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Transition to distributed energy generation in Finland: Prospects and barriers

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HIGHLIGHTS

- We examine the possibilities and challenges of the transition to DE in Finland.
- Technological niches are emerging both in the heat and electricity sector.
- Business model innovation is evident only in the electricity sector.
- Removing barriers and developing new business models will accelerate the transition.

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ABSTRACT

Small-scale distributed energy generation is expected to play an important role in helping Finland increase its energy self-sufficiency. However, the overall strategy to date for promoting distributed energy remains unclear. It is not yet well understood which factors promote the growth of the distributed energy sector and what barriers need to be removed. In this article we present the results of a questionnaire directed at a panel of 26 experts from the distributed energy value chain and 15 semi-structured interviews with industry and non-industry representatives. We investigated, from a sociotechnical transition perspective, the possibilities and challenges of the transition to distributed energy in Finland through 2025. The results show that a shift to a prosperous future for distributed energy is possible if permit procedures, ease of grid connection, and taxation laws are improved in the electricity sector and new business concepts are introduced in the heat sector. In contrast to other European countries, the transition in Finland is expected to take place through a market-based approach favoring investment-focused measures. We conclude that incentive-based schemes alone, whatever they may be, will be insufficient to create significant growth in Finland without institutional change, removal of barriers, and the engagement of key actors.

1. Introduction

In the context of the current energy transition, distributed energy (DE) is believed to hold many advantages not only for increased renewable energy (RE) capacity but also for increased energy efficiency as a result of lower transport or transfer losses, increases in energy self-sufficiency and better security of supply (Alanne and Saari, 2006; VTT, 2015). In addition, DE offers local businesses and communities new opportunities for socioeconomic development (Li et al., 2013; Phimister and Roberts, 2012).

There are several definitions of DE, but a common one refers to a system where energy production and consumption are in close proximity (Allan et al., 2015). In such a system, prosumers (i.e. consumers with generation capacities) who produce heat or electricity for their own needs can also send their surplus electrical power into the electric grid or share excess heat via the district heating network (Alanne and Saari, 2006; Nystedt et al., 2006). DE systems usually utilize RE sources and rely on small-scale energy-generating technologies such as photovoltaics, micro-wind turbines, small CHP installations, ground source heat pumps, biofuel boilers or micro-hydro (Gaia, 2014).

EU member states have adopted differing approaches to increase their share of DE. For example, Germany has a comprehensive plan, the *Energiewende* (“energy transition”), to move away from fossil fuels and nuclear power. Under the Energiewende, a variety of policy initiatives, most importantly feed-in tariffs, have been

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implemented (Pegels and Lütkenhorst, 2014) to stimulate the shift from centralized energy production to DE (Praetorius et al., 2010). Sweden is using a quota system based on a green certificate trading scheme in combination with strong general incentives, such as a carbon dioxide tax to make fossil fuels less competitive in the household and service sector (Svebio, 2015). As a result of these policies, in both Germany and Sweden, new actors such as local communities, farmers and householders are enabled to play a key role in the spread of DE and development of new concepts of energy governance (Moss et al., 2014).

In Finland in recent years there has been increasing interest in small-scale DE generation technologies, including heat pumps (Heiskanen et al., 2011; SULPU, 2014a) and solar photovoltaics (Haukkala, 2015), but there are still great challenges to be overcome in order to achieve a large market penetration of DE (VTT, 2015). According to the vision of the Finnish government, expressed in the report *National Energy and Climate Strategy* (TEM, 2013), small-scale distributed electricity in the 2020s "may play a significant role in reducing the consumption of purchased electricity" and contribute to meeting the national "self-sufficiency target" (2013, pp. 11, 39). However, it is unclear how this goal will be reached in light of the fact that in Finland at the moment there is only an estimated 4–6 MW of photovoltaic capacity and 36 small biogas CHP power plants connected to the grid (Auvinen, 2015). The possibilities of distributed heat production have also been discussed in Finland for a decade (Sipilä et al., 2005), but centralized district heating relying on fossil fuels remains the most important method of heat provision (Finnish Energy Industries, 2013).

Prior research has discussed the overall potential of RE technology (Lund, 2007; Peura and Hyttinen, 2011) and energy efficiency services in Finland (Matschoss et al., 2015). Some studies have discussed, in general terms, the factors hindering the deployment of DE in the Nordic countries (Järvelä et al., 2011; Palm and Tengvard, 2011) and energy diversification in Finland (Aslani et al., 2013). Few authors have discussed the deployment of specific RE sources, highlighting issues such as the success factors for the market growth of heat pump technology (Heiskanen et al., 2011), the institutional aspects affecting wind power development (Spodniak and Viljainen, 2012; Varho, 2006) and the barriers to green electricity purchase in Finland (Hast et al., 2014). However, to date it remains unclear (a) why the overall Finnish DE capacity remains low despite the government's endorsement, (b) which factors promote the growth of the sector and (c) what barriers should be removed. Additionally, scant attention has been devoted to analyzing the development of the DE sector from a systemic perspective.

In this article, we address these identified research gaps by investigating, from a socio-technical transition perspective, the possibilities and challenges for the development of the Finnish DE sector in the next decade. We assume a socio-technical transition perspective because it provides a broad understanding of the factors at play in the transformation of an energy system, including regulation, infrastructure, industrial networks and consumer demand (Geels, 2002). By *possibilities* we mean the potential growth outcomes that could be achieved in Finland and by *challenges* we refer to the difficulties that need to be overcome to allow the transition to take place. Thus, our research question can be formulated as follows: What are the possibilities and challenges of the transition to DE in Finland through 2025? The scope of our analysis is limited to small-scale DE generation. Specifically, we use the Finnish Government's definition of small-scale electricity generation, which includes production up to 2000 kVA (Motiva, 2014), and assume a limit of 1000 kW for small-scale heat production.

To answer our research question, we used a questionnaire directed at a panel of 26 experts in the DE value chain and 15 qualitative semi-structured interviews with energy industry and non-industry actors. Our findings show that the transition to DE in Finland can have a prosperous future but market barriers need to be removed and new business models are required. This study contributes to the growing body of research in energy transition by examining the situation in a country that is trying to achieve a transformation of its energy system with less government intervention than in other European countries.

The article includes a description of the Finnish energy sector in Section 2, the theoretical framework in Section 3, material and methods in Section 4 and the results in Section 5. Results are discussed in Section 6 and we conclude with some policy recommendations in Section 7.

2. The Finnish energy sector

2.1. Electricity

Finland possesses many energy-intensive industries, such as paper and pulp, metal, and chemical industries, which, when combined with the northern location of the country, contribute to high per capita energy use. There are about 120 companies operating in the electricity sector but three companies own nearly half of the total installed capacity (Kivimaa and Mickwitz, 2011). Standalone electricity production is mainly used in summer cottages and as an emergency backup.

Finnish electricity production relies on several energy sources. The average shares of energy sources and net imports in Finnish total electricity consumption for 2010–2012 are given in Fig. 1. The shares of each source vary considerably from year to year, depending on temperatures and on the availability of hydropower in the Nordic countries. Renewable power accounts for about one third of total electricity consumed in Finland and is mostly based on forest biomass and hydropower (Statistics Finland, 2014). Nuclear power has the largest share (26%) of total electricity consumption and new capacity is being built by a consortium of Finnish power and industrial companies (Olkiluoto 3). In addition, the partially state-owned power company Fortum and several municipality-owned energy companies are planning to purchase another reactor (Hanhikivi 1).

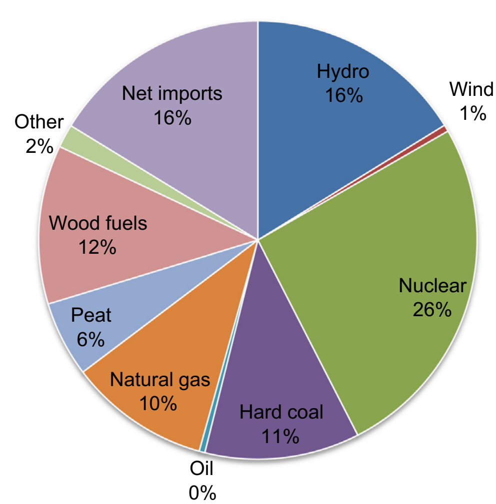

Fig. 1. The average shares of energy sources and net imports in Finnish electricity consumption 2010–2012.