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Organizational innovations in the era of renewable energy systems

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Abstract: In this paper, the importance of organizational innovation related to renewable electrical energy industry is discussed. The study has shown that development and implementation of the energy strategy in Finland, as probably in any other country, should be considered as a complex implementation of all the types of innovation including technological and organizational ones. The approach on how firms can obtain knowledge of changes in the environment of forthcoming renewable era was elaborated and implemented. The suggested approach combines megatrend and industry analysis followed by a Delphi survey. Based on this data, the potential organizational innovations in Finnish wind energy sector were identified. The results can be used by energy generation firms as well as other interested entities in the energy market.

Keywords: Disruptive technologies; renewable energy; electricity generation; wind power; organizational innovation.

1 Introduction

The paper aims at investigating the potential areas of organizational innovation in Finnish energy sector (considering both the generation and the consumption) that is under transformation due to forthcoming disruptive technologies. Disruptive technologies as

such lead to considerable changes in value-creating networks which, in their turn, open up new business and innovation opportunities for actors (Amshoff at al., 2015). Without new organizational and social regimes, or well-developed business models the technological innovations may never be efficiently implemented (e.g., Geels and Schot, 2007; Teece, 2010).

To become and remain successful firms must consider the business environment as a dynamic and continuously changing system. (Bergman et al., 2006). That makes a firm to consider changes in its strategy and, in particular, changes of functional innovation strategy as a part of the overall strategy. Each firm must periodically renew itself in a rapidly changing environment which can be seen as manifestation of their strategic resilience (Hamel and Välikangas, 2003). A firm must explicitly realize that to be able to adapt itself to continuous change of the environment it should keep it organizational structure flexible and be always ready to modify it quickly in accordance to challenges of both the external the and internal environment (Ellis and Shpielberg, 2003; Dukeov, 2008).

Studies on organizational innovation noticed that the organizational innovation often play a role to get a technological innovation to be implemented as well as to let a firm to obtain a competitive advantage in the emerging and fast developing business environment (e.g., Strupeit and Palm, 2016). Our study provides further knowledge for the early phases of the innovation process in Finnish wind energy sector.

Energy system in Finland has developed during the 20th century to fulfill the challenges of cold climate, long distances and increasing needs of the energy-intensive industry. As a part of the Nordic electricity market it faces nowadays the energy system disruption presented in Nordic countries due to the wind energy system rapid development. Record-low electricity prices have already challenged the traditional energy sector, as investing into conventional power plants has become unprofitable. These challenges will become even stronger when the era of renewable energy generation is considered (Child and Breyer, 2016).

To examine further the organizational innovation in renewable energy sector, our study uses multiple sources of data combining public energy sector futures reports and data collected through Delphi survey. The data was obtained from three different types of sources: 1) archival data including global-level future reports on energy sector; 2) trends of wind energy technologies; 3) Delphi survey with the followed workshop.

Firstly, the mega-trend analysis was carried out in order to outline the Global trends in energy generation and consumption in the World. The mega-trend analysis provided the understanding of forthcoming global trends that pertained for the energy sector in general and their specific appearance in Finland. Secondly, we also provide the technology trends related to the wind energy development until the year of 2050 based on the technology reviews. The technology trends underlie the Delphi survey with the followed workshop. That survey was conducted to investigate the most influential drivers affecting the wind electrical energy sector development in Finland. Based on the obtained data we define the organizational innovation related to external relations that seem to be the most relevant to be implemented for the further efficient development of the wind energy sector in Finland.

We organize our paper as follows. We discuss the theoretical framework of organizational innovation in general as well as with some focus made on renewable energy sector through the extensive literature review. Next, we introduce the used

methodology and present the data obtained. Finally we present the results and future studies foreseen in the frame of our theme.

2 Literature review

Renewable energy generation sources combined with digital technologies of grid control as well as with advanced technologies of energy storage, shape the forthcoming new era in energy generation and consumption. In some studies (e.g., Manyika et al., 2013; Stoiciu et al., 2017) wind power is often referred as disruptive technology with high potential in the future. As per technology side, it is expected of high innovation activity in the area of smart energy solutions that would lead to appearance of new business models as well as ecosystems. The last in their turn will radically change the existing pattern of relationship between producers, service providers and consumers (Heiskanen et al., 2017).

It is consensus in the literature that to maximize the benefit from implementation of the product innovations, firms at the same time must develop intensively appropriate organizational innovations to multiply successfully the overall effect innovations into profit (Teece, 2010). In previous innovation management research organizational innovation is considered as a crucial factor in firm survival in the environment that is unstable and is ever-changing (Armbruster et al., 2008; Birchall et al., 2011).

Despite the fact that Joseph Schumpeter introduced the term “new industrial organization” in the beginning of the 20th century, organizational innovation is a relatively new concept to be researched and implemented (Klette et al., 2004). Scholars provided various definitions and classifications of organizational innovation in an attempt to explain and specify what they understand by this term. The organizational innovation area was widely acknowledged by the scholars but for many reasons it is less investigated and discussed than technological innovation (Sapprasert and Clausen, 2012). Some researchers (e.g., Fagerberg et al., 2012) stressed the role that organizational innovation plays in the theory of innovation.

In the year of 2005 OECD-EUROSTAT (2005) introduced in the document “Oslo Manual” the definition of organizational innovation that is widely used in the modern theory of innovation. This document understands by organizational innovation “the implementation of a new organizational method in business practices, workplace organization or external relations” (OECD-EUROSTAT, 2005, p.51).

The interest towards the problem of what impact organizational innovations have on the performance and competitiveness of firms is continuously increasing. According to Wengel et al., (2000) there are two main reasons of why organizational innovation topic attracts attention of scholars and practitioners. Firstly, it is always attractive to learn about or introduce new organizational forms or management methods that are more efficient compare to existing ones. Secondly, because of some product or process innovation cannot be effectively implemented without support of organizational innovation.

According to several studies in renewable electrical energy industry the efficiency and eventual success of the electrical power generation and consumption depends much on organizational innovation (e.g., Strupeit and Palm, 2016). For example the incumbent energy companies are very slow in following the continuing change in business environment not introducing the sufficient level of innovation and therefore losing their

market share and profitability (Richter, 2012; Kungl, 2015). Partly it can be explained by the fact that in the energy sector, new innovation are still emerging from based on activities of new entrants or even grassroots actors (Korjonen et al. 2016). However the role of incumbents is decreasing and the overall situation is changing rapidly (Frantzis et al., 2008).

There is strong agreement in the literature that the forthcoming disruptive renewable electrical energy technologies will change dramatically the existing pattern of the industry introducing the growth amount of innovations of all the types (Klose, 2010). This leads the firms operating with the generating and consumption electrical power face the challenge of fitting their business models for the new reality of the continuous change in that industry (Richter, 2012). The crucial issue for the firms is how fast they could come with new set of organizational innovations that lift them to the state-of-the-art stage of operating their business in the era of renewable energy sources.

In the next chapter, we investigate what kind of organizational innovations are demanded by forthcoming state of the art electrical energy generation and consumption technologies in Finland. For the purpose of this study we limited ourselves only to organizational innovations related to external relations. That means new forms of organizing relations with public institutions, customers, suppliers, subcontractors, i.e. new sources for organizational innovations. We also limited our study only to the wind power energy sector.

3 Research design

Methodologically this study aims at the environment analysis and employs three different methods to collect and analyze data. The data was obtained from three different types of sources: 1) archival data including global level future reports on energy sector, 2) trends of wind energy technologies, which allows us to analyze some renewable energy related technology in much more detail, 3) the Delphi survey that comprises both the numerical data obtained by mean of the questionnaire and the key insights from workshop discussions an example of the style for a first paragraph after any heading, figure, table, list, quotation or formula.

The structure of the analysis in the study is presented in fig.1. On the first stage the mega-trend analysis was carried out in order to outline the Global trends giving the global frames and motivation for energy sector development. The key aim of the mega-trend analysis was to provide the understanding on the future needs for technological and organizational innovations regarding the disruptive electrical energy generation and consumption technologies are coming. We consider as megatrends the transformative, global forces that determine the development of the world, especially the energy sector. The megatrends strongly influence all kind of social activities (business, societies, economies, culture, and personal lives, as well as physical world (Sitra, 2015). The analysis was made based on the selected global futures reports, provided by EEA (2015), EU (2011), Heinonen et. al (2015), IEA (2015), REN21 (2016), Shell (2013), Sitra (2015), UN (2011), WEF (2014), and WWF (2015).

Firstly, based on the analysis, the megatrends were grouped by specific areas as Globalization, Ecosystem, Urbanization, Technology, Energy, and Economics. *Secondly*, the megatrends pertained to the energy industry of Finland have been selected and

analyzed in order to define organizational innovation potential for the energy industry of Finland (fig. 1).

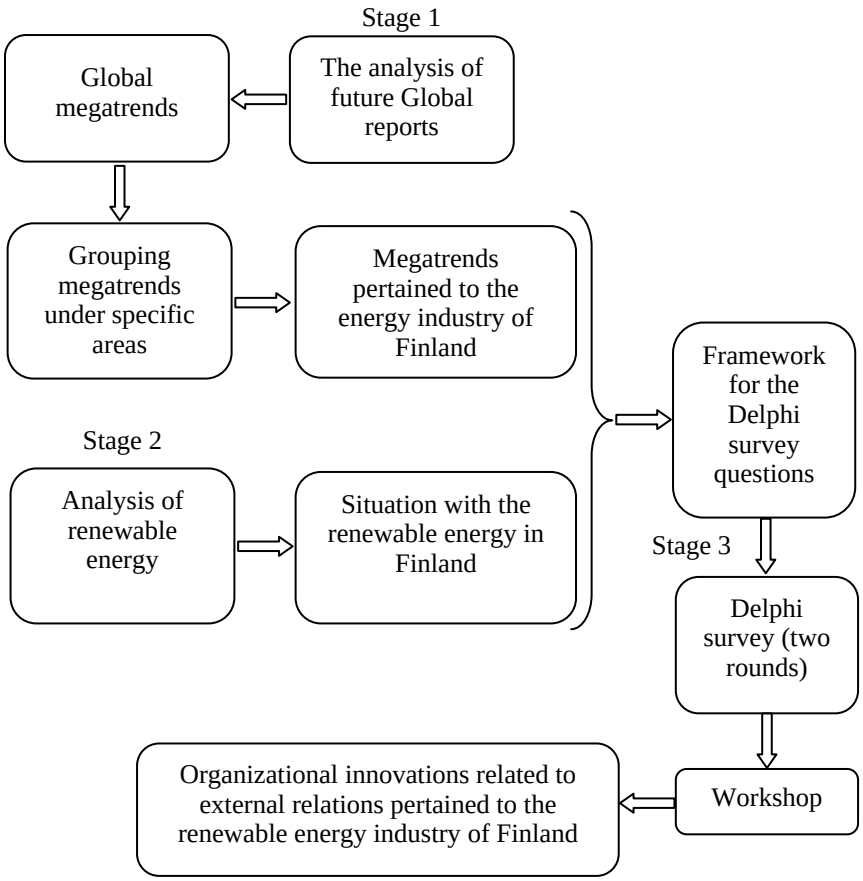

Figure 1 The structure of the analysis in the study.

On the second stage the renewable energy generation and consumption sources were investigated in the more detailed form in order to receive the pattern on the current event of things with the renewable energy industry in Finland. The trends of wind energy technologies were derived from the industry related reports provided by institutions and agencies involved in industry monitoring and survey (e.g., IRENA, 2012; GWEC, 2014, 2016).

On the third stage, the data obtained on the first and the second stages underlie the design of the third stage that is Delphi survey (Linstone and Turoff, 1975). Delphi research process typically comprises an anonymous survey, as this allows collection of individual views concerning technologies and topics in the survey. In our survey, we conducted the first and the second round of the Delphi survey in April and May correspondingly of the year 2016 with the following workshop in June of the same year. We sent the surveys to 250 energy sector experts in Finland. The experts included

academic, industry, and public authorities. In each round 50 respondents retuned the filled in forms. At last, based on the Delphi survey results, the workshop was organized in order to gain deeper understanding of potential innovations pertained to the forthcoming energy sector change in Finland.

4 Data analysis and results

Megatrend analysis

Based on the above-mentioned futures reports the following megatrends were detected and seem to have the most significant influence on Finnish energy sector.

Globalization associates with making the world more transparent and shared by means of increasing volume of information exchange. Finland, being a small and very coherent society, has a kind of “mindset of personalization” that drives creation of solutions for small group of users. The challenge for the country would be to disseminate these solutions globally. For instance, wind energy technology development and implementation offers to potential business entities two levels of actions: domestic and export activities. At the moment, renewable energy business in Finland often comes to implementation of imported technologies and solutions. Nevertheless adapting those technologies and solutions to the local needs forces the development of innovation in both the technological and the non-technological areas. Finland posses some competitive advantages in the energy sector, e.g. in power machinery, energy transmission, and wooden biomass processing. Finland cannot beat though the competitors in production process like solar panels, heat pumps, and wind turbines.

By the global ecosystem is assumed a complex cause-effect system that connects humans with the environment. On one hand, Finland has received experience in operating various projects in extreme environment and, on the other hand, keeps the very environment unpolluted. This provides a high competence level in developing and implementation projects in some specific areas such as mobile hybrid emergency energy solutions, energy efficiency solutions for buildings, special equipment for extreme conditions as robotics and energy storage, clean technologies, and similar.

Since Finland is a sparsely populated country with long distances between the urban areas, it has received experience in developing and implementing long-distance electricity and regional energy transmission systems as well as transportation logistics.

Finland based on its previous experience could develop further the competences in arctic type renewable technologies, energy storage technologies, prosumer concept development, mobility concepts, smart gridding regarding to long-distance electricity transmission, as well as other kind of IT solutions related to energy generation and storage control. The competencies in the ICT provide potentials for Finnish actors in, e.g. analysis of big data, global energy network security approaches, personalized energy services, intelligent control of energy generation and consumption.

From the global perspective, Finland is extremely small market having very limited but focused resources to compete internationally. Finland can be seen as a grassroots-level innovation platform for testing state-of-the-art solutions and their diffusion among the small communities. In other words the whole country can be regarded as the

community that generates continuously new globally scalable innovations. This demands developing new kind of mindset for Finnish actors.

The megatrend analysis gives the operative frames for global institutions as well as for grassroots-level actions. The effect of megatrends on the society vary depending on the actions taken by that society against or along with those megatrends. More than that, the actions can be reactive or proactive. Ignoring the megatrends is also an action that would most likely lead increasing the lag in the society development. In other words, megatrends determine the directions of economy development. Thus, Finland should develop itself in the way that takes in account the global megatrends. This can only happen if Finland sustains and foresees competencies of the future demand. These competences are difficult to identify in advance.

Industry analysis

Wind energy systems have taken grounds for the renewable energy production during the last two decades. In year 2013 wind energy systems had the share of 2.9 % (GWEC 2014) of the annual global electricity generation.

According to (GWEC 2016) globally installed capacity of wind energy systems has increased by 35.8 % within the years of 2013-2015. In natural values that means from 318 458 MW in 2013 to 432 419 MW by the end of 2015. Thus, current installed capacity at the end of 2015 was around 840 TWh, or approximately about 3.5 % of the total global electricity consumption.

There is only a very general strategy on wind energy development in Finland nowadays, which includes only the general targets (MEE, 2014). The regulatory environment in Finland has not been over-supportive towards new methods of electricity production, such as wind power. Positive changes in the regulatory environment have started to take place after 2010. Feed-in tariffs for wind power that were designed to support economically both the use and development of wind power in Finland were introduced in 2011.

By the beginning of 2017 wind power capacity in Finland was 1533 MW as 182 new turbines and combined capacity of 570 MW was put into operation during the year of 2016 (FWPA, 2017).

With this capacity about 3,6 % of the total energy consumption in Finland is covered by the wind energy that is generated by 552 wind turbines. The objective is to have 2500 MW of installed wind turbine capacity by the year of 2020 and 3750 MW of installed capacity by the year of 2025. The size of the potential projects is growing towards 20-50 MW for on-shore farms. As for the future development of the wind energy sector the offshore wind farms and arctic technologies are considered (MEE, 2014).

Delphi survey

The Delphi survey comprises both numerical data obtained with questionnaire and key insights from workshop discussions by 40 experts. That data is used as comparative source of information for developing future solutions for the Finnish energy sector actors. The main results of the Delphi analysis are described in this section.

In general, 51% of Delphi survey respondents have claimed that the wind energy consumption will be between 10 and 30% by 2030 and about 3% of respondents claim this share as being exceeding 30% of the total electricity demand in Finland.

Regarding the wind energy, based on the Delphi survey results in the short term wind is the most important technology for CO2-emission reduction. More than 80% of respondents agree that before 2030 no disruptive wind energy generation technologies would be developed and implemented in Finland. The new and existing systems will be only incrementally modernized technically. About 10% of the respondents claimed that by 2030 Finland would develop wind energy generation technologies that could be exported. About 45% and 20% of the respondents claimed that Finish wind energy sector would attract about 50% and 70% correspondingly of all the demanded investments from the domestic sources. The broad range of organizational innovations related to windmill deployment, technology, economics, legislation, and social aspects are needed to be discussed, solved, and implemented in order to get speeded wind power generation technology in Finland. Figure 2 presents findings of the Delphi survey respondents concerning the importance of different energy technologies in Finland in 2030.

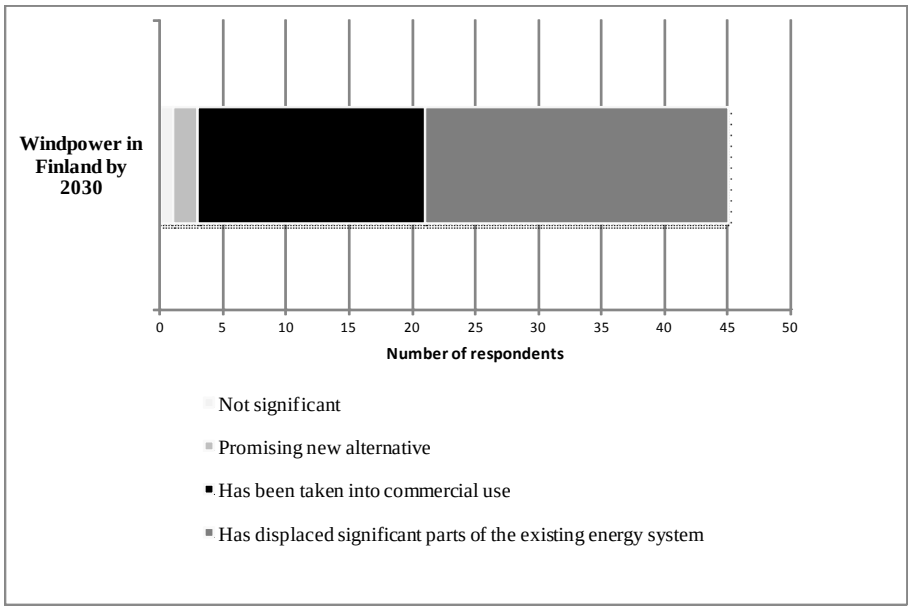

Figure 2 The findings of the Delphi survey respondents concerning the importance of different energy technologies in Finland in 2030.

Our findings could be categorized in two areas: potential patterns of renewable electrical energy technologies development in Finland, and promising modern approaches on development organizational innovations supporting disruptive technologies in the electrical energy sector of Finland.

The table 1 provides a few examples of the results obtained by means of the suggested approach. The first column of the table presents the findings related to the barriers needed to be overcome in Finland to have the wind energy be developed further. The second column indicates which actors should be involved in the process of

overcoming the given barrier. The third column presents the potential innovation that would create circumstances to overcome those barriers as it was found during the Delphi survey and the workshop. This synthesizes the whole study and can be considered when elaborating the renewable energy related strategy for the country.

Table 1 Some examples of the results obtained in the study

The findings elated to the barriers	*Actors that should be involved in the process of overcoming the given barrier*	*Potential organizational innovation*
Renewable energy system elements coming to be in mass production	Suppliers, Sub-contractors	Efficient network should be elaborated
Very often it is easy to build wind power farms in locations where there is no consumption. This creates needs for transmission capacity. Nowadays The technology of transmission goes behind the technology of generation.	Public institutions	New solutions of energy transmitting and storage must be developed by R&D organizations
Variability in wind energy production will need the demand-side flexibility. Thus, fluctuation of prices should also reflect available demand-side capability.		New model economic relations with customers should be introduced
On investment phase there is not much potential for private customers and their capital inputs	Customers	New approaches in individual financing are demanded
Specifics of Finnish energy marketplace due to cold climate	Public institutions	Research on how to use wind energy under the environmental specifics of Finland provided by R&D organizations
	Sub-contractors	Developing technologies for being implemented under low temperature (in particular, de-icing of the wind-turbine propellers)
Energy storage	Public institutions	New solutions of energy transmitting and storage must be developed by R&D organizations
	Sub-contractors	Can be connected to the district heating network and heat pumps in order to take full advantage of production
The relations between turbine operators and local community. The local community could both create the troubles or be very supportive to turbine operators	Other interested parties	The models to involve the local residents should be introduced

5 Conclusion, limitations and further research

Our study has shown that development and implementation the energy strategy in Finland, as probably in any other country should be considered as a complex implementation of all the types of innovation including technological and organizational ones. Provided the success in the mentioned above innovation activity Finland will get independence from fossil energy generation technologies. The Finnish society will benefit from receiving the reliable up-to-dated system of electrical energy generation and the modern approaches to manage this system (Heinonen et. al, 2015).

The study has some methodological limitations. The first limit is that from all the range of renewable sources only wind energy related issues are considered. Second, we carried our study in frame of only one country. Third, data set should be large to find more organizational innovation and much stronger relations between organizational and technological innovations as well as between organizational innovation and other types of non-technological innovation. The further research should take into consideration that the development of the renewable energy sector driven in a large its part by disruptive technologies associates with continuous introduction of technological innovation (Richter, 2013). The last in their turn provokes high demand for organizational innovation.

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