in our lives, and the trends tells us that the consumption of electricity are increasing. Due to climate changes and human impacts, it is clearly that we need to slow down this trend. The question is how to achieve this, without sacrificing our normal ways of living? This dilemma involves all groups of electrical users, and has given both governmental and consumer pressure.

As we have learned, the arguments for implementing AMS smart metering are all about saving energy and reduction of consumptions. It seems to be a necessary tool to resolve the electricity consumption dilemma.

The aim of this thesis is to gain knowledge of AMS smart metering from the consumers' point of view. The focus groups are within household and manufacturing companies as they stand for a large amount of consumption. Due to provided theories and data collections above, this chapter will present discussions within this matter.

5.2 Why should we have AMS smart meter?

As we have learned, temperatures and economic reasons could affect electricity consumptions. However, Electricity consumptions depend on the consumers them self. According to NOU 1998 (43), the usage of electricity will continue to increase unless the society put in joint efforts to avoid this.

Based on different articles and literature researches, I have come to an understanding that it seems to exists a strong faith in AMS smart meter and the importance of this technology within public organs. This matter was mention in chapter 3.4. According to EU, smart metering system (AMS) is a tool that could contribute to achieve the 2020 targets through energy efficiency, the predicted average energy savings by using smart metering are around 3 % (5). NVE confirms similar arguments that AMS smart metering system could contribute to less electricity consumption through consumers conscious.

Obviously, based on these arguments, one can be persuading into believing that AMS smart meter is a magnificent tool to reduce consumption. Less consumption is appealing to most peoples and organizations.

However, in reality the AMS smart meter is just another technological solution. This technical solution can be define as an information system that collect and provide information. The information could be used to provide measure scale of a manufacturing process, or overall usage within household etc. Overall, one can state that all information is important, if you are going to do something about that information.

According to NVE regulations §4-5, advance metering system (AMS) will be installed for all electricity consumers in Norway by 1. January 2019. (42) In the light of this, one may assume that most consumers are aware or at least have some knowledge of AMS regulations. However, is does not seems exist much knowledge of the subject among responders. This

issue occurs especially during my data collection process. Most responder's comments were: what is AMS smart meter? Or said that they don't have any knowledge of the meter system. This was indicated by the results in question no 17. The question was about if the responder were aware of NVE regulation regarding Smart meter. 65 percentage of responder answers ''no'' and 4,3 percentage answers '' I don't know''. Which confirms that not many people have knowledge of this matter.

According to regulations §3-3 (56) two -ways communicated meters are already installed for consumers that have above 100 000 kWh per year. This indicates that most manufacturing companies should have a similar system to AMS smart metering already installed. It is important to notice that some household and companies already have installed the AMS meter system, but based on responds from the survey very few of responder said that they have AMS smart meter system installed. The fact from this indicate that most responders do not have any experience with AMS smart meter, or one can only assume that maybe some already have AMS installed but do not know what it is. However, based on the regulations and the benefits that public organs have state about AMS smart meter, I found it interesting that it has been conspicuously silent about the subject within medias etc.

The subject of this chapter is to discuss about why should we have AMS smart meter? AMS smart meter have impacts on all electrical users, but in this thesis, the main focus groups are household and manufacturing.

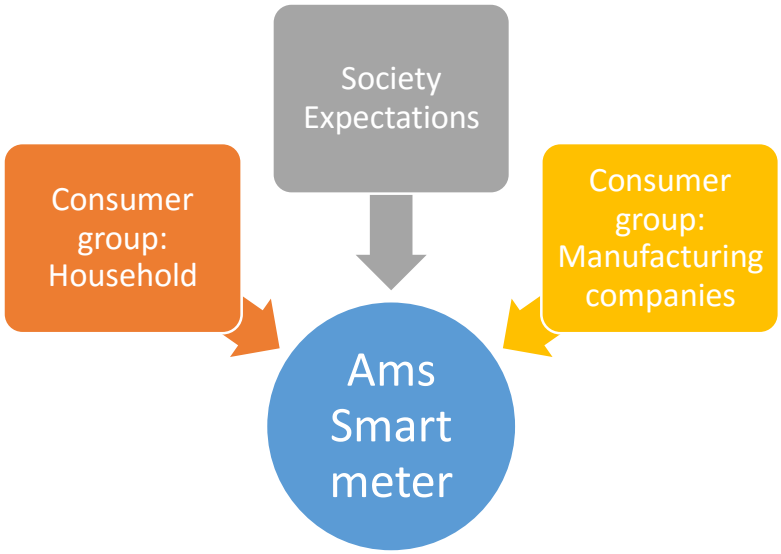

Figure 56: The impacts of AMS smart meter within household and manufacturing companies. By Author

Figure 56 illustrates which consumer groups AMS smart meter have impacts on, and the society expectations of AMS smart meter system.

In the next chapters, the reason why AMS smart meter should be installed for household and manufacturing companies will be discussed. The aim is to discuss about the benefits and reveals challenges of AMS meter system based on existing theories and findings within data collections.

5.2.1 Why should Household have AMS smart meter?

As mentioned in chapter 3.3.7, household stands for around 33 percent of the total electrical consumption. Trends predict that household will continues to increases, the demand of electricity will also follow.

Household group differ from the manufacturing companies by the way they use electricity. This matter was illustrated in chapter 3.3.6, by figure 14. The electrical consumption in this group depends largely on temperature as about 73 percent of heating sources within household is based on electricity.

However, prices play a large role in consumptions tendency as well. If the electrical prices were too high for a household, they would most likely prefer using other types of heating sources than electricity. This matter was confirmed in question no 24, about what would be the main motivational factor for implementing energy saving actions. 39 percent of responder answers that economical motivation have very large extent for this matter, while 30 percent answers that economical motivation have large extent for this matter.

Based on existing benefits AMS smart meter would contribute to consumer according different public organs. We can summarize some of the main benefits for household as the following:

- Economic benefits
- Environmental benefits
- A more secure electricity supply

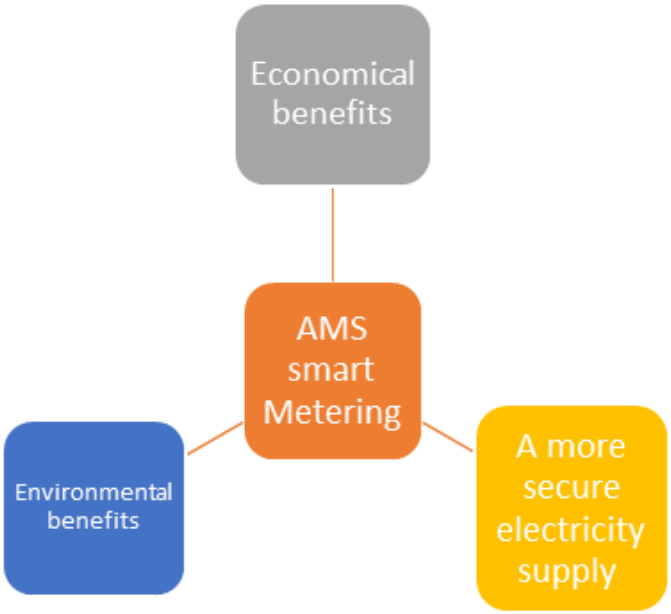

Figure 57: AMS smart metering benefits for household. By Author.

Figure 57 above illustrated the benefits, and possible reasons why Household group should have AMS smart meter.

However, when dig deeper into each of these benefits, we can see that benefits do not comes from the technology itself. The benefits depend largely on human interactions.

- Economical Benefits:

As mentioned earlier, based on data collection from question no 24, indicates that economical factor, have a significant impact due to consumption. We have learned that AMS smart meter provide information, and provide a platform that can be used to gain economic benefits.

The economic benefits can be gained through smart metering provide real time data of consumptions from the consumers. The consumers will have opportunities to update their usage due to the electrical prices. NVE states that the benefits of such meter is to provide faster, correct and better fundament for the customer's electrical settlements. (48)

Another factor that contributes to economic benefits is that cost conscious consumers may use electricity in times that the prices are lower in the day, which contribute to less blast capacity and in addition give them better economical profits.

Despite the possible benefits that consumers can gain from having an AMS smart meter system. There are a few challenges when it comes to achieve economic benefits for consumers.

One of the challenges that can be mention is the cost of investments for the new metering system. Whom will this settlement go to? It does not seem to be a specific answer to this matter. As mentioned in chapter 3.5.4, NVE states that the distributor operators are entire responsible for the cost and implementations of smart metering system. However, there is no regulations about distributor operator can recoup their investments for AMS metering through higher tariffs. One can only assume that consumers are really the ones these settlements would most likely goes to in some form of tariffs or other types of electrical costs.

Today mechanical metering system and settlement system are based on the average calculations of electrical prices in a month or year. Depends on the resident sizes and their contract. AMS smart metering would provide surely a much more accurate settlement and as mentioned one can achieve economic benefits by using electricity in times that price is lower.

However, this matter indicates that in peak time period, electrical prices would most likely be much higher than other times of the day. Which lead to question: How about consumers that do not have the ability to avoid usage in these peak time hours? These groups of consumers would risk much higher settlement than others group of consumers. Therefore, in other terms, smart metering economic benefits seems to do not benefits ''vulnerable'' consumers.

In summery for economic benefits, one can argue that there are possible to achieve economic benefits but there are also challenges within this matter.

The figure below illustrates challenges in contrary with economic benefits:

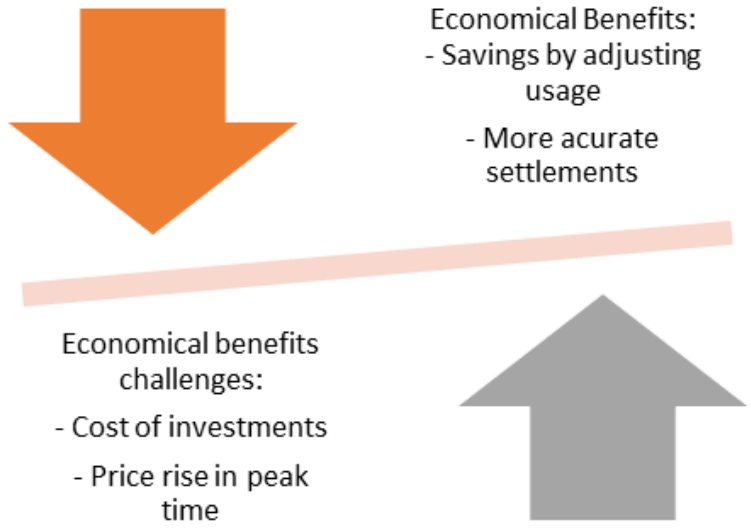

Figure 58: The contrary of economic benefits and its challenges. By Author.

Figure 58 summarizes the possible cause to economic benefits of AMS smart metering, and its challenges within costs of investments and price rise in other times of the day.

- Environmental Benefits:

According to several political documents, environmental benefit was often mentioned as important factors when it comes to AMS meter installation. The environmental benefit can be achieving through reduction of electrical consumption.

It has been claimed that AMS smart meter will give each of us the opportunity to manage and changes our consumption by ourselves. This matter will contribute to a more effective energy usage. Effective energy usage in a long-term perspective will lead to less need to develop new electricity plants and therefore gain positive impacts for the environment.

The way to achieve environmental benefits from AMS smart metering are illustrate by figure 59:

Figure 59: AMS smart metering and human interactions lead to environmental benefits. By Author

As we have learned from this, environment benefits are able to achieve, if consumers are willing to contribute in this matter. In order to gain energy effectiveness, one must know how, and have a plan to achieve this.

However, is it important to notice that even if consumers receive information about their consumption, does not necessarily mean that all consumers will do anything about their consumption. This matter was discussed as well in document no 138, 2002 – 2003 (44). Why some consumers choose not do anything about their usage is a difficult question to answer, but one can assume that it may exist several psychological answers to this matter.

This issues were tested with question no 23 during data collection. Responders were asked if they would implement energy savings action because of AMS smart meter. Answers in this question indicates that there are 56,5 percent of responders would most likely not implement energy savings action on basis of AMS smart metering. The other 30 percent were not sure about this. Only 13 percent of responder answers ''yes'' to this question.

Due to the low rate that have answers ''yes'' to this matter, one can't help but to wonder if the statement of AMS smart meter system would lead to environmental benefits are true, or in such large impact as expected.

In this thesis, I have included environmental psychology theories in hope that we can understand this phenomenon. Environmental psychology is relevant to the topic as it studies the links between individual's behavior, experience and the impact it has on the natural environment.

Lewin (1890 – 1947) (76) have tried to explain this matter through his well-known equation:
$B = \int(P, E)$

The important factor of the P in Lewins equation consist 3 areas of research that are important in order to explain the way people responds to the environment. It can be summarizes as the following:

1. Environment perception: This involves how a person actually perceive the environment that they are living in. In context with the interaction of social and psychical elements.

2. Environment appreciation: This factor involves emotional or evaluations of how a person actually feels about their environment.

3. Environmental personality: The natural personality in order to reflect different responds to different environment.

I have found this theory helpful in order to gain an understanding why people do not want to reduce their usage. Question no 25 was asked to responders in order to learn more about this matter. The question was about what responders think is the main reason that people do not implement energy savings actions. Answers reveals that the majorities of responder

are satisfied with the current solution and do not wants changes. Other groups of responders do not believe that it would made any different. In the light of this, one can assume that the reasons to not engage energy savings action are the following:

1. Environmental Perception: Consumers most likely are aware of the environmental benefits of reducing energy consumption, but do not want to perceive it that way. Which is quite similar to the theory of Gestalt psychology that was illustrated by the invisible triangle figure in figure 31.

2. Environmental appreciation: Consumers most likely are satisfied with their environment in the moment and therefor does not want to change behavior.

3. Environmental Personality: Most of us are grown up with electricity available at all time. We use electricity in times of need, and in time when we do not need it as well. Therefore, in that way consumption is just a natural behavior, it would feel unnatural to reduce consumption.

Gardner and stern, 2002 (81) suggested 4 approaches due to changes. The detailed about the approaches were described in chapter 3.7.3. The approaches can be summarizing as the following:

- Religious and moral approaches
- Educational and interventions
- Society incentives
- Community management strategies

Based on this theory, question no 24 was created in order to find out what is the motivations for implement energy savings incentives. The responders were asked if they would implement energy savings action, which would be the main reason for that. The total answers can be seen in figure 44.

Figure 44, illustrated that the amount of responder would save energy due to environmental consideration represents 29 percentages, and for morals considerations it represents 24 percentage of responders.

The rate for the environmental considerations can be seen in figure 46, there were 52,2 percent that answers that environmental consideration would be in a cause in a moderate extent. The rate for morals or conscientious reasons illustrated in figure 47. There were about 64 percentage of responders answers to a very small or small extent.

Based on collected data and the existing theories. The arguments about AMS smart metering environmental benefits depends largely on the changes approaches that we created as society.

We can only assume that the main factors for consumers to engage energy savings actions with the help from AMS smart metering are as illustrated by figure 60.

Figure 60: Approaches to achieve environmental benefits. Inspired by Gardner and stern, 2002 (81). Made by author.

Figure 60 illustrated approaches to achieve environmental benefits. The approaches are summarized as the following:

- Religious and moral approaches
- Local incentives
- Educational and interventions about environmental issues.
- Society incentives through AMS technology

- A more secure electricity supply:

Another reason to install AMS smart metering were mentioned by EU and NVE. Which was about to maintain a secure supply of electricity. This benefit is closely connected with the benefit mentioned above, environmental benefit.

It has been discussed that AMS smart meter will give each of us the opportunity to manage and changes our consumption by ourselves. This matter will contribute to a more effective

energy usage. Effective energy usage in this term will give a better prediction of consumption, there for a more secure, and stable electricity supply.

This benefit is closely connected with how people chooses to do with the information that they have received. Even through the information are provide, it does not mean that people would engage any action based on that.

Another factor that is important to discuss is about the solution that exist today towards AMS smart metering system. Today's metering system only provide usage information that consumer chose to report to DSO. The amount of usage is usually monthly or less. The fact is that DSO do not know if the amount of reported usage is correct. It is impossible to control all reported data from consumers with the metering system today.

AMS smart metering system in other hand would provide information that is not available in today metering system. The importance of accurate information is crucial due to studies about the trends of usage. This matter is important when it comes to discussions of investment and building new power plants. A challenge within this matter is the security and quality of data for AMS smart metering.

As mentioned in chapter 3.5.4, Sintef have done an overall risk assessment for the general AMS technology. The events that can occurred that Sintef considered to be at highest risk can be seen in chapter 3.5.4, Table 5.

Two of the mentioned risk is:

- Central system error or hacked data
- Not reliable server, unfaithful employee misuses knowledge and / or legitimate accesses

Based on this risk, it is appropriate to confirm this as one of the factor that does not encourage change of behavior. Robert Gifford, 2011 (79) mentioned one of barriers as mistrust. Trust is very important factor when it comes to change of behavior. Mistrust may occur when a person feels that the information from them have been misused such as stolen emails, personal information, lies from unprofessional scientists or politics.

Based on this matter, it is appropriate to argued that in order to achieve stable in supply, information security, and quality of data from AMS smart meter is crucial factor, in order to avoid mistrust and poor data quality.

5.2.2 Why should Manufacturing companies have AMS smart meter?

This research has focuses on manufacturing companies that are defined as power intensive. Which means data collections has been focuses on responders group within manufacturing that has more than 100 000 Kwh usage per year. As mentioned in chapter 3.3.6, power intensive manufacturing industry are one of the largest electricity consumers in the country, besides household.

The consumption in this group differ from household group, as it does not depend on temperatures. An important factor that have impact on electricity within this group is electrical prices. Understandable because electricity represents a large part of the total cost of the production.

Electricity is an important factor for the production processes, international economic conditions, import/exchange rates and metals prices within manufacturing companies.

Because manufacturing companies does not rely too much on seasons and temperatures, the consumption in this group are more stable and easier to manage. However, to achieve effectively usage of electricity in this group requires attention from management and the decided energy system. Managers are the ones that decides and makes decisions within companies in general. If the goal is to achieve effective energy usage, energy management system should be included in the management system.

In this thesis, energy management system has been included in order to gain knowledge of management system that AMS smart metering system can be a part of. It is assumed in the thesis that AMS smart metering can be include in the management system as an information tools.

In the light of gathered theories and data collection. The reasons why manufacturing companies should have AMS smart metering are based on the possible benefits that are possible to gain. The assumed benefits are the following:

- Economic benefits
- Competitive benefits
- Production stability

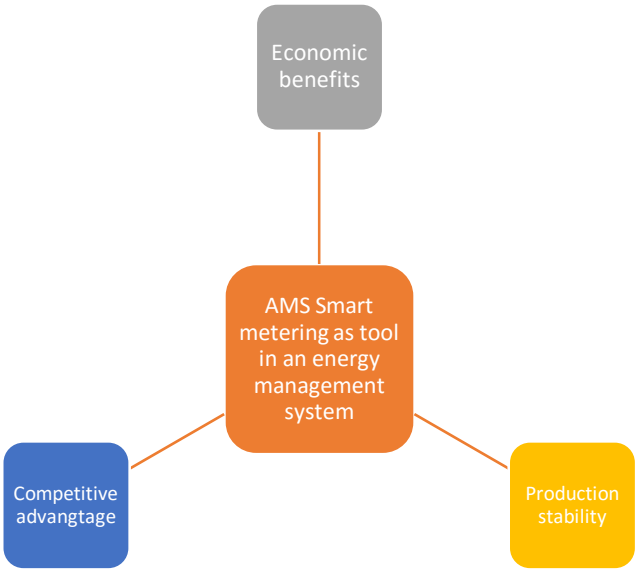

Figure 61: AMS smart metering as a tool in an energy management system benefits within manufacturing companies. By Author.

Figure 61 above illustrates the benefits, and possible reasons why manufacturing companies should have an energy management system that includes AMS smart meter.

These benefits are persuasive for all companies to strive for, in order to gain a stable position in the marked and achieve sustainable manufacturing process.

- Economic benefits:

As we have learned, electricity is an important factor within manufacturing companies. There are few, or maybe none manufacturing that can survive without electricity. The Economic benefits in this group of consumers are quite similar to the household group. The different is that within household there are less effort to engage an energy savings plans. Household groups depends on decisions made often from one to two persons in the household. While within an organization such as manufacturing companies, decisions are often made from manager or managers, and executions of the plan involves a corporation between the managers and employers.

In other terms, energy savings action within manufacturing involves several parts in the organizations. In order to implementation of an actions plan, it requires changes, routines and guidelines in a management system.

The figures below illustrate the different decisions makers between household and manufacturing companies.

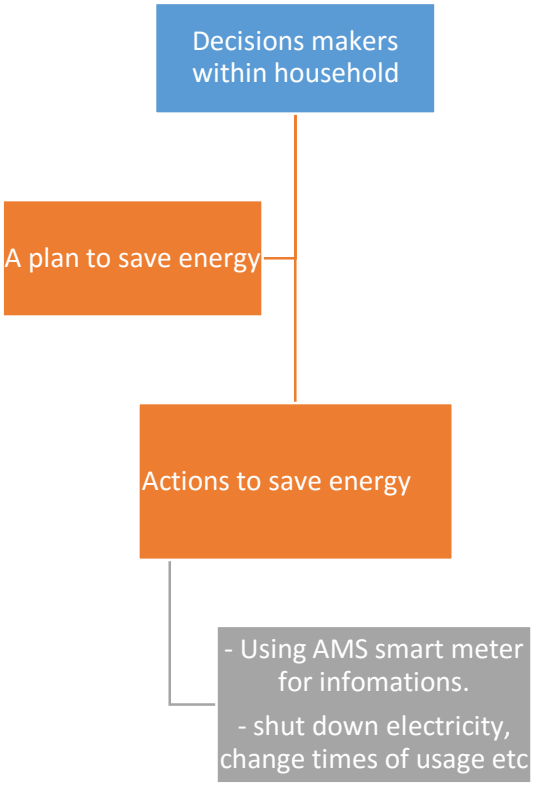

Figure 62: Energy savings actions and decisions makers within household. By Author.

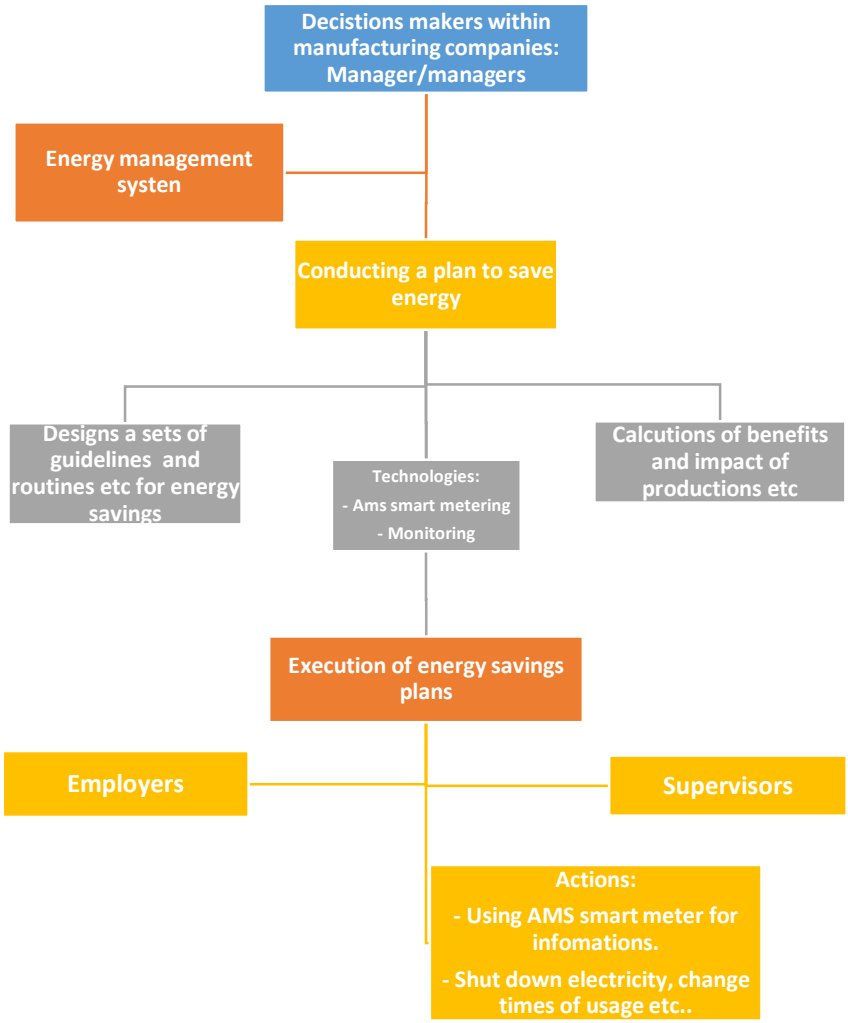

Figure 63: Energy savings actions and decisions makers within Manufacturing. By Author.

As the figurers illustrated, Energy savings action within an organization requires different stages, comparing to the private household group. Energy savings incentives and economic benefits within this group is a complex process, which involves calculations of eventual benefits and its impact on the production. The process involves corporations of employers, technologies and supervisors as well in order to succeed. The economic benefits are important because it have impacts on the total costs of the productions and the total costs of the company.

Based on data collections, there was 80 percentages of responders within this group that answered yes to question no 4, about if the company have implemented any kind of energy saving actions. Question no 6 were asked what kind of benefits the company have gained with energy savings actions, the amount of responders that answers economic benefits were 100 percentages, which indicates that benefits of economic have high priorities in order to engage energy savings incentives.

We have learned that AMS smart meter provide information, and provide a platform that can be uses to gain economic benefits. The benefits here are similar to what have been discussed for household group such as smart metering provide real time data of consumptions from the consumers. The consumers will have opportunities to update their usage value due to the electrical prices and receive much more accurate settlements. However, the challenges here are quite similar to the challenges that were discussed for household group. This matter is illustrated in figure 58.

The challenges are the following:

- Cost of investments
- Prices rise in peak time

There is a discussion about the cost of investments especially for consumers that have over 100 000 KWh usage per year. Most of the electricity meter system in this group already have a two-ways communications meter system. However, there are still functions missing in order to meet the AMS smart metering regulations. Due to the hearing documents, 7 – 2011 (49) some of the arguments to not implement a complete AMS smart meter as regulations requires are about the total cost of it. It has been considered as unnecessary and will not increase its advantage for any part that are involves. However, in contrary, EU argued that the benefits of the AMS smart metering system can achieve in its fullest, but it depends on the chosen function of the system. In other words, in order to gain benefits in its fullest, the function of the meter is important. Which raised the question about in what extent? Are the economic benefits big enough to defense the total costs of investment?

Another challenge is about prices in peak time, which are similar to what have been discussed for household group. It is possible to assume that prices for electricity may rises in peak time and or, tariffs are raised in order to recoup the investments of AMS smart meter. For whatever reasons, prices rise of electricity have large impacts for manufacturing companies as the electricity costs stands for a large part of the total costs.

It has been mentioned that many company can choses to close down their production processes in a short period of time due to critical power situations or for economic reasons. These episodes have reportedly happened during the winter months in from 2009 to 2010, and winter months from 2010 to 2011. However, some companies do not have the opportunities to do this type of shut down. Which again lead to question: How about consumers that do not have the ability to avoid usage in peak time hours such as shut down in production?

In summary, we can see the similarities of energy incentives and challenges within household and manufacturing companies when it comes to economic benefits. Economic benefits represent a large factor for both groups. In order to achieve this matter requires different action stages in both groups and the corporations between humans and technologies that AMS smart meter provide.

- Competitive advantage:

Based on data collections, question no 6 were asked what kind of benefits the company have gained with energy savings actions. The amount that collected competitive advantage, as a benefits were 60 percentages. This indicates that being a head of competitors have high priorities in order to engage energy savings incentives as well. On can only assumed that this is one of the reasons why 80 percentages of responders within this group has answered yes to question no 4, about if the company have implemented any kind of energy saving actions.

Due to the large amount of responders that have implemented energy savings actions and the mentioned benefits, indicates that they have implemented some sort of energy management system. Such management system is rewarding for those that successful at implemented it. However, companies were asked if they were ISO 50001 certificated (energy management certification) Due to the respond rate of this question, none of the responder have this type of certifications. It seems to be little interest to gain certification as well, question no 8 asked this question and there were only 15 percentage of responders that would think of getting a certification of ISO 50001. Which indicates a low rate for this, one can only assume that because most companies have implemented energy savings actions, indicates that most responders have their own type of energy management system. However, it is understandable that the interest of certification ISO 50001 is low because it is not a requirement by law.

Energy management system can be defined as management system includes sets of routines, guidelines etc. in order to gain effectively energy usage. AMS smart metering system in this term can be understood as a tool, a technology in this matter. It can be seen in similarities with a company's IT system. Today, IT system are a formal part of the company. In similarities with IT, AMS smart metering provide information, which gives the company opportunities to coordinate and share knowledge, in order to achieve effective usage. By doing this one can achieve and improve company's competiveness.

Challenges when it comes to implement energy management system is how the organizations react to this type of changes. This matter is quite similar to human psychologies toward changes that were discussed earlier in household group. However, changes within organizations are different in some areas. This thesis included Rørvik 2007, theory about changes within organizations in order to gain knowledge of this matter. A description of this theory were provided in chapter 3.8. In summary, implementing energy management, energy savings actions with the help of AMS smart metering can be describes as a virus, and a consequence of a virus may have different outcomes. Which means that results depend on what the idea do to organization, and what organization do to the idea itself. In order to achieve competitiveness advantage, requires a solid management system

and functional tools. It is important as well to continue to develop, as the competitors will always try to compete. AMS smart metering system can be considered as an upgraded tool in order to achieve this benefit.

- Production stability:

Based on the answers of question no 6, about what types of benefits the responders have gained with energy savings action, the amount that answers production stability were about 30 percent. Which indicates this matter as moderate priorities for energy savings actions.

The benefits of production stability can result economic benefits and a stable production line. Several factors lead to production stability, which can be for example calculations of production, market demands and requirements of sources. Market demands and resources are often factors that are difficult to calculate as this matter are often subject to changes. Therefor production stability is often difficult to achieve at a 100-percentage rate.

When it comes to electricity and production stability, it is important to have a secure supply of electricity in order to gain stable in production. Secure electricity supply was discussed earlier within household and it is quite similar to manufacturing. The different is that most manufacturing companies as we have learned have a very stable consumption, and the knowledge of consumption within this group are available because most of them already have two-way metering system installed.

An issue when it comes to current situations and secure electricity supple that has been discussed that in critical electrical times of the day, some manufacturing companies choses to close down their production. This action assumed to not contribute to stability in production. However, it is important to notice those companies' choses to do this, and some may have gained benefits of such shut down as well.

In the light of this benefit, one can argue that AMS smart meter system does provide informative data due to usage, which can lead to production stability. However, several factors within productions process need to be involve as well, in order to achieve production stability. This may explain the lower rate that answers stability in production in question no 6.

5.2.3 Society expectations

Based on the mentioned benefits, society expectation can be describes as achieving economic and environmental benefits. Achieving society economic benefit gained different types of groups within the society. The economic benefits within manufacturing and household were described earlier. The main factor for this benefit seems to be determined by prices of electricity.

Environmental benefits are based on climate changes, which cause extreme weather conditions that were described in chapter 3.7.2. It is understandable that society strive to achieve ways to reduce emissions and human impacts. Electricity is one of the factor that have impacts on the environment. In order to reduce emissions and human's impacts,

electricity consumption need to slow down and the production of electricity must be more environmental friendly.

Norway's electricity is mainly based on hydropower and it is considered as one of the most environmental sources of power. Different types of power production in Norway are closely describes in chapters 3.3.1, 3.3.2, 3.3.3 and 3.3.4. Despite that most of production types considered as environmental friendly, there are still some sort of impacts to the environment in each of the methods whether we like it or not. The best way to reduce emissions and humans' impacts can be argued to be based on reducing consumptions. Based on reduced consumption will lead to less need to invest in new power plants.

However, despite knowing that consumption should be reduce, the trends tells us that the consumption are increasing. Public organs seem to have faith in AMS smart metering as a solution to reduce consumption. The solution was argued to be a worthy investment for both future consumption and leading us to a future of digitalization of electricity. Comparing to the mechanical metering system that exists today, AMS smart metering is no doubt an innovative technology that provide many options as consumers.

The society expectations often rely on solutions and technologies in order to achieve economic and environmental benefits, but many often forget that the main results come from actions from each of us, as private, as managers, and as employers.

Chapter 6: Conclusion – All we need is a new metering system?

Electricity usage is increasing as our society keep on growing. As we have learned, Norway's electricity production methods are considered as environmental friendly, but it is still not enough in order to avoid climate changes and impacts on the environment. One of the most important activities that each consumer can contribute due to this matter is to reduce our usage.

Through reducing electrical usage, there would be less need to invest in new power plants and grid systems. The risk of blast capacity will reduce, and it would contribute to a more stable electricity supply. These matters sound very convincing and surely seems like a win, win situation for all involve parts.

Public organs have reached out to the AMS smart metering system in order to achieve this matter. AMS metering are consider as a new technology, and one of the tools to help us reduces our electricity consumption. It seems to exist a strong faith in AMS smart meter and the importance of this technology. Obviously, comparing to the metering system that exist today, AMS smart meter is no doubt an important investment that fits for the future.

However, as we have learned based on existing theories changes within human's behavior is a complex process whether it is as individuals or as an organization. Human behavior does have impacts on the environment, which make electricity consumption a common problem. Based on this matter, all we need is a new metering system is not a solution itself, however, a step forward through technology may be a better term to define AMS smart metering.

The aim of this thesis is to gain knowledge of AMS smart metering system within a consumer's point of view and the main target is to answers the research questions based on existing theories and findings.

Based on findings and existing theories one can conclude the following:

Research Questions	**Conclusion**
Does AMS smart meter contribute to reflect on own usage as a manufacturing organization?	Based on findings through data collection AMS smart metering as a tool itself would lead to some reflection of usage because the technology provides direct data to consumers. However, based on findings it is due to a small or moderate extent, and maybe not as much as it has been taken accounts to.
Does AMS smart meter leads us to reflect on our own usage as individual?	Based on findings through data collection AMS smart metering as a tool itself would lead to some reflection of usage.

	However, similar to the results of manufacturing companies. Most responders refer to very small, small or to a moderate extent. The majorities do not seem to believe in this technology as much as it has been taken accounts to.
Are there different perceptions between individuals and organization, when it comes to energy savings incentives?	Based on findings, it seems to quite unified perception between individuals and manufacturing companies. Manufacturing companies seems to have a more focus on energy savings incentives than individuals. One important benefits seem to be important within both groups. Which is economic benefits. This benefit seems to be a driven benefit in both groups. Within manufacturing companies, the responds of economic benefits were as high as 100 percent, while within household group economic benefits were considered as one main factor to energy savings motivation as large or very large extent.
Assumed that smart meter (AMS) can contribute to energy management as a control tool/technology, what are the benefits of it within manufacturing aspect?	Assuming that AMS smart metering system can contribute as a tool within an energy management system the benefits it would have gained such management system is as an informational tool. If Energy management system were implemented successful and routines for AMS smart metering are defined clearly other benefits such as economic, competitive advantage and stability within production process can be achieve. However, it is important to stance that AMS smart metering would not bring the benefits by itself. Benefits can only be achieving with a combination of human interactions within the companies and the technology that are available.

Table 7: Conclusion Table, By author.

Future Work

According to NVE regulations §4-5 (42) advance metering system will be installed for all electricity consumers in Norway by 1. January 2019 (42). Future work can focus on the after effect of AMS metering system due to consumer's consumption trends and benefits.

This research presented the views of AMS from consumers within household and manufacturing companies; it could be interesting to gain opinion from other consumer's groups as well.

The opinion within this research are subject to changes in the future after the systems are installed, and it will be interesting to do a review within the subject sometimes after the AMS system are installed.

Another interesting proposal for future work is to compare the before and after effect of the AMS smart metering system. Future work should provide measurements of consumptions, in addition eventual economic and environmental benefits AMS metering system have contributed to after it have been installed.

References List

1. Statistics Norway, Energy account and energy balance, 2011-2012. Visited mars. 2016. Link: https://www.ssb.no/energi-og-industri/statistikker/energiregn/aar-forelopige/2013-05-06

2. Sintef 2009: Vulnerability in the power supply and emergency: Contact Meeting on 29 October 2008 at OED (Petroleum and Energy). Last updated feb.2009. Visited Mars and April 2016. Link: http://www.sintef.no/sintef-energi/xergi/xergi-2008/xergi_3_08/sarbarhet-i-kraftforsyningen-og-beredskap/

3. Statkraft on Hydropower. Visited Mars. 2016. Link http://www.statkraft.com/energy-sources/hydropower/

4. Documents no 28/2015: A new and more ambitious climate policy for Norway by regjering.no. Visited Mars and April. 2016. Link: https://www.regjeringen.no/no/aktuelt/ny-og-mer-ambisios-klimapolitikk/id2393609/

5. European Commission about smart grid and smart meters. Visited Mars and April. 2016. Link https://ec.europa.eu/energy/en/topics/markets-and-consumers/smart-grids-and-meters

6. Guidelines for student thesis from NTNU Gjøvik. Visited April 2016. Link: http://english.hig.no/student/student_thesis

7. Business Research Methods and Statistics Using SPSS, 2008. By Robert P Burns, Richard Burns.

8. Towards a Guide for Novice Researchers on Research Methodology: Review and Proposed Methods, 2008. By Timothy J. Ellis and Yair Levy. Visited Mars and April 2016. Link: http://iisit.org/Vol6/IISITv6p323-337Ellis663.pdf

9. Practical Research: Planning and Design, 2004 (8th Edition). By Paul D. Leedy and Jeanne E. Ormrod.

10. Introduction to Social Research: Quantitative and Qualitative Approaches, 2013. By Keith F Punch

11. Methodology for creating business knowledge, 2009. By Ingeman Arbnor and Bjorn Bjerke.

12. Research Methods, Journal of Business & Economic Research – March 2007. Visited February and Mars. 2016. By Carrie Williams. Link: http://www.cluteinstitute.com/ojs/index.php/JBER/article/view/2532/0

13. Master thesis: Assessing the Environmental Costs and Benefits of Households Electricity Consumption Management, by Ida Lund Segtnan. 2011. Visited Mars/April. 2016. Link: https://www.ntnu.edu/c/document_library/get_file?uuid=f46048a5-fe94-4cfc-b48b-1cfbc12bc87e&groupId=163835

14. Information about statnett. Visited February, Mars and April. 2016. Link: http://www.statnett.no/en/About-Statnett/

15. Information about Nord Pool. Visited Mars/April. 2016. Link: http://www.nordpoolspot.com/About-us/

16. Information about NVE. Visited February and April. 2016. Link: https://www.nve.no/om-nve/

17. Statistics Norway: Energy account and energy balance, 2014. Visited Mars/April. 2016. Link: https://www.ssb.no/en/energi-og-industri/statistikker/energiregn/aar-forelopige/2015-05-06

18. Norwegian Meteorological Institute, Weather report in 2014. Visited Mars/April.2016. Link: http://met.no/filestore/2014-133.pdf

19. Statistics Norway: Electricity, 2014. Visited Mars/April.2016. Link: http://www.ssb.no/en/energi-og-industri/statistikker/elektrisitet/aar/2015-12-22?fane=tabell&sort=nummer&tabell=250567

20. EDF Energy: Picture of Hydropower plant. Visited April. 2016. Link: https://www.edfenergy.com/future-energy/energy-mix/hydro

21. HYDROPOWER AND THE ENVIRONMENT: Towards better decision-making. By Dr. Ute Collier. Visited Mars/April. 2016. Link: http://www.un.org/esa/sustdev/sdissues/energy/op/hydro_collier.pdf

22. Water for people, water for life, 2003. By the United Nations. Visited Mars/April. 2016. Link: http://www.un.org/esa/sustdev/sdissues/energy/op/hydro_collier.pdf

23. Statkraft about Wind Power, 2010. Visited Mars/April. Link: http://www.statkraft.com/globalassets/old-contains-the-old-folder-structure/documents/wind-power-aug-2010-eng_tcm9-11473.pdf

24. National instrument. Introduction to a Wind Power System. Visited Mars/April. 2016. Link: http://www.ni.com/example/31272/en/

25. Environmental impact of wind energy, 2011. By R. Saidur ∗, N.A. Rahim, M.R. Islam, K.H. Solangi. Visited mars/April. 2016. Link: http://www.beren.sakarya.edu.tr/sites/beren.sakarya.edu.tr/file/1380752968-02-Windenergy.pdf.pdf

26. SSB report no 2/2011. Supply and use of electricity in the period 1993-2009, 2011. Visited February, Mars and April. 2016. By Magne Hostad. Link: http://www.ssb.no/a/publikasjoner/pdf/rapp_201102/rapp_201102.pdf

27. Statistics Norway: Standard Industrial Classification (SIC2007). Visited Mars/April. 2016. Link: http://stabas.ssb.no/ItemsFrames.asp?ID=8118001&Language=en&VersionLevel=classversion&MenuChoice=Language

28. Power intensive industries: A description and financial analysis of power intensive industry in Norway. Report No 69/2013. By NVE. Visited Mars/April. 2016. Link: http://webby.nve.no/publikasjoner/rapport/2013/rapport2013_69.pdf

29. Statistics Norway: Energy consumption in households, 2012. Visited Mars/April. 2016. Link: http://www.ssb.no/en/energi-og-industri/statistikker/husenergi/hvert-3-aar

30. The Norwegian Parliament representative proposal in document 8:18 (2012 – 2013). Visited February and April. 2016. Link: https://www.stortinget.no/globalassets/pdf/representantforslag/2012-2013/dok8-201213-018.pdf

31. The Parliament report about energy plan, value creation, supply security and environment, 2012. Document NOU 2012:9. Visited February, mars and April. 2016. Link: https://www.regjeringen.no/contentassets/eb90bf50e63b4df7ae472b75a1d4a71c/no/pdfs/nou201220120009000dddpdfs.pdf

32. The Policies of the European Climate Change Program. Visited Mars. 2016. Link: http://ec.europa.eu/clima/policies/eccp/index_en.htm

33. The EU Climate strategies & targets. Visited Mars 2016. Link: http://ec.europa.eu/clima/policies/strategies/index_en.htm

34. Official Journal of the European Union. On energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32, 2012. By EU. Visited February, Mars and April 2016. Link: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0027

35. Trends and projections in Europe 2015 — tracking progress towards Europe's climate and energy targets. EEA Report No 4/2015. Visited Mars/April 2016. Link: http://www.eea.europa.eu/publications/trends-and-projections-in-europe-2015

36. Concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, 2009. Directive 2009/72/EC. By EU. Visited February/Mars. 2016. Link: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1460567693198&uri=CELEX:32009L0072

37. Concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, 2009. DIRECTIVE 2009/73/EC. By EU. Visited Mars/April 2016. Link: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0094:0136:en:PDF

38. United Nations, about the Kyoto Protocol. Visited Mars/ April 2016. Link: http://unfccc.int/kyoto_protocol/items/2830.php

39. United nations handbook. Climate get the big picture. Visited Mars/April 2016. Link: http://bigpicture.unfccc.int/

40. The Norwegian Parliament report no 13 (2014 –2015). Visited Mars 2016. Link https://www.regjeringen.no/no/dokumenter/meld.-st.-13-2014-2015/id2394579/?q=&ch=4

41. The Norwegian Parliament: A new and more ambitious climate policy for Norway, Last updated February 2015. Visited Mars/April 2016. Link: https://www.regjeringen.no/en/aktuelt/ny-og-mer-ambisios-klimapolitikk/id2393609/

42. NVE regulations, chapter 4: Advance metering and control system. Visited February, mars and April. 2016. Link: https://lovdata.no/dokument/SF/forskrift/1999-03-11-301/KAPITTEL_4#KAPITTEL_4

43. The Norwegian Parliament: Energy and power balance 2020. NOU 1998:11, 1997. Visited February, Mars and April 216. Link: https://www.regjeringen.no/no/dokumenter/NOU-1998-11/id141308/

44. The Norwegian Parliament: Recommendation of the energy and environment committee on a proposal from parliament Sylvia Brustad to facilitate that electricity customers across the country are offered two-way communication between electricity customers, electricity suppliers and grid operators. Doc no 138, (2002 – 2003). Visited Mars/April 2016. Link: https://www.stortinget.no/no/Saker-og-publikasjoner/Publikasjoner/Innstillinger/Stortinget/2002-2003/inns-200203-138/

45. NVE: New technologies and Flexibilities of consumers. Last updated 17. Mars. 2016. Visited Mars/April 2016. Link: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/ny-teknologi-og-forbrukerfleksibilitet/

46. The Norwegian smart grid center: Cautioning against AMS exception. Last updated 4. mars. 2016. Visited Mars/April 2016. Link: http://smartgrids.no/advarer-mot-ams-unntak/

47. Technology Roadmap, Smart Grids, 2011. By IEA – International Energy Agency. Visited Mars 2016. Link: https://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf

48. about AMS by NVE. Last updated 26.01.2016. Visited February, Mars, April 2016. Link: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/smarte-strommalere-ams/

49. NVE hearing report about: Advance metering and control system. Document no 7/2011. Published 2011. Visited Mars/April 2016. Link: http://www4.nve.no/Global/Publikasjoner/Publikasjoner%202011/Dokument%202011/dokument1-11-oppsummering.pdf?epslanguage=no

50. European Smart meter Alliance final report, 2010. By BEAMA and other organizations. Visited Mars/April 2016. Link: https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/esma_publishable_report_en.pdf

51. Standard Norway. Standards within AMS project. Last updated 19.11.2015. Visited Mars/April 2016. Link: https://www.standard.no/nyheter/nyhetsarkiv/elektro/lavspenningsinstallasjoner/flere-store-ams-kontrakter/

52. NVE hearing report about: Advance metering and control system. Document no 1/2011. Published 2011. Visited Mars/April 2016. Link: http://publikasjoner.nve.no/dokument/2011/dokument2011_01.pdf

53. NVE report: status and implementations of AMS meter, 2015. Document no 77/2015. Visited Mars/April 2016. Link: http://publikasjoner.nve.no/rapport/2015/rapport2015_77.pdf

54. NVE about Elhub. Last updated February 2016. Visited Mars/April 2016. Link: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/elhub/

55. EU report: Smart electricity grids and meters in the EU Member States, September 2015. Visited Mars/April 2016. Link: http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568318/EPRS_BRI(2015)568318_EN.pdf

56. NVE regulations, chapter 3: Measurement data. Visited February, Mars and April 2016. Link: https://lovdata.no/dokument/SF/forskrift/1999-03-11-301/KAPITTEL_3#KAPITTEL_3

57. Report from OECD: ICT Applications for the Smart Grid OPPORTUNITIES AND POLICY IMPLICATIONS, 2012. Visited Mars 2016. Link: http://www.oecd-ilibrary.org/science-and-technology/ict-applications-for-the-smart-grid_5k9h2q8v9bln-en

58. Report about Smart metering, 2006. By Rob van Gerwen, Saskia Jaarsma and Rob Wilhite, KEMA, The Netherlands. Visited Mars/April 2016. Link: http://paginas.fe.up.pt/~ee04012/smart%20metering_Rob%20Gerwen.pdf

59. The Norwegian Parliament: We build Norway – about developing power grid. Document no 14 (2011 – 2012). Visited February, Mars and April 2016. Link: https://www.regjeringen.no/no/dokumenter/meld-st-14-20112012/id673807/

60. Report of Sintef: Risk of AMS. Assessing information security vulnerabilities in AMS, 2012. Visited Mars/April 2016. Link: http://www.sintef.no/en/publications/publication/?pubid=sintef+a22318

61. Article from TU about AMS smart meter: Automatic electricity meters can be a giant mistake investment. Published January, 2016. Visited mars/April 2016. Link: http://www.tu.no/artikler/automatiske-strommalere-kan-bli-en-gigantisk-feilinvestering/223534

62. The UK Parliament: MPs report on preparations for the roll-out of Smart Meters. Published 17. Jan. 2012. Visited Mars/April 2016. Link: http://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news/smart-meters-report/

63. ENOVA guidelines: Energy Management, 2012. Visited Mars/April 2016. Link: http://www.enova.no/upload_images/E9C369B5C52A4340955BAC25A1B69F22.pdf

64. Strategic Management: Theory: An Integrated Approach, 2012. By Charles W. L. Hill, Gareth R. Jones

65. ISO standards: management system standards. Visited mars 2016. Link: http://www.iso.org/iso/home/standards/management-standards.htm

66. Energy Management Handbook, Sixth edition, 2007. By Wayne C. Turner.

67. Energy management of the industry under pollution Act, 2013. By the Norwegian environment Directorate - Randi W. Kortegaard. Visited Mars/April 2016. Link: http://miljodirektoratet.no/Global/dokumenter/tema/for%20n%C3%A6ringsliv/miljoforum2013/2_Randi_Warland.pdf

68. The Pollution regulation in Norway. Visited mars, 2016. Link: https://lovdata.no/dokument/NL/lov/1981-03-13-6

69. Norwegian Energy: Energy management -The new focus in the Industry. Visited Mars 2016. Link: http://www.energi.no/en/energy-managemen-en

70. The Demning institute: Information about The PDSA Cycle. Visited mars 2016. Link: https://www.deming.org/theman/theories/pdsacycle

71. ENOVA, - Interaction between people, technology and organization. Visited mars, 2016. Link: http://www.enova.no/upload_images/48C892FCE1DF4DADBA53313E0DDCCAC6.pdf

72. The Training and Development Sourcebook, Human Resource Development, 1994. By Craig Eric Schneier.

73. ISO standards: The ISO Survey of Management System Standard Certifications, 2014. Visited Mars 2016. Link: http://www.iso.org/iso/iso_survey_executive-summary.pdf?v2014

74. ISO Standards: World distribution of ISO 50001 certificates in 2014, 2014. Visited Mars/April. 2016. Link: http://www.iso.org/iso/home/standards/certification/iso-survey.htm?certificate=ISO%2050001&countrycode=NO

75. Environmental Psychology: Behavior and Experience in Context, 2013. By Tony Cassidy

76. Environmental Psychology: An Introduction, John Wiley & Sons, 2012. By Linda Steg, Agnes E. van den Berg, Judith I. M. de Groot.

77. The IPCC report: Climate Change 2014 Synthesis Report Summary for Policymakers, 2014. Visited mars 2016. Link: https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

78. Article about Psychology's Contributions to Understanding and Addressing Global Climate Change. By Janet K Swim, Paul C Stern, Thomas J Doherty, Susan Clayton, Joseph P Reser, Elke U Weber, Robert Gifford and Georg S Howard. Visited Mars/April 2016. Link: https://www.apa.org/pubs/journals/releases/amp-66-4-241.pdf

79. The Dragons of Inaction. Psychological Barriers That Limit Climate Change Mitigation and Adaptation, 2011. University of Victoria. By Robert Gifford. Visited Mars 2016. Link: http://www.scp-knowledge.eu/sites/default/files/knowledge/attachments/The%20Dragons%20of%20Inaction.pdf

80. Encouraging pro-environmental behaviour: An integrative review and research agenda. University of Groningen, Faculty of Behavioural and Social Sciences, The Netherlands, 2008. By Linda Steg, Charles Vlek. Visited Mars 2016. Link: https://www.rug.nl/staff/e.m.steg/stegvlekencouraging.pdf

81. Environmental problems and human behavior, 2nd ed, Pearson Custom Publishing, Boston, 2002. By Gerald T. Gardner and Paul C. Stern.

82. Trender og Translasjoner, - Ideer som former det 21. århundrets organisasjon, 2007. In English: Trends and translation, 2007. By Kjell Arne Rørvik.

83. Information about Questback from NTNU Gjøvik. Visited Mars/Mai 2016. Link: http://hig.no/student/oppgaveskriving/questback

84. NRK interview with water resources and energy director Per Sanderud. Article name in Norwegian: Vil gjør det dyrere å lade elbilen på ettermiddagen. By Kristine Hirsti, Lars Sigurd Sunnanå, Kristi Marie Skrede and Pedja Kalajdizic. Last updated 31.05.2016. Visited 01.06.16. Link: https://www.nrk.no/norge/vil-gjore-det-dyrere-a-lade-elbilen-pa-ettermiddagen-1.12975883

85. NVE report:
Endringer i forskrift om måling, avregning og samordnet opptreden ved kraftomsetning og fakturering av nettjenester. Document no 51/2015. Visited Mars/April/May 2016. Link: http://publikasjoner.nve.no/rapport/2015/rapport2015_51.pdf

Appendices

Appendix 1 1
Appendix 2 3

Appendix 1

Title: Presentation and information to responders

Name: Jenny Grøterud, 120 577

Internal supervisor: Professor Stig Ottosson

Master Thesis Master of Science in Sustainable Manufacturing

30 ECTS

Faculty of Technology, Economy and Management

NTNU Gjøvik University College, 2016

Presentasjon mal ved telefon intervju:

Hei,

Mitt navn er Jenny Grøterud og studerer Master i bærekraftig produksjon ved NTNU Gjøvik.

I forbindelse med Master oppgave ved NTNU ønsker jeg å gjennomføre en spørreundersøkelse blant strømbrukerne med hoved fokus innen for husholding og produksjonsbedrifter.

Denne undersøkelsen handler om smarte målere, problemstillingen handler om smarte målere vil faktisk gjør oss mer bevisste på vår egen strømforbruk.

Undersøkelsen tar ca. 5 - 10 minutter, og resultatene vil ikke kunne knyttes til deg eller din virksomhet.

Introduksjon før spørreundersøkelse ved Questback:

Hei,

I forbindelse med Master oppgave ved NTNU ønsker jeg å gjennomføre en spørreundersøkelse blant strømbrukerne.

Denne undersøkelsen handler om smarte målere, generelt strømforbruk og retter seg mot private og produksjon sektor.

Problemstillingen handler om smarte målere vil faktisk gjør oss mer bevisste på vår egen strømforbruk.

Undersøkelsen tar ca. 5 - 10 minutter, og resultatene vil ikke kunne knyttes til deg eller din virksomhet.

Appendix 2

Title: Questionnaire

Name: Jenny Grøterud, 120 577

Internal supervisor: Professor Stig Ottosson

Master Thesis Master of Science in Sustainable Manufacturing

30 ECTS

Faculty of Technology, Economy and Management

NTNU Gjøvik University College, 2016

Spørreundersøkelse om Smarte strømmålere (AMS)

Spørsmål 1: Gjelder svaret ditt for privat eller bedrift?

- Privat
- Produksjonsbedrifter

For Produksjonsfirma:

Spørsmål 2: Hvilken produksjons næring ligger din bedrift under?

- Produksjon av papirmasse, papir og papp (treforedling)
- Produksjon av kjemiske råvarer
- Produksjon av jern, stål og ferrolegeringer
- Produksjon av ikke-jernholdige metaller
- Vet ikke
- Annet

Spørsmål 3: Hvor mye strøm bruker deres bedrift ila ett år?

- Mellom 10 000 Kwh – 50 000KWh
- Mellom 50 000 KWH – 100 000 KWH
- Over 100 000 KWH
- Vet ikke
- Annet

Spørsmål 4: Har dere innført noen form for strømsparende tiltak i deres bedrift?

- Ja
- Nei
- Vet ikke

Spørsmål 5: Vurderer dere å innfører strømsparende tiltak i deres bedrift?

- Ja
- Nei
- Vet ikke

Spørsmål 6: Hva slags gevinst har dere fått ut av deres strømsparende tiltak?
Flere valg muligheter

- Økonomisk Gevinst
- Konkuranse fortrinn
- Stabilitet i produksjon
- Bedre renommé
- Annet

Energi ledelse er en ledelse system som inkludere metode for å kunne utnytte energi effektiv. ISO 50001 er en sertifisering for dette.

Spørsmål 7: Er dere ISO 50001 Sertifiserte? (energiledelse)

- Ja

- Nei
- Vet ikke

Spørsmål 8: Vurderer deres bedrift å bli ISO 50001 sertifiserte?

- Ja
- Nei
- Vet ikke

Spørsmål 9: Har dere AMS smarte målere installert i deres bedrift idag?

- Ja
- Nei
- Vet ikke

Spørsmål 10: Tror dere at AMS målere kan ha en reduserende effekt på strømforbruket i deres firma?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 11: Tror dere at AMS målere kan føre til at dere blir mer bevist over deres eget strømforbruk?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

AMS målere har to-veis kommunikasjon mellom måler og nettselskap, og vil kunne gi deg som kunde løpende informasjon om eget forbruk og øyeblikks prisene for kraft og nettleie. Norges vassdrags- og energidirektorat (NVE) har fastsatt fristen for innføring av automatiske strømmålere / smart strøm (AMS) til 1. januar 2019. Dvs alle hjem og bedrift vil får denne typen måler installert innen 01/01/2019.

Hovedbegrunnelse for installasjon av AMS smart målere, er at dette skal får brukerne til å være mer bevist over sin strøm forbruk og innfører strømsparende tiltak pga økonomiske og miljø hensyn.

Spørsmål 12: Tror dere at AMS målere kan bli brukt som en del av Energy ledelse system?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad

- I svært stor grad
- Jeg vet ikke

Spørsmål 13: Tror du ved bruk AMS målere kan ha en reduserende effekt på klima utslipp?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 14: Tror dere at AMS målere kan bli brukt som en del av Energy ledelse system?

- Ja
- Nei
- Vet ikke

For husholdning:

Spørsmål 15: Hvilken husstand bor du i?

- Enebolig
- Leilighet
- Tomannsbolig
- Rekkehus
- Annet

Spørsmål 16: Hvor mye strøm bruker du/dere ila ett år?

- Mellom 5000 KWh – 10 000 KWh
- Mellom 10 000 KWh – 20 000 KWh
- Mellom 20 000 KWh – 30 000 KWh
- Vet ikke
- Annet

Norges vassdrags - og energidirektorat (NVE) har fastsatt fristen for innføring av automatiske strømmålere /smart strøm (AMS) til 1. januar 2019. Dvs, alle strømkunder vil får nye og smarte strømmålere innen 1. januar 2019.

Litt info om AMS målere: Måleren har to-veiskommunikasjon mellom måler og nettselskap, og vil kunne gi deg som kunde løpende informasjon om eget forbruk og øyeblikks prisene for kraft og nettleie.

Spørsmål 17: Var du klar over NVE forskriften ang smarte målere?

- Ja
- Nei
- Vet ikke

Spørsmål 18: Har du AMS måler installert i ditt hjem idag?

- Ja
- Nei
- Vet ikke

Spørsmål 19: Hvor ofte lese du av strømmåleren din?

- Hver måned
- Annen hver måned
- Hver tredje måned
- Vet ikke Annet

Hoved begrunnelse for installasjon av AMS smartmålere, er at dette skal får brukerene til å være mer bevist over sin strømforbruk og innfører strømsparende tiltak pga økonomiske og miljø hensyn.

Spørsmål 20: Tror du det kan ha en reduserende effekt på strømforbruket ditt?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 21: Tror du AMS målere kan føre til at du blir bevist over ditt eget strømforbruk?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 22: Tror du AMS målere kan ha en reduserende effekt på klima utslipp?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 23: Tror du at du kommer til å innføre strømsparende tiltak på grunn av AMS målere?

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Dersom du skal innføre strømsparende tiltak.
Spørsmål 24: Hva tror du vil være hovedårsak til det?
Flere valg muligheter

1. Av Økonomisk Hensyn

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

2. Av Miljø Hensyn

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

3. Av Samvittighet eller moralsk hensyn

- I svært liten grad
- I liten grad
- I Noen grad
- I Stor grad
- I svært stor grad
- Jeg vet ikke

Spørsmål 25: Hva tror du er hoved årsak til at folk ikke ønsker å innføre strømsparende tiltak?
Flere valg muligheter

- Uvitenhet om eget forbruk
- Er fornøyd med nåværende løsning og ønsker ingen endringer
- Har ingen tro på at det vil medfører noe forskjell
- Vet ikke
- Annet