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Attitude towards energy efficient buildings in Finland

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The purpose of this bachelor's thesis was to understand the current situation and progress of energy efficient buildings in Finland. Another goal was to find out how energy efficiency in buildings can be achieved. This study also discussed various policies and regulations made at national level on energy efficiency in Finland.

To study the energy efficiency market of buildings and its progress, research on the current situation was done. Interviews and surveys were conducted with experts from various backgrounds in the real estate sector in Finland. The views of the experts were analysed as it was important to understand the market situation in Finland and to obtain the knowledge of people's attitude towards energy efficient buildings. The attitudes of tenants and real estate market players towards energy efficient buildings were also been demonstrated in this study.

The study showed that companies look for various ways to achieve energy efficiency as it can be financially viable for them. Housing companies try to involve tenants in energy saving projects as it benefits both parties. Furthermore, energy efficiency or sustainability can only be achieved through the co-operation of all parties, including the government, business and individuals. This study can be used as a reference to understand the behaviour of people in energy consumption. However, more intense interviews in wider scale covering more parties in real estate sector including the tenant or the building user are needed.

Keywords	energy efficiency, market players, energy consumption

Contents

Abbreviations

AEC	Architecture, Engineering and Construction
BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Method
CO_2	Carbon dioxide
EEA	Energy Efficiency Agreement
EED	Energy Efficiency Directive (Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC)
EPBD	Energy Performance of Buildings Directive
ESD	Energy Services Directive
GDP	Gross Domestic Product
HVAC	Heating, Ventilating and Air-Conditioning
IAQ	Indoor Air Quality
ICT	Information and Communication Technology
IEA	International Energy Agency
IoT	Internet of Things
LCC	Life Cycle Calculation
LEED	Leadership in Energy and Environmental Design
NEEAP	National Energy Efficiency Action Plan
NEEAP-1	First National Energy Efficiency Action Plan pursuant to the Energy Services Directive (26 June 2007)
NEEAP-2	Second National Energy Efficiency Action Plan pursuant to the Energy Services Directive (27 June 2011)
NEEAP-3	First National Energy Efficiency Action Plan pursuant to the Energy Efficiency Directive (29 April 2014)
Non-ESD	Non- Energy Services Directive
TFC	Total Final Consumption
VAETS	Rental apartment operational program (Vuokra-asuntoyhteisöjen toimenpideohjelma)

1 Introduction

The consumption of energy in the past few decades has evolved very rapidly because of an increase in the population, increase in the demands, and improvements in the quality of life. The increase in population and higher demands in accommodation have boosted the number of buildings in the world, and buildings consume a significant amount of energy. The consumption of energy in buildings varies according to climatic zones and the use of buildings. The living quality of people has improved significantly, resulting in high energy use. There has also been an improvement in the building energy efficiency, but a lot has to be done to cope with the high demand of energy in the building sector. [1.]

Buildings and their final energy consumption account for about 40% of the energy usage in the world. Also, about one-third of the CO_2 emissions in the world are caused by buildings and their construction. The majority of the energy in a residential building in a moderated European climatic zone, like Germany, is used in heating. The heating demand is even higher in the Northern European climatic zone, like Finland, than in the other European zones. [1.]

Technologically, Finland is one of the advanced countries in the world and yet, the energy efficiency technologies in Finland are not very popular, or are not being implemented widely. New technologies in every sector are being developed now and yet, many companies and buildings are failing to utilise the new technologies in energy efficiency sector. [1.] The energy efficiency of buildings can be affected by different measures like legislation and building codes, affordability of technologies in building energy efficiency, construction companies and various real estate market players.

The main aim of this study is to find out the progress of energy efficiency in buildings in Finland and the target achievement of Finland in building’s energy efficiency in the future. The role of different market players in the real estate business for the implementation of energy efficiency measures in buildings is also studied. In addition to the building codes in energy efficiency, different parties can influence the process of adopting energy efficiency measures. The parties involved in the process can be the portfolio owners or the investors, construction companies, HVAC consultants, real estate owners and various real estate market players. Attitude and behaviour of people towards energy efficient buildings is also studied in this study.

The scope of this study is to understand the market of energy efficiency in the building sector and market players in adopting energy efficiency in buildings in Finland. The role of different market players is also demonstrated. The interest of the tenants or the building users in energy efficient buildings is also discussed. However, the views of the tenants or the building users are not studied in this research.

2 Research Methodology

The study is done by reviewing the current state in energy efficient buildings and interviewing experts in building sector. Through the research and interviews, the attitude and behaviour of different market players in the building sector are studied. In the first phase of the study, relevant literature is studied to gain a deep understanding about the technologies in current energy efficient buildings. Furthermore, various classifications of Finnish buildings and energy auditing in Finland are looked into. The understanding of the Finnish real estate market is also necessary for the study.

The second phase of the study consists of interviews with experts. Various market players in the real estate businesses such as the HVAC consultants, building engineers, energy consultants and housing companies are interviewed for the research. Information from the experts is collected through personal interviews and an online survey. A set of questions is prepared for the interviews, and all the interviewees are asked the same questions, despite of their expertise. The data collected from the interviews is reported collectively and not individually, and the information of the participants is kept anonymous. The questionnaires can be found as an appendix at the end of the report.

3 Status of Buildings

As the technology in buildings has developed, several classifications and measures have also been adopted. Buildings are classified in different categories according to their use, such as an apartment building and a sports facility are categories. Differently categorised buildings consume energy in different level as their uses are different.

3.1 Classification of Building

According to the Finnish building code, buildings are classified into nine categories. The categorization is done according to their uses and the energy consumption. Thus, energy efficiency measures in a building are implemented according to the categorisation of a building or according to their uses. The adaptation of energy efficiency measures in an apartment building and a commercial building can be different because of their different level of energy consumption. Buildings categorised in different categories have their own set of regulations for indoor climate according to Finnish building code. A ventilation system or a heating system categorised for an apartment building or a factory building can be different. If a building is used for two purposes, it can be categorised in two different categories. However, if the secondary purpose of the building occupies less than 10% of the total building area, it can be categorised in a single category. [2.]

Table 1 shows the E-value per year for differently categorised buildings in Finland. E-value is simply defined as a building's calculated overall energy consumption and represents the annual energy consumption of purchased energy per net heating area. The E-value is based on the standard use of a building type and the weighted coefficients of the used forms of energy. The E-value is a significant assessment criteria when determining the energy efficiency of a building. A lower E-value represents lower consumption of energy. [2.]

Table 1. E-value per year for different categorized buildings. [2.]

Category	Types of Buildings	E-value (kWh/m^2 per year)
1	Detached, terraced houses	150-250
2	Apartment buildings	150
3	Office buildings	130
4	Commercial buildings	240
5	Accommodation in commercial buildings	240
6	Education building and day care centres	170
7	Sports halls	170
8	Hospitals	450
9	Other buildings	E-value is calculated but, not subject to requirement

The consumption of energy or the E-value is the highest in category 8 buildings and the lowest in category 3 buildings i.e. 450 kWh/m^2 per year and 130 kWh/m^2 per year. Commercial buildings and commercial accommodating buildings have the same E-value, 240 kWh/m^2 per year. The E-value for category 1 buildings, which consist of detached and terraced houses, can be from 150 kWh/m^2 up to as high as 250 kWh/m^2 per year. The category 9, which consists of buildings not subject to any specific E-value requirements, can have different E-values according to their utilisation. The category 9 buildings, such as skating rink, can have a very high E-value, whereas a storage facility for materials which do not need to be well preserved can have a very low E-value. [2.]

3.2 Current energy consumption in buildings

The total end-use of energy in all sectors in Finland increases every year and it is estimated to reach 347 TWh by 2020 if no steps towards energy saving or energy efficiency are taken. [3.] Around 40% of the total energy in Finland is used in buildings, and the greenhouse gas emissions from the buildings accounts 35% of the total Finnish greenhouse gas emissions. [4.] In 2010, 22% of the total end-use energy in Finland, 70 TWh, was used in the household sector. [3.]

The end-use of energy per sector in Finland from the year 2000 to 2012 can be seen in figure 1. The industrial sector consumes the largest portion of energy followed by residential, tertiary and other sectors. The energy consumption in the industrial sector dropped around 2008 because of the economic crisis. The sector that uses the least energy in Finland is the transportation sector. [3.]

Figure 1. Energy end-use per sector in Finland. [3.]

In Finland, the energy efficiency measures have been guided by the national building code since 1976. In the 2000s, the energy efficiency requirements have been made stricter. By the year 2003, the level of energy requirements was tightened by 25-30% from the level of 1976. Further adjustments were made in 2008 and 2010 in the airtightness of the building envelope. The latest change was made in 2012, when the energy efficiency level was tightened by 20% from the level of 2010. [4.]

The dependency of imported fossil fuels is very high in Finland. This is challenging for the government in terms of energy security in longer term. The Finnish energy consumption per capita of is the highest in the International Energy Agency (IEA) countries and among the highest in the world because of the cold climate. In Finland, 80% of the CO_2 emissions are from energy generation and energy consumption. [5.]

4 Energy Audits

An energy audit is enquiring of the total consumption of energy. All the energy consumption or energy flow in a particular building or property is audited in the process. It is in growing process in Finland in the real estates to reduce the energy expenses.

In Finland, almost 13 million euros were provided as subsidy for energy audits in industries, municipal, and property and building sectors between the periods of 2008 to

2014. These subsidies were granted to the parties participating in EEA. 95% of energy audits done in municipal sector, and 90% of energy audits done in industry sector are linked with EEA scheme. And in the service sector, energy audit has been carried out at least once in 60% of its building volume. [8.]

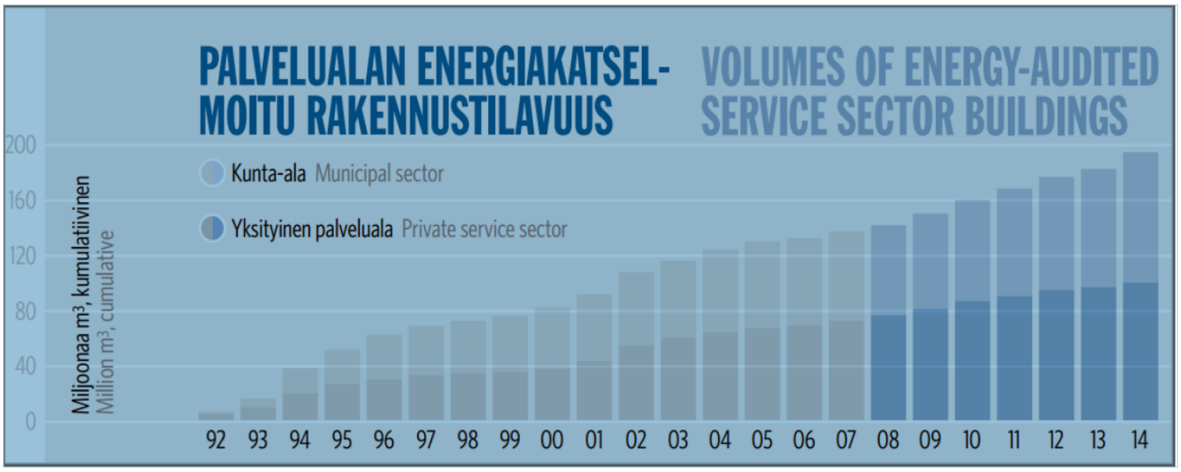

Figure 2. Energy audit of service sector buildings by volume in cubic meter from the year 1992 till 2014 [8.]

Figure 2 shows that almost 200 million cubic meter volume of service sector buildings were energy audited at least once by the year 2014. The initial bars in figure 6 from 1992 till 2007 represent the energy audited before the EEA, whereas the bars from 2008 till 2014 represent energy audited after EEA. The lighter colour section of the bars of grey and blue represents the energy audited of the municipal sector, and the darker colour section of grey and blue bars represent the energy audited in the private service sector. [8.]

5 Energy Efficiency in Finland

An Energy Efficiency Agreement (EEA) was made by Finnish Ministry of Economic Affairs and Employement at the end of 2007 for the period of 2008 to 2016 to increase the energy efficiency in Finland. [6.] The EEA covers the industrial, municipal, housing, oil and transportation sectors. By joining the EEA, a company agrees to its scheme and plan, which depends on the operational field of the company. Companies join EEA to avert climate change, build better public image and to compete with the stricter rules and regulations in energy use in the future. [7.]

5.1 Energy saving

By the end of 2014 hundreds of Finnish companies had signed up to the EEA. This accounted for about 65% of the total energy use in Finland i.e. 372 TWh. Countries in the EU are committed in increasing their renewable energy use and energy efficiency, and cutting the greenhouse gas emissions by 20% by the year 2020. The EEA has been a key element in Finland achieving its 2020 goal in the energy sector. [8.]

Figure 3 shows the realised annual energy savings in 2014 in various sectors. 73% of the energy savings in 2014 was in industrial sector. Energy saving in the energy production sector was at 17% and the 10% of energy savings were made in all other sectors combine. [8.]

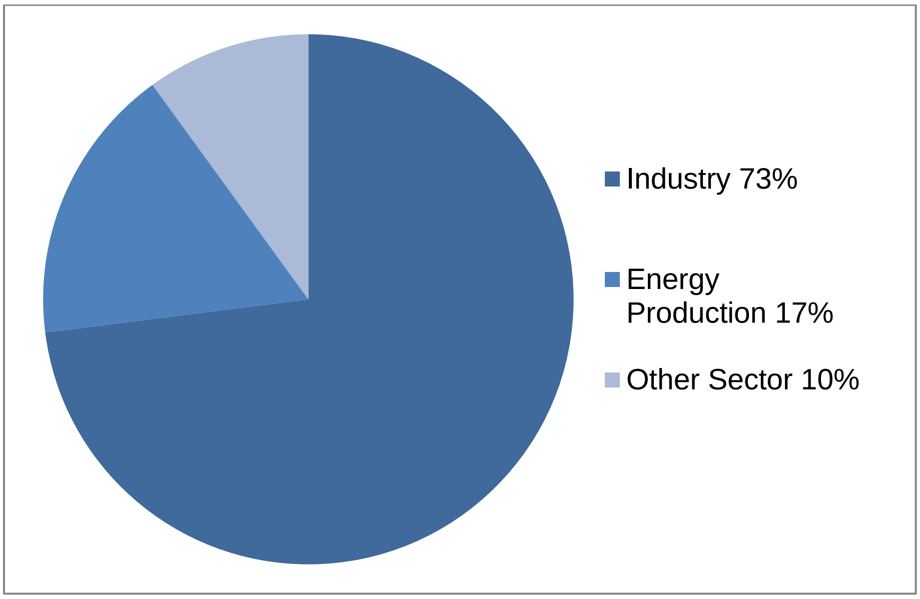

Figure 3. Annual energy savings in 2014 in different sectors. [8.]

Almost 12 TWh of energy was saved in Finland in 2014. The saved energy accounted 3.2% of the total energy consumption in 2014. Out of the total energy saved, 8.76 TWh were in the form of heating and fuel energy, whereas, 3.27 TWh were in the form of electric energy. In terms of price, this accounted for € 440 million of the annual savings in energy costs. This saving helped Finland to reduce its CO_2 gas emissions by 3.6 million tonnes. [8.]

5.2 Investments in energy efficiency

Figure 4 shows the investments made in different sectors from 2008 and 2014. More than 35% of the investments done in energy efficiency were done in the industrial sector. The energy transmission and distribution sector had the lowest amount of investments in energy efficiency between the years 2008 to 2014. The second highest investments in energy efficiency were seen in the energy production, followed by the service sector and property and building sector. Approximately 800 million euros of investments were made in energy efficiency during the 6 year period, and more than half of the investment was returned in one single year. In the energy sector 440 million euros of the cost saving was made in the year 2014. [8.]

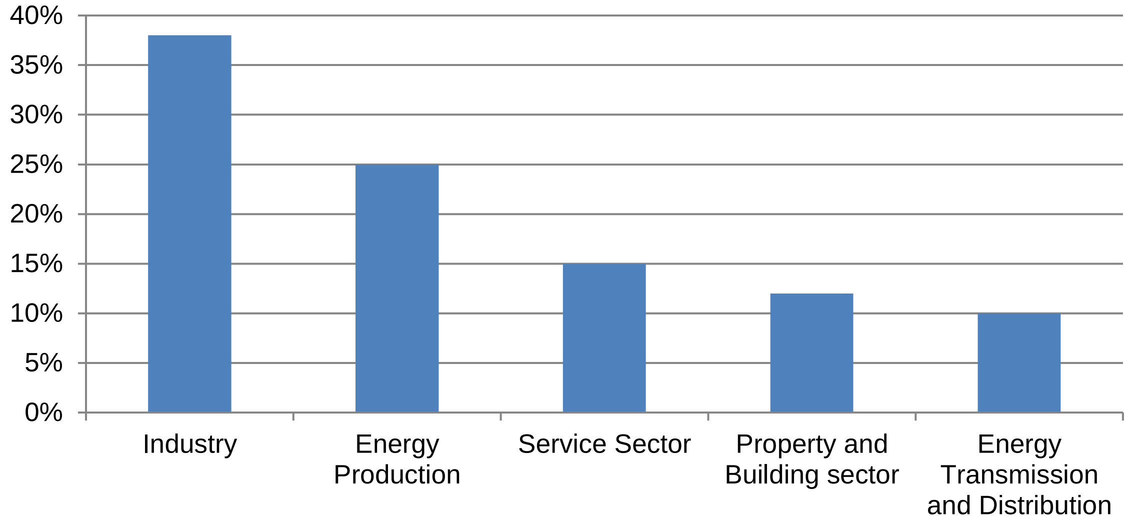

Figure 4. Percentage of all investments in energy efficiency according to sector between 2008 till 2014. [8.]

During the same period, from 2008 till 2014, about 85 million euros of subsidies were granted by the Finnish Ministry of Economic Affairs and Employement. Most subsidies were granted for investments, approximately 72 million euros as investment subsidies and the rest, 13 million euros, in energy audit subsidies. With active energy saving projects launched by companies and municipalities, subsidies of approximately 72 million euros were granted to over 700 projects by the end of 2014. These subsidies were granted to the companies, industries, municipalities and building properties which have joined EEA on the basis of individual assessment. [8.]

5.3 Energy Efficiency Trends

In Finland, the household sector uses most of its energy in space heating. The proportion of space heating in the household sector in the year 2012 accounted for 72% of the normalised Total Final Consumption (TFC). The energy used in saunas is also calculated under space heating in the national energy statistics in Finland. In addition, 15% of the energy used in the household sector was used in water heating, and approximately 13% of the energy consumption was for other uses, which include lighting and appliances. The use of energy in lighting and appliances is in decreasing order in the household sector because of the stricter laws and regulations on energy consumption of electronic appliances. Energy labelling and eco-design of electronic appliances have helped in decreasing energy consumption. However, the use of energy in space heating and water heating is increasing. [3.]

High uses of energy for space heating in the household sector can be clearly seen from figure 5. The consumption of energy in space heating has increased significantly from the year 2000 to 2012. However, the energy use in water heating has only increased slightly, and other end-uses of energy have decreased, mainly due to stricter product policies in electronic appliances. Breaking down the data in figure 5 below, consumption of energy in space heating, approximately 4 Mtoe (Million Tonnes of Oil Equivalent) in the year 2012, is much higher than energy consumed in water heating and other end-uses combined, less than 1 Mtoe, respectively. Energy efficiency in space heating decreases the energy consumption of buildings in Finland significantly, because of the cold and long winter. [9.] Energy used in heating the saunas is classified under other end uses in figure 4, extracted from ODYSSEE, a project supported by the Intelligent Energy Europe programme, database. However, it is classified under space heating in the Finnish national energy statistics. [10.]

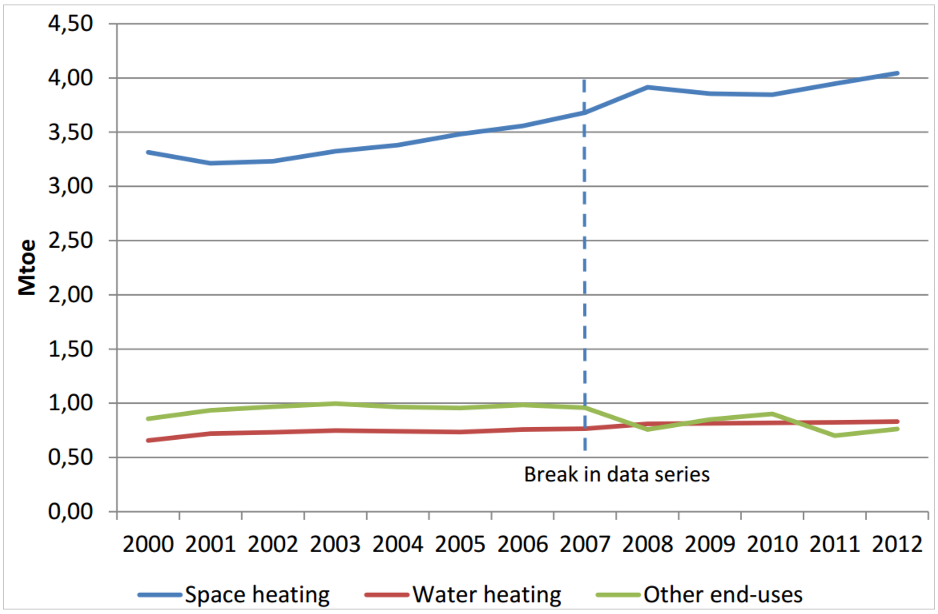

Figure 5. Energy consumption by households in Finland (with climatic correction for heating). [3.]

As can be seen in figure 6 below, 90 m^2 of floor area in the tertiary sector consumed approximately 2.6 Mtoe or 34.61 m^2 per Mtoe of energy in 2000. However, the energy consumption has decreased in 2012, when a 120 m^2 floor area in the tertiary sector consumed 3 Mtoe or 40 m^2 per Mtoe. [3.]

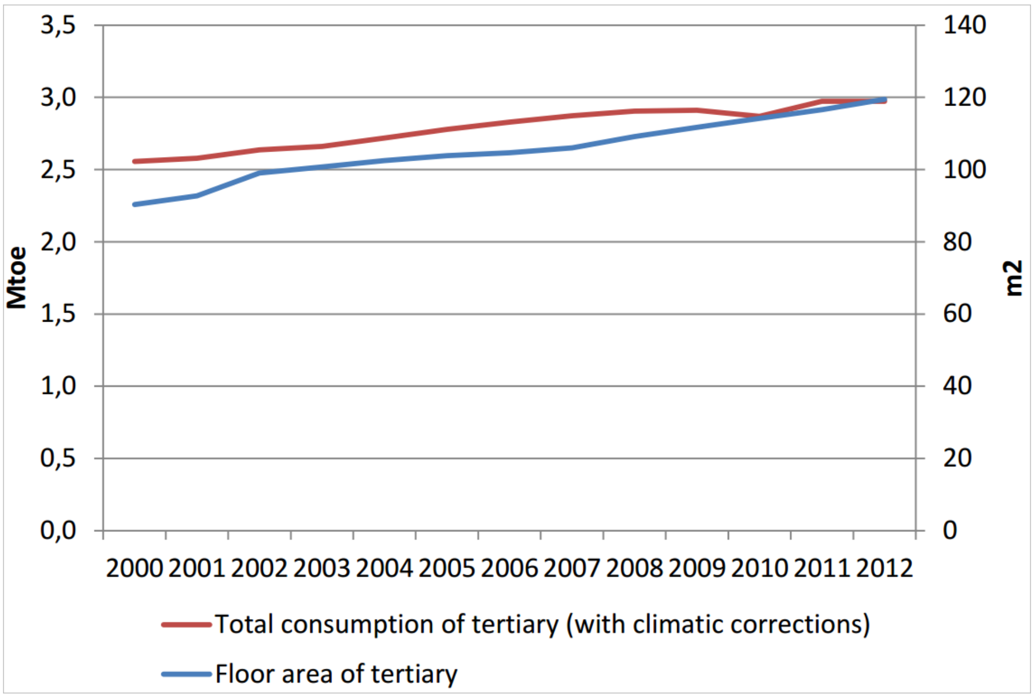

Figure 6. Total energy consumption and floor area of tertiary sector in Finland. [3.]

The total energy consumption in a tertiary sector, or service sector, has increased from the level of 2000, as has the floor area of the sector, which can be seen in figure 6 above. With the growth of the gross domestic product (GDP) of Finland, the construction of new buildings in the service sector such as shopping malls, commercial buildings, etc. has also increased which resulted in the increase of the floor area in the tertiary sector. The GDP of Finland increased by 22% from the level of 2000 to 2012 resulting in more new buildings. [9.] The renovation of old service sector buildings for proper utilisation of space has also added an additional floor area to the total tertiary sector area. The final energy consumption in the tertiary sector has increased by 16% from the level of 2000 to 2012. However, the floor area of the tertiary sector has increased almost the double i.e. 32% in the same period, which means that the specific energy consumption in the tertiary sector has decreased significantly from the year 2000 to 2012. [3.]

5.4 Energy Efficiency Policies

There are various strategies and programmes, both at the national level as well as sectoral level for energy efficiency improvement. Policies regarding energy efficiency are set in various government resolutions. The policies and regulations set in the European Union (EU) level have a major impact on government resolutions. In Finland, energy saving programmes were established in 1992 and 1995 and revised in 2000 and 2002. Since the year 2005, all the activities related to energy saving and energy efficiency have been incorporated into Finnish national climate and energy policy strategies. [3.]

The Energy and Climate Strategy of 2013 is the prevailing strategy or policy in Finland in energy saving and energy efficiency. It was updated by a ministerial working group appointed by the government of Prime Minister Katainen. The main objectives of the updated strategy were to ensure that the national targets for 2020 are achieved and to set a pathway for the long-term objectives set by the European Union on energy and climate. The updated strategy also includes reducing the dependence of oil in Finland. The strategies were approved by the Finnish government on 20 March 2013. [3.]

Various measures are adopted to save energy in the building sector. Among the measures adopted, the three main measures to have the largest savings by the year 2020 are the increase use of heat pumps, new building codes and the eco-design directive. An increase use of heat pumps in buildings can have a saving of 7.7 TWh/a by

2020. New building codes for new buildings can give an estimated saving of 7.1 TWh/a and an eco-design directive can give an estimated saving of 4.2 TWh/a by 2020. The use of heat pumps in buildings, both air and ground source, has grown rapidly. The number of air to air heat pumps installed by 2013 was 457,000 in a country with 1.56 million dwellings in single-family and terraced houses. In a new single family house, a ground source heat pump is the most commonly used heat pump type. The strict energy efficiency requirements and building code for new buildings have been strictly enforced over the past years, all new buildings need to comply with the requirements. Annual surveys in Finland show that people building their own houses aim at even better energy efficiency than required. The decline in energy consumption for lighting in the households sector that can be seen in the Finnish national energy statistics is mostly due to the eco-design directive. [3.]

In addition to the measures, implemented for quantified savings, other important measures have also been adopted in Finland although no estimation of the possible savings has been made. The use of smart metering for electricity is in growing use in Finland, one of the first countries to implement it. Over the past fifteen years, the government has issued several recommendations and resolutions, encouraging municipalities in energy efficiency. The Finnish government also established an advisory service for sustainable public procurement in Motiva Oy in 2009. National Energy Efficiency Action Plan (NEEAP), plan on descriptions of energy efficiency measures and energy savings were first submitted by Finland to the European Commission in 2007. In accordance to the Energy Services Directive (ESD) was called First National Energy Efficiency Action Plan pursuant to the ESD (NEEAP-1). ESD is based on end-use efficiency and energy services. Another NEEAP was also submitted by Finland to the European Commission in accordance to ESD in 2011, Second National Energy Efficiency Action Plan pursuant to the ESD (NEEAP-2). However, the third NEEAP submitted in 2014 was in accordance to the Energy Efficiency Directive (EED), called First National Energy Efficiency Action Plan pursuant to the EED (NEEAP-3). EED was established with a set of measures to help the EU meet the 20% energy efficiency target by 2020. Tables 2, 3, 4 and 5 show the savings reported in the building sector in Finland and the estimated savings in the future based on the NEEAP-3. [3.]

Table 2 presents the energy savings in 2010 and the estimated energy savings of 2016 and 2020 together with the different measures of the ESD. Also the savings arising from building regulations in various sectors are included. The estimated total at energy savings in 2020 is 21,009 GWh/a compared to 6,614 GWh/a in 2010. The largest estimated energy saving in 2020, which is 7,726 GWh/a, derives from the promotion of heat pumps in small buildings, whereas, the smallest saving is from window energy labelling, which is 93 GWh/a. [3.]

Table 2. Energy saving estimates in buildings in NEEAP-3 of Finland. [3.]

Energy saving measure	Energy Savings		
	2010 GWh/a	Estimate 2016 Gwh/a	Estimate 2020 GWh/a
Orders for energy efficiency in new buildings 2003, 2008, 2010 and 2012	1923	4925	7085
Decree on improving the energy performance of buildings undergoing renovation or alteration	0	750	1750
Subsidies for energy efficiency improvements	282	1323	1321
Promotion of heat pumps in small buildings	2326	5347	7726
Mandatory water metering	0	74	128
Window energy labelling	52	66	93
Programme for energy conservation in oil-heated buildings, the “Höylä III” programme	1988	2297	2476
Energy Efficiency Agreement of the Property and Building Sector - Rental Properties	44	299	430
Total energy savings (ESD Savings)	6614	15081	21009

Table 3 shows the energy savings in the public sector in 2010 and the energy saving estimates in the years 2016 and 2020 that are based on NEEAP-3. The public sector saved 393 GWh/a of energy in 2010. The estimated energy saving in 2016 is 674 GWh/a and in 2020, it is 842 GWh/a. Two of the largest estimated energy savings in 2020 are in municipalities and central government, 440 GWh/a and 402 GWh/a, respectively. On the other hand, the smallest estimated energy saving in public sector in 2020 is 21 GWh/a, gained by improving energy efficiency in new construction for the state. In 2010, only 1 GWh/a was saved in that way. [3.]

Table 3. Energy saving estimates in the public sector in NEEAP-3 of Finland. [3.]

Energy saving measure	Energy Savings		
	2010 GWh/a	Estimate 2016 Gwh/a	Estimate 2020 GWh/a
Energy Efficiency Agreement and Programme of the Municipalities	178	266	328
Energy audits – municipalities	97	125	112
Making the use of space more effective in central government	7	70	126
Renovation of state property stock	3	32	61
Improving energy efficiency in new construction for the state	1	10	21
Maintenance activity and user information for state property stock	107	171	194
Total energy savings in municipalities (ESD Savings)	275	391	440
Total energy savings in central government (ESD savings)	118	283	402
Total energy savings (ESD Savings)	393	674	842

Table 4 introduces the total energy saved in 2010 and total estimated energy savings in 2016 and 2020 in private sector. The measures for energy saving in the private services sector are mainly gained through Energy Efficiency Agreement (EEA) -services, EEA of the property and building sector and energy audits. The biggest estimated energy saving in 2020, 200 GWh/a, is gained with the EEA, an increase from 33GWh/a in 2010. The estimated energy saving due to energy audits in 2020 is 108 GWh/a a decrease from 141 GWh/a in 2010. This is due to the strict building codes and regulations; it is no longer possible to gain further savings through energy auditing. [3.]

Table 4. Energy saving estimates in the private services sector in NEEAP-3 of Finland. [3.]

Energy saving measure	Energy Savings		
	2010 GWh/a	Estimate 2016 Gwh/a	Estimate 2020 GWh/a
Energy audits – private services	141	118	108
Energy efficiency agreement − services	33	162	200
Energy Efficiency Agreement of the Property and Building Sector – Commercial Properties	15	153	198
Total energy savings (ESD Savings)	189	433	506

Below, table 5 shows the total energy savings in 2010 and the estimated total energy savings in the years 2016 and 2020, gained through the Eco-design directive. No significant savings due to the Eco-design directive could be seen until the year 2010, but by the year 2016, Eco-design directive shows an estimated energy saving of 1278 GWh/a followed by 4259 GWh/a in 2020. [3.]

Table 5. Energy saving estimates of the Eco-design Directive in NEEAP-3 of Finland. [3.]

Energy saving measure	Energy Savings		
	2010 GWh/a	Estimate 2016 Gwh/a	Estimate 2020 GWh/a
Eco-design directive	0	1278	4259
Total energy savings (ESD Savings)	0	1278	4259

The Eco-design directive saves energy from the use electronic appliances. The energy saved by the Eco-design directive in a building is not included in the total energy savings made in different sectors as mentioned in tables 2, 3 and 4 above.

6 Different Market Players

In a conventional way of designing and constructing a building, the main players involved are the building owner, architecture, engineering and construction (AEC) firms, commissioning team, contractors and sub-contractors. The design documents for the buildings are reviewed to ensure they fulfill the requirements of the building code. Authorities with proper jurisdiction authorise the building permits. The building code reviewers and related authorities can also be categorised as a secondary group among the market players. Finally, the last group among the players are the attorneys of the firm. The attorneys of the firm handle the firm's lawsuits and also familiarise the basics architectural, engineering and construction practices to the firm managers and employees. [10.]

Generally, in a typical design and construction process, the needs and expectations of the owner are primarily communicated to the architect of the building. Depending on the size and type of the building, preliminary design of the building is drawn by the architect. According to the need and use of the building, a group of engineers such as civil and structural engineers, HVAC consultants, plumbing engineers and fire engineers are employed to design the building engineering. For the delivery of a successful product, close communication among all the players is essential. [10.]

No one party is solely responsible for the energy efficiency of a property. For example architectural firms, construction companies, investors, energy consultants and HVAC consultants are responsible for the construction and design of the property and also responsible for the energy consumption and energy efficiency of it. Building Information Modelling (BIM) is a tool for architects, engineers and HVAC consultants to share the knowledge digitally. BIM has improved the communication in designing among the expertise. [10.]

The energy efficiency of a building is determined in its design and construction phases and can be maintained during its whole life cycle. Parties such as HVAC and construction companies are responsible for the energy efficiency during the design and construction phase. However, the property manager is responsible for keeping the energy consumption of the property as efficient as designed during the life-cycle. The market players with a major role in energy efficiency are discussed in this chapter.

6.1 HVAC consultant

The HVAC systems are needed for example to improve the indoor air quality in a building through the provision of fresh air, or to improve the thermal comfort in a building. A HVAC system should be flexible depending on its use in different categories of buildings as, the requirements of HVAC vary according to the category as discussed in chapter 3.1. The HVAC system should remove smells, moisture and pollutants originating from the residents, equipment and machines. A HVAC system is also needed to remove excess heat generated by the people and machines as well as to heat the property evenly. [11.]

Supplying clean air to and extracting contaminants from the indoor air as efficiently as possible is the primary task of a HVAC system. The flow rate of supply air to a building can depend on the category of the building. The parameters for controlling the HVAC system to supply the airflow, heating, cooling and fresh air are specified according to the categorised buildings and building codes. The function of HVAC system is not always based on the level of CO_2, but on how fresh the indoor environment is and the satisfaction of the people living there. [11.]

HVAC technology in a building can have an impact on the value of a building. In achieving sustainability in a building, the HVAC system has an important role, since it uses a lot of energy. One-third of the greenhouse gases emitted in Europe come from the building sector. The energy use of a building can emit up to 50-80% of the life-time emissions of a building. Good communication between the owners and HVAC engineers can help in improving the way in which a HVAC system is used during the lifetime of the building. [17.]

A HVAC consultant for a building identifies the most efficient way to use the HVAC system. The excessive use of energy by the HVAC system is identified by a HVAC consultant. A HVAC consultant also issues recommendations on lowering the energy consumption and reducing the carbon footprint. The demand of heating, cooling and air-conditioning is identified for a building by a HVAC consultant and analyzed to reduce the energy load. [17.]

6.2 Construction company

The design process in a consulting engineering firm or construction company starts with the reception of preliminary plans and guidelines from the architect. The orientation and function of the building, the sizes of each space in the building and other small details are addressed in the preliminary plans according to the wishes of a building owner. [10.] The client’s requirements of energy efficiency in the plan should be met.

The importance of cost savings that can be achieved by energy efficient construction needs to be understood by all responsible parties. The importance of a balance between the initial costs in the construction phase and the long-term savings needs to be all parties in the construction industry. [18.]

One of the main challenges in energy efficient construction can be to keep the project costs down. Better co-operation between the architects, engineers and builder can help in achieving energy efficiency within the budget. The budget should be presented to the client clearly to keep the energy efficiency plan as budget often go higher while constructing a energy efficient. [19.]

Energy efficient building construction takes on even greater importance as corporations and businesses understand the value of building new facilities or upgrading existing facilities based on a model of environmentally responsible and energy efficient design. From the first blueprint to the last inspection, each step in the process should not only include the latest trends but also be built to last well into the future. Key factors affecting in energy efficient building construction process are notable reduction in waste and pollution, increase use of natural, bio-degradable and energy efficient building materials. More efficient use of natural resources and energy sources such as water and electricity can also help in achieving energy efficient construction. [19.]

Besides of the market players already mentioned, there are also various other players with an important role in making a building energy efficient. A real estate agent or broker can greatly influence a buyer's investment in a property.

7 ICT in the energy efficiency of buildings

The effect of Information and Communication Technology (ICT) on the life cycle of a building can be enormous. Also the Internet of Things (IoT) has the potential to affect the way people consume energy. Energy saving potential through ICT or IoT can be considered alongside the life-cycle of a building. [12.]

Energy companies advice their customers about the energy efficiency and energy use through different media, for example at events, via email, on websites and in magazines delivered to all customers. These advicing programmes are highly recommended by the Energy Efficiency Agreement (EEA). [8.]

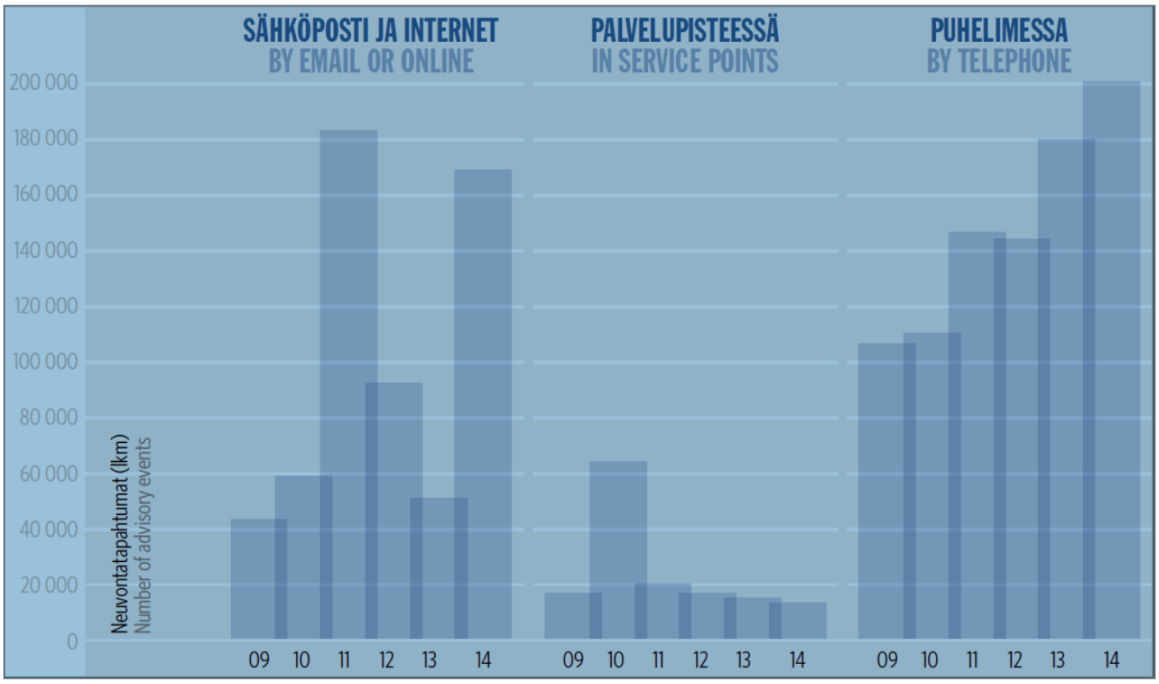

Figure 7. Number of advisory events for energy efficiency to final customers in the year 2009 till 2014. [8.]

Figure 7 shows a clear picture of advisory events through different channels from the year 2009 till 2014. Advice through telephone about energy efficiency to the final customers is in large number compared to other channels. Email or online channels used for the energy efficiency advisory program can be seen having a big variation in different years, and advisory events through a service point have been used the least and are in decreasing order. [9.]

8 Case Study: SATO

SATO housing company, a provider of energy efficient housing in Finland, is taken as a case study. To date over 220,000 homes have been built by SATO in Finland till now. SATO joined an agreement of VAETS (Vuokra-asuntoyhteisöjen toimenpideohjelma/ Rental apartment operational program) in Finland in 2009, with an objective to reduce the energy consumption by 7% from the level of 2009 by 2016. [13.]

SATO's objective is to decrease the consumption of heat and water by 23% from the level of 2009 by the year 2020, by proper maintenance of its properties and by investments in energy saving methods. SATO has by now invested over 3 million euros in repairs and renovations to make its building more energy efficient. The investments have included energy efficiency auditing in buildings and building systems, as well as a decrease in the consumption of water in the buildings. As a result, SATO succeeded in saving 22.2 GWh of its total energy consumption, including heating and electricity by 2016, compared to the level of 2014. [13.]

Figure 8 illustrates how the heating consumption in SATO's buildings is decreasing. The standardised heating consumption of SATO's buildings in the year 2004 was above 50 kWh/m^2. The target is to reduce it to be below 40 kWh/m^2 by the year 2020. [14.] From the level of 2009, SATO aims to reduce its specific heat consumption up to 23% by the year 2020. [13.]

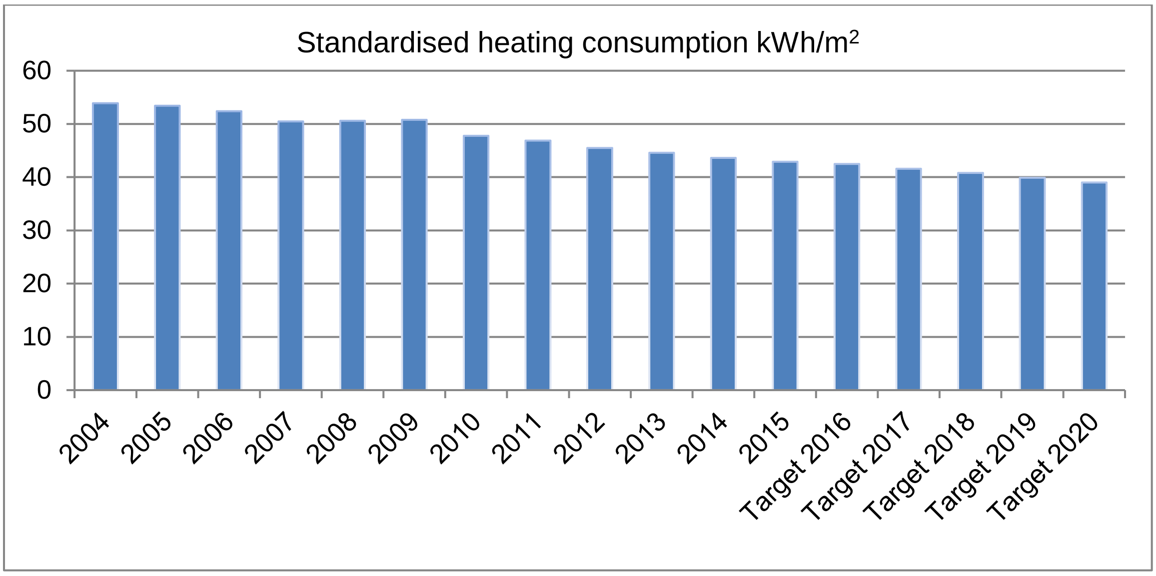

Figure 8. Standardised heating consumption of SATO's buildings. [14.]

Figure 9 shows the specific consumption of water in SATO's housing property. The decreasing trend in the water consumption can be clearly seen. However, a slight rise in the consumption of water can be seen in the years 2014 and 2015. SATO aims at reducing the specific water consumption in its buildings to 343 l/m^2 by the year 2020, which means a reduction of 20% from the consumption of 2009. [13.] [14.]

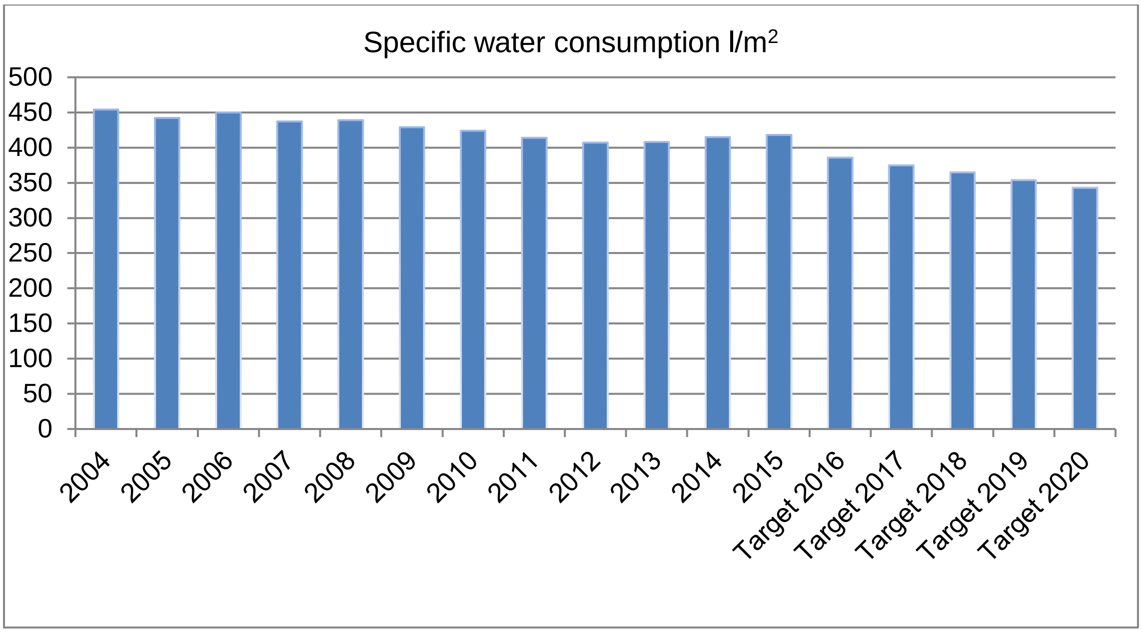

Figure 9. Specific water consumption in SATO's buildings. [14.]

The reductions in the standardised heat and specific water consumption of SATO were the result of an investment in energy efficiency method. In terms of costs, SATO's target of reducing the heat consumption to 42.5 kWh/m^2 by 2016 means annual savings of €2.5 million from 2009. Similarly, in case of water consumption, SATO can save about €1.4 million annually by achieving its 2016 target of 386 l/m^2 compared to the water consumption level of 415 l/m^2 in 2014. To reduce the consumption of water in SATO's properties, different water saving methods are applied, such as the installation of water saving fixtures at home, a decrease in the water pressure in the buildings to reduce the flow of water through showers and taps, as well as fixing the leakages in the buildings. [13.] [14.]

In order to save energy, it is also very important that the residents are engaged. So, a water saving competition was organised by SATO for its residents in Lahti, Finland. The residents of Asunto Oy Lahden Nuolikatu 9, owned by SATO, participated in a water saving competition and within three months, the residents reduced approximately 20% of their water consumption without compromising their living comfort. [13.]

9 Energy efficient buildings in the future

Designing a building is always a complex task and requires close co-operation among different firms such as architects, construction companies, HVAC consultants and engineers. A few decades ago, the main requirement to build a building was to make it look beautiful, comfortable for the people living there, and cost effective. But with the rising price of energy and adverse effect on the environment from buildings, people are more concerned about the energy consumption of a building, as well as building's impact to the environment. This has resulted in stricter laws and regulations, as well improved building codes. New buildings are now built to use less energy, and some buildings are even designed to produce energy. [10.]

With the increasing awareness of the impact of buildings on the environment, different organisations are also classifying or certifying buildings according to the consumption of energy and the carbon footprint. Leadership in Energy and Environmental Design (LEED) from the USA and Building Research Establishment Environmental Assessment Method (BREEAM) from the UK are the most popular building certifying organisations in the world. The certification system of building has added the tasks of an architect, HVAC consultant or an energy consultant, since improving the energy efficiency of a building can be very challenging. [10.]

10 Interview and survey

For this thesis experts of different fields were interviewed. The interviews were conducted either personally or through an online survey form. The focus was on housing companies and the main aim was to find out why energy efficiency measures are not being adopted widely in Finland even though the technology is available. The interview and survey also covered the attitudes of the experts towards energy efficient buildings, and their view of what can be done to make buildings more energy efficient. Altogether, nine experts from seven housing, construction and consultant companies were interviewed. The interviewees included were for example a Real Estate Director, a Director of Energy Management, a Maintenance and Purchasing manager, a Building Systems Manager, a Project Development Engineer, a Building Engineer and a Project Manager. The information collected from the interviewees is summarized in an anonymous manner in this thesis. The time of the interviews was 40 minutes on average. The questionnaire for the interviews and the survey can be find as appendix 1 in this report.

The interviews revealed that the price of energy is a major concern in all housing companies and all the building projects in Finland. Companies are looking for various possibilities to decrease the consumption of energy in the buildings as huge part of their rental income goes to the energy cost. As the price of energy is going up, minimising the energy consumption has been a major aim to the housing companies. The use of new technologies to save energy in buildings is also seen as a challenge. According to the interviewees, manufacturers claim to have the best product, but in the reality the products do not work always as claimed. New technologies in the energy efficiency of buildings are launched, but the interviews showed that the housing companies have limited knowledge on their life cycle impact on the buildings. The energy saving potential of the newly launched technologies is also not well known to the housing companies, which has made it difficult for the housing companies to adapt the technologies.

The interviews revealed the status of housing buildings in Finland. A lot of housing buildings in Finland were built decades ago and the HVAC systems installed in them are old and consume a lot of energy. The renewal of the systems is very important to decrease the consumption of energy, but renewing a whole system can be very costly and it is difficult to keep the budget during a renovation. An older HVAC system is kept in the building as long as it functions because a new system is expensive. The interviewees assured that replacing an older HVAC system is seen as a very important part in making a building more energy efficient, but many companies fail to do so in order to keep the renovation project within budget. This has resulted in a higher consumption of energy and, hence, decreases the energy efficiency of a building. The interviewees also claimed that the energy efficiency is considered as the least priority in a renovation project.

The interviews showed that the energy auditing of properties was very important to all housing companies, as well as to the construction and energy consulting companies. However, not all properties were energy audited. Energy auditing of a property depend on the scale of a company. Companies operating in various locations with a high number of buildings and properties were more likely to energy audit their property whereas companies operating on a local level were less likely to energy audit their property. Bigger companies tend to have their own internal energy auditor. The interviewees assured that energy auditing is more important to bigger companies as it can save a significant amount of energy in bigger properties. The interviews also revealed that bigger companies tend to have their own internal auditor within the company. Monthly or annual consumption of energy is also reported by an internal energy auditor. However, companies operating in a smaller scale were unlikely to have an internal energy auditor, and unlikely to do the energy auditing. The cost of having an energy auditing department or internal energy auditor can be high for companies performing on a smaller scale. A lack of an internal auditor meant less auditing of the property, and fewer measures for energy efficiency were implemented in the properties run by smaller companies.

The interviewees insisted that the Internet of Things (IoT) is seen as a very important platform to reach people or to encourage people to save energy. The potential of IoT in saving energy in buildings is understood very well by all housing companies as well as by different market players in the field of real estate. The use of a digital meter or online tools that show one's own energy consumption is already reality in many new apartment buildings, as well as in buildings for commercial purposes. Digital meters are installed in the apartment or in a rented property so that the energy consumption can be seen by the tenant and the housing company. However, the interviewees suspected that the use of a digital meter has not succeeded as planned despite its potential. Companies believe that when people can observe their own energy consumption, it can help them to change their behaviour in using energy. However, people do not seem to be interested in observing their energy consumption. In addition, the interviewees claimed that some tenants seem to dislike the idea of their energy consumption being seen by someone else from the housing company.

Figure 10 shows an analytical bar chart of the information collected from the interviews and surveys. The blue part of the bar shows that the interviewee supports a measure at least to some degree. The red part shows that the interviewee does not support a measure. The first bar shows the concerns of the companies on energy in their properties. Energy here includes electricity, space and water heating, as well as, all other energy use in a building. Almost 85% of the companies interviewed were concerned about the price of energy in their properties. However, some smaller housing companies where the energy is handle by a third party or a broker were less concerned about the price of energy in their business plan. Only 15% of the companies interviewed were not concerned over the price of energy.

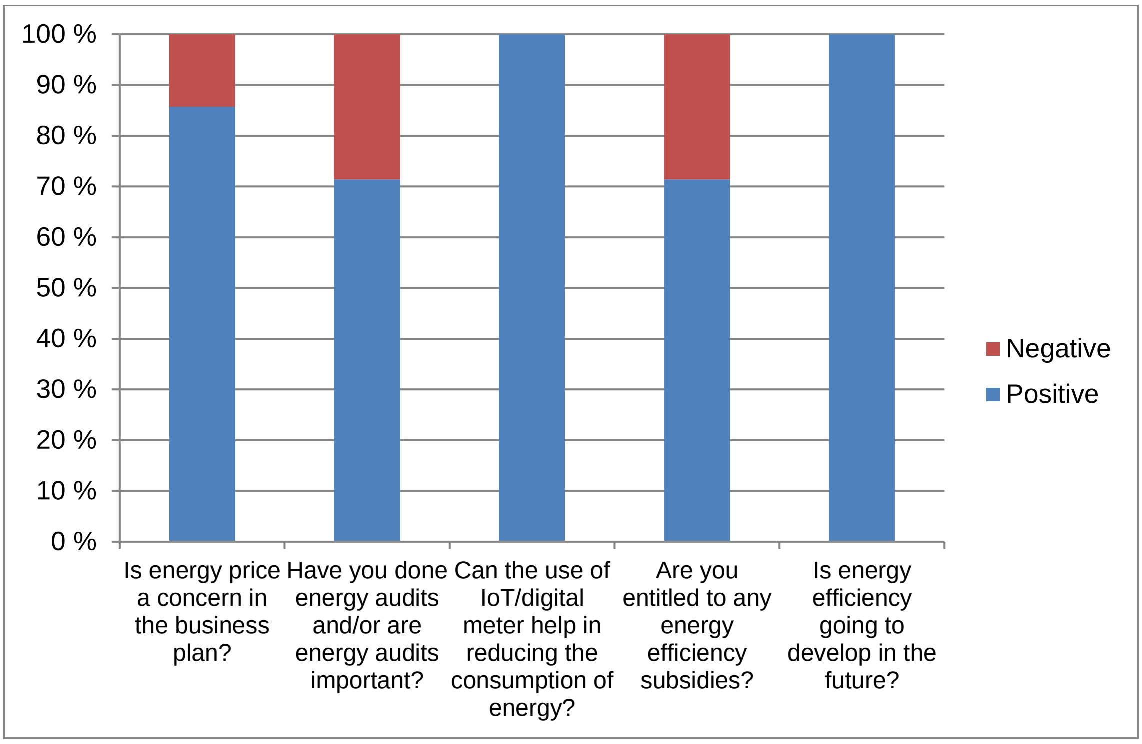

Figure 10. Analytical bar chart of the interviews and surveys.

The second bar in figure 10 shows the energy auditing in the properties or the importance of energy auditing by the housing companies. Most of the companies operating in bigger scale were more likely to do energy auditing as it can help to save significant amounts of energy. Around 70% of the interviewees have done some energy auditing in their property, and perform annual energy audit reporting. Around 30% of the companies had not done any energy auditing of their property.

The third bar in figure 10 represents the use of IoT, a digital meter or online tools to help reducing the consumption of energy. All interviewees agreed that the energy consumption can be reduced by the use of IoT or digital. Tenants or the people using the building not being interested in using the digital meter has been the biggest challenge to the companies. Housing companies also try to find different ways of making the digital meter more user friendly to the tenants, as the outcome data from the digital meter or online tools may not be understood by all the tenants. The digital meter or online energy tool has also been seen as security risk by the tenants as well as by the companies.

As shown in the fourth bar in figure 10, over 70% of the companies have received some sort of subsidies from the government for energy efficiency. The subsidies were provided for example for reducing the consumption of energy by making the building more energy efficient, or for retrofitting with new technology. The amount of subsidies depends on the type of a project and the measures for energy efficiency. Subsidies were granted once an energy audit report was. The subsidies were part of a government plan to encourage companies to help in meeting Finland's goal to increase energy efficiency by 20% by 2020. However, such subsidies have been stopped with the improvement of the Finnish building code and stricter regulations in energy efficiency. [8.]

As shown in the last bar of figure 10, all interviewees were very positive or agreed on the development of energy efficiency in the future. Better co-operation and smooth communication is needed between all parties during construction to build an energy efficient building. Changes in the rules and regulations in the field of energy efficiency, and even stricter building codes are needed to reach the Finland's energy efficiency goal of Finland.

11 Results and analysis

Earlier, energy efficient buildings were seen as an expensive way to build a house, but with the change of regulations, the view towards energy efficient buildings has also changed. Now the focus in construction is not only on making the building look beautiful and the occupants of the building comfortable, but also on reducing the consumption of energy in the building and making it as environmentally friendly as possible. Although the architects and HVAC designers who have recently joined the work force have a lot of knowledge, the necessity of designing energy efficient and sustainable buildings has not changed to the entire group of professionals. Also, at the same time the new building codes and standards are implemented and the professionals do not have the adequate knowledge to implement them. [10.]

The tables in section 4.4 above demonstrate the energy efficiency policies in Finland. The Finnish energy efficiency targets for 2020 seem achievable as compared to the energy consumption level of 2010. The policies and regulations on energy efficiency set at the EU level also impact the Finnish policies and targets. The EU 2020 climate change goal of reducing the emissions of greenhouse gases by 20%, achieving 20% of energy from renewable sources and increasing the energy efficiency by 20% has been taken in a very positive manner. [16.] The energy savings target to meet EU 2020 goal has been pursued aggressively in Finland although not all companies are yet ready to comply with the goal. Some constructions in Finland to be completed after the year 2020 are not prepared or ready for the 2020 goal as revealed by the interviews.

Chapter 10 demonstrated the outcome of the interviews and surveys conducted for the analysis of the report. For many of the participants, the consumption of energy was a real issue, and reducing the consumption of energy was a real challenge. A change in the consumption of energy can also make a change in the lifestyle of the tenants on the way they use energy. The first priority of the housing companies was the wellbeing of the tenants. Some changes such as reducing the water pressure for the shower resulted in dissatisfaction of the tenants. Also, controlling the temperature of the property resulted in dissatisfaction. Changes made in an occupied building were more likely to receive negative feedback as it may require changes in the tenant’s behaviour. Complaints were more likely when the tenants could compare their earlier behaviour in the same location. However, it was less likely to receive complaints about changes in the energy when a new tenant moved into the building. Complaints regarding the energy uses were also less likely from tenants in a new building.

The use of renewable energy such as solar power did not seem to be profitable for all the companies as the perfomance of the products was overrated by the manufacturers. Understanding the real life cycle impact of retrofitting a building with new technology was very crucial. However, all the interviewees expected the price of solar panels and renewable energy to decrease in the future with the development in technologies.

All interviewees and survey participants agreed that the first thing the tenants are interested in is location, followed by the price of the property or rent. Involving the tenants in saving energy in the property has been very important to the housing companies. Energy efficiency of the property was the least priority for the tenants. All interviewees assured that the digitalization or IoT can help in reducing the consumption of energy and also involve tenants in saving energy. As the tenants do not understand the consumption of energy in the standard units of energy, a clear idea to the tenants on the consumption of energy through IoT was necessary. The digital meters which are already installed are not used by the tenants, partly because the user interface of the digital meter is not easy and clear for the tenants to use. In addition, the security risk of the digital meter has also prevented its wider use.

12 Conclusion

As the real estate sector is a growing business, sustainable and energy efficient buildings are already a big business in the sector. Energy efficient buildings are already seen as a key to long term profitability. As the real estate sector represents a very large part of the national wealth and the development of the country, sustainability in the sector is very important. Energy efficient buildings can be seen as a sign of sustainable development.

Proper utilization of IoT in buildings can be very beneficial for all parties by keeping the consumption of energy and cost down. New innovations in the field are necessary to make the tenants use the technology and follow their consumption of energy. Clear and proper understanding of energy efficiency and payback time is necessary to the tenants and should be provided in the simplest way possible. User friendliness of the digital meter or online tool is seen as the most important feature to make the tenants use it.

The EU2020 goal has been a very challenging target for the companies to achieve. The construction projects that are to be completed after the year 2020 are not planned to fulfil the EU2020 goal. The government regulations and policies can be a key driving force to do more. Even though sustainability is not a highly profitable business today, it ensures a sustainable environment and successful business in the long run.

The experts interviewed for this study were chosen on the basis of their experience and familiarity in the field of building sector. This study gave a general idea of the attitudes of the tenants as the experts in real estate sector see it. More interviews of the experts from the field is necessary to have the better understanding. The opinions of the tenants or the building users were not studied in this research, but their views towards energy efficiency would be valuable because tenants are the end users of the building.

To conclude, sustainability cannot be achieved without including buildings. Sustainable development can only be achieved by the collective responsibilities of all parties including the government, businesses and individuals. Energy efficiency in buildings should not highly increase the price of the property as the people or tenants look for properties with a lower price and this can lead to a decrease in the demand for the energy efficient buildings.

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Interview and Survey Questionnaires

Hi,

I am a final year student of Sustainable Building Engineering in Metropolia UAS, Helsinki and I am conducting a research about housing companies in Finland. For this research for my bachelor's thesis, I am interviewing experts related to real estate's such as HVAC consultants, building engineers and housing companies. My thesis is on "Attitude towards energy efficient buildings of different market players". The main aim of this project is to find out why energy efficiency measures are not being adopted widely in Finland even though the technology is available.

Players can be for instance:
- Real estate owners
- HVAC-planning agencies
- Housing companies
- Contractor and so on

The data will be reported only in aggregate not individually. Your information will be completely anonymous and all information will only be used in the thesis. I appreciate every given information and will be thankful for the time you use for filling this survey. For more information, feel free to contact me.

Best Regards,
Suresh Gurung
suresh.gurung@metropolia.fi
Sustainable Building Engineering
Metropolia University of Applied Sciences

Interviewee details
Name:
Company:
Position/Background:

Questionnaires:

1. Is the energy price (including electricity, heating and so on) concerned in your business plan?
2. What do you think about energy auditing in your built property?
3. Companies or individuals adopt energy efficiency measures for different reasons. If you adopt energy efficiency measures, why would that be?
4. Are the energy efficiency measures expensive to implement?
5. Online tools for energy use or digital meter are being installed in different properties nowadays. Do you think it will help in using less energy?
6. What are the main obstacles for not doing even more for energy efficiency?
7. What are the predictions of the future in energy efficiency field in real estates?
8. If you have implemented any of the energy efficiency measures in your property, what kind of feedback have you received from the tenants or occupants?
9. Have you entitled to any government subsidy on energy auditing or on adopting energy efficiency measures?
10. Any comments you would like to add.