Tampere University of Applied Sciences

Assessment of Resident Perspective in Replacing Oil Heating in Detached Houses

Elisa Pekkola

BACHELOR'S THESIS
October 2019

Energy and Environmental Engineering

ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Energy and Environmental Engineering

ELISA PEKKOLA:
Assessment of resident perspective in replacing oil heating in detached houses

Bachelor's thesis 75 pages, appendices 3 pages
October 2019

Climate change and increased carbon dioxide emissions have recently been significant driving forces for various organisations to improve and develop new more sustainable practices. In addition, urbanisation will increasingly create opportunities, but also pressure, for major cities such as Tampere to grow sustainably. As an act to respond to these challenges and to mitigate climate change, the City of Tampere has set an objective in its current strategy to reach carbon neutrality by 2030. One of the steps in achieving this goal is to replace all individual oil heating systems in residential buildings with alternative heating methods.

This thesis was commissioned by EcoFellows Ltd. which is a subsidiary of the City of Tampere. The aim was to conduct an overview on the opinions of the residents of oil heated detached houses and examine the challenges they are facing in the process of replacing an oil heating system. Another aim was to provide suggestions for the City of Tampere to assist in planning services that would ease the house owners' process towards oil-free heating.

The data was collected from two recent surveys that examined heating habits in detached houses in the Capital Region and in the City of Hyvinkää. The surveys also examined the residents' inclination towards deploying alternative heating methods and, in particular, renewable energy heating systems. In addition, a survey was conducted in the City of Tampere to achieve a more extensive overview.

The findings indicate that the most pressing issues that hinder the willingness of detached house residents to change their main heating system is the investment costs and annual heating costs of alternative heating systems. The results also suggest that more unbiased information is needed regarding heating system alternatives. Based on the results, the most preferred ways to receive information is online advice and more personal forms of advice such as face-to-face, via e-mail or over the phone. To conclude, it is suggested for the City of Tampere to offer the residents information on the investment and annual costs of different heating systems and on alternative heating methods in the form of online advice or in a more personalized form.

The results of this study offer an estimation of the residents' opinions, however particurlaly due to the small sample size in the survey conducted in Tampere, more research is needed to form a more accurate overview.

Key words: detached house, oil heating system, carbon dioxide emissions

ABSTRAKTI

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Energy and Environmental Engineering

ELISA PEKKOLA:
Selvitys asukasnäkökulmasta pientalojen öljylämmityksestä luopumiseen

Opinnäytetyö 75 sivua, joista liitteitä 3 sivua
Lokakuu 2019

Ilmastonmuutos ja kasvaneet hiilidioksidipäästöt ovat viime aikoina olleet keskeisiä tekijöitä organisaatioiden kestävän kehityksen vauhdittajina. Lisäksi, kaupungistuminen luo mahdollisuuksia mutta asettaa myös paineita suurten, Tampereen kaltaisten kaupunkien kestävälle kasvulle. Vastatakseen näihin haasteisiin ja hillitäkseen ilmastonmuutosta, Tampereen kaupunki on asettanut tavoitteekseen saavuttaa hiilineutraalius vuoteen 2030 mennessä. Yksi tärkeimpiä askelia tämän tavoitteen saavuttamiseksi on öljylämmityksestä luopuminen asuinrakennusten erillislämmityksessä.

Tämä opinnäytetyö tehtiin Tampereen kaupungin tytäryhtiön Ekokumppanit Oy:n toimeksiannosta. Työn tavoite oli muodostaa yleiskatsaus öljylämmitteisten pientalojen omistajien ajatuksista ja tutkia heidän kohtaamiaan haasteita öljylämmityksestä luovuttaessa. Työn toinen tavoite oli tarjota Tampereen kaupungille suosituksia, joita voitaisiin hyödyntää suunniteltaessa vaikuttavia palveluita, jotka auttaisivat pientalojen omistajia öljylämmityksestä luopumisessa.

Tietoa kerättiin kahdesta tuoreesta kyselytutkimuksesta, jotka tutkivat pientalojen lämmitystapoja pääkaupunkiseudulla ja Hyvinkäällä. Kyselytutkimuksiin vastanneilta kysyttiin myös halukkuutta päälämmitysjärjestelmän vaihtoon. Näiden lisäksi tietoa kerättiin tässä työssä toteutetulla kyselytutkimuksella, johon vastasi Tamperelaisia pientalo-omistajia.

Tulokset osoittivat, että tärkeimpiä lämmitysjärjestelmän vaihtoa hidastavia syitä ovat investointikustannukset ja lämmitysjärjestelmien vuotuiset kustannukset. Tulokset osoittivat myös että vastaajat tarvitsevat lisää tai luotettavampaa tietoa lämmitysjärjestelmävaihtoehdoista. Kyselyyn vastanneista suurin osa haluaisi saada tietoa verkkosivuilta tai henkilökohtaisessa muodossa kasvotusten tai sähköpostin tai puhelimen välityksellä. Näin ollen, suositus Tampereen kaupungille on tarjota tietoa vaihtoehtoisista lämmitysjärjestelmistä ja niiden kustannuksista ja käyttää tiedonvälitykseen verkkosivuja tai henkilökohtaista neuvontaa.

Tämän työn löydökset antavat arvion pientalojen omistajien mielipiteistä. Erityisesti Tampereen kyselytutkimuksen pienen otannan vuoksi laajempaa tutkimusta tarvitaan tarkempien tulosten saavuttamiseksi.

Asiasanat: pientalo, öljylämmitysjärjestelmä, hiilidioksidipäästöt

CONTENTS

ABBREVIATIONS AND TERMS

CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
GHG	greenhouse gas, a naturally occurring gas that absorbs and re-emits solar radiation
CHP	combined heat and power plant
COP	Coefficient of Performance, a term to describe efficiency of a heat pump
SCOP	Seasonal Coefficient of Performance, a term to describe efficiency of a heat pump
SPF	Seasonal Performance Factor, a term to describe efficiency of a heat pump

1 INTRODUCTION

Sustainable Tampere 2030 -programme was established in 2018 to promote the strategic goals of the City of Tampere to grow in a sustainable manner and to become carbon neutral (Kaupunginhallitus 2018, 3). In the path towards carbon neutrality, the programme determines that oil heating in residential buildings and in particular, detached houses ought to be replaced by alternative heating methods (Kaupunginhallitus 2018, 7). Therefore, the aim of this thesis is to conduct an overview on the opinions and concerns of detached house residents when they are planning to change their main heating system. The purpose is to find relevant information for the City of Tampere to assist in planning services that would ease the property owners' process towards oil-free heating.

The overview is done based on three surveys that focused on heating methods in detached houses and inclination towards deployment of alternative heating methods. As a part of this thesis, a survey questionnaire was conducted in Tampere and the target group was residents of oil heated detached houses. The two other surveys utilized in this study were conducted in 2018 by Helsinki Region Environmental Services Authority (HSY) and by City of Hyvinkää in collaboration with Motiva Ltd (Öljylämmittäjät pohtivat muutoksia… 2018). Based on these surveys, this thesis will also provide with suggestions for the City of Tampere to assist with planning effective services targeted for residents who are planning to replace oil heating with an alternative heating method.

As a part of the theoretical foundation, this thesis will introduce technical alternatives for oil heating systems. In addition, the potential carbon dioxide (CO_2) emission reductions are presented by calculations in chapter 4.6 to show the effect of replacing oil heating to the CO_2 emissions.

Some of the suggestions created for the City of Tampere were implemented during the writing process. Therefore, chapter 9 will evaluate the effectiveness and feasibility of the suggestions that were conducted.

2 CLIMATE WORK IN TAMPERE

2.1 Sustainable Tampere 2030 -Programme

City of Tampere has set an objective in its current strategy to reach carbon neutrality by 2030. In practice, this means that the CO_2 emissions in Tampere region need to be reduced by 80 % compared with 1990 levels and the remaining 20 % must be compensated in other ways. To achieve this goal and to grow sustainably, City of Tampere established the Sustainable Tampere 2030 -programme. Sustainable Tampere 2030 is a part of an extensive development programme Smart Tampere, and it was agreed on and put into action on June 18, 2018, by the Tampere City Council. The main aim of the programme is to plan actions and initiate projects to reach the goals stated in the new City Strategy from March 2018. (Kaupunginhallitus 2018, 3−4, 6.)

The programme comply with international sustainable development targets and climate change agreements: Paris Agreement; 2016 New Urban Agenda for the UN; 2015 Sustainable Development Goals and Agenda 2030 for the UN and Urban Agenda for the EU. The programme also complies with and implements the national sustainable development targets as well as Finland’s climate targets. The programme defines the actions that are needed to reach the goal of carbon neutrality and these actions are implemented in collaboration with multiple partners within and outside the city organization. (Kaupunginhallitus 2018, 3−4.)

A national publication organization CO2-raportti offers emission calculation services for municipalities and it published a preliminary report on Tampere’s CO_2 emissions from 2018 (CO2-raportti & Benviroc Ltd. 2019). The report highlights that municipalities and cities play an important role in promoting sustainable development and climate work locally in Finland (CO2-raportti & Benviroc Ltd. 2019, 7).

2.2 Company Introduction

EcoFellows Ltd. (later EcoFellows) was established on 2003 by Tampere Regional Solid Waste Management Ltd. and the City of Tampere together with its public utilities Tampere Regional Transport, Tampere Water and Tampere Infra. Then, on 2009, a part of the ownership was assigned to Tampereen Sähkölaitos Ltd. Among these three owners, City of Tampere has the largest share of ownership. In addition to its owner organizations, EcoFellows' extensive network includes European partner cities, educational institutes and universities, businesses, unions, housing companies and associations. (Ekokumppanit 2019.)

The company is also a part of a European energy agency network ManagEnergy, a European Commission initiative with an aim to assist the partner agencies towards gaining a leading role in energy transition and to increase the deployment of sustainable energy solutions. The Horizon 2020 Framework Programme of the European Union funds the initiative. (ManagEnergy 2019.)

With a mission to promote a sustainable way of living and sustainable business operations, EcoFellows produces information, consulting and training services in many fields of expertise in Tampere region. The company also produces campaigns and events with themes such as material efficiency, recycling and energy consumption. EcoFellows is involved in many regional, national and international development projects and is active in taking part in new project opportunities. Its projects gain funding from the Council of Tampere Region, the European Regional Development Fund, European Agricultural Fund for Rural Development and other municipalities and businesses in Tampere Region. (Ekokumppanit 2019).

Currently, EcoFellows participates in multitude of projects ranging from developing nature services to discovering opportunities to combine smart technologies and buildings. The company aims to work in close cooperation with its owners and other stakeholders to produce impactful services. Through a multitude of successful campaigns, events and projects EcoFellows strengthened its position as a leader in sustainable development in Tampere region. (Ekokumppanit 2019.)

2.3 AREA 21 -Project

AREA 21 is a three-year transnational project within the Sustainable Tampere 2030 -programme and its key goal is to develop new operations models to decrease the carbon dioxide emissions from residential buildings. The project includes 10 partners from the Baltic Sea Region, and City of Tampere and Tampere University of Applied Sciences act as the project partners in Finland. In the beginning of the project, each project partner has evaluated their district and chosen the key areas and issues that will be developed in the project. City of Tampere and Tampere University of Applied Sciences has chosen Härmälä district as their pilot area in which energy improvement actions will be implemented. In the next stage of the project the partners defined the concrete actions that will be put into action in the chosen pilot area. (AREA 21 N.d.a)

One of these defined actions focuses on developing a new operations model to reduce the carbon dioxide emissions of oil heated detached houses. In practice, this means that residents of such houses will be encouraged to replace their current oil heating system with a heating method with less environmental impact. These alternative heating methods include heating systems such as geothermal heating system, air-to-water heat pumps and district heating. (Kaupunginhallitus 2018, 14; Pilot Area - EID Härmälä Tampere n.d.)

As EcoFellows is a subsidiary of the The City of Tampere, many of its operations have been commissioned by the City of Tampere. The AREA 21 operation model development for replacing oil heating is done in cooperation with the City of Tampere and EcoFellows. (Rinta-Rahko 2019.)

3 CLIMATE CHANGE AND FOSSIL FUEL CONSUMPTION

3.1 Greenhouse Gases as an Accelerating Factor

Greenhouse gases (GHGs) are naturally occurring gases that have enabled life on Earth by creating warm conditions in which human and non-human species can thrive. As sunlight reaches the Earth's surface, it is absorbed and subsequently re-emitted into the atmosphere as infrared radiation. This infrared radiation is then absorbed and re-emitted back towards the Earth's surface by greenhouse gases creating the greenhouse effect in which the heat originated from the sun is capsuled inside the atmosphere. (Burch 2014, 111–112, 119.)

The most significant GHGs are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (Brander 2012, 1; Ilmasto-opas n.d.). Human activities, however, have increased the amount of GHGs, mainly CO_2, CH_4 and N_2O, in the atmosphere significantly over the past two centuries, which has increased the average global temperature (Healey 2014, 3; Burch 2014, 12). In particular, CO_2 concentrations have increased significantly after the beginning of the industrial era mostly due to fossil fuel combustion (Healey 2014, 3). Many scientists and experts have agreed that this phenomenon is causing the climate change, the effects of which are already visible as extreme weather conditions, droughts, declining species populations and rising sea levels (Burch 2014, 5; 111; Intergovernmental Panel on Climate Change 2018, 53; European Commission n.d; Kaupunginhallitus 2018, 3). Another significant reason that has been proved to contribute to climate change is land use change mainly due to deforestation (Healey 2014, 3).

Many nations globally have acknowledged the gravity of climate change and have signed treaties and agreements on the actions that need to be taken to mitigate climate change. Three of the most important environmental treaties established are the UN Framework Convention on Climate Change (UNFCCC) on 1992, the Kyoto Protocol on 1997 and the Paris agreement on 2015. (Ympäristöministeriö 2018, 27–30.)

Intergovernmental Panel on Climate Change has published one of the most significant reports of the field in 2018, and the report has combined results of multiple studies on global warming. The report presents the possible impacts if global warming were to exceed 1.5 °C above pre industrial levels. The report also introduces actions and ways to mitigate global warming. (IPCC 2018.)

3.2 Carbon dioxide emissions

Carbon dioxide (CO_2) is one of the most important greenhouse gases with a great ability to absorb and re-emit infrared radiation. Of all greenhouse gases, CO_2 has the longest lifespan, a feature that creates issues whenever CO_2 is excessively added into the atmosphere by human activities. Vegetation, soil and oceans bind carbon dioxide naturally from the atmosphere, however, according to Burch (2014, 111), the pace of the natural systems to sequestrate CO_2 from the atmosphere is too slow to bind all the human-induced emissions. This phenomenon combined with human induced CO_2 emissions has and will increasingly add to the atmospheric CO_2 concentrations, which means there will be more CO_2 to prevent heat from escaping in to space. (Burch 2014, 111; 120.)

Since the beginning of the industrial era, one of the most significant sources of CO_2 emissions has been consumption of fossil fuel burning in energy production (IPCC 2018, 53). Burch also states (2014, 111–112) that humans have been too focused on the production and consumption of energy, products and services that we have reached a state where our inflow of CO_2 emissions is significantly higher than the outflow. According to IPCC (2018, 96) the most effective way to decrease the atmospheric CO_2 concentrations is to prevent the emissions from being produced altogether. Replacing fossil fuels with renewable energy sources plays an important role in achieving this goal as well (Kaupunginhallitus 2018, 8).

3.3 Carbon dioxide equivalent

Carbon dioxide equivalent, or CO_2e is a common term to describe the GHG emissions of human activities (Brander 2012, 2). Greenhouse gases all act differently in the atmosphere and they have a different potential to contribute to global warming (Benviroc Oy 2019). For each greenhouse gas, CO_2e indicates the amount of CO_2 that would be required to reach the same global warming potential (Brander 2012, 2). By converting the emissions of all GHGs into a single unit, the emissions are more easily compared with each other (Brander 2012, 2).

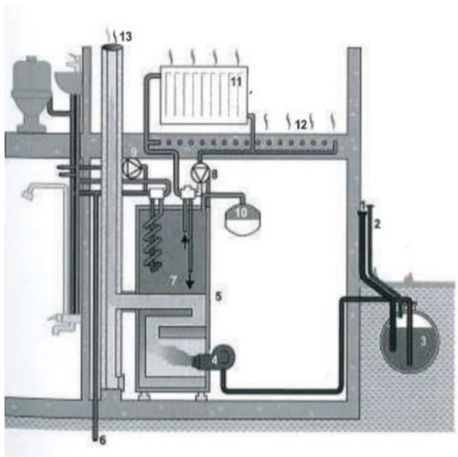
3.4 Fossil Fuels in Residential Heating

3.4.1 Oil Heating Principles

Fuel oils are refined from crude oil, a naturally occurring liquid that can be derived from oil deposits deep in the bedrock or below the seafloor. Crude oil has formed over the course of millions of years as organic matter has buried and fossilised. To Finland, crude oil is imported for refining from Russia, Norway and Great Britain. (Johnson & Standiford 2009, 211; Öljy- ja kaasulämmitysyhdistys 1999, 11.)

Light fuel oil can be used for various purposes such as heating residential buildings and as a fuel for diesel-powered tractors and other types of machines (Öljy- ja kaasulämmitysyhdistys 1999 ,13). In residential buildings, light fuel oil is used in specific oil heating systems that provides heat to warm up the indoor air and the domestic water used in households (Öljylämmitys 2017).

The operating principle and components of an oil heating system are presented in figure 1. Oil is pumped from the oil tank (3.) to the oil burner (4.) in which a combination of oil and air are combusted to create heat. Combustion heat is transferred to the boiler water through radiation and conduction. Then, the boiler water heats the domestic water used in households and the water that circulates in the heating network of a building. (Rakennustieto Oy 2007, 9.) Since oil is mostly composed of carbon, the main by-product from oil combustion is carbon dioxide (Seppänen 2001, 297–298). Although new systems have a high efficiency of nearly 95 %, older systems reach only approximately 85 % efficiency. This means that older systems consume more fuel to cover the heat demand of a house. (Suomi rakentaa 2019.)



1. Oil fill valve
2. Ventilation tube
3. Oil tank
4. Oil burner
5. Boiler
6. Water supply line
7. Boiler water
8. Water circulation pump
9. Water circulation pump
10. Expansion tank
11. Radiator
12. Floor heating
13. Flue gas chimney

FIGURE 1. Components of an oil heating system (Rakennustieto Oy 2007, 9)

The typical life cycle of oil heating systems is 20 to 30 years, however the burner is typically renewed every 10 to 15 years (Energiatehokas koti 2016). Those in favor of oil heating state that oil heating is an energy efficient and inexpensive heating method with low environmental impact (Rakennustieto Oy 2007, 9; Mukavaa asumista n.d.). However, according to LämpöYkkönen, a company with expertise in energy efficient heating solutions, oil heating is one of the most expensive heating methods available (Lämpöykkönen 2017a) and oil prices are still predicted to rise in the future (Laitinen 2010, 67). In addition, among all heating methods and fuels available for detached houses, heating oil has the highest CO_2 emission coefficient, a factor that is used to describe and estimate the CO_2 emissions of different fuels (Suomen virallinen tilasto 2019). Biofuels, such as wood, woodchips or pellets, have a higher CO_2 emission coefficient than heating oil. However, these renewable fuels are considered carbon-neutral in the current Finnish CO_2 emission calculation models since these fuels are manufactured from wood that has bound the emitted CO_2 as it were growing before harvesting (Suomen virallinen tilasto 2019; HSY 2018b).

3.4.2 Detached Houses in Finland

In this thesis the Statistics Finland's definition of a detached house was utilized (Suomen virallinen tilasto n.d.). In its database, Statistics Finland defines a detached house as a residential building with one or two apartments, a semi-detached house in which two apartments are split by a main wall or an individual residential building similar to a detached house, such as a permanently occupied second residence. (Suomen virallinen tilasto n.d.) Of all the residential buildings in Finland, the number of detached houses was 1 157 072 according to the 2018 data (Suomen virallinen tilasto 2018a).

Figure 2 presents the share of different heating methods and fuels in Finland's detached houses from 1995 to 2015.

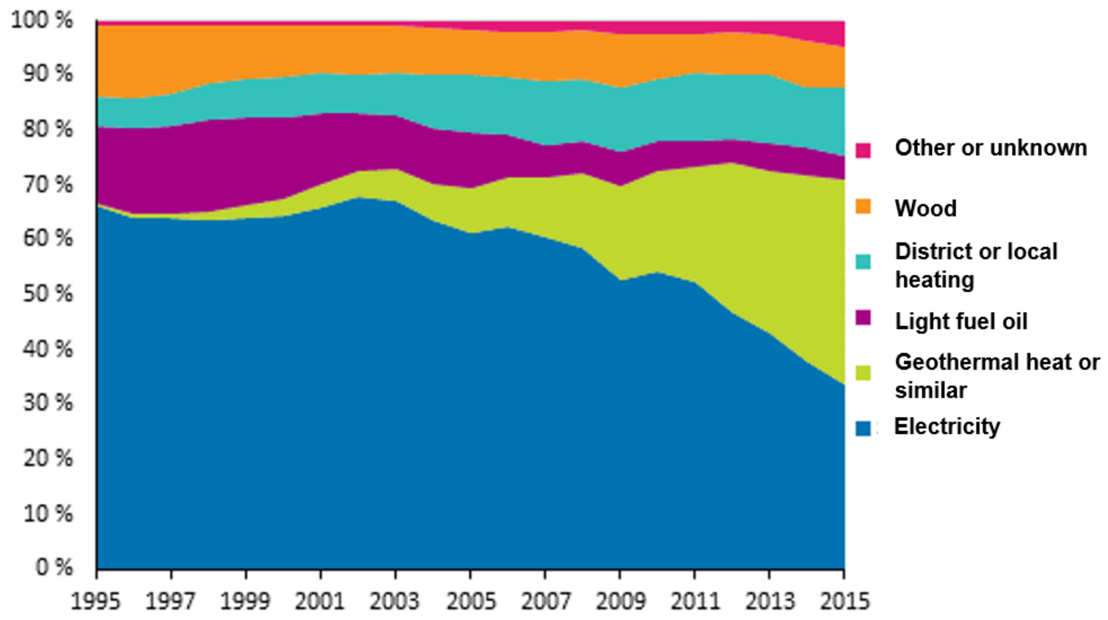


FIGURE 2. Share of heating methods in detached houses in Finland from 1995 to 2015 (Tilastokeskus 2016 Maalämmön osuus lämmönlähteenä kasvussa)

The figure indicates that in 2015 the most common heating method was geothermal heat, electric heating being the second most common method. District heat that is produced in combined heat and power production (CHP) or solely as heat production (Finnish Energy n.d.), was the third most popular heating method. The least common heating methods were wood heating, oil heating and other or unknown heating methods (Suomen virallinen tilasto 2016).

3.4.3 Oil Heating in Detached Houses in Finland

As can be seen in figure 3, oil heating systems are rarely installed into new detached houses while more energy efficient, mostly heat pump -based heating technologies have increased their share (Energiatehokas koti 2018).

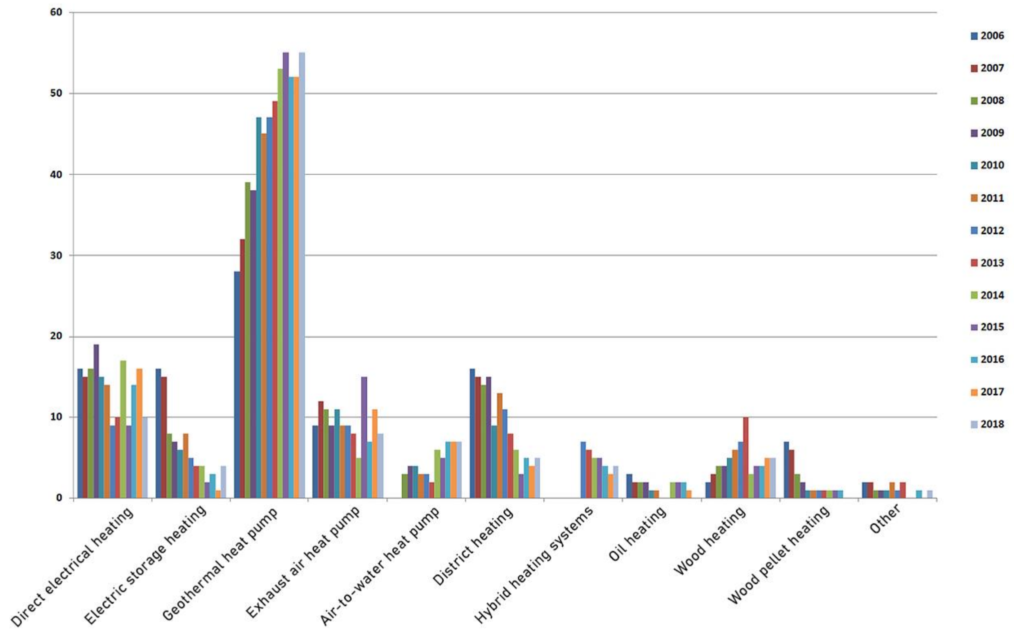


FIGURE 3. Heating systems in new detached houses built between 2006 and 2018 (Energiatehokaskoti 2018)

However, the share of oil heated detached houses in the current building stock in Finland is still significant considering the negative environmental impacts of oil heating. The reason why oil heating is still being widely used is that oil heating was commonly deployed in 1960's and 1970's in detached houses (Riistaniemi 2018). As can be seen from figure 4, a large share of the detached houses in Finland have been built between 1950 and 1989. Therefore, oil heating is still a popular heating method in Finnish detached houses, even though many systems have most like been replaced.

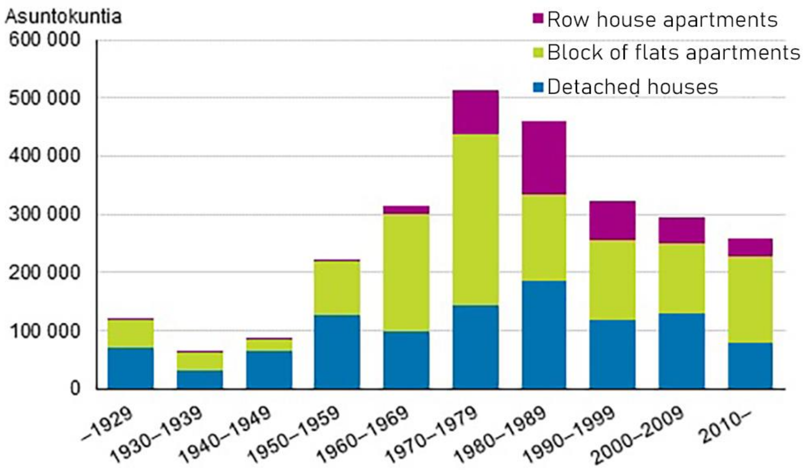


FIGURE 4. Residential buildings in Finland based on the year of construction (Suomen virallinen tilasto 2018b)

As an old oil boiler reaches its end-of-life, the cost of renewing the old system is much lower than investing to a new heating system altogether (Öljylämmitysjärjestelmän kunnostuskustannukset n.d.). Additionally, heating oil taxation has been in favour of oil heated house owners and decision makers have not yet taken action towards increasing heating oil taxation. According to Kyytsönen in his article (2017), these two factors are the most pressing reasons why heating system renovations are being postponed and the residential building stock in Finland is only slowly shifting towards deployment of sustainable energy solutions.

According to the Statistics Finland’s data from 2018, there were 248 615 detached houses in Finland that used heating oil or natural gas as their main heating fuel (StatFin 2019). However, based on the Finnish Gas Association data from 2018 (Suomen Kaasuyhdistys 2019), only 4093 detached houses in 2018 were heated by natural gas which would indicate that over 244 500 Finnish detached houses would be heated by oil. On the other hand, data from Rakennustutkimus RTS Ltd. (Herrala 2019) shows that in 2017 there were 155 000 oil heated detached houses in Finland and the estimation for 2019 is 150 000. It is evident that there is contradictory in the available data on oil heating and a possible reason for this is the different categorisation in the calculations. For example, if detached houses with two separate apartments are not included in the detached house categorisation, the total number of oil heated houses would be lower than if they were included in the categorisation.

Moreover, according to the Statistics Finland's database (StatFin 2019) the number of oil or gas heated detached houses in Tampere was 5161 in 2018. While this number includes both heating methods, according to Janne Laurila, a project employee in the sustainable development unit of the City of Tampere, it can be assumed that nearly all of those 5161 houses are heated by oil rather than gas (Laurila 2019). If this assumption is correct, then approximately 31 % of all detached houses in Tampere are heated by oil. However, there is not enough data available on the gas heating statistics in Tampere to support this assumption.

3.4.4 Emissions from Fossil Fuel-Based Heating

Building heating is one of the major CO_2 emission sources in Tampere (CO_2-raportti & Benviroc Ltd. 2019, 5). District heating production is one of the key focus areas as more than 30 % of the buildings in Tampere are heated by district heat (StatFin 2019). The local energy utility Tampereen Sähkölaitos Ltd. has already planned to develop its district heating production in the beginning of 2020's so that a larger share of energy sources would be renewable (Tanninen 2018; Kaupunginhallitus 2018, 6).

Another focus area in the Sustainable Tampere 2030 -programme is the oil heating in detached houses (Kaupunginhallitus 2018, 7). Thus, The City of Tampere has set a goal, along with other climate targets, to have all the individual oil heating systems in Tampere's detached houses replaced with alternative heating solutions by 2030 (Kaupunginhallitus 2018, 7). However, one of the most challenging questions is how to encourage citizens to participate in the process towards achieving this goal.

Giving up oil heating in residential buildings would be an important step in the path towards carbon neutrality since heating with oil creates more CO_2 emissions than any other heating method available for Tampere residents (CO_2 päästökertoimet 2019; Tampereen Sähkölaitos 2019; Suomen virallinen tilasto 2019).

According to the CO_2-report (CO_2-raportti & Benviroc Ltd. 2019, 16) heating of buildings is one of the largest emission sources in Tampere. The emission share from individual heating systems that includes wood-, oil- and natural gas-based heating systems is 9,8 % out of the total emissions that originates from the building heating (figure 5). The report stated that the emissions from individual heating systems in 2017 was 76,6 kt CO_2e and the emissions estimated for 2018 was 76,7 kt CO_2e (CO_2-raportti & Benviroc Ltd. 2019, 17).

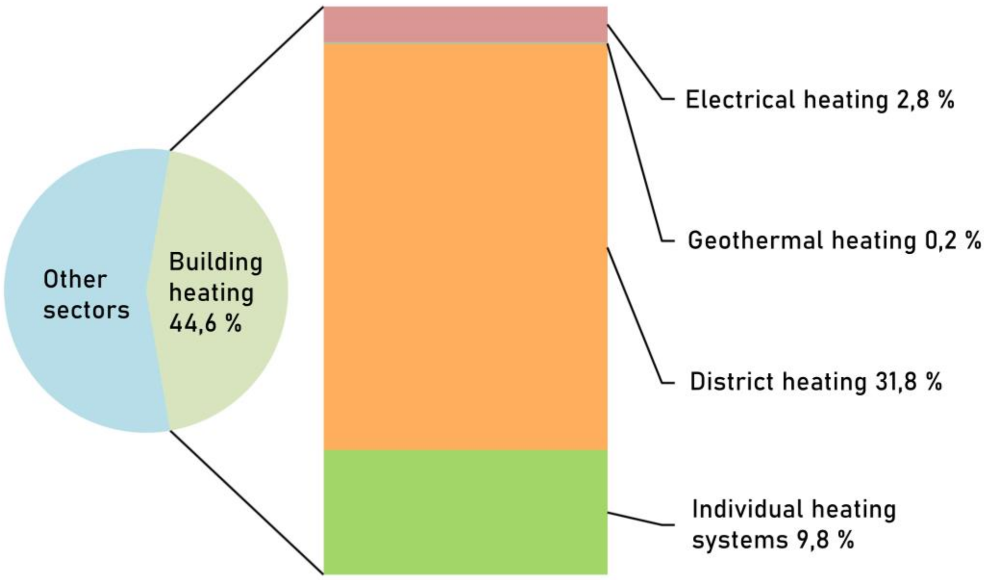


FIGURE 5. The share of emissions from heating of residential buildings out of the total emissions in Tampere (CO_2-raportti & Benviroc Ltd. 2019, 16)

Although district heating creates the greatest share of the total emissions from building heating (CO_2-raportti & Benviroc Ltd. 2019, 16), the share of individual heating in the total emissions is still significant. Moreover, as the goal of The City of Tampere is to reach carbon neutrality by 2030, reducing fossil fuel consumption in individual heating is an important action even though it is not the greatest emission source (Kaupunginhallitus 2018, 7).

3.5 Recent studies

In 2018, Motiva Ltd., an expert organization focused on sustainable development, published a report presenting the findings of two recent surveys directed to residents of detached houses in Southern Finland (Motiva 2018). In the surveys, two organizations investigated the current state of heating in detached houses and the interest of the residents towards deploying alternative heating methods (Motiva 2018). Although the surveys were directed for residents from all types of detached houses, the report highlighted in particular the findings on inclination towards replacing oil heating systems (Motiva 2018).

Ilmastoinfo (Climate info) is an information service administered by Helsinki Region Environmental Services Authority (HSY 2018a). Through Ilmastoinfo, HSY conducted the other survey for residents in the Capital Region, the metropolitan area surrounding Helsinki in autumn 2018 (Motiva 2018). According to the report (2018), the HSY survey consisted of a questionnaire and additional interview and the target group was residents of detached houses. The questionnaire was filled out by 168 respondents. (Motiva 2018.) One of the key themes in the survey was the inclination of the residents towards deploying energy efficient and renewable energy based heating solutions in their houses (Motiva 2018). The second survey was conducted by the City of Hyvinkää in collaboration with Motiva Ltd. in August 2018 (Motiva 2018). The survey investigated similar topics than the HSY survey and it received 125 responses (Motiva 2018).

The findings from these surveys were utilized in this thesis to conduct an extensive overview on the opinions of detached house residents. Although the surveys by Motiva Ltd./City of Hyvinkää and HSY were directed towards residents that utilize a variety of heating methods, the results offered important insights regarding heating system renewals in general. Thus, the results could be utilized in this thesis that focused on oil heated houses. The results of the surveys are further discussed in chapter 7.

4 TECHNICAL ALTERNATIVES FOR OIL HEATING SYSTEMS

This chapter introduces the most common heating solutions that can be installed to replace oil heating. The following heating methods comprise of heating systems that can cover the heating demands of one detached house single-handedly, and hybrid systems in which two or more heating methods work in unison. (HSY n.d.)

In some cases if the oil-heating system is recently renewed or the old system is still in good condition, supportive heating systems can be installed alongside the oil-heating system to reduce oil consumption (Motiva 2016). However, as the goal for the City of Tampere is to abandon oil heating of detached houses entirely by 2030 (Kaupunginhallitus 2018, 7) only those heating solutions that can fully cover the energy demand of detached houses and replace an oil heating system are introduced in this study.

4.1 Geothermal Heat Pump

As Hundy, Trott and Welch state in their book *Refrigeration, Air Conditioning and Heat Pumps* (2016, 393), heat pumps and refrigerators share the same operating principle but the thermodynamic process is reverse. The primary purpose of heat pumps is to transfer heat from a hot reservoir to a cold reservoir, which is why they are increasingly used for heating purposes in buildings (Hundy, Trott and Welch 2016, 393). In a heat pump, a fluid (refrigerant) is vaporized and condensed in various stages of the system absorbing and releasing heat in the process (Arvela & Mäkinen 2014). Geothermal heating system is used for heating the indoor air but can also be harnessed for heating the domestic water (Perälä & Perälä 2013, 63).

Figure 6 presents the main operating system of a geothermal heat pump, however the operating principle is the same in all heat pumps. The system consists ofa heat collection piping in which a heat collection fluid absorbs the heat from the soil or a water body. Inside the heat pump, the heat collection fluid releases the heat to the gasified refrigerant that is then transferred into the compressor. In the compressor, the refrigerant is compressed and the pressure and temperature of the refrigerant increases significantly. After this, the high temperature and pressure refrigerant enters a heat exchanger in which it condenses and releases heat into the water in the heat distribution network of a house. In this phase, the refrigerant is also condensed to reach a liquid phase. Finally, the cooled, liquid refrigerant enters the expansion valve in which its temperature and pressure decrease leading to gasification. Then the cycle begins again, as the gasified refrigerant absorbs the heat from the heat collection fluid. The fluids in the heat collection piping, in the heat pump and in the heat distribution network do not mix in the process. (Perälä & Perälä 2013, 28−29; 59−60.)

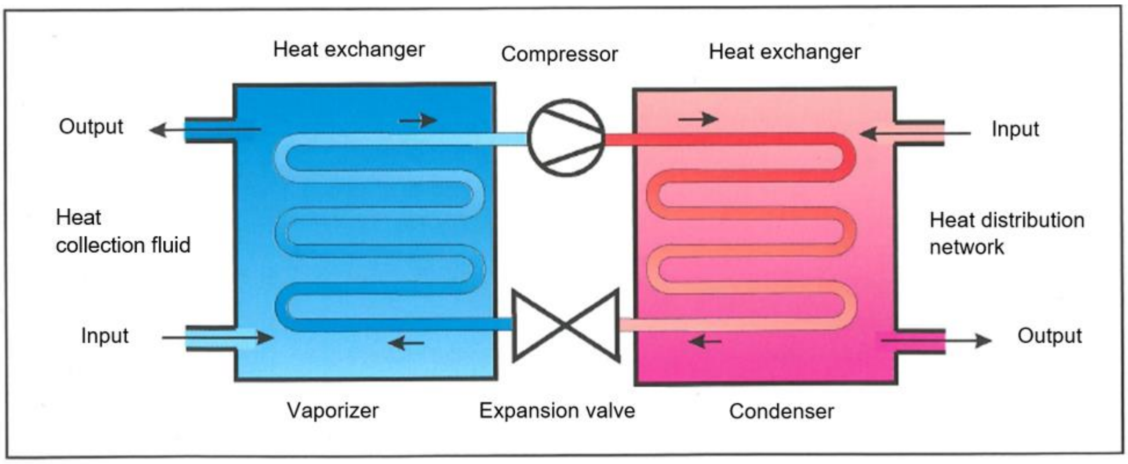


FIGURE 6. The heat collection fluid collects the heat from the geothermal heat source and the heat distribution network of a house distributes the heat for heating and domestic water use (Perälä & Perälä 2013, 34)

Geothermal heat refers to heat originated from the sun that has been stored in the soil or surface waters (Perälä & Perälä 2013, 60). A geothermal heat pump collects this thermal energy with pipes that can be installed vertically inside a borehole (figure 7) or horizontally in the ground’s surface layer (figure 8) (Perälä & Perälä 2013, 59). Also, if a building is located near a water body, the heat collection pipes can be installed to the bottom of the water reservoir. (Perälä & Perälä 2013, 59). According to Sami Seuna, an expert in energy and residential heating in Motiva Ltd., boreholes are the most common heat collection method in Finnish detached houses (Maalämpöpumppu 2018).

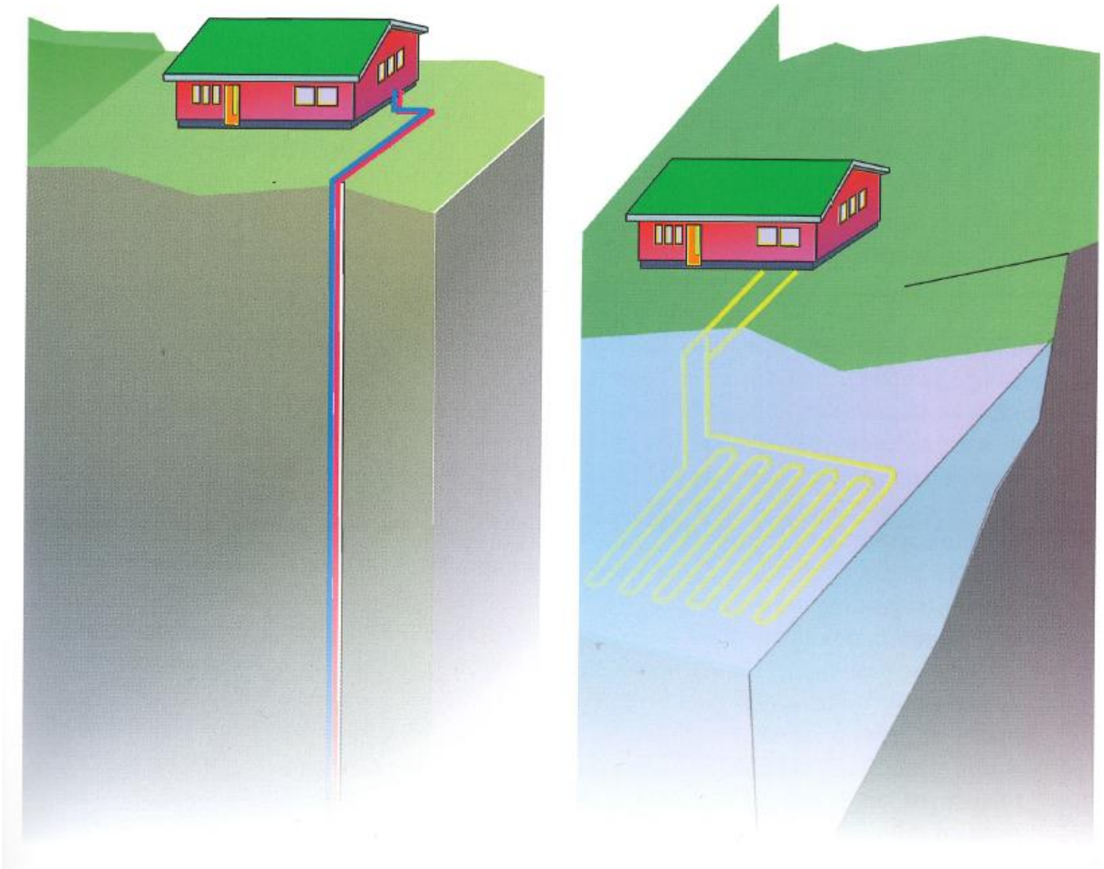


FIGURE 7. Geothermal heat collection piping in a borehole and in a water body (Perälä & Perälä 2013, 61)

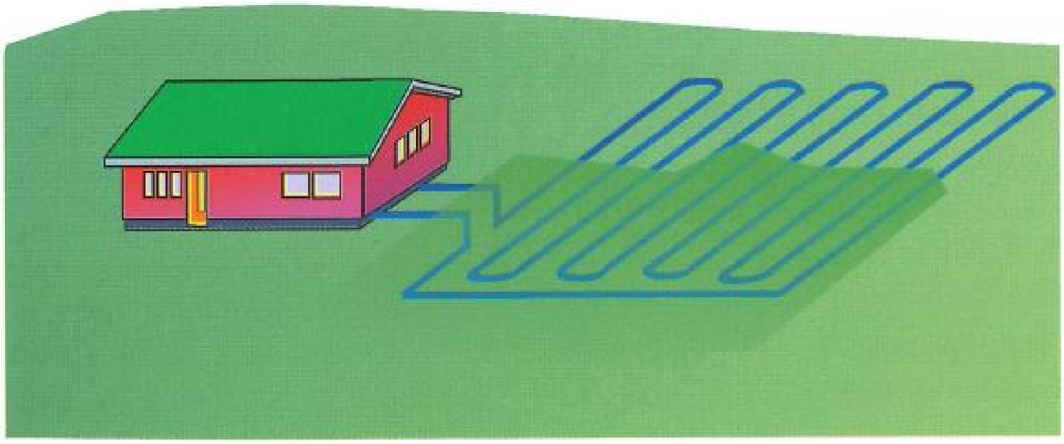


FIGURE 8. Geothermal heat collection piping horizontally in the ground (Perälä & Perälä 2013, 60)

There are different terms to describe the efficiency of heat pumps, or in other words how much energy a heat pump yields in relation to the amount of energy it consumes (Thermia n.d.). The most commonly used terms are Coefficient of

Performance (COP) and Seasonal Coefficient of Performance (SCOP) (Maidment 2013, 16-17). COP informs the ratio of energy output to the energy input at a given moment. SCOP, on the other hand, offers a more realistic value as it describes the annual performance by taking into account the seasonal changes (Thermia n.d.; Maidment 2013, 16–17). Seasonal Performance Factor (SPF) is not commonly used, although it describes the efficiency of a heat pump most reliably (Thermia n.d.). SPF informs the efficiency similarly as COP and SCOP, however it takes into account the heating of domestic water whilst COP and SCOP do not (Thermia n.d.).

According to Laitinen, the typical COP of geothermal heat pumps is approximately 3, which means that by 1 kilowatt hour of energy the pump can yield 3 kilowatts of energy (Laitinen 2010, 77). Hence, 1/3 of the heat provided by a geothermal heating system is produced by electricity and the rest is renewable geothermal heat (Suomen lämpöpumppuyhdistys n.d.). Geothermal heat pumps consume approximately 66 % less electricity than direct electric heating, in which each room is typically heated by an electric radiator. Hence, the heating costs of a geothermal heating system are significantly lower than with a direct electric heating. (Laitinen 2010, 77.)

The energy demand of a detached house in Finland is 30 000 kWh annually by average and the share of energy used for heating is approximately 70 %, or 21 000 kWh (Ymparisto.fi 2016). With a COP of 3 and without taking into account heat losses, approximately 14 000 kWh worth or thermal energy would originate from renewable geothermal energy.

Although the investment cost of a geothermal heating system is significantly high, it is a competitive alternative to oil regarding its low costs during use (Laitinen 2010, 76-77). Additionally, the environmental impacts of geothermal heating systems are remarkably low as 2/3 of the provided heat is produced by emission-free, renewable energy (Lämpöä omasta maasta 2012, 14). However, if a geothermal heating system is designed to only partially cover the heat demand of a building, the system is not able to provide the necessary heat during colder temperature peaks (Lämpöä omasta maasta 2012, 14). When this occurs, the heat demand will be covered by resistors, which require significantly more electrical power to operate than the heat pump. Thus, the heat created by resistors creates more GHG emissions as more electicity is consumed. (Lämpöä omasta maasta 2012, 14.) To minimize the electricity consumption of resistors, supportive heating methods such as wood based heating are recommended to be used during colder temperature peaks (Lämpöä omasta maasta 2012, 14; Laitinen 2010, 104).

4.2 Air-to-water Heat Pump

As Motiva describes in one of its guidebooks (Lämpöä ilmassa 2008, 4), air-to-water heat pumps (or UVLP) share the same operating principle as geothermal heat pumps, as they both are based on heat pump technology. However, air-to-water heat pumps collect thermal energy from the outdoor air rather than the ground. As the name refers, this heating method requires a building with a water-based heat distribution network and it can also be used to heat the domestic water used in a household. (Lämpöä ilmassa 2008, 3.) Air-to-water heat pumps are a competitive alternative to oil especially for houses that cannot utilize geothermal heat. The investment costs are lower than with geothermal heating systems, but air-to-water heat pumps are less efficient than geothermal heat pumps (Suomen lämpöpumppuyhdistys n.d.).

Figure 9 offers a simple graphical presentation of the operating principle of an air-to-water heat pump. The system operates similarly than the geothermal heating system described in the previous chapter, but the heat is collected from the outdoor air rather than from the ground. Also, air-to-water heat pumps do not produce as much heat especially during cold winter temperatured as a geothermal heat pump, since the efficiency of an air-to-water heat pump decreases when the temperature difference between the outdoor air and the indoor air increases. (Perälä & Perälä 2013, 37.)

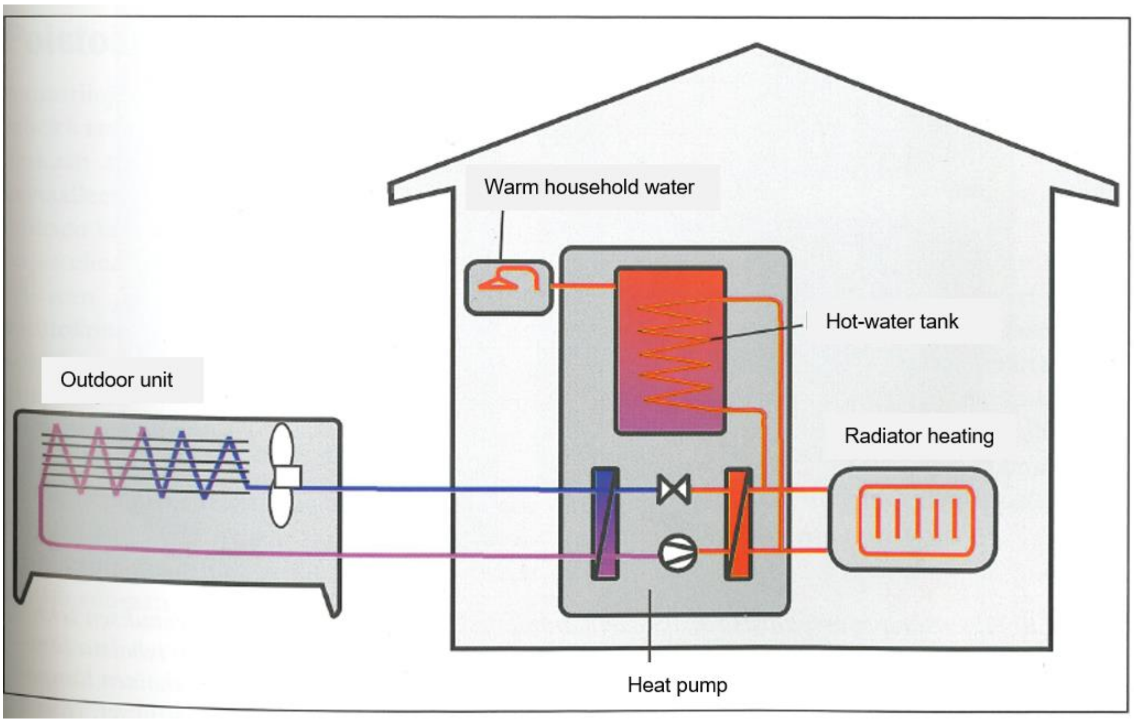


FIGURE 9. Air-to-water heating systems typically consist of an outdoor unit and an indoor unit containing the heat pump (Perälä & Perälä 2013, 75)

The popularity of air-to-water heat pumps has increased significantly over the past few years (LämpöYkkönen 2017b) as can be seen from a figure (10) published by the Finnish Heat Pump Association (2019). According to their recent press release (Suomen lämpöpumppuyhdistys 2019), air-to-water heat pump sales increased 25 % between 2018 and 2019. The reason for this is that air-to-heat pump technology has undergone remarkable development in Finland resulting in better performing systems that are able to operate even during colder weather conditions (Suomen lämpöpumppuyhdistys 2019; LämpöYkkönen 2017b).

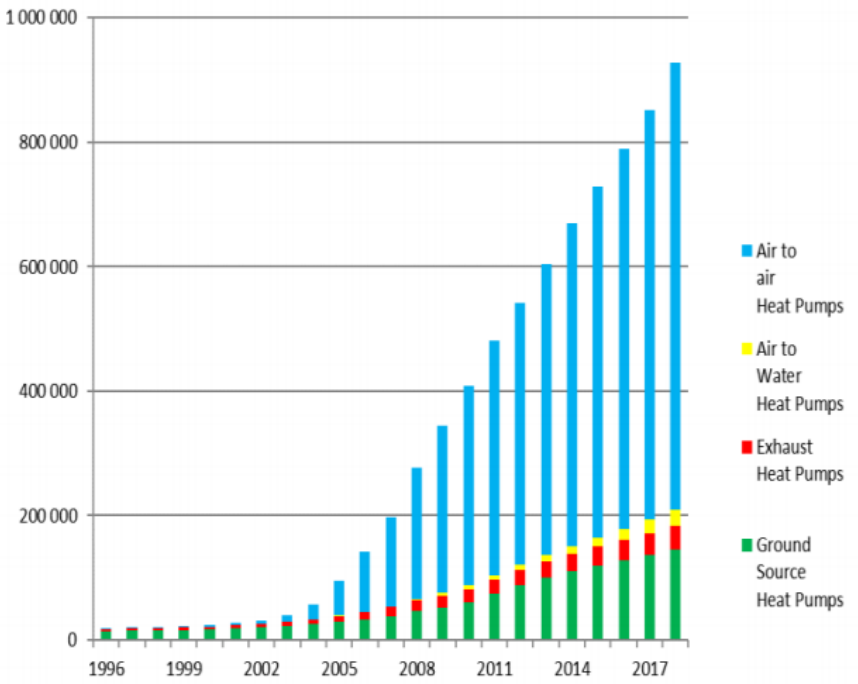


FIGURE 10. Heat pump sales in Finland by heat pump type (Suomen lämpöpumppuyhdistys 2019)

As with all heat pumps, the efficiency of an air-to-water heat pump can also be indicated by COP, SCOP and SPF (Thermia n.d.). However, the Finnish Heat Pump Association (Suomen lämpöpumppuyhdistys n.d.) points out that the efficiency of air-to-water heat pumps is strongly correlated with outdoor temperature. During winter, the temperature difference between the outdoor and indoor air can grow significantly, lowering the air-to-heat pumps' efficiency and ability to produce heat (Suomen lämpöpumppuyhdistys n.d.). However, oil heating can been replaced with an air-to-water heat pump and during colder climate conditions, the resistors of the system produce the required heat (Perälä & Perälä 2013, 37).

4.3 Wood Pellet Boiler

Wood pellets are produced by compressing biomass into small energy-dense pellets. The raw material for wood pellets is usually sawdust or wood chips, both by-products of the bioprocessing industry. (Pelletin tuotanto n.d.) Before the raw material is compressed, it undergoes a drying process after which its water content is only 10 %. Due to low water content and consistent quality, the fine particle emissions from pellet burning are lower in comparison with other wood fuels. (Ympäristö n.d.)

A pellet heating system is less expensive than most alternatives for oil heating, but the equipment require more maintenance (Kontiainen 2016). A good alternative to oil heating is a pellet heating system that transfers heat into the water-based heat distribution system of a house similarly as an oil heating system (Pellettilämmityksen laitteisto n.d.). In this type of systems, pellets are automatically transferred from a storage tank to the boiler, in which they are combusted (figure 11). This heat of combustion heats the boiler water that subsequently heats the water circulating in the building’s heat distribution network. (Pellettilämmityksen laitteisto n.d.) Modern pellet boilers have a high efficiency over 90 % (Kaukora Oy n.d.).

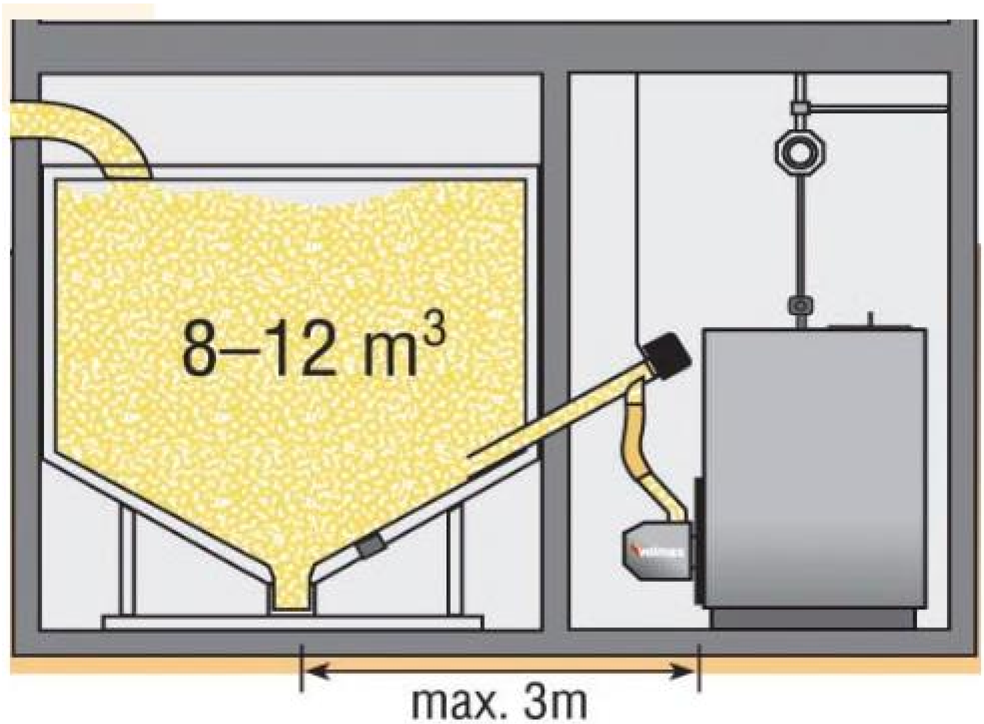


FIGURE 11. Main components of a pellet heating system (Pellettilämmityksen laitteisto n.d.)

The HSY survey results show that pellet-based heating is not currently considered a noteworthy heating method for detached houses (Öljylämmittäjät pohtivat muutoksia… 2019). According to Hannes Tuohiniitty, a bioenergy expert in the BioEnergy association of Finland, the lack of retailers and poor reputation of equipment quality are two of the main reasons why pellet heating systems are not deployed more commonly (Kontiainen 2016).

As all biofuels, wood pellet heating is considered a carbon-neutral heating method by calculation, as wood has absorbed the CO_2 that is eventually released during heating (Ympäristö n.d.). However, the atmospheric effects of increasing the share of wood-based fuels and the methods to calculate the CO_2 emissions from wood burning are still under debate (Sandell 2015). Regardless, replacing oil with renewable fuels, such as pellets would support the national goal to increase the share of renewable energy in the end consumption (Ministry of Economics… n.d.) and the goal of The City of Tampere to give up oil heating (Kaupunginhallitus 2018, 7).

4.4 District Heating

District heating is the most common heating method in Finland (Kaukolämpö tuotetaan lähellä… n.d.). A report by Energy Finland shows that in 2017 the estimated share of district heating in residential heating was 46 % (Tiitinen 2019). However, in detached houses it is not a widely utilized heating method as only less than 6 % of Finnish detached houses use district heating (StatFin 2019). District heating is more common in public or office buildings and row houses. Regardless, district heating system requires only little maintenance during use and it utilizes the same heat distribution network as oil heating which makes is a noteworthy heating alternative (Laitinen 2010, 81).

District heat is produced in separate heat plants and in combined heat and power (CHP) plants that co-generate both heat and electricity (Kaukolämpö 2019). Combined heat and power generation is an energy efficient production method as the lost heat energy that cannot be utilized to produce electricity is utilized to produce district heat (Kaukolämpö 2019). In 2018, the main fuels in Finnish district heat production were coal (20 %), biofuels (17 %) and peat (16 %). The share of fossil fuels in district heat production was 35 % and the share of renewable energy sources and CHP production 46 %. (Kaukolämpö 2019.) The environmental effects of district heat depends on the fuel type and on the production plant

(Kaukolämpö 2019). Production plants that use renewable fuels create less emissions. Additionally, CHP plants are more energy efficient than separate heat production plants, thus they have a smaller environmental impact as less heat is lost in the process. (Kaukolämpö 2019.)

District heat is a noteworthy option for detached houses that are located near district heat network, as the pipes connecting the production plants and buildings cannot be installed too far apart (Laitinen 2010, 81). District heat is distributed to buildings via two-piped district heat network in which one pipe is used to transfer hot water to customers and the other to return cooled water back to production plants (Lämpöä kotiin verkosta 2017). A district heating system's main component is a heat distribution centre that is located in a building's technical room. The heat distribution centre includes a heat exchanger that transfers the heat in the water circulating in the district heat network into the building's own heat distribution network. (Lämpöä kotiin verkosta 2017.)

4.5 Calculating CO_2 Emissions of Different Heating Methods

In 2012 Motiva published instructions created by Ilkka Hippinen and Ulla Suomi (2012) for calculating the CO_2 emissions of a single emission source such as a residential or commercial building. The instructions are also useful when evaluating the effects of energy efficiency measures on the CO_2 emissions (Hippinen & Suomi 2012, 2). The CO_2 emissions of a detached house can be calculated by multiplying the amount of energy of fuel used for heating by the emission factor of the heat source or the fuel. For example, if a detached house is heated by oil, the amount of fuel consumed is multiplied with the emission factor of heating oil. (Hippinen & Suomi 2012, 2.) The emission factors of district heat, electricity, biofuels (including pellets) and heating oil are introduced in table 1. Both a geothermal heating system and air-to-water heat pump utilize electricity. The emission factors have been gathered from Motiva and Statistics Finland (CO_2-päästökertoimet 2019; Suomen virallinen tilasto 2019).

TABLE 1. Emission factors of different heat sources (CO_2-päästökertoimet 2019; Suomen virallinen tilasto 2019)

Heat source	Emission factor (kg CO_2/MWh)
Heating oil (light fuel oil)	278
District heat	164
Electricity	158
Biofuels (incl. pellets)	0

Approximately 1000 litres, or 1 cubic meter, of heating oil produces 10 000 kilowatt hours’ worth of thermal energy (Suomen lämmitystieto Oy 2019). As stated in chapter 4.1 the energy consumption of one detached house in Finland is by a rough average 30 000 kWh per year and approximately 70% of that energy is used for heating (Ymparisto.fi 2016). Thus, the thermal energy demand of one detached house, which is approximately 21 000 kWh, could be produced with 2100 litres, or 2,1 m^3, of heating oil.

Below are two example calculations of reductions in the CO_2 that could be achieved by replacing oil heating with an alternative method. A detached house in Tampere region with an oil heating system consumes 2 500 litres of heating oil annually which is 25 MWh worth of thermal energy. The efficiency of the boiler is 85 %. Two alternatives, an air-to-water heat pump (UVLP) and a pellet heating system are under consideration and their CO_2 emissions are being evaluated in comparison with the current oil heating system. Table 2 presents the required information for the calculations.

TABLE 2. Initial values for emission calculations

Unit	Value
Heating oil CO_2 emission factor	278 kg CO_2/MWh
Electricity emission factor	158 kg CO_2/MWh
Pellet emission factor	0 kg CO_2/MWh
Efficiency of an oil boiler	85 %
SCOP of an air-to-water heat pump (UVLP	4
Efficiency of a pellet boiler	95 %

First the CO_2 emissions of the oil heating system (CO_{2OIL}) is calculated.

$$CO_{2_{OIL}} = 25\ \mathrm{MWh/a} \cdot 278\ ^{\mathrm{kg\ CO_2}}/_{\mathrm{MWh}} = \mathbf{6950\ kg\ CO_2}/\boldsymbol{a} \tag{1}$$

As the efficiency of the oil boiler is 85 %, the heat demand (Q) of the house is calculated next (equation 2).

$$Q = 25\ \mathrm{MWh} \cdot \left(\frac{85}{100}\right) = 21{,}25\ \mathrm{MWh/a} \tag{2}$$

Next, the energy production (Q_{PELLET}) of a pellet heating system and CO_2 ($CO_{2PELLET}$) of this heating method are calculated (equation 3 & 4).

$$Q_{PELLET} = 21{,}25\ \mathrm{MWh/a} \cdot \left(\frac{100}{95}\right) = 22{,}368 \ldots \mathrm{MWh/a} \approx 22{,}37\ \mathrm{MWh/a} \tag{3}$$

$$CO_{2_{PELLET}} = 22{,}37\ \mathrm{MWh/a} \cdot 0\ \mathrm{kg\ CO_2}\ /\mathrm{MWh} = \mathbf{0\ kg\ CO_2}/\boldsymbol{a} \tag{4}$$

Lastly, the electricity consumption (Q_{UVLP}) and CO_2 emissions (CO_{2UVLP}) of an air-to-water heat pump (UVLP) are calculated (equation 5 & 6).

$$Q_{UVLP} = 21{,}25\ \text{MWh/a} \cdot \left(\frac{25}{100}\right) = 5{,}3125\ \text{MWh/a} \approx 5{,}31\text{MWh/a} \tag{5}$$

$$CO_{2_{UVLP}} = 5{,}31\ \text{MWh/a} \cdot 158\ \text{kg CO}_2/\text{MWh} = 838{,}98\ \text{kg CO}_2 \approx \mathbf{840\ kg\ CO_2}/\boldsymbol{a} \tag{6}$$

The annual CO_2 emissions of the example house with oil heating is 6950 kg CO_2 whereas with an air-to-water heat pump the emissions would reduce to 840 kg CO_2 and with a pellet heating system to 0 kg CO_2. The results of the example calculations show that the CO_2 emission reduction would be significant if oil heating was replaced in the detached house in question.

As a regard, the previous emission calculation example does not take into account the emissions in the production phase, emissions of other GHGs or particulates and it does not assess the life cycle of equipment. A more extensive calculation would be required to accurately assess the CO_2 emissions of a heating system.

5 PUBLIC PARTICIPATION IN PLANNING AND DECISION MAKING PROCESSES

Public participation is a widely used method in decision-making processes as it enables interaction between the decision makers and the people who will be affected by the made decisions. In its basic form, public participation is a way of incorporating the opinions, values and concerns of the public into the administrative planning and decision-making processes. From the governmental and organizational perspective, the information collected through public participation is useful in solving issues and making decisions that meet the needs of the public. On the other hand, public participation offers the public an opportunity to express their opinions and concerns and a way to influence decisions that would affect their lives. (Creighton 2005, 7; 17).

Public participation has been incorporated in the AREA 21 -project implementation as well (AREA 21 n.d.a). As the project description in its website states, "*AREA 21 brings together public authorities, energy providers, property owners and citizens to find and apply the best solutions for saving energy to decrease CO_2 emissions."* (AREA 21 n.d.a). Moreover, one of the main objectives of the project is to engage the public in planning energy efficient residential districts to have a better understanding on the opinions, motives and concerns of the residents (AREA 21 n.d.b).

In his handbook *The Public Participation Handbook: Making Better Decisions Through Citizen Involvement* (2005) Creighton describes public participation as a continuum of interaction between the decision makers and the public. The same level of participation often cannot be applied in each phase of a decision making process which makes public participation a continuous process rather than a single method or event. Although there are actually an infinite number of points in the participation scale, Creighton has divided public participation in four main categories shown in figure 12. (Creighton 2005, 8–9).

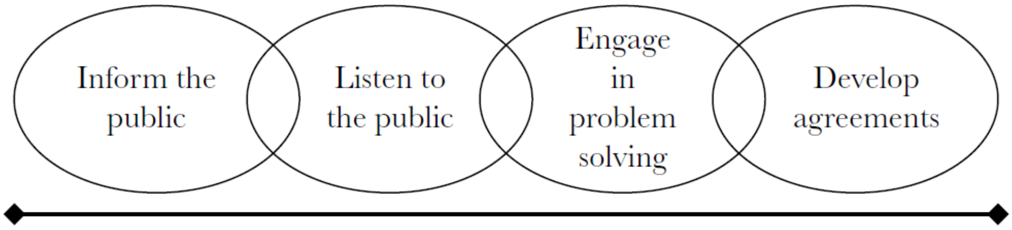


FIGURE 12. Continuum of participation by Creighton (2005, 9)

Informing the public is a one-way flow of information. Although it is not adequate to carry out a public participation programme only by informing the public, it is an important component and thus a step one should not disregard. In order to participate properly, the public must be presented with a complete description of the situation so that they can base their opinions on solid ground. (Creighton 2005, 9.)

Commonly public participation programmes also include public hearings and other similar events to offer the public a chance to share feedback. This, however, does not ensure that the feedback from the public will influence any decision making and it is important to state clearly how great of an impact their feedback will have on the decisions. (Creighton 2005, 9.)

Higher level of participation can be achieved by engaging the public in problem solving which is a method that is gaining popularity amongst many agencies. This method has been proven as even more successful than mere informing or listening. Collaboration with the public in seeking the best possible solutions ensures that the majority of the public will support the made decision and those who oppose the decision will at the least understand the reasoning that lead to the decision. Creighton describes this method as consensus seeking and it, in fact, seeks the highest level of consensus even though full consensus might not be achieved. The public can, however, influence the decision with this approach. (Creighton 2005, 10.)

The last approach is where the public can influence the decision in the highest possible level. Agreement development is an approach in which full support from all the stakeholders must be achieved before a decision is made. To build full consensus requires huge effort and also the ability from the agency to economically and resource-wise to be able to implement the decision that meets the interest of all stakeholders. (Creighton 2005, 10-11.)

6 SURVEY RESEARCH

6.1 Fundamentals of Survey Research

Surveys are an effective way of obtaining information about people's opinions, attitudes and knowledge, and they can be used for various purposes from inquiring customer satisfaction to improving business performance. Surveys can be either quantitative or qualitative depending on the data that needs to be collected. Quantitative surveys are often an inexpensive and effective way of collecting data and they can be executed in various forms such as in the form of self-administered questionnaires or telephone surveys. The results of quantitative surveys can also often be analysed by statistical methods. (Phillips, Phillips & Aaron 2013, 13.)

Qualitative surveys, on the other hand, are used to collect different, more in-depth information that could not be gathered by asking structured questions. Qualitative surveys are often performed as events in which the target group is being observed or interviewed and the responses are analyzed by interpreting rather than creating statistical data. (Phillips et al. 2013, 13.)

6.2 Research Plan

Research plan contains the details on how the desired information will be collected. This part of the research can also be called the research design. Research design is, thus, the plan on how to answer the research question. (Metsämuuronen 2003, 29). Chapters 6.11, 6.12 and 6.13 introduce the research question, sampling, data collection and limitations of the research respectively.

6.2.1 Research Purpose and Research Question

In the very beginning of their book *An Introduction to survey research* (2015, 1) Cowles and Nelson state, that "*research starts with a question*''. A specific question lays the foundation for a successful survey research. The question in this case study was complex and layered.

For the the City of Tampere, having a goal of reaching carbon neutrality and oil-free heating in the entire region by 2030 (Kaupunginhallitus 2018, 7), the question is how to encourage owners of detached houses to give up oil heating and switch to alternative heating methods. By investigating the opinions of the homeowners and unravelling the challenges they might be facing in the process towards oil-free heating, the City of Tampere is able to plan more effective services to cover the needs of the residents in question. The purpose of this study was, thus, to collect relevant information for the City of Tampere to provide answers for their underlying question: How to encourage residents to give up oil heating.

6.2.2 Sampling

Another key factor that determines whether a survey is successful and the results adequately reflect the general opinion of the population is sampling (Cowles & Nelson 2015, 13–14). A sample, when selected properly, can represent and reflect the opinion of a larger group without having to examine each person in that target group individually (Cowles & Nelson 2015, 13–14). In this study, the target group consisted of owners of oil heated detached houses in Tampere and the sample was selected from that target group. In addition, since the AREA 21 project had chosen to implement energy improvement activities in Härmälä district (figure 13), the survey was chosen to be carried out for the residents in of Härmälä. To simplify, the sample area was cropped as shown in figure 14.

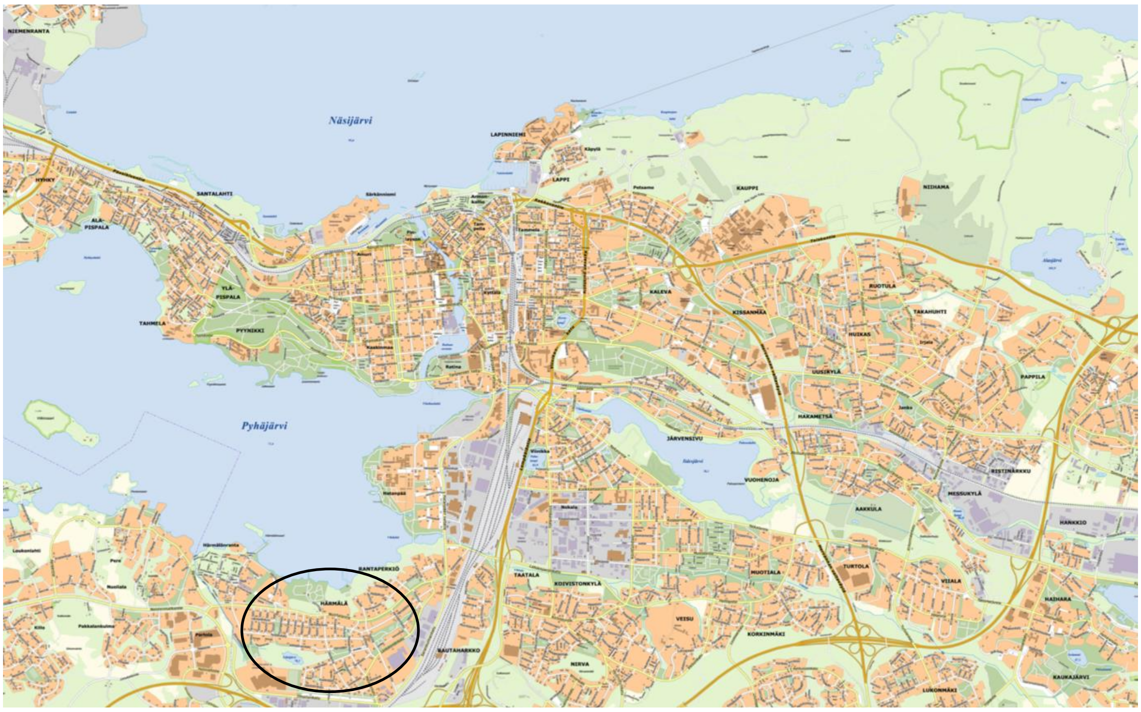


FIGURE 13. A map of Tampere with Härmälä district circled in black (Tampereen kartat 2017)

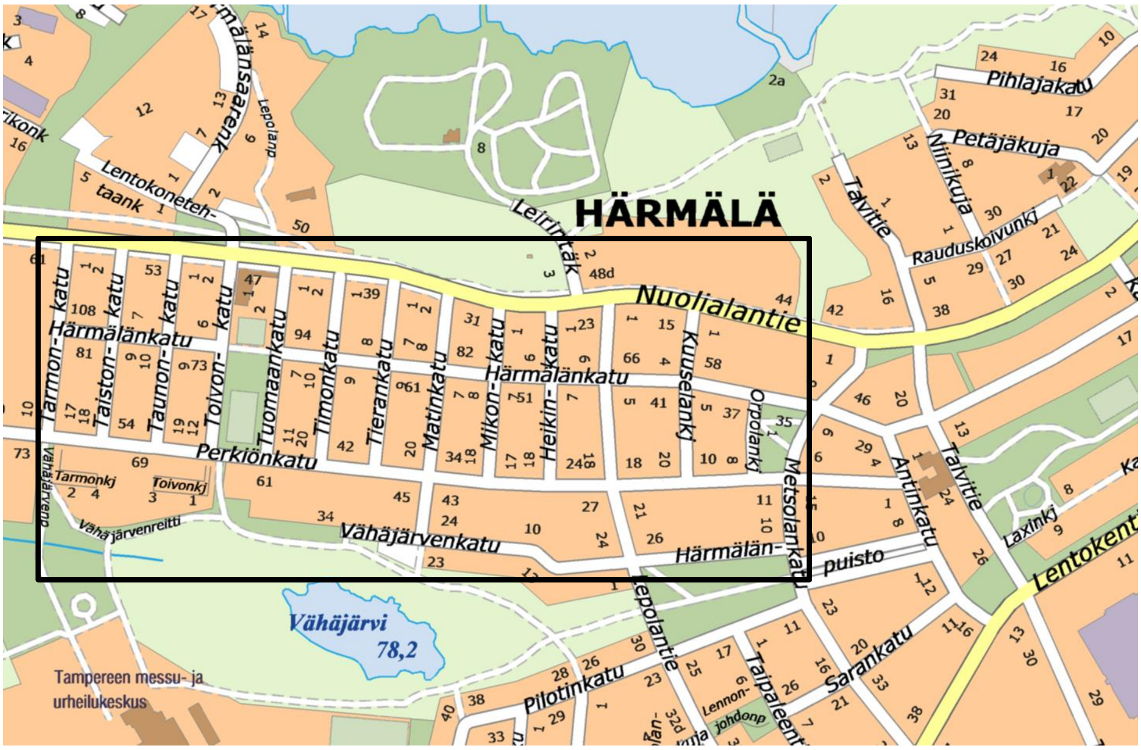


FIGURE 14. Sampling area in Härmälä district (Tampereen kartat 2017)

There was no available database on oil heated house owners that could have been accessed with the resources given for research, so the target group was contacted with a different method. The City of Tampere administers an open online database service that contains a variety of maps and geographic information on Tampere region (Tampereen kartat 2017). Oskari is an online map service in which one can select and examine different maps and geographical layers created by various organizations. For example, one layer highlights residential buildings with different colours based on the year of construction.

For this study, one map layer was of particular interest as it enabled to categorize buildings based on the fuel that they use for heating. Figure 15 presents a capture of the Härmälä district map in which such layer is selected. The colour classification indicates the following heating methods:

- Turquoise: District heating
- Light purple: Electric heating system
- Bright yellow: Wood-based heating
- Mustard: Geothermal heating system
- Red: Oil heating system

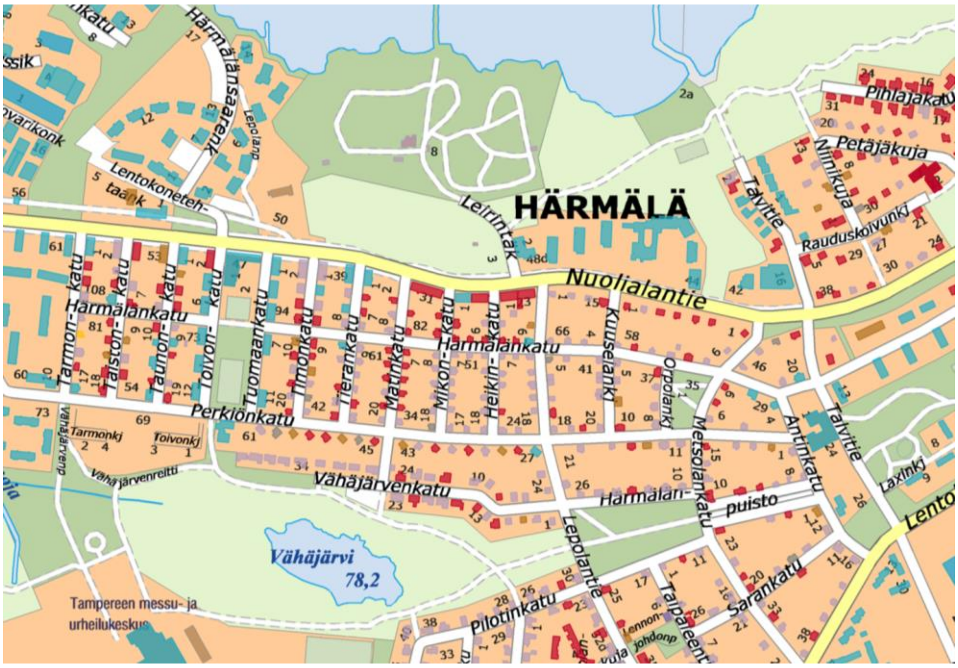


FIGURE 15. Buildings in Härmälä district categorized by heating method (Tampereen kartat 2017)

In this study, the red coloured buildings represented the target group. Once a building is selected in the Oskari map service, an information box opens up that shows additional information on the building such as the year of construction, main use of the building (such as residential or industrial) and for residential buildings the number of apartments in the building. The latter was also relevant in this study, since the number of apartments indicated which buildings were detached houses, or in other words, which included one or two apartments.

By using this map, oil heated detached houses in the sample area were identified and the homeowners were contacted by approximating the addresses and building numbers of such houses.

6.2.3 Data Collection

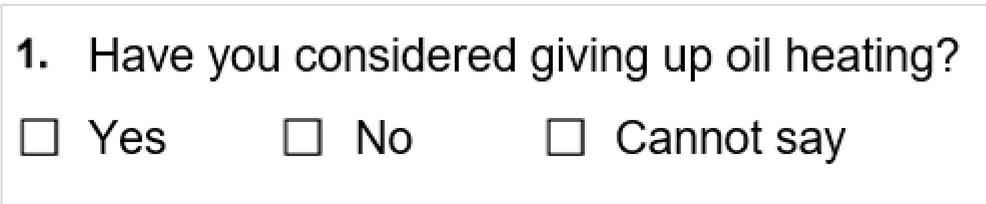
The methods for obtaining the required information were evaluated and a survey questionnaire was used as the data collection tool in this study. Often self-administered surveys are used to collect numerical data that will be analyzed by statistical methods (Phillips et al. 2013, 13.) and they are most commonly used in quantitative research (Metsämuuronen 2003, 168), but the questionnaire created for this research shared characteristics of both quantitative and qualitative surveys. The questions consisted of multiple-choice questions and open-ended and the results were analyzed by collecting numerical data from questions with different options and by interpreting the meaning behind responses on open-ended questions.

The plan was to execute a survey in a small-scale event and to invite people from the sample area by mail to join the event. In the meeting, the attendants would be shortly introduced with Sustainable Tampere 2030 -programme and AREA 21 project. The questionnaire would then be answered by the residents attending the event. The plan was to perform the questionnaire also in another event organized by a local detached house association Petsamon Omakotiyhdistys ry.

The reason behind performing a questionnaire rather than an interview was that this method enabled more responses in a certain time limit, whereas carrying out an interview would have required more time and resources. Since the plan was to have the respondents fill the questionnaire on their own during the event, it was possible to organize the participatory meeting with only two employees present: the writer of this thesis and the supervisor of this thesis.

6.2.4 Data Processing and Survey Analysis

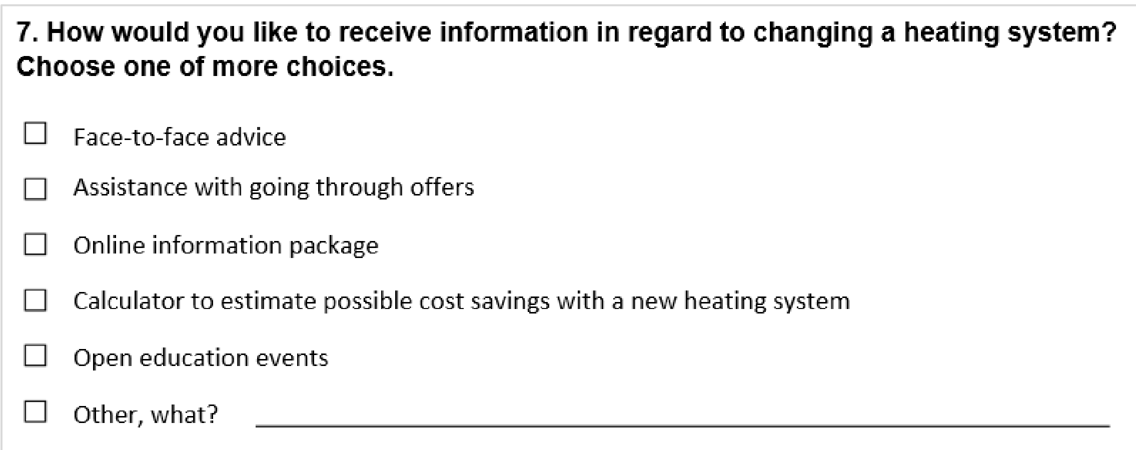
The data was processed and analysed in different ways depending on the question type. In their book *Survey Basics* (2013, 115) Phillips et al. divide the measurement of survey responses into four categories: nominal, ordinal, interval and ratio. Metsämuuronen uses the same scale categorization in his book (2003, 37-40). Nominal and ordinal scales were used in this survey, which is why interval and ratio scales were not introduced here. The choices in nominal scales have the same value, and survey respondents can answer the question by selecting a choice, or choices, of preference. Such responses were processed by counting the number of responses and presenting the results graphically. (Phillips et al. 2013, 115–119.) Figure 16 and figure 17 present examples of questions with a nominal scale in the questionnaire created for this research.



1. Have you considered giving up oil heating?

☐ Yes ☐ No ☐ Cannot say

FIGURE 16. A question with nominal scale response choices (Pekkola 2019)



7. How would you like to receive information in regard to changing a heating system? Choose one of more choices.

☐ Face-to-face advice
☐ Assistance with going through offers
☐ Online information package
☐ Calculator to estimate possible cost savings with a new heating system
☐ Open education events
☐ Other, what? ____________________

FIGURE 17. A question with nominal scale response choices (Pekkola 2019)

Question 1 in figure 16 inquired the respondents whether or not they have considered giving up oil heating. The respondent would then choose one of the choices and this way the questionnaire would indicate how many of the respondents have or have not considered giving up oil, or if they are not sure of the answer. Question 7 in figure 17 inquired the respondents' in which form they would most preferably want information regarding replacement of oil heating systems.

Another type of scale used in this survey is the ordinal scale. Some of the questions in this survey measured the attitudes and opinions of the respondents on certain topics by a commonly used Likert-scale (Metsämuuronen 2003, 40). Likert-scale is more commonly categorized as an interval scale, but when it is used to measure attitudes, it can be categorized as an ordinal scale (Phillips et al. 2013, 116–117; Metsämuuronen 2003 37–40).

In questions with ordinal scale choices, the respondents are asked to evaluate their feelings and attitudes on certain topics. For example, options might vary from "agree completely" to "do not agree at all" and there would be options with less intensity in between these extremes such as "agree", "neutral" or "do not agree". In this study, responses to questions with ordinal scale choices were analyzed so that the number of responses for each option was calculated. Figure 18 presents an example of a question with ordinal scale used in the questionnaire made for this study. Question 2 (figure 18) inquired the respondents thoughts on factors that have made them consider giving up oil heating.

2. If you have, what factors have contributed in having you consider giving up oil heating?

	Important factor	Slightly important factor	Not an important factor
High costs of oil heating	☐	☐	☐
Environmental effects and carbon emissions of oil	☐	☐	☐
Age of the oil boiler	☐	☐	☐
Oil heating system is burdensome to maintain and use	☐	☐	☐

Other, what? ______________________________

FIGURE 18. A question with ordinal scale response choices (Pekkola 2019)

6.2.5 Survey Limitations

In every survey, there is some level of inevitable error, states Cowles and Nelson (2015, 35). The most important thing to minimize error is to identify beforehand when and why error might occur and try to avoid it as well as possible. One of the most important sources of error in this survey was the sample size and how adequately it would reflect the general opinion of the owners of oil-heated detached houses of Tampere region. This error possibility was identified during sampling and, in the limits of the resources in this study, the sample size was maximized by handing out the invitation to the survey event to as many houses as possible.

Another source of error was adequacy of the Oskari-map service and the up-to-dateness of the data. Since home owners are not obliged to inform any authorities in the case of renewed heating system, except for when applying for a permit for a geothermal borehole, some of the detached houses that were categorized as oil heated in the map might have changed their heating method and the map data has not been updated. This error was minimized by excluding the houses that were marked as red in the map, or as oil heated, but that had a geothermal borehole mark as can be seen in figure 19. There was a different map layer showing the geothermal heat boreholes that needed to be selected.

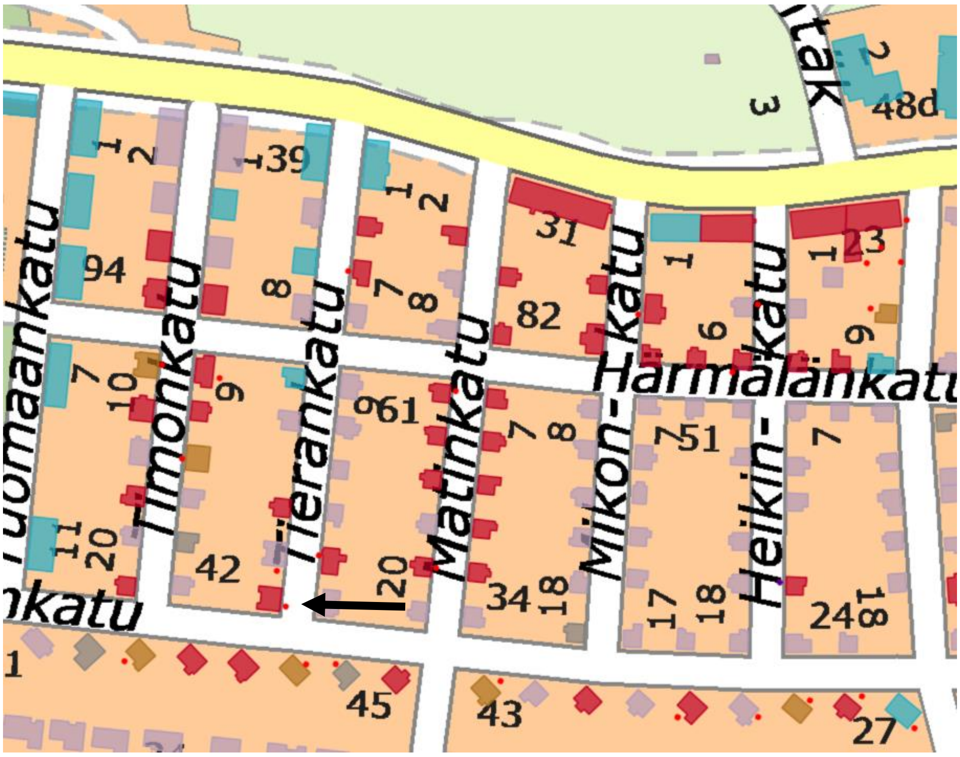


FIGURE 19. A geothermal heat borehole mark pointed by an arrow (Tampereen kartat 2017)

In the questionnaire itself, errors might occur in how well the sample reflects the opinions of oil heated house owners in general. The best way to minimize this was to select a sample that included all types of people from the target group. This means that the sample group would include residents of houses from different decades and residents from different age groups.

According to Cowles and Nelson (2015, 5) sometimes the way people feel and how they behave are not consistent with each other. (Cowles & Nelson 2015, 5.) This is a very important factor particularly in climate related issues. People might tell that they feel they are concerned about emissions and climate change and feel that preventive actions are highly important. Regardless, how they behave might not support this ideology. There are many, often very fundamental reasons why these two aspects do not correlate with each other, which was important to keep in mind when analyzing the results of this survey.

6.3 Survey Design

The questionnaire consisted of 10 questions and it is attached in the end of this thesis as appendix 2. The questionnaire begun with inquiring whether or not the respondents have considered giving up oil heating. The next two questions inquired the respondents' opinions on why they have considered some other heating methods and if something concerns them if they were to switch to an alternative heating system. Questions 4 to 8 asked the respondents on available information related to alternative heating methods: is there enough and accessible information or guidance available; should there be more information and guidance and in what form information and guidance should be presented or organized. Question 9 inquired that if the City of Tampere could offer some financial support for the home owners who wish to replace oil heating, in which area that support could focus on. Finally the last question was an open-end question to which the respondents could fill any optional feedback for the City of Tampere. In the footer of the questionnaire were the logos of EcoFellows Ltd., The City of Tampere and AREA 21 -project.

6.4 Survey Execution

The questionnaire was executed in two events that were organised a week apart in March. In the other event, that was organised by another organisation, three people fillef the questionnaire. For the other event, fifty invitations (appendix 1) were delivered to the mailboxes of presumably oil-heated houses residents in-Härmälä district. The letter invited residents to join an open event to participate and help to plan services that are designed for owners of oil heated detached houses. Since the number of responses remained so little, the responses from both events were combined and they were analysed as a whole.

7 SURVEY RESULTS

As a remark, regarding the small sample size, the results of the questionnaire performed in Tampere are not able to adequately reflect the general opinion of the target group, that is residents of oil heated detached houses. Hence, the questionnaire results merely offer insight on the opinions of the respondents and cannot be regarded as a representative to the opinions of the target group in general. Regardless, the results were analyzed by comparing them with the more extensive results from the surveys conducted by HSY and City of Hyvinkää in collaboration with Motiva

7.1 Interest towards deployment of alternative heating methods

Based on the results, 100 % of the respondents in Tampere had considered replacing their oil heating system with an alternative heating method. This result can most likely be explained by the nature of the event in which the questionnaire was performed. As the event was organized for residents of oil-heated houses to discuss their inclination towards switching to an alternative heating method, it was likely to be discovered that the respondents had considered giving up oil heating. The survey by HSY (Öljylämmittäjät pohtivat muutoksia… 2019) indicated that 43 % of the respondents with oil-heated houses in the Capital Region had planned to switch to an alternative heating method. Additionally, 22 % of the respondents in the Capital Region had considered adding a supplementary heating method alongside oil heating (Öljylämmittäjät pohtivat muutoksia… 2019).

The survey conducted in Hyvinkää (UE-kysely hyvinkääläisille… 2018) showed similar results. As mentioned in chapter 3.2.3, oil heating was commonly deployed in 1960’s and 1970’s which is supported by the results from Hyvinkää. The majority of respondents of the survey lived in detached houses that were built in 1950’s and 1960’s and the heating in the respondents’ houses was mainly based on oil, wood or electric heating (UE-kysely hyvinkääläisille… 2018). The results from Hyvinkää also indicated that many of the respondents had considered deploying solar energy and heat pumps in their houses (UE-kysely hyvinkääläisille… 2018).

In Tampere, the respondents were asked about the factors that have contributed in having them consider alternative heating methods (figure 20). The results indicate that the majority of respondents considered the environmental effects and CO_2 emissions of oil heating to be important factors. Furthermore, 6 respondents considered the age of the oil boiler in their house to be an important factor. Additionally, 9 respondents out of 11 see that the inconvenience of maintaining and using an oil heating system was not an important factor. The reason for this result is most likely that the majority consider oil heating a convenient and effortless heating method.

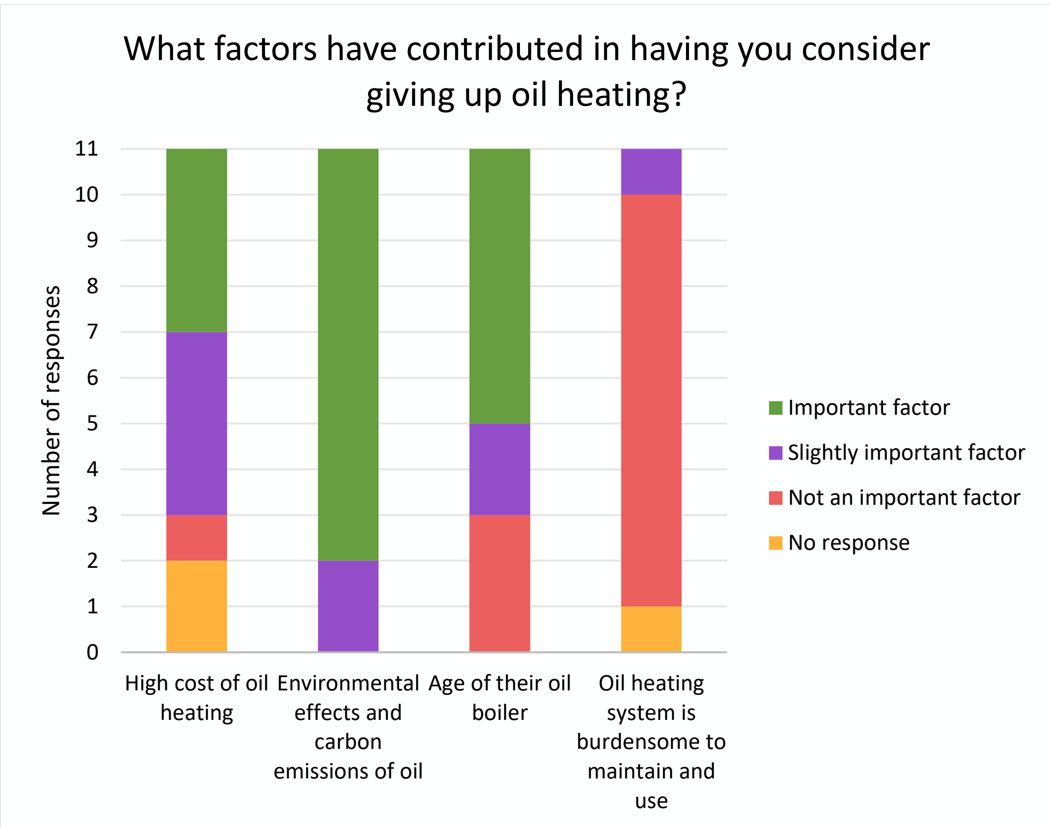


FIGURE 20. Factors that have contributed in having the respondents in Tampere reconsider giving up oil heating

The survey by HSY also inquired the factor that have made the respondents consider changing their main heating method (Lämmitystapakysely 2018). The responses are presented in figure 21. The responses that are closer to 1 in the scale are regarded as the most effective and the responses closer to 4 are regarded as less effective. The results indicate that the effects on the annual heating costs was the most important factor to affect the decision whereas better cooling possibilities was regarded as the least important factor. Also the investment costs and profitability of the investment had significantly impacted many of the respondents. The environmental effects and easiness and safety of the new heating method were chosen to have somewhat impact on the decision.

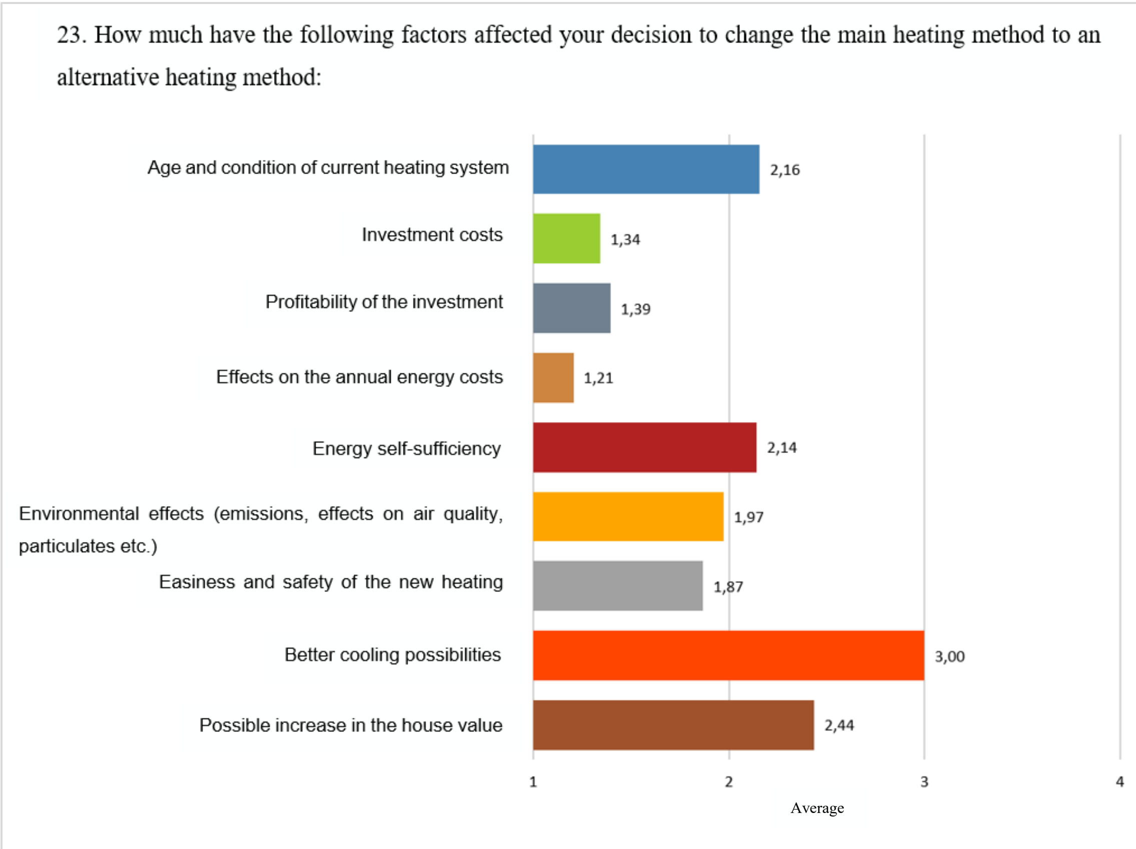


FIGURE 21. Factors that have affected the respondents in the Capital Region to change the main heating method (figure published with permission) (Lämmitystapakysely 2018)

In Hyvinkää (UE-kysely hyvinkääläisille… 2018), the respondents were asked about the reasons for investing in a renewable energy heating system or why they are considering a new investment (figure 22). The respondents could choose two reasons that were most important for them. The results show that 57 % of the respondents saw that the environmental reasons and/or energy savings were important reasons affecting the renewable energy investments they already had made or considered making. In addition, 42 % people chose short repayment period and/or savings in heating costs as one of the most important reasons.

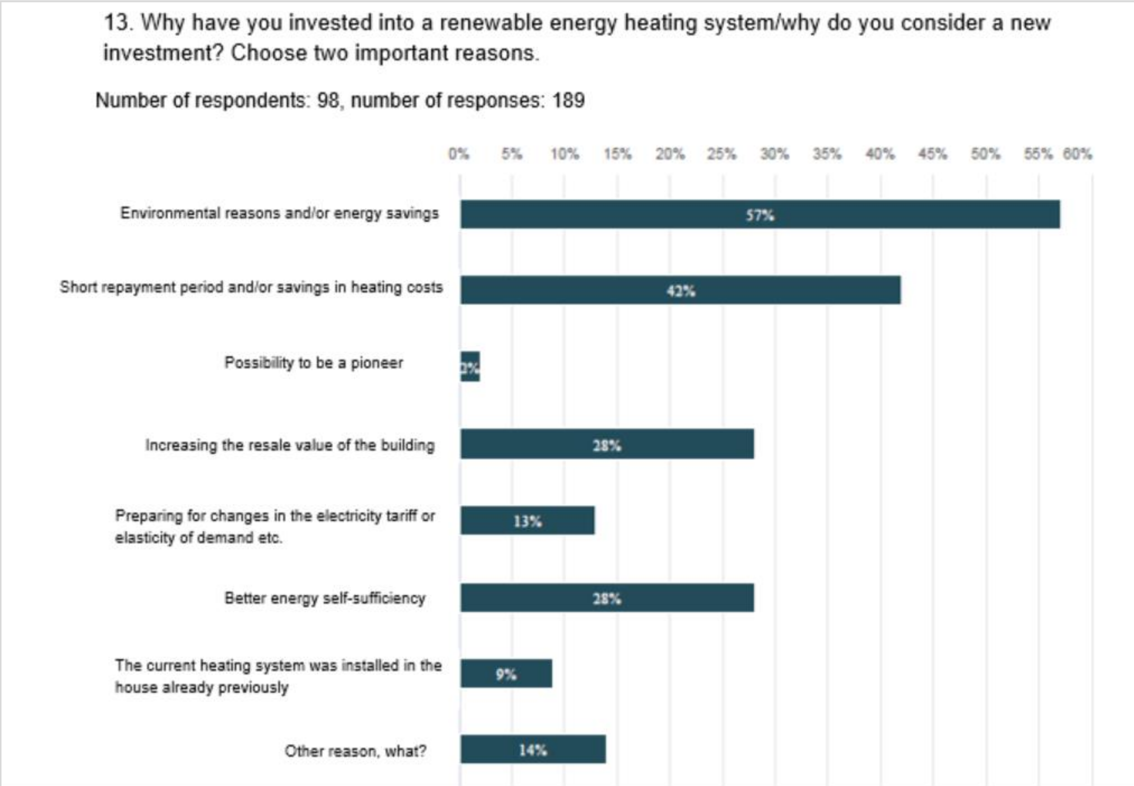


FIGURE 22. Reasons why respondents in Hyvinkää have invested or will invest into renewable energy sources (figure published with permission) (UE-kysely hyvinkääläisille… 2018)

To conclude, the Tampere survey supported the results gathered from the surveys conducted in Hyvinkää and the Capital Region. The results showed that the respondents had similar views on the factors that have had them consider alternative heating methods. The results indicated that the investment costs, heating costs and environmental reasons were one of the most important contributing factors. However, the results are not fully comparable as the respondents in Tampere all had oil heating systems while only 43,5 % of the respondents in the Capital Region and 27 % of Hyvinkää respondents had oil heating.

7.2 Factors that hinder the deployment of new heating methods

The surveys also inquired on the factors that concerned the respondents in regard to changing the main heating system of a house. In Tampere, two of the most important factors that concerned the respondents are the cost of the new heating system and finding a suitable heating system (figure 23). Finding a qualified contractor was also chosen as an important factor by 45,5 % of the respondents. According to the results, the least concerning factors were the aspects regarding the removal of oil boiler.

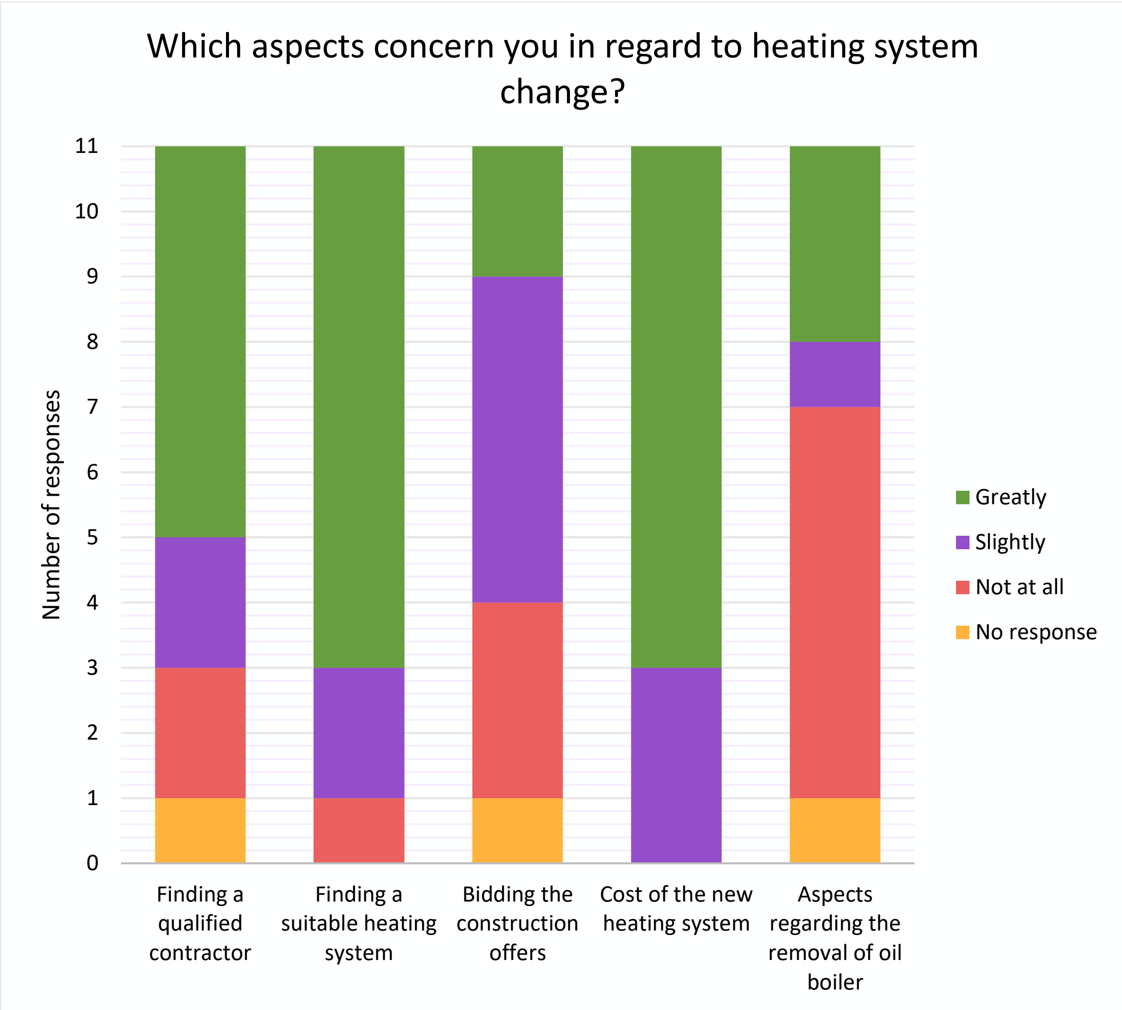


FIGURE 23. Aspects that concern the respondents in Tampere in regard to heating system change

Similar responses can be seen in the results from the Capital Region (figure 24). More than half (53,5 %) of the respondents felt satisfied with their old heating system, which is one of the main reasons why they were not too keen on investing in a new heating system. The second most important reason (with a 41,1 % share) that hindered the deployment of alternative heating methods were the high investment costs of a new heating system. The results from Tampere coincide with these results. The other factors that were highlighted in the Tampere results (suitability of a new heating system and finding a qualified contractor) were not regarded as highly important in this survey.

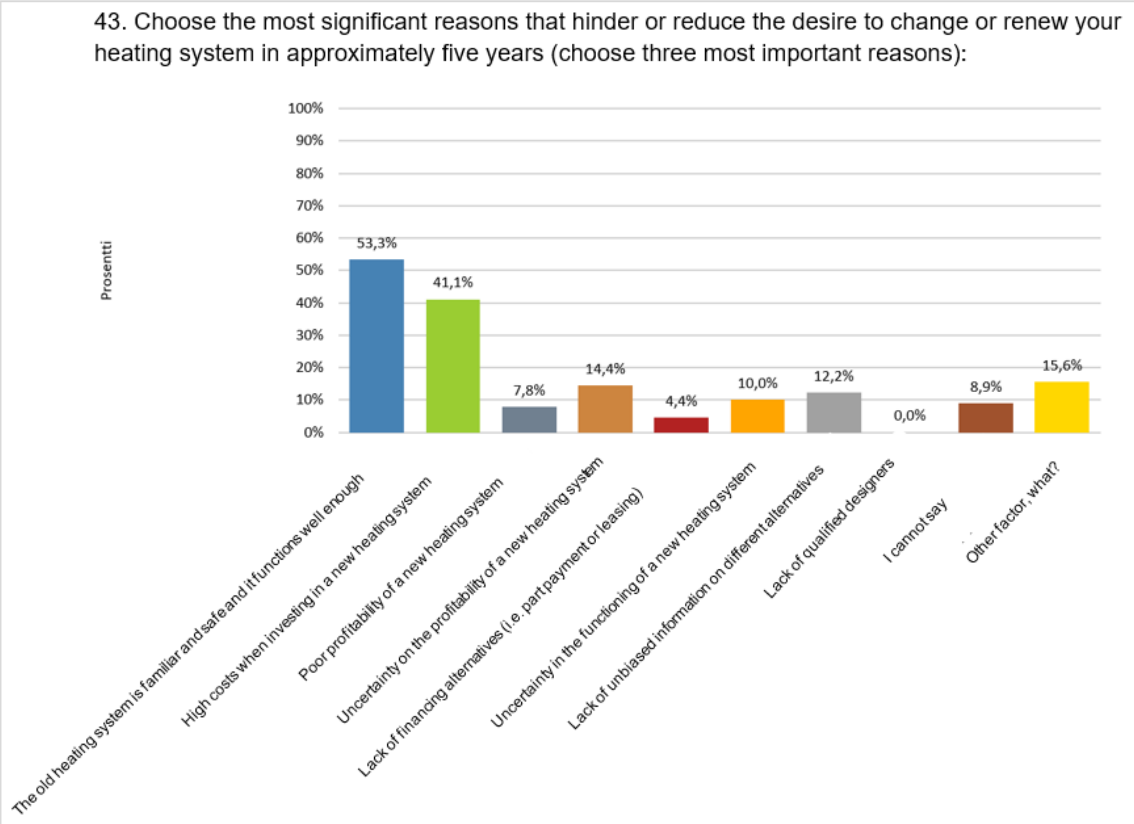


FIGURE 24. Reasons that hinder or reduce the desire of the respondents in the Capital Region to change or renew heating system in approximately five years (figure published with permission) (Lämmitystapakysely 2018)

As a continuum to question 13 (figure 22) the Hyvinkää survey also inquired the factors that would promote making a decision to invest to a renewable energy heating system (figure 25). Financial aspects were also highlighted in the results as 49 % of the respondents felt that they would need more or better quality information on the economy of the investment. The second most important promoting factor (by 43 %) was the need for more or better-quality information on the most suitable heating options. The results from Tampere supported the results from Hyvinkää in most part.

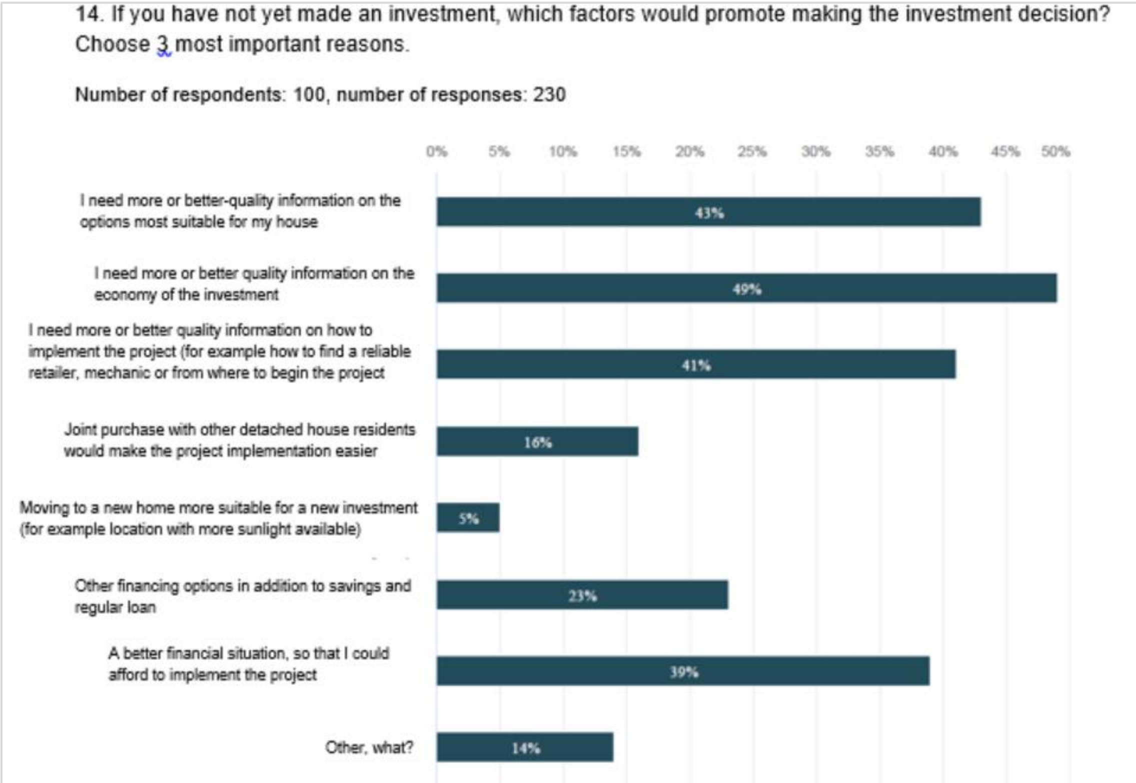


FIGURE 25. Most important reasons for the respondents in Hyvinkää that would promote making a renewable energy investement decision (figure published with permission) (UE-kysely hyvinkääläisille… 2018)

The results from Tampere supported the results from Hyvinkää in most part. The findings from Hyvinkää also brought up the aspect of offering alternative financing solutions to a regular loan. This will be further discussed in chapter 9.

7.3 Receiving information

The last topic in the surveys was receiving information. The majority of the respondents (73 %) in Tampere had searched for information in regard to replacing an oil heating system, but only 27 % felt that there is enough information and advice available on the issue. The respondents responded that they have found information online (55 %), from events (18 %), from an energy advisor (18 %), from acquintaces (18 %) and from exhibitions (9 %). None of the respondents had received information from contractors or designers.

Figure 26 shows results of a question that asked the respondents on the preferences for ways of receiving information and advice on new heating systems. The majority of the respondents would be interested in a calculator that would estimate possible cost savings of a new heating system. In addition, approximately half of the respondents would prefer face-to-face service and an online information package.

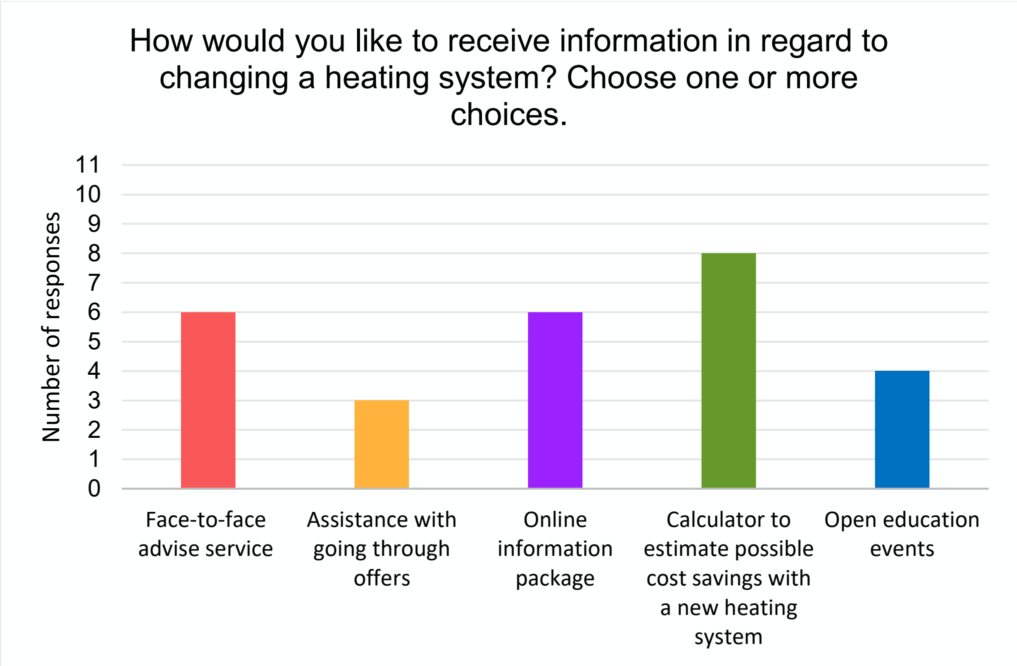


FIGURE 26. Preferences of the respondents in Tampere of ways of receiving information

Figure 27 shows a question about the topics related to heating system change that the respondents in Tampere would be interested in. The results show that the respondents would be most interested in learning more about the costs of alternative heating systems and also on the pros and cons of different heating systems. Third most popular option were case houses in which oil heating has been replaced. The Tampere questionnaire also asked that if The City of Tampere were able to provide financial subsidies regarding heating system change, in which particular part of the process is should be focused on. Most of the respondents would prefer receiving subsidies regarding the investment of a new heating system. However, as the topic did not arise in the other two surveys, it would require more study and will not be discussed on this thesis.

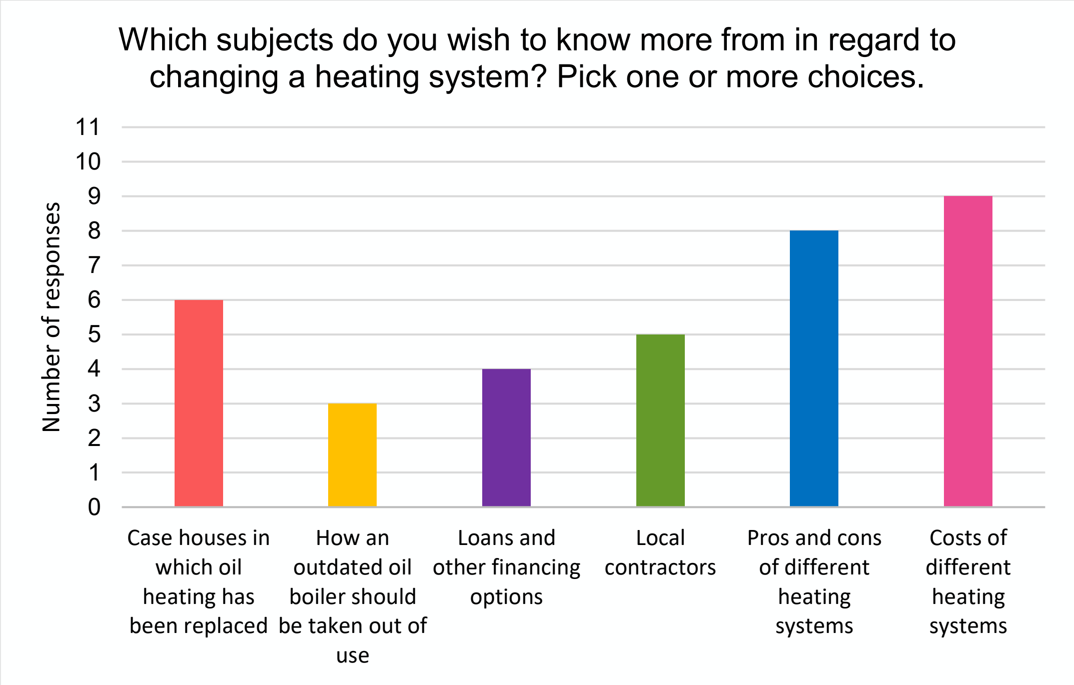


FIGURE 27. Preferences of the respondents in Tampere of information contents

In the HSY survey a similar question as in figure 27 was asked from the respondents (figure 28). The question inquired how useful they considered the suggested ways were to receive unbiased advice regarding the change of a heating method. The choices are scaled so that 4 is most useful and 1 is least useful. The results indicate that the respondents felt that advice on a website would be the most useful method in receiving unbiased information and advice. Also, personal advice via e-mail, phone or face-to-face was the next useful option. The results from the Tampere survey were coherent with the results from the Capital Region in regard to information source preferences. The respondents in both surveys preferred to receive information online or in a more personalized form as face-to-face, phone or e-mail advice. Most of the respondents in Tampere were interested in a heating system cost calculator, however, the demand for this type of service would require more study.

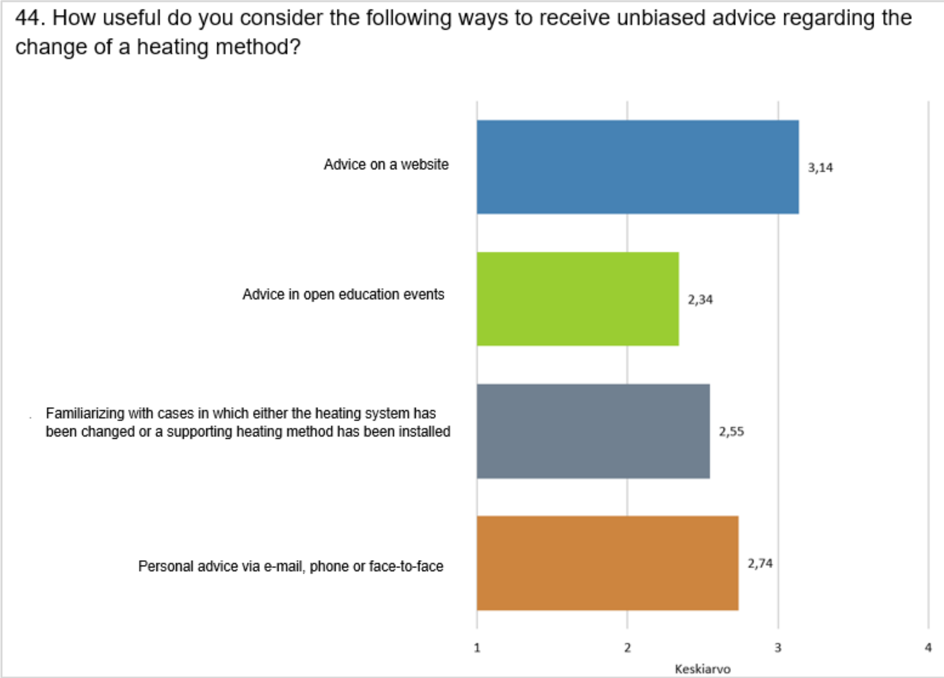


FIGURE 28. Preferences of the respondents in the Capital Region on ways of receiving information (figure published with permission) (Lämmitystapakysely 2018)

In the Hyvinkää survey, a similar question was asked as in the Capital Region and Tampere, but the viewpoint was slightly different. In Hyvinkää, the respondents were asked about the reliability of different information sources (figure 29). However, it can be assumed that once a respondent chooses a reliable information source, they would prefer receiving information through that source rather than an unreliable source. Thus, the question was comparable with the questions presented in Tampere (figure 26) and in the Capital Region (figure 28).

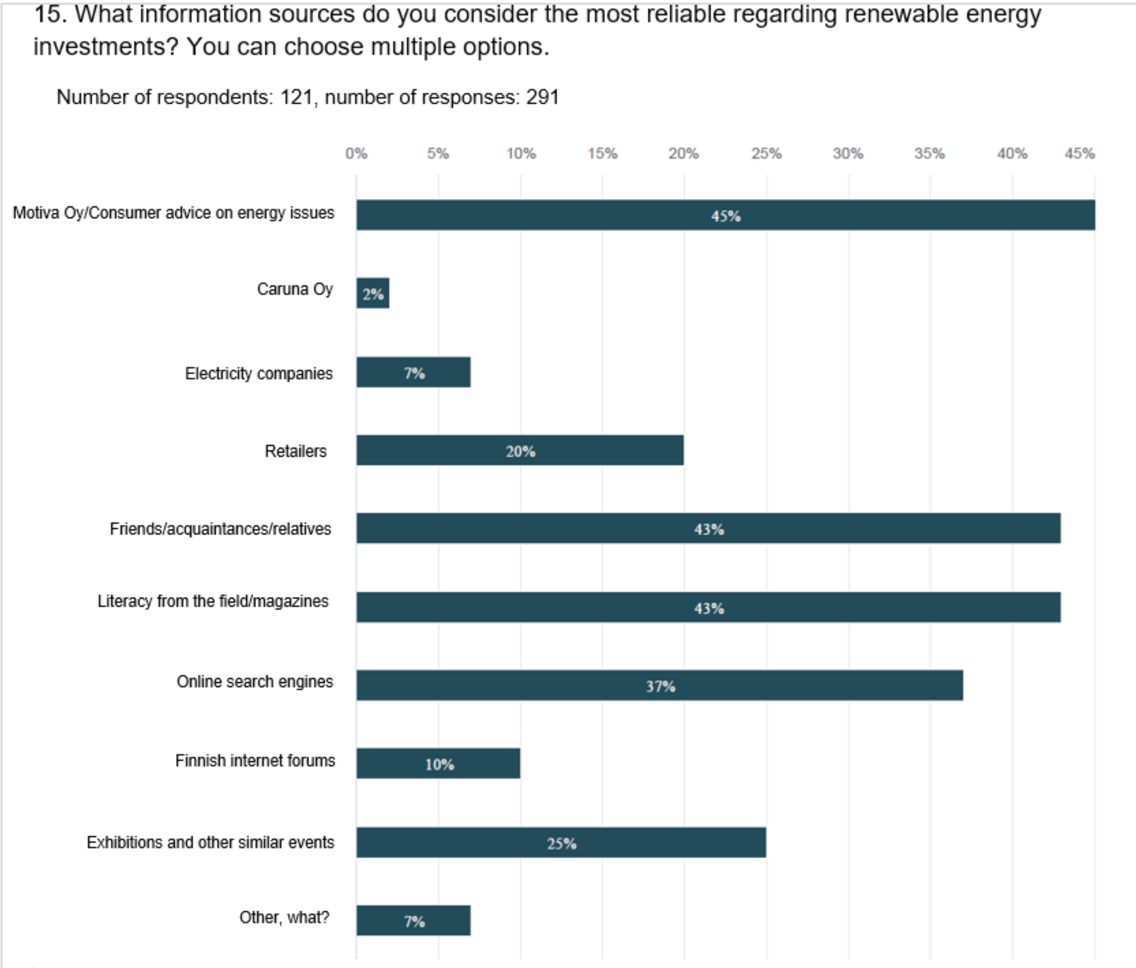


FIGURE 29. Preferences of the respondents in Hyvinkää on reliability of information sources (figure published with permission) (UE-kysely hyvinkääläisille... 2018)

As can be seen from the results (figure 29), 45 % of the respondents in Hyvinkää considered Motiva Oy and Motiva's Energy Advice for Customers -service a reliable information source. In addition, 43 % of the respondents felt that information received from friends, acquaintances or relatives and literacy or magazines from the field were reliable sources. Online search engines was selected a reliable source by 37 % of the respondents.

8 RECOMMENDATIONS FOR THE CITY OF TAMPERE

The results of the surveys were analyzed and an overview on the opinions of the respondents was conducted. The most important findings were collected together to form a set of suggestions for the City of Tampere. These suggestions can then be used to assist in engaging the residents of oil heated houses to change to an alternative heating system.

8.1 Information on investment and annual heating costs

The importance of financial aspects was visible in the results of all three surveys. Firstly, most of the respondents in the Capital Region answered that their decisions in regard to choosing a new heating system are more affected by the annual and investment costs than by other factors (figure 17). Secondly, based on the results from Hyvinkää, the most pressing aspects behind made or future heating system renewals have been environmental reasons and/or energy savings and the short repayment period and or/ savings in heating costs (figure 18). The results from Tampere were coherent with the surveys, as most of the respondents felt that the cost of the new system was the most concerning aspect in regard to heating system change (figure 19). Similar opinions arose questions in figure 20, 21 and 23. As mentioned before, these responses are gathered from residents with a variety of heating systems. Regardless, the process of changing the main heating system of a house is similar in any case as the home owner must ponder between different alternatives and choose the one best suited for the purposes of the residents in that house (Energiatehokas koti 2018).

Based on the results, to engage residents to change their oil heating system, the City of Tampere should offer reliable, unbiased and up-to-date information on the costs of different heating systems. Especially the modern heat pump technology is significantly more energy efficient and the annual heating costs are therefore lower than for example in oil heating (Hakala 2018). Also, a recent thesis case study shows the possible cost savings that could be achieved if oil heating was replaced with alternative methods (Räsänen 2018). Hence, to encourage residents to change their current oil heating system it would be important to bring focus on the cost effectiveness of alternative heating methods. Based on the results, the investment costs is one of the most concerning aspects, thus The City of Tampere could provide annual cost calculations of different heating methods and show the repayment periods of different systems.

8.2 Offer information on different alternatives

The respondents' concern on finding the most suitable heating method was also visible in the results. In Hyvinkää, nearly half (43 %) of the respondents felt that they would need more or better quality information on the options most suitable for their house (figure 21). The results from Tampere were parallel with these results (figure 19 & 23). Some of the respondents (12,2 %) in the Capital Region also felt that the lack of unbiased information on different alternatives was a significant reason to reduce the desire to change or renew their current heating system (figure 20).

It is evident form the results, that a large share of the respondents are not satisfied with the amount of information available regarding alternative heating systems and their suitability on different houses. Hence, The City of Tampere should focus on offering extensive information on different alternatives.

8.3 Information on case properties

As a continuum to the previous chapter, another aspect that the City of Tampere should focus on is offering information on example houses. The results from Hyvinkää show that 41 % of the respondents felt that they would need more information on implementing a heating system change (figure 21). The results from Tampere were parallel, as many respondents answered that they would like to receive information on case houses, in which oil heating system has been replaced.

By offering the residents with real-life example houses, in which heating system has been renewed, they would have a better understanding on the process implementation and on the savings that would be possible to achieve.

8.4 Focus on online and personal advising

The last topic in the surveys dealt with receiving information. In the Capital Region, a large share of the respondents considered receiving information from a website very useful (figure 24). Many also considered receiving information personally via e-mail, phone or in person useful. In Hyvinkää the respondents considered Motiva, acquaintances, literacy from the field and online search engines, respectively, the most reliable sources in regard to renewable energy investments (figure 25). The survey from Tampere supported these results (figure 22).

Based on the results many residents would prefer receiving information online or more personally via e-mail, phone or in person. Therefore, the City of Tampere should focus on providing information to residents through these communication channels. Additionally, as a large share of the residents in Hyvinkää saw Motiva as a reliable information source, an alternative for the City of Tampere would be to create up-to-date informative guides on replacing an oil heating system with alternative heating methods.

9 DISCUSSION

The surveys by HSY, Motiva and City of Hyvinkää and the survey conducted in Tampere offered insights on the opinions of residents of detached houses towards heating system renewals. The results indicated that one of the pressing factors to affect the implementation of heating system change is financial aspects. Many respondents were concerned on the investment costs of alternative heating systems and the effects of a new system on annual heating costs. This result was expected since there is always the financial aspect in house renovation projects. Although the investment costs are high especially in geothermal heating systems, the annual heating costs are the lowest among all heating methods (Räsänen 2018, 61−71). Therefore, in theory the investment can be repaid with the savings in the heating costs compared to oil heating and the residents do not have to compromise comfortability in lifestyle. Still, many do not want to take a loan by principle, which adds depth to the issue. The possible solution for this would be to offer alternative payment methods alongside a regular loan, a topic that was brought up in the Hyvinkää survey as well (figure 25).

Although the goal of the City of Tampere is to end fossil fuel -based heating, a recent calculation in a thesis from Tampere University of Applied Sciences shows that the least expensive heating option would be a combination of oil heating and an air-to-water heat pump (Räsänen 2019, 76). The CO_2 emissions would still decrease significantly if heating oil would be consumed only during colder temperature peaks when the efficiency of the air-to-water heat pump decreases. Additionally, it is not wise to replace a recently renewed or installed, well-functioning system as the energy efficiency in newer equipment is significantly higher than in older systems. Energy is always consumed in the production phase of heating system equipment and the most sustainable option would be to maintain the oil heating system until the end of its life cycle.

Another method to accelerate the replacement of oil heating would be to provide subsidies or other incentives for home owners. Researchers in BCDC Energy – a research project on increasing solar and wind power utilisation – have compiled a list of recommendations for the Finnish Government to promote the deployment of clean energy solutions in residential buildings (Ikonen 2019). The recommendations highlight the importance of incentives for home owners to achieve reductions in emissions (Ikonen 2019). The recommentations state that the incentives could include subsidies or loan guarantees offered by the State.

Another approach to accelerate the replacement of oil heating is taxation. The current government of Finland aims to mitigate climate change and has stated that it will increase the fossil fuel taxation significantly in the near future resulting in increased heating costs in oil heated houses (Ikävalko 2019). Although the exact number of taxation increase can not be predicted yet, it would be beneficial to include an estimated taxation increase into the heating cost calculations provided for the public. As mentioned earlier, another way to promote the transtition to oil-free heating is to offer incentives for the home owners. Of these two options, incentives would most likely promote the deployment of alternative heating methods more rapidly than increased taxation. Increasing taxation serves the interest of the government and it would be a noteworthy method to rid of oil heating. It has even been proven succesfull for example in Sweden, where increasing oil taxation resulted in the transition towards mostly heat pump -based heating (Kyytsönen 2017). However, incentives would serve the interest of the residents and the transition towards oil-free heating could still be achieved. The difference is that by increasing taxation the residents would be punished for having oil heating and by offering incentives the residents woud be rewarded for making smart, energy efficienct heating choices.

Another topic that arose in the results is the lack of reliable and unbiased information on different alternatives and their suitability on different houses. This issue was visible in all the surveys (figures 19, 20, 21 & 23). In addition, a large share of the respondents in Hyvinkää and in Tampere were interested in receiving information through case examples. Example houses would offer reliable and realistic information for the residents.

Lastly, the surveys examined in which forms residents of detached houses would prefer to receive information regarding heating system change. The most preferred options were online advice and advising more personally via e-mail, phone of in a face-to-face situation. The survey in Tampere also brought up the high level of interest among the respondents towards an online calculator that would estimate the savings in heating costs with alternative heating methods. However, due to the small sample size and unreliability of the survey, the demand for such calculator would require more examination.

The main aim of this thesis was to create an overview on the opinions of the residents of oil heated detached houses, however, a fully reliable overview was challenging to form due to various reasons. Firstly, the surveys conducted in Huvinkää and the Capital Region were extensive and the sample size was large in both cases. Therefore, the surveys could adequately represent the opinions of a larger population. However, as both questionnaires were targeted at residents of detached houses with varying heating systems, it was unclear of how well the results could be applied in this thesis.

Another factor that affected the reliability of the results was the small sample size in the Tampere survey. As mention in chapter 6.2.2, the key to a reliable survey in which the respondents accurately represent the opinions of all the people in a larger population (Cowles & Nelson , 14) is sampling. There was no up-to-date database on oil heated detached as home owners are not obliged to inform any authority on heating system change. The drilling of a geothermal heat pumps borehole requires a permission and the boreholes have been marked in the Oskari map service, however it remained unclear of how often the map is updated.

It is clear that the 11 respondents that were the sample in the Tampere survey could not accurately represent a larger population. Regarding that 50 invitations were delivered in Härmälä district and eight people attended the event, the ratio of attendees to the invitations is fairly good. Additional three people filled out the questionnaire in another event. However, the findings from Tampere were mainly parallel with the findings from Hyvinkää ja the Capital Region, which indicates that there is reliability in the findings. A higher response rate in Tampere could have been achieved by an online survey, however, the data analysis and survey execution would have required more resources and then the entire scope of the thesis would have been different.

10 CONCLUSION

The aim of this thesis was to conduct an overview on the opinions and concerns of detached house residents when they are planning to change their main heating system. The purpose was to find relevant information for the City of Tampere to assist in planning services that would ease the property owners' process towards oil-free heating. The overview was formed by utilizing three surveys that investigated the current state of heating in detached houses and the interest of the residents towards deploying alternative heating methods (Motiva 2018). Although two of the surveys were targeted to detached house residents that heat their houses in variety of ways, many parts of the results were applicable to serve the goal of this study. Based on the overview, a list of suggestions was created for The City of Tampere to assist in engaging property owners in giving up oil heating.

Based on the results, one of the most pressing issues that hinders the willingness of detached house residents to change their main heating system is the financial aspect. The results indicate that the investment costs and annual heating costs concern many home owners and they would like to receive more information regarding these topics before they could make a decision on heating system renewal. The results indicated that more unbiased information is needed regarding heating system alternatives. Based on the results, the most preferred ways to receive information is online advice and more personal forms of advice such as face-to-face, via e-mail or via phone.

The surveys conducted in Hyvinkää and in the Capital Region addressed residents that heated their houses with varying methods whereas the survey in Tampere was directed only for residents of oil-heated detached houses. Also the sample size in the survey conducted in Tampere was small which means that the results are not able to represent the opinion of a larger population. Therefore the reliability of the result should be taken with reserve.

By the end of 2019 EcoFellows will publish a website in collaboration with the City of Tampere regarding oil-free heating. The website will offer information for the residents of oil-heated detached houses on alternateive heating methods and instructions on how to replace their heating system.

REFERENCES

AREA 21. N.d. Tampere: Energy Improvement District Härmälä. Read on 15.6.2019. https://area21-project.eu/pilot-areas/tampere/

Arvela, P & Mäkinen, E. 2014. Measurement of the Coefficient of Performance (COP) of a Heat Pump. Course material. Physics laboratories. Tampere University of Applied Sciences.

Aurinkolämpö. 2019. Motiva Oy. Read on 22.8.2019. https://www.motiva.fi/ratkaisut/uusiutuva_energia/aurinkolampo

Brander, M. 2012. Greenhouse Gases, CO_2, CO_2e and Carbon: What Do All These Terms Mean? Ecometrica. Read on 22.8.2019. https://ecometrica.com/assets/GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf

Burch, S. L. 2014. Understanding Climate Change: Science, Policy and Practice.

CO_2-päästökertoimet. 2019. Motiva. Read on 15.8.2019. https://www.motiva.fi/ratkaisut/energiankaytto_suomessa/co2-laskentaohje_energiankulutuksen_hiilidioksidipaastojen_laskentaan/co2-paastokertoimet

CO2-raportti & Benviroc Ltd. 2019. Tampereen kasvihuonekaasupäästöt 1990, 2010-2017: Ennakkotieto vuodelta 2018. Read on 22.8.2019. https://www.tampere.fi/tiedostot/c/nMONFbNzn/CO2-raportti_Tampere_13032019.pdf

Cowles, E. L. & Nelson, E. 2015. An Introduction to Survey Research. Business Expert Press: New York.

Energiatehokas koti. 2016. Lämmitysjärjestelmien elinkaari. https://www.energiatehokaskoti.fi/suunnittelu/talotekniikan_suunnittelu/lammitys/lammitysjarjestelmien_elinkaari

Energiatehokas koti. 2018. Lämmitys. https://www.energiatehokaskoti.fi/suunnittelu/talotekniikan_suunnittelu/lammitys

European Commission. N.d. Causes of Climate Change. Read on 4.6.2019. https://ec.europa.eu/clima/change/causes_en

Finnish Energy. N.d. District heat is produced close to the customer. Read on 9.8.2019. https://energia.fi/en/energy_sector_in_finland/energy_production/district_heating

Hakala, J. 2018. 5 erilaista talo: Näin paljon maalämpöpumppu säästää vuodessa – pakkaspäivinä yli 10e/vrk. Read on 25.8.2019. https://www.is.fi/taloussanomat/art-2000005578707.html

Healey, J. 2014. Climate Change Crisis. Australia: The Spinney Press.

Herrala, O. 2019. Öljylämmittäjän paheneva kiirastuli: "Veroraippaa tulee selkään koko ajan". Read on 15.9.2019. https://www.kauppalehti.fi/uutiset/oljylammittajan-paheneva-kiirastuli-veroraippaa-tulee-selkaan-koko-ajan/d43384c8-d757-496f-808c-728f156a03f8

Hippinen, I. & Suomi, H. 2012. Yksittäisen kohteen CO^2-päästöjen laskentaohjeistus sekä käytettävät päästökertoimet. Motiva Oy.

HSY. 2018a. Ilmastoinfo toimii. Read on 16.8.2019. https://www.hsy.fi/fi/asukkaalle/hillitse-ilmastonmuutosta/ilmastoinfo-toimii/Sivut/default.aspx

HSY. 2018b. Puunpoltto. Read on 9.8.2019. https://www.hsy.fi/fi/asiantuntijalle/ilmansuojelu/tietoailmasta/Sivut/Puunpoltto.aspx

HSY. N.d. Öljystä uusiutuviin. Read on 26.8.2019. https://energianeuvonta.fi/tietoa-sivustosta/
https://ilmasto-opas.fi/fi/ilmastonmuutos/hillinta/-/artikkeli/28259fe8-7b5e-4806-8ab6-7c06739ef5cc/kestavat-kuluttajavalinnat.html
https://www.managenergy.net/ManagEnergyProject

Hundy, G. H., Trott, A. R. & Welch, T. 2016. Refrigeration, air conditioning and heat pumps. 5th edition. United Kingdom: Butterworth-Heinemann is an imprint of Elsevier.

Hybridilämmitys. 2018. Energiatehokas koti. Motiva. Read on 21.8.2019. https://www.energiatehokaskoti.fi/suunnittelu/talotekniikan_suunnittelu/lammitys/hybridilammitys

Ikonen, K. 2019. Uusi politiikkasuositus: Hallitusohjelmalla vauhtia rakennusten puhtaisiin energiaratkaisuihin. Read on 15.9.2019. http://www.bcdcenergia.fi/blogi-ja-uutiset-uusi-politiikkasuositus-hallitusohjelmalla-vauhtia-rakennusten-puhtaisiin-energiaratkaisuihin/

Ikävalko, K. 2019. Suomi reiluun etukenoon ilmastotalkoissa – fossiilivapaus tuo isoimmat veronkorotukset autoilijoille, mutta myös teollisuus ja öljylämmittäjät saavat osansa. Read on 15.9.2019. https://yle.fi/uutiset/3-10814125

Ilmasto-opas. N.d. Kasvihuonekaasut lämmittävät. Read on 16.8.2019. https://ilmasto-opas.fi/fi/ilmastonmuutos/ilmio/-/artikkeli/3a576a6e-bec5-44bc-a01d-11497ebdc441/kasvihuonekaasut-lammittavat.html

Intergovernmental Panel on Climate Change (IPCC). 2018. Global Warming of 1.5 °C: An IPCC Special Report on the Impacts of Global Warming of 1.5 °C pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

Janne Laurila. Project planner. 2019. Interview on 20.11.2018. Interviewer Rinta-Rahko, J. Tampere.

Johnson, W. & Standiford, K. 2009. Practical Heating Technology. 2nd Edition. Delmar: Cengage Learning.

Kaukolämpö tuotetaan lähellä asiakasta. N.d. Energiateollisuus ry. Read on 21.8.2019. https://energia.fi/perustietoa_energia-alasta/energiantuotanto/kaukolammon_tuotanto

Kaukolämpö. 2019. Motiva. Read on 21.8.2019. https://www.motiva.fi/koti_ja_asuminen/rakentaminen/lammitysjarjestelman_valinta/lammitysmuodot/kaukolampo

Kaukora Oy. N.d. Jäspi-pellettilämmitys. A brochure. Read on 22.8.2019. https://jaspi.fi/wp-content/uploads/2017/03/Jaspi_Pellettikattilat_web_1209.pdf

Kaupunginhallitus. 2018. Smart Tampere: Kestävä Tampere 2030. The City of Tampere programme plan.

Kestävä Tampere 2030 - kohti hiilineutraalia kaupunkia -linjaukset. 2018. Publication. Tampere: Yhdyskuntalautakunta, Kaupunginvaltuusto & Kaupunginhallitus.

Kontiainen, T. 2016. Öljystä tai puusta on helppo siirtyä pelleteillä lämmittämiseen. Read on 20.8.2019. https://www.maaseuduntulevaisuus.fi/rakentaminen/%C3%B6ljyst%C3%A4-tai-puusta-on-helppo-siirty%C3%A4-pelleteill%C3%A4-l%C3%A4mmitt%C3%A4miseen-1.161470

Kyytsönen, J. 2017. Öljylämmitystä hillitään Suomessa Norjaa hitaammin. https://www.maaseuduntulevaisuus.fi/talous/%C3%B6ljyl%C3%A4mmityst%C3%A4-hillit%C3%A4%C3%A4n-suomessa-norjaa-hitaammin-1.194825)

Laitinen, J. 2010. Pieni suuri energiakirja - opas energiatehokkaaseen asumiseen. Helsinki: Into Kustannus Oy.

Lämmitystapakysely. 2018. Helsinki Region Environmental Services Authority (HSY). A survey for detached house residents.

Lämpöä kotiin verkosta. 2017. Motiva. Read on 21.8.2019. https://www.motiva.fi/koti_ja_asuminen/rakentaminen/lammitysjarjestelman_valinta/lammitysmuodot/kaukolampo/lampoa_kotiin_verkosta

Lämpöä omasta maasta. 2014. Publication by Motiva. Helsinki: Motiva Oy.

Lämpöässä. 2016. Lämpöässä Ground Source Heat Pump: Instructions for Use, Installation and Maintenance. User Manual. Lapua:

Lämpöykkönen. 2017a. Fakta 80-85: Omakotitalon sähkönkulutus - mitä eri lämmitysmuodot maksavat? Read on 20.8.2019. https://lampoykkonen.fi/100faktaa/faktat-80-85-omakotitalon-sahkonkulutus-mita-eri-lammitysmuodot-maksavat/

Lämpöykkönen. 2017b. Fakta 4: Mistä ilma-vesilämpöpumpun huima suosio johtuu? Read on 20.8.2019. https://lampoykkonen.fi/100faktaa/fakta-4-mista-ilma-vesilampopumpun-huima-suosio-johtuu/

Lämpöykkönen. 2019. Myllymäet päätyivät vesi-ilmalämpöpumpun hankintaan. Youtube-video. Released on 22.5.2019. https://www.youtube.com/watch?v=WYy9vHQ4R14

Maalämpöpumppu. 2018. Motiva. Read on 19.8.2019. https://www.motiva.fi/ratkaisut/uusiutuva_energia/lampopumput/lampopumpputeknologiat/maalampopumppu

Maidment, G. 2013. Groud Source Heat Pumps. London: Chartered Institution of Building Services Engineers.

Malin, R. 2018. Hybridilämmitys yleistyy - näin lämpöpumppua voi hyödyntää. Read on 22.8.2019. https://www.kauppalehti.fi/uutiset/hybridilammitys-yleistyy-nain-ilmalampopumppua-voi-hyodyntaa/19b2b2f4-bf78-3832-8c12-568c348910ec

Metsämuuronen. 2003. Tutkimuksen tekemisen perusteet ihmistieteissä. 2. updated edition. Jyväskylä: Gummerus Kirjapaino Oy.

Ministry of Economic Affairs and Employment of Finland. N.d. Renewable Energy in Finland. Read on 21.8.2019. https://tem.fi/en/renewable-energy

Mukavaa asumista. N.d. Suomen Lämmitystieto Oy. Read on 22.8.2019. https://www.oljylammitys.fi/nykyaikainen-oljylammitys/mukavaa-asumista

Oittinen, K. 2015. Suomessa 190 000 taloa lämpiää öljyllä, uusin taloihin ei öljylämmitystä juurikaan valita. https://yle.fi/uutiset/3-8557655

Pellettilämmityksen laitteisto. N.d. Pellettienergia. Read on 26.8.2019. http://www.pellettienergia.fi/Pientalon%20laitteet

Perälä, O. & Perälä, R. 2013. Lämpöpumput, Suomalainen käsikirja aikamme lämmitysjärjestelmästä. 3. renewed edition. Helsinki: Alfamer/Karisto Oy.

Phillips, P. P., Phillips, J. J. & Aaron, B. C. 2013. Survey Basics. E-book. Alexandria, Virginia: ASTD Press cop.

Pilot Area - EID Härmälä Tampere. N.d. Information report. City of Tampere & Tampere University of Applied Sciences. https://area21-project.eu/wp-content/uploads/Pilot-Area-%E2%80%93-EID-Tampere.pdf

Punch, K. F. 2003. Survey Research: The Basics.
Puulämmitys. 2017. Energiatehokas koti. Read on 22.8.2019. https://www.energiatehokaskoti.fi/suunnittelu/talotekniikan_suunnittelu/lammitys/puulammitys

Rakennustieto Oy. 2007. Rakennusten lämmitysjärjestelmät. Helsinki: Rakennustieto Oy.

Räsänen, K. 2018. Review of Heating Systems of a Single-Family House. Degree Programme in Energy and Environmental Engineering. Tampere University of Applied Sciences. Bachelor’s thesis.

Riistaniemi, T. 2018. Öljylämmityksen päivittäminen nykyaikaan säästää öljyä ja rahaa. https://www.karjalainen.fi/uutiset/uutis-alueet/maakunta/item/199930

Rinta-Rahko, J. Project expert. 2019. Interview on 20.8.2019. Interviewer Pekkola, E. Tampere.

Räsänen, K. 2018. Review of Heating Systems of a Single-Family House. Energy and Environmental Engineering. Tampere University of Applied Sciences. Bachelor's thesis.

Sandell, M. 2015. Bioenergian päästöt - nolla vai ihan muuta? Read on 21.8.2019. https://yle.fi/uutiset/3-7844226

Seppänen, O. 2001. Rakennusten lämmitys. 2nd edition. Helsinki: Suomen LVI-liitto ry.

Solar Heat Europe. N.d. Solar Heat for Buildings (residential and commercial). Read on 22.8.2019. http://solarheateurope.eu/about-solar-heat/solar-heat-buildings-residential-commercial/

StatFin. 2019. Number of buildings by intended use and heating fuel, 2018. PxWeb-database of Statistics Finland. Read on 21.8.2019. http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__asu__rakke/statfin_rakke_pxt_116h.px/

Suomen Kaasuyhdistys. 2019. Kaasutilastot. https://www.kaasuyhdistys.fi/kaasu-suomessa/tilastot/

Suomen Lämpöpumpputekniikka Oy. Read on 20.8.2019. https://www.lampoassa.fi/wp-content/uploads/2017/04/Emi_EN_Manual_10-2016.pdf

Suomen lämpöpumppuyhdistys. 2019. Heat pump sales shop up by 22 % - investments exceed half a billion. Press release. Read on 20.8.2019. https://www.sulpu.fi/documents/184029/0/SULPU%20Press%20release%201.2019_en%20with%20picture%20.pdf

Suomen lämpöpumppuyhdistys. n.d. Ulkoilma-vesilämpöpumppu (UVLP). Read on 20.8.2019. https://www.sulpu.fi/ilma-vesilampopumput

Suomen virallinen tilasto (STV). 2018a. Liitetaulukko 1. Rakennukset, asunnot ja henkilöt talotyypin ja kerrosluvun mukaan 31.12.2018. Helsinki: Tilastokeskus. Read on 21.8.2019. https://www.stat.fi/til/rakke/2018/rakke_2018_2019-05-21_tau_001_fi.html

Suomen virallinen tilasto (SVT). 2016. Maalämmön osuus lämmönlähteenä kasvussa. Helsinki: Tilastokeskus. https://www.stat.fi/til/ras/2016/09/ras_2016_09_2016-11-25_kat_001_fi.html

Suomen virallinen tilasto (SVT). 2018b. Asunnot ja asuinolot. Helsinki: Tilastokeskus. Read on 21.8.2019. https://www.stat.fi/til/asas/2018/asas_2018_2019-05-14_tie_001_fi.html

Suomen virallinen tilasto (SVT). 2019. Fuel classification 2019. Helsinki: Tilastokeskus. Read on 21.8.2019. http://www.stat.fi/tup/khkinv/khkaasut_polttoaineluokitus.html

Suomen virallinen tilasto (SVT). 2019. Fuel classification 2019. Helsinki: Tilastokeskus. Read on 22.8.2019. http://www.stat.fi/tup/khkinv/khkaasut_polttoaineluokitus.html

Suomen virallinen tilasto (SVT). N.d. Rakennukset ja kesämökit: Käsitteet ja määritelmät. Helsinki: Tilastokeskus. Read on 21.8.2019. https://www.stat.fi/til/ras/kas.html

Suomi rakentaa. 2019. Öljylämmitys uuteen aikaan järjestelmän saneerauksella. Read on 22.8.2019. https://www.suomirakentaa.fi/korjaaja/laemmitys/oljylammitys-uuteen-aikaan-jarjestelman-saneerauksella

Tampereen kartat. 2017.

Tampereen kasvihuonekaasupäästöt 1990, 2010-2017. Ennakkotieto vuodelta 2018. 2019. Espoo.

Tampereen Sähkölaitos. 2019 Lämpöä pientaloille. Read on 20.7.2019. https://www.sahkolaitos.fi/lampoa-ja-viileytta/lampoa-pientaloille/

Tanninen, J. 2018. Naistenlahden uusi kattila pärjää puulla - turve pysyy rinnalla. Yle. Read on 6.8.2019. https://yle.fi/uutiset/3-10115965

Thermia. N.d. Kolme tärkeää tekijää, jotka vaikuttavat lämpöpumpun valintaan. Read on 19.8.2019. https://www.thermia.fi/hyodyllista-tietoa/osta-lampopumppu/lampopumppu-kolme-tekijaa/

Tiitinen, M. 2019. Energiavuosi 2018: Kaukolämpö. Report by Energy Finland (Energiateollisuus ry).

UE-kysely hyvinkääläisille kuluttajille. 2018. Motiva Ltd. & City of Hyvinkää. A survey for detached house residents.

Ympäristö. N.d. Pellettienergia. Read on 20.8.2019. http://www.pellettienergia.fi/Ymp%C3%A4rist%C3%B6

Ymparisto.fi. 2016. Pientalon energiankulutus ja päästöt. Read on 19.8.2019. https://www.ymparisto.fi/fi-FI/Rakentaminen/Korjaustieto/Pientalot/Energiatehokkuus/Energiatehokas_pientalo/Energiankulutus

Ympäristöministeriö. 2018. Kansainväliset ympäristösopimukset ja Suomi: Sopimukset kansainvälisen ympäristöyhteistyön edistäjinä. Ympäristöopas 2018. Helsinki: Ympäristöministeriö.
Öljy- ja Kaasulämmitysyhdistys ry. 1999. Öljylämmitystekniikka. Helsinki: Suomen Lämmitystieto Oy.

Öljylämmittäjät pohtivat muutoksia lämmitystapaan. 2019. Motiva. Report. Read on 16.8.2019. https://www.motiva.fi/ajankohtaista/tiedotteet/2018/oljylammittajat_pohtivat_muutoksia_lammitystapaan.13750.news

Öljylämmitys. 2017. Motiva. Read on 8.8.2019. https://www.motiva.fi/koti_ja_asuminen/rakentaminen/lammitysjarjestelman_valinta/lammitysmuodot/oljylammitys

Öljylämmitysjärjestelmän kunnostuskustannukset. N.d. Suomen Lämmitystieto Oy. Read on 7.8.2019. https://www.oljylammitys.fi/kustannukset/oljylammitysjarjestelman-kunnostuskustannukset

Öljyn rinnalle uusiutuvaa kuten aurinkolämpöä. Suomen lämmitystieto Oy. Read on 22.8.2019. https://www.oljylammitys.fi/nykyaikainen-oljylammitys/oljyn-rinnalle-uusiutuvaa-kuten-aurinkolampoa

APPENDICES

Appendix 1. Invitation to the residents of Härmälä to an open meeting

KUTSU

Tampereen kaupunki haluaa tukea öljylämmitteisten pientalojen omistajia lämmitysjärjestelmän vaihdossa. Järjestämme Härmälässä keskustelutilaisuuden, jossa pientalojen omistajat pääsevät vaikuttamaan heille tarjottaviin palveluihin.

Aika ti 2.4.2019 klo 18-20
Paikka Lumikello-sali (1. krs), Kuuselakeskus, Nuolialantie 46, Tampere

Tervetuloa!

Tilaisuuden järjestävät Tampereen kaupunki ja Ekokumppanit Oy.

Lisätietoja: Juho Rinta-Rahko, 040 176 2621, juho.rinta-rahko@tampere.fi

Tilaisuus on maksuton ja 25 ensimmäiselle osallistujalle luvassa pullakahvit.

eko KUMPPANIT TAMPEREEN KAUPUNKI AREA21 Interreg Baltic Sea Region EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

Appendix 2. Questionnaire for residents of oil heated detached houses in Tampere 1 (2)

KYSELY ÖLJYLÄMMITTEISTEN OMAKOTITALOJEN OMISTAJILLE

1. Oletko harkinnut öljylämmityksestä luopumista?

☐ Kyllä ☐ En ☐ En osaa sanoa

2. Jos olet, niin mitkä tekijät ovat saaneet sinut harkitsemaan öljylämmityksestä luopumista?

	Tärkeä tekijä	Hieman tärkeä tekijä	Ei lainkaan tärkeä tekijä
Öljylämmityksen korkeat kustannukset	☐	☐	☐
Öljyn ympäristövaikutukset ja hiilipäästöt	☐	☐	☐
Öljykattilan ikä	☐	☐	☐
Lämmitysjärjestelmän käyttö/huolto on työlästä	☐	☐	☐

Muu syy, mikä? ______________________________

3. Mitkä asiat mietityttävät sinua uuteen lämmitysjärjestelmään vaihtamisessa?

	Paljon	Hieman	Ei lainkaan
Pätevän urakoitsijan löytäminen	☐	☐	☐
Sopivan lämmitysjärjestelmän löytäminen	☐	☐	☐
Tarjousten kilpailuttaminen	☐	☐	☐
Uuden lämmitysjärjestelmän hinta	☐	☐	☐
Öljykattilan poistoon liittyvät asiat	☐	☐	☐

Muu syy, mikä? ______________________________

4. Koetko, että tukea (neuvontaa, tietoa yms.) on riittävästi saatavilla lämmitysjärjestelmän vaihtoon liittyen?

☐ Kyllä ☐ En ☐ En osaa sanoa

5. Oletko etsinyt tietoa öljylämmitysjärjestelmän vaihtoon liittyen?

☐ Kyllä ☐ En

6. Jos olet, niin mistä olet löytänyt tietoa?

☐ Verkosta ☐ Tapahtumista ☐ Energianeuvojalta

☐ Urakoitsijoilta/Suunnittelijoilta ☐ Muualta, mistä? ______________________________

eko KUMPPANIT TAMPEREEN KAUPUNKI AREA21 Interreg Baltic Sea Region

7. Missä muodossa haluaisit saada tukea lämmitysjärjestelmän vaihtoon liittyen? Valitse yksi tai useampia.

☐ Kasvokkain tapahtuva neuvonta

☐ Apua tarjousten lukemisessa

☐ Tietopaketti verkossa

☐ Laskuri, joka arvioisi kuinka paljon voisit säästää lämmitysmuotoa muuttamalla

☐ Avoimet koulutusillat

☐ Muuta, mitä? ____

8. Mistä asioista haluaisit tietää lisää lämmitysjärjestelmän vaihtoon liittyen? Valitse yksi tai useampia.

☐ Tietoa esimerkkikohteista, joissa öljylämmitys on vaihdettu muuhun lämmitysmuotoon

☐ Kuinka vanha öljykattila tulee poistaa käytöstä

☐ Lainoista ja muista rahoitusmahdollisuuksista

☐ Paikallisista urakoitsijoista

☐ Eri lämmitysjärjestelmien hyödyistä ja haitoista

☐ Lämmitysjärjestelmien hinnoista

☐ Muusta, mistä? ____

9. Mikäli lämmitysjärjestelmän vaihtoon olisi saatavilla rahallista tukea, mihin haluaisit sen kohdistuvan?

☐ Öljykattilan käytöstä poistamiseen liittyviin kustannuksiin

☐ Urakoitsijoiden kilpailutukseen

☐ Asiantuntijan arvioon urakoitsijoiden tarjouksista

☐ Uuden lämmitysjärjestelmän hankintaan

☐ Muuhun, mihin? ____

10. Palautetta, ideoita ja toiveita Tampereen kaupungille:

____
____
____
____
____
____
____