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Finland's energy system for 2030 as envisaged by expert stakeholders

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ABSTRACT

To reach the 2030 decarbonization targets, EU Member States develop national strategies. We examine the views of key stakeholders in Finland to outline how those responsible for developing, steering and implementing the energy system assess the various solutions. The Finnish choices are of interest owing to the mixture of assets, constraints and path-dependencies shaping them. Our Q methodological analysis uncovers three main views: international competition and smart solutions; active consumers; national competitiveness and local solutions alongside a consensus upon which the implementation of Finland's own 2030 strategy can be built. The key stakeholders in Finland are ready for solutions comprehensively shaping the energy system, which can also influence several vested interests, existing business models and eventually break existing path-dependencies.

1. Introduction

The Member States of the European Union (EU) have agreed on several energy strategy targets for 2030, including a 27% increase in energy efficiency, a 27% share for renewables and a 40% reduction in greenhouse gas emissions. To help reach these targets on the Union level, the Member States prepare their own national plans for the European Commission [1]. The Member States also commit to such planning and monitoring processes coordinated by the Commission in preparation for the Energy Union [2].

The targets for 2030 represent a step towards a more resource effective and decarbonized energy system, implying not only a technological transition but also profound economic and social transformations [3]. This means that many stakeholders with established interests in the economy and society will be affected. Since it is realistic to expect that the transition will be more successful if it serves these interests, the way in which the stakeholders involved envision the process really matters. Which solutions to prioritize vis-à-vis the production, network and consumption sectors? How to combine these solutions and, eventually, support the realisation of the strategic targets set for 2030? In this article, we examine how the key expert stakeholders of the electric energy system in Finland envision the solutions for the 2030s. Our focus on the case of Finland is timely; it reminds us how even Member States with considerable assets supporting the energy transition simultaneously face significant constraints and path-dependencies standing in the way, some of which relate to stakeholders.

1.1. Finland's energy system in 2030: assets, constraints and path-dependencies

On the one hand, the asset base of Finland's energy system includes a high share of carbon neutral production, i.e. renewable energy sources (RES) such as hydropower, various types of biomass, wind and some solar power potential, as well as nuclear power. The share of RES is roughly speaking twice the EU average. In 2015, RES in Finland covered an estimated 39% of final energy consumption. In electricity production the share of RES was 45% with nuclear power accounting for an additional 33% of low-carbon production [4]. The 2030 energy strategy of the Government of Finland, published in November 2016 as an input to the Union level planning, targets an over 50% share of renewables in the final consumption of

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Table 1
Energy policy targets of Denmark, Finland, Norway and Sweden.

	Denmark	Finland	Norway	Sweden
Share of RES in final energy consumption (2020-40)	2020: 50% of electricity from wind power; 2035: 100% of electricity and heat from RES	2020: 38% 2030: over 50% (incl. peat)	2020: 67.5%	2020: 50% (achieved) 2040: 100% of electricity from RES[b]
National emissions reduction targets[a]	2020: 40% reduction in total emissions vs. 1990; 2050: carbon neutrality	2050: at least 80% reduction from 1990 levels	2030: carbon neutrality	2045: carbon neutrality
European Commission proposal for emissions reduction (non-ETS)	2030: 39%	2030: 39%	[2030: 40%]	2030: 40%

[a] Includes own reductions and offsetting with international investments.
[b] Implies ‘a target, not a deadline for banning nuclear power, nor does it mean closing nuclear power plants through political decisions’ [12].

energy. Cross-border transmission networks link the Finnish electric energy system to the Nord Pool electricity market, where two thirds of the electricity traded is from RES, consisting mainly of Norwegian and Swedish hydropower but increasingly also of Danish and Swedish wind power. In the consumption sector, Finland's new 2030 strategy targets a 30% share for biofuels in road transport, reflecting the asset base of the country's forestry industry [5].

On the other hand, Finland remains a relatively energy intensive economy. The ratio between gross inland energy consumption and GDP far exceeds the levels of the other Nordic states except for Iceland, which has a large geothermal powered aluminium industry. In the EU, this puts Finland into the same group as the east and central European Member States [6]. The high energy intensity is attributable to Finland's export-oriented forestry, metal, machinery and shipbuilding industries, long distances within the country, sparse and unevenly distributed population and relatively low temperatures in winter. The structure of the Finnish economy therefore generates a marked interest in energy supply on the part of the industrial and transport sectors as well as the building stock, resulting in some powerful path-dependencies.[1] One such example is the high share of nuclear power, which is set to increase towards the 2030s, reflecting the interests of industry for a stable supply of base-load power [8]. The Commission's 2016 proposal for Finland of a 39% emissions reduction target in the non-emission trade sectors, made as part of the Union's 2030 planning, also cuts into such existing paths. The Confederation of Finnish Industries criticized the resulting pressures on transport costs and on the use of oil in transport in particular, and the Central Union of Agricultural Producers and Forest Owners for moving production out of the country [9].

Given this constellation of assets, constraints and path-dependencies, the Government's energy policy targets in the 2030 energy strategy remain more cautious than those of its Nordic neighbours, even though the Nordic states jointly strive to decarbonize the energy system by 2050 [10] (Table 1). Yet Finland's 2030 strategy clearly departs from the country's previous policies, which prioritized the production sector of the energy system in the interests of the energy intensive industries [5,11]. The new 2030 strategy moves towards a more holistic understanding of the system by discussing partial solutions for decarbonization in the sectors of smart networks and transport, the benefits of improving flexibility and by noting the prospects of involving energy consumers and citizens in the transition [5].

[1] However, the energy intensive industry has potential for the demand response needed in an energy system with a higher share of intermittent RES, and can profitably use any momentary surplus RES [7].

1.2. The importance of stakeholder views

Even though we acknowledge that several visions may ultimately lead to similar outcomes [13], we propose that the implementation of any vision will benefit from agreement among stakeholders. Furthermore, because the 2030 strategy is a guideline document not strictly prioritizing any possible solutions, it is useful to know how those responsible for developing, steering and implementing the system assess the various solutions vis-à-vis each other.

In the next section we introduce Q methodology as a tool enabling us to systematically uncover and compare the views of stakeholders. The results section presents three different views emerging from the analysis. Our discussion elaborates the areas of consensus upon which the implementation of the 2030 strategy could be built.

2. Research design and methods: do the key stakeholders share the same vision?

2.1. Existing studies

Existing studies on stakeholders have mostly used interviews. They agree that experts are crucial for the formation of Finnish energy policies. Although in the past decade the circle of key stakeholder experts has widened towards the expanding RES and nuclear power sectors [11], it nevertheless remains narrow [14]. Simultaneously stakeholders' views regarding RES depend on the interests they represent [15]. A survey among energy experts and decision-makers found support for a market driven energy transition where RES subsidies could continue until the 2020s if they were technology neutral, while opinions diverged regarding capacity payments. The same experts wanted to maintain the country's strengths in combined heat and power (CHP) [16]. Yet we lack information on how key stakeholders view the full spectrum of solutions.

2.2. How to systematically compare stakeholders' views?

We use Q methodology to conduct a systematic comparison of the views of key expert stakeholders vis-à-vis the Finnish energy system (17). Q methodology combines qualitative and quantitative techniques in order to model the subjectively held views of stakeholders and build firm typologies of these views according to where they agree and disagree [18]. Q methodology can moreover uncover the extent of consensus that could pave the way for widely accepted energy strategies. We asked the key stakeholders: which solutions should Finland prioritize on the way towards a more resource efficient and climate neutral energy system by 2030?

The first step in a study applying Q methodology is to carefully scrutinize the full range of views expressed in the relevant debate

Table 2
A heuristic model of the 2030 energy debate.

Component of the electric energy system	Interests vis-à-vis the electric energy system		
	a. Resource efficiency	b. Climate neutrality	c. Further interests[a]
A. Production	Aa	Ab	Ac
B. Network	Ba	Bb	Bc
C. Consumption	Ca	Cb	Cc

[a] e.g. R&D and capacity building, energy market development, energy business including its effects on employment and taxation, energy efficiency, security of supply, etc..

[17]. For this we used reports, studies and scenarios on the energy system published by the key stakeholders in the public, energy industry, business and NGO sectors. The source material included the key Finnish energy strategy documents setting targets for 2030 alongside similar documents from the other Nordic countries and the EU, which constitute Finland's main reference groups. Scientific articles and some items from the press were also included.

From these sources we extracted altogether 425 statements with the help of a two-dimensional heuristic model of the debate. The first dimension focused on the three sectors of the energy system (A. production, B. network, C. consumption). The second dimension focused on the different interests stakeholders may have regarding the energy system in the context of the 2030 strategies as discussed above (a. resource efficiency, b. climate neutrality, c. further interests) (Table 2). In this way we ensured that our sample covered the whole energy system and included different types of statements potentially resonating with the differing interests of our stakeholder groups [19]. By eliminating overlap among the statements, we selected 48 items for inclusion into the final Q sample, which represents equally all cells of the model (Aa, Ab, etc.). The final statements were slightly edited with the help of an interdisciplinary expert workshop to ensure their relevance to the stakeholders as well as the appropriate scope.

To represent the key expert stakeholders, we selected 24 respondents from the Finnish energy companies, energy business lobbies, the public sector and NGOs. This normally yields a sufficient number in an intensive method such as Q and covers well the main interests shaping the Finnish energy debate (see Table 3). In face-to-face interviews the respondents arranged the set of 48 statements printed on cards into a Q sorting grid (Fig. 1). The instruction was to place one card in each cell in order to represent the views held by the respondent's organization. The statements most compatible with the views of the organization were placed in column +5, and the least compatible in column −5. If a statement was placed in the middle section of the Q sorting grid (i.e. around the 0-column), it was assumed that the organization did not have a clear view on the issue or considered the theme not to be salient. The respondents interpreted the statements in light of their own background knowledge. They were also encouraged to discuss the specific content of a particular statement if they so desired. In this way the researcher group could enhance the validity of the interpretation of results. After the sorting was completed we conducted an interview.

The Q sorts resulting from the experiments were systematically compared by means of factor analysis. After scrutinizing various factorial solutions, we selected three factors for interpretation on grounds of sufficient resemblances among the Q sorts.[2] Participants with a statistically significant loading define each of these three views (see Table 3). To support the interpretation of the three

Table 3
Respondents' factor loadings.

Respondent	F1	F2	F3
1. Business/interest group	0.69X	−0.13	−0.14
2. Business/network services	0.51	0.49	0.11
3. Business/environment	0.23	0.53X	0.07
4. Business/production & network	0.66X	0.29	−0.09
5. Business/network	0.60X	0.26	0.29
6. Public	0.68X	0.20	−0.25
7. Business/R&D	0.36	0.68X	−0.22
8. Business/system equipment	0.52X	0.31	0.23
9. Business/network	0.61X	0.06	0.26
10. NGO/consumers	0.04	0.31	0.65X
11. Public	0.62X	−0.10	0.18
12. Business/equipment	0.30	−0.13	0.65X
13. Public/business	0.70X	0.31	−0.04
14. NGO/consumers	0.21	0.18	0.54X
15. Business/interest group	0.68X	0.11	−0.06
16. Business/production & network	0.52X	−0.19	0.24
17. Business/interest group	0.54X	0.33	0.24
18. Business/interest group	0.38	0.30	0.29
19. Business/interest group	0.01	0.66X	0.34
20. NGO/environment	−0.03	0.84X	−0.06
21. Business/interest group	0.06	0.10	0.53X
22. NGO/environment	0.16	0.82X	−0.12
23. Business/interest group	0.54X	0.16	0.05
24. Business/interest group	0.55	−0.05	0.41

X = Respondent selected for a factor. Criteria: the factor loading must be statistically significant, > 0.37 ($1/\sqrt{48}*2.58$ (SEr) = 0.37) while the next highest loading of the same respondent on any other factor(s) must be at least < 0.20 than the significant loading.

views, we also used the respondents' answers to free format questions in the post-sorting interviews. In addition to the typology of three views, the analysis also revealed a group of statements to which all participants reacted in a similar manner, representing a common ground.

3. Results: three views of the 2030 energy system[3]

3.1. View I: international competition and smart solutions

Half of the respondents, i.e. twelve, support the first view which explains 24% of the variance among the Q sorts. The respondents supporting this view cut across different interest groups as they come from the energy industry, the public sector and NGO sectors alike.

According to *View I*, international markets and competition should determine the sources of energy. Production should be technology neutral. In the interviews, respondents subscribing to this view often highlighted the benefits of international markets for Finland's competitiveness, as well as on the purchasing power of Finnish consumers. Cross-border electricity trade could also help to offset any upward pressure on prices. These respondents, however, want consumers to share the investment costs of low-carbon energy. For example, the increasing share of small-scale production of electricity and heat might necessitate reforming the tariff structure to maintain sufficient investments in grids and other infrastructure.

[2] Taken together, the factors explained 48% of the variance among the Q sorts of the respondents which is a methodologically satisfactory result.

[3] We illustrate the results with tables indicating the rank-ordering values (−5 … +5) of the statements that are crucial to each factor (View).

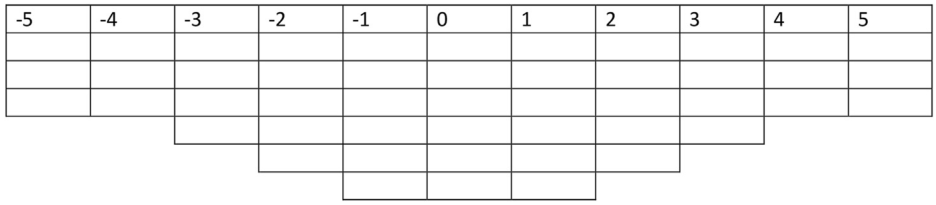

Fig. 1. The Q sorting grid.

The first view also assigns importance to grid development to improve energy and resource efficiency: the bottlenecks in the transmission grid should be removed and smart grids promoted. To enable a more resource efficient system, the first view supports the use of a power-based tariff structure (€/kW) on the level of distribution networks alongside the existing basic rate (€/month) and energy-based tariff (€/kWh). In the background here is the need to control peak demand situations on grounds of their effects on the required capacity for power generation and the transmission and distribution grids [20] (Table 4).

According to the first view, the regulation method of the network companies should provide incentives to invest in new flexible smart grid solutions alongside investments in the primary grid. Such solutions include, for example, metering systems enabling demand response and automation vis-à-vis data collection and analysis, energy storages and grids. This view foresees no need to alter the legal unbundling of the electric energy system into production, network and retail; the present system does not hinder the investments needed in grids. In transport, energy efficiency should be improved by integrating electric vehicles (EVs) with smart grids in order to control the power loads in the grid.

View I does not support strong state management of Finland's future energy system. Therefore large-scale state-owned production is not a viable solution to guarantee security of supply. Neither are specific tax incentives required to ensure the demand for renewable fuels; the investments of the producer companies themselves should suffice. Reservations also prevail regarding support schemes for wind power. The idea of phasing out nuclear power from the Nordic grid in order to increase the share of wind and solar power likewise fails to gather support. Instead, wind and solar power should be promoted by facilitating their connection to the grid by means of streamlining the involved bureaucracy.

3.2. *View II: active consumers*

Five of the respondents, representing energy companies and NGOs, are in favour of the second view, which explains 15% of the variance among the Q sorts. The respondents supporting our second view want to help Finnish consumers to use electricity prudently. Therefore no specific policies to control any possible increases in electricity prices are required. Neither does this view support power-based tariffs as the first view does; therefore in the future, too, electricity prices must be based primarily on energy consumption.

This view situates the electric energy system into the international context as the first view does, but simultaneously underlines the role of consumers and decentralization in the production of renewable energy. District heating networks should be coupled with decentralized renewable heat production such as heat pumps. Wind and solar power must be connected to the grid cost-efficiently with a minimal licensing process (Table 5).

According to *View II* Finland does not need to become a self-sufficient producer or net exporter of electricity despite importing a fifth of its electricity in 2015 [4]. Instead, a cost and resource efficient energy system requires the integration of local, regional and state-level production and consumption. At the same time Finnish society should be active in promoting the low-carbon transition. Any tax-based support schemes for energy intensive industries – which so far prevail in Finland – should be adjusted to help to minimize the climate impact. Carbon capture and storage does not qualify as a suitable measure for reducing emissions from industrial processes.

Society should guide the development of the transportation system, for example through support schemes for electric vehicles. EVs could help to control power loads in the network and function as an energy storage (incl. vehicle-to-grid solutions). This view also identifies smart grids as a means to improve the energy efficiency of the transportation system.

3.3. *View III: national competitiveness and local solutions*

The third view explains 10% of the variance in the Q sorts and is supported by four respondents representing organizations in all sectors. This view sees maximizing the use of local energy sources in energy production as the optimal way of using resources. The use of forest-based biomass in energy production should be increased. Vehicles using biofuels are seen as a feasible solution in reducing the environmental impact of transportation. On the other hand, emissions of particulate matter from fireplaces and stoves, both of which are widespread in Finnish houses are not an issue. Further, purpose-built energy islands have potential both to enhance the efficient use of local resources and improve security of supply during disruptions. This means that the regulation on network companies should encourage coupling energy and power independent micro grids with the existing network infrastructure. At the same time, respondents subscribing to this view acknowledged the challenges of such policies for incumbent actors and their business models.

Table 4
The first view on the development of energy markets and networks.

Statement	Value
15. Electricity production must be based on competition between solutions of different types and sizes.	+5
19. The regulation method of network operators must also promote new types of flexible smart grid solutions, in addition to investments into the primary network, in order to develop energy efficiency.	+5
25. The cost of electricity distribution service must not depend on energy consumption; instead, the grid companies must switch to using power-based tariff structures.	+5

Table 5
The second view on combining cross-border and local resources.

Statement	Value
14. Consumers must be encouraged to become small-scale producers of renewable electricity.	+3
20. The bottlenecks in the electricity transmission grid must be removed by connecting the production resources to consumption both on the state and regional levels, because it is energy and cost efficient.	+5
24. The district heating networks must accept renewably generated heat, such as geothermal heat, that has been produced in a decentralized manner.	+4

Table 6
The third view on local and regional solutions.

Statement	Value
13. Our country must be at least self-sufficient in producing electricity and preferably a net electricity exporter.	+3
31. The regulation method of network companies must promote the development of microgrids that are energy and power independent, to function as parts of the distribution network infrastructure.	+4
32. The potential of energy islands in using local resources efficiently and improving the security of supply vis-à-vis disruptions must be explored and tested.	+5

Like the second view, this view also seeks to promote net zero energy buildings by means of accepting a share in a nearby renewable energy production unit in the energy self-sufficiency of buildings, unlike present policies which moreover impose distribution tariffs upon such co-operative small-scale production. The state should integrate citizens and businesses in the process of building a climate-neutral society by offering information on energy efficiency and climate issues on the time they decide on energy solutions.

View III also emphasizes national competitiveness and the purchasing power of Finnish consumers. The future energy system should guarantee reasonable energy prices. Therefore this view includes an idea of protecting consumers against the possible risks involved in low-carbon energy solutions. Simultaneously the country should aim at self-sufficiency in electricity production, and preferably, also at net exports. The national R&D budget should be oriented towards resource and material efficient products, services and procedures due to their competitive advantage. Flexibility of demand is not seen as crucial in the development of the electric energy system (Table 6).

According to this view, the solutions for the production of electricity should be chosen on the basis of competitiveness in the national context. Support schemes for wind power and the phasing out of nuclear power do not receive support.

3.4. Discussion: from common ground to strategy implementation

The common ground identified offers some starting points for making Finland's 2030 energy strategy a reality in terms of partial solutions likely to enjoy support from the key stakeholders. The respondents broadly agree on six statements, regardless of which of the three views they support (Table 7). First, the ‘polluter pays’ principle should be the cornerstone of energy and climate policies. Thus the direct and indirect support mechanisms for fossil fuels, which by far exceed renewable support schemes, could gradually be lowered. RES subsidies, routinely criticised by the incumbent energy industry,[4] could correspondingly be adjusted with RES production becoming more competitive, which is soon to be the case for wind power.

Second, the respondents oppose investments in (new) fossil fuel plants regardless of their potential benefits in securing electricity supply during peak demand when low winter temperatures prevail. This suggests that the energy transition should eventually also extend to the predominantly fossil fuel based CHP which has lost its former competitiveness [23]. Finland is one of the leading developers of CHP in the EU. The country's heavy industry and power industry have a vested interest in this effective conversion technology that accounts for a quarter of the electricity supply [4] and three quarters of district heating. Given Finland's 2030 targets, we propose that some of the remaining fossil fuel based CHP plants should switch to co-firing with bioenergy sources to become pure back-up power units or form part of the country's power reserve. Eventually, a combination of bioenergy plants as well as new storage, renewable and distributed energy solutions should replace them. To prepare for the greater intermittency that will nevertheless characterise such a system, we propose new investment in demand side management solutions better to balance production and consumption, as well as the gradual phasing in of power based tariffs and a wider hourly variation in prices to be allowed in the Nord Pool market [20].

Third, the respondents see geothermal heat pumps as a resource effective solution regardless of the variation they cause to the power load in the system or the economic challenge they pose to the district heating system including CHP. Finland's 2030 energy strategy does not propose any measures vis-à-vis geothermal heat pumps, although they may number over 300,000 units by 2020 in a country of five million people [24]. The 2017 ruling of the Supreme Administrative Court allows installing high capacity geothermal heat pumps – which would not require extra heating with electricity from the network even in winter-time – in areas where the city plan otherwise obliges connecting to the district heating network. To further incentivize the installation of such heat pumps, and to minimize their impact on the power load during the peak hours, we here also propose the introduction of power-based tariffs.

Fourth, the respondents do not see underground cabling as the *only* solution to improve reliability in the face of virtually annual weather-induced disruptions, although Finland's electricity market legislation practically expects distribution system operators (DSOs) to switch to it. We support legislative changes to modify this requirement for DSOs. Especially when implemented in sparsely populated areas, it results in unnecessarily high network tariffs for all customers of the DSO. Furthermore, it is not always the most resource effective solution when compared to the potential benefits of incentivizing micro-grid solutions in such areas. By switching to locally available resources and reserve power solutions such as batteries and fuel cells during disruptions, micro-grids would

[4] The ‘environmentally harmful’ subsidies on the energy sector alone amount annually to some 800 million euros, alongside subsidies for the use of fossil fuels in the transport sector [21]. The 2016 budget of the Government of Finland reserved 234.6 million euros to support RES production, 75 million for investments, 55 million for sustainability in forestry and 7 million in agriculture, and 2 million for energy efficiency improvements [22].

Table 7
The common ground.

Statement	Value		
	V I	V II	V III
11. The polluter pays principle must act as the cornerstone of energy and climate policy in order to reduce emissions.	+3	+5	+4
12. Investments in fossil fuel power plants must be supported by the same market mechanisms as the production of renewable and low-carbon energy, so that production can be ensured during both normal and peak hours.	−4	−5	−5
21. The benefits of geo-thermal heat pumps in the efficient use of resources must be questioned, because they increase the use of electricity and endanger the future of the existing district heating network.	−4	−4	−4
28. Underground cabling is weatherproof and as such the only solution for ensuring the security of supply of the network.	−3	−2	−3
18. Network operators must have the possibility of using energy storages as a part of grid operations.	+2	+2	+4
5. The use of natural gas to produce electricity and heat must be ensured during the transition towards lower-emission technologies.	−2	−4	−4

support a common interest in increasing the resilience of the system as a whole. This would also offer alternative business models for DSOs and emerging actors. In line with the 2030 energy strategy, it would empower citizens.

Fifth, the respondents wish to allow DSOs to use energy storage as a part of their business. This is currently not allowed in Finland, and EU Member States differ greatly in how they regulate this issue within the bounds of the EU unbundling regulation [25]. The Commission's winter package of 2016 seeks to confine energy storage to a business of service providers. DSOs could own storage only if there are no such interested service providers for a specific installation [26]. European DSOs propose a simple procedure for determining this without mandatory tendering, and, when feasible, allowing them to own storage to ‘operate and plan their networks ”flexibly”’. That our respondents would probably prefer such an ‘active DSO model’ to find support on the EU level, is explicable in terms of the perceived national competitive advantage in the sector of smart networks, frequently mentioned by our respondents with reference to the country's export potential.[5] Should the Commission's position prevail, we suggest that the costs of purchasing storage services should not be treated as operative costs subject to a streamlining obligation, as the current Finnish network business regulation model does, but that they be treated on par with other network investments.

Sixth, the respondents would not prioritize natural gas as a transition fuel as do some Finnish analysts and existing studies [27,28]. On this point, the respondents mentioned in the interviews the political and infrastructural constraints of natural gas in Finland. Politically, it is primarily a Russian import, while the 2030 energy strategy seeks to increase self-sufficiency to 55% of the final consumption of energy (excluding domestically produced nuclear power). In terms of infrastructure, the first liquefied natural gas terminals are only entering the market. The Balticconnector pipeline, which would eventually facilitate opening a connection to the central European markets, is only in the planning phase. Other gas-based solutions (e.g. biogas in transport and power-to-gas technologies) appear promising to our respondents. Although they do not see biogas as decisive for the whole energy system, we recommend the implementation of the 2030 strategy to include a specific target for biogas fired vehicles alongside the target for 50,000 gas-fired vehicles by 2030 [5]. Biogas can offer more resource effective and climate neutral solutions including improved air quality when compared to the planned increase in biofuels, some of which would be forest-based. The target of the 2030 strategy of expanding the use of forest-based biomass could significantly reduce Finland's forest carbon sink because of the resulting one-third increase in annual harvests [29,30].

[5] Yet the Finnish hopes in this respect are hardly unique; each of the Nordic countries seeks to enter the global cleantech market [31]. Yet this is interesting as the decarbonization targets of the EU may enable countries detached from the global fossil fuels business to assume significant shares of the emerging energy technology market even though the energy sector overall becomes more local and regional.

4. Conclusion

Our Q methodological analysis shows that Finnish key expert stakeholders and the organizations they represent stand firmly behind the overall goal of decarbonization of the energy system as manifested in EU and national level 2030 strategies. This will significantly influence some of the vested interests of incumbent actors as well as existing business models, and hence, eventually, break some of the existing path-dependencies. However, we found some differences of emphasis regarding how to implement the transition and reported these differences in the form of a typology of three views. Each view receives support from several sectors. This shows that the field of Finnish key stakeholders is not deeply divided into separate camps, which is promising regarding the prospects of implementation.

The differences between the views pertain to the extent to which they support international or national electricity markets, and the role they prefer to assign to for state level governance. *View I* prioritizes an international, market driven system based on smart grids and the effective management of loads within it. *View II* likewise has an international outlook but prefers to have society assume a greater role in order to minimize the climate impact of the energy system. It furthermore wishes to empower and incentivize consumers to actively conserve energy, and pave the way for decentralization. While these two views nevertheless value the supply of affordably priced electricity through the expanding Nord Pool trade, *View III* accentuates how locally available renewables afford higher self-sufficiency and may eventually make Finland a net exporter of electricity, allegedly strengthening the competitiveness of the country. The different methods of generating electricity should, according to the third view, rely on local resources and compete nationally without unnecessary state regulation.

Concomitantly our analysis reveals a common ground on which the implementation of Finland's 2030 energy strategy can build. Because the polluter should pay, we propose gradually phasing out the direct and indirect support mechanisms for fossil fuels. We support the gradual introduction of power-based tariffs to prepare for the eventual intermittency effects of a greater amount of RES, including fossil fuel free back-up and reserve power. Power-based tariffs would also encourage the installation of high capacity heat pumps not requiring buildings to rely on extra heating with electricity from the network even in wintertime. Network operators should be allowed cost-effective access to storage in the interests of experimenting with the ‘active DSO’ model. They should also be encouraged to explore micro-grid solutions in sparsely populated areas as alternatives to underground cabling. This would offer new business models, increase the resilience of the whole system, lower distribution tariffs and empower citizens. Finally, the respondents' emerging interest in biogas could be supported by introducing a specific target for biogas-fired vehicles in the interests of more resource effective and climate neutral transport.

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