Aalto University
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For Peat's Sake

Addressing the barriers and bridges to a transition away from peat energy in Finland's district heating sector

Master's Thesis
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Abstract of master's thesis

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Abstract

Low carbon energy transitions offer pathways to sustainable futures. In Finland's district heating sector (DH), the combustion of peat as a fuel source has been a hotly contested debate. While some support peat as a cheap, supply-secure source of domestic energy, others point towards its high level of carbon emissions. In the face of the increasing carbon emissions price under the European Union Emissions Trading Scheme and the Finnish Government's goal to be carbon neutral by 2035, the DH sector has felt increasing pressure in recent years to switch to non-combustible sources of energy. This thesis is inspired by the continued use of peat energy despite the 2035 target date. By using one of the leading theories on sociotechnical change, this thesis incorporates the Multi-Level Perspective (MLP) into the theoretical framework for understanding the barriers that confront a transition away from peat-use in Finland's district heating sector, and how they can be overcome.

The literature review discusses the historical appeal and policy support for peat-use in DH. It then provides an overview of transition theories by describing the fundamental tenets of the MLP. The empirical findings are derived from interviews with Members of The Parliament of Finland from the Centre Party and the Greens League, a policy advisor for the Left Alliance, the CEO of a bioenergy advocacy, a peat energy government working group representative, and an energy production lobbyist. The data was collected from these informants then sorted through a coding analysis, where their insights were bifurcated into either "barriers" or "ways to overcome" the barriers (WTOs).

The findings show that there were twelve barriers and seven distinct WTO clusters identified in the interviews. The barriers reflect the embeddedness of peat-use in DH, but the WTO clusters offer both niche-nurturing and regime-destabilizing solutions to these barriers. The prevailing contribution of this thesis is in finding that the scaling speed and diffusion of non-combustible alternative technologies will determine the rate of the transition away from peat, but the existent EU-level and national public policy mechanisms to help in this regard are currently lacking. This means that DH is in a crucial position to quickly diffuse these alternatives through the window of opportunity they currently occupy before the imprudent and impending increased use of biomass and wood-burning takes over.

Keywords district heating, peat energy, climate change, sustainability transitions, sociotechnical transitions, energy transitions, low carbon, non-combustible, Multi-Level Perspective, Finland

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1. Introduction

This thesis takes a social sciences approach to the ongoing peat energy-use debate in Finland's district heating (DH) sector. Peat energy is debated in Finland because it is a highly carbon-intensive fuel that contributes to considerable amounts of greenhouse gas emissions. According to a report published in June 2020 by the Finnish Innovation Fund, also known as Sitra, peat fuel burning accounts for 12% of Finland's greenhouse gas emissions, but only a 0.1% share of the added value produced by the Finnish economy (Laita, 2020). Yet, peat and other combustible fuels such as wood, coal, and natural gas are used to power Finland's combined heating and power plants (CHP) and heat-only boilers in Finland's district heating systems because they are cheap and secure in supply (Finnish Energy, 2020a). In the country's efforts to transition to a carbon-neutral future by 2035, however, the technological lock-in of combustible fuel sources to Finland's district heating energy supply has presented a grand challenge. By conducting a thematic analysis of six semi-structured interviews across a range of different stakeholders who are involved in this debate in Finland, I address my central research question:

What are the barriers that confront a low-carbon transition away from peat energy in Finland's district heating sector, and how can they be overcome?

The research methodology uses a sustainability transition framework known as the Multi-Level Perspective (MLP) in order to uncover interesting and insightful barriers behind Finland's transition from peat energy in district heating. Moreover, this thesis uses the MLP to also uncover some possible solutions to these barriers. The MLP offers a framework of analysis on understanding sociotechnical change, or changes in a sociotechnical system. A sociotechnical system can be understood as the linkages that people form when they interact with technology, and how these linkages and networks of actors form a system that is embedded into society. In this thesis, the sociotechnical system of analysis is Finland's district heating network, which is currently set up to be fueled by combustible resources. The end result of the use of such an energy supply within this system is high carbon emissions. The literature review will discuss the terminologies associated with sustainability transitions after first providing a review of peat energy-use and its application to the district heating network in Finland. Therefore, the literature review is divided into two parts: first, a historical and

political overview of peat energy in Finland's district heating network, and second, a review of transition theory and how it brings to the reader a broader understanding of the challenges behind implementing noncombustible alternatives to the district heating sector in Finland. This thesis is motivated by the current dilemma between carbon-intensive peat-use in district heating, and the Finnish government's goal to be carbon neutral by 2035. The journey begins with a look at why peat energy is interesting in Finland and why it has become problematic. After World War II, Finland focused on increasing their energy generation (Vadén et al., 2019). Since energy efficiency is high within combined cogenerated CHP plants fueled by combustible energy sources, district heating was adopted. In the early 1970s, the OPEC oil crisis skyrocketed the price of oil, which caused a global shortage. This sparked a strategic initiative by the Finnish government to harness domestic fuel sources for its energy sector. Extracting peat and burning it in CHP plants was reliable, secure, and cheap, and with an abundance of peatlands in its backyard, Finland subsequently began its tradition of the widespread use of energy peat. From state-owned electricity and heat-production facilities such as Vapo, to rural Finnish farmers hinging their ideologies to the peat industry as their source of livelihood in the central and northern regions of Finland, peat as an energy source has driven the way of life for Finns for many years. As such, this resource has provided income for multiple generations of Finns, and government subsidies continue to support the industry. Today, peat production "employment estimates vary between 4000 and 10,000 direct and indirect jobs annually" (Lempinen, 2019, p. 1). However, peat extraction in Finland is currently responsible for nearly 24 million tons of CO_2 emissions annually, which is twice as many CO_2 emissions as the entire transportation sector in the country (Krings, 2020). Besides, peat extraction has cataclysmic effects on waterways in Finland, as well (Mustonen, 2013).

In an effort to combat global climate change by transitioning Finland's energy sector towards a low-carbon future, the prices of coal, natural gas, and peat as heating sources have staunchly increased since 2011 (Finnish Energy, 2020b, slide 11). However, the prices of alternative noncombustible technologies are still not price-competitive enough to take over combustible fuels on an industry-scale system level. Moreover, the recent 2019 Government Programme announced the goal for Finland to become carbon neutral by the year 2035 (Finnish Government, 2019). All in all, this thesis is important not only because 62% of Finnish

residents wish to stop using peat as a source of energy (YLE, 2019), but also because there is a demand by Finnish citizens, institutions, and government bodies for Finland to take ambitious steps towards achieving the 2035 carbon neutrality target date and to set an example for the global community as progressive combatants against climate-change. As a resource that has a global warming potential (GWP) 12% higher than that of coal (Ylönen & Simola, 2012), and with a government target for halving its use by 2030, the projection of peat-use in the near future presents both the risk and opportunity for Finland to indeed be global forerunners in achieving a zero-carbon district heating sector.

The first chapter of the literature review for this thesis showcases the political dimensions that have governed and supported peat energy production and how these dimensions have driven the resource to be revered as a cheap and secure domestic fuel for district heating networks. In the second chapter of the literature review, I will introduce the fundamentals of the MLP framework: changes in the exogeneous landscape (i.e., climate change) have put pressure to phase-out peat energy-use in the district heating regime, which has allowed windows of opportunity for low-carbon niche alternatives to percolate up into the sociotechnical regime in order to replace peat-use. Throughout these two chapters, I will point out what barriers to a peat phase-out have already been identified, as well as how the regime-niche interactions identified in the literature can offer possible suggestions on overcoming them. On the other hand, the research analysis has aimed towards using lessons from the MLP in such a way that allows for a broader level of understanding between the niche-regime interactions in the DH sector that are specific to peat-burning. For my research method, I collected data by conducting six semi-structured interviews with industry and political party representatives involved in the peat debate. I then conducted a thematic analysis of the data by coding all relevant insights and dividing them into categories: barriers, and possible solutions (WTOs).

A variety of the publications I used to triangulate the validity of my interview results are written in Finnish. Therefore, at a base level, this thesis contributes to the field of sustainability transitions by pulling together many of the latest storylines that would otherwise not have been easily discoverable by the international (English-speaking) community. Moreover, the empirical findings may offer not only insights into the medial role that biomass

plays in Finland's peat phase-out, but also a valuable model for other countries who strive for low-carbon energy systems. As a country who has historically led the charge on progressive climate policy (i.e., being the first country in the world to institute a carbon tax in 1990), Finland's sustainability initiatives offer far-reaching potential for solving a problem that knows no borders. Hopefully, this thesis will contribute even the smallest additional focus to the ever-thickening lens of transition analysis from the outside looking in.

On a final note, as a Masters student working to become a sustainability professional, this topic is important to me for both personal and practical reasons. The practical importance is perhaps best expressed by Dunphy (2011): "There is a need for a new level of cooperation between business schools and organizations. Academics need to get out of the ivory tower and into the marketplace. We must learn to construe the world as a sphere of action rather than merely a system to be analyzed" (p. 20-21). On a personal note, this Master's thesis represents the culmination of what I learned over the past two and a half years while pursuing a Double Degree in International Business at the University of South Carolina Darla Moore School of Business, and the Sustainability Management track focus at the Aalto University School of Business. This thesis also incorporates sustainability lessons and themes that I learned while achieving my undergraduate Bachelor of Arts degree in Environmental Policy at Sewanee: The University of the South. Moreover, as a citizen of the United States – a country that has only recently re-entered the Paris Agreement as of February 2021 – my hope is that I can share the sustainability advisory knowledge I gained at Aalto University when I return home. Peat is a unique resource that is not widely used in other countries, and Finland's Coordinated Market Economy is a unique national political economy where institutional distrust in government-led climate initiatives is low, and where labor, employer, and the state have relatively equal bargaining power (Rose & Henderson, 2018). As such, my hope is that the uniqueness of these variables and the other elements assessed in this thesis will gain traction among sustainability professionals back in my home country, where special interest groups dominate policymaking in the energy sector and have created barriers to sustainability transitions with incredible inertia (Bakke, 2016). The pressure to rapidly decarbonize the Earth's atmosphere is mounting, and US firms, institutions, and individuals can no longer ignore the call to action for sustainability transitions.

2. Literature Review

The Literature Review explains peat energy-use in Finland's district heating system from a historical and policy standpoint. The objective in doing so is to contextualize the current state of attitudes towards peat-use and the ensuing policies within the industry. I will then provide an overview of transition theory and the MLP. Because transition theory is an expansive field with hundreds of publications, I chose elements from the literature that are appropriate for this thesis topic and research question. Such elements include mechanisms for reconfiguring regimes from an MLP perspective, and policies that catalyze a transition.

2.1. Historical Context and the Case for Peat Energy in Finland

Understanding the history of peat production in Finland allows one to recognize just how gravely critical this resource was and is to the backbone of the Finnish government's energy strategy. Peatlands in Finland have a long history of use dating back to the Stone-age, but the story of peat energy-use in Finland for this thesis starts from the end of the Second World War, when Finland increased its industrialization capacities, and considerable discussion rose over which energy sources the country should use (Vasander, 1996). High transportation costs of natural gas, coal, and oil were some of the main factors that historically promoted the use of peat in Finland. Additionally, long transport distances and the lack of abundance of other fossil fuels were key factors that have resulted in the exploitation of local peat mires in the country. What also makes peat popular is its high concentration of energy: according to The Peat Industry Association (2015), 120 cubic meters of peat can heat a home for three years. With such concentrated energy potential, it makes sense why peat is an attractive source of energy. Furthermore, peat is attractive because it is a domestic resource, and it reduces the dependency on imported energy (Lempinen, 2019).

Vasander (1996) goes on to explain the historical context of peat production in Finland. According to the source, the decision to initialize a large-scale peat industry in Finland was made in 1968. At this time, annual peat production was 0.2 million cubic meters, but the Finnish Government's goal was to increase production to 10 million cubic meters by 1980. Vapo, a state-owned corporation, was tasked with the responsibility of driving peat production, and ample government funds in the form of investment aids were provided in

order to assist them in this task. In 1972, a power plant in the city of Kuopio began using peat to produce electricity and district heating. 'District heating' can be defined as "heat generated by power plants, heating boilers or heating plants that is transmitted through a district heating network to heat buildings and produce hot water" (Statistics Finland, 2019). In 1970, there were less than 5,000 km of district heating pipelines. Today, there are over 15,000 km of pipelines (Finnish Energy, 2020c). When Kuopio began producing such forms of energy in 1972, their plant generated 30 MW of electricity and 60 MW of district heat (Vasander, 1996), and national peat production for that year was 975 TJ (Statistics Finland, 2019). Though annual peat production varies depending on the weather conditions of harvesting season (Karhunen et al., 2015), to showcase the increase in peat energy production over the past fifty years, production in 2019 was 56,398 TJ (5.7 TWh), or 15% of total district heating production (Statistics Finland, 2020a). Peat-use in district heating production peaked in 2007 at 7.0 TWh, or 21% of the total district heating production (Statistics Finland, 2020b).

In 1973, the OPEC oil crisis precipitated a government push to raise the 1980 peat target from 10 million cubic meters to 20 million cubic meters (Vasander, 1996). By 1979, the nation's first energy plan was set up, and peat policy in Finland has been characterized by contradiction and equivocation ever since. This first energy plan aimed to promote domestic energy sources such as peat and wood, and actor networks such as the Working Group for Cooperation on Energy (otherwise known as EYR) vied to support the industry in these early stages of the industry's growth (Ylönen & Simola, 2012, p. 167). Meanwhile, rival programs and environmental activist groups opposed them with efforts to conserve the peatlands. Established by the Ministry of Trade and Industry in these early days, the EYR was charged with the task of identifying which peat mires were needed to meet the country's energy needs. However, the opposition they faced set the stage for controversy and backlash for years to come. From the 1970's until the end of the 20th century, peat production was primarily seen by Vapo and Turveruukki, which together made up 90% of all peat production for heating and electricity in Finland (Vasander, 1996). As of 2005, these two companies make up 88% of all peat production, with Vapo dominating at 78% and Turveruukki at 10%. To this day, Vapo is the largest peat producer in Finland (Lempinen, 2019).

Peat's historical context to Finland's energy strategy is relevant to this thesis from an energy security standpoint, which influences government subsidies for peat energy, and sparks debate over what government policies should be leveraged towards competing low carbon alternatives in Finland's district heating sector. Special interest groups and actor groups that support the peat industry have lobbied to make sure the peat industry continues to exist by citing the myriad of economic benefits to peat extraction, including job provisions. Lempinen (2019) reported that peat production provides between 4,000 and 10,000 jobs annually as well as the opportunity for hundreds of firms and entrepreneurs to generate revenue in the central, eastern, and northern regions of Finland where unemployment rates are higher compared to other provinces. Other economic benefits include cost savings from not having to pay to import energy from abroad. With over half of Finland's energy being secured from outside its borders, there is a strong case indeed for Finland to take advantage of cheap domestic energy sources such as peat (Lempinen, 2019). Furthermore, peat plays a vital role in generating heat within the country, as homes for one million Finns are designed to be fueled by peat-fired DH systems, according to the source. It is important to point out the immensity of district heating as an established energy system in Finland (Bush et al., 2017) because some argue that transitions are easier when newcomers use the existing infrastructural networks (Kemp, 1994). More discussion on this will be found in Section 2.3.

In the past ten years, two publicity campaigns have advertised and promoted the case for peat energy-use in Finland. Lempinen (2019) explains Vapo's 2010 "2 prosenttia" internet campaign, as well as The Bioenergy Association of Finland's 2017 "Turveinfo" campaign. These two campaigns referenced the cost-effectiveness of peat energy due to the "locked-in" nature that the industry's infrastructure has, arguing that it would be difficult, timely, and expensive to switch away from the resource. An example of expensive power plants that has already been optimized to use peat as a fuel source is the Toppila power plant in Oulu, which spent €6 Million in 2012 on a high-pressured turbine retrofit to improve production efficiency for its peat-fired electricity and district heating capacity (Alstom, 2011).

The aforementioned historical and economic underpinnings to Finland's use of peat explain why the energy source is prevalent, but they conclusively do not offer any direct steps towards

accomplishing the Finnish Government's goal to cut in half the use of energy peat by 2030. A relevant comparison to this dilemma would be lessons from *The Grid* by Gretchen Bakke (2016), which discusses the social and political complexities behind the electrical power grid in the United States. In this novel, Bakke makes the case that the electrical grid is not simply a multitude of power plants and wires. Rather, it is a deeply embedded cultural and legal web of policy, billion-dollar investments, institutional support networks, and special-interest groups who have lobbied for over a decade to maintain the *status quo* of fossil-fueled electrical energy production. Bakke's novel is relevant to the discussion of peat production in Finland because both topics center around the irreversibility of a sociotechnical regime, and the barriers that 'history' and 'precedent' have created in direct relation to a regime's embeddedness. It also puts into context the effectiveness of government goals and how businesses are incentivized to coordinate around them. Such dynamics of interrelated sociotechnical regime elements are central to the Multilevel Perspective (MLP), which will also be further discussed in the transition theory chapter of this literature review.

2.2. The Contemporary Peat Discourse and Political Perspective on Peat in Finland

Energy is used in Finland across four sectors: industry, transportation, residential, and commercial. Of these four sectors, district heating falls under the 'industry' category. In 2019, 14% of district heating was fueled by peat (ET, 2020d). Across all sectors, however, district heating is responsible for heating about 40% of all the buildings in Finland, and "the district heating sector contributes the largest share of CO_2 emissions related to buildings" (IEA, 2018, p. 70). The fact that 5.2 million tons of CO_2 came from peat energy in 2017, which is 12% of the 43 million tons of total CO_2 emissions from fossil fuels emitted in the same year (IEA, 2018, p. 158) is what justifies the need for this thesis to study peat in district heating. Further justification comes from the IEA (2018) who affirmed that "phasing out peat could thus substantially contribute to the CO_2 emissions reduction target of 2030" (p. 158). To showcase the problem with peat-burning in another way, the global warming potential of peat energy is 12% higher than that of coal (Ylönen & Simola, 2012), which explains why it accounts for twice as many carbon emissions as did the entire transportation sector in Finland in 2019 (Krings, 2020). Furthermore, peat extraction has innumerable detrimental effects on the country's natural ecosystems (Ylönen & Simola, 2012; Mustonen, 2013).

In terms of total primary energy supply (TPES), peat accounted for 3.7% of Finland's energy source mix in 2017, and in terms of total final consumption (TFC), peat accounted for 2% in 2017. The reason why the percentage of peat energy *supply* is greater than the percentage of peat energy *use* is because peat is stockpiled and saved in case of emergencies. The most important role that peat plays is its use in CHP plants in Finland (IEA, 2018, p. 20). According to an ET (2020a) webpage, "district heat is produced in combined heat and power production or solely as heat. In one district heat network, there are many power plants." Most of these peat-fired plants are in small municipalities in Finland's northern and central regions. Finland's energy consumption attributes CHP as "the most important mode of electricity generation, accounting for 30.3% of the total electricity consumption" (Häyhä et al., 2011, p. 82). Peat energy, alongside solid wood and other byproducts of the forest industry, is among "the most important domestic fuels in Finnish CHP production" (Karhunen et al., 2015, p. 45). Simply put, peat is a major fuel source for combined heating and power.

And, since CHP is responsible for the lion's share of electricity consumption in Finland, there is a deep precedent for the utilization and importance of peat as a domestic fuel source. Karhunen et al. (2015) provides insight into the specific types of technology that are used to generate energy in peat power plants. CHP plants, the source states, use multi-fuel boilers. As such, the boilers co-combust peat or coal along with wood fuels. The reason the power plants operate this way is because the chemical components of the wooden fuels alone can cause complications with the boilers. Not only is co-combustion important in avoiding corrosion and boiler fouling, but it is also important for supply security. While 90% of the respondents from the study conducted by Karhunen et al. (2015) expected peat-use to decrease or remain at current levels in the future (though a specific time period for the future was not mentioned), *the price of alternative fuels was the primary factor in managers selecting replacement fuels for peat.* The article makes no mention of using renewable energy as replacement fuels for the boilers, though.

The entrenched precedent for peat-burning does not go unchecked, however. The Finnish Environmental Institute (SYKE) referenced biodiversity loss and water quality deterioration as the cataclysmic effects to local ecosystems that peat energy is responsible for (Ylönen &

Simola, 2012). During spring-time floods and downpours of rainfall in the summertime, according to the source, the existing water protection structures and installments surrounding peat extraction sites "do not prevent the outflow of nutrients" nor do they protect against "dissolved humic acid", which "have a multifarious effect on many water quality parameters" (p. 169). Other negative environmental effects also include widespread fish kills and lowered water quality (Mustonen, 2013; Krings, 2020; Laasasenaho et al., 2017).

In light of these environmental problems, The Finnish Government's push for a systematic sustainability transition has spurned the country to make great strides in shifting away from fossil fuels and to instead take up low carbon sources of energy. Three key policy documents are concerned with broadscale, comprehensive energy and climate goals: National Energy and Climate Strategy 2030 (TEM, 2017), Energy and Climate Roadmap 2050 (TEM, 2014), and the 2015 Finnish Climate Change Act, which is set to have a reformed version published Spring of 2021. The most important policy documents for the future of peat energy, however, are found in Sanna Marin's Government Programme (Finnish Government, 2019), and in Finland's Integrated Energy and Climate Plan (TEM, 2019a). These two documents are the first official government documents that express how Finland will aim towards cutting peat energy production in half by 2030. However, the only policy mechanism that is mentioned in the Government Programme to achieve this goal is to "assess the necessary changes to the taxation of peat."

The Ministry of Economic Affairs and Employment, or Työ- ja elinkeinoministeriö (TEM), "is the primary actor in Finnish energy policy" (Kivimaa & Mickwitz, 2011, p. 1813). The TEM website affirms this by stating that "energy policy and coordination of the preparation and implementation of the climate policy at national level" is an area that falls under the ministry's remit. On a broader basis, the TEM also has the ability to put into action Marin's Government Programme by guiding other agencies under its administrative control and by drafting any necessary legislation that falls under its remit. It is suiting, then, that under the 2019 Government Programme, the TEM currently has a working group to find out how peat can be used for more valuable uses other than as energy (TEM, 2020a). The TEM has appointed this working group to assess the differing stakeholder opinions revolving around the peat industry

from April 2020 until March 2021, which is why I decided to interview a representative from this working group for this thesis. Transition theory insights on policy mechanisms suggest that the TEM's peat working group alone will not solve the peat energy carbon emission problem in Finland, however. These insights support the notion that government must subsequently initiate more specific and targeted policy actions besides setting the halved target date that was put forth in the 2019 Government Programme. Instead, specific and targeted policies will require a heightened coordination across the differing political parties' interests within the Finnish parliament to create legislation that responds to the TEM working group's recommendations. Such forms of legislation include "creative destruction" policy mixes, or a policy mix where some policies work towards destabilizing regime elements that uphold peat energy-use into the combustible fuel source, while other policies work towards building up noncombustible technology use in district heating (Kivimaa & Kern, 2016). Such policies must be leveraged simultaneously in order to work hand-in-hand with each other.

Less than one year after the Government Programme was released, Prime Minister Marin announced in September 2020 the new state budget for 2021. The five-party coalition was able to come to an agreement to double the peat tax by increasing it by €2.70/MWh, while also introducing a price floor to ensure that the 2030 halved peat production goal is met (Teivainen, 2020). This doubled peat tax is a prime example of a more specific and targeted policy mechanism to destabilize the peat energy sector. The impetus for "creative destruction" public policy adheres to such new measures put forth by Marin and her coalition, as well as to advocate for heightened government coordination. However, more policies are needed to encourage low-carbon alternatives in district heating, so the increased peat tax and halved 2030 target date are necessary but not sufficient policy criteria for Finland's peat energy phaseout in the district heating sector.

Since the new millennium, there have been intermediary pushes towards a peat phaseout prior to the recent doubled peat tax. In 2007, The Finnish Association for Nature Conservation (FANC) published a paper on ending peat energy by 2020 (FANC, 2008). This 'FANC Peatland Programme 2020' policy paper elaborates on five central goals for conserving peat mires, including a call to reform legislation through more ecologically minded permitting

processes, and to change people's perceptions towards peatland nature by realizing its inherent value for humans. These goals are more abstract than the more recent working paper from Sitra (Laita, 2020). Although the Sitra report is in Finnish, I was able to read the key recommendations on ways to ensure a just transition from peat in Finland, as well as recommendations on how to replace peat energy. These include encouraging communication from all stakeholders, gradually abolishing the tax subsidy on peat by 2025, promoting more non-combustion energy technologies, and enacting a law that outright bans peat burning by 2030. The peat working paper from Laita (2020) can be juxtaposed with Marin's coalition tax as a step in the right direction towards achieving this endeavor. The TEM working group on peat is an example of intermediary multi-stakeholder communication. "Promoting more non-combustion energy technologies", however, is vague and does not offer a firm pathway. *How* are noncombustible technologies promoted? The research for this thesis aims to address this.

The 2007 FANC peat paper brings up an engaging consideration on consumer preferences when it comes to the proliferation of peat energy-use, as there is an existent feeling of nationalism harbored by its advocates in Finland (Lempinen, 2019). These proponents argue that Finland must capitalize on its domestic sources of energy for the sake of achieving energy security and independence rather than having to import it. Such sentiments of national pride underpin the cultural and symbolic significance of peat production, which could theoretically feed into the ideologies of peat energy supporters. Altogether, alongside the existing subsidies that the peat industry receives to this day, the ideological value behind peat as a domestic fuel source further embeds the industry into the *status quo* (Lempinen, 2019). According to Tolvanen et al. (2013), there was an ideological barrier behind a transition away from peat energy in Finland in the early 2010s. In their study, which recorded the values of 712 survey respondents, they found that production-oriented individuals put a higher level of importance towards peat as an energy source than as any other ecosystem service from peatlands, whereas the 'environmentalists' group thinks the opposite (Figure 1). This is an important barrier to recognize, given that energy consumer-users must be amenable to the concept of changing their energy-use habits and the way their energy is (renewably) sourced for the transition to succeed (Vainio et al., 2019).

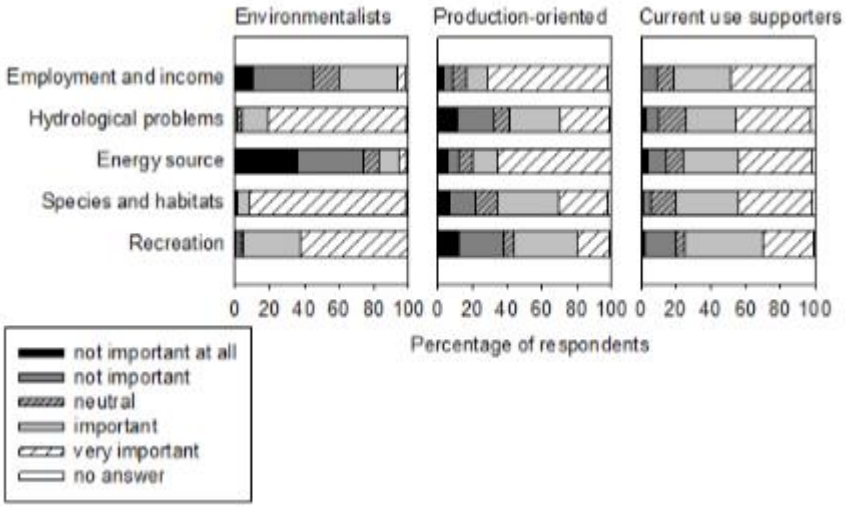

Figure 1: Ecosystem services provided by peatlands.

Source: Tolvanen et al., 2013, p. 6

At the firm-level, there are inspiring instances of Finnish companies who are taking charge of their energy mix by making efforts to lower their carbon footprints. Valio, a large dairy company in Finland, has disclosed that they will phase out peat-based energy in their productions in an effort to meet the government's 2035 carbon neutrality goal. *The Dairy Reporter* states that Valio's plan is to buy more wind energy to the point where it will account for 20% of its energy-use in future years (Cornall, 2019). This may sound like an ambitious step towards switching to non-combustible alternatives, but the article also mentions that its peat-fired energy will be replaced with a new wood-burning boiler. Economies of scale are important to this thesis in terms of production learning curves and comparative pricing models for alternative noncombustible fuel sources versus the traditional combustible sources like wood and peat. The fact that Valio is beginning to make a switch away from peat-burning shows an example of how large firms in Finland can commit to the transition without government assistance in scaling, but therein also lies the reality in Finland that peat-fired production facilities are also switching to biomass. Valente (2015) cites Tesla to back his argument that firms can play a transformative role in their respective industries by convincing their competitors to make the switch to sustainability, too. This makes a greater impact on reducing an industry sector's carbon footprint than a single firm's sustainability initiatives.

Though Valio's peat phaseout applies to a dairy company, it can still offer a valuable model for DH on what a timely response to the carbon neutrality goal looks like.

To complement the findings from Karhunen et al. (2015), who reported that CHP plant managers in Finland decide to use peat energy in their plants as a direct response to the government policies that incentivize them to do so, a 2019 article from the Helsinki Times reported a similar statement from the director of communications and public relations at Vapo, Ahti Martikainen, regarding biofuels as an alternative to peat. In the report, Martikainen disclosed that peat energy can be stopped in Finland, but it would have significant effects on employment and the price of district heating. Martikainen went on to say that replacing peat with wood "would result in an increase of 25 million cubic metres" of wood burned each year, which is why, according to Martikainen, "Vapo believes it wouldn't be smart to transition rapidly to large-scale burning of wood" (Teivainen, 2019). However, just as with Karhunen et al.'s (2015) research, the article only mentions wood as the alternative to peat and does not bring up wind energy, nuclear, heat pumps, geothermal, or any other innovative alternatives (Teivainen, 2019).

The relationship between scientific findings and policymaking – with environmental activist groups, worker unions, firms, and individual energy consumer perceptions in the middle – make up the institutional frameworks that can either drive or challenge a sustainability transition. Institutions can act as intermediaries between these interrelated groups, and as the next section will discuss, these stakeholder interests affect the sociotechnical regime. Sitra is an example of an intermediary that helps to drive transitions, and so is The Finnish Climate Change Panel. Established in 2012, the Panel is a think-tank that promotes a dialogue between scientific findings and policymaking. According to their website, the Panel is comprised of "top-level Finnish scholars" who are "tasked with assessing the coherence of climate policy and the sufficiency of the implemented measures to answer the challenges of climate change" (Linnanen, 2020). The website also states that current projects by the Panel include consumer perspectives on climate policy, where they report that household consumption of energy in Finland accounts for 70% of all GHG emissions in Finland (Linnanen, 2020).

After reviewing the contemporary discourse on peat energy in Finland, it appears that the historical appeal to addressing energy supply security concerns created sectoral policy to encourage the peat industry. Intermediaries have helped in this strategy, but they also can work towards helping in the transition. The cultural and symbolic meaning behind peat as a symbol for self-reliance is also responsible for peat energy use. The MLP explains how these forces relate to each other. In the next section, I will review the MLP and relate it to the existing discourse.

2.3. General Description of Transition Theory

Sociotechnical systems can be conceptualized as the network of actors and institutions that connect to any given sector such as water supply, transportation, or, as in the case for this thesis, energy supply (Markard et al., 2012). Sociotechnical transitions, meanwhile, refer to the processes and mechanisms that bring about a fundamental change in a sociotechnical system, and specific cases that are commonly cited as examples of sociotechnical transitions include the switch from cesspools to modern plumbing, horse-and-carriage to automobiles, and clipper ships to the steamboat (ibid). Sociotechnical transitions involve the largescale societal changes that are required for a sustainable future (Köhler et al., 2019), and the four main frameworks that transition scholars use to interpret, understand, codify, and explain transitions are ‘Strategic Niche Management (SNM)’, ‘Technological Innovation System (TIS)’, ‘Transition Management (TM)’, and the ‘Multi-Level Perspective (MLP)’ (van den Bergh et al., 2011; Markard et al., 2012). The three-tiered MLP framework to sustainable transitions provides a systematic and holistic theoretical framework for understanding transitions within a sociotechnical system (Figure 2).

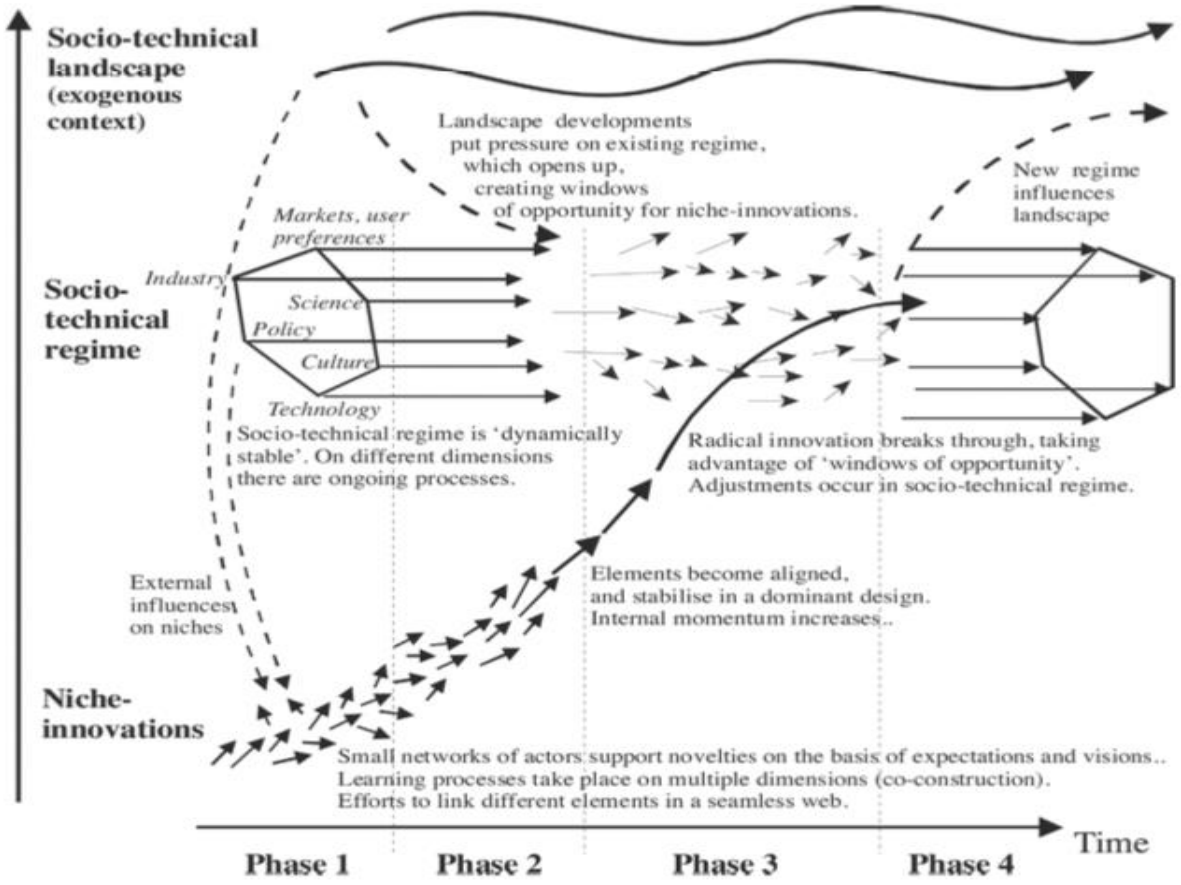

Figure 2: The three-tiered Multi-Level Perspective (MLP) framework to sustainability transitions.

Source: Geels et al., 2017, p. 3

The MLP is central to this thesis because it "broadens the unit of analysis from technological products to socio-technical systems that provide societal functions such as heat" (Geels, 2017, p. 2). A broadened unit of analysis that involves looking at the multi-dimensionality of all the moving parts inside a peat-fueled district heating system allows for the ability to see how deep the barriers go "beyond the tip of the iceberg". The research for this thesis will use the MLP theory in the analysis, discussion, and final conclusions to offer suggestions on how to overcome the barriers. Although an "analytical and heuristic framework to understand technological transitions" (Geels, 2002, p. 1273), the MLP's emphasis on the interaction between its three levels may indeed provide insightful perspectives on how to chip away at the path dependence of the incumbent peat energy producers.

At the bottom, or the micro-level, are emergent, niche technologies. These niches include novel innovations that arise when there are both disturbances within the sociotechnical regime and shifts in the landscape above them. In Finland's district heating sector, Sitra identified non-combustible energy solutions that the MLP literature would describe as environmentally benign niches (Laita, 2020). These generally include wind energy, solar, heat pumps, geothermal, heat storage, excess heat, and ambient heat (Rinne et al., 2018). However, the lack of profitability for niches is a core idea of the MLP, and in the case of Finland's district heating, the lack of profitability for noncombustible alternatives and the existence of natural monopolies within centralized district heating companies have been cited as the main challenges behind diffusing niche alternatives into Finland's district heating sector (ibid).

At the meso-level is the sociotechnical regime, made up of heterogenous elements within a sociotechnical configuration. Geels (2017) cites seven of these "interdependent and co-evolving" elements: "technology, supply chains, infrastructure, markets, regulations, user practices, and cultural meanings" (p. 2). In the Finnish district heating sociotechnical system, the Section 2.1 and 2.2 identified that the cultural and symbolic meaning of peat as a cheap and secure domestic fuel source helped to drive sectoral policy to fund the construction of district heating pipelines throughout the country. This further drove more peat subsidies, market formation, and user practices and propensities towards peat fuel. The interrelatedness of the district heating regime and the growing cost-effectiveness to use peat and other combustible fuels is a positive feedback loop: each element perpetuated and further embedded itself comfortably within the district heating sector. The embeddedness of the regime inherently makes it a barrier for non-combustible newcomers.

Finally, at the macro-level, is the landscape. The landscape layer "contains heterogenous factors, such as oil prices, economic growth, wars, emigration, broad political coalitions, cultural and normative values, and environmental problems. The landscape is an external structure or context for interactions of actors" (Geels, 2002, p. 1260). The landscape also puts pressure on the existing regime, creating windows of opportunity for new technologies to rise from the micro-level into the meso-level. From the literature on transitions, it seems that climate change is one of the most pertinent landscape elements for this thesis because it has

created a sense of urgency to rapidly decarbonize the earth's atmosphere (Rockström et al., 2009), which has influenced the 2035 target date for carbon neutrality. Geels (2017) describes how transitions occur over four phases (p. 2):

> "In a nutshell, radical innovations emerge in peripheral niches in phase 1, and stabilize and enter small market niches in phase 2. Breakthrough in phase 3 depends on niche-*internal* drivers such as price/performance improvements, scale and learning economies, the development of complementary technologies and infrastructures, positive cultural discourses, and support from powerful actors. But diffusion also depends on *external* windows of opportunity, due to regime destabilization because of landscape pressures or persistent internal problems. Regime transformation occurs in phase 4, including adjustments in infrastructures, policies, lifestyles and views on normality." (Geels, 2017, p. 2)

Other examples of *external* landscape pressures on the DH regime include the increased price on carbon allowances under the European Union Emissions Trading Scheme (EU ETS). As Figure 3 shows, the price of peat as a fuel source has become more expensive than forest residues between 2017 and 2019 as a result of the 52% increase in the cost-effect of the EU ETS.

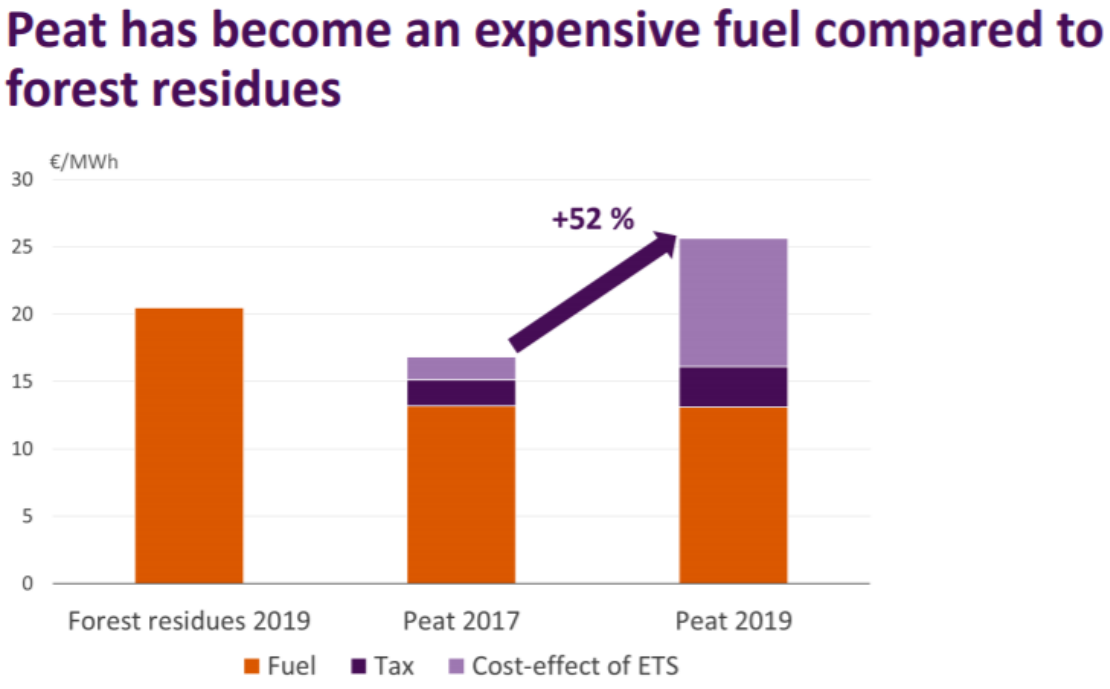

Figure 3: From 2017-2019, the EU ETS has increased the cost effect of burning peat by 52%. Source: Finnish Energy, 2019

While Geels (2017) and Markard et al. (2012) provide a contemporary overview of the current principles and applications of the MLP framework, Kemp (1994) offers some of the originating principles of the theory. By reviewing these early principles, the reader can better understand a more in-depth analysis on how the embedded linkages associated learning curves can obstruct sustainability transitions. Rip & Kemp (1998), on the other hand, were the first to introduce the Multi-Level Perspective and are widely cited in most of the MLP publications that have followed in years since. Within the context of combating climate change by integrating environmentally benign technologies into the sociotechnical regime, there are many economic, technical, social, and institutional barriers that confront technological regime shifts away from hydrocarbon-based energy technologies (Kemp, 1994). The author mentions that the main economic barriers are the varying cost structures and the differing price comparisons between fossil fuels and low-carbon-emission fuels.

Dynamic scale and learning effects can be understood in terms of a learning curve: as production increases, the per unit cost of a product decreases. In other words, it gets cheaper to produce something the more it gets produced. This inverse relationship is bolstered by the selection environment, defined as "the capital outlays, physical infrastructure, supplier-user linkages, production routines, skills, technical standards, government rules, norms, and people's preferences and beliefs" (Kemp, 1994, p. 1031). The learning curve, then, is directly related to the selection environment. Kemp's description of the 'selection environment', first introduced by Nelson and Winter (1972), is another way of explaining the seven aforementioned elements of the sociotechnical regime, as outlaid from Geels (2017).

Previous publications on sociotechnical change have reported that transitions are not sudden or quick in nature. Rather, they occur sometimes slowly and over multiple generations (Köhler et al., 2019; Markard et al., 2019; Rotmans et al., 2001). As the *X*-axis on Figure 2 shows, the MLP framework posits that sociotechnical transitions occur over four phases. These four phases relate to the S-shaped model of the four phases that Köhler et al. (2019) mentions, as well: *predevelopment*, *take-off*, *acceleration*, and *stabilization*. New replacement technologies may have a difficult time in the acceleration and stabilization phases because they are not cost effective in relation to their selection environment, nor are they developed to meet the same

production capacity that combustible fuels in DH are able to offer. It could be considered that the stability of the district heating system – designed from supply-security considerations to be fueled by combustible energy sources – is what makes it the regime, which reinforces the stability of peat as a fuel.

Though the early literature on transitions claims that sociotechnical change occurs over a considerable amount of time (fifty years or more, according to Markard et al., 2012), more recent academics argue that 'expediting transitions' must be the future focus of transition research (Köhler et al., 2019). Other contemporary scholars argue that in the face of the ongoing Covid-19 pandemic, change can happen quite rapidly (Kanda & Kivimaa, 2020): by referencing the MLP framework, the authors refer to the coronavirus pandemic as a "landscape shock" that could potentially rattle the electricity and mobility sectors. Under the MLP theory, a landscape shock such as a global pandemic or a change in macroeconomic conditions provide windows of opportunity for new entrants to disrupt the regime, as discussed in the beginning of this section. Geels (2017) calls this an exogeneous shock, and cites wars, economic recessions, and political instability as other examples.

2.4. Processes of Reconfiguration

Much of the early work on transition theories was first published over twenty years ago. However, the MLP theory is still pertinent in today's discussions of sustainability transitions, particularly regarding the reconfiguration of the regime. In order for regime reconfiguration to occur – and thus for sociotechnical change to happen – it must involve the process of "reweaving" the seven elements of the regime's selection environment, where "changes in one element in the network can trigger changes in other elements" (Geels, 2002, p. 1259). Niches can diffuse as a result of "reweaving", but the hegemony and stability of the regime is a force to be reckoned with. In their review on the contemporary importance of the MLP, Köhler et al. (2019) state that "the systemic dimension of transitions and the tensions between stability and change are central to the MLP" (p. 2).

The relationship between s*tability* and *change*, the authors posit, is a core issue in transition research because the "impulses for radical change" that rival the "forces of stability and path

dependence" are the essence of niche-regime interactions that are so central to the MLP (Köhler et al., 2019, p. 2). This information is relevant to this thesis because the deeply entrenched, locked-in nature of the meso-level necessarily presents political struggles between the niche and regime (Hess, 2016). This argument is evinced by the differences of opinions on the use of peat between Finland's political parties: the Centre Party represents the agrarian interests of rural peat farmers, while the Greens League is interested in quickly curtailing Finland's greenhouse gas emissions.

Other recent literature describes the reconfiguration of sociotechnical regimes by delineating "foundational interest in *system* innovation," where the interdependency between a "co-evolving mix of technologies, supply chains, infrastructures, markets, regulations, user practices and cultural meanings" is conceptualized by the interactions within and between the micro, meso, and macro levels (Geels, 2017, p. 2). System innovation, according to the source, implicitly involves a singular focus on technological production and innovation that occurs at the niche level. Niche-level analyses are the seminal concern of other transition theories such as SNM and TIS, but to elevate the unit of analysis of innovations to a system-level is to complement such theories with a "greater attention to multiple innovations and system reconfiguration" (ibid, p. 3).

Technological production at the regime level, and not just the niche level, is certainly an important unit of analysis for understanding the inertia behind stability and path dependency. Figure 4 shows a model of sociotechnical system inputs for factory production. Although factory production is a completely different topic from DH, the model shows a striking resemblance to the research area for this thesis: on the outside of the dotted circle in Figure 4, the energy supply is linked to the technologies that feed into the sociotechnical system. The same type of relationship between the CHP boilers and the combustible fuel supply that uses peat and other combustible resources is apparent. The point here is that even though peat is not the regime itself, it is a crucial component to the regime because it is a part of the energy supply that fuels the technologies that are intrinsically embedded into the district heating regime.

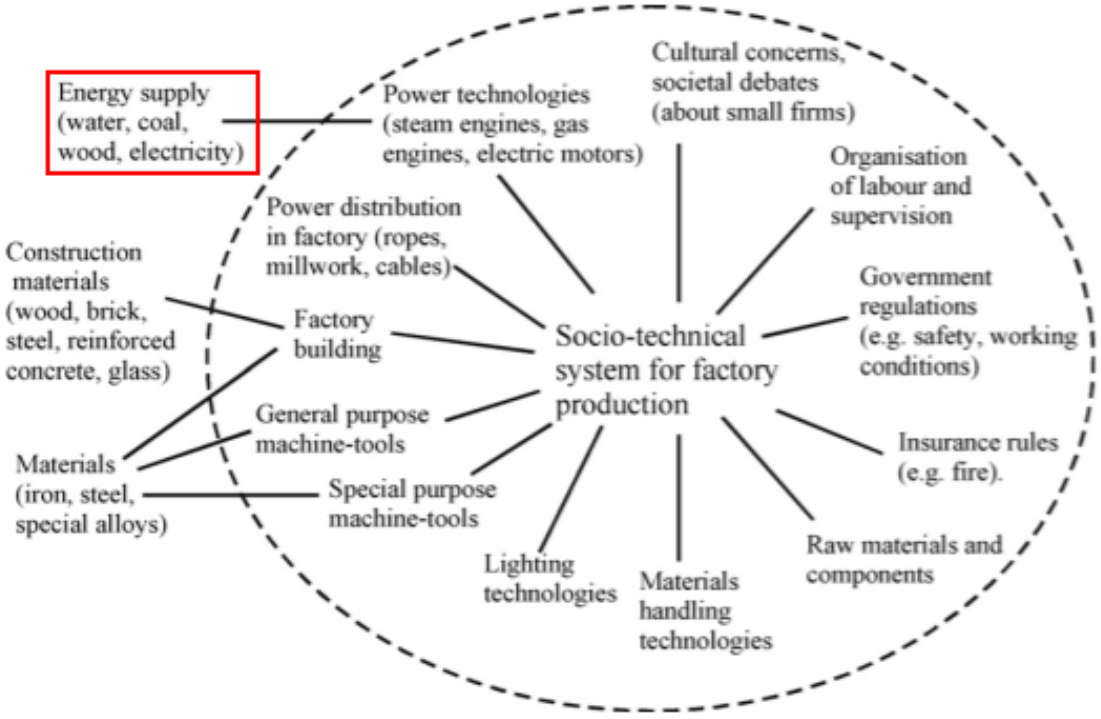

Figure 4: The relationship between 'energy supply' and the sociotechnical regime. Source: Geels & Schot, 2007, p. 412

A concrete example of a system reconfiguration mechanism is a process called hybridization, or the rapid acceleration of niche innovations into the existing regime. Theoretically, for Finland to achieve a district heating system that significantly reduces its emissions, hybridization would include noncombustible produced heat into the existing centralized district heating system. According to Geels (2017), however, hybridization can also be confined to two combustible sources such as coal-with-biomass, which is already being seen in the Finnish district heating regime, as peat is currently being cofired with biomass. However, some have argued that biomass is not completely sustainable (Vadén et al., 2019). Thus, it could be argued that a more fruitful pursuit for achieving low carbon heating would be the hybridization of non-combustibles with combustibles as combustibles are phased out. This process of hybridization does not happen overnight, however. In fact, Geels (2017) reaffirms

that "a multitude of successive gradual changes can also have transformative effects" (p. 3). *Gradual*, however, is a relative word.

One way to envision hybridization as a compromise between *stability* and *change* is to look beyond the idea that niches must overthrow regimes, and to instead consider that niche-innovations can be implemented *within* the existing regime (Geels, 2017). This could feasibly be done in respect to the existing selection environment through peat producers either forming alliances with new entrants or by developing the niche-innovation themselves. Smith (2007) offers more insight on successful niche integration by positing that niches have success when they are compatible with the regime. Paradoxically, however, a niche that is compatible with the existing system will not catalyze great changes to the sociotechnical system, and radical niches will not see much success in diffusing into the sociotechnical system so long as their proliferation requires too many structural changes. Radical niches, therefore, will have to be profitable "before mainstream actors become enrolled" (Smith, 2007, p. 430).

Niche protection measures support the cost effectiveness of implementing geothermal, wind power, heat pumps, and heat storages. Bush et al. (2017) discusses such niche protection roles that intermediaries play in district heating. The source cites Finland's switch to district heating after the OPEC oil crisis in the 1970s, finding that there is a "potential for intermediaries to support the restructuring of [the] institutional framework to enable more radical 'stretch and transform' empowering activities" (p. 137). Here, "stretch and transform empowering activities" is a segue into niche empowerment and niche nurturing, which Smith & Raven (2012) describe in the following way: "the niche is empowered by enabling it to change its selection environment, rather than be subordinated by it. This, we label as stretch and transform empowerment, and define it as processes that re-structure mainstream selection environments in ways favourable to the niche" (p. 1030). As they relate to *stability* and *change*, the research for this thesis will aim to show whether a fuel supply of low-carbon alternatives to peat will "fit and conform" to the district heating regime, or "stretch and transform" (Smith & Raven, 2012).

The “irreversibility”, or the sunk investment costs on peat technologies are what “lock-in” peat into the district heating regime. (Lempinen, 2019; Karhunen, et al., 2015). An example of this is a six million-euro investment from Oulu Energy ten years ago, which went towards optimizing a peat plant (Alstom, 2011). Such lock-ins relates to transition theories because they clarify peat-use within the district heating regime as a “seamless web” in society (Figure 2). On a meta-analysis level, it is important to note that much of the research done to create and apply sustainability transition theories is funded by government institutions. This ties into what these frameworks teach: that collective actors and actions from government agencies to stream taxpayer money towards innovative research and development plays an integral role in the predevelopment phase of transitions from Köhler et al. (2019). Such nonmarket mechanisms between and among universities, public labs, and government procurements are crucially fundamental to driving environmentally friendly sociotechnical transitions. Niches must achieve economies of scale before they can stabilize within the district heating regime. To do this, niche empowerment, niche protection, regime destabilization, and landscape pressure are important.

2.5. Transition Policies

Legislative barriers are a central component to Finland’s strides away from peat fuel, and the precedent of gradual sociotechnical change that spans across multiple generations (Markard et al., 2012) will not suffice for achieving the Finnish government’s goal to cut peat energy use in half by 2030 – although Sitra’s idea of “gradual” is to abolish the discounted tax rate for peat by 2025 (Laita, 2020). According to a questionnaire-based study answered by large CHP plant managers across Finland, the “most important driving forces” behind the cost effectiveness of peat power plant operations are government decisions on energy policy and taxation, as well as international prices of fuel (Karhunen et al., 2015). From the firm perspective, it may be true that political decisions, laws, and taxes are central to running a cost-effective peat power plant. An example of a specific policy to incentivize the growing use of heat pumps in Finland comes from IEA (2018), which stated that “building performance standards are a main driver of the growth in heat pumps installed in new buildings, and carbon taxation promotes low-carbon options for heating of both new and existing buildings” (p. 61).

Kivimaa & Kern (2016) provide a more comprehensive overview of the type of policy mixes that governments should implement to facilitate sustainability transitions. These authors go into detail about the concept of 'creative destruction': Creative policies accelerate novelties, while destructive policies target the breakdown of the regime to make way for novelties and to stabilize them into the regime. Abolishing the tax rate for peat as well as introducing the new government peat tax are examples of disruptive policy pieces from Kivimaa & Kern (2016) and may offer an effective way to speed up transitions. Public funding support schemes and innovative policy mixes such as renewable energy technology subsidies are creative policies that incentivize niche growth.

Kanda & Kivimaa (2020) argue that the initial Covid-19 lockdown policies enacted in Finland can be staunchly contrasted with the creative destruction carbon phase-out policies that transition scholars have been calling upon for years (Kivimaa & Kern, 2016). Even so, the societal response to government lockdowns in efforts to "flatten the curve" can shed light onto our understanding of the role that government plays in sustainability transitions, and, more importantly, how the general public and markets would respond to the same type of stringent command-and-control measures as they relate to the outright bans on peat burning that Sitra recommended. Interestingly enough, the authors cited that the NordPool power market in the Nordic and Baltic region reported no decrease in electricity production levels in March or April of 2020, when the pandemic did not yet have as great of an effect on industrial production as it did in the UK. This is promising for Finland, since researchers have argued that electricity markets must be updated in such a way that enables "market-based investments for [solar and wind] capacity" if the country wants to successfully phase out fossil fuels in its district heating energy system (Rinne et al., 2018). The fact, then, that electricity production stood resilient in the face of a global pandemic is a promising sign that such decentralized, demand-response mechanisms can eventually be realized in Finland's district heating system. Recent indicators within Finland's energy sector suggest that it may be warranted to consider whether the coronavirus has become an exogeneous landscape pressure on the underlying district heating peat regime: Neste announced in November 2020 that coronavirus has accelerated the decrease in consumer demand for "fossil petroleum products". As a result, the firm decided to close down their oil refinery plant in Naantali in March 2021 (YLE, 2020).

On the other hand, some argue that the type of top-down, command-and-control policies are no longer seen as effective way for government to enact climate policy measures during this epoch of collaboration-based environmentalism (Manzmanian & Kraft, 2008). Kivimaa & Kern's (2016) call to creative destruction is therefore reminiscent of Rip & Kemp's (1998) call for governments to play the role of "strategic game planners", not obtrusive authoritarians. These two groups of researchers argue that governments who are coordinated and creative can facilitate sustainability transitions more effectively than governments who leverage command-and-control policies. Strategic government planning also means to facilitate change at an institutional level between varying actors across the sociotechnical landscape (Bush et al., 2017). Examples of such strategic policies include re-education programs, creating long-term goals like the Finnish Government's 2035 carbon neutrality goal, and creating actor networks such as Sitra, the Finnish Climate Change Panel, and the TEM working group on peat energy (TEM, 2020a). European Union-wide strategic policy initiatives, meanwhile, include the European Climate Change Programme. Under this Programme is the EU ETS, which is a strategy to lower greenhouse gas emissions in Europe by charging a price for carbon emission allowances so that companies such as those within the energy sector can compensate for not achieving emissions reductions requirements (Cadez & Czerny, 2016).

The role of government according to the MLP, then, is to reconfigure regimes by constructing strategic mechanisms that overcome the challenges that confront sociotechnical change and sustainability transitions. New forms of "creatively destructive" legislation written from the pens of "strategic government game planners" could well indeed offer an avenue of support for the trajectory of environmentally benign technologies in Finland's district heating sector. In their paper on managing the societal tensions that may arise from low carbon transitions in Europe, Turnheim et al. (2018) offers the suggestion that "policy should proactively deploy strategies to deal with losers, for example, develop re-education schemes for those currently employed in those sectors that are to be phased out" (p. 157). Re-education considerations for peat workers can be considered applicable to the peat phaseout in Finland, too. Therefore, the research for this thesis will aim to address more specific re-education possibilities for workers in the peat industry.

2.6. Theoretical Framework

The theoretical framework for addressing the area of research for this study is the way in which governmental, institutional, and multi-actor interests and policies position themselves within the three levels of the MLP. The framework is to help understand the gap between peat's continued use and the Finnish Government's 2035 carbon neutrality target date. From this gap, the theoretical framework aims to conceptualize the solutions to the barriers that confront a transition away from peat-burning. Moreover, I am using the MLP to assess the contemporary peat discourse in relation to the combustible district heating regime in Finland so as to find inconsistencies between the normative outlook on what the MLP teaches and the descriptive reality as told by my interview informants. From these inconsistencies are the suggested mechanisms and pathways to a transition away from peat.

Now that I have identified in this literature review the backstory to peat energy, the pertinent fundamentals of transition theories, and the theoretical framework for this thesis, I will discuss in the next Chapter the research methods and methodology that I used.

3. Methodology

This chapter discusses the methodology and methods I used to conduct my research. First, I will re-introduce my central research question, explain why I wanted to conduct this study, and provide an overview of the philosophical tradition that supports the qualitative research approach I chose. Next, I will break down what qualitative data collection methods I used and my rationale behind choosing the different interview subjects. Finally, I will discuss how I will analyze the data in such a way that incorporates the Multi-Level Perspective into the theoretical framework, what the significance of that means in terms of coming to empirical findings, and how I addressed ethical concerns in the research.

3.1. Research Design

The central research question that this thesis aims to address is:

What are the barriers that confront a low-carbon transition away from peat energy in Finland's district heating sector, and how can they be overcome?

The setting for this research question is empirical by using the MLP to uncover the barriers identified in the research and how they link to the ways to overcome said barriers (henceforth known as WTOs). The use of the MLP in the theoretical framework also serves the purpose to compare and contrast the interview results and the existent landscape-regime-niche interactions identified in the MLP literature.

To clarify this central research question and the base-level assumptions that superimpose it, *barriers* is defined as anything that hampers the predevelopment, take-off, acceleration, and/or stabilization of a niche technologies. For this thesis, niche technologies are referred to as *non-combustible technologies*, *non-combustibles*, and/or *low-carbon alternatives to peat*. Furthermore, although the literature review identified low-carbon technologies that have already been reported as viable alternatives in Finland's district heating sector, it does not restrict the possibility for additional new alternatives to be surfaced in the data collection. Indeed, that is part and parcel to the essence of this research plan: asking knowledgeable people to share their thoughts on this matter in order to identify ways to overcome the challenges associated with a sustainability transition in Finland's district heating.

To put into context my reasoning behind the qualitative research method that I chose, I decided to pursue this topic for my Master's thesis in the first few months after I moved to Finland in the Autumn of 2019. During this time, I came across a news article about how the peat industry was being subsidized, yet peat energy was carbon intensive. Having grown up in a beach town in the Southeastern United States, I had very little idea what peat energy was. After reading more, I discovered the *YLE* (2019) survey that reported how 62% of Finns oppose peat energy-use. Thus, I decided that it would be insightful and worthwhile for me to explore the competing views within the discourse on peat energy-use in Finland by interviewing different stakeholders and trying to understand their reasoning for either supporting or opposing peat energy-use. I eventually came to the conclusion that I wanted to conduct my thesis on this topic for the additional reason that I found it an interesting contradiction to subsidize peat despite the 2035 carbon neutrality goal.

After a few months of not really knowing where to go from there, my research interest gained momentum after learning about sustainability frameworks from the Energy Business and Innovation class at Aalto University. In this class, I was introduced to the MLP framework for the first time. I was immediately hooked: as an empathetic person, I like to consider all angles of analysis in any given situation, regardless of whether such angles align with my worldviews or not. Moreover, the MLP framework resonated with me because it involved a disruption of the carbon-based *status quo.* To me, this is the essence of exemplifying the ecological case for sustainability action. Most importantly, I felt that the peat energy discourse fit perfectly within the MLP framework because of the extensive dimensional ties to policy and culture that have historically kept peat firmly embedded within the sociotechnical DH regime. In order to truly get to the bottom of these ties, I knew that interviewing people first-hand was the only way to get there.

This thesis has an onto-epistemological starting point, as I mentioned in the Introduction: "Academics need to get out of the ivory tower and into the marketplace. We must learn to construe the world as a sphere of action rather than merely a system to be analyzed. Living in the tension between theory construction and its application and testing is difficult but necessary, both for theory development and for practice" (Eweje and Perry 2011, p. 21). The

even deeper onto-epistemological starting point for this thesis comes from Eriksson & Kovalainen (2008): "Knowledge is seldom based on one unified idea of science and research. Instead, different and equally legitimate philosophically embedded views exist regarding how and in what ways we can know the world." (p. 16). To me, these insights resonate with the inherent biases that we all carry in our day to day lives, which legitimize our own conceptualization of Being, as argued by King et al. (1994). Such biases include our political views, which is as intrinsically involved with the peat discourse in Finland as it is with my decision to pursue this topic: "Political philosophy is as ideological as any other kind of discourse. We accept from it what agrees with our normal core beliefs and values. This is why all political concepts are always 'essentially contrasted'" (Robinson & Groves, 2011, p. 7).

Just as with any study in the social sciences, *bias* is at the root of this study; I am internally motivated to pursue a career towards mitigating climate change, and, therefore, I agree with policies that push towards that direction. A stakeholder whose interests align with the peat industry's vitality, on the other hand, is (presumably) motivated to keep the proliferation of biomass on the political agenda. Yet, when we make an honest attempt to simplify a social situation, we must also make our best effort to put our biases aside in order to learn new insights that may re-shape our worldviews. In an attempt to put these biases aside by "essentially contrasting" my own political philosophy, my decision to use the MLP framework for this thesis necessarily involves understanding the totality of the competing sides of the peat discourse. As such, the MLP can best be seen as a "heuristic device" to "guide the analyst's attention to relevant questions and problems" rather than seeing the MLP as a "truth machine that automatically [produces] the right answers once the analyst has entered the data" (Geels, 2011, p. 34).

The research was also philosophically driven by my interest in learning about and understanding cultural debates within societies that are separate from my own. In this regard, this thesis is rooted in social epistemology because interviews are social in nature, thus, a successful interview is one that is engaging and light-of-heart for both parties. I value setting rapport from the moment I reach out to a potential interview subject until the conclusion of the interview. For this reason, I chose to conduct semi-structured interviews so that I could have

the flexibility of asking questions on an *ad hoc* basis based on the feedback I was getting in real-time from my interview subjects. A key limitation to this was that my interviews were conducted over an online video and audio communications platform as a Covid-19 precaution, so I was not able to receive the type of feedback that body language, vocal inflection, or eye contact would warrant. Nonetheless, the open-ended and neutral questions I strove to ask were designed with the intention of letting the interview subjects answer in their most honest way. This proved to be true: every single person I reached out for an interview responded positively to my request and was willing to answer my questions. Another socially epistemological underpinning of the research was the fact that peat has a cultural relevance to it. This philosophical drive was especially important to consider when I conducted my interview with the representatives from the Centre Party and Bioenergia ry.

3.2. Data Collection Methods

My goal in this research is to expand my knowledge and understanding of how "the real world" solves carbon emission problems. Therefore, I knew I had to interview a variety of stakeholders on both sides of the peat energy debate, and I knew that I had to ask a combination of descriptive questions and causal questions. The reason why I asked descriptive questions was so that I could understand the point of view of my interview subjects' most honest explanations for the political and economic characteristics of peat as a fuel-source for district heating. Once they stated the description of peat's involvement in the district heating system as they saw it, I began asking causal questions to gain insight on what their opinion was regarding the relationship(s) between the multitude of variables that they identified. These causal questions were probing in nature because I wanted to push the envelope on why they felt a certain way about the answers they provided to the initial descriptive questions.

To obtain empirical qualitative data, I conducted six semi-structured interviews through the use of an online video and audio communications platform, one structured email questionnaire, and one unstructured phone call interview (Table 1). In respect to ethical considerations for this thesis, I asked for and was granted permission from each informant to use their comments and insights for this thesis. For the six representatives with whom I conducted the informal interviews, I also asked for and was granted permission to record our

conversations before the interviews began so that I could go back through the recordings to transcribe them and to conduct the coding analysis. On a final note of ethics, I avoided plagiarism throughout this thesis by citing authors' and academics' ideas in the text and in the References chapter. For direct quotations, I included the page number of the publication. I then submitted the thesis to a plagiarism-checking software interface, as provided by the University, before my final submission.

The six interviews were with representatives from the following organizations: Finnish Energy (ET); Bioenergia ry; the Centre Party; the Ministry of Employment and Economic Affairs (TEM) Working Group on Peat; the Left Alliance (Left); and the Green Leagues (Greens). The email exchange was with a Chief Researcher at the VATT Institute for Economic Research in Helsinki, and the unstructured phone call interview was conducted with a Senior Advisor from the TEM's Department of Energy. The interview schedule was as follows:

Event	Stakeholder	Date
Interview (1 hr.)	Finnish Energy (ET), *Energy production expert*	17 Nov., 2020
Interview (1 hr.)	Bioenergia ry, *CEO*	18 Nov., 2020
Interview (30 min.)	Centre Party, *Member of Parliament*	23 Nov., 2020
Interview (1 hr.)	TEM working group on peat, *Secretary*	23 Nov., 2020
Interview (45 min.)	Left Alliance, *Energy and Climate Policy Advisor*	27 Nov., 2020
Interview (1 hr.)	Green League, *Member of Parliament*	30 Nov., 2020
Email	VATT, *Chief Researcher*	26 Nov., 2020
Phone call (15 min.)	TEM, *Senior Advisor, Dept. of Energy*	25 Nov., 2020

Table 1: Type and length of the event, the organization and position title of the interview respondent, and the date of the event. All interviews were conducted remotely in Helsinki, Finland.

The reason why three out of six interview subjects are representatives of political parties is because, as the literature review reflects, sustainability transitions are deeply political issues. Thus, I wanted to gain insight on whether any 'creative destruction'-type policymaking was on the agendas for each party (Kivimaa & Kern, 2016). Two of my interview subjects – the Centre informant, and the Greens informant – are Members of Parliament. The Left Alliance representative, on the other hand, is a Climate and Energy Policy Advisor for the Left. I was

able to secure an interview with the Left informant as a result of snowball sampling: initially, I reached out to a different representative of the Left Alliance, but that person referred me to the Advisor I ended up interviewing. Their reasoning was that the Climate and Energy Policy Advisor who I interviewed would be able to more appropriately offer insights that represented the Left Alliance regarding the peat debate.

The fate of a peat phaseout does not rest solely with politicians. As the literature review showed, a multitude of stakeholder activities are responsible for the predevelopment, takeoff, acceleration, and stabilization of transitions (Köhler et al., 2019). This includes intermediaries and advocacies. Before conducting my interviews, I determined that ET, TEM, and Bioenergia ry are intermediaries because their responsibilities are to link policymakers with industry representatives. These determinations were confirmed by my descriptive questions at the beginning of each interview.

My original research plan was to conduct a one-hour interview online with the VATT Chief Researcher, but they were only able to answer questions over email. Because the VATT informant is an economist, I purposely waited to send them my questions *after* I received sufficient knowledge and understanding regarding the EU ETS and the 2021 peat tax via interviews with ET and the TEM working group Secretary. I did this so that I could formulate more directed questions in regard to the strategic construction of innovative policy mixes that complement and mutually reinforce regime-destabilizing policies such as the EU ETS and government peat tax increase. Policies that help niches include R&D support schemes for innovators and low-interest loans for entrepreneurs, as per the analytical framework from Kivimaa & Kern (2016, p. 7).

The phone call with the Senior Advisor from the Department of Energy was unstructured and unplanned. The rationale behind placing this phone call was also effectively due to snowball sampling, as well as a means of cross-checking interview data that I received from the Centre Party informant's interview: after my interview with the Centre representative, the informant sent me an email about WTO "M" (Table 3, Section 4.2). In this email was a press release issued by the TEM regarding a recently announced funding mechanism for renewable energy

startups. At the bottom of the press release, I found the Senior Advisor's name and decided to call them with some clarifying questions. Just as with my other interview subjects, I asked for consent to use their insights for this thesis.

My goal with the interviews was to follow the theoretical framework by asking each person similar types of open-ended questions so that I could get the most honest and neutral responses from them in terms of how their respective interests are represented in the peat discourse. I wanted to achieve validity in my results, therefore, I asked the same types of open-ended questions, then triangulated them back to publications, news releases, and/or reports, as necessary.

3.3. Data Analysis

The end-goal of the data analysis is to answer the research question. The data analysis happened in five stages, and they are presented in the Findings, Analysis, and Discussions sections. First, I conducted a thematic analysis by coding the interviews and putting them through a coding framework. The coding can be found in the Appendix. The objective of the coding framework was to come up with a concise list of what the interview informants offered as barriers to the transition from peat, and ways to overcome these barriers. I executed the coding analysis by filtering the transcriptions in such a way that would deductively organize the data: by categorizing the discussions and sorting them into prevailing themes, these themes were bifurcated and labeled by either one of two categories: "barriers", or "ways to overcome barriers" (WTOs). The coding framework also comprises of an insight column. The insight column is inductively defined to include any preliminary thoughts, themes, or standalone takeaways from the interview insights that proved to be helpful in answering the central research question.

Second, I assigned number values to the barriers, and alphabetical values to the WTOs. To do this, I used the insight column as a reference point. I assigned these values in chronological order from when the interviews were conducted. In other words, the original alphanumeric values for each barrier and WTO were assigned in chronological order from when the interviews took place. For example, the first interview was with the ET representative, so,

naturally, Barrier 1 and WTO "A" were first identified in the interview with the ET informant. If Barrier 1 or WTO "A" was found in an interview that followed, it would still be assigned and labeled as such.

Third, I refined the insight column into discernable names for the Barriers and WTOs and organized and compiled them into two Tables in the Findings section. Table 2 contains all the barriers, and Table 3 contains all the WTOs. I then provided an overview of each interview informant in the Findings section by describing the main points that were brought up in their respective interviews. This overview also contains critical statements where I scrutinize the interests, positions, and political alignments that I determined to be held by each informant. The purpose of this was to contextualize each informant's relation to the peat industry by qualifying any given statement they said with my own conjecture of why they said it. I also qualified some of these statements with key insights and commentary from the VATT Economist and the TEM Department of Energy informant, who both offer varying perspectives and criticisms on the key insights from some of the main six interview subjects. In that sense, the representatives from the VATT and the TEM Department of Energy can be considered Peripheral Informants. Their comments and insights are first introduced in the Findings section and will be referred to intermittently throughout the entirety of the thesis.

Fourth, I move on to the Analysis section, where I analyze the individual barriers and WTOs. The process of analyzing the barriers included triangulating any relevant comments from my interview subjects regarding preexisting policies, publications, and/or press releases. I conducted the triangulation by using an internet search to ensure the validity of their comments, and thus, the validity of the research findings. After analyzing the barriers, I begin the WTO Analysis by providing a new table that categorizes the numerous WTOs into seven WTO clusters (Table 4). I categorized the WTOs into clusters because many of the original twenty-three WTOs shared the same overarching themes. This makes it easier to link them to the barriers, and thus to answer the central research question. I conclude the Analysis section with a critical evaluation of the WTO clusters by describing what the informants had to say about each of the individualized, alphabetical WTOs that fall under their respective clusters.

As with the barriers, I triangulated and cited any relevant policies, publications, and/or press releases as they pertained to the WTOs.

The fifth and final stage of the data analysis can be found in Table 5, which answers the research question by linking the barriers and WTOs in the Discussions section. Table 6 reintroduces the barriers from Table 2 so that the reader does not have to flip back and forth between pages in order to make sense of the linkages in Table 5. In the Discussions, I also cite these linkages back to references to the MLP that were discussed in the literature review before offering my concluding remarks, limitations, and suggestions for further research.

4. Findings

This section will introduce the Barriers and WTOs that were identified from the research. As the Methodology section described, I conducted a thematic coding analysis of the informal interviews by categorizing the informants' insights as either Barriers or WTOs in order to reach empirical findings (Appendix). A total of twelve Barriers and twenty-three WTOs were identified from the coding analysis. The Barriers can be found in Table 2, and the WTOs can be found in Table 3. In this section, I will also provide an overview and a critical assessment of the relationship that each of the six interview informants has with the peat industry. Sections 5 and 6 will provide a more in-depth analysis of the Barriers and WTOs by comparing and contrasting the empirical data and by integrating each of the Barriers and WTOs into the text. The goal of the Findings section is therefore to introduce them and to contextualize the positions of the informants. At the end of the Findings section, I will provide a conclusion of the main themes that I identified from the interviews in order to lay the groundwork for the Analysis that follows.

4.1. Barriers

	Type of Barrier	Interview Informant
1	Technological lock-in creates a sunk cost behind peat investments	ET, Bioenergia ry, Left, Greens
2	Alternatives not ready to meet capacity	ET, Bioenergia ry, Centre
3	Abundance of peat satisfies supply security	ET, Bioenergia ry
4	Gov. peat tax hinders a controlled transition because it forces biomass, which means spending more money to build biomass plants	ET, Bioenergia ry, Centre
5	Effects of peat transition are more severe for small companies than big	Bioenergia ry, TEM, Greens
6	Peat producers' pushback on re-education	Bioenergia ry, TEM
7	Ideological differences/ difference of opinions between parties	Bioenergia ry, Centre, Left
8	New tech expensive	Left
9	Path dependency of peat-use is fed by a centralized view of DH	Greens
10	Socioeconomic lock-in (jobs) behind peat industry	Greens, Left
11	Identity politics = pushback against wind and other noncombustible sources of energy	Greens
12	Heating tech gap can lead to too much wood- burning	Greens, TEM, Centre

Table 2: Research findings that suggest the existent barriers confronting a transition from peat.

4.2. Ways to Overcome

	Type of WTO	Informant
A	Increasing carbon allowance price under EU ETS is the pressure driving the transition	ET, Bioenergia ry, Centre, TEM
B	Controlled transition to maintain energy security. (Gradual phase-out of peat, while simultaneously increasing biomass-use and scaling noncombustible alternatives)	ET, Bioenergia ry
C	Mechanisms to encourage niche technologies	ET
	1. For established companies: Early bird funding incentive	ET
	2. For small startups: public support	ET, Greens
D	Scaling noncombustible technologies means obtaining reliable (proven) tech providers and reaching cost-competitive tech	ET, TEM, Greens
E	Small Modular Reactors (SMR) as a long-term solution	ET, TEM, Greens
F	Customers who are committed to the transition	ET
G	Intermediaries flexible to market conditions	Bioenergia ry
H	Re-education, new products, and new businesses	Bioenergia ry, Left
I	Just Transition Fund	Bioenergia ry, TEM, Greens
J	Local decision-making, not managing everything from Helsinki	Bioenergia ry, Left
K	Afforestation	Bioenergia ry, Left
L	Financing methods through the EU Recovery Fund	Centre
M	2020 Amending Budget (*Lisätalousarvio*) to support heat pumps and excess heat	Centre
N	30-million-euro TEM grant to seven renewable energy projects	Centre
O	Cooperation between companies, universities, and research institutions (i.e., the TEM working group on peat)	Centre, TEM
P	Peat producers are demanding direct monetary compensation to pay off peat plants	TEM
Q	Gov. decreasing electricity tax for large heat pumps (applies to D, and C_2)	TEM
R	New business models: Vapo (the state) buying off and restoring small peat farms	Left
S	Switching from peat by innovating quickly is better than gradual change	Greens, Left
T	Biomass tax	Greens
U	Help for small and medium municipalities: direct investment support for noncombustible tech	Greens
V	Pool resources (VTT hub)	Greens
W	Compensating local communities with wind energy tax revenues	Greens

Table 3: The twenty-three identified WTOs from the research findings.

4.3. ET

The representative from ET disclosed at the beginning of the interview that they essentially work as a lobbyist: ET represents energy companies by relaying the companies' thoughts and ideas to governmental decision makers. Thus, ET's vested interests are within the 'industry' element of Geels' sociotechnical regime (Figure 3). The ET representative shared with me a model they created in 2018 which showed the projection of peat energy use (Figure 5). The model predicts that based on public announcements from energy companies, peat energy-use will decrease by 62% from 2018 to 2030. Thus, the representative strongly felt that not only will the government goal for halving peat-use by 2030 be achieved, but also that the eventual phase-out of peat is inevitable. Here are what I thought were key points from the informant:

1. Peat-use will decrease over the next five years, and this is primarily driven by the increasing price on carbon allowances under the EU ETS. This means that wood-burning will have to increase as a result, which has its own climate impacts. Therefore, Finnish politicians should not push DH further towards wood-burning via more taxes on peat.
2. The Finnish government's peat tax is excessively hurting peat plants because these companies could be using the millions of euros that they are spending on new taxes to instead invest in noncombustible alternatives to peat and biomass.
3. Three things must be solved: low carbon alternatives to the fuel supply of DH systems must be reliable, and they must also be cost-competitive. Furthermore, customers must be committed to the transition.

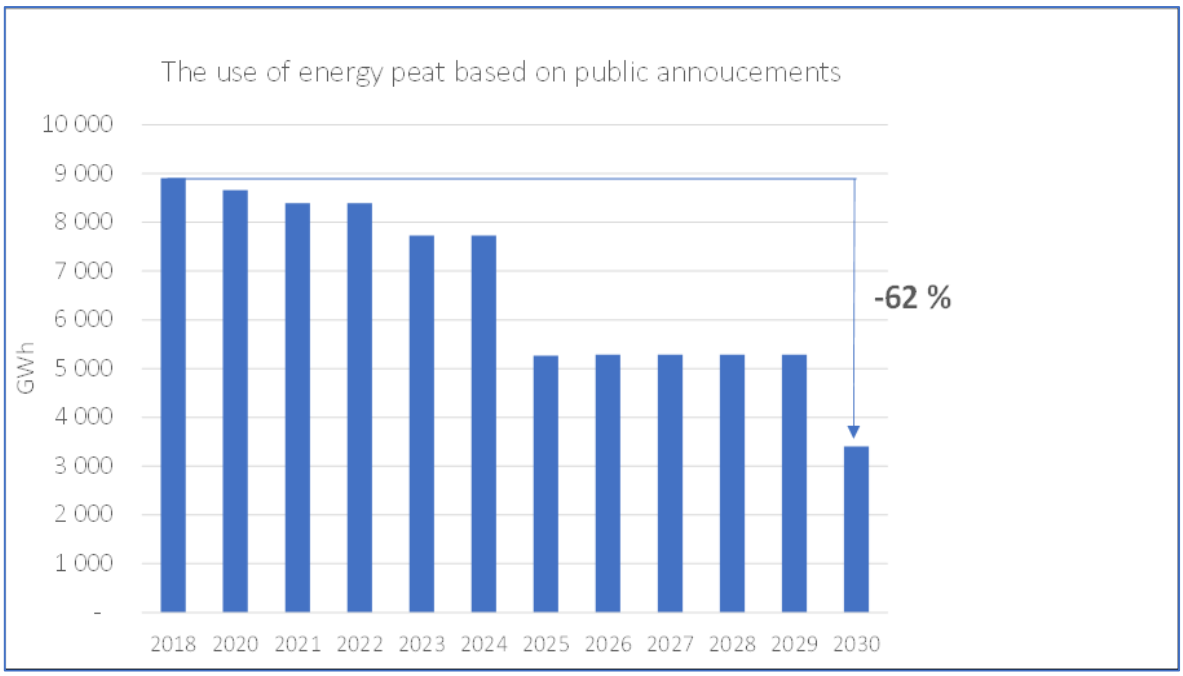

Figure 5: 62% decreased projection of peat use from 2018-2030.

Source: Created by the ET informant.

Critical assessment of ET

The model is based on public announcements from the energy companies, so of course it would make sense for them to state that their peat-use is decreasing in order to create the narrative that the new peat tax is unnecessary in order to save money. One must keep in mind that ET is a lobbyist. Thus, the fiscal interests and profitability of peat-fired power plants are their own best interests, too. This sentiment is counter-balanced by the representative from the Greens and Left, who confirmed that the tax is not high enough (to be discussed later). Furthermore, the ET model is directly refuted by a model that the VATT Chief Researcher revealed to me via email (Koljonen et al., 2019). Because this 100-page report is written in Finnish, I cannot find the model, but the VATT representative summarized its main takeaway for this thesis by disclosing that, "the claim that peat producers are already motivated to phase out their peat fuel-use does not seem true in light of scenario modelling from 2019 [ibid]." The ET informant also stated that "sector coupling" as a means to lower industrial emissions is drawing more attention than the peat debate and should be the main future focus towards achieving the 2035 carbon neutrality target date. Sector coupling nonetheless has implications

for DH because it means integrating different sectors who consume energy (DH, industry, transport, construction) under the same electrified, renewably produced energy sector (Appunn, 2018).

4.4. Bioenergia ry

As an advocacy for the bioenergy industry, the role of Bioenergy ry is to represent the goals of their member companies. According to the representative, the ry is a relatively small organization with only seven employees, but they have 300 members total: 250 companies, and 50 individuals. The companies range in size – including large companies such as Vapo and Neste, small one-person companies, consultancies, and everything in between. The business model is to charge annual membership fees to companies in the bioenergy industry. In return, Bioenergia ry offers consulting services for these companies by meeting with governmental decision makers on their behalf. The informant from Bioenergia ry, who is the company's CEO, began the interview by discussing the vision and the strategy of the company. Their vision is "to promote an environment where Finland has the best preconditions for development of sustainable or even carbon negative biomass-based products," but the informant acknowledged that the present condition of the bioenergy industry is far from this goal. Because of this, their strategy is to enact *controlled steps* to this transition by balancing climate goals, economics, and social goals. They also said that there is a need for more biomass because if the transition away from peat is done quickly, companies may go bankrupt and lose their licensing. Peat-extracting businesses must therefore be given ample time to pivot and adapt by developing other business models.

Similar to what the representative from ET argued, the main driver behind district heating companies' goals to reduce peat-use is driven by the increased price on carbon allowances under the EU ETS, not the Finnish government's peat tax. They argued that the peat tax makes the transition uncontrolled, which is problematic for peat producers. They also reiterated a point made by the ET informant, which is that peat production will cut in half by 2025 – well ahead of the 2030 Government Programme target.

Critical assessment of Bioenergia ry

Just as Finnish Energy works on behalf of DH companies who use a combustible fuel supply, Bioenergia ry represents the use of biomass as a DH fuel source. Indeed, the representative expressed during the interview that biomass is necessary in the transition away from peat. Although the representative admitted that the goals and objectives of the bioenergy industry may be different in ten years, and that the vision for the biofuel industry now is to become sustainable, the informant nonetheless believes that their industry is still relevant in the Finnish energy system because noncombustible alternatives are not ready to meet capacity. The representative also admitted in the interview that they do not have much expertise regarding the challenges that these technologies face in their development and implementation.

While this is not surprising, given that they are advocates for the bioenergy industry, this reluctancy and "turning a blind eye" to the relationship they have with noncombustible alternatives may ultimately be a disservice to the company and to the long-term goals of the companies that Bioenergia ry represents.

4.5. The Centre Party

The Centre Party representative is the current Vice Chair of the Committee on Economic Affairs, which deals with energy issues. The informant is also a member of the Committee on the Environment, which also deals with energy issues in climate alongside environmental groups. Last year in their role as the Centre Party's Energy Environment and Climate Chair, they were instrumental in discussions about research and innovation in the energy sector and how to make better use of finances and other resources. These committees are committees within the Finnish Parliament. The representative acknowledged that they have a lot of contacts within the peat industry and that they represent peatland owners and small, community-owned district heating companies.

Just as the ET and Bioenergia ry informants stated, the Centre Party representative stated that peat-fired DH companies "have done good research and good scenario work" in their

projected future use of peat and have come to the conclusion that their production will cut in half by 2025. The informant also emphasized the notion that their party is more "realistic" than the other parties, in that they recognize that it is tremendously difficult to phase out peat energy-use rapidly. The informant stated that it will take billions of euros to build new plants that use noncombustible alternatives, and that other parties like the Greens seem to think unrealistically that noncombustible alternatives such as solar, wind, heat pumps, and waste heat can be scaled quickly.

Other main findings from this interview include a list of three different public support measures that aid the transition process in varying ways. These measures include financing support from the EU Recovery Fund to help peat producers recuperate their losses on their sunk cost investments, the 2020 Amending Budget for research and development towards noncombustible alternatives, and a TEM grant that was awarded to seven renewable energy projects. All three can also be found in Table 3 as WTO "L", "M", and "N", respectively. Although the interview with the Centre Party representative was only thirty minutes – an outlier to the one-hour interviews that I had with the other informants – I still felt like I covered substantial ground, because they touched on four of the twelve total barriers identified throughout all the interviews. As far as the WTOs are concerned, the representative from the Centre Party was the only informant who mentioned specific names of national public funding measures.

Critical assessment of The Centre Party

After my interview with the Centre Party representative, the informant sent me a follow-up email with a link to a TEM-issued press release that describes WTO "N", which is the 33-million-euro TEM grant for seven renewable energy projects across Finland (TEM, 2020c). In order to gather more details about these projects, I placed a phone call to the Senior Advisor of the TEM Department of Energy, who was listed at the bottom of the press release as a contact. I learned from this phone call that none of the seven projects relate to the peat transition, and that the Centre Party informant was mistaken in thinking otherwise. Instead, all seven of the projects are related towards other applications, which will be discussed in more detail in section 6.3.

Nevertheless, it was evident from the interview with the Centre informant that the Centre Party's position is in favor of a gradual transition away from peat as opposed to a rapid transition. This is presumably because the Centre Party represents peat producers and rural and agrarian interests inside Parliament. Just as ET and Bioenergia ry affirmed, the Centre Party believes that as peat is phased out, wood and other biofuels will be increasingly used to replace peat because noncombustible alternatives will not be readily available to meet capacity quickly enough. The Centre informant also stated that as a result, more wood will have to be imported from Russia because it is cheaper there, but that this will be a "total disaster for climate".

4.6. TEM Peat Working Group

Enacted in April 2020, The Ministry of Economic Affairs and Employment (TEM) Working Group on Peat is perhaps the most neutral informant to the peat discourse of all the other interview subjects. The Secretary of the working group who I interviewed mentioned that the chief goal of the group is to come up with suggestions for the use of peat besides energy-use. The Secretary cited the increasing CO_2 allowance price under the EU ETS and the subsequent pressure that it is putting on the peat industry as the driving force behind the working group's genesis. The working group is not a political party, nor are they lobbyists, nor are they legally or financially obligated to adhere to any special interest groups. Therefore, the working group necessarily requires the inputs from a broad range of stakeholders in order to deliver their suggestions by the end of March 2021 (TEM, 2020a). Indeed, the Secretary confirmed that the working group listens to opposing views from a variety of stakeholders, including peat producers, entrepreneurs, natural preservation organizations, and other environmentalists. The Secretary also mentioned that the environmental activists and NGOs are demanding an immediate phase-out and ban of peat energy-use. These sentiments are comparable to the 2029 'outright ban' against coal in Finland.

The TEM Secretary followed up with me after the interview to provide some statistics via email, disclosing that between 2016 and 2018, the average total energy-use of peat was 15.3 TWh in Finland: 1.5-2 TWh of peat fuel was used for district heating production in heat-only

boilers; 5-5.5 TWh of peat fuel was used in CHP plants; and the rest (8.8-7.8 TWh) was used for electricity production and steam production in industry. They also sent me a link to a report conducted by the Finnish consulting firm Afry in August 2020 (Afry, 2020). The 70-page document is written in Finnish, but the TEM Secretary told me in their email that the report predicts the downwards projection of peat production in the years to come due to the EU ETS' increasing price on carbon allowances. Thus, the Afry document supports predictions provided by the working group Secretary, along with the model composed by ET (Figure 5), as well as the insights from interviews with Bioenergy ry and the Centre Party. The notion that peat production will decrease in the next five years is not supported by the VATT economist, however.

Critical assessment of TEM Peat Working Group

The TEM representative was not at the liberty to disclose the full recommendations from the working group, since these recommendations will be revealed to the public in the spring of 2021. The term of the group is set to end on 31 March 2021. Therefore, the insights from the interview I had with the Secretary may be deemed as unrefined or even obsolete by the time the working group's final recommendations are published. Furthermore, the objectives of the working group were to look at the future of peat itself, not district heating. In other words, the working group's interests mostly lay in finding creative new ways to support the peat industry at large insofar as finding different uses for the resource rather than finding alternative fuel sources for district heating, which is what this thesis is concerned with. Even though some of the environmental NGOs who are participating in the working group are calling out for the outright ban of peat energy-use, the working group cannot fully take their side due to the opposite interests they are simultaneously listening to, and vice versa.

Whereas this thesis is chiefly interested in "alternatives to peat, i.e., low carbon district heating fuel sources", the working group is interested in "alternatives to peat, i.e., other products that can be made using peat." Thus, the baseline starting point of the working group ("pro-peat industry, just not energy peat") is different than the baseline starting point of this thesis ("transitioning from energy peat in DH").

4.7. The Left Alliance

The interview was conducted with a Policy Advisor to the Left Alliance and the results showed a slight deviation from the other interviews. In this interview, they told me that the driving forces behind halving peat-use by 2030 was not the increasing EU ETS carbon allowance price, but instead are a combination of three mechanisms: 1) the government tax increase on peat, 2) the price floor, and 3) the elimination of tax subsidies for peat. The Left informant also suggested that the Finnish law that bans coal burning by 2029 could offer a valuable market predictor on the response to the peat phase-out because investments in coal plants immediately started to divert after the law was announced in 2017. But, since the Government Programme goal of merely *halving* peat use by 2030 is not as ambitious, according to the representative, the only evidence of a market effect is the September 2020 announcement from Vantaa Energy that they will end their peat energy production by 2021 (Vantaa Energy, 2020). It is important to note that Vantaa Energy, with a turnover of nearly 300 million euros in 2019, is assuredly considered a large power plant. This is a critical distinction from the substantially less capital outflows of small to medium-sized municipal peat producers that were brought up in three of the interviews (Bioenergia ry, TEM, Greens), which presents a barrier for these entities to a transition from peat (Barrier 5 from Table 2).

Critical Assessment of The Left

The Left representative chastised Sanna Marin's coalition government on several occasions throughout the interview, characterizing the peat policies as "not ambitious enough", and as "mere compromises". The fact that the Left has only two ministers represented in Marin's nineteen-member cabinet may have been the source of the Left representative's unduly contempt towards the peat policies enacted by the federal government last Fall, but that is only a conjecture of my own. Furthermore, the Left representative held a junior role with the party and is not a member of Parliament like the informants from the Centre and Greens who I interviewed. The Left informant may therefore not be as well-informed as their political counterparts. *Equitable housing* is a chief concern to the Left informant, too, as evinced by the representative's admonishment against wood-burning in lieu of wood-use for building houses. Therefore, their argument against wood-burning as an immediate replacement to peat may

have been uniquely inspired by this consideration rather than from a climate change and energy market standpoint. Coincidentally, a recent article from Aalto University discusses the tremendous carbon storing potential of constructing more wooden buildings across Finland and Europe (Aalto University, 2020). This consideration could help stakeholders argue against wood-burning on the basis of both 'equitable housing' and 'climate change' alike.

4.8. The Greens

The key takeaway from the Greens representative is that the current policies against peat energy from Fall 2020 are sufficient in catalyzing a phaseout, but Finland must now also rapidly scale noncombustible technologies so that they can be reliable for the DH system. The Greens informant was also the only interviewee to use MLP terminology such as "path dependency" and "lock-in". Their interview revealed Barriers and WTOs that none of the other informants suggested: they brought up creative, unique policy mechanisms such as small companies pooling together their money into R&D through research hubs like VTT (WTO "V"). Within such a hub, the Greens informant suggested that all of the participating niche-level companies would reap the benefits from the VATT's findings, thereby scaling these technologies in terms of price and production capability. The Greens informant also introduced the idea of a tax against biomass (WTO "T") to ensure that the DH sector does not fall into an imprudent reliance on wood-burning.

The informant offered insights that were consistent with some of the other interview informants' insights, such as Barrier 5, which states that the effects of a peat transition are more severe for small companies than for big companies. The Greens informant was more specific in their explanation of Barrier 5, however, by explaining that smaller companies have a greater challenge in scaling noncombustible alternatives because they lack the extent of financial capital held by large companies such as Vapo. Public funding schemes from the Finnish Government should help with these challenges, however, according to the informant. The Greens informant also said that the combustible, centralized DH system is not inherently a barrier to a low carbon future in Finland's district heating sector, since centralized systems are efficient for big cities. It would therefore be a challenge, according to the informant, to

implement a distributed network in big cities such as the capitol area, but that a decentralized system may work well in smaller towns.

Critical Assessment of The Greens

The Greens are primarily interested in curtailing Finland's greenhouse gas emissions, and they do not seem to care as much as their counterparts about the idea of peat producers losing money in the transition to low carbon alternatives. On the topic of the high costs associated with transitioning, the representative expressed that "sunk cost is not an excuse for bad policy." By this, the Greens informant meant that just because peat producers invested in peat production machinery and peat energy technologies a decade ago does not mean that the government should excuse their bad decision by capitulating to the industry's demands for a gradual transition away from peat. The Green Party's calls for a rapid transition, however, may be detached from the reality that peat producers face, as suggested by the Centre Party, Bioenergia ry, and ET informants. However, it is difficult to say in either case because nobody can tell the future. The argument for taxing biomass energy put forth by the Greens may resurface the importance of the Bioenergia ry informant's contention that peat- and biofuel-powered plants may be forced into bankruptcy if the transition is too quick. Regarding the Green informant's notion that centralized DH is not inherently a barrier, the Green informant also conceded that centralization precipitates Finland's affinity for energy-secure, combustible fuel sources such as peat (Barrier 3), which further embeds the technological lock-in of peat-fired power plants (Barrier 1) within a combustible, centralized system.

4.9. Conclusion of the Findings

The Findings showed that instead of pro-peat and anti-peat stakeholders, a more appropriate way of categorizing the informants and their insights is by "pro-controlled transition" and "pro-rapid transition" stakeholders. That is to say, the opinion that "carbon-intensive peat burning is bad" was universally recognized by all the informants. The difference of opinion, however, was chiefly in the *speed of the transition* and what steps should be taken to achieve it. Finnish Energy, Bioenergia ry, and the Centre Party support a controlled transition, and the Left and Greens support a rapid transition. A controlled transition means a balance between

peat-burning and wood-burning for the next five years until noncombustible alternatives are ready to be integrated within Finland's DH system. A rapid transition means prioritizing the implementation of noncombustible alternatives as soon as possible so that the DH fuel supply does not have to rely on wood-burning in the face of a peat phaseout.

Moreover, the Findings identified that there is a difference between *position* and *interest* among the entities that the informants represent: an *interest* is what someone believes in or wants. For example, the Centre Party's interest is to protect the peat industry. A *position*, meanwhile, is the stance they take or the words they use as a means to satisfy their interest. Based on the interview results, the Centre Party is taking the position that Finland must gradually phase out peat-use because a rapid phaseout would force excessive levels of wood-burning, which would be unpreferred. This position is further supported by the notion that noncombustible alternatives are not ready, and that it is "unrealistic" to think that they will be ready in the near future. The same is true for the Greens Party: The Greens' interest is to lower Finland's carbon emissions, and their position is to direct more funding towards ensuring that noncombustible alternatives can be price-competitive and reliable as soon as possible.

5. Analysis of the Barriers

In this section, the Analysis will make further steps towards answering the central research question by critically analyzing each of the Barriers and WTOs that were introduced in Table 2 and Table 3 from the Findings section. Some insights and opinions from the informants were similar, while others varied. As Table 2 reflects, most of the informants were unanimous about Barrier 1: that prior investments in peat-fired power plants are expensive and have thus created a technological lock-in for its continued use. Both sides acknowledged this Barrier presumably because it is obvious: it concerns millions of euros of owed debt. However, each informant provided their own unique explanation behind the Barrier's existence. ET, Bioenergia, and the Centre agreed with each other fairly consistently on the embeddedness of peat-use within the district heating regime, while the Greens offered their own unique Barriers and WTOs that mostly centered around a more critical view of combustible sources within the DH fuel supply. The Secretary from the TEM Working Group on Peat did not provide many Barriers, as the discussion with them was predominantly focused on WTOs, while the Left Alliance representative was the only informant to mention the expensive cost of niche technologies (Barrier 8), which the Literature Review identified as a key barrier that is cited in the MLP literature.

5.1 Analysis of Barrier 1: Technological lock-in creates a sunk cost behind peat investments

The ET informant introduced the technological lock-in of peat-fired power plants by explaining how CHP plants must use peat in order to avoid harmful sulfur emissions that would otherwise result from the combustion process. This notion takes the base assumption that combustible district heating is necessary in the first place. ET went on to explain that the main reason why a controlled transition is necessary is because energy companies have not yet paid off their investments on peat-related technologies, which both ET and Bioenergia ry cited can have payback periods of up to twenty years. Bioenergia ry affirmed that it is difficult to find an economic case for quickly dismissing these sizeable investments, which is what the Greens and Left stood by in their interviews, as well. Nonetheless, the Left acknowledged this barrier by asking who will pay off these investments, and the Greens stated in their interview

that previous government incentives for the peat industry as well as investments in expensive peat technologies are examples of the path dependency that locks-in peat to the district heating system. As such, Barrier 1 is the only barrier that is agreed upon by both the pro-controlled transition and pro-rapid transition stakeholders. While the sunk cost factor for technological lock-in of peat-fired power plants was also identified in the Literature Review, the Greens representative stated that "sunk cost is not an excuse for bad policy."

5.2. Analysis of Barrier 2: Niches are not ready to meet capacity

This barrier was brought up by the ET, Bioenergia ry, and Centre informants. The ET informant focused mainly on geothermal, stating that at this moment, Fortum's geothermal plant in Otaniemi can only produce 20-30 MW of heat, as opposed to the 40 MW that was promised when the project started. The ET representative went on to say that hopefully within two years we will know whether geothermal is viable to meet capacity. The Bioenergia ry CEO also mentioned that geothermal is not ready yet and that the novelty of other niche technologies means that they are not proven to take hold of the DH regime. Bioenergia ry brought up waste heat, as well, citing that there is not as much of an abundance of widespread sources for this low carbon niche as there are for biofuels. The informant mentioned Mikkeli as an example and explained that as a service-based city, the lack of big factories and heavy industrial projects means that there are not significant wasted sources of heat to capture and re-use. The Bioenergia ry informant explained further that even in cities where a wasted heat source is available, it could be uneconomical to connect it to the current DH network. This notion of *infrastructure compatibility* is in line with 'selection environments' from the transition literature, in that transitions are more likely to succeed if new infrastructures do not have to be built to support the emerging niches (Kemp, 1994; Geels, 2017). The Centre Party representative said that heat pumps and heat waste are "far away from real production", although the TEM working group secretary as well as Rinne et al. (2018) refuted such a notion by saying that heat pumps are indeed market ready. The Centre Party informant also said that noncombustible alternatives cannot be scaled quickly enough to preempt increased biofuel use over the next few years in Finland's DH system, although they went on to mention public funding measures. Such measures include the 7th Draft Amending Budget 2020 for Coronavirus Impact (*Lisätalousarvio*) – which gave 330 million euros to The Finnish Climate

Fund – that could be leveraged towards scaling such niches as heat pumps and excess heat. Public funding measures will be discussed in more detail later in the WTO Chapter 6.

5.3. Analysis of Barrier 3: Abundance of peat can meet capacity

The literature review mentioned peat-use in district heating on the basis that it meets supply security concerns (Karhunen et al., 2015), but the informants from ET, Bioenergia ry, and the Centre reaffirmed this notion within the context of noncombustible alternative niches not currently being able to meet capacity. Thus, they argued that because peat is abundant, and because niches are not ready to meet demand, that a controlled transition is better than a rapid transition. Barrier 1 and 3, therefore, go hand-in-hand because they are mutually reinforcing and thus show the embeddedness of peat-use. The Greens also cited supply security concerns that make peat appealing and thus difficult to overcome from a combustible DH system-centric point of view, though they did not express it was a barrier per se since they mentioned that scaled niches can overcoming this barrier. The overarching effect of Barrier 3 is that it justifies a centralized view on DH, which creates a path-dependency for peat energy-use that results in the technological lock-in of peat-fired power plants. In other words, Barrier 3 creates Barrier 9, which creates Barrier 1.

5.4. Analysis of Barrier 4: The Finnish Government's peat tax hinders a controlled transition because it forces biomass, which means spending more money to build biomass plants

This is perhaps the most important barrier because it exposes the difference between *interest* and *position* among the pro-controlled transition stakeholders. This barrier also has the most severe and immediate implications for the DH fuel supply over the next five years. The peat tax that was passed in 2020 goes into effect in 2021, and whether it pressures energy companies to transition quicker or hurts them worse was debated between the informants. Those who took the position of a controlled transition felt as if the government peat tax will cost energy companies millions of euros that could otherwise be spent on the research and development of noncombustible niches. But, the Left informant, who took the position towards a rapid transition, said that the peat tax and price floor were not enough, and that the Finnish government could do more to destabilize the peat industry by taxing them even more

heavily. The Greens stated that the novel price floor and peat tax mechanism is adequate at present moment, and that no more peat policies on behalf of the Finnish government are necessary. Instead, they said that it is time for the Finnish Government to now focus on policies that help scale niches.

This barrier was brought up by those whose interest lie with the peat industry. Interestingly enough, it ignores the possibility of skipping biomass-use altogether by going straight into the use of niches that are cost-effective and meet capacity. Within this barrier is a "Slippery Slope" fallacy of logic because it assumes that the dramatic event of "being forced into costly biofuel plant investments" will inevitably result from the peat tax, without any actual evidence for this casual chain in the first place. This barrier, however, was not brought up with alacrity; the future increased role of biomass was instead seen as a "necessary evil" because it would require increased costly wood imports from Russia, a move that all three stakeholders as well as the TEM Secretary said was a bad policy. Nonetheless, it is a barrier that is being used by the pro-controlled transition informants as an argument for a gradual phaseout of peat.

5.5. Analysis of Barrier 5: Effects of peat transition are more severe for small companies than big

This barrier addresses the different realities that small and medium-sized municipally owned DH companies face compared to big companies. Simply put, big energy companies have the capital to invest in the funding for new projects, while, as the Greens put it, small municipally owned companies who are already not doing well economically have the heavy burden of high costs when faced with the initial investments towards similar projects. In the interview with the TEM working group Secretary, it was brought to my attention that Vantaa Energy is willingly phasing out peat by investing in heat storage underground. The Left informant mentioned that Vantaa Energy's decision to close their peat-fired plants was announced after the government decided on the new peat policies in the fall of 2020.

Smaller peat plants do not have this same luxury and flexibility. According to the TEM working group Secretary, Afry consulting company published a report written in Finnish over the summer of 2020 concluding that if peat were completely phased out in five years, then

small peat producers would need to avoid going bankrupt by being directly compensated with 210 million euros. This sum would cover their investments in peatlands and machinery (Afry, 2020). The CEO from Bioenergia ry stated that much of his duties revolve around weighing these different interests and that one of his core responsibilities is to relay their respective messages to decision makers. This responsibility exemplifies the role that the ry fulfills as an intermediary in support of the mixed-capacity bioenergy industry, and the challenges that the industry faces.

5.6. Analysis of Barrier 6: Peat producers' pushback on re-education

This barrier was mentioned by the Bioenergia ry representative and is important because it plays into the motivational drive for whether peat entrepreneurs are willing to pivot their businesses towards different models. This sense of motivation and willingness to comply with the transition was a factor that the TEM Secretary mentioned, as well. Re-education is a concept that the transition literature discusses (Turnheim et al., 2018), and to have a successful energy transition, there must be policies and mechanisms that 'deal with the losers'. That is to say, phaseout policies must offer adequate incentives for changing peat production into new business models. Such a pivot may require re-education, but the research indicated that peat producers are not going to want to take the time to learn new skills unless it is appealing to them financially. This conceptualization of *tradeoff* and the tremendous opportunity cost that lies therein produces pushback and contempt towards a peat phaseout and ties into the identity politics from Barrier 11. Furthermore, it is a challenge that the TEM peat working group is striving to overcome, according to the working group Secretary.

5.7. Analysis of Barrier 7: Ideological differences/difference of opinions between parties

This barrier was overtly discussed by the Bioenergia ry representative, who stated that due to ideological differences in the government, the Greens Party sees the peat taxation as "an important tool to increase the incentives for getting rid of peat." The bioenergy industry's message in response, according to the representative, is that the tax "is excessive at the moment", "is making life difficult for the peat companies" and is unnecessary "because peat is going down anyway head of the curve."

The Centre Party representative told me that the Greens believe that noncombustible technologies can replace peat quickly, while the Centre "is more realistic" and believes that maximum production capacity from these niches is still a long way from being realized. Based on my interview with the Greens, however, this is not so: The Greens representative agreed that noncombustible niches are not ready, but they did not indicate that these niches will magically become readily available in a short time frame. Instead, the Greens representative said that alternatives must be rapidly scaled to be cheaper and more reliable through public funding mechanisms so that Finland does not fall into increased wood-burning at the hands of a heating technology gap (Barrier 12).

The research indicated that the parties' ideological differences are not polarizing to the point of political gridlock, however. Rather, the existent political differences between parties are balanced by a comment made by the Centre Party representative. When asked whether the Centre Party is making efforts to seek middle ground with the Greens via innovative policy mixes such as collaborative R&D schemes, the informant said that "both [the Greens and Centre] parties believe in science, research, and innovation". When asked to provide an outcome of these shared values as an example, the informant mentioned the nonpartisan *Lisätalousarvio*, or the Seventh Draft Amending Budget 2020 for Coronavirus Impact. The Amending Budget awarded €330 million to the Finnish Climate Fund and will be discussed in more depth in Section 6.3, WTO cluster 3.

5.8. Analysis of Barrier 8: New tech is expensive

This barrier was only brought up once, from the Left Alliance, within the context of avoiding increased wood-burning as peat is phased out. The Left informant acknowledged that low carbon alternatives such as Power-to-X (P2X), hydrogen energy, solar PV, and wind exist, but they are too expensive at the moment to be implemented in district heating. The informant stated that LUT University in Lappeenranta is working on a project to develop P2X solutions. Because these alternatives are too expensive at the moment, the Left informant stated that wood is the cheaper option. The greatest risk to the peat phase-out, therefore, is that the subsequent increased burning of wood would be a waste of this resource, which could otherwise be used for building homes. This 'housing' consideration struck me as odd at first,

because I had not heard it from the other informants. However, it makes sense because The Left Alliance's political agenda is to advocate social equality through affordable and equitable housing, healthcare, and employment – both in the cities and in the rural areas of Finland. From this perspective, it would make sense why the Left informant would oppose increased wood-burning. Furthermore, after my interview with the Left representative, I read that the informant announced they would be running for election on the platform of providing affordable housing. So, this particular Policy Advisor with whom I spoke was personally interested in the opportunity cost of wood-use in district heating.

The Left informant also stated that the plan to introduce noncombustible alternatives in Finland's district heating sector could be more precise, namely, that the Finnish government could make a law against wood-burning. Such policies would go against the Centre's interests, the representative said, which is why "it was a big stretch, or compromise, for [the government] to half the peat production by 2030." Low carbon niches must be cost-effective in order for them to accelerate and stabilize within the district heating regime, and process of making new technologies cheap is yet another crucial dilemma that confronts successful energy transitions.

5.9. Analysis of Barrier 9: Path dependency of peat-use is fed by a centralized view of DH

This barrier was brought up by the Greens representative, who stated that the centralized view on DH in Finland has historically meant that the system needs a large combustible fuel source compared to a distributed or decentralized system. The technical reason for centralized DH is that centralization is an efficient way of distributing heat, according to the informant.

With the advent of the 2018 coal ban and the increasing carbon allowance prices under the EU ETS, however, it is already becoming less economically viable to generate district heating through combustible sources than it was in the past, according to the Greens informant. Now that there are new regulations and policies against peat-burning, the resulting pressure for companies to find alternative energy sources does not convince the Greens informant that there is a need for "fundamental change in the current institutional setting for district heating." "The point is that a centralized system does not necessarily mean that a low carbon

distribution would not happen. It is happening already. Whether it's happening fast enough is another question," they stated. The Greens informant justified their argument by explaining that the existing infrastructure that supports a centralized DH system is efficient because it allows for scalability, and they used Helen as an example: "Having a centralized system for Helen is one of the reasons why they have been able to do heat pumps, thermal heat and heat storage investments on a scale that would not emerge if you just threw out the district heating system on the basis that it's based on the combustion of fossil fuels, and to therefore incentivize houses to provide their own heat."

Even though the Bioenergia ry representative also brought up the consideration of niche alternatives becoming integrated within the existing DH infrastructure, the opinions of the Greens and of Bioenergy ry diverge: Bioenergia ry stated that decentralized waste heat would be challenging to implement within the existing system, while the Greens representative indicated that the existing system makes the scalability of heat pumps easier. These two insights indicate that some alternatives are more fit for the existing infrastructure than others. Indeed, the Greens addressed this by stating that alternative energy solutions "can be optimal on a smaller scale", but not from a system perspective, and that because of this, "the system perspective must be kept in mind when designing policies regarding DH."

5.10. Analysis of Barrier 10: Socioeconomic lock-in (jobs) to the peat industry

While Bioenergia ry, the Centre, and the TEM representatives discussed how it is a challenge to phase out peat energy-use in DH because the peat industry is responsible for thousands of jobs across Finland, the Left representative mentioned the topic within the context of how to find new jobs for people working in the peat industry. The Greens representative, meanwhile, directly stated that the local economy's connection to peat production results in "socioeconomic path dependency" due to its source of employment and livelihood for farmers and small businesses who produce peat production machinery. Job dependency on peat production was mentioned in the literature review as a barrier, but it is nonetheless important to include it as a barrier in the research findings, as well, because the topic serves as a grounding point for the informants' considerations on ways to overcome this barrier.

5.11. Analysis of Barrier 11: Identity politics results in pushback against wind energy and other noncombustible sources of energy

This barrier was introduced during the interview with the Greens representative. While discussing consumer use of wind energy in rural areas, the informant stated that citizens who are politically conservative and who do not believe in climate change are against wind energy because it can be a symbol for what these people oppose. However, the right-wing True Finns Party, according to the informant, agrees indeed that climate change exists. The "Finnish twist" on this position, according to the Greens informant, is that they argue that Finland is too small of country to be taking such drastic measures to combat it. Instead, they say that China should bear the brunt of the responsibility for fixing the climate problem. "With the identity politics dynamics, even if you have something beneficial like windmills, people become dubious of it because it's part of a transition you're skeptical about," the Greens representative stated. The limitation to this barrier is that it is hearsay to put words in the mouths of the True Finns Party without conducting a proper interview with a representative from their Party. However, regardless of whether the True Finns Party would support these comments that the Greens representative claims they hold, the fact that the representative from the Greens *believes* that the True Finns Party and their constituents have formed an identify around transition skepticism qualifies it as an ideological difference of opinions (Barrier 7) and the political gridlock that could ensue as a result.

5.12. Analysis of Barrier 12: Heating tech gap can lead to too much wood burning

The twelfth and final barrier has severe implications for the speed of Finland's district heating transition. As informants from ET, Bioenergia ry, and the Centre have indicated, a gradual change that does not bankrupt peat producers is favorable to a rapid change, and as the Left Alliance and the Greens Party have indicated, bigger steps towards a more rapid transition are the best way to ensure a low carbon energy future in Finland. The existence of a heating technology gap that leads to too much wood-burning is a balanced insight that was brought up by a variety of stakeholders, including the Centre informant, the Greens informant, and the TEM working group Secretary. The Centre party representative stated that too much wood-burning is ill advised because it requires expensive dependency on wood imported from

Russia. The TEM Secretary stated that such reliance on imports is a recipe for bad policies, too, and the Greens informant stated that wood-burning is an unsustainable solution in terms of carbon emissions. Though the informants from all three of these camps acknowledge the existence of a heating tech gap, their opinions on how to deal with it differ. As mentioned, the Centre's position is to be "realistic" in the assessment of this gap by being careful not to force the transition quickly. The Greens' and Left's position is to be proactive about jumping this gap by introducing a biomass tax, banning wood-burning, and passing legislation that supports the production capabilities and cost-effectiveness of noncombustible alternatives.

5.13. Concluding Remarks on the Analysis of the Barriers

The different stakeholders offered their own puzzle pieces that, when put together, have allowed for an identifiable list of barriers. The new peat tax and price floor, whether peat producers like it or not, have been passed. These producers, whether they like it or not, must now incur the costs associated with paying these taxes. What did the research unveil as possible ways to overcome these barriers, though? Furthermore, are there any promising solutions to the embeddedness of these barriers? By presenting through the research framework the WTOs as seven distinct WTO clusters in the next chapter, solutions could lie within an institutionalist, policy-driven approach to the transition from peat-use.

6. Analysis of the WTOs

Before the WTOs are reviewed and analyzed, a new table can be implemented so as to make the linkages between the barriers and the WTOs more palatable. In a new step towards answering the research question, Table 4 consolidates each of the WTOs (A-W) into a WTO cluster (1-7). In accordance with the theoretical research framework, the Discussions section that follows this Analysis will match each WTO cluster with one or more corresponding barriers. The purpose of this is to answer the research question by offering possible suggestions on how to overcome the barriers that confront a peat transition.

WTOs	**New Consolidated WTO Clusters**
A	1. Landscape pressure
C_1, C_2, D, Q, U, V	2. Scaling niches
I, L, M, N, U, P	3. Public funding
O, G, V	4. Flexible intermediary support
F, H, J, K, R, W	5. Social support and commitment
S, T, B	6. Rapid transition (S, T) vs. Controlled transition (B)
E	7. Small Modular Reactors

Table 5: The twenty-three "A-W" WTOs from Table 3 that are consolidated into seven distinctive new themes. These themes are called 'WTO Clusters'.

6.1. Analysis of WTO 1: Landscape pressure (A)

The increased carbon allowance price under the EU ETS was unanimously cited by the informants as the driver behind the transition away from peat. Since the time that the interviews were conducted, the EU ETS carbon allowance price has increased 60% (Sheppard, 2021). While the Greens representative did not think it was the main driver, they still recognized how instrumental it is to the peat phaseout. The Left Alliance informant stated that the recent peat tax was not satisfactory from their party's standpoint, and that the price floor on peat was instituted in case the future carbon allowance price ever happens to decrease under the EU ETS.

The informants in support of a controlled transition felt that the increasing carbon allowance price was the *main* driver that is influencing the peat phase-out, and they coupled this support with the contention that the recently approved Finnish peat tax is unnecessary and does more

harm than good. Nevertheless, the macroeconomic implications behind the EU ETS can firmly posit it as a landscape development that is putting pressure on peat producers. As such, the increased price under the Scheme is considered a step towards overcoming the embeddedness of the district heating regime, which has been upheld in part by policies in support of Finland's peat industry since the 1970s. Such embeddedness is manifested through Barriers 1, 3, and 9.

6.2. Analysis of WTO 2: Scaling niches (C_1, C_2, D, Q, U, V)

The interviews unveiled a myriad of potential ways to enhance the profitability and reliability of low carbon tech. These scaling mechanisms address a plethora of the barriers that have been identified. These barriers include the present inability for alternatives to meet capacity (Barrier 2), differently sized burdens that large versus small energy companies shoulder when faced with pressure to transition (Barrier 5), the expensive cost to develop and implement new technologies (Barrier 8), and the heating technology gap that is leading Finland's district heating into increased levels of wood-burning (Barrier 12).

The representative from ET suggested two different mechanisms that could encourage the development of niche technologies: "early bird" funding incentives for incumbents to switch away from peat (C_1), and public support for smaller startups like QHeat, which is a Finnish firm who produces innovative geothermal technologies (C_2). The ET informant stated that their suggestion for early bird funding incentives is modeled off the same mechanism that incentivized incumbents to switch away from coal, which the Ministry of Economic Affairs and Employment announced in March 2020. Under this scheme, the Finnish Government will award cities and companies 30-40% of the project cost for them to switch early from coal production to renewable energy production by 2025, four years before the 2029 coal ban (TEM, 2020b). The ET informant said that a comparable scheme should be offered to peat producers, as well. The Greens informant offered an extension of this idea, which is for the government to offer the same type of percentage investment support, but for small and medium-sized municipally owned district heating companies who wish to invest in these technologies (U).

The ET and Greens informants suggested C_2, or public support for small startups. The ET representative stated that alternative technology providers for district heating should be offered public support on the basis that Finland cannot afford to risk its energy system. The two main companies in Finland – Calefa Oy, who produces heating waste recovery solutions, and QHeat, who produces geothermal technologies – are new and small, according to the ET informant.

What does "scaling" mean though, exactly? Based on the research findings, it means to make niche alternatives less expensive and more reliable (D). These are considerations that were mentioned by informants from ET, TEM, and the Greens. In order to scale geothermal plants, for instance, the ET informant suggested a straightforward development pathway: if the production demand is for 1000 MW of heat, and the geothermal plan in Espoo can only produce 40, then the first order of business is to prove the reliability of the geothermal plant to its full capacity by using reliable sources of energy technologies. These energy technologies are developed by small startups, who should be supported by public funding measures (C_2). Once a plant is developed in that sense, then the ET informant suggested that the scaling continues by buying and developing new plants – over and over, about ten times, until the 1000 MW demand can be satisfied.

The TEM representative discussed scalability in terms of heat pump technology and stated that these technologies are reliable, commercial-ready, and do not need more R&D. Rather, heat pump technologies are chiefly concerned about profitability. As the TEM Secretary indicated, now that district heating companies in Finland are increasingly beginning to consider heat pumps, the Finnish government is lowering the electricity tax rate (Q), as these pumps consume a considerable amount of electricity when producing heat. Addressing the storage concerns is part of creating the solution, too, because innovative heat storage is complementary to noncombustible heat production. The Secretary stated that when electricity production from wind turbines exceeds the demand, it can be fed into heat storage reservoirs deep underground. And, according to the TEM Secretary, heat storage is relevant to scalability because it is cheaper at storing electricity than batteries. Going back to the Left informant's comment about LUT University's P2X piloting project, I did further research and found a joint

report written by representatives from LUT University, ST1, and Wärtsilä. This report projects a scenario where Finland can go from being a net importer of fossil fuels to an exporter of carbon neutral fuels (Laaksonen, Aho, and Kortela, 2020, p. 10). Although the report's scenarios are written within the context of electrifying Finland's transportation sector and make no mention of the DH sector, the report's findings on the potentially massive impact that P2X can have on low carbon electricity generation from wind power could theoretically be applicable to DH via heat storage. These insights are reminiscent of the ET informant's comments on sector coupling, or the generation of low carbon electricity for a multitude of sectors.

Whether noncombustible alternatives can be scaled quickly enough to avoid the heating tech gap is another question, though. The TEM Secretary seems to think that Finland's district heating will fall into that gap: "In the next five years, biomass will dominate because it is too short of a time period for heat pumps to become common because of this profitability question." The informant from the Greens offered somewhat of a unique take on the scalability of heat pumps and heat storages, which was that of customer segmentation. According to their interview, the housing scale of heat pumps is "pretty much on the market already", but the industrial scale of heat pumps is still being developed because of electricity supply challenges. This did not seem to concern the Greens representative, however, who followed up their comment by stating, "we know how to produce low carbon electricity in this country." This sense of optimism once again reflects the difference of opinions expressed by the Centre informant who stated that the Centre is more realistic in their opinion of when niche alternatives will be scaled and ready.

The final suggested scaling mechanism was offered by the Greens. This scheme is for companies to pool together their resources in a research hub such as VTT, who would coordinate and pilot new technologies such as geothermal wells (V): "all the companies would pay something to support the project, and they would also get the kind of results from the pilot that would help them scale. Creating this kind of hub will help different companies share and learn from each other." This type of solution offers equitable support for noncombustible technology producers, and it resonates with the "co-construction of learning processes that

take place on multiple dimensions" within the niche-innovation level of sociotechnical transitions (Geels, 2017, p.3).

6.3. Analysis of WTO 3: Public funding (I, L, M, N, U, P)

While the interviews revealed suggestions that public funding should be leveraged towards scaling niches, the research findings also showed that some stakeholders feel that public funding should go towards helping the peat producers invest in noncombustible technologies (U). This is especially insightful for the small- and medium-sized municipalities, although the TEM Secretary indicated that peat producers across the entire industry are also demanding direct monetary compensation in order to pay off their peat-fired plants (P). The email exchange that I had with the VATT economist, however, suggested that such demands are inappropriate: "I don't see though why the government should help the companies recuperate their sunk costs, seems like an argument from the lobby groups. What is needed is that future investments will go into the non-fossil, non-wood technologies" (Appendix).

The remaining four public funding proposals that were mentioned in the interviews (I, L, M, and N) all have to do with specific amounts of money, which puts these WTOs into real terms. The CEO from Bioenergia ry, the TEM Secretary, and the Greens Party representatives mentioned the potential benefit that the Just Transition Fund (I) could bring for Finland. In the interview with Bioenergia ry, the informant mentioned that the Fund could be helpful by paying off the peat production investments and by helping to re-educate workers. However, the discussion about how to use the JTF money was still open and ambiguous at the time of the interview. The Greens representative also stated that they are unable to pinpoint exactly whether the JTF will offer direct investment support. As a heuristic, the Greens informant stated that the JTF *should* be used to help in this way. At the time of the interview with the TEM Secretary, which was November 2020, the informant also indicated that it is still unclear how, or if, the JFT would help peat producers. During the interview, they stated that the number one priority of the working group is to find a solid answer from Brussels regarding whether the JTF will offer public funding to Finnish peat producers.

In February 2021, a news article written in English by *YLE* reported on a news article written in Finnish by Kyytsönen (2021) from the *Maaseudun Tulevaisuus* newspaper that said that the Chairman of the Just Transition Fund declared that the Fund will in fact not offer public funding support for peat entrepreneurs (YLE, 2021). Because of this shortfall from the JTF, the report also states that dismayed peat producers and pro-peat stakeholders are arguing for the continuation of peat production. The Greens representative, however, offered a counterargument to this viewpoint by stating that regardless of whether the JTF proves itself to be helpful for peat entrepreneurs in the future, Finland has its own public policy mechanisms that can be used as back-up. In other words, Finland does not have to rely on EU money, according to the Greens informant, in order to follow through on a prudent transition in the district heating sector. Thus, according to this insight from the Greens, the claim that "the JTF isn't helping us, therefore we must continue peat production in Finland" is invalid. The article also purportedly mentions that new jobs may not be available for the projected 400 peat-related jobs that will be lost both in Southern and Northern Ostrobothnia as a result of the halved peat production goal. In Section 6.5, WTO cluster 5 will discuss the Left Alliance informant's proposal to mitigate this challenge by providing new jobs for peat industry workers through the afforestation of peatlands (K) and a pivot towards agriculture in order to bring soy-based food products to market (H).

The Centre Party informant indicated in their interview that the EU Recovery Fund (L) could help peat-fired power plants in their transition to low carbon alternatives. This Covid-19 relief package is set to be smaller for Finland than for other EU countries not only because Finland did not suffer from the pandemic as gravely as other countries did in Europe, but also because the Finnish Government is warry of taking on considerable amounts of debt. It has been reported that the money from the EU Recovery Fund will be used in Finland to support six different initiatives that span a variety of disciplines. Some of these disciplines include education, healthcare, and infrastructure. Another discipline is to reduce greenhouse gas emissions, too, through 2.3 billion euros of targeted investments towards energy transitions from 2021-2023 (YLE, 2020b). Whether this money will go towards a transition in the district heating fuel supply remains to be seen, but to keep consistent with the Centre Party

informant's insights and the VATT economist's suggestion, some of the money from the Fund should be allocated towards scaling non-fossil, non-wood technologies.

The Lisätalousarvio (M), or 2020 Budget Amendment, is the Ministry of Finance's allocation of funding to help with the coronavirus impact. In late October 2020, Finland's Ministry of Finance issued a press release that proposed 300 million euros for Ilmastorahasto Oy, or The Finnish Climate Fund (Ministry of Finance, 2020). Formerly known as Vake, the Fund's organizational structure has been altered in recent months, and a Board of Directors was appointed as recently as December of 2020. While the Climate Fund website states that they are primarily focused on scaling industrial projects, some of these 300 million euros should be allocated to the district heating sector. The press release is vague, however, and only mentions that the money going towards Ilmastorahasto Oy is for the purpose of "funding for projects focusing on combating climate change", as well as other efforts to encourage the digitalization of decarbonizing Finland's industrial sector (Ministry of Finance, 2020). Just as with the EU Recovery Fund, the 2020 Budget Amendment should earmark funds for scaling noncombustible solutions to the DH fuel supply.

The Centre informant also mentioned a 30-million-euro TEM grant (N) that will fund various renewable energy projects across Finland, and that this grant could help peat producers. A press release issued by the Ministry of Economic Affairs and Employment does indeed mention such a grant, and it asserts that seven renewable energy projects will be funded (TEM, 2020c). One of the projects relates to "deep heat", which can be considered geothermal, and another project relates to heat pumps. At the bottom of this press release, I found a list of contacts for further information. So, I decided to place a phone call to one of the names listed, noted as "Specialist", who turned out to be a Senior Advisor for the TEM's Department of Energy. After asking for the names and companies of these seven projects, the informant sent me an email that listed all seven of the project details. As it turns out, the funding for the heat pump project was awarded to Adven Oy for a beer malting project with Viking Malt Oy in Lahti, and the funding for the geothermal project was awarded to Helen for a geothermal heating plant in Helsinki. The remaining five projects were for biogas plants and biomethane plants for the forestry and food industries.

The Department of Energy informant also sent me a supporting document written in Finnish that describes the Helen project in more detail (TEM, 2019b). However, after using an online translation platform to translate the document, it appears as though the document was published by TEM on 20 December 2019 and does not mention a geothermal plant by Helen. Instead, the document seems to discuss a 5 MW gasification biorefinery in Helsinki from Helen, and the purpose of it is to replace coal in district heating, not peat. Given that I used translation software, I realize that this document cannot be seen as completely credible for this thesis. Regardless, as per the email that the Department of Energy informant sent me, the fact that Helen was awarded one of the projects – and not a small or medium-sized municipally owned district heating company who uses peat – proves that there is still a need for public support to scale low carbon alternatives in rural peat-burning areas.

To summarize the WTO 3 cluster, the specific monetary public support measures that were introduced by the Centre informant do not appear to be convincingly supportive for a transition away from combustible fuels in Finland's district heating sector: 1) the JTF Chairman stated that the JTF will not help peat entrepreneurs; 2) the Amending Budget will allocate funding for The Finnish Climate Fund to work on industrial transition projects, with no mention of DH; 3) there are no reports that the EU Recovery Fund will specifically target district heating; and 4) after cross-checking the TEM grant projects with the Department of Energy informant, this support scheme seems to not provide any direct assistance towards the pre-development and takeoff of alternatives to peat-use. In theory, WTO cluster 3 should address Barriers 1, 3, and 5, but the research findings suggest that there is not enough compelling evidence to support the claim that they do. Should there be a rollout of any promising public support measures in the future, they could very well indeed be used to overcome Barriers 1, 5, and 8.

6.4. Analysis of WTO 4: Flexible intermediary support (O, G, V)

Intermediaries play a vital role in transitions by linking together different entities to create some sort of agreement or shared field of understanding. The literature review discusses intermediaries in terms of niche protection (Bush et al., 2017), but only briefly and not on a

deep level. The research findings under WTO cluster 4 necessitate more discussion on intermediaries, especially following the Greens informant's commentary on the VTT research hub (V). A more comprehensive and relevant overview of intermediaries for this thesis is offered by Kivimaa et al. (2019a), who introduces a typology of five different intermediaries in sustainability transitions. These are "systemic intermediaries", "regime-based transition intermediaries", "niche intermediaries", "process intermediaries", and "user intermediaries" (Kivimaa et al., 2019a, pp. 1068-1070). Three of them are identified here in WTO 4. In terms of specific niche acceleration in Finland, Hyysalo et al. (2018) credits citizen users within internet forum intermediaries for accelerating heat pumps across Finland. While internet forums were not brought up as intermediaries in the research for this thesis, these findings are nonetheless relevant because Kivimaa et al. (2019b) states that this acceleration, which occurred from 1995-2018, has brought heat pumps to the cusp of the stabilization phase to the point where they are beginning to "destabilize the hegemony of district heating as 'the only viable option' in urban areas" (p. 119).

Insights from the Bioenergia ry informant indicate that their company's role as an advocacy is to put into action the goals of their members. Their members, according to the informant, are committed to carbon neutrality. As an advocacy for the bioenergy industry, then, it is in Bioenergia ry's best interest to facilitate cooperation between its members and the decision makers in Parliament while pursuing the eventual transition to carbon neutrality, which is a process "that still needs more biomass", according to the informant. The informant suggested also that their role is flexible because they are "only a tool to reach the goals of our members…in ten years, we will not necessarily have the same objectives as right now" (G). The transgression of the advocacy's objectives indicates that they can assist towards overcoming Barrier 10, which is the socioeconomic lock-in of jobs in the peat industry: as the bioenergy industry's goals change, so too would their business models pivot towards different products and services that would subsequently generate new job creation.

The fallout of this 'flexibility' from Bioenergia ry is a double-edged sword, however, because even though the ry may claim that they are supporting carbon neutrality in the long run, Bioenergia ry is taking their position to advocate a controlled transition that uses an increased

amount of biomass and wood-burning in the short-term. This could lead to high investments in biomass plants, as the TEM Secretary indicated, which could threaten the window of opportunity that noncombustible niches have right now to become integrated into the district heating regime. Upon this analysis, it is therefore appropriate to categorize Bioenergia ry as a "Regime-Based Transition Intermediary" from Kivimaa et al. (2019a)'s typology of five intermediaries because they are "pursuing given (sustainability) goals through typically more incremental solutions", and they are also "regarded as a player in the dominant system but pursuing or empowered for change" (p. 1069).

The VTT research hub (V) that the Greens informant proposed is a different type of intermediary support that stays true to the timely acceleration of noncombustible niches. In this case, VTT would be the intermediary, so its role would be to coordinate the development of niches in the hub. The ultimate goal of VTT as an intermediary would be to overcome Barrier 12 by closing the heating tech gap that has the potential to lead to increased wood-burning. It also has the ultimate goal of shortening the distance between the acceleration and stabilization phases for these niche technologies. I think the concept of such a hub plays beautifully to Finland's Coordinated Market Economy and the cooperative environment that companies operate within (Rose & Henderson, 2018). In line with the intermediary typology from Kivimaa et al. (2019a), a VTT research hub would be considered a "Niche Intermediary" because it "intermediates between local projects, and/or higher level of aggregation" by "pursuing given (sustainability) goals and solutions from a perspective of a given niche" (p. 1069). While the Greens informant suggested that geothermal technologies could be scaled under such a hub, Kivimaa et al. (2019) posits that it is better for Niche Intermediaries to create space for a *variety* of niches by simultaneously destabilizing existing structures within a regime (i.e., the combustible fuel supply that includes peat).

Cooperation between companies, universities, and research institutions was brought up by the Centre Party informant and the TEM Secretary (O). The Centre representative stated that connections between companies and research institutions are what lead to innovative solutions to climate change, while the TEM Secretary delineated the inherent cooperative nature of TEM working groups throughout history. Recall from the literature review that a working

group was established in the 1970s to bring about the peat industry's initial growth in Finland, known as the Working Group for Cooperation on Energy, or EYR (Ylönen & Simola, 2012, p. 167). Working groups, according to the TEM informant, are mainstream in Finnish politics: "In Finland, the culture is if some topic is very controversial, and difficult, then politicians want to set up a working group for that. Unlike in a typical working group, this group has so many different views, almost like opposite views." Today's TEM working group on peat is aiming to pivot the industry away from energy-use by flexibly weighing opposing views between entrepreneurs, producers, and environmental activists while ultimately supporting a transition. The TEM Working Group on Peat can therefore be seen as a "Systemic Intermediary" for many reasons. First, the working group "intermediates on a system level between multiple actors & interests" (Kivimaa et al., 2019, p. 1069). Second, the working group can be "regarded as a position of neutral, unbiased facilitator and broker, despite having an interest in stimulating transitions" (ibid). Third, the working group operates outside any given niche, yet the suggestions they will give for alternative uses of peat will effectively create space for niches.

Identifying the three different types of intermediaries under WTO cluster 4 sheds a new light into the chasm between the proponents of a controlled transition and the proponents of a rapid transition. The heating tech gap exists, and Regime-Based Transition Intermediaries like Bioenergia ry operate in incremental steps to fill this gap with wood-burning. Meanwhile, Niche Intermediaries like a VTT research hub operate to fill the gap with the diffusion of noncombustible niches. For Finland's DH sector to reach a low carbon future, the goals of niche-intermediation seem to be preferable to the goals of regime-based-intermediation. The key takeaway for DH from a policy standpoint, therefore, runs parallel to Kivimaa et al.'s (2019a) concluding argument: intermediary policies that support and set up Niche Intermediaries can speed up a variety of developments, and they must be pushed for with great vigilance (p. 1073).

6.5. Analysis of WTO 5: Social support and commitment (F, H, J, K, R, W)

As discussed in the literature review and in the description of the barriers, some hold a sense of opposition and skepticism for a transition. For instance, Barrier 7 pertains to the differences

of opinions between the parties when it comes to the rate of speed for the transition. The interviews offered a way that may help to overcome these barriers, however, through mechanisms that can foster social support and commitment for the transition.
The broad-based notion of commitment to the transition (F) was initially introduced as a WTO by the ET informant, who stated the idea within the context of firms responding to customer demand and pressure, "which is already increasing". An example of such firm response is energy companies and hardware stores accelerating the heat pump diffusion across Finland by selling them in retail chains, which brought the number of heat pumps in Finland from 30,000 in the early 2000s to 800,000 by 2018 (Kivimaa et al., 2020b).

The Greens representative, meanwhile, mentioned the existence of wind farms in Northern Ostrobothnia as an example of communities who can see the economic effects of having wind energy via the tax revenues that they receive (W). These benefits offer a way to overcome Barrier 11 that the Greens representative also brought up, which is pushback against alternatives such as wind on the basis of identity politics. However, such direct financial benefits are not necessarily guaranteed for smaller entities such as cottages or farms, who may be negatively affected by their close proximities to wind farms, according to the Greens informant. The Greens informant went on to suggest that the process of compensating local entities should be streamlined so that it is faster and standardized among the other municipalities in Finland. That way, the entire value chain of wind energy would be more predictable and transparent, which could hypothetically enhance more social support and commitment to the transition.

The Bioenergia ry informant discussed how local decision-making, and not managing everything from Helsinki, could offer solutions to the unique challenges that peat producers face (J). The informant expounded on this suggestion by stating, "all the decisions should be made on a local basis, rather than trying to manage everything from Helsinki. We need to listen to what kind of problems and solutions these companies see on the ground around the country. They can be different." The Bioenergia ry informant mentioned that one of these problems is how companies are not interested in re-education when faced with a peat phaseout (Barrier 6), but that a possible resolution to this could be seen within localized solutions

towards managing the fate of existing peatlands: as the Greens informant brought up how Vapo will soon face the challenge of figuring out alternative business models once peat production decreases, The Left representative suggested that Vapo could help smaller peat farmers by buying off their lands and restoring them (R). The "low hanging fruit" behind such restoration efforts, said the Left informant, is afforestation (K), which is an initiative that the Bioenergia ry representative also brought up. Planting trees in old peatlands has carbon-storing potentials, is a job with a relatively transferable skillset for peat producers, and it is a process that does not require an onerous degree of re-education, according to the Bioenergia ry representative. The Left and Bioenergia representatives did not mention how buying off peatlands and replanting trees in former peatlands would provide revenue growth for Vapo, but it can be deduced that the lumber grown on these former peatlands can be harvested and sold. In this case, such new business models as "K" and "R" can be considered long-term solutions that are made at the local level (J) in order to drive social support and commitment to the peat transition.

Another localized solution for workers in the peat industry could be to become farmers. According to the Left informant, fava beans and oats are being developed in Finland to replace meat, and there is a great potential for both the domestic use and exportation of these Finnish plant-based proteins: "so this is also connected to this whole scheme of transitioning into a more sustainable society. There are jobs, definitely there are jobs in both farming beans and oats since the demand is growing", the Left representative stated. This proposed short-term solution is applicable to WTO "H", or "re-education, new products, and new businesses".

This section included WTOs F, H, J, K, R, and W into the 4th WTO cluster. These six mechanisms are all ways to incentivize the entities who are pushing back against the transition, to no longer push back. With the exception of H and W, the research findings mostly identified pushback on behalf of the peat producers and the peat industry itself. Therefore, when it comes to facilitating social support and commitment towards a shift away from peat-use, the mechanisms under WTO cluster 4 run are constructive and worthwhile ways to "deal with the losers" of a transition (Turnheim et al., 2018, p. 157).

6.6. Analysis of WTO 6: Rapid transition versus a controlled transition (S, T, B)

All of the informants acknowledged the environmental cost to burning peat, and all of the informants acknowledged that peat is carbon-intensive and must be replaced with low carbon alternatives. The informants' insights varied, however, when they addressed the strategy to overcome the heating tech gap barrier (Barrier 12) to achieve a low carbon energy future in Finland's district heating sector. Namely, there are two main schools of thought behind the speed in which a peat transition should occur. Section 4.9, Conclusion of the Findings, discussed the difference between *position* and *interest*: ET, Bioenergia ry, and the Centre take the position of a controlled and gradual transition away from peat (B), because their interests are congruent with the vitality of the peat industry. The Greens prefer a rapid transition because their interests are sensitive to climate change concerns. This is why the Greens informant proposed the rapid scaling of noncombustible alternatives (S) and a biomass tax (T). The TEM Secretary stated that while they believe that the majority of peat-burning will be replaced with wood-burning in the near future, the eight-million cubic meters of wood that would be needed to replace the 15 TWh of peat that is currently used is bad policy.

The government wants to avoid this situation, according to the TEM informant, because it would require increased importation of wood from Russia, which is both expensive and environmentally unsustainable. The Left, meanwhile, stated that their party's concerns lie in ensuring job placement for these peat producers as their industry starts to dwindle. Furthermore, the Left informant did not speak on the specific rate that the transition should occur in terms of number of years, but they did state that the phase-out could be faster by having more precise goals and targets: as of now, the Finnish government's goal is merely to *half* peat production by 2030; yet there is no target date to totally ending its use. The barrier of ambiguity that this creates in relation to the different informants' mixed opinions on Barrier 4 can be solved with a clearer, more precise target date to *end* peat use, just as there is a firm 2029 deadline to ban coal. The Left also said that the government plan of scaling Power to X technologies, hydrogen energy, and small modular reactors in the next five to ten years could be more precise, as well.

6.7. Analysis of WTO 7: The long-term consideration of SMRs (E)

The final WTO is small modular reactors (SMRs). According to VTT Technical Research Centre of Finland, SMRs are small-scale nuclear fission reactors, not the large nuclear plants that draw controversy, and they have the potential to replace combustible fossil fuels in Finland's district heating system by 2030. They are relatively quick and easy to build, and their payback time ranges from ten to twenty years (Tulkki et al., 2017). This alternative was brought up in the interviews with ET, TEM, and the Greens as a long-term consideration to fuel district heating after ten years. The ET informant, who is pro-controlled transition, stated that "when we replace our biomass plants in 2030s, we'll get SMRs." The TEM Secretary revealed that as of now, there are laws in Finland that prevent any type of nuclear energy from gaining any traction. The legislation in Finland will therefore have to be re-written in order to create a pathway for SMR development. The informant from the Greens mentioned how VTT did an assessment of SMRs in Finland, which is the Tulkki et al. (2017) report above. In their report, VTT argues that SMRs offer not only a low carbon way of producing electricity and district heating solutions, but also a new approach to nuclear energy in Europe. In a press release, VTT discusses how conventional nuclear energy reactors pose tremendous safety considerations and legal barriers, but SMRs offer a cheaper, safer, and more efficient alternative to nuclear fission for district heating systems in Finland, which operate at 100° C. There is already intermediary support for SMR development in the form of the Finnish Ecosystem for Small Modular Reactors project (EcoSMR), which is being funded by Business Finland. Fortum and LUT University are involved in the project's piloting and research, as well (VTT, 2020).

From the interviews, the TEM Secretary offered the most insight into the viability of carbon free SMRs in Finland's district heating by explaining that it can be easily integrated into the DH networks. A change in user groups' opinions will have to change in order to support it, though, because if used in DH, these SMRs will have to be established within densely populated areas. The networks cannot be longer than ten kilometers, according to the TEM Secretary, which means that the reactors should be set up in neighboring municipalities to the capital area. The proximity of SMRs to cities is what makes it deeply controversial, but with more media coverage and government support, the TEM Secretary said that these laws and

attitudes could feasibly be reversed over time in favor of SMR development within the next decade.

On a final note, the consideration of SMRs is somewhat outside the scope of analysis for this thesis because it does not offer a solution to the heating tech gap in the immediate future (Barrier 12). However, as energy transitions occur over decades along fluctuating transition pathways, and sustainability transitions in general require a mindset of long-term thinking, it is nonetheless important to include small modular reactors in the list of WTOs due to their long-term potential to fill the heating tech gap towards a low carbon DH future.

7. Discussions

The Discussions will begin by answering the central research question. Table 5 links the WTO Clusters with corresponding Barriers to show how the Barriers can be overcome by the WTOs:

WTO Cluster	Barrier
WTO 1 – Landscape Pressure	B1, B3, B9
WTO 2 – Scaling Niches	B2, B5, B8, B12
WTO 3 – Public Funding	B1*, B5*, B8*
WTO 4 – Flexible Intermediary Support	B10, B12
WTO 5 – Social Support and Commitment	B6, B7, B11
WTO 6 – Rapid vs. Controlled Transition	B12
WTO 7 – Small Modular Reactors	B12

Table 5: The linkages between WTO clusters and Barriers that were identified in the research.
* B1, B5, and B8 have conceptual linkages, but the research did not validate these linkages.

The Barriers are reconfigured below to provide a convenient reference for Table 5 above:

Barrier	Description
B1	Technological lock-in = sunk cost
B2	Alternatives not ready to meet capacity
B3	Abundance of peat can meet capacity
B4	Peat tax hinders controlled transition b/c it forces biomass and expensive new plants
B5	Effects of peat transition are more severe for small companies than big
B6	Pushback on re-education
B7	Ideological differences/differences of opinions between parties
B8	New tech is expensive
B9	Path dependency of peat-use is fed by a centralized view of district heating
B10	Socioeconomic lock-in (jobs) behind peat industry
B11	Identity politics = pushback against wind and other alternatives
B12	Heating tech gap can lead to too much wood-burning

Table 6: Reconfiguration of Barriers from Table 2, excluding the stakeholder names.

By using the theoretical research framework, the Barrier-WTO linkages that answer the research question will be applied to lessons from the MLP literature. After reviewing the deeper meaning behind the core findings, I will offer my concluding remarks on system change outside of the theoretical framework, followed by the limitations that I confronted in this study as well as suggestions for further research on this topic.

7.1. Answering the Research Question

The barriers overlap and interconnect: The Greens informant suggested that the centralized view on district heating (B9) was historically influenced by the abundance of cheap, domestically available peat (B3). This justified the cost-effectiveness to invest in peat-burning power plants. However, in the face of a recent increased pressure to phase out peat burning, these investments are locked into a sunk-cost scenario (B1) that make it more burdensome for small municipally owned energy companies to allocate any up-front investments towards expensive niche alternatives (B8) than it is for large companies (B5). The financial implications to this burden, combined with new peat taxes (B4) has created pushback among peat producers whose jobs – at present moment – depend on the industry (B10). They are therefore opposed to the idea of pivoting their business models and reeducating themselves (B6), and, by extension, they have created an identity around this opposition to the effect that they and those who side with them do not support a low carbon transition (B11). The Centre Party, meanwhile, who represents these rural agrarian peat producers and who adhere to their opposition, are at odds with the Greens (B7), whose chief aim is to curtail Finland's carbon emissions at the peat industry's expense. To support their position, stakeholders whose interests align with the longevity of the peat industry have posited the narrative that 'because alternatives are not ready to meet the energy production demanded by Finland's district heating sector (B2), and because a heating tech gap exists (B12), Finland therefore must not invoke a rapid transition away from combustible DH fuels'. The interrelatedness of these barriers thus resonates with the 'embeddedness of sociotechnical regimes', a core tenet of the MLP framework.

The empirical findings show twenty-three possible solutions to overcome the twelve interrelated barriers. These twenty-three WTOs can be funneled into seven distinct clusters

(Table 5). One of the key takeaways from Table 5 is the mismatch between WTO 3, 'Public Funding', and the existent public funding measures in Finland (Section 6.3). This mismatch means that there is an opportunity to catalyze the transition by providing financial support to both the regime-level and the niche-level. At the regime level, the research suggests that public funding should help rural peat-fired power plants with the initial investments to switch to noncombustible technology, as well as for paying off their peat-burning technologies. At the niche-level, the research suggests that public funding should help towards scaling noncombustible niche technologies.

When it comes to reaching the 2035 carbon neutrality target date, the informants indicated that the industrial sector and transport sector seem to be of a higher priority than a peat phaseout. Triangulating these data insights validated this. However, through sector coupling (as suggested by the ET informant), the pathways towards decarbonizing these sectors may extend to DH, as well: the research findings suggested that P2X, heat storage, wind, and geothermal should be accelerated quickly to avoid the heating tech gap that would otherwise result in excessive wood-burning and heavy investments in biomass plants over the next ten years. Comparatively, based on the triangulation of interview data, heat pumps have already accelerated in earlier years than these other niches have and may be closer to stabilization than what the informants seem to believe.

WTO 6 is another key finding that answers the research question because it demonstrates that there are two leading perspectives on the peat transition: those who advocate a gradual transition, and those who advocate a rapid transition. ET, Bioenergia ry, and the Centre Party informants sided with a gradual transition, while the Greens and Left informants sided with a rapid transition. This shows, therefore, that the difference between one's *position* and one's *interest* is central to the phaseout of peat, and that bridging the gap between these competing interests may be realized by offering viable strategies to help peat producers with the impending phaseout under mechanisms that are included in WTO 5. Table 5 shows that all but one of the twelve barriers were addressed by the WTO clusters; the informants did not offer any solutions to Barrier 4, "peat tax hinders controlled transition because it forces biomass and expensive new plants". My belief is that Barrier 4 is most likely a 'slippery slope' argument

because the peat tax has already been passed, and there is no evidence that the tax has indeed subtracted from any companies' R&D budgets for a transition. Pro-rapid policymakers and their constituents should therefore keep a careful eye on those who use Barrier 4 as a way to drive the narrative that 'a gradual phaseout of peat is necessary' by reinforcing mechanisms under WTO 5 as a means to make the peat phaseout more attractive for the pro-controlled counterparts.

The last key finding to answer the research question is that the Landscape Pressure from the EU ETS emissions price has indeed put tension on the linkages that promulgate peat-burning within the DH regime. The pressure created by this ever-increasing carbon allowance price bolsters the argument that "[climate] policy stringency" under emissions trading schemes "has a positive effect on corporate efforts to reduce emissions," and that "more stringent policies may be an effective means to facilitate progress beyond a carbon paradigm" (Cadez & Czerny, 2016, p. 4141).

7.2. Applying the MLP

With the Barriers and WTOs matched, what can the MLP teach about their linkages? By following the theoretical framework and by looking at the WTO clusters, it is clearly evident that some of the clusters comprise of policies and mechanisms that are nurturing for niches (Smith & Raven, 2012), while other clusters comprise of policies and mechanisms that are disruptive to the district heating regime (Kivimaa & Kern, 2016). The nurturing clusters include Scaling Niches, Public Funding, and Flexible Intermediary Support, while the disruptive clusters include Landscape Pressure and a Rapid Transition. As Table 5 and Section 6.3 indicate, however, the public funding mechanisms that were brought up in the research (the Just Transition Fund, the EU Recovery Fund, the Amending Budget, or the TEM grant) do not seem to be aimed towards projects related to the peat phaseout nor to niche acceleration. Therefore, there is an opportunity for more precise public funding mechanisms in this direction. Furthermore, while "Flexible Intermediary Support" is a nurturing cluster, I would also make the suggestion that there should be more intermediaries that actively work towards destabilizing the combustible DH fuel supply in such a way that is more specific and targeted to the peat phaseout. An example of this could be a research hub similar to the

proposed VTT hub, but for finding innovative new uses for peat. Results from this type of research would complement WTO 5 by offering completely new business models or products that use peat, thus destabilizing the current socioeconomic embeddedness of peat energy production. Kivimaa et al. (2019a, p. 1070) also explains how "Systemic Intermediaries" can initiate destabilizing functions. These destabilizing functions can either precede or follow the niche acceleration phase, according to the source. Examples of these functions are offered by Kivimaa et al., (2019b) and include "decreasing public legitimacy for an existing regime", as well as "deconstructing existing networks, markets, and institutions" (p. 115).

Transition pathways

This thesis showed that the timing between landscape pressure and niche acceleration is important for the peat transition. In their seminal paper on MLP transition pathways, Geels & Schot (2007) discussed this topic by writing, "if landscape pressure occurs at a time when niche-innovations are not yet fully developed, the transition path will be different than when they are fully developed" (p. 405). They add that when this timing is off, the niches cannot take advantage of the windows of opportunity created by the landscape pressures, "which may subsequently close" (ibid). The research from this thesis suggests that landscape pressure is indeed putting tension on the DH regime, but the niches are not yet fully developed to take over the combustible energy supply. In other words, the heating tech gap may be filed with expensive biomass plants, which would result in an additional setback to the niche acceleration of noncombustible alternatives. Other lessons on transition pathways from Geels & Schot (2007) indicate that in the next five to ten years, noncombustible niches can either have a symbiotic relationship with the DH system, or a competitive relationship. A symbiotic relationship would mean that these niche alternatives can be integrated into the existing DH infrastructure along a marginally disrupted selection environment. Heat pumps, however, are in a competitive relationship against the DH regime by offering an entirely different way to distribute heat to urban consumers (Kivimaa et al., 2019b).

Geels & Schot (2007) identify and explain six different transition pathways: *reproduction*, *transformation*, *de-alignment and re-alignment*, *technological substitution*, *reconfiguration*, or *a sequence of transition pathways* (p. 406 – 413). The interview insights indicate that the

transition from peat currently occupies a 'transformation path'. A transformation path is characterized by an existent landscape pressure, yet underdeveloped niches that are symbiotic to the existing system. The value in understanding which of the six transition pathways DH occupies is to expose the work that is left to be done in order to deliver a low carbon DH future without peat. Such a future could be offered through elements of the "technological substitution" pathway, where niches *have* become fully developed under existent landscape pressure. A low carbon DH future could also be offered through elements of the "reconfiguration" pathway towards sector coupling, where a multitude of different niches are incrementally developed and taken upwards into the regime, thereby reconfiguring the regime into a completely "new architecture of elements and linkages" (Geels & Schot, 2007, pp. 411-413).

Although the research revealed that policy plays a keystone role as the transition plays out, it is not a 'silver bullet'. More actors must realign in order for DH to progress along the transition pathway. Transitions happen through the combination of "social movements, media, public opinion, advisory bodies, researchers, and special-interest groups" (Geels et al., 2015, p. 6). This thesis included all of these "heterogeneous configurations with co-evolving elements" (ibid) except 'social movements'. Nevertheless, lessons on transition pathways, systemic intermediary functions, and *timing* show that district heating in Finland is indeed in a crucial position to quickly leverage intermediary and public support in order to scale the alternatives so as to not miss the window of opportunity that they are in. The VTT hub proposed by the Greens is a promising mechanism to capitalize on this window of opportunity. It is also similar to a policy instrument suggested by Kivimaa & Kern (2016), which is a way to catalyze improvements in price-performance for innovations: "subsidies enabling learning-by-doing; R&D support (cost reductions through learning)" (p. 7).

'Dealing with the losers'

The rural areas must not be neglected in pursuit of carbon neutrality goals, but it is not a sure bet to expect peat producers to run towards cultivating fava beans and oats, as the Left Alliance informant suggested. This uncertainty is due to pushback against the idea of pivoting so late in their careers. However, with enough incentivization, and following the release of the

TEM working group's suggestions in the spring of 2021, whatever alternative employment options are offered should be substantial. The Finnish Government should therefore consider a proactive and preemptive allocation of their own funding to help *rural* peat producers pay off their investments, which the Afry report stated was 210 million euros (Afry, 2020). Now that the carbon allowance price under the EU ETS is around €37 per ton – a 60% increase since November 2020, according to Financial Times (Sheppard, 2021) – this increasing Landscape Pressure means that the need for rural support is greater now than ever. A substantial portion of the 2.3 billion euros from the EU Recovery Fund should be directed towards scaling geothermal plants or offering low-interest loans to companies such as Calefa and QHeat to ensure that they can make a greater impact on district heating. The ability to provide fair jobs to peat production workers is a necessary challenge that must be overcome in the journey of phasing out peat, too. This suggestion capitulates to the notion that there is a benefit to 'dealing with the losers in a transition' (Turnheim et al., 2018). Otherwise, the peat transition will face excessive pushback and delay to the extent that the window of opportunity for noncombustible niches will be shortchanged for a strategy towards increased biomass and wood-burning.

Lessons from coal

The story of Finland's coal phaseout offers some lessons for the peat phaseout, too. 'Creative destruction' policies in Finland's coal saga are exemplified by the 2029 ban, as well as early-bird funding incentives for coal plants to transition by 2025. This policy mix is more stringent than the 2030 halved production of peat target date. In an assessment of the path dependencies of coal within Helsinki's district heating network, Vadén et al. (2019) explains that carbon emissions from biomass are higher than that of coal, in terms of "per produced energy unit" (p. 2). From this consideration, the authors suggest that reliance on biomass in the long term may not be prudent. Perhaps coal is treated more harshly because there is more international pressure on phasing out coal, even though the global warming potential of peat is higher than that of coal. Either way, "the current availability and pricing of heat sources" are what make biomass the "most likely replacement" for coal, according to Vadén et al. (2019). If nothing is to be done to quickly scale alternatives, it may be the most likely replacement for peat, too.

Predictions and Looking Forward

The barriers present the greatest obstacles in two of the four growth stages of niche development: *take-off* and *acceleration*. In the next five years, district heating can either rely on increased biomass and wood-burning, or noncombustible technologies can be scaled and diffused into the regime. Interview results indicated that there are three possibilities for this progression:

I. Present – 5 years → biomass → **within** the sociotechnical combustible DH regime
II. Present – 5 to 10 years → niches (geothermal, heat pumps, wind, etc.) → either **symbiotic relationship** or **competitive relationship** with the combustible DH regime.
III. 10+ years → radical niche (SMRs) → **can replace fossil fuels** in the DH regime.

Regardless of what will be the predominant fuel source(s) of DH by 2030, the research did not give any indication that the DH infrastructure will be significantly hybridized with combustibles and noncombustible technologies until the issue regarding scaling is addressed. This means that Finland's district heating sector will most likely operate biofuel niches that fit and conform *within* the selection environment for a combustible, centralized sociotechnical DH regime until price performance improvements and production capacity upgrades from noncombustible niches can facilitate a "stretch and transform" pathway towards reconfiguring the DH regime (Smith & Raven, 2012, p. 1030). Furthermore, incumbent peat producers will not go out quietly. Their pushback will only be softened when their concerns are met. With so much heavy interest in the biomass industry, and due to the seeming lack of current public support funds that should be targeted to abate the peat transition, my prediction is that biofuel will increase in the near future, although I do not think it is wise to build new biomass plants with long payback periods. A biomass tax and wood-burning ban could be introduced, as the Greens and Left informants advocated, but it does not seem likely.

As this thesis showed, the majority of the barriers and possible solutions on overcoming said barriers were indeed reflected in the MLP literature that was reviewed, and insights from the informants have been pinpointed to these broader themes. From a social sciences perspective, the empirical findings revealed that the interview subjects on both sides of the peat debate firmly believe that a phaseout of peat energy is inevitable, with the exception of the VATT

economist – whether it is true remains to be seen, the VATT economist warns. Climate change and the macroeconomic implications behind the EU ETS carbon emissions allowance price can be conceptualized as the exogenous landscape developments that are putting pressure on the district heating regime. The fate of noncombustible diffusion, therefore, seems more likely to be affected by these external landscape pressures that work to destabilize the regime rather than "persistent internal problems" within the regime (Geels, 2017, p. 2). The key niche-regime interactions are chiefly facilitated by intermediary functions and government policy measures, though targeted public support must be enhanced. This thesis also showed that the crux of the peat discourse nowadays is not to debate whether peat should be phased out, but instead *to come up with ways to rapidly scale low-carbon niche technologies in the district heating regime*. "Scaling" the niches means making them cheaper and more reliable than combustible sources. To address this, the interview informants introduced a number of creative policy mixes and intermediary functions such as R&D hubs that have the goal of supporting the pre-development, take-off, acceleration, and stabilization of noncombustible, low-carbon niche alternatives to peat energy.

7.3. Concluding Remarks

This thesis included insights from reports written in Finnish, such as the Alfry consultancy report, the Sitra report, the supporting document from the TEM Department of Energy informant, and the peat production model from the VATT economist. Just as Finland was the first country to impose a carbon tax in 1990, Finland is still to this day a leader in sustainability transitions for the rest of the world. However, these insights must be accessible to the international community: while the Bioenergia ry informant and the ET informant stated that low carbon electricity systems have already been realized in Finland, such is not the case for other countries. This study can serve as a liaison between insights on the domestic peat discourse and insights on the peat discourse as communicated in the media.

In other countries, the phasing out of domestic, carbon-intensive fuels is also a hotly contested debate. In the United States, coal is public enemy number one: in 2019, 15,000 MW of electricity from coal-fired power plants were shut down or converted to alternative sources, and in 2015, nearly 20,000 MW were shut down (DiSavino, 2020). Following global trends,

the increased availability of cheap solar PV and wind energy can account for this transition, but natural gas can also claim responsibility for the shift. In a country that does not have a carbon tax, the US's abundance of natural gas and the rise of fracking has not only led to a decrease in coal-use, but it has also resulted in a decrease in energy-related CO_2 emissions, as well (IEA, 2020a). In Germany, meanwhile, a coal and nuclear energy phaseout is well underway. Although nuclear energy is not considered a domestic natural resource in Germany insofar as it is not a stock resource, nuclear power plants in Germany are nonetheless on the downswing. This offers an interesting comparison to Finland's long-term solutions for SMRs and for sector coupling that were brought up in the interviews. China, however, continues to heavily invest in coal and is responsible for nearly half of its global production (IEA, 2020b). While global trends show a decrease in coal investments since 2017, China has increased its investments in coal from 47 billion USD in 2017 to 59 billion USD in 2019 (IEA, 2020b). The Greens representative mentioned the topic of China's sizeable levels of carbon emissions. In the interview, they stated that the True Finns Party in Finland is "pointing the finger" to China, saying that they feel that Finland should be more worried about encouraging China to take the appropriate steps towards carbon neutrality than themselves. While this argument is gaining traction among right-wing populists like the True Finns, I would disagree with these right-wing sentiments on the basis that Finland can be leaders in setting a proper example for energy transitions.

On the steps of the Helsinki Cathedral in 2018, climate change activist Greta Thunberg proclaimed to a crowd of people below, "the climate crisis has already been solved. We already have the facts and the solutions. All we have to do is wake up and change" (Thunberg, 2018). So, too, exist the solutions to the combustible DH fuel supply. The existence of noncombustible alternatives means that they are not inherently radical. They are not third generation energy technologies. They exist, but they are not scaled for diffusion. As the literature review stated, we have known since 2015 that the price of alternative fuels is the primary factor behind whether managers select replacement fuels for peat (Karhunen et al., 2015). What makes these technologies "radical", then, is the implication behind scaling their price-performance and for decentralizing the way that energy is produced and transmitted. We just need to wake up and do it.

The Sitra report on peat recommended in June 2020 that the reduction of carbon emissions from a peat phaseout must be accompanied by social support for it (Laita, 2020). Citizens vote to elect the decision-makers who have the power and influence to scale these technologies, right? Specific to grassroots organizations who confront hegemonic regimes, Schot et al. (2016) argues that consumer activists in social movements play the role of "user-citizens". The proper next step for the peat phaseout from this perspective, then, is not so much "further research in the field" as it is sparking a co-created social movement that aims to promote a greater sense of urgency and demand from decision-makers to reconfigure the energy system. The degree of populist urgency specifically towards a peat phaseout remains unclear to me, and future research can address this, but Finnish Deep Ecologist Pentti Linkola promoted similar demands a generation ago. To him, radical change fixes human-caused environmental problems, but the research for this thesis did not show that there are demands on the same level as Linkola's.

The absence of radical environmental groups may be a good thing. Geels et al. (2015) critiques radical change and the revolutionary outlook on sustainable consumption and production by citing its abstractions and failures to offer pathways to new socioeconomic systems. The authors instead promote reconfiguration strategies through sociotechnical transformation as a more impactful way to "offer the promise of substantial sustainability gains", because these strategies "do not necessarily presume the abandonment of capitalism, economic growth or the embrace of frugality" (Geels et al., 2015, p. 6). However, in terms of sustainable energy systems, when discussing social movements to spark a transition with the Greens representative, the informant stated that there is indeed a lack of direct pressure and outrage from social groups in Finland and that such pressure would probably catalyze a comprehensive district heating transition.

When I attended a climate protest on New Year's Day 2021 in front of The Parliament House in Helsinki, less than ten people were there (Image 1). Perhaps this was due to the pandemic. However, amidst a pandemic, tens of thousands of people nonetheless showed up to the Black Lives Matter protests in the US demanding change during the summer of 2020. As a result of these protests, government officials swiftly responded by initializing several omnibus bills and

policy measures to assuage race relations in the US. Although improving race relations in the US and in the rest of the world is an ongoing challenge, I believe that the issue linkages between the fight against climate change and environmental injustice – and whether similar themes from the MLP could be reconditioned towards assessing and dismantling systemic racism – would be an interesting further study. As the Greens informant stated, however, until the day comes when the effects of climate change are drastically being felt in Finland, users' complacency in a combustible DH fuel supply may prolong. In the absence of such demands from the bottom up, the most promising option therefore is that of regime reconfiguration through sociotechnical change.

Image 1: New Year's Day 2021 fossil fuel protest in Helsinki. (Source: original)

7.4. Limitations

One of the limitations to this study is that I discovered many helpful publications during the interviews. These publications could have been used in the literature review and in the process of constructing my interview questions. Another limitation was that, as a non-Finnish speaker, it became evident that many of these publications were only written in Finnish. Thus, for the same aforementioned reasons, it would have been difficult for me to find these documents when writing the literature review, given that I only searched for publications written in English. Furthermore, the validity of the data would have been strengthened had I interviewed more stakeholders. To make the research more credible, I also could have interviewed both a wider variety and a greater number of informants. Another limitation is the time it took for me to analyze the data and draw conclusions after I gathered the data. However, this three-month separation allowed me to include the JTF Chairman's announcement that the Just Transition Fund will not help peat entrepreneurs, as well as to include the 60% increase in the carbon allowance price under the EU ETS from November 2020 – February 2021.

7.5. Further research

If noncombustible niches stabilize into the DH energy supply by 2025, it would be interesting to see how this reconfiguration will influence the landscape in such a way that affects SMRs. This topic was brought up by the Greens and TEM working group informants, who said that more policy legwork must be done in order to allow for the development of SMRs. For now, it is too controversial and there is too much resistance to it. Looking at Finland's climate fight outside the scope of this thesis, I fully acknowledge that Finland faces far greater emissions problems in the chemical manufacturing, industrial, and transportation sectors than in the combustible energy supply to district heating. Practically speaking, then, it would seem logical for people who are interested in this topic to look at 'sector coupling' for further research opportunities. An outlook on what these solutions would provide for transitions in these industries would certainly be enlightening, as many of the sociotechnical regime elements are existent in these sectors, such as nurturing policies, the science that is associated with piloting and early take-off stages, and, of course, the technology to make it happen. Using case studies as a qualitative method may shed light on reoccurring patterns in future studies, as well.

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9. Appendix

9.1. Coding Analysis

Barriers are indicated with numbers, and WTOs are indicated with letters.

1) Finnish Energy (ET)

Quotation	Barrier vs. WTO	Insight
1. There's a graph on the use of energy peat, and there's a reductions of use by minus 62% [from 2018 until 2030]. And this is conservative. More is happening. We know that some of our energy companies haven't published yet their 2030 target. We know that there are plenty of more energy companies who will reduce 2. So we know that this emission rating system is going up to 50 or even higher. We already know peat is already losing cost competitiveness in the fuel market, so when it does go up to 50, it's not wise to use peat anymore in heating. 3. **EU ETS is the main driver to go carbon neutral**. 4. Energy system is already heading to a low carbon future.	A	Peat is already being phased out.
1. That the strategy is pretty much the same in every company. So it is true that they are increasing their use of biomass, but in the meantime they are trying to use other techniques, other non-combustible techniques, meaning geothermal, ambient heat, and heat pumps. And excess heat is from the industrial or data centers. There's plenty of cooling which the data centers need 2. Our companies can reduce peat, but it goes directly into the biomass fuel chips. but if you will see this climate issue, there are some limitations to how much you can increase the use of biomass. So we are saying to the politicians or decision makers, please don't push us to biomass because there's a limitation. And if you force us to invest in biomass, those plants cost several million euros. And then it will take us 10 years to pay it back. **So, we ask decision makers "don't take peat away at this moment, because we are heading to the biomass." We want to hit to geothermal or heat pumps. But we are asking that they give us time invest in these new technologies.** This is kind of our mission right now that we are asking time that we can build this new energy system, build this new district heating system 3. But coal and peat must be replaced in ten years, and we don't want to replace it with biomass. The problem in the increased use of biomass is that we don't have that amount of biomass in Finland- That is the problem, we will have to import it from Russia. We have biomass, but it's in the wrong place. The eastern part. Consumption is on the coastal sides.	B	Energy companies' strategy is to decrease peat by increasing biomass, while trying non-combustible techniques (Geothermal, ambient heat, heat pumps, excess heat from industrial or data centers).
1. In some CHP plants, you have to use peat because there's a sulfur emission and you need peat in the combustion process. So that's why companies cannot get fully rid of peat. There is a kind of a technical lower limit for peat. 3 or 4000 gigawatt hours is kind of the technical limit that we have to use with the existing boilers. We have to use at least that much peat. So, this is kind of a fundamental issue. 2. If you have invested 100 million euros something in 10 years ago, you need 20 years more to pay it back. Some are quite big investments. That's the main reason that we need some time to make this transition happen.	1	Technological lock-in. Sunk cost = time needed to transition
1. Technical limits also for geothermal. 2. When this project started, they promised or said that it would produce 40 megawatts heat. And I understood that at this moment, it's something like 20 or 30 megawatt. So it's lower than what they promised. 3. I hope they're collecting experience to figure out how to make it work. 4. I'm hoping that we'll know in two years whether geothermal is viable. I'm hoping that we'll get that information very soon.	2	Geothermal not ready
1. If you think about using heat pump, then you're pretty dependent on the electricity system. So what if you don't have enough electricity? How do you heat your city or municipality? That kind of thing you have to solve because your customers are always waiting for a warm building. At this moment, if you make heat combustible, it's easier.	3	Supply security of combustible district heating system.

2. But if you're using heat pump, you may need some reserves. These kinds of things are what energy company companies are at this moment solving		Heat pumps need reserves to meet capacity
1. We prefer mechanisms which are already taking place in the market. Public money is not that good idea for now. 2. We have a coal ban by 2030, and early bird companies will get some kind of funding if they change from coal to something else. The deadline is 2025. If you move up before then, you get some kind of funding for that investment.	C_1	Mechanisms to encourage established companies
1. But if you have to deliver heat with 1000 megawatts. And this geothermal in Espoo is 40 megawatts. So those scales. Maybe you try it first one geothermal generation plant first, and replace your combustion with that. And if it works, you buy the next one and then you do that maybe 10 times or something like that. And you have to find those places for those geothermal plants. Because if you take this city area, there is no free space a lot. So you have to find a right place to place those kind of things. And so that kind of scaling you need. It's step by step scaling that you have to scale those new technologies from step by step. And at first, you have to prove those technologies. So at this moment, we don't have any proven technology…this geothermal, it hasn't yet been proven. They haven't proven that. So that's why our energy companies need reliable sources of energy technologies. 2. **But also there are plenty of kind of startup companies**, and they have to prove something. Because if you think this from the energy company side, it's not wise to deal with a company who is too small. If a startup is too small and something goes wrong, there should be some kind of support with this kind of technology providers can handle these risks. We can't afford to risk our energy system, so that's why the new tech providers will get some type of public support. 3. Calefa is reliable because they're old (they have experience). And Q Heat. They're newer and smaller. Their problem I'm afraid though is that they can't carry that risk. If you can find these types of companies outside of Finland, it might be beneficial to Finnish society because we already know their thoughts. If you can find for example from Denmark, it might be helpful for your thesis and provide something more. I hope our energy companies have several options of where to pick their technology providers. At the moment, we only have these two which is quite a small number.	D ← C_2	Scaling startups
1. If some companies like Oulu Energy who use peat a lot by 2 euros, [the government peat tax] means several million euros [owed by] that company. In our logic, if you don't have those millions of euros because of the taxation, you can't invest those millions in the new clean technology. So we're against the raise of taxes. 2. [The EU ETS] is already causing extra cost to the peat. It's already losing cost competitiveness. 3. If you raise tax and it's effective next year, you can't do anything to avoid it, at least in the next year. You can't make a change to your combustion plant in that short of period of time. Maybe if you need the taxation, do it later, but not yet. The government also decided to create a roadmap for taxation. And that's a good idea. We support that. We know that at least we need 10 years to get the new technologies on board. But if we don't have that time, the companies will head to the woodchip biomass. And the environmental associations agree that it's not the wise way of doing things. Give us time, and we'll try to get to those new technologies in use so that we won't need that much biomass.	4	Gov. peat tax backfire?
1. Maybe someday but at this moment our companies and tech providers SMR (small modular reactors), and those are expected to help the situation in the 2030s. When we replace our biomass plants in 2030s, we'll get SMRs. But there are plenty of issues with SMRs too, that it's not ok to put it in Helsinki area.	E	Nuclear in the long term
1. At least following three things have to be solved: Energy companies need cost-competitive, proven technology from the reliable tech providers. **If we want to make this happen fast, customers should be committed into the transition. The pressure from the customer side is already increasing, which is good.** 2. Peat phaseout is already happening based on strategies of energy companies. At this moment, I think that the most relevant question is, how we get **new techs reliable** and **proven**. And tech isn't only thing. We need to develop tech providers reliability. For example, geothermal is risky, one-time show for the energy company. Tech provider gain all the benefits and can scale it to the other customers. That's why we need to improve support for the start-ups etc.	F	1) Cost-competitive tech (**D**) 2) reliable tech (**D**) 3) support for tech provider companies (**F**)
1. Industrial emissions and sector integrations are the next big issues		Sector coupling

2) Bioenergia ry

Quotation	Barrier vs. WTO	Insight
1. Energy peat, in particular, is in a very strong transition right now. 2. And there is now a consensus that there is a transition ongoing. 3. In our vision, we don't mention peat at all. But the starting point of our strategy is that the use of energy peat in Finland will drastically decrease already in the next few years. We have estimated that it will be half by 2025. 4. It's partly understood in the energy industry that energy peat will be phased away. It's only a matter of time. The time can be different in different companies. But if you look at the overall use, it's really going to be significantly decreased in the in the next decade. So the Finnish current government has a program where they want to cut it to half by 2030. But we believe that this is a sensible targets. It's very realistic, because in practice, the consumption of peat is decreasing a lot more rapidly than it's targeted in the Government Programme.		Peat is transitioning
1. **And the vision is that we would like to promote as an association an environment where Finland has the best preconditions for development of sustainable or even carbon negative biomass based products.** So that's the kind of vision. And in the strategy, we understood that this vision is quite far from the present situation. So, we need steps. We need a transition. And therefore, we have some targets for 2025 in the strategy. 2. And **in this transition, we emphasize that the transition needs to be controlled. And we believe that in the transition we still need more biomass because we are simultaneously leaving energy peat and hard coal.** And that's altogether quite a significant amount. And we need to replace that with mostly renewable energy, and biomass has a role there. 3. It's more like a survival game for these companies. So if you do everything very quickly, they might go bankrupt, and lose the company. And the people would need to find something totally new. If you do a slower process, they might develop another business besides the extraction and survive as companies. 4. Coming back to **our strategy, and this controlled transition, we would like to make this transition in a way where we maintain energy security in Finland, and that is one reason why it is possibly not smart to decrease the use of peat overnight, and maybe to have a planned and controlled process.** We would like to have time for the companies to adapt.	B	Step by step, controlled transition
1. The question is only how we do this transition. There are people in Finland who say that we should immediately increase the tax very, very significantly. And that would imply an uncontrolled, from our point of view, an uncontrolled process. So that would be an abrupt change to the local companies. And what we would like to see is a controlled transition.	4	Taxes = uncontrolled, abrupt transition
1. The amounts [of peat that companies use] are quite significant. Peat is still, altogether, some 14 to 15 terawatt hours in Finland. And if you cut it to half, then you need to find like seven or eight terawatt hours of alternative energy. And obviously, what these energy companies around the country are doing, they're trying to find all possible new sources like heat pumps, solar, and in particular waste heat. They're looking for all these kinds of sources to maximize. But they are not enough in most places, and they will also need biomass.	3	Peat is heavily used, but biomass is necessary during the transition because heat pumps, solar, and waste heat is not enough.
1. With waste heat, you don't have good sources everywhere. For example, Mikkeli is a fairly service based city, if you look at the overall economy in that city, they don't have big factories, or heavy industry which would have significant wasted sources. So they need to find something else. And, and even if you have a wasted source, then it can be in the wrong place. It can be uneconomical to connect to the current network.	2	Technical barriers between current network and alternatives in "wrong place"
1. Most of these technologies are quite new, we don't have too much proven technologies. We don't have much experience on [geothermal] yet.	2	Geothermal not developed enough
1. But on the other hand, I mean, we are serving our membership in the association. We are only a tool to reach the goals of our members. And if we have a role in that exercise, then we are a part of part of the process, and we also then need to adapt to the new situation. In 10 years, we [Bioenergia ry] don't necessarily have the same objectives as right now.	G	The ry is a flexible intermediary to energy companies' sustainability goals

1. Vapo is our member, the largest peat producer in Finland. But we also have smaller companies that are peat producers. Of course, their interests are a bit different than of those local energy companies. So what we also do is formulate the position on new legislation, we need to find a common message around for all these companies that we represent	5	Varied interests between small/medium companies and large companies
1. Many of these companies have invested in peat extraction equipment, some of them quite recently. And the payback time of such an investment is maybe 20 years. So they will need to write down quite a lot of these investments in a very quick process. And that's very difficult to find an economic case for that.	1	Prior investments in peat extraction.
1. But that's basically what they are trying to do now: make more from less. **And try to make new products and businesses.** And if that's not possible, they need to re-educate themselves. But that's obviously not a preferred choice for these companies, that's quite clear.	H	New products, businesses, and re-education
1. And from the Just Transition Fund, Finland will receive a lot of be of money for this Just Transition. But the discussion is still very open about how we are going to use this money. And this is exactly a question in that process: should people re-educated, how, and what exactly we should do with this money. That's an ongoing process right now. But what is very clear is that these peat-producing companies, what they would like to see is that the state would somehow participate in these write downs that they have to make. Because they have made these investments which are sometimes very significant. And they kind of use the investments for the whole lifetime. So there is a write down of the value of the equipment. **2.** It needs a lot of local discussions around the country. And that is our position towards this Just Transition Fund. **We have been saying that all the decisions should be made on a local basis, rather than trying to manage everything from Helsinki. We need to listen to what kind of problems and solutions these companies see on the ground around the country. They can be different.**	← I ← J	EU Just Transition Fund pay for sunk costs? Localized decision making
1. We have also been discussing with the companies and it seems that they are not so interested in re-education in the companies. Which is a slight problem.	6	Companies don't want re-education
1. You would rather see a carbon sink than a carbon source. You would either need to restorat the area or create an afforestation area or maybe a wetland. But this is part of the process as well, when you transition away from peat. I see this as a significant climate problem in Finland because only a small portion of peatlands in Finland are use for peat production. A larger problem is what do you do with all the dry peatlands in Finland, not just the production areas. This is one of the key issues in the land use sector.	K	Post-transition afforestation
1. With peat reductions, though, we are ahead of the curb. **What we haven't been discussing yet is the significance of European emissions trading. The main reason for this development, why we are seeing this decrease in the use of peat** and the announcement by Vapo the day before yesterday (you can see the announcement in Helsinki Sanomat), that **because of this increased price of emissions allowance**. So you can argue that you don't need to manage this at all, that the EU has already done this. The energy tax for peat is a much smaller driver than the initial EU emission trading scheme. **2. If you increase the tax, you increase the burden for the use of peat.** 3. All these companies that are producing peat are in big problems. Problems because they already have those investments that they made. And they know now that they need to get rid of peat. And you can make those transitions harder or more simple. **And if you increase the tax it makes it harder.** 4. Green party sees the taxation as an important tool to increase the incentives for getting rid of peat. But our message to them is that this is excessive at the moment, we don't need that, peat is going down anyway ahead of the curve and that this is making life difficult for the peat companies.	A ← 4 ← 4	EU ETS more effective than tax
1. Ideological differences between the parties. There are parties that would not have increased the tax.	7	Ideological dif. b/w parties

3) The Centre Party

Quotations	Barrier vs. WTO	Insight
1. They understand the developing emission trade system and how it cost more and more. They have done good research and good scenario work and really know that it will cut in half to 2025.	A	EU ETS a driver for 2025 half
1. New tax amount and it's also really bad news for them. So it has been quite a lot of bad news for them already.	4	New tax bad?
1. Our party is a realistic party. And they know it's really difficult. We know we should invest in new plants like immediately, but it would take billions of government money. It will be so that we will burn wood. So then it will be so that we will import wood from Russia because it's cheap but it's not climate friendly. It's a total disaster for climate.	12	Expensive, new biomass plant investments a "necessary evil"
1. I think we will use the financing methods from the EU Recovery Fund to help these peat power plant companies. still we have a problem, as I said, with where we will get enough eco-trademarked wood 2. We trust this EU recovery fund and that this kind of funding will solve a bit of this problem.	L	EU Recovery Fund help peat plants
1. And in the long term how we will cope with this problem because the Greens and other parties are not so realistic, they think that solar systems, wind, and all kinds of energy systems can be made really quick. But that's not so. And with heat pumps, and heat waste energy and things like that is really far away for real production. And we don't have many years left.	2 & 7	Ideological dif. between parties / differences of opinion between parties
1. Heat pumps and excess heat as a fuel source can be supported by "Lisätalousarvio". In English it's the Corona extra money that we have put in recovering the country.	M	"Lisätalousarvio" "Corona extra money" Amending Budget
1. Over 30 million euro to these kind of renewable energy companies.	N	TEM grant to 7 renewable energy projects
1. We have studied ecosystem work with the companies, universities and research institutions, that they make ecosystems and they get themes that they will investigate and they will research together. And that we gave money as well. And, of course, we discussed with these kinds of companies and universities and, and research institutes, as well. So there's lots of different kinds of connections to these companies and to research acts.	O	Multi-actor research intermediaries sponsored by the government

4) TEM Working Group on Peat

Quotation	Barrier vs. WTO	Insight
1. The trend of peat use is quite clear already. I mean, it's decreasing all the time.		Peat is decreasing
1. **The EU ETS. So that's the main driver for it.** So in that respect, it's not so much in the current government's hands anymore. I mean, of course, of course, now maybe you are aware that the government just decided to almost double the taxation on peat. It sounds very dramatic. But not in the big picture compared to the EU ETS system	A	EU ETS the main driver, not government tax
1. So typically, in Finland, the culture is if some topic is very controversial, and difficult, then politicians want to set up a working group for that. 2. Unlike in a typical Working Group, this group has so many different views, almost like opposite views. Because what when one side is these entrepreneurs or producers, and then there's some environmental people.	O	Re: intermediaries from transitions lit. "Strategic planning".
1. Environmental people like from natural preservation organizations. So, they would like to phase it out immediately. Or even ban it.		NGOs a relevant voice: pressure.
1. Current peat use is 15 TWh, most of it owed to DH. To replace that with wood would require 8 million cubic meters, which is not very sustainable from nature's point of view. And it could even lead to increased imports of wood to Finland. That's not good policy. And the government is trying to avoid that. I think most of it, especially in the	12	Replacing peat with wood is bad. Gov. is trying to avoid that. But

near future will be replaced with wood, but the government is trying to subsidize heat pumps, geothermal heat, heat from sea water, maybe even from the air. The government is also lowering the electricity tax for large heat pumps that produce district heating.		wood will replace peat in near future. **But alt. tech subsidies are the key**
1. These producers are now demanding direct monetary compensation for what they owe on peat fired plants. And that's very controversial. It could be realized. The government could decide, "okay, we're trying to do this," and then inform the EU and ask if it's okay. But that's ultimately up to the politicians. And, and I'm not sure if that will ever happen, but nobody knows.	P	Peat producers demand direct monetary compensation for what they owe on peat-fired plants
1. But then the EU has this JTF, which is an abbreviation for Just Transition Fund. And that is meant for any projects that advance sustainable development, for example, something like a transition to a more carbon neutral society, something like that. So from that fund, it would be possible for those entrepreneurs to get some subsidies for retraining, new education, for example. But they don't seem to be very happy with that because many of those entrepreneurs are already maybe at their 50s. 2. This question [regarding whether JFT funds extend to producers of alternative technologies] has been asked at least a few times now of the Commission, and they still haven't provided any clear answer to how, in practice, the funds can be used as investments advancing carbon neutrality. They haven't given any examples of technologies that it would fund, such as heat pumps. We must be persistent to get a clear answer from the EU. 3. Number 1 next priority for this TEM peat working group is to get answers from the EU Commission regarding the JTF fund. How it can be really used. What kind of investments really quality because we still haven't gotten the answers we need.	I	EU Just Transition Fund to help projects that advance sustainable development, but peat producers unhappy about re-education **Unclear whether JFT helps alt tech producers**
1. In the medium-term near future (5-10 years), heat pumps can fulfil the energy capacity demands in Finland's DH sector by way in which they utilize waste heat streams. If there's a factory near any district heating network. Like, for example, pulp mill or something. They always produce waste heat streams, but at lower temperatures. But the heat pump technology has become so much better in the last decade. So even if the waste heat steams are 10 degrees Celsius, it can be utilized. It's pretty profitable already. And that's what the **government is trying to advance with their plan of decreasing the electricity tax for large heat pumps** 2. I don't think the heat pump technology needs so much research anymore. It's pretty commercial. The only problem now is **profitability**. I think almost all district heating companies in Finland are at least considering heat pumps. It's very good for their public image, for them to use waste heat streams.	Q D	Heat pumps can use waste heat streams (like from pulp mills) in 5-10 years.
1. Money is what determines whether DH companies switch to wood or heat pumps that use waste heat. **So, the government is decreasing the electricity tax because heat pumps consume a lot of electricity when they produce heat.**	D&Q	Decreased elect tax helps acceleration
1. On the district heating side, it's possible to use for example, **renewable wind power as an electricity source, and then use heat pumps. And then at times when the production exceeds the demand, then heat storage is also come to the picture. They already exist, and they're so much cheaper than batteries at storing electricity.**	D	Dif. techs can collaborate to offer low carbon solutions. "Sector coupling" (ET)?
1. In the next five years, biomass will dominate if we're talking about the next five years because that's too short a time period for heat pumps to get super common because of this profitability question.	12	Biomass will dominate in the next 5 years.
1. Also, district heating companies are so different. Those big companies have more capital to fund new projects. They have more resources for that. Vantaa energy is phasing out peat and investing in heat storage underground. 2. Small companies and towns might struggle to find money for those new projects, even if they looked profitable on paper. **The initial investment can be very problematic for some companies**. And also the companies differ/vary a lot in not even using peat a lot, and some companies may rely on peat in some municipalities by 80%. 3. Afry report estimated that small peat producers have 210 million euros invested in peatlands and machinery and other assets. Thus, if peat was phased out in five years, it would mean that small peat producers should get direct compensation for this, according to the report.	5	Small companies have a greater burden when faced with transitioning. They don't have enough money for up-front investments.
1. Nuclear Power. SMR. Not a short term solution but maybe after the next decade it can be a real solution for the district heating sector. it's controversial so it's not viable in	E	SMRs Long term (+10 years)

the short term. Will require massive changes in the current legislation. Will require changes to people's attitudes, too. If it's used for district heating production, the distance can't be super long. 10 km. It should be quite near even densely populated areas. And many people oppose that. In Finland they have policies against nuclear, so to make it viable, the time constraint inherent to changing the legislation is the biggest barrier there. Some kind of overhaul of legislation is already underway, but it's not a quick process. The changes in law are being considered, and the media has reported on it.		
1. They don't seem to be very happy with that because many of those entrepreneurs are already maybe at their 50s. And they also feel like they want to be entrepreneurs, but **they don't really see so many opportunities in re-education.** Maybe they're just not so enthusiastic about it. I mean, some are, some are not enthusiastic about it, but at the same time**, they still think that their life will be ruined if they don't get any direct compensation for the current investments in peatlands and machinery**	6	Greater preference towards direct compensation than reeducation or pivoting their biz.

5) The Left Alliance

Quotation	Barrier vs. WTO	Insight
1. It's a good analogy to talk about the coal burn law. I think it was 2017. After that everybody started diverting away from coal because it was clear that "this is going to end at this year, so investment was diverted away from it." So it's harder to approximate what is the similar diversion effect on the peat, now that the decision is that "Yeah, we are halving it, we're moving away from it, but there's no clear date for phase out." Although already after these peat decisions from this autumn I think Vantaa decided to get rid of peat completely because the general direction is moving away from it.		Diversion effect: Halved 2030 peat goal not as impactful as 2029 coal ban
1. The deal on peat is written in the form that it's going to be reviewed and checked, whether it functions or not, this mechanism of raising the taxes and the floor price. It's a compromise. It's less than what the Left Alliance and what the Greens would want to do.	7	Dif. of opinion... Left: 'halved by 2030' AND peat tax not enough
1. It's not good regional policy to take away peat production from the areas whose livelihoods depend on it. But, all things considered, it's a small enough industry that makes the action of phasing out peat the most cost effective way to reduce Finland's GHG emissions. For the Left, we take the social effects of the policy into account.	10	
1. **[Replanting trees]** is an obvious suggestion, in my opinion, because these people who are involved in the industry obviously know how these soils work. Their money has been in digging up peat. But with very little **further education or further training**, or maybe even zero of that, they could know how to restore them into carbon sinks again. That's a very low hanging fruit.	K H	Low-hanging fruit: labor force can switch to forestry. Peat production workers can replant trees in peatlands once peat is phased out
1. Finnish plant-based proteins in the grocery store, but there is a big potential of both domestic use and exports in that. For example, making these plant based proteins out of oats; that's been a success. And some kind of beans (fava beans??) they're developing them to replace meat. could be, but they're making like, they're developing these further to, like, replace meat products. **So this is also connected to this whole scheme of transitioning into a more sustainable society: there are jobs, definitely there are jobs in both in farming beans or oat since the demand is growing.**	H	Labor force can switch to agriculture: fava bean farming for food production from plant-based proteins.
1. The most obvious risk when phasing out peat is that we add the burning of other biomass. And here, it also means burning wood. And in the worst case, it means burning wood that you could use for building houses. Let's say you could use the wood way better. So and that's the big risk if there is a sudden phase out of peat without a separate law that says that you can't burn wood to replace for it, then that's exactly what's going to happen.		Left doesn't want wood burning because wood could be used better, such as building houses
1. Renewables in the sense of both solar and wind, then, like in some time horizon, let's say maybe five or 10 years, it's also these power to X technologies that they're developing, especially in the University of Laaparanta. University of Technology there. They're doing hydrogen energy. And then there are these small nuclear reactors.		The plan to scale renewables is not precise

I don't know if you've heard about those. The **plan, obviously, could be more precise.** 2. I'm not worried about the [renewable] energy palette itself. **It just might be a lot more expensive than what we've been using at the moment.** And **who has to pay the pay the cost for the lost investments?** Those are the actual questions.	8&1	
1. I think the simplest example [of renewing the business structures of energy companies who use peat] is to talk about the restorations of the soils or the peat sites again. Maybe that's like the first step. So with Vapo, even though the state itself is making money out of peat industry at the moment, we have the same problem as these private small peat people, as well. And the first step, I really think, is that Vapo , the state, buys off these lands of the smaller peat farmers, and then restores them. That's one possible business model, But it is so that if you're making your money out of digging up peat and then selling it for heating, that's over	R	New business models for big peat companies is to buy peatlands from small companies
1. This is a Left wing party, so obviously, any policy that this party is suggesting has taken the social effects of the policy into account. So it's easier to manage this amount of people, it's easier to, for example, to promise all of them that they will have free education to transfer to another profession. It's even easier to give them a livelihood for a couple of years from now, when they've lost their job. 2. Either you have to replant trees and have something on top of it, or then you need to refill it with water so that the emissions stay in. **So that's an obvious suggestion, in my opinion**, **because these people who are involved in the industry obviously know how these soils work.** 3. **This is connected to further regional politics**, that it's very important to keep universities in all corners of this country…if you want to create real possibilities for people to keep living in those places, if you take their livelihood away, of course, you have to have these schools or universities or vocational schools or institutions to get training for new things. **So it is connected to a bigger cities vs. countryside division and what to do with it.**	J	Providing a firm stepping stone for peat producers' next step after phaseout means being attentive to local solutions and offering opportunities that are specific to the regions and accessible to people living in rural areas
1. Yeah, but how to prevent going through the wood burning phase. That's the big question.... heat pumps. I wish to see them in a way bigger role in the future.	S	Wood burning means gradual, which isn't good

6) The Greens

Quotation	Barrier vs. WTO	Insight
1. We've had policies supporting peat, its competitiveness, taxation has been low, peat has been considered ever since 70s a good secure way of producing heat as a domestic source of energy. And we've had a kind of strong **path dependency also lock-in** to peat so far. So all the incentives besides EU ETS Trading Scheme have been quite pro peat. So make sense that it's been used, and of course, well, regarding ETS, and everything else, it's also kind of a symptom of not having a high enough carbon rise in general. 2. I think [the investments in expensive peat technologies] is an example of the path dependence. But I think sunken costs don't really justify continued bad policies	1	Policies and cheap price create path dependency for peat lock-in
1. The whole idea that we have about district heating based heating sector is one thing, it also it means that you have bigger heating and combined heat and power plants, you kind of need a big, source of fuel compared to if you would have some kind of other more distributed system, I'm not saying that it would be better, but the centralized view on district heating has been feeding into this kind of path dependency	9	Technological path dependency: Secure fuel, centralized DH feeds its path dependency. B3→B9→B1
1. **Socio economic lock in** becomes apparent when you have a significant amount of local economy that's connected to peat production. So it's, its source of employment. And also natural for a part of livelihood for farmers and machinery small businesses and so on. So there's also this kind of social economic path dependency on this type of activity being around.	10	Socio economic path dependency: jobs
1. Now we need to **innovate quickly** and switch from peat to something else. Instead of a gradual change, you have bigger steps.	S	Bigger steps > gradual change

2. The gradual shift is that the oldest least economically profitable facility shuts down first and so on, so this is what is supposed to happen.		
1. 2030 halved peat goal is a good goal. There are solid arguments for that, I think it's been that the ETS price itself hasn't given a clear enough signal for the phasing out of peat. And it gives enough time to adapt. But I think not all have understood that it's also quite a rapid schedule. And we also need policy instruments, to make sure that that stuff coming to replace it is sustainable. So I think it's a good schedule. But the schedule itself doesn't kind of make sure that that the transition is moving well.		ETS and 2030 goal gives time to adapt. Both are necessary, but not sufficient: more policy needed
1. I think we need a lot of the noncombustible based sources of heat, like heat pumps, thermal energy, especially like deeper thermal energy. **Storages, waste heat from data centers, perhaps even electric boilers, small nuclear, whatever, a lot of these have the challenge that they need to be scaled. So we probably also need like public instruments to encourage and speed up the scaling of these technologies.** So that that's, that's one thing I think we have in place the tax and economic incentives are okay. But then **we need to boost the replacing forms of energy a bit faster.**	D	Policy instruments help scale low carbon alternatives
1. And also, the problem here is biomass. So I think **we would need a need to have a tax for burning biomass energy.** The details of that need to be planned carefully. But in general, that's too easy of a way of kind of just replacing peat with biomass. That path is too easy at the moment that we don't want to see heavy investments on biomass burning. We need to phase out that as well, on some schedule. So in that sense, I think the overall the taxation the ETS, and now if we have a floor price are okay**, so no more actions on peat I don't think. But can we make sure that replacing form of energy is sustainable, so we need some policy instruments there.**	T	Reliance on biomass a problem, therefore, **institute disruptive policy instruments like a biomass tax.**
1. Not necessarily renewable, but low carbon. Those need to be that you need to be sure that those are scaled up. And here we come to a problem where you also have to not just look at the kind of economic theory point of view of the market, but also what kind of market actors there are. **So a lot of the a lot of the power companies are actually Small and Medium municipally owned companies, and these same municipalities are not doing that well economically. They have a heavy burden of high costs.** 1. If we just put these taxes and the incentive for [small and medium municipally owned companies] to do something, **we probably also need to support them in scaling up the alternatives, especially when we know that these are early market technologies on this scale**. So there are risks involved. We would need to have policies that make sure that these smaller, medium municipally-owned power operators, peat providers, can actually scale off these alternatives.	5 ← C_2	Differing resources between differing market actors (small vs. medium)
1. **Direct investment supports**. Let's say you invest in heat storage, then we could make a list of technologies that will need national public support. So then we say, ok if you invest in a heat storage, you pay 80% and we pay 20% or whatever. I just pulled these out of my hat. So it could be 50/50 or whatever. This stuff is okay. **And I think the EU Just Transition Fund also enables this.** 2. **Then I think we could also pool resources. So, we have actors like VTT, the technological Research Center. It could be used as kind of like a hub**. Where we give 10 million in funding. (But I'm just making these figures up so don't get stuck on them). So I'd say that VTT would coordinate a project where they would take all the interested **heating companies, small and medium ones**, and then you would see what would be the best pilot site for let's say, I didn't know, some new technology or something like a geothermal well. And then you would say, okay let's put it here somewhere, and then all the companies would pay something to support the project, and they would also get the kind of the results from the pilot that would help them scale. So creating this kind of **hub** for helping getting the different companies to share and learn from each other. 3. Supporting schemes and supporting the transition is of course part of it, not just leaving them by themselves like, okay, right, too bad for you guys. But also, like, have this policy instrument, but that supports the transition.	← U ← I ← V	1) Direct investments, 2) EU JTF, 3) pooling resources in research hubs: …these are ex. of public policies/ mechanisms that can help small companies scale low carbon alternatives
1. I have to say that I'm not completely sure of this either. I thought it would be possible. There are of course some limitations from the EU regarding public support of companies operating on free markets. But, what from my point of view, I'm saying **that's what the JTF *should* do**…	I	Possibility of JTF help

1. But we have different instruments, we have our own budget, which we can use, then we have different funds already, like national funds that we can use, then we have JTF now. And then of course, we have the Green recovery package, the bigger EFF coming out now and so on. So I'm not completely sure if the details of which what are the specific legal restrictions regarding each of these, but the main idea is that there is that there are instruments of public funding that can be used, that's for sure.		Finland should help itself not wait around for EU.
1. TEM and maybe there's a regional authority through the JTF [that would be the kind of group that will see to the execution and distribution of the funds]. But again, these are specifics that I could check, but I do feel that those are the guys and that's the institution responsible, but it might also be that it goes through some regional funds or funding, but basically that stuff is under them.		TEM and regional authorities allocate funds from JTF to small municipalities
1. We have **small and medium** peat producer businesses. And of course, they will **run out of** that source of **income**, that sorts of business **when the peat production goes down**. 2. And then we have **Vapo**, which is the state owned corporation, that is responsible for a large share of peat production, and even some power plants in this country. And those guys don't become meaningless, **but they need to find a new direction** of what to do when there's not so much of a demand for peat anymore	5	Practical (natural?) monopoly of centralized DH (as opposed to distributed)
1. But looking at success stories esp. in Northern Ostrobosnia, the municipalities economically benefit from having wind energy. They get tax revenues out of that. That can be a local mechanism, not necessarily being community owned, but the local communities feeling like they can be compensated. Some of the issues now are whether it benefits a smaller local perspective…if you're farm or cottage was close by, if you get compensated for the damage you get from its proximity. For Finland, we need to streamline the processes so that it's faster, so that the process would be the same in each of the municipalities.	W	Wind energy can generate tax revenues for local municipalities
1. Wind power has problems with identity politics. IF you don't agree in climate change, if you're right wing, then wind mills become a symbol of what oppose and you make illogical reasons against it when you just weren't with it from the start. 2. With the identity politics dynamics, even if you have something beneficial like wind mills, people become dubious of it because it's part of a transition you're skeptical about. But there are interesting parts for instance with biogas. People from rural areas want to invest in biogas, and they don't seem to have this opposition. It's seen as an alternative to electric cars, and for some reason electric cars are bad and something to be dubious about. So a complex field of trends and attitudes.	11	Wind power issue with identity politics
1. You could argue that just by having the taxation and regulation in place that makes peat burning (fossil burning, biomass burning) less economically sound, and that creates the pressure for these companies to find new sources of heat and then they go to new sources of waste heat. So **I'm not convinced that you need a fundamental change in the current institutional setting for district heating**.		DH system doesn't need to be revamped
1. As far as district heating, they have kind of practical monopoly anyway. Of course, they have to compete with others maybe if the heat they provide is expensive, then it gives more incentives for people to heat their homes, and kind of separate themselves from the district heating. So that's the competition they're facing: centralized. versus distributed. So it would be hard for these companies to be replaced by someone new entirely. Their product is heating service, heat and power. 2. But still, the monopoly is already broken down in the sense that opening up district heating is a good idea. But there are risks in this. District heating is somewhat of a natural monopoly in the sense that we the infrastructure in place in an efficient way in terms of scalability. And it works on the level of economies of scale. But if you work to break up that scale, on a system level, it's not optimal. So it may not be a good idea to break this setting where you have economies of scale. But I do think that opening up district heating for a more market-based approach is just fine. 3. What I mean is that **there's a technical reason for us to have a central district heating in many places. It's a very efficient way of distributing heat.** 4. If you start opening it up to make it more lucrative for waste heat providers and more distributed systems to emerge is a good thing, (and I don't know what the right answer here is), but you have to realize that there is a balance to where **you can't incentivize energy solutions that are sub-optimal on a system level**. They can be optimal on a smaller scale, but not from a system perspective. So the system perspective has to also be kept in mind when designing policies regarding district heating.	9	Technical reason for centralizing DH: it's efficient. Distributed systems are viable on the smaller scale, not viable on a systems level (large municipalities).

5. The point is that **a centralized system doesn't necessarily mean that a low carbon distribution wouldn't happen. It's happening already. Whether it's happening fast enough is another question.**		
1. That we do have a **heating technology gap that will be fueled too much with wood burning if we don't have proactive policy instruments that make sure that noncombustible low carbon alternatives will be used to replace peat.** It's been brought up more and more in the last year or two, but this perspective needs to be emphasized more. Just by taxing peat itself is the right thing to do, but just doing that will not lead to the outcomes we're looking for. **And we have to make sure that we then fill up with support policies that scale the other alternatives fast enough.** Researcher: So instead of going from peat, to biofuel, to low carbon alternatives, it needs to go directly from peat to low carbon alternatives. Greens: Exactly. Researcher: And the way to do that is with **careful policy making.** Greens: Yea and **proactively emphasizing that the alternatives exist and are scalable**. And that you need R&D and piloting and demonstration and scaling instruments and funding and that type of stuff. So that would be what I would have to say. And also probably looking at the **taxes of biomass burning.**	12	**Heating technology gap**: Be careful about biofuel! Cannot switch fully to it. Proactive policies are the way to overcome the heating tech gap
1. Technologies exist, but **scaling them up on the level of being able to provide all this heat is the question.** But heat pumps, heat storages (which they also need electricity to work)…on different scales. The industrial scale and the house scale. But the house scale is pretty much on the market already. Then thermal heat. We have a very deep hole in Espoo now, and a not so deep thermal things like Q Heat (Q Power?). Then we have waste heat, like from data centers. Industrial level waste heat. Then synthetic fuels (power to X). Probably not a good way to produce baseload of heating, but good for the peak hours. Then electric boilers. Direct electric heating, that's an alternative as well. Then **nuclear Small Modular Reactors**, just for heating. VTT looking at this. But there are several technologies available, but regarding heating pumps and stuff, it comes to the question of where the electricity comes from. But that's not a problem, we know how to produce low carbon electricity in this country.	D E	(List of low carbon alternative technologies)
1. I strongly suggest you look at an article looking at the path dependency regarding the district heating in Helisnki, and getting rid of coal. It's a very short research article, but it touches on the same themes. I think it would be useful for you. I'll email you the link. https://www.sciencedirect.com/science/article/abs/pii/S2214629619303007		Coal in Helsinki DH a useful case study to compare to

9.2. Interview questions

9.2.1. Email questionnaire

My questions to the VATT economist:

1. In my interviews over the past two weeks, representatives from ET and the Bioenergy Association have told me that the recent doubled peat tax for the 2021 state budget is counter-productive to peat producers' efforts in phasing out their peat fuel operations. Their premise is that peat producers are *already* motivated to phase out their peat fuel-use – and are already doing so by switching to wood chips – due to the ever-increasing EU ETS carbon tax, and that this new increased tax by the Finnish government only eats into funds that they would otherwise use to develop and implement alternative fuel sources for district heating beyond wood chips (i.e., technologies that don't require combustion such as heat pumps, geothermal, or heat from electricity). However, a representative from the Centre Party who I also spoke with said that the Finnish government's peat tax isn't that expensive for peat producers (only a few cents on the dollar), albeit certainly not preferred. **Which is true? Or, do you have a different perspective on it entirely? Generally speaking, what comments do you have on next year's increased peat tax, and what effects will it have on the peat energy industry moving forward in their journey to adopt low carbon alternatives?**

2. The crux of my thesis is to find ways to overcome the barriers that stand in the way of replacing peat fuel in Finland's district heating sector. I've learned so far that it is indeed already being phased out and being replaced with biofuels (woodchips), but that the long-term goal is to use geothermal, heat pumps, and to generate heat using

electricity (as I mentioned above). However, the peat companies aren't happy with the urge to *immediately* switch because they have recently spent millions of dollars on peat technologies. Instead, they want the switch to be more gradual. My questions on this matter are, **what innovative policy mixes can the Finnish government introduce in order to recuperate the sunk cost investments that the peat production plants have already made? I.e., can they write a check to pay off the outstanding balances on peat plants to these companies? Or, can the EU Just Transition Fund write such a check? Alternatively, can the EU Transition Fund subsidize any type of (mobility) policies for entrepreneurial Finnish geothermal technology startup companies/heat pump companies in order to make their innovations cost effective and thus attractive for district heating? Are there any other innovative policy mixes out there in general that can catalyze the transition away from peat in Finland's district heating?**

Email answers from the VATT economist:

1. "The claim that peat producers are *already* motivated to phase out their peat fuel-use does not seem true in light of scenario modelling from 2019 (Koljonen et al. Valmisteverotuksen kehittäminen Suomessa…). You should ask Tiina Koljonen (VTT) about their more recent modelling regarding this issue. I think the tax increase sends the correct signal – that investment in peat technology is now longer a wise choice. The aim of the policy is not to have plants stop producing peat tomorrow, but to steer investments so that there will be no new plants, and once the plants now in operation reach the end of their lifecycle, they will be replaced by something else.
2. For this question you could ask a representative from SYKE – their group has been thinking about the policy options, and they could probably also point you towards some of their research output and policy reports on the topic. I don't see though why the government should help the companies recuperate their sunk costs, seems like an argument from the lobby groups. What is needed is that future investments will go into the non-fossil, non-wood technologies. I am not very familiar with the EU Just Transition Fund but sounds like it can be used for this type of transition as well – but I don't have any further information than what has been discussed in the media."

9.2.2. Informal Interview Questions:

A. Tuesday 17.11.2020 – Energiateollisuus (ET). *Energy Production Expert*. Areas of expertise: Climate policy, emission trading system (EU ETS); former ET Biomass Analyst

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. To start out, could you please tell me about yourself, what your role is with ET, how long you have worked there, and what is the mission of ET?
2. What relation and/or level of experience do you have with peat as a source of fuel for district heating?
3. Why is peat used in district heating in Finland?
4. What is peat good for? What is bad about peat?
5. What forces, or drivers, keep peat as a fuel source for district heating in Finland?
6. In September, the state budget for 2021 included a doubled tax increase on peat energy. From a climate policy and emissions trading perspective, what is your reaction to this and how does this tax increase affect your job duties at ET?
7. In your opinion, are there any low-carbon fuel alternatives to peat available for the district heating sector in Finland?
8. To carry the same thought from the previous question, what are some new technologies that can be used in district heating which would circumvent the use of peat energy altogether?
9. Should peat be replaced by these new technologies and low-carbon alternatives? Why or why not?
10. What would be the negative effects of replacing peat, in your opinion?
11. Based on your knowledge and experience, what are the key challenges that stand in the way of implementing more low-carbon fuel alternatives to peat in Finland?
12. Why do these barriers exist, and are there ways to overcome them?
13. What are the forces or drivers that would encourage new technologies to replace peat?
14. Who are the big energy companies that use peat, and what do you think are their chief concerns regarding switching away from peat?
    a. Are you familiar with Vatajankosken Sähkö's district heating switch from peat to the use of excess heat from nearby factories? If so, could this be a viable in more cities across Finland? Why or why not?
15. Finland has one of the highest per capita rates of energy use in Europe. How can Finland restructure its energy mix in such a way that would decrease this high rate of per capita energy use?

16. Candidly speaking, what do you think is the future of peat energy use in Finland? Is the study that I'm conducting a worthwhile investigation, or are you confident to say that peat energy will be phased out within the next five to ten years?

B. Wednesday 18.11.2020 from 9:30 - 10:30 – Bioenergia ry (The Bioenergy Association). *CEO*

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. To start out, could you please tell me about yourself, how long you have worked at The Bioenergy Association, what your key interests are as CEO, and what is the mission of the association?
2. What relation and/or level of experience do you have with peat as a source of fuel for district heating?
3. Why is peat used in district heating in Finland?
4. What is peat as a fuel source good for? What is bad about peat?
5. What forces, or drivers, keep peat as a fuel source for district heating in Finland?
6. In September, the state budget for 2021 included a doubled tax increase on peat energy, and the EU ETS carbon tax is ever-increasing per CO2 ton of carbon. From a climate your perspective, what is your reaction to this and how does these increased financial costs affect The Bioenergy Association?
7. In your opinion, are there any low-carbon fuel alternatives to peat available for the district heating sector in Finland, or is it not really in the best interest of the Association to explore these?
8. To carry the same thought from the previous question, what are some new technologies that can be used in district heating which would circumvent the use of peat energy altogether? Or, again, is this something not on your radar?
9. Should peat be replaced by these new technologies and low-carbon alternatives? Why or why not?
10. What would be the biggest negative effects of replacing peat as a fuel source, in your opinion?
11. Based on your knowledge and experience, what are the key challenges that stand in the way of implementing more low-carbon fuel alternatives to peat in Finland?
12. Why do these barriers exist, and are there ways to overcome them?
13. What are the forces or drivers that would encourage new technologies to replace peat, and would the Bioenergy sector benefit from these in any way?
14. Who are the big energy companies that use peat, and what do you think are their chief concerns regarding switching away from peat?
    a. Are you familiar with Vatajankosken Sähkö's district heating switch from peat to the use of excess heat from nearby factories? If so, could this be a viable in more cities across Finland? Why or why not?
15. Finland has one of the highest per capita rates of energy use in Europe. How can Finland restructure its energy mix in such a way that would decrease this high rate of per capita energy use while also ensuring that the Bioenergy sector is well off?
16. Candidly speaking, what do you think is the future of peat energy use in Finland? Is the study that I'm conducting a worthwhile investigation, or would you say that peat energy will be phased out within the next five to ten years?

C. Monday 23.11.2020 from 14:30 - 15:00 – The Centre Party. *Finnish Parliament Member*, and *former Minister of Science and Culture from August 2019-August 2020*

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. Could we begin by discussing your role in Parliament and how it relates to energy policy for peat as a source of fuel for Finland's district heating sector, as well as how your role as former Minister of Science and Culture was involved in peat policy as a district heating fuel source?
2. When it comes to the peat energy industry, which interest groups or stakeholders does the Centre Party have in mind the most, and what measures are the Party taking to safeguard these interests and advocate for these groups?
3. From what I have read, there are differing target dates for carbon neutrality between the Centre Party and the Greens. From your standpoint, what accounts for this difference, and specific to the peat phase out:
    a. Do you think peat will be phased out in the first place?
    b. If so, is there also a differing timeline between the Centre and Greens for it to happen?
4. In September, a doubled peat tax was passed for the 2021 tax budget. What is your opinion on this?
    a. The reason I ask is because I spoke with representatives from both the Biofuel Association, as well as ET, who stated that the recent tax increase is, in fact, counterproductive. Given the existing EU ETS tax

increases on carbon, an additional peat tax taxes money away from companies who could otherwise put those millions of euros towards innovating and switching from peat. What are your thoughts on this – does the Centre Party agree or disagree with this sentiment and the increased peat tax, and why?

5. A lot of this sustainability transition literature I'm reading talks about the 'lock-in' of widely used energy systems such as Finland's district heating sector. It seems that the biggest lock-in for the case of peat energy in Finland is the millions and millions of euros of sunk investment costs that have already been spent on peat-fired power plants. Costs that are still being paid off today and well into the future. Considering that peat will eventually be phased out, what role should the Finnish government play in helping break these lock-ins? In other words, would it be as simple as the government paying companies what they owe outstanding balances on these peat power plants so that they can focus on innovating towards new fuel sources? Why or why not?
6. **KEY** On the note of innovation and alternative fuel sources, what innovative policies, if any, (such as deployment subsidies, R&D funding schemes, training schemes, re-education programs for peat producers) are being formulated and supported by the Centre Party to incentivize private actors (firms, consumers) to transition towards alternative fuels after peat becomes eventually phased out?
7. What would you say is a good or promising alternative energy source or new technology that Finland can switch to in its district heating sector, and what are the biggest barriers from your point of view that stand in the way of them becoming more widely used now and into the future?
8. What are the most prominent political struggles between the big peat fuel producers and the newcomer alternative fuel sources that offer low-carbon energy options for Finland's district heating sector? Is there any active resistance to a peat transition held by the Centre Party?
9. Do you know of any new entrants who are lobbying for public support, such as low-interest lows? If so, who are these entities, what types of public support are they asking for, and how does the Centre Party deal with them?
10. Who would you say has the most power and agency when it comes to implementing alternative fuel sources in Finland's district heating sector? What needs must be met from the Centre Party's point of view for there to be a higher degree of multi-party and multi-actor collaboration and cooperation in the quest to find alternative low-carbon fuel sources in Finland's district heating sector?
11. Have there been any changes in technology in the district heating sector that have affected or facilitated policy change from the Center Party's perspective?
12. Are there any policies that the Centre Party stands by that destabilizes peat as a fuel source for district heating? Examples of which include control policies such as the EU ETS, as well as reducing support for the peat industry by removing subsidies.
13. Does the Centre Party believe in reorienting big peat producers to new alternative fuel markets? If so, what policy measures or government actions can facilitate this reorientation?

D. Monday 23.11.2020 from 15:15 - 16:15 – The TEM Working Group on Peat. *Secretary*

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. What is the mission of the TEM peat working group and what role do you play for this working group?
2. Is the TEM working group an intermediary between incumbent firms, new entrants, and government bodies
3. You mentioned over email that 'cannot comment on any measures to *mitigate* problems the group is going to propose', but can you comment on what the group *is* going to propose? Or, in other words, what work has the group done so far since the April 9th press release of the group's existence, and what key insights have you all come up with so far?
4. How, or in what ways and end-uses, can Finland transition energy peat to more valuable uses of peat?
5. How can energy security demands be met and maintained in Finland's district heating sector once peat energy becomes phased-out?
6. What alternative low-carbon fuel sources can fulfill the energy capacity demands in Finland's district heating sector, and what steps must be taken to ensure that district heating can rub effectively and efficiently by using alternative fuel sources or new types of technologies?
7. Is there any discussion in your group about any types of re-education programs for the big peat energy producers or any other type of reorientation towards new markets or fuel sources of the existing incumbent big peat energy producers?
8. What types of jobs will peat production workers be able to work in once peat is phased out? Can they be retrained to work in renewable energy?

9. From the press release in April, I read that there are quite many organizations being represented in this working group? What are some of the main concerns that these organizations are bringing to your attention, and how is the group managing these concerns or sentiments?
10. How has covid effected the working group and the work that you must do?
11. Between now and the end of the working group on 31 March 2021, what priorities do you and the group have? From your point of view, what are the things of the upmost importance that must be addressed and solved between now and then?
12. DONE. There was a background survey conducted to assess the trend of energy peat to 2030 and 2040. What findings or interesting insights did the survey present?
13. Since the group began its work, the peat tax was doubled as of September of this year. What are your thoughts on this and how does this effect the future of peat fuel?
14. The crux of my research is on finding ways to overcome the barriers that stand in the way of implementing alternative low carbon fuel sources in Finland's district heating sector. In your opinion, what are these barriers, and what new technologies or fuel sources look the most promising for replacing peat?
15. Sunk costs of peat fired power plants. How to pay that sunk cost so that these companies can focus on transitioning away from peat?

E. Friday 27.11.2020 – 13:30-14:15 – The Left Alliance. *Policy Advisor*

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. Sanna Marin announced a goal to cut peat energy use in half by 2030, and between the Centre Party and other parties, there seems to be many differing timelines and gradual phaseout plans between the differing parties. What is the Left's timeline on phasing out peat energy? Is it the same as Marin's?
    a. The paper mentioned 196 million euros of tax subsidies in 2020. What's the timeline on the gradual removal of these subsidies by 2030? Does it start in 2030 or end in 2030? When does the removal of subsidies start? What are all the policy mechanisms available that will complement and assist in this gradual removal of subsidies and the peat energy industry in general?
    b. What is the relationship between a gradual removal of peat subsidies by 2030 and a gradual phaseout of peat altogether? In other words, are there any other factors that contribute to the phaseout of peat altogether besides removing subsidies?
2. The Left Alliance's Just Transition Paper states that ending the energy use of peat is one of the most cost-effective ways to reduce Finland-s greenhouse gas emissions. Why, or how, is it cost-effective to do this?
3. The paper also mentioned that the peat energy industry contributes to 4300 jobs, both directly and indirectly. What would a re-education program look like, and how would it ensure that these 4300 people working in the peat energy industry will be able to find new jobs? Do such programs already exist, or is the Left helping to create some
4. The Paper mentions the Spanish coal mines as a model for the transition. What are the greatest challenges in getting the government and trade unions to cooperate successfully in running down peat operations?
5. Do you think it is feasible for the government to help producers in the transition by buying the peat production areas? What about paying off the outstanding balances that these producers owe on their production technologies? Could the Just Transition Fund pay for these?
    a. How exactly can the Just Transition Funds be applied?
6. Which non-burning technologies should peat be replaced with? What barriers stand in the way of their implementation?
7. What type of support should the government give to energy companies in updating plants, and what are the names of these energy companies that should get support?
8. What type of resources should be given to renew the business structures of energy companies who use peat? What does a renewed business structure even look like? And does this mean renewal of organizational structure, or strategy, or both?
9. The paper mentions that Vapo is gradually transforming their business model towards renewable alternatives to peat. What are these alternatives, and what is motivating Vapo to turn to these? Can the same motivating factors be applied to other peat producers? Why or why not?
10. The public sector work project for giving afforestation work to people unemployed for 12 months is interesting, and it reminds me of Roosevelt's New Deal that helped get the US out of the Great Depression. Is this initiative gaining any traction among other parties in Parliament, or is the Left the only ones pushing for it? How can this become a reality?

F. 30.11.2020. The Green League (Greens). *Finnish Parliament Member*

**Begin by providing context for this interview, who I am and what the research is about. Confirm that I have permission to record the interview for my research.*

1. Why is peat energy still being used in Finland's district heating sector?
2. What is your opinion on Sanna Marin's 2019 Government Programme to half peat energy use by 2030?
3. What are your thoughts on the recently announced doubled peat tax for the 2021 state budget? Is it appropriate, too ambitious, or not ambitious enough?
4. How can there be more urgency among the people to shorten this timeline? Are people outraged?
5. Will it require the same type of protests that we have seen in the US this year with the Black Lives Matter movement?
6. A lot of proponents of peat energy say that it will be difficult to give up peat quickly because so many production facilities have recently invested in expensive peat technologies that they are still paying for. What is your reaction to this, and how can this problem be solved?
7. Taxing peat energy and removing the subsidies that help the peat industry have gotten a lot of headlines recently. But what about policies to help the emerging low carbon technologies that will take the place of peat fuel in district heating? Technologies such as heat pumps, geothermal, wind...what policies do the Greens advocate, and what challenges is your party facing in getting them on the agenda? Can the Just Transition Fund help? How are the Greens communicating with this Fund to help these renewable energy producers?
8. Cleantech sector and the integration of peat producers with this new market. Is the government doing anything to facilitate peat producers efforts to get involved with cleantech or any other of the alternative fuel sources for Finland's district heating?
9. Community wind power projects. I've read that in Finland, wind energy is more likely to be socially acceptable if it's community owned. But project developers have too much control, and local communities don't have enough decision-making. And that the project developers don't sufficiently communicate who in the local communities will benefit from monetary compensation for the projects. Can the government help this problem in any way, or is this not really on the radar for the Greens?
10. I want to read for you an excerpt from a study published by the Smart Energy Transition. The recovery of excess heat, distributed energy solutions and demand response automation require the integration of energy users and buildings into the district heating system. The current natural monopoly model of the district heating companies that manage both the production assets and distribution networks, is not supportive for handling multi-directional markets or attracting energy users to participate. There is a need for a a system integrator who can run the district heating and cooling networks as a virtual power plant and establish attractive partnership models for clean heating and flexibility producers.
11. What does it mean to integrate energy users and buildings into the district heating system, and can the government do this? Are there any policies that are currently working towards breaking up the natural monopoly that district heating companies have in managing both the production assets and distribution networks?

Post interview notes: Article about path dependencies of coal in Helsinki district heating (Vadén et al., 2019): Greens informant will sent it. Offers a good model on some of the same themes as my thesis, according to the informant.