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Early adopters boosting the diffusion of sustainable small-scale energy solutions

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ABSTRACT

Local level actors have an important role in developing small-scale energy innovations as well as disseminating the gained knowledge to key audiences. Diffusion of these energy solutions from innovators and early adopters to wider user groups has often been slow. This study explores the innovators' and early adopters' experiences of their projects, motivations for their behavior, and obstacles that inhibit the diffusion of energy innovations. Four different types of innovators and early adopters of new energy solutions are identified: Enthusiasts, Utilizers, Green Developers and Green Consumers. These groups are characterized by different sets of motivating factors, including environmental concern, interest in technology, economic profit, self-sufficiency, willingness to utilize excess material, promotion of innovations and image reasons. They also have encountered different kinds of barriers to their actions, such as lack of relevant information, poor product quality and lack of economic and institutional support. The different motivating and forestalling factors should be identified and taken into account when developing incentives as well as interaction and communication strategies to enhance the diffusion of innovative, sustainable small-scale energy solutions.

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1. Introduction

Climate change and the depletion of non-renewable energy sources are major challenges encountered by societies of our time. A transition towards renewable energy sources and more efficient energy consumption is essential [1,2]. For example, the European Union has set three targets for mitigating climate change until the year 2020. These are reducing greenhouse gas emissions by 20% from the 1990 level, increasing the share of renewable energy to 20% and improving energy efficiency by 20% [3]. The Renewable Energy Directive [4] defines the binding national targets for the shares of consumed energy from renewable sources in the EU-27 member states by 2020. The share of renewable energy is to be 27% in the EU by the year 2030, but this target is not defined as binding national targets. Even more ambitious targets have been called for and potential solutions to meet the targets have been presented. Jacobson and Delucchi [5] have suggested that all of the world's energy need could be produced by wind, water and solar power by the year 2050. They argue that the barriers to realize the plan are primarily social and political instead of technological or economic. To achieve the ambitious targets and to build a society less dependent on the depleting sources of energy, transitions of energy production and consumption are required [6,7].

Renewable energy sources are typically more diffuse than non-renewable energy sources and possibilities to increase their small-scale local production are ample [2,8]. As for energy efficiency, it can be improved everywhere where energy is being used. Due to the losses and transfers in centralized energy production, local production and efficient use of energy are promising future strategies for the energy system.

Various technologies to produce and save energy at small-scale exist and, for example, biogas and PV (photovoltaics) production have increased rapidly in some countries, but the adoption of these solutions has been slow in many European countries, such as Finland [9]. Large-scale transitions to sustainability entail not only technologies, but also cultural meanings, policies, user practices, information sharing and markets [10]. This is also the case in the smaller scale processes of diffusion of innovations. Diffusion of innovation refers to a process, where information and ideas of a certain innovation spread through interaction channels inside a social system [11]. Diffusion of innovations and adoption of new technologies is not just a matter of technological development and rational choices; it is also a social process. Even evidently advantageous innovations will not automatically diffuse among potential adopters. Competing innovations, social norms and routines or simply lack of efficient communication, for example, might hinder or prevent the diffusion processes [11].

The diffusion of new energy technologies takes place in stages ranging from innovation to adoption and stabilization and in this article we will focus on the first adopters of innovations, whom we call forerunners. Syvänen and Mikkonen have noted a great interest among homeowners towards energy efficiency and new local services of small-scale production of renewable energy in Finland [12]. To convert the interest into action, it is vital to review and explore the reasons that hinder or advance forerunners in the adoption of renewable energy and energy efficiency solutions. This knowledge could help in developing effective interaction and communication strategies as well as in supporting the diffusion of the energy innovations.

Our objective is to study how the forerunners enhance diffusion of innovations and create paths for innovative small-scale sustainable energy solutions. We review the experiences of forerunners of such solutions in Finland and report the results from interviews and an internet survey. Based on 54 interviews and 36 questionnaire responses, a qualitative analysis of the characteristics, experiences and perceptions of the forerunners is performed. The informants were selected from the 'Forerunners'-project, consisting of over 250 Finnish innovators and early adopters of new energy solutions. These actors have implemented concrete and innovative measures to switch to renewable energy sources or to improve energy efficiency. The project focused on identifying the key factors contributing to the actions or restraining them. Based on the material, a typology of the respondents is created. We argue that different types of forerunners have different kinds of needs for support and communication.

We start by briefly reviewing some key concepts of diffusion of innovations (Section 2). We will then describe our case (Section 3) and the material and methods used (Section 4). Results are presented in Section 5. We discuss the results and present some concluding remarks in Section 6.

2. Diffusion of innovations

One key factor hindering adoption of new innovations is path dependence [13,14]. Technological "lock-in" is also a commonly used term. Both terms refer to a situation where earlier choices and processes have created structures that hinder the adoption of new innovations. Not only physical infrastructures such as grids but also knowledge, education, social norms, and legislation are structures causing lock-in. Many actors within the structures have vested interests in the existing system. Energy production systems are highly path dependent: they usually require large set-up or fixed costs, enjoy high learning effects from past experiences, have remarkable coordination benefits with other actors on the field, and profit from customers' existing expectations of the product [15–17]. These factors hinder new energy alternatives and entrepreneurs from entering the field and challenging the existing structures.

In the coming decades energy prices will probably increase due to the depletion of conventional energy resources and the tightening greenhouse gas emission regulations. This will likely counter the old path dependencies and increase demand for renewable energy production and energy efficiency solutions. In this kind of forced change the role of state and energy and environmental policy is emphasized over pure innovation-driven change [15]. A strong and focused innovation policy directed to renewable energy innovations could be a part of the process, and has been called for in the case of Finland, as well [18,19].

In energy systems, the physical product that a consumer receives – electricity or heat (or cooling) – is quite similar regardless of the production manner [15]. Therefore the price, other resource demands (e.g. related workload or energy storage needs), perceived environmental effects and risks, and social values dominate the decisions related to energy consumption. External costs and benefits of different energy sources are difficult to assess and they are typically not included in prices. This has often given advantage to the conventional centralized energy sources that have better price competitiveness compared to alternative energy solutions. Heat pumps are a good example, as the technology has been available for decades, but not until recent years have they started to become common in Finland [20]. The change has been induced by the increasing prices of oil and electricity and renewable energy

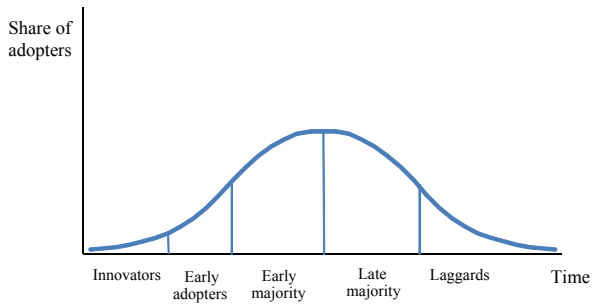

Fig. 1. Different types of adopters on an adoption curve. Innovators and early adopters are the first users of an innovation. Modified from Rogers 1995 [11].