Becoming an Energy Hero

Final report for the 2020 Design for Government project
'Just Transition to Post-oil Heating in Homes'

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Executive Summary

Our Aalto University Design for Government 2020 course team's project was to develop a solution proposal for a 'Just transition to post-oil heating in homes' commissioned by the Finnish Ministry of Environment and ORSI research project.

Our solution proposal is to organize a government led regional pilot where different locally feasible alternatives for significant energy efficiency improvements (possibly including, but not limited to, phasing out oil-heating), their providers, implementation models and financing alternatives would be presented to that region's households (focus on oil-heated houses) through a communication and education package shared to homes. Additionally, the households would be offered either an on-site energy efficiency auditing by a professional energy advisor or a self-auditing option online to determine the household's individual status and provide energy efficiency improvement measures best suitable for that particular status.

Based on the scale of improvements proposed, the household would also be offered possible financial support by the public sector and implementation

support by local companies and associations. After the planned renovations are performed, the achieved energy efficiency improvements are measured. Finally success stories of successful renovations and energy transitions are shared to inspire other households to engage in a similar transition process. The stakeholders playing a key role in the proposal would be the government, municipalities, energy solution providers and relevant associations. We want to encourage the transition by boosting social norms and offering as much support as possible. Based on our research, we believe that aiming at maximizing energy-efficiency of oil heated houses is a just and natural milestone towards a complete post-oil heating transition and eventually, towards a carbon neutral society.

This challenge was considered especially a social and financial problem with strong local and household level variation. Human-centred design approaches and systems thinking were therefore crucial for addressing it. Thus, we involved several experts in the research process to help us define the right problems to be addressed and potential solutions to them. Most importantly, we engaged an extensive number of residents living in detached houses to share their perceptions about the matter and to provide their ideas on how to best enable a just transition to post-oil heating. Additionally, we studied several previous studies related to the subject and similar transitions, both in the Finnish and international context. Our research methods included desk research and literature reviews, stakeholder workshops, expert and resident interviews, Cultural Probes, questionnaires, systems mapping, insights, design challenge and design drivers development, ideas and design intervention development and finally, detailed proposal building. All in all, our solution proposal was developed through a thorough three-month research process.

The key insight derived from our research, findings and design process was that “most residents are willing to transition to different means of heating to save costs in the long run but lack certainty and trust regarding the available options”. And, our proposal making was informed by the following five key insights.

1 Cost

The perceived relative cost of an alternative heating solution is one of the key decisive factors of a successful heating transition. This cost is affected especially by the estimated total lifecycle costs of the alternative solution compared to the current one (savings vs. costs, energy-source costs, maintenance costs, logistics costs and taxes), the switching cost between solutions, the estimated development of the house’s value, disposable income of the resident, availability of funding and the life expectancy of the inhabitants. Location of the house affects these perceptions strongly. Many people might have motivation for the transition but no true financial means and/or incentives to do it as a major proportion of people living in oil-heated houses are elderly and/or have low income levels. Many people have not even chosen their current heating solution themselves and might thus not have so strong initial feelings towards it. Additionally, a so-called “point of discontinuity” – for example the point where a current heating solution reaches its end-of-life, a house is planned to be sold or a house is about to become empty – is an important momentum for a heating transition. Arising from all this, it might be wise to support strongly especially those residents who lack financial means and are approaching some point of discontinuity. In contrast, those about to naturally transition and/or having particularly strong means for the transition might not need so much attention.

2 Awareness, knowledge and trust

Awareness, knowledge and trust are essential for a resident to have motivation and means to perform a heating transition. Awareness building requires continuous and consistent information sharing, such as news and communications campaigns, about the important themes, especially climate change, governmental targets and available solutions. Sufficient knowledge can be provided through educational publications and advisory services. Trust can be built with reliable and easily accessible sources of information and personal contacts to the residents. Important sources of information are, among others, publications of interest associations, email newsletters, advisory and guidance networks, general media and heating solution companies. Also information received from peers (the effect might be positive or negative) can be important. Timing of the information shared is crucial – enough details need to be available for people to be able to form holistic understanding of the matter. The communications should preferably be focused on facts and positive opportunities and remove fears and feelings of "must".

3 Independence, personal resilience and freedom of choice

Many residents living in detached houses value independence, personal resilience and freedom of choice highly. Thus, the reliability and crisis resilience of a heating solution is crucial for them. The requirements and conditions for this vary greatly by region. Residents might also seek protection from monopolistic energy providers and aggressive heating solution sales companies. For the residents to perceive having personal freedom of choice, the availability of multiple different heating options is important as well as being forced in a certain direction by regulation as little as possible. The high availability of different heating solutions also enables the residents to choose an appropriate solution for their particular circumstances.

4 Designing policies and taxes

Designing policies and taxes related to heating is a delicate matter. For example, energy taxes might be really strong drivers for transition but somewhat harsh for low-income residents. Subsidies and benefits have proven to be effective drivers of transitions but they need to be designed so that they are realistically available for people in the biggest need (e.g. not too big shares of own risk). Regulations need to be perceived fair and clear. Benchmarking previous mistakes (e.g. regarding waste water management and district heating obligations) made in policy design might be useful to achieve this. The estimated magnitude of impact as well as appropriate transition periods need to be carefully considered when designing policies. A long-enough transition period gives residents and markets time to react and helps avoid problems arising from monopolistic market situations in certain regions. It is also important to acknowledge the somewhat biased views of different lobby organisations.

5 Energy efficiency improvements

In addition to pursuing complete transition away from oil heating, it might be worthwhile to aim at significant energy efficiency improvements in the current heating solutions. Possible ways for achieving this, among others, are different hybrid solutions, use of biofuels in the current heaters and overall energy efficiency renovations performed in the house. This could be a feasible tactic especially in regions where the so-called "low-hanging fruits" have already been harvested – that is, there might not be for example district heating available or ground-source heat-pumps cannot be installed. For a complete transition, hybrid solutions not including oil-heating, ground-source heat-pumps, electric heating with emission-free electricity and district heating seem the most relevant options.

The design drivers for our proposal were easiness, transparency, equality, flexibility and voluntariness. We also came to a conclusion that instead of just focusing on phasing out oil heating, targeting significant energy efficiency improvements in oil-heated houses would enable a more just and fair transition taking residents' different situations in life into account.
Our proposal focuses on the Finnish government's and municipal organizations' role as a Choice Architect. That is, our proposal's aim is to nudge residents of oil-heated houses to move to more environmentally friendly heating sources and other energy solutions by providing a clear set of alternatives based on their individual situations. We ended up to Choice Architecture and nudging because the just transition to post-oil heating in homes is a rather complex and multifaceted, socio-economic-technical problem which, based on our research and in order to be perceived as 'just', requires quite a flexible approach respecting people with varying situations in life.

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Introduction

We, Ásta Ágústsdóttir, Sumi Moon, Ville Pellinen and Shreya Sood, represent a project team in the Aalto University's advanced studio course Design for Government (later DfG) in 2020. The course is about utilizing different design methodologies to develop solution proposals to challenges commissioned by governmental organizations. Our project team was addressing a challenge commissioned by the Finnish Ministry of Environment and ORSI research project. The challenge was labeled 'Just transition to post-oil heating in homes' and it was about assessing measures to ensure a fair and just transition away from using fossil oil in heating, specifically in Finnish single-family homes, or detached houses. The commissioners acknowledged that this transition is not just a technical matter but also very much a social and financial problem with strong local and household level variation and thus, human-centred design approaches and systems thinking were considered crucial for addressing this challenge.

Currently, there are approximately 130,000 homes in Finland using oil to centrally heat their houses. Due to the cold climate, residential heating consumes a high amount of energy. Finland has a target to become a carbon-neutral society by 2035. These oil-heated homes, therefore, represent a significant CO2 emission reduction potential, and the government's target is actually to get rid of oil heating in houses already by 2030 (municipal buildings already by 2024). The reasons why residents are not transitioning to a greener source of energy are not straightforward; they can include financial issues, geographical limitations, as well as value-laden personal perceptions. One solution will not be able to fit all; some of the houses are small and others are large farms with varying demographic and economic status of the inhabitants. Our task was to aid this transition by gaining a better understanding of the inhabitants' needs and wishes and finding possible solutions that would be just and socially acceptable.

What made this year's DfG course special was the COVID-19 crisis which forced us to conduct the majority of the learning, research, analysis, design and communications work remotely. This was naturally a challenge for applying human-centred research and design methods that normally require quite close collaboration with various stakeholders. However, we consider that we succeeded rather well despite the challenges to approach the complex challenge from different perspectives, study it thoroughly and finally, develop a realistic and feasible solution to it.

This report presents the research conducted and proposal designed for the challenge by our project team. The report is organized as follows. Firstly, we present the research, design interventions and analysis we conducted. Secondly, we go through our most important findings, insights, design drivers and ideas based on them. Thirdly, we discuss our final proposal addressing the challenge presented, refined from the findings and insights. Finally, we summarize and conclude the main content of this report.

1
Research & Analysis

Human Perspective
Systems Perspective
Intervention Perspective
Proposals Perspective

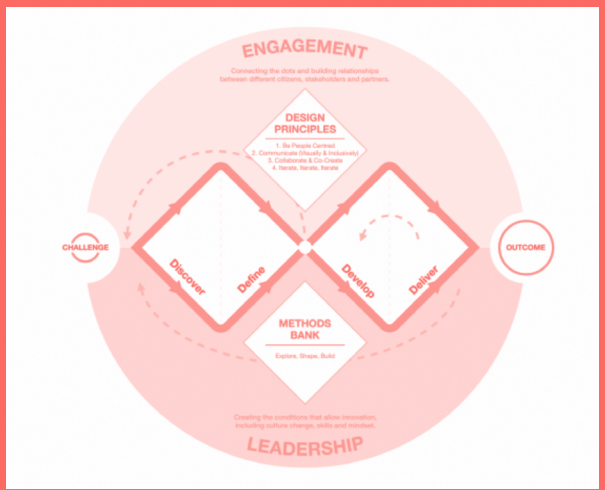


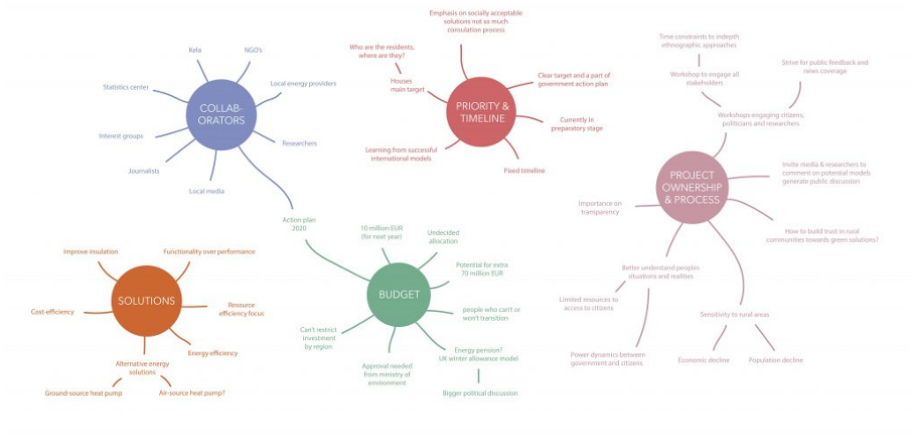
Figure 1
Double Diamond design Process
Source: (Design Council, 2020)

Our work towards developing a proposal for just transition to post-oil heating in homes was organized into four different phases with different perspectives: human, systems, intervention and proposals. The human perspective was about generating a project plan and familiarizing oneself with and applying different human-centred qualitative research and design methods. The systems perspective was about continuing the research work and applying systems thinking to the data and findings gathered through human-centred research and design and analyzing the data with the help of different systems maps as well as developing insights based on the analysis. The intervention perspective was about identifying certain opportunity areas and feasible design drivers arising from the insights developed as well as choosing behavioural design intervention types with good fit to the opportunity areas and design drivers. The proposals perspective was about formulating and refining sharp proposals to the commissioned challenges based on the chosen intervention types.

Overall, our whole journey from the project brief to the eventual proposal followed the so-called Double Diamond design process (Design Council, 2020) where we first diverged from the original brief to discover the right research questions and problems to address, then converged to define the clarified challenge to be addressed, then diverged again to develop multiple potential solution ideas to the the challenge and then finally, converged to formulate the final solution proposal. We did this by following and mixing several co-design (as defined for example by Chisholm, 2020) principles, processes and tools inspired especially by Annala et al. (2015), Blomkamp (2018) and Kimbell & Bailey (2017). They all emphasize the usefulness of prototyping and experimentation in co-design for policy processes and this can be seen also in our final proposal.

Figure 2 Brainstorming and documenting in the commissioner workshop.
Photo: Shreya Sood

Figure 3 Mindmap produced during the commissioner workshop.



1.1 Human perspective

The DfG 2020 course started with the human perspective where the focus was on planning and starting our research and design work with a human-centred approach. Concretely this meant familiarizing ourselves with the commissioners of the project as well as identifying other potential key stakeholders based on desk research conducted on the matter. Team-building within our project team and deciding on desired working methods and roles was also important.

COMMISSIONER WORKSHOP

We got to know our commissioners better through a workshop organized in Aalto University on March 3rd 2020. The workshop was organized between the commissioners and all three project teams working on the same challenge. Present from the commissioners' side were Heta-Elena Heiskanen and Riikka Siljander from the Finnish Ministry of Environment and Mikko Jalas from the ORSI research project. During the workshop, the commissioners introduced us to the challenge of just transition to post-oil heating in homes in more depth. Additionally, we co-designed initial insights, assumptions and relevant research questions regarding the matter to help us direct our research and design work. Concretely, we did this through various icebreaker, brainstorming and mindmapping exercises.

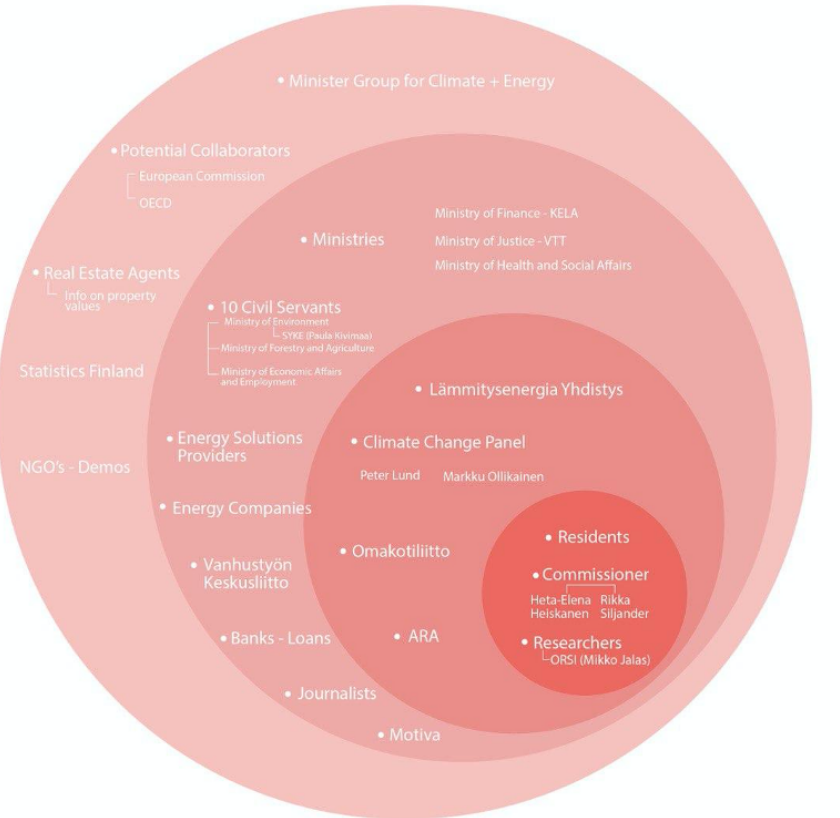
DESK RESEARCH

While conducting the desk research, we familiarized ourselves with the project brief and additional background material provided by the commissioners. Then, we tested the main presumptions drawn from the project brief through finding evidence for or against them from research literature. Additionally, we studied what kind of measures are already proposed in the Finnish context to improve households' energy efficiency and help them transition away from fossil fuels. A very important part of our desk research was to go through several international examples and studies of similar kinds of transitions.

EXPERT INTERVIEWS

The main part of our research was to study chosen experts' and residents' perceptions, views and ideas about the challenge of just transition to post-oil heating in homes. The most important research methods were interviews and questionnaires. Thus, following the detailed guidelines by Portigal (2013) on how to plan and conduct good-quality user research interviews was extremely helpful. The focus of our expert interviews was in studying the perceptions of experts representing presumably the majority of the current oil-heaters, of experts representing the heating solution industry and experts representing the academic viewpoint to energy solutions and their environmental impact. We therefore interviewed Financial and Development Manager Katja Keränen from Omakotiliitto (association for people living in detached houses), Executive Director Arto Hannula and Senior Specialist Eero Otronen from Lämmitysenergia Yhdistys (association for companies providing heating solutions) and Professor, Engineering Physics (Advanced Energy Systems) Peter Lund from Aalto University and the Finnish Climate Change Panel. The expert interviews were particularly crucial for understanding, who would be the main stakeholders to take into account in the heating transition as well as for designing, what should be asked from the residents during our resident research in the Systems Perspective phase. The identified key stakeholder groups are illustrated in figure 4. The questions asked from the different experts can be found from Appendices 1-3.

Figure 4 Stakeholder Map.



1.2 Systems Perspective

When we moved to the second phase of our project, the systems perspective, we continued our research work and simultaneously, started analyzing the data gathered and applying systems thinking to it to form meaningful insights. One of the main goals of our analysis work was to reframe the general problem presented in the project brief and identify more specific and concrete sub-problems to address. The main tools for analyzing the data from a systems perspective were different systems maps to group, connect and visualize the findings and their relations. The systems perspective phase culminated in our project's Mid-Review where we presented our findings and analysis to our commissioners and other key stakeholders and got invaluable feedback from them to further direct our work towards feasible design interventions and proposals.

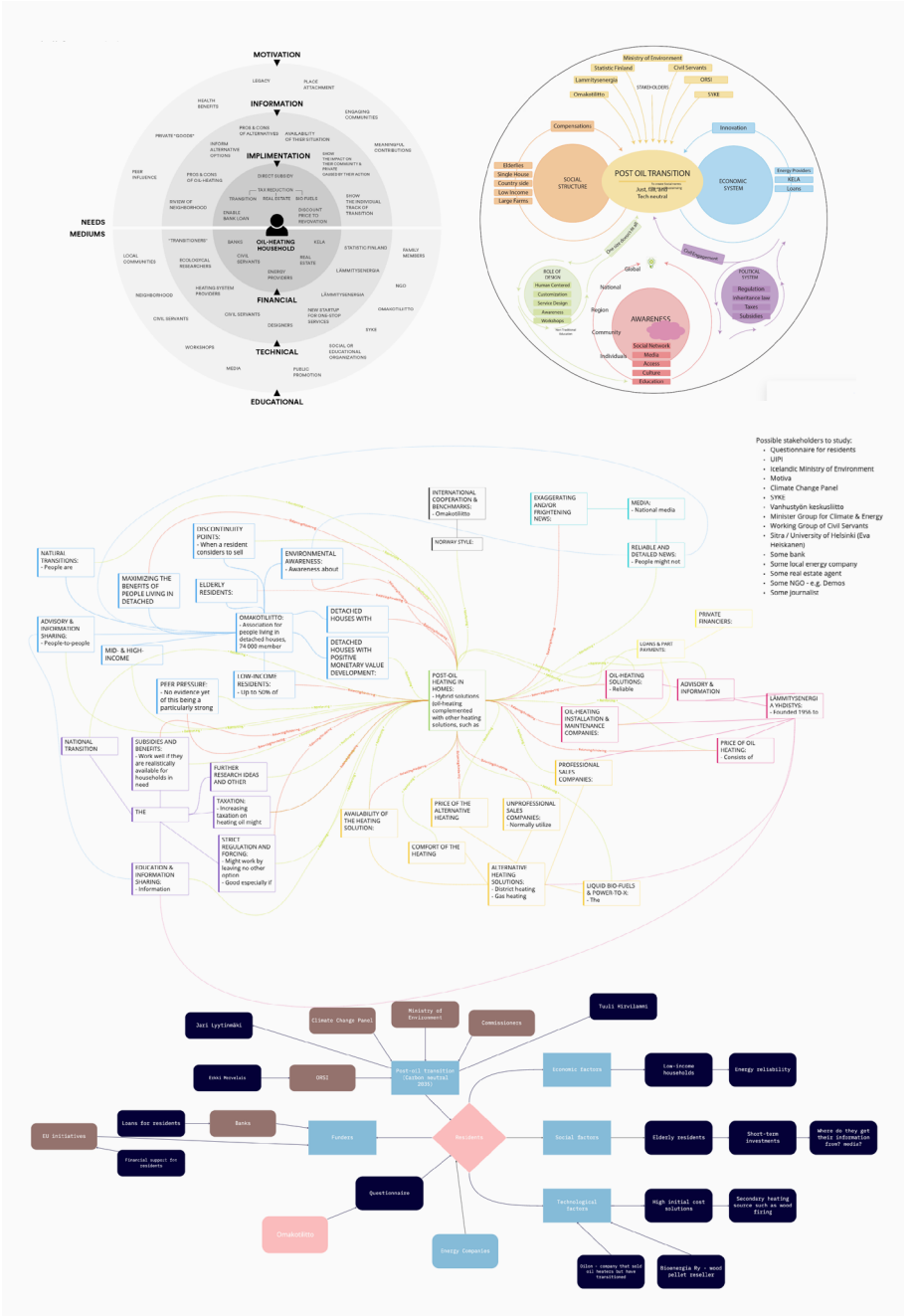
CULTURAL PROBES

During the systems perspective phase we needed to move entirely to remote working mode due to the COVID-19 crisis. Thus, we also needed to revise our project plan and for example abandon planned field visits to study actual oil heated houses and their inhabitants and neighbourhoods in their authentic context. Instead, we interviewed several residents remotely and asked them to participate in so-called Cultural Probes through which we studied their regular activities related to oil heating. The original idea of a Cultural Probe, presented by Gaver, Dunne & Pacenti (1999), is that it is a physical package of different materials (e.g. maps, camera, postcards and pens) and exercises (e.g. diaries) that are meant to "provoke inspirational responses" (Gaver et al., 1999, p. 22) from people studied. When designing our Cultural Probes, we also familiarized ourselves with the teachings of Legros (2018). However, to make the process faster, more agile and easier for the respondents, we organized our Cultural Probes in fully online-mode through a short form available in Appendix 4. The aim was nevertheless the same: to encourage our respondents to tell about their regular life with oil heating. We were able to study the life of an oil-heater more in-depth with three respondents of the Cultural Probes.

RESIDENT QUESTIONNAIRE

In addition to the Cultural Probes, the main body of our resident research was formed by an extensive questionnaire sent to members of Omakotiliitto – that is, people living in detached houses. The questionnaire was sent to about 45 000 email recipients of Omakotiliitto and altogether, we received close to 3 800 answers of which almost 1 000 came from current oil-heaters, almost 800 from previous oil-heaters and almost 2 100 from residents who do not have or have not had oil-heating in their house. The questionnaire contained 24 multiple-choice questions and additionally related open-text questions to which we received altogether approximately 7 600 open-text answers. Although the sample was not randomized, the questionnaire's results can be considered as reliably indicative due to the large size of the sample. The questionnaire was divided into three sections: one

Figure 5 Systems Map draft.



for all recipients to gather some basic information and perceptions as well as to create the experimental and control groups, one for the oil-heater experimental group to study their views and experiences and one for ex-oil-heaters to gather the same information regarding them. The recipients had ten days to fulfil the questionnaire. The questionnaire as well as its all anonymous answers can be found from Appendices 6 and 7.

SYSTEMS MAPPING

The data categorizing, mapping and visualization methods we mainly used were Affinity Diagramming, other systems maps and archetype creation. As defined by Lucero (2015, p.231) “affinity diagramming is a technique used to externalize, make sense of, and organize large amounts of unstructured, far-ranging, and seemingly dissimilar qualitative data”. When developing the other systems maps, we sought inspiration from the Soft Systems Methodology (later SSM) by Checkland & Poulter (2006), although we did not fully follow any of their mapping methods but improvised a few of our own. The main purpose of our systems mapping, applied from SSM, was to map out and connect different stakeholders’ views, perceptions, ideas and influences regarding the post-oil heating transition. This enabled us to make sense of the data gathered and identify some patterns and potential leverage points, “places in the system where a small change could lead to a large shift in behavior” (Meadows & Wright, 2008, p.145), that could enable to drive the transition in a just and fair manner. Through the Affinity Diagram and various other systems maps, we were able to identify the main driving forces of a heating transition as well as their linkages which further helped us form our guiding insights that are presented in detail in the paragraph Findings & Insights.

AFFINITY DIAGRAM

Our Affinity Diagram was organized into three layers. On the first layer, our data was categorized into thirteen broad groups to catch the overall patterns and relationships between groups of data we had labeled earlier (see figure 6). On the second layer, the thirteen groups from the previous layer were narrowed down into five bigger groups, which were Social, Communicational, Governmental, Economical and Technological. The third layer connected the groups with lines to show how the groups correlate with each other.

RESIDENT AND TRANSITION MAPS

To possibly identify any other drivers and systemic connections, in addition to the Affinity Diagram, we organized our data following other SSM inspired systems map models as described above. Eventually, we synthesized our different systems map drafts into two maps: one that focuses on illustrating the different factors affecting the heating transition from a resident's point of view and one that makes the same illustration from a successful transition's perspective.

From the resident's perspective (see figure 7) we identified several influencers (enablers and hindrances) for the heating transition, stakeholders that are important for it, their social structures that need to be taken into account, key elements in their financial state and remarks about their awareness regarding the need for a heating transition. Similarly, for a successful heating transition (see figure 8) we identified several influencers, stakeholders and social & economic aspects affecting it. Additionally, from the transition's perspective, technical considerations are crucial.

Figure 6 Affinity Diagram.

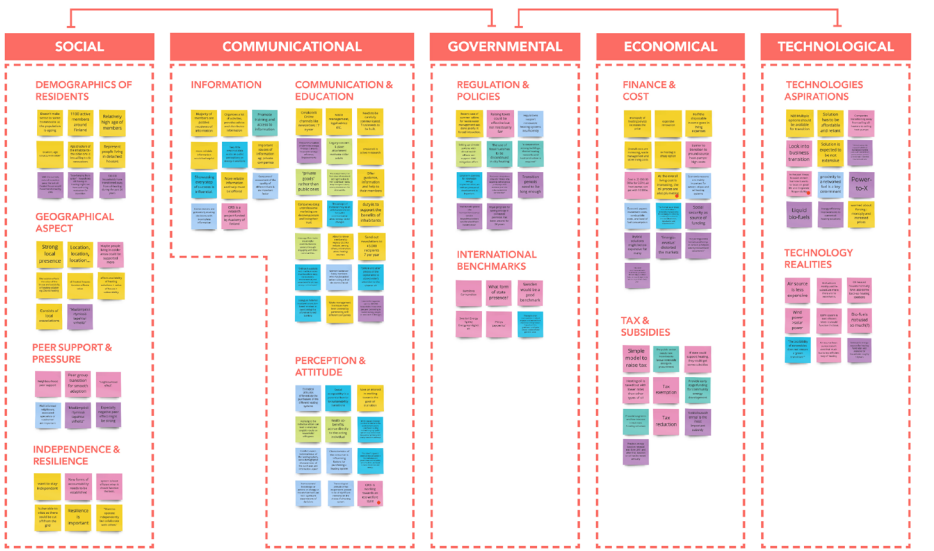
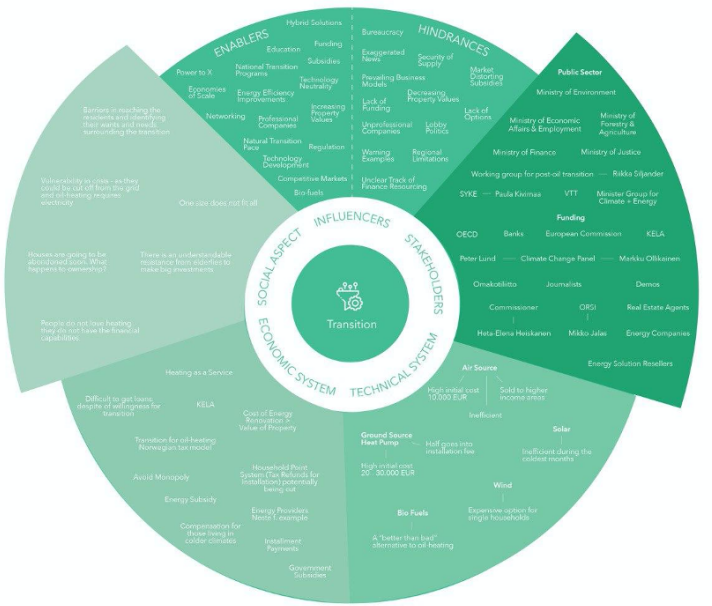


Figure 7 Systems Map from a resident's perspective.

Figure 8 Systems Map from a successful transition's perspective.



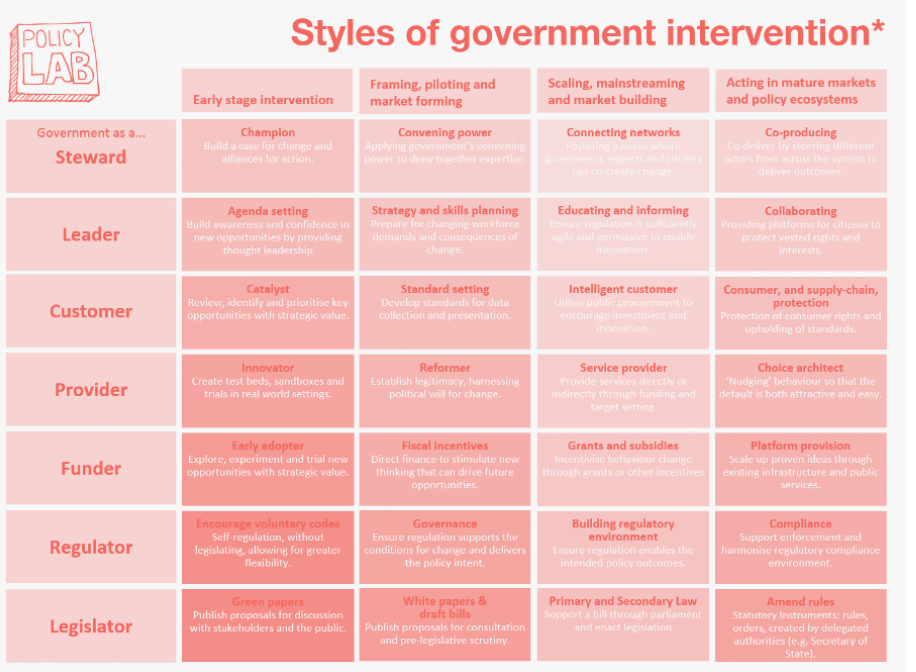
1.3 Intervention Perspective

During the intervention perspective phase, we started to shift our focus from research and data analysis to identifying design challenges and opportunity areas as well as feasible design drivers based on our findings and insights. A description by Solsona Caba (2020, p.8) states that an opportunity area or design challenge, "is based on high potential insights", it provides "framework and direction for ideation", it helps "generate a number of possible solutions", is "not too broad, not too specific" and "it contains a goal + a user/actor + object". According to Heinonen (2020a, p.3) "insights are crystallized forms of understanding that support the creative work or decision making. [...] Insights are NOT just data. Insights are NOT just findings of market research. Insights give perspective that inspires good business decisions. They don't just answer WHAT, but also WHY and HOW. Truth is not final". Additionally, Heinonen (2020b, p.2) defines "Design drivers as a way to guide oneself from insights to ideation". They are "Principles and directions for ideation. Checklist for making sure you have common goals and aims - based on your insights. Different parts of the solution may have different design drivers".

The aim of this phase was to generate a rich variety of ideas guided by the design opportunities, challenges and drivers and eventually, to formulate potential proposals to the clarified challenge. The proposals

developed were fundamentally design interventions following certain behavioural and policy design principles. When starting to formulate our proposal based on the ideation, we sought guidance from the different styles of government interventions by Siodmok (2017), presented in figure 9. To help concretize and clarify a potential proposal, we tested it making a three minute pitch and validating it with our peers and teachers.

Figure 9 Styles of government intervention
Source: (Siodmok, 2017).



1.4 Proposals Perspective

By the proposals perspective phase, the research, analysis and ideation work was mainly done and it was time to refine a coherent, comprehensive and easily communicable final proposal for our commissioners. This phase of the project was its ultimate climax as it culminated with the Final Show and this Final Report.

To sharpen our proposal, we translated it into a graphic presentation and presented it multiple times to our peers and teachers to get feedback on the essential aspects of it. Due to the COVID-19 situation, the presentations were in the format of pre-recorded videos this year which put additional requirements for the proposals clarity and communicability.

Next, we will present you in detail our most important findings and insights as well as the design drivers and ideas derived from them.

2
Findings, Insights, Design Drivers & Ideas

Findings from Commissioners
Findings from Desk Research
Findings from Expert Interviews
Findings from Resident Research
Insights, Design Drivers & Ideas

We have categorized our main findings under four different sources: the commissioners, desk research, expert interviews and resident research (interviews, Cultural Probes and questionnaire). From these findings we synthesized our insights and design drivers which led to our ideation phase informing our final proposal.

2.1 Findings from Commissioners

One of the first things that came up when discussing with our commissioners was technology neutrality. The government has not been advocating for one energy alternative above another which could be seen both as a positive and a negative aspect. On one hand, it is a liberal policy that allows consumers to decide for themselves which energy alternative suits them best without the state interfering. On the other hand, it can leave people feeling confused with plenty of options without a lot of guidance, support or certainty about the provided alternatives' credibility. Thus, technology neutrality, and more broadly speaking market neutrality, was something we clearly needed to address in our proposal in one way or another.

The commissioners also stated that a just transition involves a balance between national-level and regional-level politics. This means that there must be sensitivity towards people living in rural areas, as with growing urbanization these areas are more prone to population and economic decline. Furthermore, they stated that a just solution should take into account distributive and procedural justice (see e.g. Rawls, 1978) as well as recognition justice (see e.g. Honneth, 1995).

Other insights and ideas from the commissioners were that in addition to possibly directly supporting households in the heating transition, one tactic could be to support and oblige local energy companies to facilitate the transition in their area (a similar idea was presented by Peter Lund and described later in this report). Additionally, they pointed out that not all houses are even worth being renovated but might just be demolished. The commissioners also made the important remark that many heating transitions happen even without any governmental measures and many residents do not need any special help with their transitions. It would therefore be crucial to identify where to allocate the scarce resources. Furthermore they were worried that the level of awareness regarding the desired post-oil heating transition and related alternatives might not be high enough among residents with oil-heating. Or they might have a strong sense of mistrust towards the available information especially due to aggressive and even deceptive sales efforts (Honkonen, 2018). Some further ideas presented included an 'energy pension' for people with a low pension income wanting to transition, seminars, workshops and consultation sessions involving lay people to discuss the transition and the just post-oil heating transition being used as a positive benchmark of a successful and fair sustainability transition.

2.2 Findings from Desk Research

We conducted our desk research and literature reviews with multiple focus areas. Firstly, we sought to validate or falsify some of the strongest presumptions from the project brief. Then, we studied what kind of measures are already proposed in the Finnish context to improve households' energy efficiency and help them transition away from fossil fuels. Finally, we went through several international examples and studies of similar kinds of transitions.

Finnish Context

Our desk research in the Finnish context was about validating our presumptions, studying the Finnish Long-term Renovation Strategy and going through numerous other research about transitions and behaviour changes relevant especially in the Finnish context.

TESTING THE PRESUMPTIONS

Firstly, through our literature review, we tested some of the initial presumptions for our project. We found evidence that it is indeed highly likely that a significant proportion of oil-heated detached houses are located in areas where property prices are decreasing and that are in general losing their vitality due to people moving increasingly to bigger cities, as that is the reality for most of the Finnish municipalities (Kuntaliitto, 2019). Additionally, many of the oil-heated houses are most certainly inhabited by rather elderly people, as it is fairly common that elderly people live in detached houses (Helminen et al., 2017). Also, natural transition away from oil-heating seems to be somewhat faster than what the official statistics reveal as many of the heating renovations do not appear in the stastistics (Rouhiainen, 2018). Ground-source heating in particular is used to replace oil-heating in the cases missing from the official statistics. When evaluating the next natural transition points for different heating solutions, information regarding different heating solutions' average lifecycles and renewal prices from Energiatehokas Koti (2020) is handy. This information is summarized in table 1.

Table 1 Average lifecycles and renewal prices of different heating solutions
Source: (Energiatehokas Koti, 2020).

Heating solution	Lifecycle	Price of renewal
Pellet combustion	Boiler 20-30 years, burner 10-15 years	1 000€
District heating	Heat exchanger 20-30 years	5 000 - 6 000€
Ground-source heating	Heat-pump 15–30 years, compressor 10–15 years	2 000 - 3 000€
Air-to-water heating	Heat-pump 10–20 years	1 000 - 2 000€
Exhaust air heating	Heat-pump 20–30 years	1 000 - 2 000€
Air-source heating	Heat-pump 10-20 years	1 000 - 2 000€
Oil heating	Boiler 20–30 years, oil tank and oil burner 10–15 years	1 000€
Direct electric heating	Electric cables in the floor or electric radiators 20-30 years	unknown
Water circulation	Radiator network 40-50 years, water pumps 20-30 years, heating water heaters 15-30 years, hot water tank 10–20 year, room thermostats 10-20 years, radiator valves 10-20 years	unknown
Underfloor water heating	Piping 30–50 years	unknown

FINNISH LONG-TERM RENOVATION STRATEGY

Overall, the Finnish Long-term renovation strategy 2020-2050 report (Ympäristöministeriö, 2020) provides a good overall framework for assessing the different measures feasible for reducing the use of fossil oil in detached houses and eventually, transition completely away from it. According to the report, only 10% of the Finnish detached houses are heated with fossil fuels but they account for 44% of the total CO2 emissions of the whole detached housing base. Thus, decommissioning fossil fuels seems like a feasible and impactful target. In general, the detached houses are in rather good shape but there is a potential for energy efficiency improvements especially in houses built before 1980. One can later in this report see that of oil-heated detached houses a relatively big proportion is built before the year 1980.

The report proposes many energy efficiency improvements that came up in our other sources of information. For detached houses these measures included, but were not limited to; window and insulation renovations, installing ground-source heat-pumps, air-source heat-pumps and solar panels (so-called hybrid solutions). The report also identified that the Finnish housing base is transitioning gradually away from fossil oil heating even without any special measures, by 2050 at latest (something also Arto Hannula and Eero Otronen from Lämmitysenergia Yhdistys mentioned). However, as the government's aim is to achieve the transition already by 2030, this 'natural transition pace' is too slow. In addition to the natural transition pace, the report identified the moment when the ownership of a detached house is about to change as the most natural point of time also for energy renovations. The report identified uncertainty about the house's future lifecycle and a lack of a holistic view and understanding of the feasible renovation

alternatives as the most significant obstacles for energy renovations.

OTHER RESEARCH IN THE FINNISH CONTEXT

Hast, Ekholm & Syri (2016) emphasize the importance of the development of oil prices when considering the profitability of a heating transition. They pointed out that during the times of low crude oil prices (as currently), replacing an oil boiler before its end-of-life might not be profitable for the residents and thus, governmental subsidies as well as higher taxation on fossil fuels might be needed. They propose ground-source heat-pumps and pellets as replacements for fossil oil but point out that especially the former requires such high investments that a ground-source heat-pump investment is normally economical only at the end-of-life of the current oil-boiler without subsidies and taxation changes, if even then. Hast et al. (2016) also made the remark that not all households are entitled to the needed subsidies. In any case, the current oil-heating solutions end-of-life can be seen as a strong and natural leverage point for the post-oil heating transition.

When doing the eventual transition away from oil-heating, one needs to pay special attention to the environmental impact of the replacing solution as the renewability of an available energy source is not necessarily a guarantee of sustainability, especially when it comes to deforestation and local particulate emissions (see e.g. Karner et al., 2017). Additionally, Temmes et al. (2019) provide a good list of aspects that need to be taken into account when driving a transition towards cleaner energy sources. For the just transition to post-oil heating in homes the most relevant remarks are that "residential investments in renewable energy and energy efficiency deserve the same support as the investments of other building

owners", "the energy and power components in district heating tariffs have to be regulated in a way that incentivises the building owners in energy efficiency and demand response" and "a compensation scheme is needed for those who suffer inordinately from the transition" (Temmes et al., 2019, p.1-2).

We also studied the Finnish Energy Efficiency Agreements, 'Energiatehokkuussopimukset' (Energiatehokkuussopimukset, 2020). We realized that the agreements made for the real estate industry (Energiatehokkuussopimukset, 2016a) and residential real estates (Energiatehokkuussopimukset, 2016b) are not so relevant in regards to our project as they mostly cover rental apartments and most of the oil-heated houses are detached houses inhabited by their owners. However, the HÖYLÄ IV agreement for heating fuel distribution companies (Energiatehokkuussopimukset, 2016c) is highly relevant for it includes, among others, targets for improving energy efficiency of buildings and their oil heating equipment, increasing the use of renewable fuels in oil-heated buildings, increasing advisory and energy efficiency inspection services, repairing and replacing old oil-heating equipment and enhancing communication and training regarding energy efficiency improvements.

One potential source for getting even significant additional funding for this initiative would be the fairly new European Green Deal Investment Plan and Just Transition Mechanism (European Commission, 2020). Considering the financing of this initiative, positive news when writing this Final Report is that the Finnish government decided to propose appropriations for grants to phase out oil-heating in both households and municipal properties, totaling EUR 45 million in 2020, as part of their fourth supplementary budget proposal for 2020 (Valtioneuvosto, 2020). Additionally, budget authority of EUR 20 million will be allocated to major energy-subsidy pilot projects.

Piloting would be quite a natural next step after the research and design phase of the project, as Annala et al. (2015) emphasize its usefulness of experimentation in observing certain measures' effects on people's behaviour. The rather limited budget of ten million euros allocated for advancing the transition at this point speaks for careful prototyping and experimenting. A full-scale transition might not be realistic with a budget of this size but several sharp experiments could easily be organized with it. Furthermore, due to the rather abstract nature of the object of the design process, the 'post-oil heating transition', slow-paced prototyping would be quite a natural approach as we are talking about a transition over time, not just a 'simple' service or an event. Thus, some time and room for behavioural change and stakeholders' reflections about their experiences would need to be allowed. Annala et al. (2015) also emphasize the importance of studying people's actual behaviour through experimenting certain initiatives by public governance. Thus, a slightly more extensive trial of for example one year might be required as Annala et al. (2015) estimate that even that might be too short of a timespan when the social objectives are challenging.

The most prominent stakeholders for this kind of prototyping and experimenting identified so far are residents living in oil-heated houses, associations representing and supporting them, companies and their alliances selling heating solutions, civil servants working with governmental steering regarding the transition and possibly organizations providing funding for energy renovations as well as representatives from the media. Additionally, following the

ideas of Annala et al. (2015), an open call for ideas and best-practices supporting the heating transition could be organized and the prototyping and experimenting phase should certainly start by gathering the key experts to once more discuss about the proposals of the research and design phase as well as to validate the experiment & prototype setting. This could be a natural point to bring in other governmental stakeholders apart from the Ministry of Environment, the ministries of finance, economic affairs and employment for example. Diligent evaluation of the results of the experiments and prototypes should not be forgotten, as reminded by Annala et al. (2015). Also, the evaluation phase regarding the post-oil heating transition experiments could be made rather open, engaging several different stakeholders in the process in addition to the commissioning side. This could help ensure that the key stakeholders stay motivated towards the transition also during the eventual, full-scale implementation phase.

In our proposal, there is a strong peer-to-peer learning and -support aspect. This approach is largely inspired by Heiskanen, Nissilä & Tainio (2017) and their descriptions about the so-called "Energy Walks" and "Open Home" initiatives. They argue that these forms of peer-to-peer learning can help lay people investigate, identify, understand and communicate alternative, more sustainable energy solutions when presented by their peers in real-life environments. Furthermore, this can motivate people to perform energy renovations also in their houses. Dennehy (2020) states that "researchers have found a basic tendency for the energy-related behaviors of individuals to be influenced by members of a peer group; sometimes this influence is an even more important factor than cost or convenience". This phenomenon seems to be particularly strong among people who

do not have strong opinions and views regarding the matter beforehand.

International Context

When studying the international context, we sought benchmarks especially near Finland - from Norway, Sweden and Iceland and also outside the Nordics, mostly Germany.

NORWAY

One of the most interesting and relevant international benchmarks regarding the transition away from heating homes with oil is Norway and the decision they made back in 2017 to ban the use of oil in heating homes by 2020 (Möller, 2017). For Norway, this meant transitioning approximately 80 000 households compared to approximately 130 000 in Finland. However, Norway still allows the use of heating oil in some areas outside the electricity grid and also for backup purposes (Oljefri.no, 2020). Additionally, use of bio oil is still allowed (Flesberg og Rollag kommuner, 2019). When considering a just transition to post-oil heating in homes in Finland, one of course needs to take into account that the Norwegian and Finnish households heated with oil might differ greatly in regards to their demographics and socio-economic situations and thus, the Norwegian model might not be feasible in the Finnish context completely as is. In any case, the kind of legislative force used in Norway is at least an effective way to ensure that the transition happens and thus, it is recommended that also the Finnish government carefully studies the relevant Norwegian legislation (Lovdata, 2018).

From Norway comes also the important remark that when communicating the needed transitions, the choice of words and abstraction level is crucial – it might be better to make the targets and alternatives

as concrete as possible for the residents rather than communicating with wide and abstract terms such as 'energy transition' (Tvinnereim, Lægreid & Fløttum, 2020). For example, positive impacts on health when changing to a less emitting heating source (e.g. heating without local combustion) are suggested to be among one of the most important motivators for residents worth communicating (Amelung et al., 2019). And when communicating especially to elderly people, reminding them that through more sustainable heating choices they can positively impact the legacy they leave and the particular place they live in might help build higher motivation for a sustainability transition (Wickersham et al., 2020).

SWEDEN

Another geographical area we studied was Sweden. Nilsson et al. (2018, p.1) conducted an interesting research "by bridging an energy systems model with socio-technical systems analysis and a local action study, analysing the future transition of the residential heating system in Sweden". Additionally, they applied the famous Multi-level Perspective (MLP) framework by Geels (2002) into their research. They made an important remark that there are transitions and behaviour changes with little or no barriers but on the other hand, some might require strong governmental interventions. For a transition with few barriers they mentioned deployment of heat-pumps and increasing efficiency of heating devices as a concrete example in Sweden. On the contrary, bigger renovations and building of passive standard houses requires stronger governmental measures according to Nilsson et al. (2018). They also addressed the prerequisites for achieving system transitions through behaviour changes by stating that communication and information sharing alone might not be enough but other more directly nudging and steering methods might be needed "since a large part of our everyday actions is based on routines and habits rather than active choice" (Nilsson et al., 2018, p.10).

The following statement is well aligned with our overall research findings and summarizes quite well also the core of the justifications for our proposal: "The motivating factors need to be understood in different geographical and social contexts. By offering a broad range of activities that appeals to residents' different interests and at the same time strengthens social relations at the community level, entry points could be created for broader engagement also around energy and climate change." (Nilsson et al., 2018, p.10). For driving the transition away from fossil oil in heating of homes in Sweden, Nilsson et al. (2018) regard demand-side changes as the most impactful measures in the current situation. They find energy efficiency renovations of existing buildings as well as deployment of new technologies as the most effective approaches to decreasing market demand for oil. Demand-side changes are also essential in our proposal. Finally, a study made by Mahapatra & Gustavsson (2008) also in Sweden found that economic aspects, functional reliability and indoor air quality were the most important factors influencing resident's choice of a heating system. "But governance needs to address not only regulation and price, but also behavioural change and change in institutional arrangements to avoid split incentives or lack of incentives" as stated by Nilsson et al. (2018, p.10).

ICELAND

In addition to Norway and Sweden, we also benchmarked Iceland as they are practically independent of fossil fuels when it comes to heating buildings (Logadóttir, 2015). Their transition cannot be fully mimicked in Finland as they have such a unique combination of geothermal, hydro and wind power available (Logadót-

tir, 2015). However, what can be learned from Iceland for the post-oil heating transition in Finland is that the transition most probably requires close public-private-citizen collaboration, that empowering residents and businesses to harness their innovativeness might create the most locally feasible solutions, that government should actively try to mitigate the residents' risks caused by the attempted transition (e.g. through insuring failed transitions) and that sharing stories and examples of successful transitions might inspire new people to engage into the transition (Logadóttir, 2015).

OTHER EUROPEAN COUNTRIES

We also studied literature outside the Nordics. A study regarding house owners' perceptions and factors influencing their choice of specific heating systems in Germany showed that when deliberately choosing their heating solutions, German house owners emphasize economic aspects, comfortability and technical performance of the available solutions, available information, opinions of their peers and opinion leaders and increasingly also environmental aspects (Decker & Menrad, 2015). The authors recommend that the government should drive transition away from fossil fuel heating through direct subsidies and tax reliefs for more sustainable energy sources, through increasing taxation of fossil fuels and through increasing ecological awareness (Decker & Menrad, 2015). On the other hand, the studies by Curtis, McCoy & Aravena (2018) showed that environmental awareness would not be a decisive factor when residents are choosing their heating systems. Their studies highlighted the importance of good availability of alternative heating sources. Additionally, good availability of relevant and comprehensible information as well as peer recommendations are important for heating transitions according to Curtis et al. (2018).

2.3 Findings from Expert Interviews

We conducted detailed expert interviews with Omakotiliitto, Lämmitysenergia Yhdistys and Peter Lund from the Finnish Climate Change Panel and Aalto University.

OMAKOTILIITTO

Katja Keränen from Omakotiliitto, interviewed the 18th of March 2020, proposed that instead of concentrating on measuring how much oil-heating equipment has been replaced with other types of heating equipment, measuring how much the use of fossil oil can be reduced might be a more feasible and just approach. For achieving significant reductions in the use of fossil oil, Keränen proposed for example improving energy efficiency of the current oil-heating system and installing hybrid heating solutions. Additionally, she pointed out that because of declining house prices and low-income levels, many oil-heated households cannot get loans for the relatively expensive heating renovations. At the same time, living costs are generally increasing and consumption taxes, like taxation on oil, despite often being quite effective policy measures, might hurt low-income residents disproportionally. The ARA energy subsidies ('energia-avustus') require such extensive renovations that many households practically cannot afford such renovations to get the subsidies (ARA, 2020). As important disablers for the transition, Keränen pointed out the relatively high age of residents in oil-heated houses, sense of mistrust towards the

available information and renovation contractors. She also pointed out that possible forcing legislation needs to be designed carefully and fairly and mentioned the waste water management act ('jätevesiasetus'; see e.g. Vaalisto, 2019) and forced joining to the district heating network (see e.g. Leskinen, 2017; Sallinen, 2018) as warning examples of this. From Omakotiliitto's perspective, technological and market neutrality as well as abundant market supply of different alternatives and voluntariness are considered important factors for a just heating transition. Other important enablers for the transition, according to Keränen, are the natural transition, or 'joint' moments (current equipment's end-of-life or change of house's owner), of an oil-heated house, accessible subsidies and loans, ability to increase energy resilience and comfortability and reliable information sharing and personal advisory services. Of technical solutions for the heating transition Keränen mentioned hybrid solutions consisting for example of solar energy, air-to-water heat-pumps, air-source heat-pumps, ground-source heat-pumps and direct electricity.

What is also interesting and potentially very useful for the government is that Omakotiliitto is about to renew their membership registry system during 2021 and during this process, gather more accurate data about detached households' demographics and heating sources. Altogether, Keränen regarded the awareness level and willingness to transition, especially due to climate change, relatively high among Omakotiliitto's members. However, the financial aspects of the transition in particular need to be solved individually.

LÄMMITYSENERGIA YHDISTYS

Arto Hannula and Eero Otronen from Lämmitysenergia Yhdistys, interviewed the 19th of March 2020, considered biofuels to be the most potential short- and mid-term replacement for fossil fuels in households as they can be used in the current oil boilers without expensive renovations. Additionally, energy content and energy efficiency of oil is really good. Thus, they would urge the government to increase the ambition level of obligating fuel providers to provide more biofuels in the near future. They also pointed out that the transition periods for any steered transitions should be long enough to allow markets to adapt to the change and prevent any monopolistic situations from emerging. Among the technical solutions replacing or complementing oil boilers, Hannula & Otronen regarded air-to-water heat-pumps, ground-source heat-pumps, solar energy, wood burning, district heating and energy efficiency improvements as the most potential ones. However, not every technical solution is feasible everywhere (for example ground-source heat-pumps are rather demanding location and infrastructure wise). For financing options they emphasized household reductions ('kotitalousvähennys'), energy subsidies, bank loans and social security benefits. They were also worried that many oil-heated households could simply not afford the needed transition for example to a hybrid heating solution or the transition might not at least be financially beneficial for them.

Hannula & Otronen hoped that attention would be paid to the houses' total energy efficiency and emissions, not just on a single heating source, such as an oil boiler. They also pointed out that one needs to consider how the available electricity is produced (carbon-free or not) as most of the oil-replacing heating solutions require electricity. Additionally, energy resilience and availability of reliable information are important and need to be ensured, in their opinion. In any case, they regarded that their member companies are relatively well aware of the climate emission reduction targets. They also estimated that even if no special governmen-

tal measures would be taken, all oil-heated houses would have naturally transitioned away from oil heating by 2045. All in all, Hannula & Otronen were in favour of hybrid solutions complementing current oil heaters and for encouraging people to perform transitions in the natural joint moments.

PETER LUND

Peter Lund from Aalto University and the Finnish Climate Change Panel helped us in understanding the gap between people's intentions and their behaviour due to an information and financial barrier. Thus, he emphasized the importance of behavioural economics and nudges (e.g. service vouchers, turnkey solutions and additional services), benchmarking for example the UK (GOV.UK, 2020), as well as different hybrid solutions (i.e. concentrating on energy efficiency improvements on a broad scale).

Lund also offered insights towards considering budget-friendly yet efficient ways of energy conservation rather than a transition towards a whole new technology. Technically this could mean installing different kinds of heat-pumps or electric heating systems (direct or reserving) to the houses as well as considering the use of bio oil because it could be even more effectively used in heating than in transportation. Financially this could mean much higher energy renovation subsidies than currently available (even 50% of the total investment) as well as government backed up loan schemes (similar to ASP and student loan models). Regulation wise this kind of just transition could be about forcing the remaining 'tail' who have not done the needed energy efficiency improvements to perform the transition eventually after a long transition period. Gradual increases in oil taxation as well as demanding oil companies to offer more biofuels could be considered. He also considered the potential of public service obligations (PSO) where regional and local solution providers would be obligated and rewarded for completing a certain amount of energy efficiency improvements in their area, like for example in Denmark (Centre for Energy Efficiency, 2017). This could be piloted regionally. Lund also emphasized the fact that a relatively high portion of oil-heated houses are old and inhabited by elderly and low-income people. Additionally, he mentioned the good energy efficiency of oil as a heating source as well as the natural transition pace of households away from oil and warned about poorly designated legislation. All in all, Lund agreed with our commissioners that a successful just post-oil heating transition in homes could serve as an inspiring and positive benchmark also for other pursued sustainability transitions. He had high faith in the private sector's capabilities to perform the transition market and technology wise as they have the skills and equipment. This kind of a heating transition would also be beneficial for local solution providers and create jobs and new business opportunities. However, Lund thought that some kind of governmental certification programme might be needed to help people choose trustworthy contractors. Anyhow, also Lund had the perception that there are no strong value-based reasons for not transitioning away from oil-heating.

As a curiosity, it can be mentioned that during our project, Suomen Kuvalehti wrote an article about the aims of transitioning away from heating homes with oil in Finland (Niemelä, 2020). Among people interviewed for the article are Eero Otronen from Lämmitysenergia Yhdistys and Virve Rouhiainen from Tilastokeskus with whom also we discussed during our research phase. All in all, the article summarizes quite well many of the residents' and experts' views that came out also in our research and is thus a good read alongside this report.

2.2 Findings from Resident Research

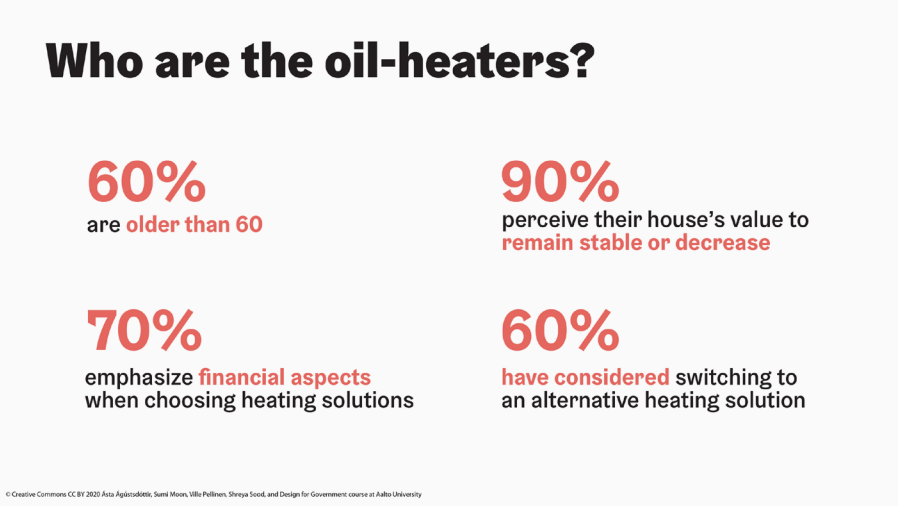
Our resident research was divided into an extensive questionnaire made to Omakotiliitto's members and to a more intimate and detailed Cultural Probe exercise made with few oil-heated households.

Questionnaire

The full analysis of the Omakotiliitto questionnaire can be found from Appendix 8. The analysis includes, among others, illustrative graphs about the different recognized household archetypes. Next, we will present some of the most important and interesting findings from the questionnaire.

Based on the extensive amount of responses we received through the questionnaire, we were able to develop six different household archetypes based on their heating solution: 1) average oil-heater, 2) special oil-heater, 3) average ex-oil-heater, 4) special oil-heater, 5) average non-oil-heater, and 6) special non-oil-heater. The archetypes 1 and 2 currently have oil-heating in their house, archetypes 3 and 4 have had oil-heating and archetypes 5 and 6 have never had oil-heating in their current house. These archetypes serve the purpose of identifying how different detached households' situations differ in general but naturally, they do not depict any actual household on scale 1:1. Next, we will present all the six different archetypes and their main characteristics in detail.

Figure 10 Chosen key figures regarding oil-heaters living in detached houses.



AVERAGE OIL-HEATER

'Average Oil-heater' is a collection of the characteristics that are most common for current oil-heaters based on the Omakotiliitto questionnaire. Most commonly, they live in two-person households. They are 50-80 years old. Their household's combined annual gross income is between 20 000€ and 60 000€. Their main income sources are salaries and public benefits, mostly pensions. They perceive their house's value to remain stable. Their house was built between 1940 and 1980 and its size is between 100 and 200 m2. For heating, they are mainly using fossil oil, wood or some other solid bio fuel and air-source heat-pump. They have not chosen the heating solution themselves. They have heard about the government's heating transition aims but are not well aware about their details. Their last heating renovation was done 5-30 years ago and it was done for renewing the old heating form, not replacing

it with another heating form. They have considered a new heating source either to replace or to be added alongside the old heating source. They have considered supplementing or complementing the old heating source with air-to-water heat-pump, ground-source heat-pump, solar energy or air-source heat-pump. Main reasons for considering a new heating source are price and cost savings, environmental aspects, reliability and easiness. They would be ready to invest 5 000€-10 000€ to a new heating source. They would finance the heating renovation with their own savings, subsidies from the public sector and bank loans. They value their own interest clearly or somewhat more than public interest. They have not had problems with their current heating solution. They live in the Uusimaa or Varsinais-Suomi region.

SPECIAL OIL-HEATER

'Special Oil-heater' is a collection of the characteristics that appear more commonly among current oil-heaters than among other archetypes based on the Omakotiliitto questionnaire. They live relatively more often in one-person households. They are relatively more often between 50 and 70 years old. They have relatively more often household's combined annual gross income below 60 000€. Relatively bigger proportion of their income comes from entrepreneur income. Relatively bigger proportion of their houses' values are perceived to be decreasing. Relatively bigger proportion of their houses are built in the 40's, 50's or 70's. Relatively bigger proportion of their houses are having size of 100-150 m2 or above 300 m2. They use relatively more liquid biofuels (and of course fossil oil). Relatively bigger proportion of them have not chosen the heating solution themselves. They have had relatively less problems with their current heating solution. They are relatively more aware about the government's transition aims but are not well aware about their details.

It is relatively more common that they have done their previous heating renovation over ten years ago or even never. In addition to renewing their old heating form, it has also been relatively common for them to add a new heating source alongside the old one if doing heating renovation. They emphasize their own interest clearly over public interest relatively more than others. They live in the Varsinais-Suomi region relatively more commonly.

AVERAGE EX-OIL-HEATER

'Average Ex-oil-heater' is a collection of the characteristics that are most common for previous oil-heaters based on the Omakotiliitto questionnaire. They live in two-person households. They are 60-80 years old. Their household's combined annual gross income is between 20 000€ and 60 000€. Their main income sources are salary and public benefits, mostly pensions. Their house's values are perceived to remain stable. Their houses were built between 1940 and 1980. Their house's sizes are between 100 and 200 m2. They are using mainly ground-source heat-pump, air-source heat-pump and wood or some other solid biofuel for heating. Their main reasons for choosing the current heating solutions aremfinancial reasons, easiness and environmental reasons. They have heard about the government's transition aims but are not well aware about their details. Their last heating renovation was done 5-20 years ago and it was done for changing the heating form. They invested 10 000€-20 000€ to transition away from oil heating. The transition was financed with own savings. They value their own interest clearly or somewhat more than public interest. They have not had problems with their current heating solution. They live in the Uusimaa or Varsinais-Suomi region.

SPECIAL EX-OIL-HEATER

'Special Ex-oil-heater' is a collection of the characteristics that appear more commonly among previous oil-heaters than among other archetypes based on the Omakotiliitto questionnaire. They are relatively more often over 70 years old. They have relatively more often household's combined annual gross income between 60 000€ and 120 000€. Relatively bigger proportion of their income comes from public benefits and investment income. Relatively bigger proportion of their houses' values are perceived to be increasing. Relatively bigger proportion of their houses were built in the 60's. Relatively bigger proportion of their houses are having size of over 150 m2. Relatively more ground-source heat-pumps, air-to-water heat-pumps and district heating used as their heating form. Relatively bigger proportion of them have chosen heating solutions due to financial, easiness, environmental, reliability, comfortability or independence reasons. They have had problems with their heating solutions relatively more often than others – especially with the electricity transfer prices, with broken pumps or pipes or with lack of skills with electronic control units. They are relatively more and also relatively less aware of government's transition aims (clear dichotomy in the group regarding this aspect). It is relatively more common that they have done their previous heating renovation less than 10 years ago. They value their own and public interest equally relatively more often than others. They live in Uusimaa, Kymenlaakso, Etelä-Pohjanmaa, Lappi or Pohjois-Pohjanmaa region relatively more commonly than others.

AVERAGE NON-OIL-HEATER

'Average Non-oil-heater' is a collection of the characteristics that are most common for detached households who have not had oil-heating at all based on the Omakotiliitto questionnaire. They live in two-person households. They are 50-80 years old. Their household's combined annual gross income is between 20 000€ and 80 000€. Their main income sources are salary and public benefits, mostly pension. Their house's values are perceived to remain stable. Their houses were built between 1980 and 2010. Their houses' sizes are between 100 and 200 m2. They are using mainly electric heating, wood or some other solid biofuel and air-source heat-pump for heating. They either have not chosen the heating solution themselves or then have chosen it due to financial reasons or ease. They have heard about the government's transition aims but are not well aware about their details. They value their own interest clearly or somewhat more than public interest. They have not had problems with their heating solution. They live in the Uusimaa, Pirkanmaa or Varsinais-Suomi region.

SPECIAL NON-OIL-HEATER

'Special Non-oil-heater' is a collection of the characteristics that appear more commonly among the detached households who have not had oil-heating at all based on the Omakotiliitto questionnaire. They are relatively more often under 50 years old. They relatively more often have a household's combined annual gross income over 120 000€. Relatively bigger proportion of their income comes from salary and entrepreneur income. Relatively bigger proportion of their houses' values are perceived to remain stable. Relatively bigger proportion of their houses were built in the 80's or later. Relatively bigger proportion of their houses have size of less than 100 m2. They have relatively more often air-source heat-pump, electric heating, wood or some other solid biofuel in use. Relatively bigger proportion of them have chosen the heating solutions due to the good availability of the heating energy source. They value their own interest somewhat over public

interest relatively more often than others. They live in the Pirkanmaa or Pohjois-Karjala region relatively more commonly.

TRANSITION ENABLERS AND DISABLERS

Through the questionnaire, we were also able to identify several enablers and disablers of the post-oil heating transition, as perceived by the respondents. These enablers and disablers are presented in tables 2 and 3 and organized in four categories: financial, technical and transition process related, regulatory and market related and knowledge and values related.

SOURCES OF INFORMATION

The questionnaire also revealed what are the various communication channels and sources of information through which residents living in detached houses seek and get information when considering for example some renovation.

Table 2 Transition enablers.

Financial enablers	Technical and process related enablers
• Anticipated cost savings (increasing running costs of current heating solution and/or decreasing costs of alternative heating solutions) • Public subsidies (especially household deduction + energy subsidies + other direct subsidies + state secured loans + other tax reliefs) with mechanisms to ensure that the subsidies do not fall into the heating solutions' prices and so that the subsidy would be secured already before the renovation • Improving financial situation (e.g. new job or some other new income sources) • Lucrative financing schemes (e.g. long payment terms and low interest rates) • Ability to positively affect the house's value with the heating transition (needs to be rather significant effect) • Good financial situation (e.g. enough savings, inheritance, stable work situation) • Sharing costs with neighbours, doing co-purchases in the neighbourhood.	• Current heating solution's end of life • Availability of good technical solutions (i.e. technological development) that are reliable also during cold winter months (e.g. district heating, ground-source heating and gas) • Better availability of biofuels with lower prices • Ability to utilize existing infrastructure and location (e.g. radiators and boilers, water circulation system, enough space for new solutions, rock enabling ground source heating) • Easiness of the transition (clear alternatives, smooth installation and light bureaucracy – availability of an easy turnkey solution and fast transition) – also the new heating solution should be about as easy and reliable as the old one • Ability and permission to keep oil heating as a backup solution • Other renovations made to the house provide good momentum for heating renovation • Increasing security through getting rid of leaking oil container • Building a completely new house • Switching to a more comfortable solution (no need to order oil, no issues with oil smell, no need to worry about oil container, heating and cooling features, easier maintenance) • Ability to release room for some other purpose by changing heating solution • Availability of alternative (fuel wood in different forms).
Regulatory and market related enablers	**Knowledge and values related enablers**
• Regulatory force • Transition period long enough • Flexibility to choose solutions that are feasible to a specific household's individual situation (not forcing one solution to everyone) • Quality guarantees / insurances for the transition • Getting the needed permissions from public officials (permission to drill ground-source heating well) • Enough solution providers, ability to race them against each other, ability to choose from many alternatives.	• Reliable, unbiased and comprehensible information, advisory and evaluations about feasible alternatives from some trustworthy sources • Clear communications regarding what needs to be done and when – easily available information that doesn't change all the time • Ability to do an environmentally friendlier choice (e.g. in case of heating solutions requiring electricity, one needs to be sure that the electricity is generated in an environmentally friendly way) • Recommendations and references from peers • Own competencies, knowledge and skills • Reliable solution provider • Health aspects • Proactively offered solution.

Table 3 Transition disablers.

Financial disablers	Technical and process related disablers
• Lack of financial incentives (e.g. low income level, low level of anticipated savings, too long payback period, too much existing debt, too high initial investment needed, does not affect house's re-selling value enough, high price compared to available income and liquidity) • Expected short life-cycle of the possible investment for example due to high age of inhabitants or due to house anticipated to be demolished, abandoned or sold • High electricity transmission costs • Some public subsidies available only for a certain time period or not eligible for public subsidies • Difficulties to get loans.	• Uncertainty about alternative heating source's reliability and effectiveness / heating power • Inconvenience for example due to just recently performed heating renovation or due to perceived difficulty of the transition process (reluctance to decommission a fully operational heating solution, easier not to switch, transition friction) • Lack of better heating solutions • Will to maintain one's energy independence and resilience • House's current infrastructure or location not feasibly enabling the needed heating renovation (e.g. lack of proper water circulation readiness, insufficient electricity system, lack of space for additional equipment or ground water area disabling transition to ground-source heating, large trees or nonoptimal roof disabling solar power) • Long process duration • Lack of time or motivation to perform the transition • Need for difficult and complex renovations • Technical errors or other problems in the transition renovation process • Not possible to get a turnkey "single window" solution • Difficult process of getting rid of old heating equipment and containers.
Regulatory and market related disablers	**Knowledge and values related disablers**
• Slow, heavy and unclear bureaucracy (for example not getting permission for ground-source heating or too high requirements for energy efficiency improvements in order to be eligible for energy subsidies or not clear if one is eligible for certain subsidies) • Waiting for the right timing (e.g. decision on state subsidies, technological development or declining prices of biofuels) • Feeling of unfairness (e.g. consumption levels otherwise so low that forced heating transition feels unfair or oil-heaters feel blamed) • Too few available alternatives, fear of monopolistic situation • Lack of guarantees for the renovation's quality • Aggressive sales efforts increase reluctance towards the transition • Not actually a disabler but households who have already made the transition would like to be rewarded as well if some subsidies are being given to new transitioners (maybe performance based tax reductions like with cars).	• Lack of knowledge and skills on how to perform the transition and what are the alternatives • Mistrust towards available information and solution providers • Ideological reasons (antipathy towards green movements or "climate panic", mistrust towards current government, importance of not being forced) • Difficulty to choose among available heating alternatives • Lack of support from the neighbourhood • Unclear offers received for heating renovation.

Sources of information for residents

Internet search engines	• Google • YouTube • Wikipedia
Facebook groups	• Rintamamiestalofoorumi • neighbourhood groups
Building and renovation sites and other sources of related information	• Rakentaja.fi • RT kortisto by Rakennustieto • Kuluttaja.fi • Urakkamaailma.fi • Veronmaksajat.fi • Urakkatarjous.fi • Sähköala.fi • Sähköinfo • Building and renovation blogs and discussion forums
Books, magazines and other literature	• Renovation books (especially from Panu Kaila) • Renovation and building magazines (TM Rakennusmaailma, Meidän Talo, Rakenna ja Remontoi, Tee Itse, Rakennuslehti)
Trusted people	• Neighbours and other peers • Professional advisors and building & renovation experts • Trusted contractors • House quality inspectors
Companies	• Energy companies • Heating solution sellers • Hardware stores • Building and renovation companies • Heating equipment manufacturers
Associations and other institutions	• Omakotiliitto (Omakotilehti) • Kiinteistöliitto • PRKK • Isännöitsijäliitto • Vanhustyön keskusliitto
Mass media	• Commercials in TV, radio and magazines • Housing and building related TV shows (Kotoisa, Huvila & Huussi)
Fairs	• Rakenna & Remontoi • Omakotimessut
Public officials	• Municipalities' building advisory services • Ymparisto.fi • Motiva • VTT • ARA • Museovirasto • ELY-centers
Own competencies	
Banks	
Environmental organizations	

Cultural Probes

To gain even further insight into the lives and habits of oil-heaters we designed a cultural probes package as previously mentioned. Ideally it would have been delivered to the residents via mail but due to the pandemic situation, we adjusted for it to be conducted fully online. The full questions from the cultural probes can be found in the appendices. We will present the most interesting findings from the cultural probes here.

There were a total of three participants all living in a detached oil-heated house. All three participants responded in a similar manner regarding their circle of trust when it comes to the topic of energy transitions. They trusted their family and friends the most, followed by local services, colleagues and neighbours and finally big business, international companies and politicians were in the outermost circle. When questioned from which source they would find vital to receive support from, family and friends again ranked the highest, followed by the state/public sector and information and advice from energy and heating solution providers. The final takeaway from the cultural probes was the insight into the upkeep of the oil-heating systems, that is, what the residents need to do in order to maintain their current heating solutions. This ranged from daily to yearly maintenance and was also dependent on the season. We were actually slightly surprised about how much maintenance at least these residents' oil-heating equipment seemed to require, at least on a monthly but even on a weekly level.

Next, we will present the insights, design drivers and ideas derived from our research.

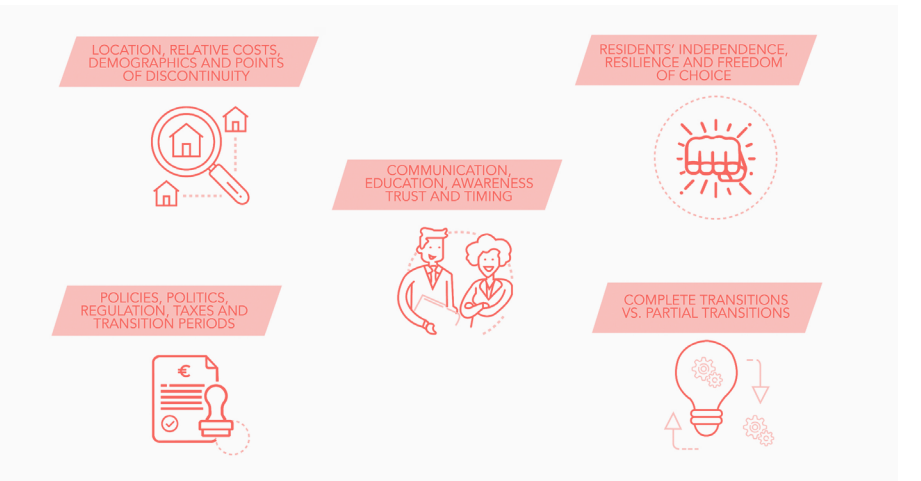
2.4 Insights, Design Drivers & Ideas

To refine our research into the solution proposal, we formulated insight statements, which led to design challenges and drivers, which led to solution ideation and finally, our proposal.

Insights

After our research process, we developed one, synthesized and concise key insight guiding our ideation and proposal design process: most residents are willing to transition to different means of heating to save costs in the long run but lack certainty and trust regarding the available options. Additionally, our proposal making was informed by the following five key insights.

Figure 11 Insights



RELATIVE COSTS, LOCATION, DEMOGRAPHICS AND "POINTS OF DISCONTINUITY"

The perceived relative cost of an alternative heating solution is one of the key decisive factors of a successful heating transition. This cost is affected especially by the estimated total lifecycle costs of the alternative solution compared to the current one (savings vs. costs, energy-source costs, maintenance costs, logistics costs and taxes), the switching cost between solutions, the estimated development of the house's value, disposable income of the resident, availability of funding and the life expectancy of the inhabitants. Location of the house affects these perceptions strongly. Many people might have motivation for the transition but no true financial means and/or incentives to do it as a major proportion of people living in oil-heated houses are elderly and/or have low income levels. Many people have not even chosen their current heating solution themselves and might thus not have so strong initial feelings towards it. Additionally, a so-called "point of discontinuity" – for example the point where a current heating solution reaches its end-of-life, a house is planned to be sold or a house is about to become empty – is an important momentum for a heating transition. Arising from all this, it might be wise to support strongly especially those residents who lack financial means and are approaching some point of discontinuity. In contrast, those about to naturally transition and/or having particularly strong means for the transition might not need so much attention.

COMMUNICATION, EDUCATION, AWARENESS, TRUST AND TIMING

Awareness, knowledge and trust are essential for a resident to have motivation and means to perform a heating transition. Awareness building requires continuous and consistent information sharing, such as news and communications campaigns, about the important themes, especially climate change, governmental targets and available solutions. Sufficient knowledge can be provided through educational publications and advisory services. Trust can be built with reliable and easily accessible sources of information and personal contacts to the residents. Important sources of information are, among others, publications of interest associations, email newsletters, advisory and guidance networks, general media and heating solution companies. Also information received from peers (the effect might be positive or negative) can be important. Timing of the information shared is crucial – enough details need to be available for people to be able to form holistic understanding of the matter. The communications should preferably be focused on facts and positive opportunities and remove fears and feelings of "must".

RESIDENTS' INDEPENDENCE, RESILIENCE AND FREEDOM OF CHOICE

Many residents living in detached houses value independence, personal resilience and freedom of choice highly. Thus, the reliability and crisis resilience of a heating solution is crucial for them. The requirements and conditions for this vary greatly by region. Residents might also seek protection from monopolistic energy providers and aggressive heating solution sales companies. For the residents to perceive having personal freedom of choice, the availability of multiple different heating options is important as well as being forced in a certain direction by regulation as little as possible. The high availability of different heating solutions also enables the residents to choose an appropriate solution for their particular circumstances.

POLICIES, POLITICS, REGULATION, TAXES AND TRANSITION PERIODS

Designing policies and taxes related to heating is a delicate matter. For example, energy taxes might be really strong drivers for transition but somewhat harsh for low-income residents. Subsidies and benefits have proven to be effective drivers of transitions but they need to be designed so that they are realistically available for people in the biggest need (e.g. not too big shares of own risk). Regulations need to be perceived fair and clear. Benchmarking previous mistakes (e.g. regarding waste water management and district heating obligations) made in policy design might be useful to achieve this. The estimated magnitude of impact as well as appropriate transition periods need to be carefully considered when designing policies. A long-enough transition period gives residents and markets time to react and helps avoid problems arising from monopolistic market situations in certain regions. It is also important to acknowledge the somewhat biased views of different lobby organisations.

COMPLETE TRANSITIONS VERSUS PARTIAL TRANSITIONS

In addition to pursuing complete transition away from oil heating, it might be worthwhile to aim at significant energy efficiency improvements in the current heating solutions. Possible ways for achieving this, among others, are different hybrid solutions, use of biofuels in the current heaters and overall energy efficiency renovations performed in the house. This could be a feasible tactic especially in regions where the so-called "low-hanging fruits" have already been harvested – that is, there might not be for example district heating available or ground-source heat-pumps cannot be installed. For a complete transition, hybrid solutions not including oil-heating, ground-source heat-pumps, electric heating with emission-free electricity and district heating seem the most relevant options.

Design Challenge and Drivers

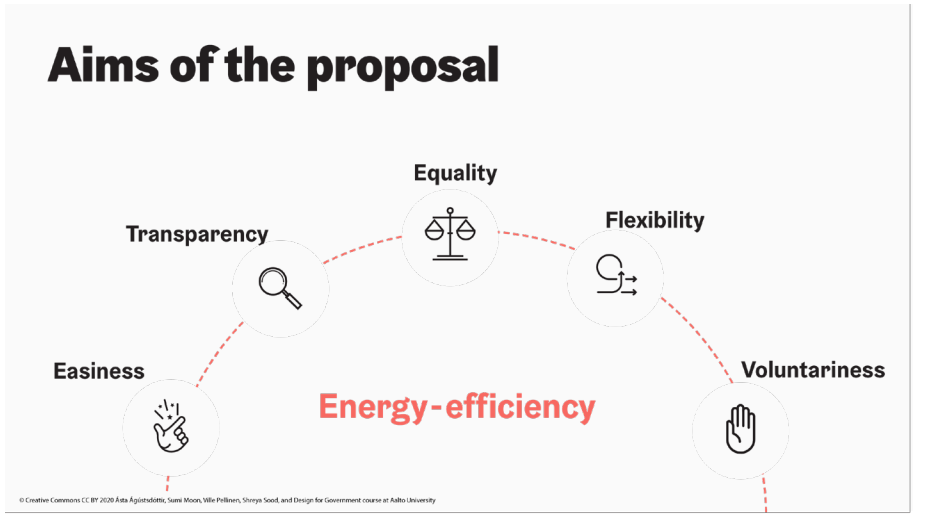
Before moving to formulating our final ideas and proposal, based on our research, insights and initial ideas we narrowed our Design Challenge, or problem statement, into the following form: 'What kind of regional pilots could the government organize to encourage residents and companies in those regions to perform feasible and effective energy efficiency improvements in households?'. This Design Challenge was chosen among seventeen alternative design challenges based on the feasibility of its implementation and potential value for the society if implemented. All the other considered design challenges we developed are presented below. In addition to the main Design Challenge, we also used them to inspire and inform our solution proposal.

- What kind of financial elements should the government and financial institutions create to make feasible financing available for all residents?
- What kind of policies and regulations should the government set to ensure that the heating transition actually happens but in a fair and controlled manner?
- What kind of a system could be developed by the government or heating solution providers to provide residents understanding about regionally available heating solutions?
- What measures should the government take to ensure high availability of different heating solutions in different regions?
- What kind of an evaluation model could the government develop to identify people needing financial aid for a transition the most and this way being able to target the financial elements appropriately?
- How could peer-to-peer knowledge making and sharing be leveraged to encourage more households towards the transition?
- What kind of a communication strategy should the government develop to ensure right information is shared to the residents at the right time?

- What kind of an information & education package should the government, associations and solution providers create to share information & education about the heating transition and this way, build awareness and skills regarding it among residents?
- What kind of resident personas and archetypes could the DfG Project generate to provide the commissioners better understanding about the different capabilities people have regarding the transition?
- Through which channels should the government and financial institutions share information about available financing solutions to make residents more aware of them?
- What channels should the government use to share information about the heating transition?
- What kind of heating solution packages should the heating solution providers provide to ensure that alternative heating solutions to oil-heating provide enough reliability and resilience for the residents?
- What heating solutions could the heating solution providers provide alongside oil-heating to enable residents to reduce their use of heating oil?
- What alternative heating solutions to oil-heating could the government and the heating solution providers promote to replace oil-heating entirely?
- Which stakeholders should the government engage in sharing information about different heating solutions to build trust among residents towards the information shared?
- What kind of network of stakeholders should the government create to build trust and sense of ownership among residents towards the policies made, solutions offered etc.?

We also formulated guiding principles for our final ideation and proposal: Design Drivers. Our design drivers were derived from our findings and insights and highly inspired by the so-called EAST framework (Easy, Attractive, Social and Timely) for behavioural change (Service et al., 2014). The design drivers for our proposal were easiness, transparency, equality, flexibility and voluntariness. We also came to a conclusion that instead of just focusing on phasing out oil heating, targeting significant energy efficiency improvements in oil-heated houses would enable a more just and fair transition taking residents' different situations in life into account.

Figure 12 Design Drivers.



Ideation

To generate a feasible and relevant solution proposal, we first organized a thorough ideation phase. Then, we identified several intervention types (Siodmok, 2017), mostly 'downstream' (latter stages of policy-making, close to implementation) and in between 'soft' (mostly voluntary instruments) and 'hard' (mostly compulsory instruments) measures, that might be feasible for implementing the ideas we had generated. We considered also intervention types 'Grants and subsidies', 'Connecting networks' and 'Service provider' (see figure 9) to be relevant for our project but eventually, our research, analysis and design work led us to formulate a proposal (presented in detail in the section Proposal) that focuses on the Finnish government's and municipal organizations' role as a Choice Architect. "A choice architect has the responsibility for organizing the context in which people make decisions" (Thaler, Sunstein & Balz, 2012, p.428). That is, our proposal's aim is to nudge residents of oil-heated houses to move to more environmentally friendly heating sources and other energy solutions by providing a clear set of alternatives based on their individual situations. We ended up to Choice Architecture and nudging because the just transition to post-oil heating in homes is a rather complex and multifaceted, socio-economic-technical problem which, based on our research and in order to be perceived as 'just', requires quite a flexible approach respecting people with varying situations in life.

Some of the most potential ideas informing our proposal and developed by our team are listed below.

1. Piloting a voluntary and temporary "service agreement" in a region considered to have the biggest challenges in regards to transition to post-oil heating in homes. This service agreement would be made among the state, the municipalities in that region and energy companies & heating solution providers providing services in that particular area. The agreement could include an energy efficiency improvement target with related metrics so that if a service provider or an alliance of service providers manages to improve a household's energy efficiency to a certain level, the service provider(s) and the household would receive a certain amount of financial grant from the state. Alongside a grant, some kind of "state secured" financing scheme could be considered so that the resident should not need to pay a big upfront investment but rather over time as possible savings from the new heating source(s) kick in. The agreement could also include a list of proposed measures on how the energy efficiency improvements could be achieved (this list should not be made too limiting). The Service agreement would enable also offering additional services by other local service providers alongside the energy efficiency improvements, if seen feasible. The state could offer some subsidies also for these additional services, if seen appropriate.

Additionally, some recommendation fee could be considered for households who manage to recruit people to do measured energy efficiency improvements (a personal recommendation code etc.). The state and the municipalities could promote the companies joining this Service agreement and committing to its requirements regarding quality and ethics of the services provided. This way trust towards these companies could be built among residents. The parties joining the service agreement could together draft some default service packages easy to be offered to the residents - e.g. a free/inexpensive energy efficiency consultation (including also evaluation of the household's lifecycle phase, i.e. what kind of energy efficiency improvements would make sense + some kind of a commitment to offer specific heating solutions and their installations & maintenance with certain fees). If the companies joining the service agreement would form some kind of an

alliance, they could share the workload, profits and subsidies generated through the service agreement. Also an online "search engine" / "service platform" for the regional service packages offered could be developed. Through this platform and through directly contacting households (letters, phone calls, text messages, emails, booths on public locations, visits etc.) in that particular region, the service packages could be made easily approachable for the residents. An information package of the services provided could include e.g. information about the available consultation, heating solutions, energy efficiency improvements and public subsidies. Additionally, an open call especially for oil-heaters could be organized so that they could easily request for a personal consultation and also provide the state and their municipality important information regarding where the oil-heated houses actually are. If this pilot would be perceived as successful, it could be fine-tuned based on feedback gathered and expanded to other regions as well, maybe accompanied by a more formal Public Service Obligation (PSO).

2. Visualizing a resident's path to transition and "Becoming a (carbon footprint) Hero". The process would start by sending residents in a certain area an information package about available alternatives to raise their awareness. Then, the resident would go to an online platform where one would see a visualized journey to zero-carbon heating based on one's household status. The status would be evaluated based on a questionnaire the resident fulfills.

3. Consumers can be encouraged to use less energy if they are given feedback about how their energy use compares with that of similar sized households in their neighbourhood, together with tacit approval or disapproval in the form of an emoticon. What if we use a similar approach and show residents how much they could

be saving annually if they made the transition, and also how they compare to their neighbours? First, the resident would be offered information on one's current situation. This could be done through offering communities a consultancy service funded by the government. Then, we would be creating a persuasive action plan for the resident nudging one so that the alternatives presented are both easier and attractive than initially perceived. This could be done through connecting service providers with the government and requesting them to come up with a list of realistic alternatives for different areas. These alternatives could be compiled and enriched with a successful and relatable transition story. Finally, the resident would be helped with the practicalities: which company to go with, how much would it cost, are there any grants available etc.

4. Direct fiscal incentives for homeowners to replace oil-heating systems with clean energy electric heat pumps and to conduct other significant energy-efficiency improvements – low income households prioritized. Additionally, an innovative financing mechanism that allows private companies, charities and local authorities to cover the upfront costs of installing energy efficiency measures. Individuals will then pay back the costs of these measures through the savings made on their energy bills. The repayments should never be more than the amount saved, so consumers should see no increase in their bills. It is not a personal loan: the charge remains with the billing at the property, rather than with the individual. Share information of successful transition within the community to encourage more households to perform the transition. (see e.g. Cabinet Office Behavioural Insights Team, 2011; Stamas, 2019).

Next, we will present our final solution proposal in detail.

3
Solution Proposal

Findings from Commissioners
Findings from Desk Research
Findings from Expert Interviews
Findings from Resident Research
Insights, Design Drivers & Ideas

"We have systematically sought to reduce oil consumption by renewing the system, maintaining it regularly, procuring air-source heat-pump and connecting solar electricity to the electric heater of the oil boiler – and, of course, reducing consumption of hot water and lowering indoor temperature. We think the oil consumption is really reasonable and we hope that there will be no need to renew the whole system for such an old house with expensive money when the next owner is likely to demolish the house..."
- Quote from anonymous oil-heated house resident

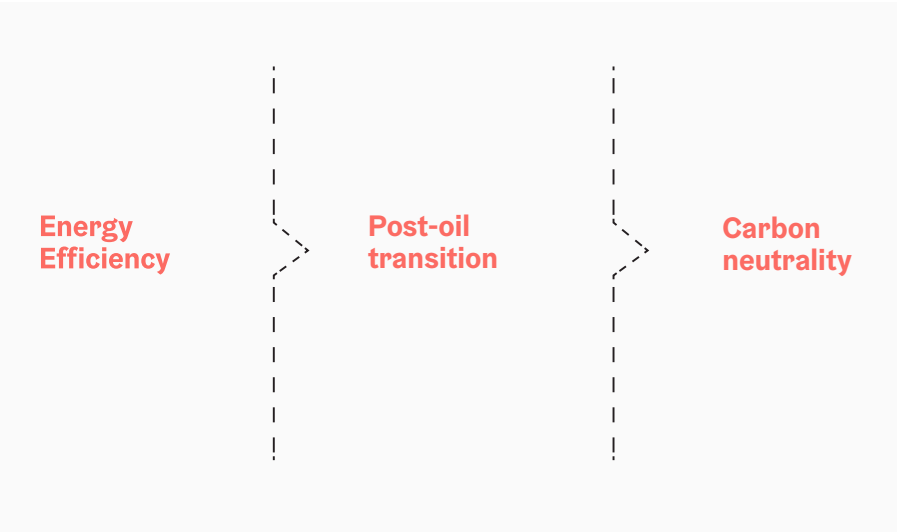
This quote summarizes well the insight that the transition towards post-oil heating can be a complex and multifaceted matter from the residents' perspective. There are many ways to eventually achieve it and not everyone's situation is optimal for a complete and immediate transition away from oil. Significant energy efficiency improvements might be included as feasible targets.

3.1 Introduction to the Proposal

The proposal's aim and the essential principles are derived from the five design drivers – easiness, transparency, equality, flexibility and voluntariness. To specify,

Easiness signifies accessibility and hassle-free conditions for the residents. Both the solution and all communication surrounding it should be as easily available as possible, motivating the residents to participate.
Transparency or clarity of the given information is vital for building trust. For example, residents knowing their current situation and tracking their own transition path, so they can anticipate what benefits are included on an individual household level.
Equality of opportunity to transition and information sharing regardless of age, income, and residence type is required to have a sense of fairness. However, equality does not mean everything is always the same for everyone.
Flexibility plays an important role as 'one size does not fit all.' Each of the household situations is different, some might need a fully changed solution, and some might not.
Voluntariness, especially as the primary user group is from an older generation. This enables the residents' to transition voluntarily, not from a top-down perspective.

Figure 13 Roadmap to carbon neutrality in heating of homes.



Our proposal is for the Government to initiate a regional pilot by providing customized solutions to the special needs of different user types. We want to encourage the transition by boosting social norms and offering as much support as possible. Energy efficiency improvements could be a part of the solution, including, but not being limited to, reducing or completely getting rid of using oil. Based on our research, we believe that aiming at maximizing energy-efficiency of oil heated houses is a just and natural milestone towards a complete post-oil heating transition and eventually, towards a carbon neutral society.

The core idea of our proposal is to nudge the residents by providing them clear information and suggest alternatives to help them find the 'most feasible and impactful' solution. We want to empower the residents to make favourable decisions. We also want to boost

Figure 14
Pilot regional in Varsinais-Suomi.

social norms and create a sense of pride for being responsible and contributing positively towards carbon neutrality. We propose Varsinais-Suomi to be the pilot region because based on our research, there is a particularly strong concentration of oil-heaters relative to the amount of inhabitants in that area.

Stakeholders playing a key role in the proposal would be the government, municipalities, energy solution providers and relevant associations. The government would be responsible for financing and providing the platform for the pilot as well as supervising it. Simultaneously, a strong network of associations could be utilised to reach out to the people, gain trust, and share information for them. Collaboration with the local energy solution providers would be crucial to ensure supply of feasible technical solutions as well as guarantees for their quality. However, we do not want to put any sort of pressure on the residents or promote monopoly of a particular supplier. Finally, it would be mainly the role of the municipalities of the region to facilitate the auditing process.

Figure 15 Choice architecture, boosting social norms and nudging residents for accessible options.

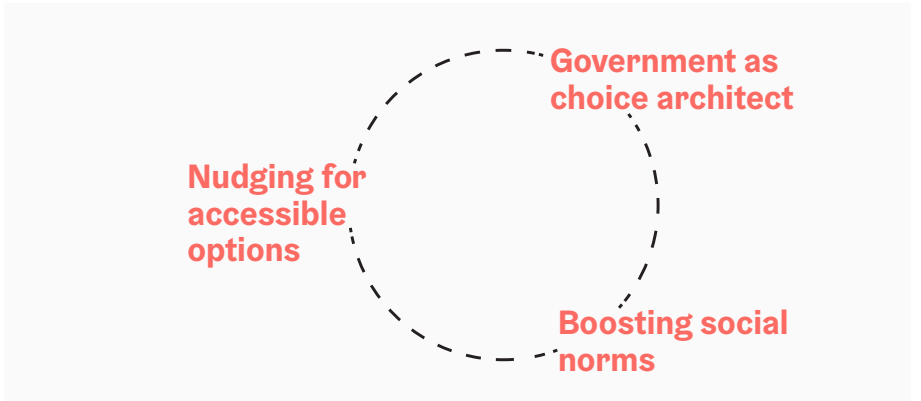
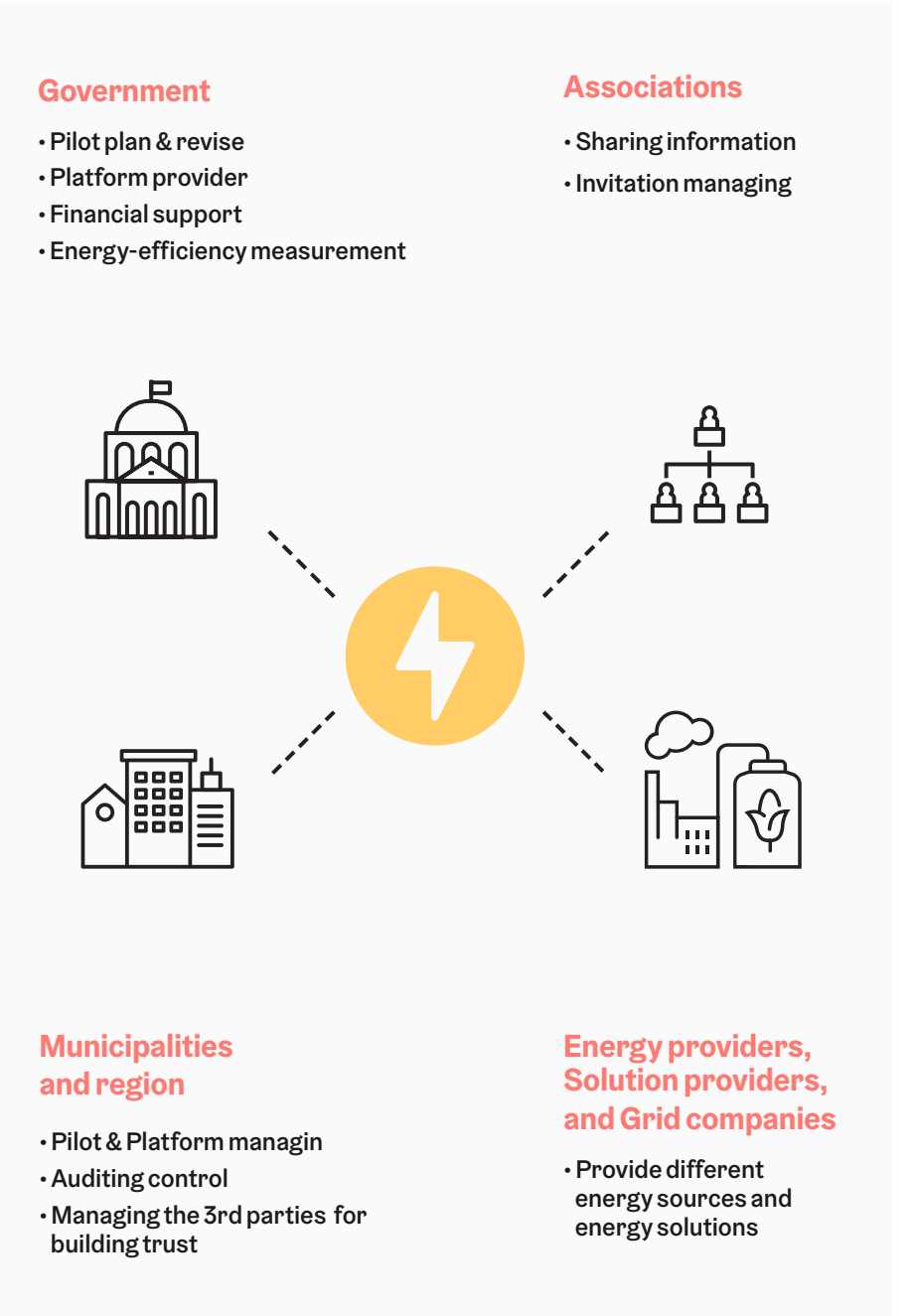


Figure 16 Roles of different stakeholders.



3.2 Overview of the Journey of an Energy Hero

In the Energy Hero journey, the municipalities and associations would first reach out to the residents of the region via phone calls and personalised letters, whose content would be targeted especially for the current oil-heaters.

Once the residents are on board, municipalities, together with for example Motiva, would perform the household-specific audits. Upon receiving the details of the households, the auditor would generate a house profile and suggest recommendations for the transition.

Once the auditing is done, the government would offer upfront financial and implementation support to undertake the transition and energy solution providers would then implement the quality-guaranteed energy-efficiency renovations. All the records would be kept online so that the progress could be tracked and compared. Finally success stories could be shared to motivate other regions and households.

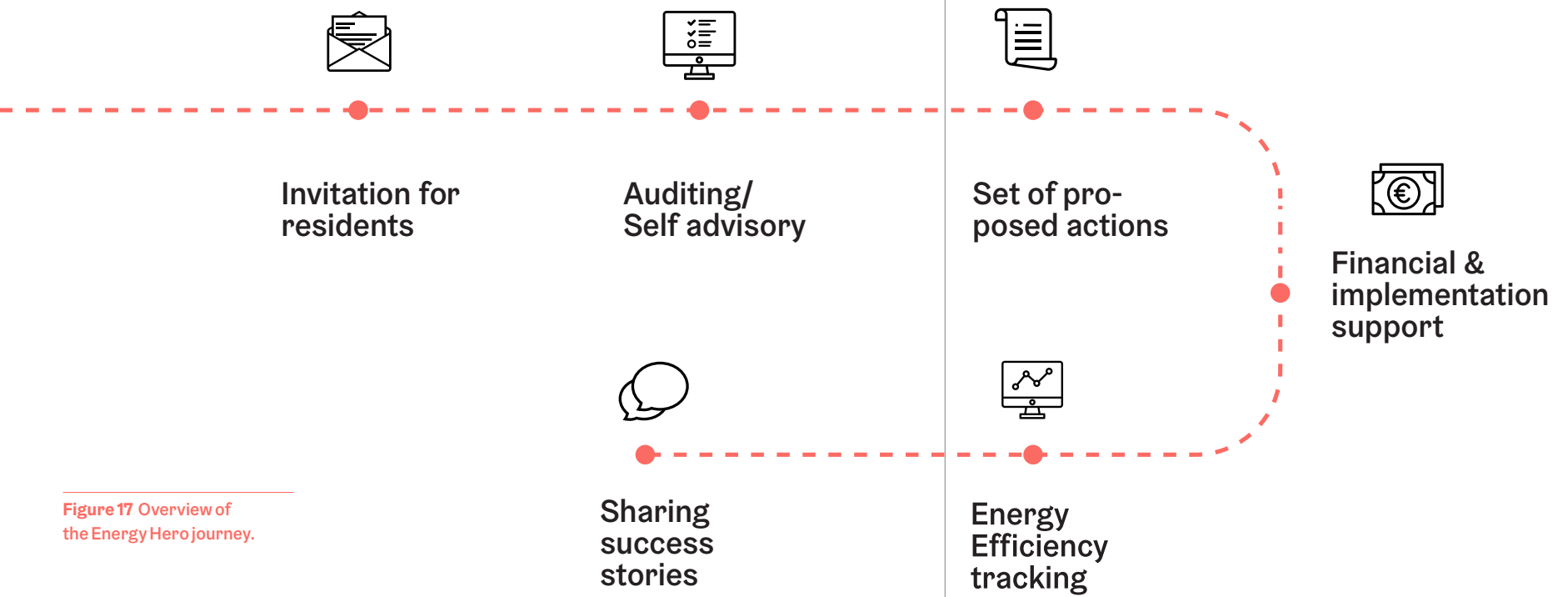


Figure 17 Overview of the Energy Hero journey.

3.2 Energy Hero Journey from the Resident's Point of View

Let us now go through the process from a resident's point of view, introducing Vivi. Vivi lives in a detached house in Salo with her husband. Her main source of income is a pension plan. Although she is aware about the impacts of oil usage on the environment, she is a bit hesitant to do the transition due to a lack of financial means and mixed information

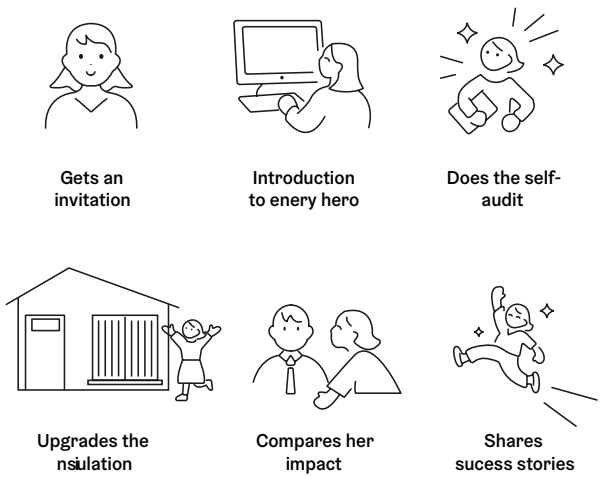


Figure 18
ViVI's Story
Start from an invitation end with sharing succes stories.

Step 1
Invitation

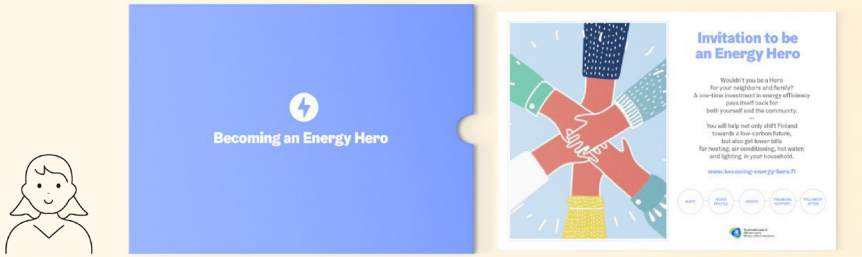


Figure 19 Invitation.

Step 2
Introduction

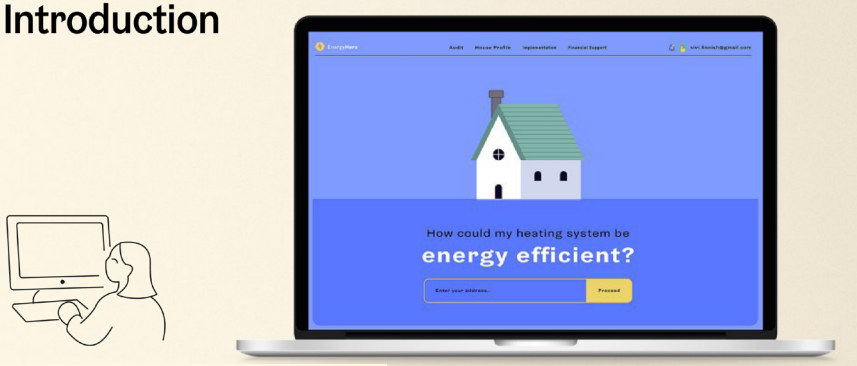


Figure 20 Introduction.

INVITATION
First, Vivi receives a letter and a call from her municipality or an association informing her about the pilot plan. The invitation includes an introduction to the initiative alongside with details of the online portal where she can find further information.

INTRODUCTION
She then logs into the website and familiarises herself with the Energy Hero package by inputting her address.

Step 3

Audit

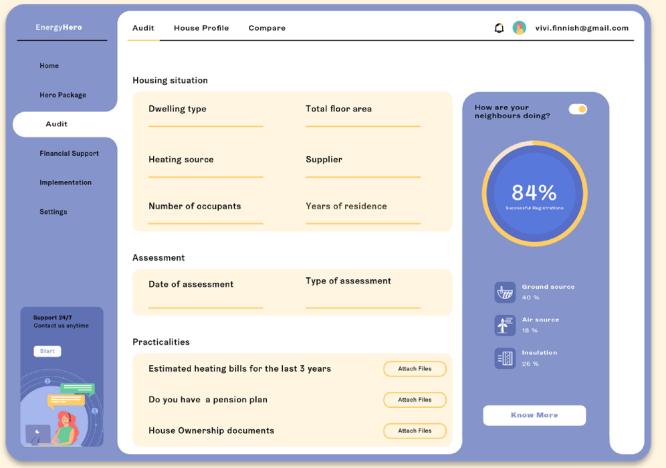
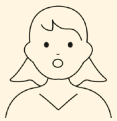


Figure 21 Audit.

Step 4

House Profile

Choice architecture of proposed actions, nudging towards the most desired call of action.



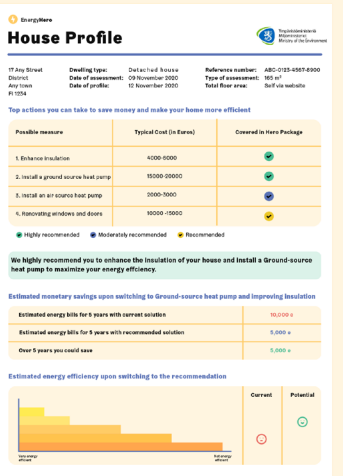


Figure 22 House Profile.

Choice architecture of proposed actions

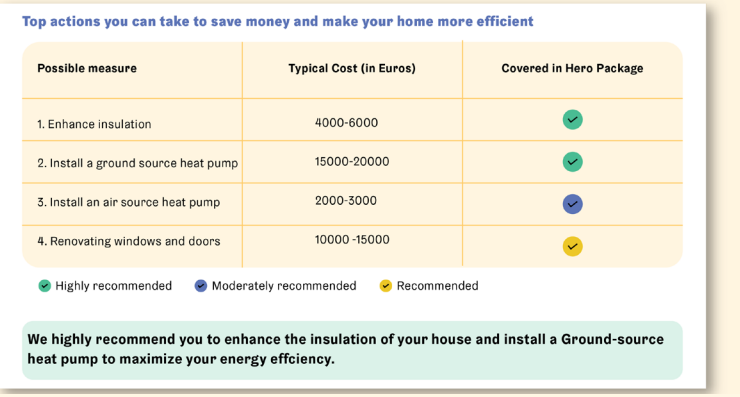


Figure 23 Details of House Profile.

Nudging towards the most desired call of action

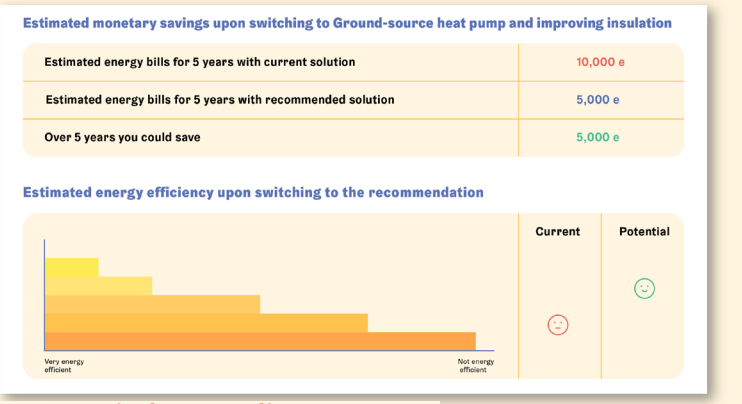


Figure 24 Details of House Profile.

AUDIT

Since Vivi is rather tech-savvy, she opts for the self-auditing process on the portal. She is asked to fill in information related to her dwelling type, number of occupants, heating supplier etc. Additionally, she is asked to attach important documents such as house ownership paper, energy bill of the previous years and details of the applicable financial means.

HOUSE PROFILE

After she fills in the audit form, a 'house profile' is generated. It is carefully designed, offering a choice architecture to nudge Vivi to the most feasible and energy efficient alternative for her. The first half of the house profile recommends her feasible energy-efficiency improvement options and prioritizes them according to their favorability. The second half of the 'house profile' gives her details of the potential energy and cost savings if she takes the above recommended alternatives. She is also presented with a set of local, trustworthy energy solution providers that could provide her the preferred solutions.

Step 5

Financial and implementation support

Figure 25 Financial and Implementation Support.

Step 6

Compare

Figure 26 Compare.

FINANCIAL AND IMPLEMENTATION SUPPORT

Once Vivi has made her choice, she is presented with the financial support she might be entitled to. Some options are via compensation vouchers while others, incurring bigger expenses, are via a combination of vouchers and affordable loan schemes. Additionally, implementation support mechanisms like guarantees, certifications and insurance plans are presented.

COMPARE

Once Vivi's house has undergone the recommended transition, she has the

Carbon Emissions

Savings

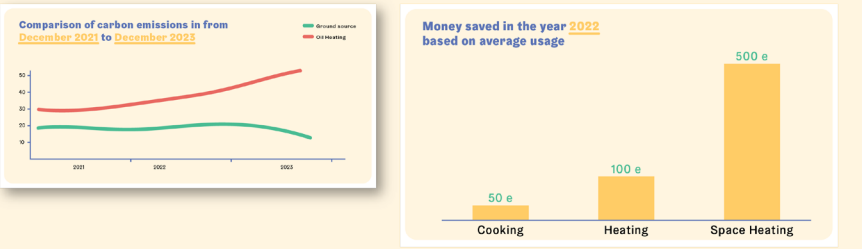


Figure 27 Details of Compare

Comparison with neighbours to boost social norms

Figure 28 Details of Compare

option to track her own journey and compare it to her previous situation. If Vivi is feeling inspired to even further minimise her carbon footprint, she could request for further recommendations. Vivi can for example see the development of her energy-use related carbon emissions and how much money she has saved in various heating related activities such as 'cooking, house heating etc'. Vivi could also compare her efficiency to others in the neighbourhood. Humans are competitive by nature, so by gamifying the comparison, we are trying to promote healthy competition amongst neighbours to be the most energy efficient.

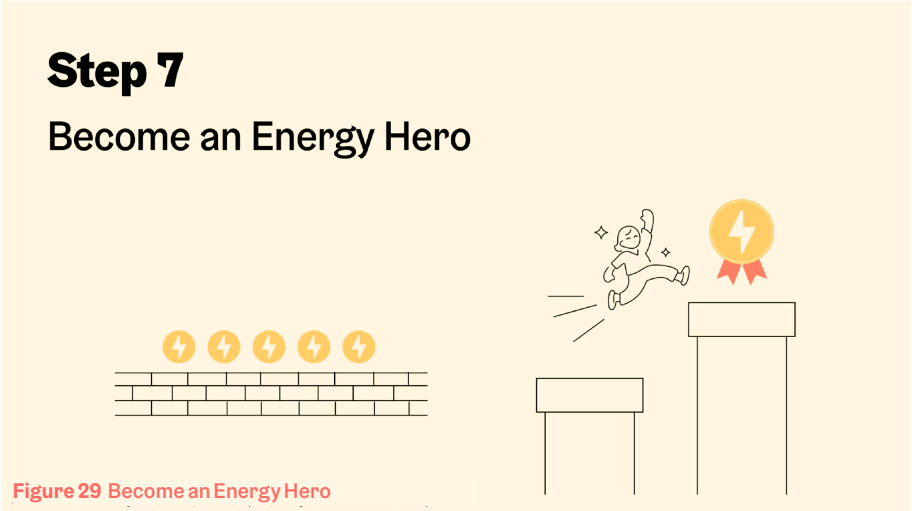


Figure 29 Become an Energy Hero

BECOME AN ENERGY HERO

After one year of the transition, Vivi is approached by a representative from the municipality to share her experience of the Energy Hero pilot and help the ministry in sharing her feedback of the pilot. She is also asked if she would like to share her positive story in the media to motivate the change on a nationwide scale.

3.3 Timeline for the Proposal

We have also mapped out a timeline for the project. This includes an initial six months dedicated to starting the pilot. The most crucial points in this phase would be to identify the households using oil-heating within the selected region, choose motivated volunteers to take part in it and finally, find ambassadors willing to share their experiences. After one year, the focus would be in scaling the pilot to a national level after improving it based on the first experiences. The desired impact from the pilot would be that 30% of households would have transitioned to an alternative source of energy while a further 50% would be in the process of either transitioning or improving their energy efficiency. In five years time, we foresee some concrete results. Our desired impact would be that 50% of households would have transitioned fully to an alternative energy source and that 30% would have done some form of energy efficiency improvements or are in a process of transitioning. Most importantly, in the end, residents are happy with the transition.

The reason this approach is beneficial for the government is because it helps them in building trusted relations with the citizens by encouraging voluntary participation. With such participation by the residents, the process of the transition becomes easier and more feasible. Thus, the 'just' transition would be more easily achieved. On the other hand, residents will be offered guaranteed quality of heating solutions that are feasible for them while having their long-term interests at heart.

Figure 30 Average lifecycles and renewal prices of different heating solutions

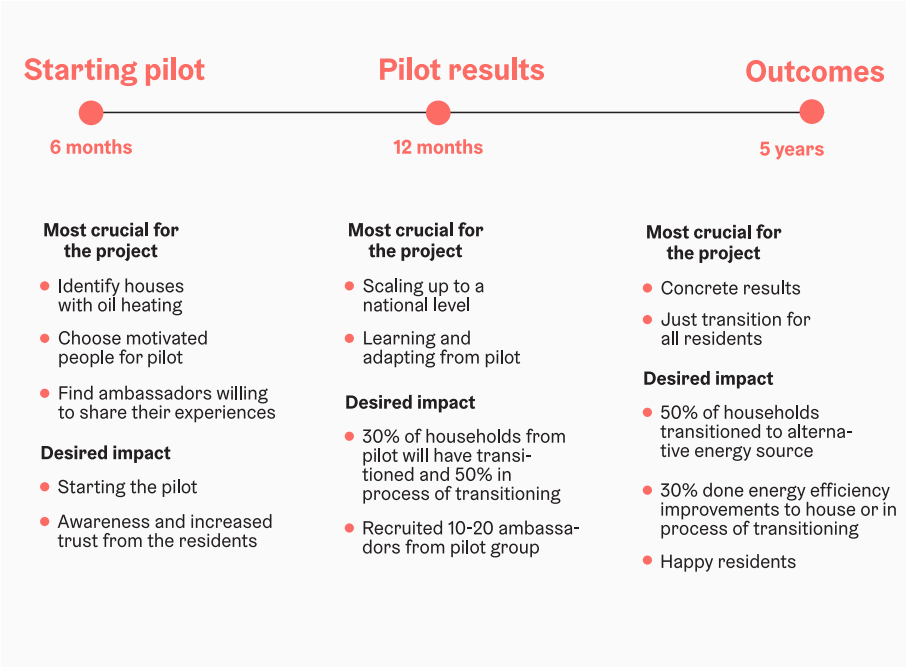
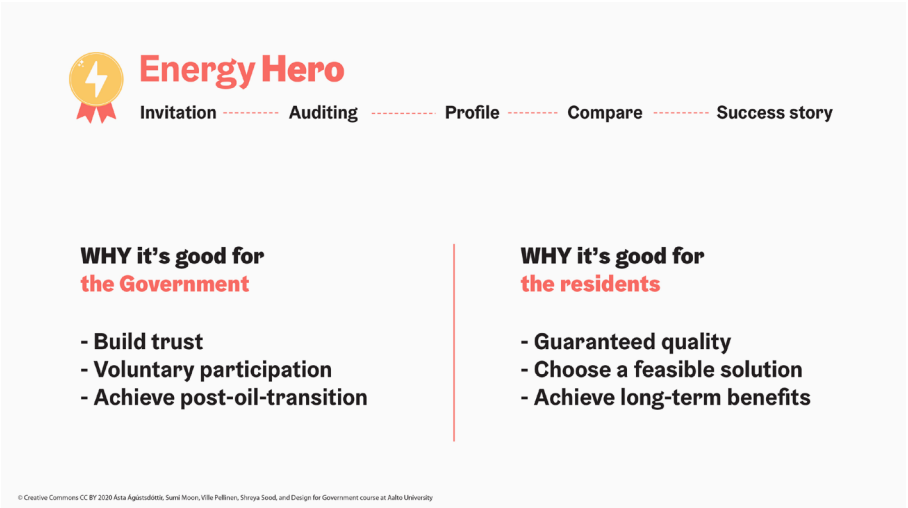


Figure 31 Average lifecycles and renewal prices of different heating solutions



EnergyHero

Journey to becoming an Energy Hero

Conclusion

To conclude, ‘Just transition to post-oil heating in homes’ is not just a technical matter but even first and foremost a social and financial matter with strong local and household level variation. The reasons why residents are not transitioning to a greener source of energy are not straightforward; they can include financial issues, geographical limitations, as well as value-laden personal perceptions. One solution will not be able to fit all; some of the houses are small and others are large farms with varying demographic and economic status of the inhabitants.

To develop a feasible solution to the given challenge, we applied several human-centred design and systems thinking methods to our research process. We involved several experts to the research process to help us define the right problems to be addressed and potential solutions to them. Most importantly, we engaged an extensive number of residents living in detached houses to share their perceptions about the matter and to provide their ideas on how to best enable the just transition to post-oil heating. Additionally, we studied several previous researches related to the matter and similar transitions, both in the Finnish and international contexts. Our research methods included desk research and literature reviews, stakeholder workshops, expert and resident interviews, Cultural Probes, questionnaires, systems mapping, insights, design challenge and design drivers development, ideas and design intervention development and finally, detailed proposal building. All in all, our solution proposal was developed through a thorough three-month research process.

The key insight derived from our research, findings and design process was that “most residents are willing to transition to different means of heating to save costs in the long run but lack certainty and trust regarding the available options”.

The design drivers for our proposal were easiness, transparency, equality, flexibility and voluntariness. We also came to a conclusion that instead of just focusing on phasing out oil heating, targeting significant energy efficiency improvements in oil-heated houses would enable a more just and fair transition taking residents’ different situations in life into account. Our proposal focuses on the Finnish government’s and municipal organizations’ role as a Choice Architect. That is, our proposal’s aim is to nudge residents of oil-heated houses to move to more environmentally friendly heating sources and other energy solutions by providing a clear set of alternatives based on their individual situations. We ended up to Choice Architecture and nudging because the just transition to post-oil heating in homes is a rather complex and multifaceted, socio-economic-technical problem which, based on our research and in order to be perceived as ‘just’, requires quite a flexible approach respecting people with varying situations in life.

Our solution proposal is to organize a government led regional pilot where different locally feasible alternatives for significant energy efficiency improvements (possibly including, but not limited to, phasing out oil-heating), their providers, implementation models and financing alternatives would be presented to that region’s households (focus on oil-heated houses) through a communication and education package shared to homes. Additionally, the households would be offered either an on-site energy efficiency auditing by a professional energy advisor or a self-auditing option online to determine the household’s individual status and provide energy efficiency improvement measures best suitable for that particular status. Based on the scale of improvements proposed, the household would also be offered possible financial support by the public sector and implementation support by local companies and associations. After the planned renovations are performed, the

achieved energy efficiency improvements are measured. Finally success stories of successful renovations and energy transitions are shared to inspire other households to engage in a similar transition process. The stakeholders playing a key role in the proposal would be the government, municipalities, energy solution providers and relevant associations. We want to encourage the transition by boosting social norms and offering as much support as possible. Based on our research, we believe that aiming at maximizing energy-efficiency of oil heated houses is a just and natural milestone towards a complete post-oil heating transition and eventually, towards a carbon neutral society.

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We would especially like to thank all the residents who participated in our resident research in its different forms. You provided us the main body of our research data and without you our project would not have been this successful.

We sincerely hope this report and our proposal help the Finnish government drive the Finnish households towards carbon-neutrality by 2030!

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Appendices

Appendix 1.
Questions for Lämmitysenergia Yhdistys

1.
Miten korkea motivaatiotaso öljylämmitteisissä taloissa asuvilla kansalaisilla on yleisesti mielestänne tällaisia transitioita kohtaan?

2.
Minkälaisia rahoituslähteitä (julkisia ja yksityisiä) olette tunnistaneet mahdollisesti tukemaan tällaisia transitioita?

3.
Mitkä ovat tehokkaimpia viestintäkeinoja ja -kanavia ihmisten tavoittamiseen ja motivoimiseen näihin transitioihin liittyen?

4.
Miten voimakkaasti näkemyksenne mukaan kansalaisten lähipiirit (esim. naapurit) vaikuttavat tällaisten transitioiden toteutumiseen?

5.
Mitkä ovat tällä hetkellä tärkeimmät lämmitysöljyn lähteet Suomessa ja kuinka keskittynyt tai hajautunut kyseinen markkina on? Entä mikä on vastaava tilanne tarvittavien öljylämmityslaitteistojen osalta?

6.
Mitkä ovat yleisimpiä öljylämmitystä korvaavia lämmitysmuotoja Suomessa ja onko näissä havaittavissa alueellisia eroja (esim. kaukolämmön hyödyntämismahdollisuudet)?
Mikä on näkemyksenne näihin eri teknologioihin liittyen - tulisiko esimerkiksi joillain alueilla suosia tiettyjä ratkaisuja vai tulisiko kaikkialla toimia teknologianeutraalisti?

7.
Minkälaisia erityispiirteitä öljylämmitteisiin asuntoihin ja näissä asuviin ihmisiin liittyy alueittain?

8.
Minkälaisia merkittäviä mahdollistajia tunnistatte tällaisille transitioille? Entä esteitä?

9.
Miten suurena asiana/haasteena pidätte asuntojen öljylämmitystä ylipäätään Suomessa ja alueellisesti huomioiden esimerkiksi kansalliset ja alueelliset kokonaisilmastopäästöt?

10.
Mikä on tällä hetkellä asuntojen luonnollinen, vuosittainen transitiotahti pois öljylämmityksestä alueittain?

11.
Mitkä tahot ovat tärkeimpiä päätöksentekijöitä näihin transitioihin liittyen kansallisella ja paikallisella tasolla?

12.
Miten paljon asuntojen öljylämmityksestä ja siihen liittyvistä transitiotarpeista käydään mielestänne keskustelua eri medioissa?

13.
Minkälaisia aloitteita ja hankkeita on jo olemassa paikallisella, kansallisella ja kansainvälisellä tasolla näihin transitioihin liittyen?

14. Mitä muita sidosryhmiä lisäksenne tulisi mielestänne osallistaa näiden transitioiden suunnitteluun ja toteutukseen?

Appendix 2.
Questions for Omakotiliitto

1.
Minkälainen on liittonne jäsenten ikärakenne ja aktiivisuustaso keskimäärin?

2.
Minkälaisia erityispiirteitä öljylämmitteisiin asuntoihin ja näissä asuviin ihmisiin liittyy alueittain?

3.
Miten liitossanne ylipäätään suhtaudutaan öljylämmitykseen?

4.
Miten paljon asuntojen öljylämmityksestä ja siihen liittyvistä transitiotarpeista käydään mielestänne keskustelua eri medioissa?

5.
Miten paljon liitossanne on jo keskusteltu näistä transitioista ja onko teillä jo meneillään joitain hankkeita tai tukitoimia niihin liittyen? Entä teettekö kansallista tai kansainvälistä yhteistyötä näihin aihepiireihin liittyen joidenkin muiden organisaatioiden kanssa (esim. Sulpu ry.)? Jos teette, minkälaista?

6.
Miten korkea motivaatiotaso öljylämmitteisissä taloissa asuvilla kansalaisilla on yleisesti mielestänne tällaisia transitioita kohtaan?

7.
Onko olemassa tahoja, jotka erityisesti vastustaisivat tällaisia transitioita?

8.
Mitkä ovat tehokkaimpia viestintäkeinoja ja -kanavia ihmisten tavoittamiseen ja motivoimiseen näihin transitioihin liittyen?

9.
Miten voimakkaasti näkemyksenne mukaan kansalaisten lähipiirit (esim. naapurit) vaikuttavat tällaisten transitioiden toteutumiseen?

10.
Minkälaisia merkittäviä mahdollistajia tunnistatte tällaisille transitioille? Entä esteitä?

11.
Minkälaisia aloitteita ja hankkeita on jo olemassa paikallisella, kansallisella ja kansainvälisellä tasolla näihin transitioihin liittyen?

12.
Minkälaisia rahoituslähteitä (julkisia ja yksityisiä) olette tunnistaneet mahdollisesti tukemaan tällaisia transitioita?

13.
Tuleeko teille mieleen relevantteja lakeja, joista täytyisi olla selvillä lämmityksen transitioihin liittyen, energiatodistusten lisäksi?

14.
Mitkä ovat tällä hetkellä tärkeimmät lämmitysöljyn lähteet Suomessa ja kuinka keskittynyt tai hajautunut kyseinen markkina on? Entä mikä on vastaava tilanne tarvittavien öljylämmityslaitteistojen osalta?

15.
Mitkä ovat yleisimpiä öljylämmitystä korvaavia lämmitysmuotoja Suomessa ja onko näissä havaittavissa alueellisia eroja (esim. kaukolämmön hyödyntämismahdollisuudet)? Mikä on näkemyksenne näihin eri teknologioihin liittyen - tulisiko esimerkiksi joillain alueilla suosia tiettyjä ratkaisuja vai tulisiko kaikkialla toimia teknologianeutraalisti?

16.
Mikä on tällä hetkellä asuntojen luonnollinen, vuosittainen transitiotahti pois öljylämmityksestä alueittain?

17.
Keskustelemme erityisesti öljylämmityksen korvaamisesta muilla lämmitysmuodoilla, mutta tapahtuuko transitioita myös toiseen suuntaan eli ottavatko ihmiset öljylämmitystä käyttöön esimerkiksi öljyn hinnan laskiessa, sen energiatehokkuuden vuoksi tai huoltovarmuuden takia?

18.
Onko teillä antaa esimerkkejä onnistuneista ja reiluista transitioista (ei ole pakko edes liittyä lämmitysenergiaan, vaan voivat olla muunkinlaisia sosio-teknisiä transitioita), joista olisi syytä ottaa mallia myös Suomessa? Onko teillä antaa esimerkkejä muissa maissa toimivista, Omakotiliiton kaltaisista organisaatioista, jotka olisivat olleet tämänkaltaisissa transitioissa mukana?

19. Mitä muita sidosryhmiä lisäksenne tulisi mielestänne osallistaa näiden transitioiden suunnitteluun ja toteutukseen?

Appendix 3.
Questions for Peter Lund

1.
Do you already have some concrete ideas of how to implement this transition? That is, what would be the most important/impactful enablers helping Finnish households transition away from oil-heating?

2.
What hinders this transition the most?

3.
What aspects we might have missed when researching the post-oil heating transition (possible pitfalls in the transition)?

4.
Do you know of some successful, controlled societal transitions (not just related to heating but overall) that we should benchmark?

5.
Could you comment and validate the insights we have developed so far? See the insights in the attached PowerPoint presentation.

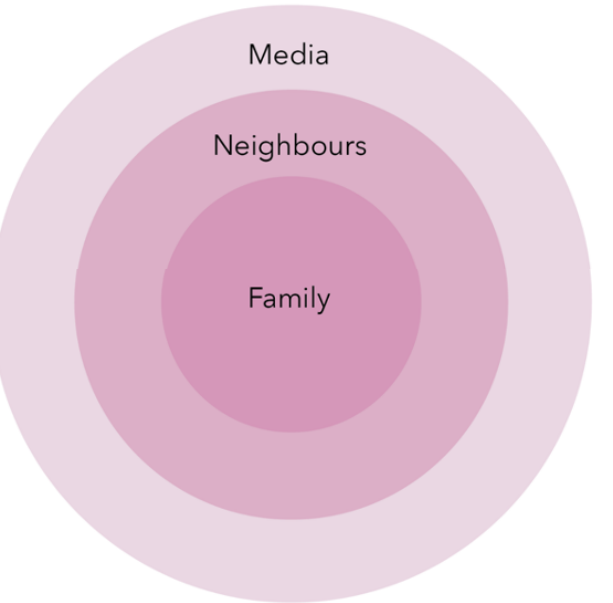
6.
Is there something in general you would still like to tell us regarding this topic?

Appendix 4.
Cultural Probe

0) Kertoisitko meille ikäsi, kotikuntasi ja asumismuotosi?

1A) Luottamuskehät

Tässä tehtävässä pyydämme sinua listaamaan yrityksiä / ihmisiä / instituutioita / muita sidosryhmiä ja organisaatioita, joihin luotat tai et luota. Kyseiset tahot asetellaan niin kutsutuille "luottamuskehille" niin, että eniten luotetut tahot ovat sisemmillä tasoilla ja vähiten luotetut ulommilla. Alla on esimerkki tällaisista luottamuskehistä. Kirjoita vastauksesi esimerkin alta löytyviin vastauslaatikoihin. Voit listata mitä tahansa mieleesi tulevia relevantteja tahoja tässä tehtävässä.



Sisäkehä (luotan paljon)

Keskikehä (neutraali suhtautuminen / luotan melko paljon)

Ulkokehä (luotan vain vähän tai en juuri ollenkaan)

1B) Tärkeä tuki

Tässä tehtävässä pyydämme sinua arvioimaan asteikolla 1-5 (1 = ei lainkaan tärkeää, 5 = erittäin tärkeää) alla listattujen tahojen tuen merkitystä sinulle. Kuvaile myös, miksi (tai miksi ei) kyseisen tahon tuki on sinulle tärkeää. Voit arvioida tuen merkitystä kotitalouttasi koskevien päätösten kontekstissa, mutta myös yleisemmin.

Valtion / julkisen sektorin tuki

1 5

3

Miksi (tai miksi ei) tämä on tärkeää sinulle?

Perheen ja ystävien tuki

1 5

3

Miksi (tai miksi ei) tämä on tärkeää sinulle?

Naapureiden ja muiden tuttavien tuki ja suositukset

1 5

3

Miksi (tai miksi ei) tämä on tärkeää sinulle?

Erilaisten yhdistysten, konsulttien ja neuvontapalveuiden tuki ja neuvot

1 5

3

Miksi (tai miksi ei) tämä on tärkeää sinulle?

Energia- ja lämmitysratkaisujen tarjoajien jakama informaatio ja neuvonta

1 5

3

Miksi (tai miksi ei) tämä on tärkeää sinulle?

2A) Arvot ja huolenaiheet

Tässä tehtävässä pyydämme sinua sijoittamaan seuraavat arvot/huolenaiheet tärkeysjärjestykseen niin, että tärkein on ylhäälla ja vähiten tärkeä alhaalla. Voit raahat kunkin arvon/huolenaiheen vasemmalta oikealle kohtaa tärkeysjärjestystä oikealle.

- Yleinen etu →
- Raha ja talous →
- Ympäristö →
- Henkilökohtainen hyöty →
- Mukavuus →

1.

2B) Auta meitä ymmärtämään tilannettasi paremmin

Miten ilmastonmuutos on vaikuttanut energian ja lämmityksen tarpeisiisi ja näihin liittyviin valintoihisi?

Mitkä ovat suurimmat huolenaiheesi tulevaisuuden kannalta energiaa ja lämmitystä koskien?

Kuinka suuri osa käytettävissä olevista tuloistasi menee keskimäärin lämmitykseen?

3A) Näkemyksesi ja tuntemuksesi nykyistä lämmitysratkaisuasi koskien

Mikä on parasta/toimivinta nykyisessä lämmitysratkaisussasi?

Mikä sinua harmittaa eniten nykyisessä lämmitysratkaisussasi?

3B) Tässä tehtävässä pyydämme sinua muistelemaan, mitä kaikkea sinun tulee tehdä eri aikajänteillä pitääksesi asuntosi lämpimänä. Listaa mieleesi tulevia aktiviteetteja alla esitettyjen aikajänteiden alle.

Täytä vastauksesi oikeisiin vastauslaatikoihin kuvan alle. Älä huoli, vaikka joutuisitkin jättämään joitakin kohtia jopa kokonaan tyhjiksi, koska on hyvin mahdollista, että sinun ei tarvitse tyypillisesti tehdä mitään lämmitykseen liittyviä toimenpiteitä kyseisellä aikajänteellä. Pyytäisimme sinua myös valmistautumaan jakamaan meille kuvia lämmitysratkaisustasi ja siihen liittyvistä aktiviteeteista tehtävässä 3C.

Viikottain

Kuukausittain

Kausittain/vuosittain

Harvemmin kuin vuosittain

3C) Tehtävään 3B liittyen pyytäisimme sinua ottamaan kuvia nykyisestä lämmitysratkaisustasi ja siihen liittyvistä aktiviteeteista. Lähetä kuvat Ville Pelliselle sähköpostilla (ville.f.pellinen@aalto.fi), WhatsAppilla / Telegramilla ( ) tai Facebook Messengerilla. Arvostaisimme myös suuresti, mikäli voisit kuvien lisäksi tarjota meille lyhyet kuvaukset siitä, mitä kukin kuva kertoo/tarkoittaa. Ottamasi kuva voi olla esimerkiksi lämmityskattilastasi kuvaten siihen liittyviä erilaisia säätömahdollisuuksia ja muita ominaisuuksia.

Mitä muita mietteitä sinulla herää koskien mahdollista siirtymää pois öljylämmityksestä suomalaisissa kotitalouksissa? Ideoita? Toiveita? Huolia? Huomioita? Jotain muuta?

Sana on vapaa!

Suurkiitos osallistumisestasi! Tarjoamasi tiedot ovat erittäin arvokkaita hankkeellemme.

Ystävällisin terveisin,

Aalto-yliopiston Design for Government -hanke

Appendix 5.
Cultural Probe Answers

See the pdf attachment ‘Cultural probe answers’.

Appendix 6.
Questionnaire for Omakotiliitto’s Members

See the pdf attachment ‘Öljylämmityskysely Omakotiliiton jäsenistölle’.

Appendix 7.
Results of the Omakotiliitto Questionnaire

See the excel attachment
‘Öljylämmityskysely Omakotiliiton jäsenistölle_Kaikki yksittäiset vastaukset’.

Appendix 8.
Analysis of the Omakotiliitto Questionnaire

See the pdf attachment ‘Analysis of Omakotiliitto questionnaire’.

Becoming an Energy Hero

Aalto University