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Futures of distributed small-scale renewable energy in Finland — A Delphi study of the opportunities and obstacles up to 2025

Vilja Varho [a,*], Pasi Rikkonen [a], Saija Rasi [b]

[a] Economy and Society, Natural Resources Institute Finland (Luke), Finland
[b] Bio-based Business and Industry, Natural Resources Institute Finland (Luke), Finland

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ABSTRACT

Distributed small-scale renewable energy (RE) production and markets expand globally. Policies play a major role in the growth. Distributed systems can help in achieving official targets, as well as offer economic opportunities for small-scale energy producers and the producers, retailers and installers of energy devices. However, small-scale energy production in households, farms or small enterprise has received relatively little attention in Finland to date. The opportunities and challenges of distributed small-scale RE sector in Finland were assessed in this study. Data was gathered using a Delphi-based method. 26 experts within the RE technology chain participated. Results were discussed and further elaborated in an expert workshop. Five scenarios representing views of the expert panel were produced for the development up to 2025: 1) Stagnation, 2) Stable slow growth, 3) Multifaceted reform, 4) Solar business prosperity, and 5) Electricity expansion at the grass root level. In no scenario was significant RE growth combined with little governmental support. Underdeveloped business concepts, insufficient information and availability of professional services, lacking profitability of small-scale energy sales, and the price of production systems were identified as key obstacles for distributed energy production in Finland. Removing barriers in domestic markets would also support exports.

1. Introduction and background

Although centralised energy systems are dominant in the industrialised countries, distributed production is increasing. Distributed small-scale renewable energy (RE) offers a potential for revolutionising the energy sector, and a partial answer to e.g., climate change mitigation and energy security. Realising the potential means new technologies, new business concepts, new actors in the energy sector and new roles even to existing actors. However, distributed small-scale RE has progressed very differently in different countries and there are still many obstacles that hinder the development. In this article we discuss how the distributed RE could develop in Finland up to 2025. How significant could the change be in about a decade? What are the most pressing barriers the actors in the field face? Our approach is based on views expressed by actors in the field in a Delphi study.

The article starts with a brief description of distributed RE and the current state of RE operational environment in Finland. In Section 2 we present the material and methods of the study. The results are described in Section 3, as five scenarios and a discussion of obstacles. Discussion and conclusions are given in Section 4.

Decentralised systems have been seen as a solution for many sustainability issues caused by centralised production systems, and to support local development and create local employment (Mangoyana and Smith, 2011). They also have potential to contribute to other policy goals such as reducing fuel poverty and increasing security through greater fuel diversity (Woodman and Baker, 2008). Increasing the capacity of distributed RE faces different barriers and there is likely no one solution to overcome them (Mangoyana and Smith, 2011). According to Woodman and Baker (2008), support systems are crucial for distributed energy, as electricity markets, for example, are designed to reward large-scale production.

Various policy goals have been set for the increase of RE. For example, all EU Member States have agreed to raise the share of energy consumption from renewable sources to 20%, and to reduce CO_2 emissions by 20% by the year 2020 (European Commission, 2008). Further, in October 2014, the EU leaders agreed on increasing the share of RE to 27% and on reducing GHG emissions by at least 40% compared to 1990 level by 2030 (European Council, 2014). For Finland the target share of RE in 2020 has been set as 38%. Nationally, a target to reduce GHG emissions by 80% below 1990 levels by 2050 was proposed in a Finnish Government's foresight report (Prime Minister's Office Finland, 2009) and set as a binding target in the Climate Act of 2015.

Although the EU has common targets, in different countries the envisioned role of distributed, small-scale RE in the move towards renewable energy varies. In the UK, for example, decentralised energy production has been seen as a possibility to achieve national sustainable energy targets (Wolfe, 2008). The German *Energiewende*, in turn, has

* Corresponding author at: Latokartanonkaari 9, Fi-00790 Helsinki, Finland.
E-mail address: vilja.varho@luke.fi (V. Varho).

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resulted in considerable increases of the capacities of different RE sources (Trendresearch, 2011). In Finland, the official view is somewhat less optimistic, as the 2013 National Energy and Climate Strategy (TEM, 2013; 39) states: "In the context of Finnish electricity production, small-scale generation has rather limited potential. Nevertheless, in the future small-scale generation may play a significant role in reducing the consumption of purchased electricity needed in buildings during the hours of daylight, in seasons favourable to producing solar power." The report goes on to point the export potential of Finnish companies, which are seen to benefit from domestic demonstration opportunities.

The support systems also vary between European countries. For example, in Finland feed-in-tariffs are only allocated to large-scaled plants, whereas in Germany small-scaled energy production is more extensively supported (Fulton and Capalino, 2012; Koistinen et al., 2014). The small-scale RE investments can be supported by a state grant in Finland, but it is not available to individuals but only to companies, municipalities, federations, associations etc. (cf. Ruggiero et al., 2015).

The emergence of distributed small-scale RE has been linked also to changing business concepts. While the traditional energy production is based on a centralised large-scale infrastructure, the emerging customer-side business concepts have been based on a large number of small projects, for example, in Germany (Koistinen et al., 2014). In these small-scale projects, energy production occurs in the consumption section of the energy value chain, instead of in energy utilities. They are conducted through, e.g., communal investment networks, co-operatives and farm clusters. This has meant new business opportunities and a need for new networks and concepts to emerge on the local level (Wassermann et al., 2012). According to Richter (2012), however, these customer-side business models are in an early stage of development. In any case, distributed systems also offer economic opportunities for the producers, retailers, and installers of energy devices.

This change in the roles and business models is only beginning in Finland. Although RE accounts for more than a quarter of total energy consumption in Finland, the RE electricity production is largely centralised forest biomass and hydropower use (Eurostat, 2014; Motiva, 2014; Statistics Finland, 2014). Wind power is only slowly increasing (~ 1% of electricity consumption), and is based mostly on large-scale production (over 1 MW turbines) (STY, 2015). Photovoltaics (PV) have mainly been used in off-grid solutions, but very recently small advances in PV have been made also in on-grid solutions. This has followed from the decreasing systems prices, but PV's contribution to electricity consumption remains marginal.

Heat production is more distributed in Finland than electricity production. Small-scale use of wood accounts for one fourth of the heating in residential buildings. Heat pumps, in particular, have quickly gained popularity, with over 60,000 units sold annually (Sulpu, 2014). They accounted for some 4% of all space heating in 2010–2012 (Statistics Finland, 2014). Co-production of heat and power (CHP) has been very common in Finland, and recently also micro-level CHP applications have appeared (Karjalainen, 2012).

This article aims at describing alternative future paths for and improving the understanding of the distributed small-scale RE in Finland, through an analysis of views to be found in the field. The aim is also to identify obstacles that are specific to the distributed small-scale RE. We ask through a Delphi study:

— What kind of probable and preferred changes do the Finnish actors in the distributed small-scale RE envision in the field in mid-term (up to 2025)? What kind of scenarios emerge from their visions?
— What are the obstacles faced by Finnish actors in distributed small-scale RE up to the year 2025?
— How do the obstacles differ in terms of building RE capacity in Finland, increasing business opportunities within Finland, and increasing small-scale RE exports?

2. Material and methods

The material for this study consists of a two-rounded Delphi process that was conducted in Finland in August 2013–February 2014. The Delphi method consists of experts' judgments by means of successive iterations of a questionnaire, to show convergence of opinions or to identify dissent or non-convergence (Linstone and Turoff, 1975; Kuusi, 1999; Rowe and Wright, 2001). We used a dissensus-based Delphi application (e.g. Tapio, 2003; Steinert, 2009). We therefore upheld the three traditional principles that can be considered as irreducible elements of the technique, namely anonymity in answers, iteration and controlled feedback between enquiry rounds (Rowe and Wright, 1999, 2001). However, the statistical aggregation of responses into a group response that Rowe and Wright (1999) also mention as a central characteristic was dispensed with, as several group responses rather than a consensus seeking single response was sought for. We were searching for the variety of views of what is possible in regard to distributed RE in Finland.

2.1. The Delphi panel

The Delphi panel was selected to represent the value chain of renewable, distributed energy production in Finland. The purpose was to cover the relevant viewpoints to be found within the field, and this was thought to be achieved best with a wide range of experts. Some panellists could be considered stakeholders rather than experts in a strict academic sense (see also Varho and Huutoniemi, 2014).

The respondents were chosen with the help of an expertise matrix. Although some characterisation of respondents was done by the research team in order to find appropriate panellists, the respondents were also asked to estimate their own expertise. They named the RE forms and the roles in the value chain they were most familiar with. They were allowed to name several energy forms as well as roles.

In Table 1 is itemised the expertise of the panel that completed the second-round questionnaire, from which the results of this article are drawn. In many cases there was more than one respondent who filled the two dimensions of a cell. For example, there were several panellists whose expertise included energy production and biogas. The bottom row of Table 1 indicates the number of panellists that named the energy source or fuel in question as their technological background. The right-hand column displays the number of panellists having indicated the role in question as their area of expertise. Although the cover is not perfect, each energy source and each role within the value chain got some coverage. Solar power and heat as well as hybrid systems are somewhat more represented in the panel than other individual technologies. However, if all bio-based technologies are considered together, also bioenergy is strongly represented.

The panel also demonstrated variety in other ways. For example, eight panellists worked in large organisations of over 250 employees, four in middle-sized organisations, and six in organisations of fewer than 50 employees. The panellists' work related to distributed, renewable and small scale energy production at least monthly, most commonly daily. Most respondents have a technical education, but some have an economic, social scientific or natural scientific background. Four panellists have doctorates, twelve have academic degrees or higher vocational diplomas, and two have a vocational or college education.

2.2. The questionnaires

During the first round of the Delphi study, data was gathered through 17 semi-structured, face-to-face interviews, and another 9 experts responded to a similar questionnaire online. The structure of the first round questionnaire allowed experts to express new questions or statements of their own.

The second-round questionnaire was organised as an online questionnaire. An invitation to the second round and a feedback report