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Maximizing bioenergy potential: policy recommendations for Finland

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Summary

In line with other renewable energy resources, bioenergy is burgeoning (Müller et al., 2015). However, some concerns and challenges exist regarding biomass production for bioenergy such as deforestation, greenhouse gas emissions and food insecurities (ibid). Therefore, for developing the bioenergy systems on large scale, we should consider those challenges. Moreover, the sustainable governance is required. Müller et al. (2015) suggest further research to formulate a set of practical policies or policy recommendations with that regards.

Finland is a global pioneer country in bioeconomy and one out of four strategic goals of its Bioeconomy goals is “accessibility and sustainability of biomasses” (Biotalous, 2014).

The innovation systems studies are suitable for assessment of current status of a technology and its future direction to provide a policy recommendation for steering the technology (Bergek et al. 2008)

In this report we ask two questions. First, what is the current state of bioenergy in Finland? Second, how the changing regime can be expected to put pressures on the niches and how this process should be managed?

Helsinki, 18th December 2016

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1. Background

Hekkert (2009) “Innovation is increasingly considered crucial to deal effectively with the negative side effects associated with economic growth”.

The components of an innovation system are the actors (i.e. individuals, firms, banks, universities, research institutes, and public policy agencies), institutions (can be in the form of legislative artifacts) and networks (the relationships and interactions between them) which contributing to develop, diffuse and utilize new products, goods, services or processes (Bergek et al., 2008; van Alphen et al., 2009a). However, it is not necessary that components have the same goal or work together in IS, indeed, the conflicts between components are often segment of the dynamics of innovation systems. According to studies (Bergek et al., 2008; van Alphen et al., 2009a), there are four main concepts for an Innovation System; national systems of innovation, regional innovation systems, sectoral systems of innovation and production, and finally technological systems.

Technological Innovation Systems (TIS) framework is particularly focused on technology changes and the influence of innovation on the process of changing (Bergek et al., 2008). In addition, when a government or a firm (as a public or private act) plans for economic growth and developments in long term, it is effective –and sometimes even arduous– to increase the speed of innovation (Hekkert et al., 2007). By analysing TIS, in the first step, the main causes of slow processes and the difficulties of influencing the innovation can be identified, illustrating what actually takes place within the innovation system (Hekkert and Negro, 2009). This purpose can be achieved by studying and analyzing the relevancies between the historical dynamics of the system and its current performance (van Alphen et al., 2009a).

“When the technology matures, the TIS also grow due to an increasing knowledge base, new entrants, growing networks in terms of size and density and due to specific institutional arrangements that come into place. On the other hand when a TIS grows, the rate of technological progress generally increases, which in turn enlarges the chances of success for the technology” (van Alphen et al., 2009b). According to Hekkert et al. (2007) various national and sectoral innovation systems influence the progress of a technology in all aspects.

1.1 Functions of TIS

Many scholars have empirically studied innovation systems to find a better understanding of different components of IS like structure, dynamics and performance. Besides, for many years, policy makers had a problem in dealing with IS looking for extracting practical guidelines based on these studies and analytical framework that can simultaneously evaluate performance of a system and recognize the different parameters which are influencing the performance (Bergek et al., 2008). The reason for this weakness of traditional IS approach is located on the focusing that takes account just the structure of Innovation systems. For these reasons, it is necessary to define a framework that can analyse different processes. These important processes, which act the main roles in the well performing of IS –finally causing technology development, diffusion and usage of new technology– are called functions of innovation systems, FIS (Hekkert et al., 2007). Different scholars mentioned different functions for IS studies. For instance Hekkert mentioned four different kinds of functions. Concerning that fact, two questions are rising; which system functions are the most relevant to understand technological change and how effective is the set of system functions to analyse the dynamics of IS (Hekkert and Negro, 2009)? In our study, we adopt the following functions: entrepreneurial activities, knowledge development, knowledge diffusion through networks, guidance of the search, market formation, resources mobilization, and creation of legitimacy.

Knowledge development is one of the most important issues in the modern economy that has a main role in any innovation systems. This function is dealing with two main processes; learning by doing and learning by research. In this reason, for analysing this function we consider three major actors: R&D projects, patents and investments in R&D. To make the knowledge production feasible, devoting both sufficient human fund and financial resources are necessary. So, resources mobilization is considered as an important input for the knowledge development. The most effective method for analysing this function is by interviewing different actors to find the role of resources (Hekkert et al., 2007).

After the process of learning and producing knowledge the main step is knowledge diffusion through networks especially when R&D faces government, competitors and market actors. In this function, policy makers have the latest technological insights, so it's acceptable to call this procedure learning by using. These network activities are prerequisites for learning by interacting. The major issues in this function are the network size and potency over time (Hekkert et al., 2007).

Function of guidance of the search is important in the process of selecting. Because when the preferences of a society are strongly changed, priorities of R&D can be altered and –as a result– this perturbation can affect the direction of technology change. Therefore, by guiding the search, it would be easier to change the technology towards a desired purpose. According to Hekkert et al. (2007); for analysing this function we need to map set targets of governments or industries for the use of a technology and to consider the number of scientific journal articles about new technological developments.

The other important issue for an innovation system is market formation. When a new technology is introduced, the main parameter for its permanency over time is the ability to perform in a safe market space. This could be done by creating a temporary niche market or temporary competitive profit or by allocating suitable tax regime (Hekkert et al., 2007). The best procedure for analysing this function is to map the number of successful niche markets which have the same described features.

Function of legitimacy is about counteracts resistance to change or support from advocacy coalitions. Interested parties in a new technology will often resist the force of ‘creative destruction’. “In that case, advocacy coalitions can function as a catalyst to create legitimacy for the new technology and to counteract resistance to change” (Negro and Kamp, 2009). To analyse the function, it is required to map the emergence and development of interest groups and their lobbies (Hekkert et al., 2007).

Entrepreneurial activities are the actions which are happening in order to turn the potential of new knowledge, networks, and markets into practice (Hekkert et al., 2007). This function is a consequence of other functions meaning that a well-functioning system would lead to blossoming entrepreneurial activities. The entrepreneurial activities are such an important factor that Negro et al. (2009) described it as: “[…] without entrepreneurs innovation would not take place and the innovation system would not even exist”.

Moreover, these functions influence each other and implementation of a certain function will influence the implementation of the others (Hekkert et al., 2007). Another important factor is interaction dynamics between different functions (Negro and Kamp, 2009). This would be necessary for finding the relationships between innovation system dynamics, performance and policy (van Alphen et al., 2009b). For having a better insights into these relations it would be useful to study each of these functions separately via evaluation questions. It is obvious that there are different questions for different functions. These questions are categorized as follow (van Alphen et al. 2009):

Entrepreneurial activity [F1]: What is the number and the degree of entrepreneurial experiments? How many different applications are dealing with entrepreneurial activities? How broad is the technology used? How are the characters of the complementary technologies that employed? What is the number of new entrants and diversifying established firms? Which functions will the entrepreneur perform? In order to perform other functions, which organizations should the firms link to? Which organizations will the firm compete with?

Knowledge creation [F2]: How many different R&D projects exist? Which type of knowledge is created and by whom? What is the competitive edge of the knowledge base? Is there (mis)match between supply of technical knowledge by universities and demand from industry?

Knowledge diffusion [F3]: What is the amount and type of (inter)national collaboration between actors in an innovation system? Which kind of knowledge is shared within these existing partnerships? How many meetings are organized for a specific topic? What is the type and weight of organized official gatherings (e.g. conferences, platforms)? How is the formation of actor-networks (homo, or heterogeneous set of actors)?

Guidance [F4]: What type of visions and expectations exist about a technology? How depth is the belief in growth potential? How accurate are the demands of leading users? What are the specific targets or regulations which are set by the government or industry?

Market creation [F5]: In which phase the specific market is? What is its domestic and export potential? Who are the users of the technology? How is their demand articulated? What are the institutional stimuli for market formation? How much uncertainties do the potential project developers are facing?

Resource mobilization [F6]: What is the availability of human capital (through education, entrepreneurship or management)? What is the availability of financial capital (seed and venture capital, government funds for RD&D)? What is the availability of complementary assets (complementary products, services, network infrastructure)? What is the level of satisfaction with the amount of resources?

Legitimization [F7]: What are the public's thoughts about the specific technology? How is the technology pictured in the media? What are the main arguments of actors pro or against the deployment the technology? Which legitimacy is necessary to make investments in the technology? How active are lobby groups in the innovation system? What is the size and strength of these activities?

1.2 Regime and landscape analysis

The procedure of understanding and interpretation of the major –and often radical– changes that accompany a systemic socio-technical transition of an innovation system is a complex analytical process that can provide invaluable information of usually vital importance for the successful implementation of an emerging technology.

The first step of this approach requires the definition of the systematic (and sub-systematic) boundaries along with the interconnections that are used for the flow of influence-related actions. Proceeding with this analysis, one needs to familiarize with the definitions of the most important terms that affect its operation. The *regime* defines as a certain set of practices, rules and shared assumptions that dominate the interaction of the system and the various actors involved (Rotmans et al., 2001). A more complete approach for the definition is "…the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artifacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures" (Rip and Kemp, 1998). Thus, the regime sphere is a rather stable –in the time and space domains– structure that engulfs the dominant technological aspects, representing the "normal" or "business as usual" approach of operation. The regime region can be regarded as the meso-level of evolution in a nested-hierarchy or multi-level perspective as depicted in recent transition analysis studies (Geels, 2002).

The projection of the regime's sphere into the macro-level often marks the appearance of the *landscape* region. This sphere is taking over a much larger context and thus it is able to move in a much slower evolution pace (Raven, 2005). Established technologies can serve as an interconnection link between the regime and landscape regions and changes of a landscape influence level are usually a result of a long effort that requires fine-tuning of different parameters over an extended time period. Some exceptions on that general rule can exist, and are usually described as global and unexpected events (e.g. major industrial accidents, wars, financial crisis and etc.). These can directly interfere in the landscape region, rapidly altering the system's conditions (van Eijck and Romijn, 2008). Landscape changes that the regime level cannot follow often result to a collapse and replacement of the regime region constituting the phenomenon known as regime change (Bergman et al., 2008).

Considering the *niches*, as local spots within the IS where rapid innovations can be generated and evolve in a relative "protected environment", the correct interpretation of their operation is crucial for the performance of the system (Bergman et al., 2008). Often located peripheral or outside of the regime meso-level, the niches are often considered as starting-points on the technological plane, from where innovation can diffuse into the regime-landscape spheres, resulting into a transition effect either on the regime level, or sometimes even on the –more difficult to influence– landscape level (Rotmans et al., 2001).

2 Analysis

In this section, we analysed the status of each function in Finland.

Entrepreneurial activity

Finland is planning to create 40, 000 new job in renewable energy and clean tech industries (Wang et al., 2014). Local heat producer or "heat entrepreneurship" in rural areas of Finland is progressing (Huttunen, 2012). However, there is need for more sustainable way of bioenergy production on the local level.

Nonetheless, back to a few year ago, Finland had one of the poorest accomplishment in biofuel with the least supportive policies among other EU states (Humalisto, 2014).

Knowledge creation

Bioenergy in the modern type has relatively a long history in Finland comparing to many other countries considering 15% of total energy consumption was supplied by bioenergy in late 1970 (Huttunen, 2014).

Finland Technical Research Centre (VTT) and the Finnish Funding Agency for Technology and Innovation (TEKES) are the main science and technology producers in Finland. They have had a few big projects for developing bioenergy systems such as BioRefine, Groove, Green Growth and BEST.

Knowledge diffusion

A robust national and international networking is lacking in Finland (Hämäläinen et al., 2011). While few analysis on socio-economic impacts of bioenergy development on the local level exist (for instance, Lehtonen and Okkonen, 2016), this area remain under-research.

It is important to form the network of local bioenergy or "heat entrepreneurship" in Finland to synergy their activities and direct them to more sustainable way of production (Huttunen, 2012).

Guidance

In 2010, the government of Finland introduced a supportive package for deployment of renewable energy with emphasis on wood-based bioenergy and wind power through feed-in tariffs and financial support such as 100 million Euro for investments in biorefineries (Hämäläinen et al., 2011). Nonetheless, still lack of funding exist in Finland for both public and private sectors (ibid).

While tax exemption exists for biofuels in the neighbouring country of Sweden, there is higher taxation for some of the biofuels (Humalisto, 2014). However, in 2012, Finland introduced "sustainability criteria for biofuels and bioliquids" for biofuel producers and distributors (Wang et al., 2014). Nonetheless, yet, there is a need for legislative for sustainable production of bioenergy which is considerably lacking (Rimppi et al., 2016).

Market creation

Finland is a leading country in the wood-based biofuel production and utilisation (Wang et al., 2014). Currently, about 20% of Finland energy consumption derive from wood-based bioenergy and the goal is to increase this capacity to 30% by 2020 (ibid). Considering the Finland ultimate energy goal from renewables is 38% by the same year (Hämäläinen et al., 2011), it appears the bio-energy is the backbone of Finnish energy policy. The share of renewable energy in Swedish energy policy is set to 49% by 2020 (ibid).

Biofuel production in Finland is based mainly on imported palm oil (Humalisto, 2014). Moreover, Finland is an exporter of biodiesel (Humalisto, 2014).The main Finnish biofuel producers such as Nesto Oil, Fortum, Gasum and Stora Enso are semi-governmental companies while they are only few private firms (ibid).

Resource mobilization

Ample biomass resources exist in Finland due to significate forest area. However, the current bioeconomy mobilization system is still focused on utilisation of side flows from the pulp industry, and this is not able to create the paradigmatic change required to respond to issues of a new magnitude (Kalliokoski, 2015). While the complementary product and actor network is in place, this network will not be able to sustain growth alone, and it is important to build networks beyond the paper industry.

Legitimization

Finnish biogas association is promoting biofuel but is not an influential actor. Greenpeace Nordic is the most influential party from the civil society which promoting the bio-energy.

There is already some debate about the scientific legitimacy of biomass emission accounting (Kalliokoski, 2015), as the Finnish climate and energy strategy states that to meet the goals of the emission reductions, biomass needs to remain accounted as climate or emission neutral (Valtioneuvosto, 2016).

All in all, risk of path dependence-policymaking for development of bioenergy in favour of other forest industries exist in Finland which that also is a hurdle for implementation of EU legislations on national level (Huttunen, 2014). Legitimisation of bioenergy is under questioned by traditional environmentalists (ibid). In some cases, this may face deployment of bioenergy system with lack of social acceptability.

3 Conclusion

Bioenergy is increasingly becoming the sine que non of Finland's energy policy. However, a conflict of interest between bioenergy sector and a few other sectors such as pulp and paper, and, forest industries exist in Finland. That is one of a major challenges of bioenergy development. It is evident that there is still a path dependent approach to energy policy in Finland especially when it comes to bioenergy production.

Strengths	Weaknesses	Opportunities
Has a considerable share in current energy production	Lack of incentives and funding for private sector	Local decentralised bioenergy production
High natural potential	Conflict of interest between stakeholder	More research on socio-economic impacts of bioenergy development
Long history of bioenergy in Finland	Lack of stringent policy and regulations	Form the network of local bioenergy producers or “heat entrepreneurship
Feed-in tariffs	Not enough supportive policy for biofuel	Increase the capacity of biofuel production
A leading country in the wood-based biofuel production and utilisation	National and international networking is lacking	
	Lack of legislative for sustainable production of bioenergy	
	Risk of path dependence-policymaking	

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