Exploration into the barriers and obstacles constraining diffusion and adoption of renewable energy solutions

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Abstract
By 2020, intermittent renewable small scale energy sources (e.g. wind and solar energy) are expected to represent about 17% of the EU's total electricity consumption[i]. However, a straight forward implementation of renewable energy options is not easy, due to various barriers and obstacles. In this paper we describe the intermediate outcomes of a European Partnership under the name of GREAT (Growing Renewable Energy Applications and Technologies), funded under the INTERREG IVB NWE Programme. GREAT aims to encourage communities and small to medium size enterprises (SMEs) to develop technological solutions for Smart Grid, Renewable Energy and Distributive Generation; research and develop policy issues for regulatory authorities and provide structured co-operation opportunities between SMEs and research institutes / technology developers. In this paper we explore what the main challenges are in relation to the diffusion and adoption process of renewable energy solutions and technologies in The Netherlands. Their target is that 14% of total electricity consumption is represented by renewable energy sources, while the share of renewables in final energy consumption was a mere 4.5% in 2013.
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Keywords
Sustainable Energy Sources, Innovation, Diffusion, Renewable Energy Solutions

JEL Classification
Q55, Q42, O33

Introduction

This paper describes the preliminary outcomes of a Partnership between the United Kingdom, Ireland, Belgium and The Netherlands entitled GREAT: Growing Renewable Energy Applications and Technologies. Ultimately GREAT aims to encourage SMEs and collectives of SMEs to develop and apply sustainable technological solutions related to Renewable Energy, Smart Grid and Distributive Generation. This paper relates the

outcomes of a small scale exploratory research activity among SMEs in Belgium and the Netherlands on the obstacles and barriers that hinder and constrain adoption and implementation of sustainable energy solutions. In the following sections we give a description of the European energy landscape and introduce the GREAT project. We then explain the problem and the focus of our research. In this section we also highlight our methodological choices and research design. In the following paragraph we present an overview of existing theory which forms our theoretical framework and research on the barriers and obstacles to the diffusion and adoption of sustainable energy solutions. The outcomes and results of our research and a few market implications are discussed subsequently. We finalize our paper with some preliminary conclusions, which also highlight the next steps that are being taken in the project.

Problem Definition & Research Design

For SMEs in Europe, energy costs now account for around 7-11% of operating costs and up to 30-35% in highly intensive energy using businesses (European Commission, 2013). In the current economic climate, all SMEs are cost conscious so energy prices are becoming important. Although energy traditionally is an area SMEs have trouble to engage with, they are increasingly becoming aware of their behaviour related to energy consumption and slowly changing their habits (i.e. spend time switching off lights or equipment etc. when going home). Very few SMEs, however are actually making significant investments in their own building to reduce energy consumption. For most SMEs, the concept of generating their own renewable energy is still more of an academic than following from genuine interest and an urgent need. In general, several barriers are being experienced, such as high capital investments, slow return on investment, and the lack of knowledge of the benefits. We can conclude that there is a need for education on the benefits and pitfalls of sustainable energy, as well as a greater contribution to costs, to accelerate the implementation process.

Although diffusion and adoption of renewable energy by SMEs lags behind, the importance of investing in sustainable technologies and energy solutions is acknowledged in both the public and academic domain. Since the film of Al Gore *An inconvenient truth*, in general sustainability stands high on the national agenda of most countries. Concern for the environment in combination with opportunities to innovate is one of the main reasons. Policy measures are mostly aimed at reduction of carbon dioxide emission, waste management and alternative use of energy sources and materials (Schout, H.J., D. Hassanpur Golriz and S.J.M. Harkema, 2011). In line with these measures companies are urged to integrate sustainability in their business models and processes and search for innovative sustainable solutions.

While on a national level policy measures towards a more sustainable society are defined, enterprises – and especially SMEs - lag behind in adopting technologies and solutions and fail in sufficiently incorporating these measures appropriately in their day-to day business. Hence there is a need to understand better what the barriers and obstacles are that hinder SMEs to adopt sustainable energy solutions.

Wittenborg University (www.wittenborg.eu) located in the city of Apeldoorn in The Netherlands, is one of the Dutch partners at the GREAT project. Wittenborg University has two main tasks within the Partnership. The first task is to carry out a small-scale exploratory research activity among SMEs together with its Belgian counterpart to identify the barriers and obstacles for renewable energy participation by SMEs. The second task

involves the development of an economic tool, in the form of spreadsheets, to help SMEs to estimate the return on investment in a sustainable energy project. The current paper focusses on the preliminary outcomes of the research.

Our main research question is: What are the main obstacles to adopt renewable energy and which factors can contribute to acceleration in the diffusion and adoption process of renewable energy solutions among SMEs? Gaining insight and und*e*rstanding the underlying factors of the low engagement among SMEs in The Netherlands is the aim of the first part of the research which is described here. In order to achieve this, a questionnaire was developed that has been distributed among 20 SME's in Belgium and The Netherlands. The results of the questionnaire give insight in the factors that are relevant for SMEs and obstacles and barriers that can hinder adoption.

In the final stage of the GREAT project, both the questionnaire and the economic tool will be used as a basis to continue the discussions between different stakeholders like municipalities, intermediary organizations, governmental bodies and SMEs to better understand the level of interest among SMEs in sustainable energy as a viable alternative for traditional energy.

Barriers & Obstacles

The theory of adoption and diffusion of innovations developed by Rogers (2005) is a useful systemic framework to describe adoption or non-adoption of new technology. Rogers describes the adoption process as a sequence of steps. Knowledge is the first step of Rogers' five-stage process of adoption. The other four steps are: persuasion, decision (to adopt or to reject new technology), implementation and confirmation. According to Rogers a great number of conditions may hinder the adoption process: e.g. personal limitations of the potential user and/or external obstacles like e.g. ineffective communication channels). The likelihood that a particular innovation will be adopted depends on a number of factors:

Factor 1 has to do with Innovation Attributes. Rogers (1995) argues that there are five attributes of an innovation which influence its rate of adoption: relative advantage; compatibility; complexity; trialability and observability. Alternatively Wolfe (1994) mentions six key attributes that influence adoption: adaptability; centrality to the day-today work of the organization; technical vs. administrative focus; pervasiveness (the proportion of total behaviors expected to be affected by the innovation); radicalness; and uncertainty about outcome. Finally Stocking (1985) describes some characteristics which include appeal to local power holders and little requirement for visible resources.

Factor 2 has to do with Adopter Characteristics. Adopters according to Rogers (1983) can be classified according to their tendencies to adopt – innovators, early adopters, early majority, late majority and laggards (Rogers, 1983). Each group he says needs to be targeted and approached with a different diffusion strategy (Green and Johnson, 1996). Additionally research shows that organizations with a long history of success are less likely to adopt new approaches because they lack a sense of urgency to do so (Sitkin, 1992; Levinthal and March, 1993; O'Neill et al, 1998). The organizational factors that are important in explaining the rate and process of adoption include strategy, structure, resources and politics (Dean, 1987; Dyer and Page, 1988; Schroeder, et al 1989).

Factor 3 is related to Environmental/ Context Characteristics. The level of contact of a change agent with a group of potential adopters is positively related to the decision to adopt (Rogers et al, 1970). In addition the credibility of a change agent in the client's eyes is positively related to the decision to adopt (Coleman et al, 1966). The most effective persuaders that may influence the adoption process, are similar in status and outlook to potential users. 'Near-peers' are seen as key in bridging the gap between innovators and adopters (Rogers, 1995). Opinion leaders are especially important for interpersonal networks (Rogers, 1983; Kautz and Larsen, 2000).

Factor 4 is about Communication Channels. Communication is a key factor in the adoption process. Mass media communication channels are more effective when there are large numbers of potential adopters in combination with low levels of complexity, and when the objective is awareness raising (Rogers, 1995). Interpersonal and local channels are of importance in engaging and trying to persuade adopters to act upon their awareness and adopt (Rogers, 1995).

Taking these factors into account, research shows that rapid adoption and diffusion of renewable energies is being hampered by multiple obstacles and that there are quite some hurdles to overcome. A large number of market failures and barriers are documented ranging from unfavorable pricing mechanisms, high costs and risks, limited transmission access, as well as non-consideration of concomitant benefits (Painuly, 2001, Beck and Marinot, 2004). A major market failure is that prices of fossil fuels, in general do not reflect adequately a range of associated social costs. The absence of an adequate overall price for fossil energy containing these social costs, fuels results in these goods being consumed above social optimum according to Brown (2001) and Gillingham & Sweeney (2006). The consequence is that – unless policy interventions don't allow it – companies do not take social costs into account of emissions, and as a consequence insufficiently invest in alternatives (Egenhofer, 2004). The risk of innovation leakage and exploitation of benefits by competitors also implies that individual firms cannot capture the full economic benefits of their R&D efforts. Finally uncertainty is also an important obstacle to the adoption of innovations. To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences.

In the next section we describe the results and outcomes of our research.

Results & Outcomes

The survey we carried out in Belgium and The Netherlands, confirmed some of the findings of research highlighted in the prior paragraph. One of the findings was that reasons to adopt and implement 'green energy' may be both positive and negative. Improvement of the company image is one of positive reasons indicated by the SMEs to invest in renewable energy. High investment costs are however mentioned as one of the main barriers to implement sustainable solutions, though in The Netherlands this is seen as less important than Belgium. This for instance has to do with the challenge to find appropriate personnel. But it also has to do with the low impact of organizational activities on the environment.

Concerning the pay-back (or return on investments) of investing in sustainable energy solutions, SMEs express that it is related to energy costs and company image. Also tax advantages and potential new customers are mentioned as reasons to invest. The majority of

SMEs share the opinion that the investment on the long term, is worth more than the initial costs on the short term. The opportunity to be able to have contracts with public organizations – intermediate organizations with a coordinating function - is not seen as adding value in their decision making process. All the SMEs that participated in the research did however indicate they wanted more information about environmental friendly plans that could have a positive impact on the overall performance of the organization. Return on investment is the most important indicator, to determine the level of possible investments that should be made. Most companies define that in terms of pay-out time, instead of effectiveness and efficacy. Companies want to see results within 5 years, sometimes even after 1 year. Also Scherer et al (2000) highlight the uncertainty about the return on investment which is often particularly large and constitutes an obstacle to increase innovative efforts.

If we review and relate these results to the factors that increase the likelihood that an innovation will be adopted, the following observations can be made:

As far as the innovation attributes is concerned, it seems to be that relative advantage, compatibility and complexity (Rogers, 1995) are important attributes that influence adoption. Wolfe (1994) mentions the centrality to day-to-day work of the organization, which is related to the earlier mentioned attributes. When speaking to SMEs and intermediate organizations that work with SMEs, they indicate that investing in sustainability is not a priority and this may have to do with the fact that the relative advantage is not self-evident and it is additionally not seen as a key factor of success to invest in sustainability, for the overall functioning and performance of the organization. The switching costs (i.e. the costs associated with changing traditional energy generation methods to renewable energy technology) may be perceived as being too high in relation to the benefits. Investing in renewable energy is not merely a matter of changing to a new energy source, but has an impact on the business in general. It requires a re-thinking of the whole business model. Uncertainty of the outcome may be a reason to not being among the early or early majority of adopters, but to wait and see how other companies deal with this.

According to interviews we had with intermediate organizations in the Apeldoorn area (the municipality and the Province), they indicate that not having a clear strategy is an important obstacle for SMEs. SMEs in general don't have a tradition to define and work with long-term strategic plans, but mostly work with short-term operational plans. Energy in comparison to the overall costs and investments of SMEs, are additionally regarded as a small portion of the overall costs that are made. Investments can only be made once is their dominant frame of mind, and then SMEs seem to prefer to invest in for instance the production process, rather than in energy efficiency. According to a representative of the municipality of Apeldoorn, who was interviewed, an obstacle is also the fact that SMEs feel there needs to be a clear institutional structure which defines who the stakeholders of the energy sector (from supply to demand and fro influencers to decision makers), their responsibilities and their roles. It seems that decision making could be influenced positively if SMEs are approached as a group of companies, rather than on an individual basis. This has to do with the fact that perceived risks are then distributed in a network of companies, rather than having to take the risk alone.

Environmental and context characteristics are important factors in creating the conditions at national and international levels to encourage the use and implementation of sustainable

energy sources. Brown (2001), Henrique and Sardosky (2008) and the IPCC (2011) refer to the low interest and awareness of policy makers, producers and consumers when it comes to energy issues, capital market barriers as well as distortionary fiscal and regulatory policies, as an important obstacle to renewable energy technology diffusion. Our research gives careful indications that the conditions at system level certainly have a big influence and may impact diffusion and adoption positively. This is also asserted by research carried out by Hekkert *et al* (2007). Due to the low sample of our selected group of SMEs, the findings of our research are however not conclusive and further research is needed to understand what the relation is between the environmental context and the behavior of SMEs.

Finally communication channels are a key factor of success in raising awareness, and persuading adopters to act upon their awareness. In can reduce uncertainty, which we saw is an important factor related to diffusion and adoption.

In summary our exploration shows that all factors that affect the likelihood that an innovation will be adopted also seem to affect the diffusion and adoption rate of renewable energy solutions among the SMEs which took part in the research. Since the number of companies is limited further research will have to clarify more in detail what the barriers are and actions that can be taken to accelerate the adoption process.

Conclusions & Further Research

The supply of energy is a fundamental element in the economic growth of societies, where the way this type of energy is produced, supplied, and consumed is a critical issue to make sure that the current generation does not prevent future generations from prospering. It is widely recognized that we need to counter the increasing amounts of environmental pollution and greenhouse gases produced through the generation of electricity using fossil fuels. This goal can be accomplished by increasing the usage of renewable energy technologies and applications. Currently the market for renewable energy technologies is experiencing rapid growth in Europe, which is due to such factors as high fuel prices, improvements in renewable energy technologies, and increased political support due to concerns about climate change and energy security. Particularly in Europe, new policies are emerging to advance or manage the integration of high shares of renewable electricity into existing power systems, including support for energy storage, demand-side management, and smart grid technologies (Global Status Report, 2014).

While trends show that thousands of cities and towns worldwide have policies, plans, and targets to advance renewable energy, these often outpace the ambitions of national legislation according to the earlier mentioned Global Status Report Renewable Trends (2014). Local governments act to reduce emissions, support and create local industry, relieve grid capacity stress, and achieve security of supply. To accomplish these goals, also Dutch government and local authorities, make use of their authority to regulate, make expenditure and procurement decisions, facilitate and ease the financing of renewable energy projects, and influence advocacy and information sharing.

However, a straight forward implementation of renewable energy options is not easy, due to various barriers and obstacles, which were described in this paper including the lack of financial tools to optimize specific scenarios. It is obvious that the success of all the initiatives taken largely depends on market acceptance and adoption. We have developed a

novel tool to increase the likelihood of investment in renewable energy by SMEs. In the coming months this tool will be tested and we expect to carry out further research to understand better what the inhibiting factors are that constrain SMEs.

References

Beck, F. and Marinot, E., 2004. Renewable energy policies and barriers, In: C. Cutler, (ed.) *Encyclopedia of Energy*, Academic Press and Elsevier Science, San Diego.

Brown, M. A., 2001. Market failures and barriers as a basis for clean energy policy, *Energy Policy* 29 (14): 1197-1207.

Coleman, J., Katz, E. and Menzel, H., 1966. *Medical Innovation: A Diffusion Study*. The Bobbs-Merrill Company, Indianapolis, IN.

Dean, J. W., 1987. Building the future: the justification process for new technology. In: Pennings J.M. and Buitendam A. (eds) *New technology as organizational innovation: the development and diffusion of microelectronics*: symposium papers Cambridge, Mass: Ballinger, p. 35-58.

Dyer, W. G. and Page, R. A., 1988. The politics of innovation Knowledge in Society, *An International Journal of Knowledge Transfer* 1(3): 23-41.

Egenhofer, C., Gialogu, K., Luciani, G., Boots, M., Scheepers, M., Constantini, V., Gracceva, F., Markandya, A. & Vicini, G. 2004, Market-based options for Security in Energy Supply, *Fondazione Eni Enrico Matei, Nota Di Lavoro 117.*

European Commission, 2013. A Recovery On The Horizon? Annual Report On European SME's 2012/2013 [pdf] Available at < http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/supporting-documents/2013/annual-report-smes-2013_en.pdf > [Accessed 15 May 2014].

Gillingham, K. and Sweeney, J., 2010. Market Failure and the Structure of Externalities. In: *Harnessing Renewable Energy*, A. Jorge Padilla and R. Schmalensee (eds), RFF Press.

Green, L. W. and Johnson, J. L., 1996. Dissemination and utilization of health promotion and disease prevention knowledge: theory, research and experience, Canadian *Journal of Public Health 87* (Supplement 2), S11-S17.

Henriques, I. and Sardorsky, P., 2008. Oil prices and the stock pieces of alternative energy companies, *Energy Economics* 30(3): 998-1010.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M., 2007. Functions of Innovation Systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, 74(4), 413-432.

IPCC, 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, Working Group III of the Intergovernmental Panel on Climate Change, Cambridge and New York.

Kautz, K. and Larsen, E. A., 2000. Diffusion theory and practice: disseminating quality management and software process improvement innovations, *Information Technology and People* 13(1): 11-26.

Levinthal, D. A. and March, J. G., 1993. The myopia of learning, *Strategic Management Journal* 14 (SP1/2): 95-112.

O'Neill, H. M., Pouder, R. W. and Buchholtz, A. K., 1998. Patterns in the diffusion of strategies across organisations; insights from the innovation diffusion literature, *Academy of Management Review* 23(1): 98-114.

Painuly J. P., 2001. Barriers to renewable energy penetration; a framework for analysis, *Renewable Energy* 24(19): 74-89.

REN 21, 2014. *Renewables 2014. Global Status Report*. [pdf] REN 21. Available at < http://www.ren21.net/portals/0/documents/resources/gsr/2014/gsr2014_full%20report_low%20res.pdf > [Accessed 10 January 2015].

Rogers, E. M., 1983. *Diffusion of innovations*. 3rd edition New York: Free Press.

Rogers, E. M., 1995. *Diffusion of innovations*. 4th edition New York: Free Press.

Rogers, E. M., 2005. *Diffusion of innovations.* 5th edition New York: Free Press.

Rogers, E. M., Ascroft, J. R., and Röling, N. G., 1970. Diffusion of innovations in Brazil, Nigeria, and India (Diffusion of Innovations Research Report 24) East Lansing: Michigan State University, Department of Communication, Various p.

Scherer, F., Harhoff, D. and Kukies, J. 2000. Uncertainty in the size distribution of rewards from technological innovation, *Journal of Evolutionary Economics* 10(1): 175-200.

Schout, H.J., D. Hassanpur Golriz and S.J.M. Harkema, 2011. Entrepreneurs as Agents of Change: Sustainable Innovation in the Dutch Construction Industry, in: Heather Fulford (ed.), *Proceedings of the 6th European Conference on Entrepreneurship and Innovation*, Reading (UK), Academic Publishing Limited, p. 778-786.

Schroeder, R. G., Van de Ven, A. H., Scudder, G. D. and Polley, D., 1989. The development of innovation ideas. In: Van de Ven A. H., Angle H. L. and Poole M. S. (eds) *Research on the management of innovation*: the Minnesota Studies New York: Harper Row, p. 107-134.

Sitkin, S. B., 1992. Learning through failure. In: Staw, B. M. and Cummings, L. L. (eds) *Research in organisational behavior*. Greenwich, CT: JAI Press, pp. 231-66.

Stocking B., 1985. Initiative and inertia: case studies in the NHS London. *Nuffield Provincial Hospitals Trust*, p. 236.

Wolfe, R. A., 1994. Organisational innovation: review, critique and suggested research directions. *Journal of Management Studies* 31(3): 405-31.

[i] http://www.eurelectric.org/10StepsTosmartGrids/