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How to Achieve a More Resource-Efficient and Climate-Neutral Energy System by 2030? Views of Nordic Stakeholders

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Abstract

The Nordic countries pursue ambitious energy transition goals through national energy policies and in the framework of Nordic cooperation. We propose that the transition is realistic only if it involves the public, private, and nongovernmental organization sectors as regulators, innovators, and advocates of relevant policies and solutions representing the multitude of interests involved. We examine these interests through Q methodological experiments, where 43 expert stakeholders' rank-order statements concerning their preferred policy measures vis-à-vis the electric energy system. Factor analysis of these subjectively held views produces three distinct views. The first two enjoy strong inter-Nordic support. The first view prioritizes market and grid development, and the second view prioritizes electric transport, and solar and wind power. The third, "Finnish" view seeks to enhance security of supply, also via microgrids, and prioritizes biofuels over electric transport. Examining the common ground among the three views, we find that enhanced cooperation requires reinforced stakeholder interaction and policy coordination.

KEY WORDS: energy, climate change, developed countries, environment

如何在2030年实现更具资源有效型和环境中立型的能源系统？北欧利益相关者的看法

北欧国家通过国家能源政策，并在北欧合作框架中追求远大的能源过渡目标。笔者提出，能源过渡的现实意义仅在特定情况下才能体现，即将公共部门、私人部门和非政府组织作为相关政策和解决措施（代表大多数参与者的利益）的监管者、创新者和倡导者。笔者通过*Q*方法论实验对利益进行了检验。实验中，*43*名专家利益相关者就电力能源系统一事，对各自所偏好的政策措施言论进行了排名和排序。笔者对这些具备主观性的见解进行了因素分析，得出了三种独特观点。前两种对北欧国家之间的强力支持予以赞赏。第一种观点将市场和电网发展列为优先事项，第二种观点则将重点聚焦于运输、太阳能和风能。第三种观点，即"芬兰式"观点试图通过微电网提高供应安全，并认为生物燃料比电力运输更需优先处理。通过检验三种观点的共同之处，笔者发现，利益相关者之间需加强互动，促进政策协调，才能提高合作。

关键词: 关键词: 能源, 气候变化, 发达国家, 环境

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¿Cómo lograr un sistema de energía más eficiente en el uso de recursos y de clima neutral para el año 2030? Opiniones de los interesados nórdicos:

Los países nórdicos tienen ambiciosos objetivos de transición energética a través de políticas energéticas nacionales y en el marco de la cooperación nórdica. Proponemos que la transición será realista solo si involucra a los sectores público, privado y de las ONG como reguladores, innovadores y defensores de políticas y soluciones relevantes que representan la multitud de intereses involucrados. Examinamos estos intereses a través de experimentos de metodología Q, donde 43 partes interesadas expertas clasifican las declaraciones de orden con respecto a sus medidas de política preferidas en lo que tiene que ver con el sistema de energía eléctrica. El análisis factorial de estas vistas sostenidas subjetivamente produce tres vistas distintas. Las dos primeras gozan de un fuerte apoyo inter-nórdico. La primera vista prioriza el desarrollo del mercado y la red, y la segunda, el transporte eléctrico, y la energía solar y eólica. La tercera, la vista 'finlandesa' busca mejorar la seguridad del suministro, también a través de microrredes, y prioriza los biocombustibles sobre el transporte eléctrico. Al examinar el terreno común entre los puntos de vista, encontramos que una mayor cooperación requiere una interacción reforzada de los interesados y la coordinación de políticas.

PALABRAS CLAVE: Palabras Clave: energía, cambio climático, países desarrollados, medio ambiente

Introduction

We scrutinize how to further energy transitions by considering the Nordic region.[1] The Nordic countries seek a 100% decarbonization of their energy systems by 2050 whereby 85% would be carbon-free production, with the remaining 15% covered by carbon credits (Nordic Energy Research & IEA, 2013, p. 8). As part of the European Union (EU), Denmark, Finland, and Sweden are committed to a 32.5% increase in energy efficiency, a 32% share for renewables, and a 40% reduction in greenhouse gas (GHG) emissions by 2030 (European Commission, 2018a, 2018b). Norway shares the 40% target for emission cuts. The Nordic states also conduct joint R&D on sustainable energy and seek to enhance their energy cooperation, having commissioned an independent report to this end (Ollila, 2017). The Nordic system operators, together with their Baltic counterparts, own the Nord Pool joint electricity market, where over two-thirds of the trade volume is renewably generated power, and they, too, seek to enhance their cooperation (Statnett, Fingrid, Energinet.dk, & Svenska Kraftnät, 2016). Moreover, each of the four Nordic states has national renewable energy and GHG emission reduction targets (Table 1).

We emphasize that these policy targets pushing forward the Nordic energy transitions on the EU, regional, and national levels are fundamentally political (see also Hoppe, Coenen, & van den Berg, 2016, p. 22; Kuzemko, Lockwood, Mitchell, & Hogget, 2016). This is not to say that they are arbitrary; each target is usually based on some scenario work or modeling of the energy system (e.g., Nordic Energy Research & IEA, 2013, 2016). Rather, the targets are political as they convey a negotiated percentage, intended to be the outcome of a series of more precise policy measures and instruments designed to support various part solutions, many of which are yet to be adopted. While some features of the existing energy systems will remain unchanged until the 2030s and beyond—such as large hydropower plants in Norway, Sweden, and Finland, and also most of the nuclear power capacity in Finland and Sweden—a plethora of options exists for developing the energy system. The policy challenge we aim

Table 1. Nordic Renewable Energy and Emission Reduction Targets

	Denmark	Finland	Norway	Sweden
Share of renewable energy sources (RES) in final energy consumption (2020–40)	2020: 30%; and 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	2045: carbon neutrality (political commitment); 2050: at least 80% reduction from 1990 levels (Climate Act)	2030: carbon neutrality	2045: carbon neutrality (political commitment)

Sources: Government of Denmark (2011), Ramöverenskommelse (2016), Government of Finland (2016), EEA (2016), and Norwegian Ministry of the Environment (2007).
[a]Includes own reductions and offsetting with international investments.
[b]Does not exclude nuclear power.

to address in this article concerns which measures to combine to effectively meet the transition targets. Because several stakeholders are involved (Hess, 2014, p. 279; Petit, 2017, p. 170), this often means "second-best" choices anticipating the institutional constraints or possible market failures involved (e.g., Hübler, Schenker, & Fischer, 2015). Here, our contribution pertains to the roots of the institutional constraints as we examine which combinations of policy measures the key stakeholders prefer. Such combinations would thus serve best as a basis for enhancing Nordic cooperation.

Policy makers need to decide which new renewable resources to prioritize—biomass, wind, solar, geothermal, or other—to fill the emerging gap when production based on fossil fuels inevitably diminishes. While *ex ante* evaluation of such policy choices can help to reach decisions, policy makers inevitably encounter resistance on the part of interest groups, industries, and incumbent energy producers affected by the changes (Andrews-Speed, 2016; Hess, 2014; see next section). In the distribution sector, decision makers will have to judge whether transferring to new locally available renewable resources presupposes a more decentralized system of electricity and heat provision and how much smarter it has to be to better link production at various sites, both large and small, with the changing needs of consumers. In the consumption sector, many technological solutions already exist to improve energy efficiency (Fawkes, 2013, p. 83); according to one estimate, on a global scale up to 21% of total primary energy could be saved this way (Petit, 2017, p. 164). However, because energy policy has traditionally focused on the production sector, the rich prospects of expediting change in the distribution and consumption sectors remain underutilized. In the field of climate policy research, a related argument holds that emission reduction policies need to focus on both the production and consumption ends (Mundaca, Román, & Cansion, 2015). With this insight, we seek to shed light on relevant combinations of policy measures regarding the whole energy system since its different parts are interdependent; in the case of electricity in particular, which is not easily storable, matching production and consumption is crucial. Here, we accept how uncertainty, complexity, and cross-sectoral linkages affect energy policies (Aalto, 2008; cf. Burkett et al., 2014, pp. 176–182).

This systemic, yet open and political nature of energy transitions, means that many existing interest structures, business models, and patterns of energy use and behavior within the society must adapt to the realities of transition. This for its part means that any realistically implementable energy policies require the support of stakeholders (Hoppe et al., 2016, p. 22; Schmid, Knopf, & Pechan, 2016). Research on science, technology, and environmental (STE) issues in the field of energy policy—such as research on sociotechnical systems in energy transitions, regimes, and institutional approaches—stresses the involvement of the whole society (Araújo, 2014; Geels, 2002; Moe, 2015). In a word, the field of affected stakeholders widens.

This widening field of stakeholders presupposes more attention to the human interface of energy transitions (Burkett et al., 2014, pp. 180–182). In this article, we cover new ground to this effect by examining the subjective views of public authorities, energy companies, and NGOs in the four Nordic states, and the clustering of opinion among them. Since these groups are crucial for mobilizing the resources to achieve the energy targets set, we seek to identify those policy measures and solutions on which they agree, regarding the production, distribution, and consumption sectors of the system. Our analysis covers cross-national issues, considering the interdependencies between the energy systems of the four countries—including trade in fuels and electricity necessary for balancing off hourly and seasonal mismatches in production and consumption. Some of the emerging measures and solutions are well known in expert circles, but we propose that establishing such support is a crucial task of confirmatory research. Otherwise, there will be few regulators, innovators, advocators, and early adopters necessary for a transition needing wide-ranging societal involvement. Alongside this, we conduct exploratory research outlining support for policies and solutions that are not yet much discussed in national energy strategies or in Nordic cooperation. By linking the subjective views of key stakeholders with the foreseen range of policy choices and technological solutions, we can alleviate the inherent uncertainty of energy transitions (Sovacool, 2017), without reducing it to a simple question of either politics, economics, or technology, and enhance regional policy integration.

The interdisciplinary research agenda that we propose has some parallels with the recent literature advocating social scientific approaches to the study of energy transitions alongside the more established technological and economic disciplines. This wider framing of energy studies will enable us to better understand how the current energy transitions pervade society (Sovacool, 2014, 2015; Spreng, 2014; Spreng, Flüeler, Goldblatt, & Minsch, 2012), including both material and social dimensions (Wong, 2016). At the same time, we strive to keep policy needs at the center of our analysis, considering how, for example, the research on sociotechnical systems has paid less attention to political actors and institutions than to the roles of companies and societal actors (Andrews-Speed, 2016; Kuzemko et al., 2016; Lockwood, Kuzemko, Mitchell, & Hogget, 2016). Overall, our approach systematically links the future expectations of actors with the social and material features policy making must take into account (Chernoff, 2005).

Our enquiry focuses on environmentally sustainable energy transitions (Hess, 2014) driven by efforts to improve resource efficiency and climate neutrality. By resource efficiency, we refer to actions extracting more outputs from a smaller amount of resources (UNEP, 2011); defined this way, resource efficiency also includes energy efficiency. By climate neutrality, we refer to a situation where human actions have zero effects on climate change.[2] In addition, we stress how sustainable energy transitions are driven, and sometimes, impeded, by several further interests (Patwardhan et al., 2012) within a society, pertaining to R&D, markets and prices, energy business, and security. This is potentially a very wide policy agenda that we for practical purposes delimit in three ways in this article. First, we focus on the electric energy system, including the use of electricity in the transport and building sectors, where the Nordic states themselves foresee great transition potential (Nordic Energy Research & IEA, 2013). Nevertheless, alternatives to electrification, including biofuels and carbon capture and storage (CCS) measures, also warrant some consideration. Second, we cannot delve deep into the wider literature on the energy/climate policy interface, on which environmentally sustainable energy transitions ultimately hinge. Third, our enquiry predominantly covers policy measures and solutions, while research on the more precise policy instruments remains a crucial task for further research. We will ask the following: (1) In the subjective views of Nordic experts, which solutions to develop a more climate-neutral and resource-efficient energy system by 2030 should be preferred? (2) Is there evidence of any clustering in the views of Nordic experts along stakeholder groups or along national lines that might influence the prospects of the intended transition, including prospects of Nordic cooperation to that end?

We first introduce our approach to stakeholders and then outline the potential of Q methodology for a systematic analysis connecting the subjective views of stakeholders to policy measures and the social and material realities in which they are to be implemented. Thereafter, we discuss the three main divergent views resulting from the Q methodological study and the lines of agreement between them, before concluding.

How to Approach Nordic Stakeholders?

Despite interlinkages and cooperation in the energy sphere among the Nordic states, most research is country-specific or at best compares two cases. Some of this research assesses the prospects of renewable generation of electricity (and heat) in the Nordic region through wind, solar power, and biomass (Holttinen, 2004; Nordic Energy Research & IEA, 2016; Salomon Popa, Savola, Martin, Fogelholm, & Fransson, 2011). Some studies focus specifically on wind power permitting (Pettersson, Ek, Söderholm, & Söderholm, 2010), and some focus on how the Nordic transmission system can cope with the increase in variable renewable generation, especially wind (ENTSO-E, 2018; Farahmand, Jaehnert, Aigner, & Huertas-Hernando, 2015). Further studies examine how political actors, consumers, and households participate in the transition (Ratinen & Lund, 2015). Sovacool (2017) probes the technological contingencies, political contestations, and social justice implications of the Nordic energy transitions including their implications for the labor market and the accompanying social barriers to the proliferation of smarter systems, such as lack of knowledge or financial resources. Aalto, Jaakkola, Järventausta, Oksa, and Toivanen (2017) note the several stakeholders affected and path dependencies needing to be broken for the Nordic 2030 targets to become reality.

Differing stakeholder interests may also be functional. A case study on the Danish hydrogen sector argues that stakeholder conflicts may prompt more experimentation and competition among technologies, increasing their resilience (Andreasen &

Sovacool, 2014), yet in the case of Sweden, diverging stakeholder interests hamper the development of the electricity grid while inter-Nordic and wider cooperation would be necessary to achieve a decarbonized Nordic power system by 2050 (Tenggren, Wangel, Nilsson, & Nykvist, 2016).

However, only few studies with a comparative or a wider Nordic focus move beyond the energy system as such to analyze explicitly and empirically the role of stakeholders or interest groups in energy transitions. We know that in Denmark the wind power industry and a variety of local actors developing wind power and a more decentralized energy system form a powerful group impervious to government efforts to digress from this transition path (Eikeland & Inderberg, 2016). In Norway, the oil and gas sector has a vested interest in CCS as the best decarbonization measure (Moe, 2015). The connection between Norwegian electric vehicle (EV) policies and the role of user imaginaries in shaping practices and anticipating the societal embeddedness of technology have been highlighted (Ryghaug & Toftacker, 2016). In Finland and Sweden, the significant energy-intensive heavy industries shape the energy system and traditionally prioritize low energy prices. Among these, the forestry sector entails a priority for bioenergy (Ruostetsaari, 2010, pp. 151–153), despite the officially declared principle of technology neutrality (Government of Finland, 2016).

We contribute to this emerging literature on the role of stakeholders in energy transitions (Mielke, Vermaßen, Ellenbeck, Fernandez Milan, & Jaeger, 2016) by offering a wider Nordic focus and by paying attention to the subjective roots of issues of acceptance and support for different combinations of policy measures. Stakeholders are especially important in the Nordic states, given their egalitarian and corporatist political traditions accentuating participation and interest group consultation. Here, we expand previous Q methodological work analyzing the views of Finnish stakeholders (Toivanen et al., 2017) by including further stakeholders from Denmark, Norway, and Sweden. Finnish stakeholders, however, are still deliberately overrepresented; of the four countries, Finland faces the greatest transition challenges. In the production sector, Finland has less hydropower than Norway or Sweden and lower investment in wind power than in Denmark. In the consumption sector, Finland has until recently introduced fewer policy measures than Denmark, where attention to energy consumers is well established and citizens as well as cooperatives have long been owners of energy production facilities (Eikeland & Inderberg, 2016). However, Finland's 2030 energy strategy (Government of Finland, 2016) introduces a more holistic approach vis-à-vis the energy system, referring to flexibility, smart networks, cleaner transport, and to citizens and consumers.

Finland is also different owing to its significant electricity imports—22.3% of electricity consumption in 2016, mostly from the Nord Pool market (Energiateollisuus, 2017). In addition, Finland imports electricity, coal, oil, natural gas, and nuclear fuel from Russia. In 2015, the share of Russian imports in final energy consumption was 45% (Tilastokeskus, 2016). Consequently, Finland seeks to increase the share of domestically produced energy to over 50% of consumption by 2030 (Table 1). Realizing this target alongside, the decarbonization aim is challenging. Thus, the extra weight on the case of Finland enables us to better analyze the complexity of the transition where decarbonization targets merge with security of supply and other targets (Aalto et al., 2017; Edberg & Tarasova, 2016).

Our approach to the Nordic stakeholders of the energy system draws on institutionalist approaches (Andrews-Speed, 2016; Moe, 2015), meaning that we assume a multitude of interests extending deep into the structures of society, shaping the views of the stakeholders in the public sector, energy companies, and NGOs (also Hoppe et al., 2016). These interests are more generic than the vested interests of stakeholders' vis-à-vis certain solutions such as wind power in Denmark, CCS in Norway, and biomass in Finland. The generic interests include not only the key focus on resource efficiency and climate neutrality, but also further interests such as research and development capacity building; competition and energy market development, including prices; and energy business, including its wider socioeconomic effects on employment and taxation, and security of supply (Figure 1; Aalto et al., 2017; Toivanen et al., 2017).

Methodological Solutions and Material

Stakeholder Views in Energy Research

Most research in this field favors case study methods, for example, frame analysis (Edberg & Tarasova, 2016), while survey and interview techniques are commonplace. For example, Elgin and Weible (2013) administered an online survey to investigate climate and energy issues in Colorado. Gulbrandsen and Christensen (2014) used interviews to study EU legislation intended to reduce carbon emissions from cars. Schmid et al. (2016) synthesized existing studies on the German case, finding the views of stakeholders and the institutional competition among them is key to the choice on whether to develop the electric energy infrastructure toward a more decentralized or centralized, all-European direction.

Analyzing subjective views with the help of Q methodology is useful both with regard to policy formulation and with regard to implementation since it helps to

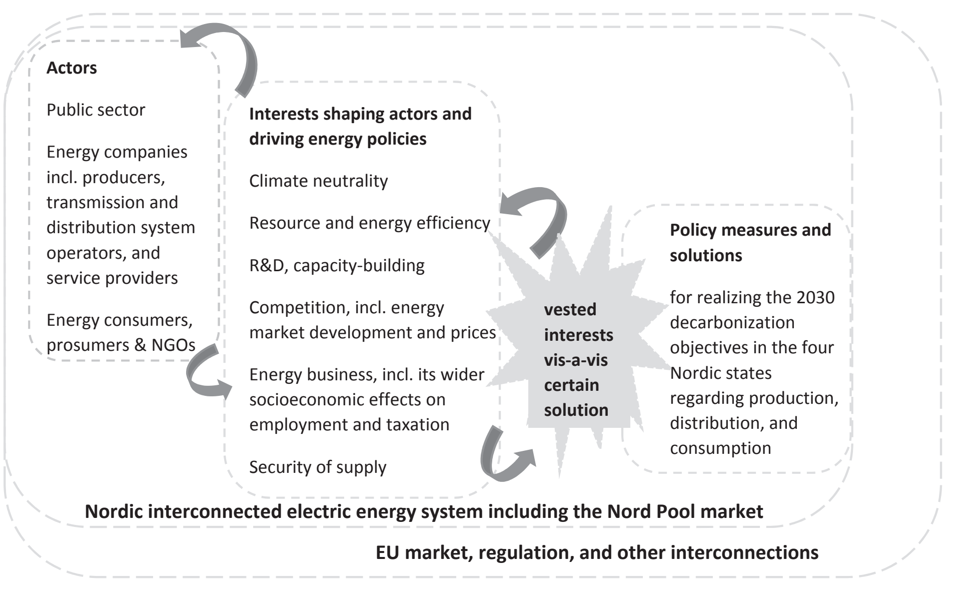

Figure 1. Stakeholders and Interests vis-à-vis the Nordic 2030 Energy Policies

develop policies that make sense to the stakeholders affected and as such have potential to be eventually accepted and adopted. Q methodology offers rich prospects for the respondents to express how they view, compare, and prioritize different policy measures in relation to one another, as opposed to survey research, where response categories are predefined and the respondents typically not encouraged to prioritize similarly. Compared to interview techniques, Q methodology enables us to compare the views of stakeholders more systematically (Robbins & Krueger, 2000). In Q methodology, human subjectivity means enabling respondents to communicate their point of view comprehensively, making it a self-referential concept (Brown, 1980; McKeown & Thomas, 1988; Stephenson, 1953).

Q methodology can powerfully elicit any diverging views held by stakeholders. This is vital in the field of energy transitions, where vested interests in existing solutions, resistant to change, need to be overcome (Moe, 2015). At the same time, Q methodology can elucidate the common ground among the stakeholders. This is valuable not only in a national context but also in our Nordic case, given the interdependencies in the Nordic energy systems and their aim of reinforcing energy cooperation (Ollila, 2017; Statnett et al., 2016). The ability to point at the common ground is also valuable in the European context, given that the European Commission's (2017) "winter package" proposes regional coordination of national energy and climate plans as a major mechanism for achieving the EU level energy targets. Such regional coordination is best focused on areas where common ground demonstrably exists.

Previous applications of Q methodology in the field of energy transitions have helped to elucidate stakeholder discourses on electricity transmission line siting in the UK, to clarify the grounds for policy making (Cotton & Devine-Wright, 2011). Cuppen, Breukers, Hisschemöller, and Bergsma (2010) use Q methodology to facilitate stakeholder selection, concluding it helps to capture a more diverse group of stakeholders. Cuppen (2012) also applies Q methodology to evaluate learning in stakeholder dialogues.

Material

Our method starts with a survey of existing studies. Q methodology first entails compiling a large amount of textual material including existing studies, scenarios, reports, policy documents, and the like, and arranging it into a structured sample of statements. The statements are then administered to a group of stakeholders in face-to-face experiments allowing researchers to focus on subjective perceptions and to uncover the range of perspectives held regarding the topic interest.

Each Q methodological study follows an established set of steps resulting in the extraction of well-defined, distinctive views from the debate on the topic (Brown, 1980; Stephenson, 1953; Watts & Stenner, 2012). The first step is to compile the Q sample, which models the domain of subjectivity of interest to us—the debate on the Nordic 2030 energy policy measures and solutions—in the form of a well-selected set of statements. For this purpose, we used reports, studies, and scenarios on the energy system published by the key stakeholders in the public, energy industry, business, and NGO sectors as well as existing academic studies (Toivanen et al., 2017). The selection of statements from the material was guided by a two-dimensional heuristic model of the debate on the development of the energy system (see Table 2). The first

Table 2. Heuristic Model of the Energy Debate Used in Statement Selection

Component of the Electric Energy System	Interests vis-á-vis the Electric Energy System		
	a. Resource and Energy Efficiency	b. Climate Neutrality	c. Further Interests[a]
A. Production	Aa	Ab	Ac
B. Network	Ba	Bb	Bc
C. Consumption	Ca	Cb	Cc

[a]R&D and capacity building, competition, including energy market development and prices, energy business including its wider economic effects on employment and taxation, security of supply.

dimension of the model focuses on the interests expressed by the stakeholders' vis-à-vis the development of the electric energy system (Figure 1). The second dimension of the model covers preferred policy measures and solutions regarding the production, network, and consumption sectors of the electric energy system, ensuring that none of these sectors is overrepresented in the sample of statements. In this way, we sought to ensure the selected statements would cover the demands the main actors and stakeholders have vis-à-vis the various parts of the system. Through the elimination of overlap between statements from the initial sample of 425 statements, a final statement sample, the Q set, of 48 statements covering each cell of the theoretical model was extracted.

The next step is the Q sort, which is the result of the respondent interacting with the statements by sorting or rank-ordering them onto a predefined sorting grid (see Figure 2). Q sorts were conducted with 43 respondents from the Nordic countries (see the Appendix). This number is reasonably high for Q methodology which as an intensive technique works best with small numbers (Brown, 1980; Watts & Stenner, 2012), especially given that the respondents represent the relatively limited group of senior experts in relevant Nordic ministries; business associations with an interest in energy, some of which have a vested interest in certain solutions; energy companies; or NGOs. The group of respondents also covers different modes of energy production, as well as the distribution and end-use sectors, thereby adequately reflecting the various vested interests discernible in the Nordic context. Business actors are slightly overrepresented owing to their centrality to the development of any future infrastructures and technologies. To form the respondent group, we expanded our previous work on Finnish stakeholders (Toivanen et al., 2017). The face-to-face Q sorts in Finland were conducted in spring–summer 2016 ($n = 25$), and the Q sorts in Denmark, Norway, and Sweden were conducted during January and February 2017 ($n = 18$).

To create a Q sort, respondents received the Q set of 48 statements printed on business card-sized cards. They were instructed to sort the statements in a continuum from +5 (most agree) through 0 (neutral) to −5 (most disagree), with the completed sorts representing their organizations' viewpoints on how to develop the electric energy system on the way to 2030.

Postsorting interviews were also conducted with all 43 respondents, consisting of open-ended questions on the Q sorts they had produced. In these interviews, the respondents critically reflected on the statement set as whole, elaborated on the way they sorted the statements, and on any further topics.

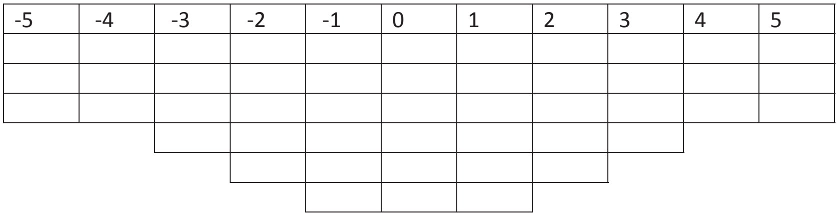

Figure 2. Q Sorting Grid

The completed Q sorts were then factor analyzed in order to identify similarities between Q sorts. After examining several possible factorial solutions, we selected a three-factor solution explaining 44% of the study variance.[3] Each factor has a sufficient number of participants loading on it significantly, thus defining the factor or viewpoint (see the Appendix). Factor analysis also served to identify statements that form lines of agreement regardless of which factor a respondent loads on. Each factor was given a name conveying the topics central to it, thereby capturing the main content of the respective factor narrative.

Results and Discussion

In this section, we introduce and interpret the three factors extracted from the Q sorts of the respondents, expressing three distinct views, while we also analyze the common ground among the stakeholders we examine.

View 1: Market and Grid Solutions at the Center of Development

Factor 1 explains 15% of the variance among the respondents' Q sorts. Nine participants load significantly on this factor. The view the factor conveys finds support across participants from the public, private, and NGO sectors alike and from all four Nordic countries. The main interest underpinning this view pertains to competition. Respondents loading high on this factor[4] stressed the market as the cornerstone of the electric energy system and relevant grid solutions constituting the physical infrastructure for the market to function properly.

To achieve a market-based energy transition, the respondents highlighted the need for flexibility of demand, market pricing, and the "polluter pays" principle. Respondents stressed that this market-based development should take place within a regulatory framework promoting innovation and new solutions (13 Dk). Competition in electricity production among different resources is vital for this view. Accordingly, this view does not seek to maximize the use of local (or nationally available) energy resources; resources that are most effectively usable and offer most gains with respect to climate neutrality should have priority. In practice, this means preference for the cross-border trade of Norwegian and Swedish hydropower, and Danish wind power that are relatively often available in volumes exceeding national consumption. Moreover, the market pricing of electricity is seen as a key component in promoting the flexibility of demand: For example, prices should be allowed to rise in peak demand situations to prompt actors to control their energy consumption. This supports the recommendation of the Nordic transmission grid operators (TSOs)[5] for higher *maximum* prices (Statnett et al., 2016, p. 22), which are currently limited to €3000/MWh in the day-ahead market. Simultaneously, View 1 prefers to keep *average* prices on a "reasonable" level, in order to support not only competitiveness but also the socioeconomic interests of customers. The market preference also prompted these respondents to treat subsidies with caution, again supporting the views of Nordic TSOs (Statnett et al., 2016), owing to how subsidies may prove long-lasting and lead to higher average prices (8 Dk, 5 Swe), yet the positive effects of subsidies on nonmature technologies received mention (18 Nor).[6] The respondents also wanted customers to share the investment risks of low-carbon electricity production (Table 3).

In the postsorting interviews, the respondents frequently spoke of the freedom of markets, linking this to the interest in the wider economic benefits that a well-functioning energy business would create: "I mean, that's more or less that we believe that the market based approach is the best in order to actually get [a] cost efficient electricity system" (5 Swe). The market focus was especially significant given that respondents loading on factor 1 came from each of the four Nordic countries and from different sectors, thus confirming broad-based support for already existing Nord Pool cooperation. However, several recent contributions to the energy transitions literature do not share this market optimism (Andrews-Speed, 2016; Lockwood et al., 2016), proposing that market-based solutions need not only economic incentives, but also ambitious policies (Mundaca & Markandya, 2016; Moe, 2015, p. 236).

A second theme in View 1 was the development of grid solutions, especially eliminating bottlenecks from the electric transmission grid (13 Dk). The Nordic TSOs highlight the economic impact of congested electricity interconnectors, especially affecting connections between Sweden and Finland that need to be reinforced through new investments (Statnett et al., 2016, pp. 44, 45). The importance of grid infrastructure development for the market entry and competitiveness of renewable energy sources also finds support in existing research (Mundaca, Dalhammar, & Harnesk, 2013; Tenggren et al., 2016). By extension, promoting new types of flexible smart grids could support interests in resource and energy efficiency.

However, these respondents were skeptical as to whether microgrids should be part of all this. As of 2019, microgrids are not part of national strategies even though they can enhance the use of local renewable resources. They can also offer resource efficiency gains by means of avoiding expensive cabling into remote villages as microgrids can be power and energy independent of the central grid. Alternatively, they may be connected and disconnected from the central grid to increase the flexibility of the system by managing situations of network congestion and optimizing the supply portfolio (Järventausta, Aalto, Peltonen, Uski, & Valta, in press). Moreover,

Table 3. View 1 on the Role of Markets

Statement	Rank
Electricity production must be based on *competition* between solutions of different types and sizes (15)	(5)
The flexibility of demand must be promoted, but primarily through the *market pricing* of electricity (37)	(5)
When building the electric energy system of the future, the increase in the price of energy must be kept reasonable in order to *support competitiveness* and the well-being and purchasing power of consumers (48)	(4)
The polluter pays -principle must act as the cornerstone of energy and climate policy in order to reduce emissions (11)	(5)

Note: (5) = most agree, (–5) = most disagree.

microgrids may improve the resilience of the system against external disruptions and enhance the security of supplies. These respondents, however, did not view microgrids from the perspective of such wider societal interests or as a means of involving people in low-carbon transition. Instead, microgrids were associated with strong individual interests (4 Swe), while the focus should be on finding national-level solutions (13 Dk) and supporting the interconnected system in socioeconomically most efficient ways (8 Dk) (Table 4).

In the interviews, some of these stakeholders highlighted possible tensions between a top-down approach and a bottom-up approach in policy making. Some respondents cited "values informing cooperation" conveying a bottom-up approach, where decarbonization and climate policy, as well as a wider concern for the environment, an energy business-friendly market-based approach, and social interests typical of the Nordic welfare system should inform policies effectively and innovatively (4 Swe, 13 Dk). This lends some support to the calls to formulate energy policies aware of their interlinkages to other policy areas and for the need of policy integration regarding the energy/climate nexus (Mickwitz et al., 2009). However, these respondents were careful not to politicize energy transitions, criticizing "political interests," and associating them with top-down efforts of politicians to gain visibility. In the same vein, the set national policy targets were criticized as mere top-down "political agreements" not grounded on a proper analysis of socioeconomic benefits based on expert consultation and communication with nongovernmental stakeholders (4 Swe, 7 Swe). Overall, these respondents were aware of the interlinkages between different sectors of energy policy and of the multiple interests driving energy policies, including the potential competition between them (see Figure 1), yet they ultimately chose to prioritize market and grid infrastructure-focused technical and infrastructural policies, echoing the position of the Nordic grid operators (Statnett et al., 2016) and largely reproducing the current institutional format of Nordic energy cooperation. Such preferences typically result in mostly market-based incentive policies light on command-and-control instruments such as bans and penalties that for many observers would be necessary for energy transitions to proceed apace, while the technology optimism View 1 conveys may downplay the importance of involving consumers to accept and use the technologies.

View 2: Smart Transport Solutions and Questions of Resources

Nine participants loaded significantly on factor 2, explaining 16% of the variance among the Q sorts of the respondents. Participants loading on this factor were based

Table 4. View 1 on Grid Development

Statement	Rank
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 (31)	(–4)
Microgrids must be developed systematically, above all by ensuring that the people within their scope are committed to building a low carbon society (30)	(–4)
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 (19)	(4)
The use of local energy sources must be maximized in electricity generation in order to optimize the use of resources (2)	(–5)

Note: (5) = most agree, (–5) = most disagree.

in Denmark, Norway, and Finland. These stakeholders also represent different sectors stretching from business interest groups and NGOs to government agencies.

Electric mobility and smart transport solutions figure markedly in this view, driven by interests in resource and energy efficiency as well as climate neutrality. Electrically powered vehicles (EVs) can reduce the emissions of the transport system owing to the high share of low-carbon power in the Nordic electric energy systems. The respondents did not, however, mention the wider resource efficiency potential of EVs. These offer an energy conversion rate superior to that of vehicles burning fuels in internal combustion engines (Figenbaum, 2017, p. 14). The efficiency gains extend to the network, where EVs can help to direct loads and store energy; for homes, they can function as a reserve power solution. Efficiency gains furthermore extend to city planning as EVs can reduce local air particle emissions and traffic noise (Kester, Noel, Rubens, & Sovacool, 2018), and hence, enable siting residential buildings closer to main roads.

In addition, these participants preferred EVs to vehicles using biofuels, while of the four Nordic states, only Norway has made such a preference official (Nordic Energy Research & IEA, 2016, pp. 64, 65; see below). Here, these respondents referred to how the climate neutrality of biofuels has been questioned in the ongoing debate. The focus is shifting to advanced biofuels produced from sources not usable for food purposes, for example, waste oil, cellulosic biomass, or algae (Soundarajan & Thomson, 2013) (15 Nor, 17 Nor); however, here resource efficiency concerns are emerging over the whole cycle of harvesting, production, and distribution, alongside the carbon sink effects of the use of wood-based cellulosic biomass (Table 5).

EVs were also related to the transforming electric energy system. "We need to electrify the transport sector if wind and solar is [*sic*] supposed to cover as much as possible of the energy needs" (9 Dk). Moreover, EVs emerged as the main way to get "green electricity in cars" (11 Dk). The doubts about biofuels pertained to the limited nature of the resource base; all except Finland import biofuels, and while imports would decrease by 2030, in a fully decarbonized 2050 scenario, they would multiply from the current 6 TWh to 60 TWh (Nordic Energy Research & IEA, 2016, pp. 55–58).

These participants moreover preferred renewables in the form of wind and solar power (including offshore wind solutions), accentuating their integration into grid development and the building of interconnectors. They also supported the early phasing-out of nuclear power in favor of these two emerging sources which they associated with the prospects of electric transport offering balance functions through vehicle batteries, thereby helping to offset the variable nature of wind and solar power generation (9 Dk). This preference for disruptive policies rejected not only the decarbonization prospects of nuclear power but also natural gas as a transition fuel and

Table 5. View 2 on Transport Solutions

Statement	Rank
The society must promote the use of *electric vehicles* not only as a solution to the energy problems of transport: they also help with directing loads and storing energy and can even function as reserve power solutions in homes (29)	(4)
The *energy efficiency of the transport system* must be improved by promoting the use of smart grids and electric vehicles (35)	(5)
Vehicles using biofuels compare unfavorably to electric vehicles, when the aim is to make the energy consumption of transportation more environmentally friendly (42)	(4)

Note: (5) = most agree, (–5) = most disagree.

questioned the sustainability of forest-based biomass; not only does biomass have to be produced sustainably but also the best use cases have to be found. Biofuels should be used as a transition fuel for as short a time span as possible (11 Dk). Subsidies for existing fossil fuel power plants were rejected (Table 6).

View 3: Security of Supply and the Centrality of Society

Factor 3 explains 13% of the variance among the Q sorts of the respondents, with seven participants loading significantly on this view. These were all from Finland,[7] representing different sectors: government, NGOs, and different interest groups.

Security of supply interests is at the heart of View 3. Stakeholders favored striving for self-sufficiency in energy production and aiming at net exports of electricity. Self-sufficiency, however, is only one aspect pertaining to interest in security of supply in this view. Guaranteeing uninterrupted energy supply also includes the ability to address disruptions through supporting microgrids, which are so far not included in official policies; and allowing network operators to use energy storage as part of their grid operations, which is so far forbidden on grounds of the Finnish interpretation of EU level regulations according to which production is unbundled from distribution and storage associated with production (Toivanen et al., 2017). Nuclear power received support on grounds of security of supply—here, these Finnish respondents may have been thinking of the 45% share of Russian imports in Finland's final energy consumption. However, preoccupation with security of supply does not mean that fossil fuel plants should be supported in the same way as renewable and low-carbon energy (Table 7).

Another characteristic feature of View 3 is support for biofuels (see Table 8) in contrast to the preference in View 2 for EVs. Respondents emphasized the potential scaling problems of biofuels (25 Fin) and the diverging use cases of liquid biofuels and biogas in the transport system, citing the poorer efficiency of vehicles running on liquid biofuels compared to those using biogas (38 Fin). The flexibility of vehicles using biofuels was emphasized, especially when compared to the need to develop the network of charging stations for EVs (39 Fin). The energy use of wood also received indirect support in the form of a reluctance to prioritize measures for reducing the particle emissions from wood-based heating, which is an auxiliary heating solution in around two million Finnish homes in a country of five million people. In Sweden,

Table 6. View 2 on Resource Questions

Statement	Rank
Wind and solar power must be taken into account in developing the electricity grid. Grid connection must be available cost-effectively, in suitable locations, and with light permitting processes (22)	(5)
The use of forest-based biomass in energy production must be increased (8)	(–5)
The use of natural gas to produce electricity and heat must be ensured during the transition towards lower-emission technologies (5)	(–5)
The production of wind power must be supported both offshore, far away from human settlements as well as onshore when people produce it locally on their own back yards (6)	(4)
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 (12)	(–5)
Nuclear power must be phased out of the Nordic electricity grid, so that we can significantly increase the share of solar and wind power (23)	(3)

Note: (5) = most agree, (–5) = most disagree.

Table 7. View 3 on Security of Supply

Statement	Rank
Our country must be at least self-sufficient in producing electricity and preferably a net electricity exporter (13)	(4)
Network operators must have the possibility of using *energy storage* as a part of grid operations (18)	(4)
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 (32)	(4)
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 (31)	(5)
Nuclear power must be phased out of the Nordic electricity grid, so that we can significantly increase the share of solar and wind power (23)	(–5)
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 (12)	(–5)

Note: (5) = most agree, (–5) = most disagree.

Table 8. View 3 on the Biofuel Debate

Statement	Rank
The use of forest-based biomass in energy production must be increased (8)	(–1)
Vehicles using biofuels compare unfavorably to electric vehicles, when the aim is to make the energy consumption of transportation more environmentally friendly (42)	(4)

Note: (5) = most agree, (–5) = most disagree.

somewhat similar reservations persist regarding measures to reduce the emissions from small-scale biomass solutions (Salomon Popa et al., 2011, pp. 4461, 4462). The alternative to the energy use of wood would be to refine wood into cleaner burning pellets or to keep it in the forest as a carbon sink or use it in construction with similar effects. Biofuels and their role in energy transitions have evoked a lively debate, involving many of the stakeholders interviewed for this study and beyond. The support for biofuels sets View 3 apart from Views 1 and 2. This reflects the vested interests of the Finnish forestry industry in biofuels (Ruostetsaari, 2010, pp. 151–153), where bioenergy accounts for over 25% of total gross energy consumption, the highest share among the Nordic countries (Nordic Energy Research & IEA, 2016, p. 54).

The involvement of society as a whole in the development of the electric energy system was also crucial for View 3. Renewed attention to citizen–consumers is also part of the 2016 energy strategy of Finland (Government of Finland, 2016). Related to this, respondents stressed the need to offer people information on energy efficiency and climate neutrality implications upon choosing a specific energy solution. Energy price increases should also be kept reasonable in order to support the wider economy and national competitiveness as well as the well-being and purchasing power of consumers. At the same time, the centrality of energy prices in Finnish society also relates to the interests of Finland's energy-intensive industry, with the previous energy strategies stressing energy production in the interests of these industries (Toivanen et al., 2017).

From Common Ground to Common Nordic Policies

The three views that emerged from our analysis represent different combinations of policy measures and solutions vis-à-vis energy transitions while they each also relate to somewhat different underlying interests. Since we suggested that energy transitions depend on the support of stakeholders and noted how the Nordic countries seek to enhance their cooperation, we need to outline the extent of any common ground among Nordic stakeholders. Some approaches to STE policy conflicts seek to form a new "metanarrative" moving beyond existing controversies to establish a new, wider context that may be more amenable to policy interventions (Roe, 1998). However, Q methodology relies on a more bottom-up approach by helping us to point at a set of statements to which the participants reacted in a similar way regardless of which of the three views they espoused. These statements indicate agreement transgressing national and sectoral boundaries, and the differences between the three views we discerned. As such, they feature potential areas of Nordic cooperation, confirming stakeholder support for some established areas and pointing out some new measures (Table 9).

First, the participants broadly agreed on the need to promote flexible smart grids, also by regulatory means, to improve the efficiency of the system. Moreover, grid development was a major theme for View 1, while View 2 identified this issue as central in managing the systemic effects of a higher share of intermittent renewable power that the proliferation of EVs could to an extent help to integrate whether the batteries of vehicles were used as a network resource. Grid development (excluding the discussion on microgrids) is predominantly a nondivisive issue among the four countries and stakeholders in the public sector, companies, and NGOs represented in this study. Indeed, the Nordic TSOs call for "Clarification of differences and common goals for grid development in the Nordic region" (Statnett et al., 2016, p. 6). However, the Finnish TSO criticized the proposal of the Swedish and Norwegian TSOs for a new governance model for Nord Pool where they would decide on the rules in the back-up and reserve power market (Fingrid, 2017). This dispute stood in some contrast to how a report commissioned by the Nordic Council of Ministers recommends more political guidance for cooperation among TSOs and raises the possibility of their eventual merger (Ollila, 2017, p. 33). Our results nevertheless suggest that enhanced cooperation is widely accepted in principle, yet besides the current TSO-based format, it

Table 9. The Common Ground

Statement	View 1	View 2	View 3
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 (19)	(4)	(2)	(3)
The benefits of geothermal 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 (21)	(–3)	(–4)	(–4)
Underground cabling is weatherproof and as such the only solution for ensuring the security of supply of the network (28)	(–3)	(–3)	(–2)
Small-scale electricity consumers and the aggregators representing them must be steered toward investing in the flexibility of demand by tariffs and electricity taxes (36)	(3)	(1)	(1)
Binding minimum requirements that become gradually stricter must be set for industrial electric motors as well as data and communications networks that consume large amounts of energy (34)	(–1)	(0)	(0)
R&D funds must be allocated more strongly to energy and material efficient products, services and operating methods for the competitive advantage they bring (46)	(1)	(1)	(1)

Note: (5) = most agree, (–5) = most disagree.

should involve energy companies, among them distribution companies, and NGOs, keeping in mind how developing smarter systems will also involve decentralization.

Second, the three views agree that geothermal heat pumps offer efficiency benefits although they use electricity and may reduce the demand for the services of existing district heating networks. For example, in Finland in the past decade the number of geothermal heat pumps has multiplied in a largely uncoordinated manner in residential housing and by 2020 may reach 300,000 in a country of five million people. Together with other heat pumps, the figure currently exceeds 800,000 units (SULPU, 2017). Such a series of individual decisions by house-owners reduces the heat demand but may result in increased electricity demand for extra heating, especially in cold wintertime when the output of heat pumps does not suffice. Properly sized heat pumps may for their part feature stand-alone solutions disconnected from the district heating network. In the former case, residents rely on centralized electricity infrastructure only occasionally, while the latter case paves the way to a more decentralized infrastructure. In either case, the result is a reduced net demand for district heating on an annual basis which questions the viability of centralized infrastructure. This once more underlines the need for a wider stakeholder involvement in grid development than the current TSO-based cooperation format, to properly factor in the systemic effects of consumers' choices that may reverberate from the national to the Nordic level, especially in peak demand situations, where access to the Nord Pool market becomes crucial. Consumers are also likely to need incentives to be more flexible in their energy use and need service providers with new business models to facilitate this. So far, such service providers report a fairly weak demand from consumers, raising the prospect of policy intervention.

Third, underground cabling is not seen as the only solution to address concerns about security of supply. In Finland, the electricity market legislation practically forces grid companies to make extensive investments in underground cabling in response to supply disruptions following heavy storms (Toivanen et al., 2017). This legislation results in solutions that are resource ineffective and costly to customers. Here, our Nordic respondents recommended a cost–benefit analysis of different solutions to serve the security of supplies interest (13 Dk), alongside different technological approaches such as microgrids that could likewise improve security of supply in remote areas as well as nationally—especially in sparsely populated Finland, Norway, and Sweden (View 2). The benefits of microgrids have so far gone largely unrecognized in national strategies, while they would also reinforce the stakeholder roles of individual consumers and communities (Järventausta et al., in press).

A fourth line of agreement concerns the aggregation of the emerging small-scale production of prosumers and communities by means of tariffs and electricity taxes to support the emergence of a more flexible system. This is one more instance offering a more active role for consumers, although when it comes to policy instruments, some respondents preferred incentives to penalties. Nevertheless, aggregation business supporting small producers' entry into the market to make profits from their investments is so far poorly developed in the Nordic region and the market heavily favors the incumbent actors (Tenggren et al., 2016, p. 150), yet Denmark is an exception here. In addition to feed-in tariffs, it has since the mid-1980s guaranteed access to the grid. These policies have promoted renewable generation and participation of smaller producers as is also well seen in Germany with its over million solar

PV producers incentivized in this way (Moe, 2015, p. 162). Although this policy has shifted the cost of grid connection from the project developer to the utility, it has improved the latter's debt-to-equity ratio on financed transmission and distribution infrastructure when new production comes online faster (Brown & Sovacool, 2011, p. 252). Denmark's cooperative, not-for-profit ownership policy has also supported R&D interests by encouraging local innovation, widening the market by benefit-sharing, and serving regional interests by improving local acceptance, which, in turn, helps to meet the costs of the transition (Eikeland & Inderberg, 2016, p. 172). Prospective policy innovation to involve consumers and prosumers, however, needs to pay more attention to how information is presented and designed, as shown in a study on smart-metering initiatives in Copenhagen (Bager & Mundaca, 2017).

Last, these stakeholders placed statements regarding the setting of binding minimum requirements for industrial electric motors and data and communication networks as well as the allocation of R&D funds in the "neutral" area, or close to the center of the distribution. Although these issues seem to have little conflict potential among the group of stakeholders participating in this study, it may be challenging to find support for the proposal in the report commissioned by the Nordic Council of Ministers for a new 67 million euro research and demonstration program that would be part of the Mission Innovation initiative where EU Member States and 22 others commit to doubling their clean energy investments, encouraging private investment in this area (Ollila, 2017, p. 23).

Agreement also prevails on the pivotal role of the transport sector for the transition, but no Nordic consensus prevails on whether to achieve this by means of biofuels or EVs. So far, Norway has introduced several incentives supporting electric transport, including bus lane access, exemptions from tax and toll road charges, parking free of charge, and reduced ferry rates, resulting in over 140,000 EVs sold every year. Together, EV owners valued the incentives at some 1,900 euros per year in 2014 (avoided costs and value of time savings) (Figenbaum, 2017, pp. 14, 15). By contrast, the 2030 energy strategy of Finland foresees a 30% share for biofuels, reflecting the strong forestry industry, with 50,000 gas-fueled vehicles and 250,000 EVs (Government of Finland, 2016). In the absence of Nordic and EU level policy coordination, the result may be expensive, with parallel infrastructures failing to optimally facilitate cross-border movement of goods and people. Our stakeholders continuously stressed the need for exchange with other stakeholders precisely in order to avoid such scenarios. No such wide enough forum with a role in policy coordination currently exists. Nordic Energy Research, an institution formally under the Nordic Council of Ministers, works mostly on technological and infrastructural cooperation as do the Nordic TSOs.

Conclusion

In this article, we analyzed the subjective views of Nordic stakeholders in the policy, corporate, and NGO sectors on how to achieve a more resource-efficient and climate-neutral energy system by 2030. We argued that the subjective views of stakeholders are crucial since the transition will penetrate deep into society, requiring the support of stakeholders. Our approach to the stakeholders furthermore postulated different interests among them. Such differences hamper the debate on the relevant policy measures and solutions and the more specific policy instruments rendering the overall 2030 goals achievable, while they also influence the prospects for energy cooperation among the Nordic states that the interlinked nature of their energy systems warrants.

In response to our first research question concerning the preferred combinations of policy measures and solutions, we found three divergent views. The first view, attracting support from respondents from all countries and sectors involved, proceeds from the interest in competition. This view prioritizes grid development to technically facilitate market development but doubts the potential of microgrids. View 2, with respondents from all sectors in Denmark, Norway, and Finland, prioritizes electric transport. These respondents were critical of the sustainability of biofuel solutions and furthermore prioritized wind and solar power solutions, whose variable outputs the use of vehicle batteries as a network resource can help to offset. The third view, supported exclusively by Finnish stakeholders representing each of the three sectors, conveyed a distinctly Finnish concern with security of supply issues, including the potential of microgrids to this effect, combined with a strong support for biofuels and focus on the involvement of society in the transition.

The three diverging views also highlight different aspects of the energy system. View 1 echoes the generic focus of the current TSO level cooperation on the technical-infrastructural grid issues in market development. View 2 follows the emerging shift in the policy debate of energy transitions toward the consumption sector, linking consumption to network and system management as well as to the changing forms of production. View 3 then highlights Finland's current dependence on supplies from the geographical neighborhood, favoring the increasing use of Finnish forestry resources to produce biofuels. In addition, this view takes up the sectors of consumption and prosumption, which until recently have played a smaller part considering the country's largely centralized, production-oriented energy system.

Our second question concerned any clustering of Nordic experts according to interest or stakeholder groups or national lines that might influence the prospects of the intended decarbonizing transition and regional cooperation to that end. The outstanding policy issue in this regard relates to the role of biofuels versus EVs in the energy transition. On this point, the Finnish vested interests in the forestry sector and biofuels figured strongly, also reflecting the geographical constraints this sparsely populated country imposes on the development of the transport and energy system. The centrality of the security of supplies interest for Finland likewise stood out. At the same time, some Finnish respondents also loaded on the other factors, while the Finnish stakeholders associated with View 3 shared the consensus statements with the other stakeholders. Agreement on these statements indicates common ground on grid development on the Nordic and national levels, willingness to integrate new solutions such as geothermal heat pumps, to test alternatives to expensive underground cabling solutions, and to integrate small-scale renewable production as part of a more flexible electric energy system. Overall, we found that policy development in these areas presupposes a wider stakeholder base and more policy coordination for regional cooperation to overcome its so far fairly technical focus.

The institutional literature from which we proceeded on the theoretical level assumes strong path dependencies on the part of incumbent actors and the presence of vested interests hampering energy transitions, while the research on sociotechnical systems concentrates on "innovation niches" and R&D actors, some of which were also included among the respondents of our Q methodological study. Our approach incorporates the two literatures by suggesting the presence of both path dependencies and innovation opening up new paths in the ongoing energy transitions in the Nordic states. It is the task of empirical research and systematic analysis of the views of stakeholders to assess the importance of each perspective. Energy transitions are slow not only due to the persistence of both sticky patterns of social behavior and not easily malleable material structures. They are slow also because stakeholders have to tread carefully when both old and new paths need to be evaluated and because policies and solutions in neighboring countries have cross-border effects requiring regional coordination. Since the present transitions increasingly concern electrification and renewables, which initially are less divisive than unequally distributed fossil fuels, prospects for such regional cooperation exist. Future STE research in the field of energy transitions needs to take better account of this regional and international level.

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Notes

1 We include in our analysis Norway, Denmark, Sweden, and Finland but exclude Iceland since it is not interconnected with the other Nordic countries and has an idiosyncratic energy system with a very high share of geothermal energy.
2 In the widest sense, climate neutrality includes the effects of human activities on the number and types of aerosols in the atmosphere, and land use issues vis-a-vis climate change (Seppälä, Alestalo, Ekholm, Kulmala, & Soimakallio, 2014, pp. 5, 6).
3 An explained variance of 44% is a methodologically satisfactory result (Watts & Stenner, 2012, p. 105).
4 A respondent loading high on a factor (see the Appendix) sorted the statements in a way similar to the idealized viewpoint presented in the factor. The closer to 1 a loading is, the more similar it is to the ideal sort.
5 The four Nordic TSOs are: Statnett, Fingrid, Energinet.dk, and Svenska Kraftnät.
6 Here the respondents presumably refer to direct subsidies for renewable production such as feed-in tariffs, although the indirect subsidies for fossil fuel production grossly exceed these, for example, in the case of Finland (Toivanen et al., 2017).
7 This may be natural owing to the purposive overrepresentation of Finnish respondents. However, concerns specific to Finland, such as security of supply issues, also emerged in our earlier studies comparing the Nordic 2030 energy strategy documents (Aalto et al., 2017).

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Appendix: Participant Information and Respective Factor Loadings

Participant Number and Country	Sector	View 1	View 2	View 3
1 Swe	Interest group/business	0.1585	0.3846	0.4111
2 Swe	Public	0.1041	0.5241	0.5029
3 Swe	Interest group/business	0.1979	0.0188	0.3726
4 Swe	Interest group/business	0.5472*X*	−0.2863	0.0956
5 Swe	Business/interest group	0.7233*X*	−0.0844	0.3600
6 Swe	Public	0.0394	0.4117	0.3134
7 Swe	Public	0.4067*X*	0.1656	−0.0356
8 Dk	Interest group/business	0.5303*X*	0.2480	0.3266
9 Dk	Interest group/business	0.3801	0.5909*X*	−0.2206
10 Dk	Public	0.4981	0.4648	0.1568
11 Dk	NGO/environment	−0.1261	0.7457*X*	0.0261
12 Dk	Interest group/business	0.2764	0.4403	0.0310
13 Dk	Public	0.7758*X*	0.2871	−0.0448
14 Nor	Public	0.1483	0.5170*X*	0.0974
15 Nor	Interest group/business	0.3242	0.5724*X*	−0.1250
16 Nor	Public	0.2985	0.4167	0.1672
17 Nor	NGO	−0.0684	0.6906*X*	0.1845
18 Nor	Public	0.7630*X*	0.1116	−0.0315
19 Fin	Business/interest group	0.4067	0.0799	0.2671
20 Fin	Business/network services	0.1963	0.4439	0.4676
21 Fin	Business/environment	0.2912	0.3961	0.4019
22 Fin	Business/prod + network	0.2282	0.2795	0.6388*X*
23 Fin	Business/network	0.4644	0.3210	0.1766
24 Fin	Public	0.2041	0.6456*X*	0.1504
25 Fin	Business/R&D	0.0238	0.3703	0.6131*X*
26 Fin	Business/system equipment	0.4590	0.1495	0.5094
27 Fin	Business/network	−0.1576	0.1920	0.6317*X*
28 Fin	NGO consumers	0.7934*X*	−0.1097	0.2682
29 Fin	Public	0.2365	−0.1727	0.5245*X*
30 Fin	Business/equipment	0.7022*X*	0.2885	0.2723
31 Fin	Public/business	−0.1067	0.0722	0.6125*X*
32 Fin	NGO/consumers	0.6920*X*	0.1251	0.1996
33 Fin	Business/interest group	0.3167	−0.3340	0.4930
34 Fin	Business/production and network	0.3735	0.2437	0.4337
35 Fin	Business/interest group	0.2178	0.3336	0.3530
36 Fin	Business/interest group	0.0369	0.5953*X*	0.1952
37 Fin	Business/interest group	−0.1548	0.7787*X*	0.0869
38 Fin	NGO/environment	0.1001	0.0054	0.3858*X*
39 Fin	Business/interest group	0.0958	0.7685*X*	0.0349
40 Fin	NGO/environment	0.1438	0.3395	0.3272
41 Fin	Business/interest group	0.3156	0.2239	0.4026
42 Fin	Business/Interest group	0.5101	−0.0458	0.5114
43 Fin	Business/network	0.1345	0.0594	0.6681*X*

Notes: 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. Dk, Denmark; Fin, Finland; Nor, Norway; Swe, Sweden.