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## Functions of intermediaries in eco-innovation: a study of business development organizations and cluster initiatives in a Swedish and a German region

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### Abstract

Eco-innovation continues to gain support as a driving force for sustainable development. In this regard, pressing questions include how to stimulate the development, diffusion and use of eco-innovations. Often, firms engaged with eco-innovation need to connect to intermediary organizations (e.g. business development organizations, regional clusters, universities, financiers, incubators) to get hold of necessary resources to tackle the challenges in the innovation process. This article analyses the functions of such intermediary organizations for eco-innovation by focusing on public-owned business development organizations and cluster initiatives in the Region Scania, Sweden and North Rhine Westphalia, Germany. We synthesise at least eight functions of intermediaries for eco-innovation as: (i) forecasting and road mapping (ii) resource mobilization (iii) networking and partnerships (iv) commercialization (v) technical consulting (vi) information scanning and distribution (vii) sector branding and legitimation (viii) prototyping and piloting. The support functions often take a “one-size-fits-all” approach with few initiatives particularly tailored for eco-innovations. This can be explained by the market complementarity roles of public intermediaries, their resource constraints and the cross-sectoral nature of eco-innovation. Even though, intermediary functions are often appreciated by clients and financiers, it is often difficult to establish a causal relation between the support and eco-innovation outcomes, a challenge which undermines the existence of intermediaries themselves. Despite these challenges, potential good practices point to a mix between general “one-size-fits-all” and tailored support activities for different types of eco-innovations and firms. Furthermore, interaction between various types of intermediaries is important since there are often numerous actors and initiatives working with eco-innovation which can confuse firms. When it comes to stimulating radical eco-innovations, a proactive approach to intermediation is particularly important.

**Keywords:** Innovation systems, Sustainable entrepreneurship, Public support, Regional development

## 1 Introduction

Eco-innovation<sup>1</sup> continues to gain widespread support among policy makers and researchers as an essential approach to create win-win situations of economic competitiveness and environmental sustainability (Coenen and Díaz López, 2010). Consequently, pressing questions for these actors – i.e. policy makers and researchers include how to stimulate the development, diffusion and use of eco-innovations in different industrial sectors and the economy as a whole. Partly as a response, firms are being increasingly challenged to contribute to sustainable development on a societal level through eco-innovation while reaping potential in-house benefits such as costs savings and competitive advantage. However, firms developing and/or adopting eco-innovations encounter challenges such as resource constraints in terms of time, knowledge and finances, difficulties in translating sustainability goals into offerings that have customer value (Keskin et al., 2013) and sometimes an adhoc, informal management of sustainability related issues (Klewitz and Hansen, 2013). In addition, there are diffused benefits in the development and diffusion phases of eco-innovations due to the public good nature of the environment which often can deter private firms from engaging in eco-innovation (Jaffe et al., 2005). Since individual firms may not possess all the competences and resources internally needed to tackle such challenges, they often need to connect to organizations outside their boundaries such as universities, financiers, incubators, business development organizations, cluster initiatives and consultants to access relevant resources to tackle the challenges in eco-innovation. To relate to existing literature, we refer to these external organizations as intermediaries (see Howells, 2006).

The support activities of such intermediaries have received attention from academic scholars in different bodies of literature. For example, Howells (2006) synthesises a set of functions of intermediaries in “conventional” innovation based on case studies in the United Kingdom. On the other hand, Klewitz et al. (2012) investigates an intermediation program – Ecoprofit® and its role in eco-innovation among small and medium sized manufacturing companies in Germany; while Klerkx and Leeuwis (2008) provide an overview of different types of intermediaries including their functions in the agricultural sector in the Netherlands. Kivimaa (2014) analyses the role of intermediaries in energy system transitions in Finland. Although previous literature emphasises the importance of external relationships and resources in the development of eco-innovations at firm level (Cainelli et al., 2015), the explicit roles of intermediaries in supporting firm-level eco-innovation is seldom discussed (Kanda et al., 2014). Contributing knowledge, this article analyses public-owned intermediary organizations and their support functions targeted at eco-innovation in firms. The empirical study is undertaken in Region Scania, Sweden and North Rhine Westphalia, Germany. We focus on public-owned intermediaries due to their keen interest and responsibilities to act as catalysts for sustainability transitions compared to private intermediaries and also the understanding that such public-owned intermediaries differ from business-based intermediaries which are typically driven by profit (Kivimaa, 2014). In addition, business development organizations and cluster initiatives, the focus of our study, offer a broad portfolio of support functions which cuts across different types of intermediaries. Such a broad focus is relevant for understanding the different roles of intermediaries in eco-innovation

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<sup>1</sup> We relate to the widespread definition of eco-innovations by Kemp and Pearson, (2008, p.7) as “the production, application or exploitation of a good, service, production process, organizational structure or management or business method that is novel to the firm or user and which results throughout its life cycle, in a reduction of the environmental risk, pollution and the negative impacts of resource use compared to relevant alternatives”

compared to specific focused intermediaries like funders, universities and incubators. Germany and Sweden are in focus since they represent countries which have been consistently ranked among the top ten global eco-innovators (WWF, 2014) with the selected regions offering the potential to find active intermediaries and good practices.

Departing from this background, the aim of this article is twofold: (i) to provide a first of its kind synthesis of the functions of intermediaries for firm-level eco-innovation and (ii) to provide some practical recommendations for intermediaries engaged with eco-innovation in other regions and countries based on good practices and challenges identified from our empirical studies. The paper is structured as follows: Section 2 reviews key literature on innovation intermediaries while the research method is presented in Section 3. In Section 4, we present results on the functions of intermediaries in eco-innovation based on case studies in Region Scania, Sweden and North Rhine Westphalia, Germany. In Section 5, we discuss the results, and offer conclusions and further research in Section 6.

## **2 Review of some literature on innovation intermediaries**

From a systems perspective on innovation, intermediaries have been studied in a range of disciplines in relation to topics such as networking and clustering between firms, organizing regional innovation systems, interactions between universities, science establishments and industry and large scale societal transitions (Klerkx and Leeuwis, 2008). A review of some of the commonly cited literature on intermediaries reveals that innovation intermediaries have been studied from different perspectives (Kanda et al., 2014). These include studies that focus on the intermediary organizations (Kivimaa, 2014), those that focus on the intermediation process and programs (Klewitz et al., 2012), the intermediary functions in innovation (Howells, 2006) and their relation to the institutional context (Klerkx and Leeuwis, 2008). The role of intermediaries in innovation has received attention from different bodies of literature, even though very few scientific articles discuss intermediaries for eco-innovation (e.g. Klewitz and Hansen, 2013) or sustainability in general (e.g. Kivimaa, 2014). Intermediaries can be defined as “actors who create spaces and opportunities for appropriation and generation of emerging technical or cultural products by others who might be described as developers and users” (Stewart and Hyysalo, 2008 p. 296). Other scholars define intermediaries as third-party organizations that help to achieve desired objectives by providing the necessary external impulse, motivation, and advice to initiative and continue with an eco-innovative activity (Gombault and Versteeg, 1999). And as Howells (2006) puts it an innovation intermediary “is an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties”. In the context of this article, we refer to intermediaries as organization that assists firms in the eco-innovation process by providing external impulse, motivation, advice and other specific support often by acting as an agent or broker between two or more parties.

Several types of organizations are identified in the literature as innovation intermediaries. Consultants, brokers, innovation centres and science parks have been identified to belong to this group (Kivimaa, 2014). Other recognised organizations include governments and local authorities, NGOs, universities and consultants (Klewitz et al., 2012). Other scholars classify these intermediaries by the ownership and source of funding as: public, non-profit and private. Based on their support functions intermediaries can be labelled as third parties, brokers, bridgers

or facilitators (Howells, 2006). In the literature, a variety of functions are attributed to innovation intermediaries, sometimes resulting in functional redundancy and confusion (Klerkx and Leeuwis, 2008). A variety of roles and functions are discussed that can generally be grouped into facilitating, configuring and brokering (Kivimaa, 2014). However, authors such as (Howells, 2006) provide a detailed list of functions of intermediaries in innovation as: foresight and diagnostics, scanning and information processing, knowledge processing and combination/recombination, gatekeeping and brokering, testing and validation, accreditation, validation and regulation, protecting the results, commercialization, and evaluation of outcomes. In summary only few articles explicitly deal with intermediaries in eco-innovation (see Kivimaa, 2014; Klewitz et al., 2012), even though the other reviewed literature on innovation intermediaries in general bear some relevance on intermediaries in eco-innovation.

### **3 Method**

The overall methodological approach of this paper is based on a qualitative exploratory study of selected cases (see Yin, 2008). We chose this approach since it leaves space for insights that were not anticipated by the researcher (see Wolcott, 2008) and also gives greater insight on a subject which is yet to receive extensive research investigation. To be specific, an interview study was undertaken on the support activities of business development organizations and cluster initiatives in Region Scania, Sweden and North Rhine Westphalia, Germany related to eco-innovation in firms. The following subsection details how empirical data was collected and analysed using an analytical approach based on the functions of technological innovation systems presented in (Kanda and Hjelm, 2014).

#### **3.1 Analytical approach**

Following the analytical approach developed by (Kanda and Hjelm, 2014) see figure 1 below , we define our system boundary by choosing a regional focus and also specifying which kinds of intermediaries to study within our system boundary. As discussed in previous literature (see Coenen and Díaz López, 2010), a careful scope definition is important in at least two ways. First it helps to avoid an over explosion of possible explanation factors for an observed phenomenon and also it allows for the comparison of different studies. We adopted a regional focus to reflect how firms seeking intermediation support are assisted on a regional basis and also how resource allocations for such support activities are undertaken in the studied countries.

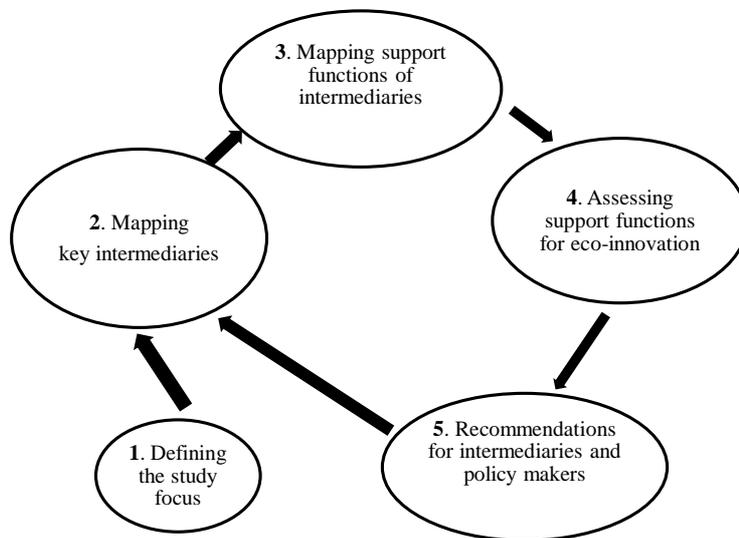


Figure 1: Analytical approach. Source author's elaboration, inspired by (Bergek et al., 2008)

Thereafter, in step 2, we identified key business development organizations and cluster initiatives within both regions using a snowball sampling approach. This approach involves existing research subjects suggesting future subjects from among their acquaintances. We registered the actors, their networks and also institutions backing their operations were possible. To be able to select a number of business development organizations and cluster initiatives to study as cases one has to have an overview of the different kinds of such actors from which to choose since it is practically impossible to cover all relevant actors in any particular region. To be able to arrive at these cases for further investigation, we read through regional innovation reports, and conducted overview interviews with technology and industry experts both from practice and academia.

To investigate the content of the support activities of these business development organizations and cluster initiatives for eco-innovation, their support functions were under scrutiny in step 3. This covered what support actions and activities they delivered to firms seeking advice in eco-innovation and also how the support activity was delivered. This was undertaken with extensive face- to-face interviews with selected respondents in the studied business development organizations and cluster initiatives which lasted between 1 and 2 hours. Questions discussed covered the intermediary organization and its history, their clients and eco-innovations they develop or adopt, the process of support and finally some outcome and challenges of the support activities. The selected cases and interviewees are presented in Table 1 below.

Table 1: Key Business development organizations including cluster initiatives in Region Scania, Sweden and North Rhine Westphalia, Germany

	Organizations	Interviewee	Comments
Region Scania, Sweden	Sustainable Business Hub	Project leader Research and Development and innovation	Cleantech cluster initiative 6 employees, 130 member companies  <a href="http://www.sbhub.se/">http://www.sbhub.se/</a> Sector specific support
		Business developer	
	Malmö Cleantech City	Project manager	Support for cleantech companies 2 full-time employees, non-membership <a href="http://www.malmocleantechcity.se/">http://www.malmocleantechcity.se/</a> Sector specific support
	Region Scania	Development manager	Regional financer of some BDOs and CIs <a href="http://www.skane.se/">http://www.skane.se/</a> General support
		Business Manager	
ALMI Scania	Innovation advisor	Support for all kinds of companies <a href="http://www.almi.se/Skane/">http://www.almi.se/Skane/</a> General support	
	Organization	Interviewee	Comments
North Rhine Westphalia, Germany	The greentech Cluster	Principal	Cluster initiative focused on the environmental technology sector Non-membership organization Sector specific focus <a href="http://www.umweltcluster-nrw.de/">http://www.umweltcluster-nrw.de/</a>
		responsible person for Innovation radar	
	The Efficiency Agency	Head of consulting	Agency focused on material and energy efficiency 30 employees in six locations including Duisburg. General focus <a href="http://www.ressourceneffizienz.de">http://www.ressourceneffizienz.de</a>
	The energy Agency	Manager of the Department for Information and Advice	Agency focused on energy efficiency 120 employees located in Düsseldorf, Gelsenkirchen and Wuppertal. <a href="http://www.energieagentur.nrw.de">http://www.energieagentur.nrw.de</a> General focus
	The local BDO in Duisburg	two Project managers	Business development support for all kinds of companies 20 employees General focus <a href="http://www.gfw-duisburg.de/">http://www.gfw-duisburg.de/</a>
	The local BDO in Essen	Responsible person for Energy – Water – Environment	Business development support for all kinds of companies 30 employees General focus <a href="http://www.ewg.de">http://www.ewg.de</a>

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Since a core aspect in this analysis was to provide practical recommendations both for intermediary organizations and policy makers, an assessment of their functions is prioritized in step 4. The support activities are assessed as to how well they assist firms to reach eco-innovation objectives. On measuring eco-innovation at the micro-level a particular challenge crops up in establishing a clear relation between the support functions provided and the eco-innovation activities in firms. Nonetheless the OECD suggests a combination of different methods for measuring eco-innovation (OECD, 2009). This covers at least the (i) input e.g. research and development expenditure, (ii) the output e.g. number of innovations, number of patents and scientific publications and (iii) the impact e.g. changes in resource efficiency and productivity of the eco-innovation. In our study, different possibilities existed in collecting relevant data to assess the usefulness of the support activities on SMEs' eco-innovation. One possibility was to conduct a survey among SMEs to collect data and measure the impacts of support activities on the dimensions highlighted above (i.e. input, output and impact). However, we had to rely on a second option i.e. secondary data in our case from BDOs and CIs on how their clients perceive the usefulness of the support they receive. This was due to two major reasons, some BDOs and CIs had already conducted similar surveys among their clients and found it as a bother to do another such survey, and some BDOs were not willing to have external actors checking on their support activities. Nonetheless, the secondary data (this secondary data will not be disclosed in its entirety at this stage due to agreement with some of the intermediaries) we received on the SMEs satisfaction provided us with some insights as to how they access, utilise and perceive the effectiveness of the support activities provided by the studied intermediaries for eco-innovation. This data in some cases covered input (e.g. number of meetings, number of consulting activities, eco-innovation projects realized), impact (e.g. resource savings in terms money, material and energy) and output (number of new products and services developed). Based on primary data collected from interviews with the studied intermediaries and also secondary data from firms receiving support from this intermediaries we were able to synthesis the functions of intermediaries in eco-innovation and also to identify improvement options and good practices in the support functions. Our analysis of the empirical data followed a thematic approach (see [Stebbins, 2001](#); [Wolcott, 2008](#)). In this approach, we iteratively looked for emerging themes and patterns in the collected data relevant for the goals of this paper. This iterative search for themes and patterns was done by the two researchers who participated in the interviews to enhance content validity.

#### **4 Results**

In this section, we present and discuss relevant findings from our empirical studies in-line with the aims of this paper. First we present and discuss the functions of intermediaries for eco-innovation and then identify some good practices and challenges with intermediation in eco-innovation based on good practices and weaknesses from our studied cases.

From our case studies and analysis, we identified eight functions of intermediaries in eco-innovation. Table 2 below summarises these functions, detailed activities involved in each

function and also studied intermediaries who are involved in particular functions. These functions are further discussed in the sub-sections below.

Table 2: Functions of intermediaries for firm-level eco-innovation

Support Function	Activity	Example BDO and CI providing function
1. Forecasting and road mapping	Generating a list of potential eco-innovations to develop. Stimulating eco-innovation projects.	Greentech Cluster, NRW Malmö Cleantech City, Scania
2. Resource mobilization	Provision of financial assistance, linkages to financiers, assistance with financing implementation projects.	ALMI Scania, Local BDOs in Essen and Duisburg; Efficiency Agency
3. Networking and partnerships	Breakfast meetings, social gatherings around a specific theme. Conferences, seminars, collaboration projects between companies and other actors.	Sustainable Business Hub; Malmö Cleantech City; ALMI Scania; Greentech Cluster, NRW; Energy efficiency agency; Efficiency Agency; Local BDOs in Essen and Duisburg
4. Commercialization	Assistance with sales and marketing; export promotion activities.	Sustainable Business Hub; Malmö Cleantech City; ALMI Scania; Local BDOs in Essen and Duisburg
5. Technical consulting	Energy and material efficiency consulting and project implementation	Energy and Efficiency Agency, NRW
6. Knowledge/Information gathering, processing, generating and spreading	Seminars, workshops, meetings around specific topics, newsletters	Sustainable Business Hub; Malmö Cleantech City; ALMI Scania; Greentech Cluster, NRW; Energy efficiency agency; Efficiency Agency; Local BDOs in Essen and Duisburg
7. Sector branding and legitimation	Seminars, workshops, meetings around specific topics, newsletters about the environmental technology sector	Sustainable Business Hub; Malmö Cleantech City; Greentech Cluster, NRW;
8. Prototyping and piloting	Field testing and measurement Provision of test beds and measurement of the environmental performance of new products and/or services as part of evaluation and assessment	Malmö Cleantech City; ALMI Scania; Greentech Cluster, NRW

*i) Forecasting and road mapping*

With this support, intermediaries provide foresight and roadmaps to firms on relevant eco-innovations based on relevant criteria and intelligent information. For example, The Greentech Cluster in NRW works with a proactive approach – an innovation radar which includes generating a list of eco-innovations for each year and then bringing together companies to develop them further. The goal of this support activity is to develop a number of new projects every year in which environmental technologies can be developed and introduced to the market (interview, Greentech Cluster, NRW). The support activity is based on the capacity of the Greentech Cluster to identify interesting eco-innovations based on market potential and relevant actors in NRW. They further bring interested companies and entrepreneurs around the eco-

innovation through seminars and workshops to stimulate them to initiate further development projects which these clients run independently. The main strength of the cluster organization is to be able to bring together the right mix and set-up of companies, universities, researchers in meetings, seminars and workshops and also to achieve a project set-up which is new along the value chain. The companies invited to the workshop are actively selected based on how fitting their profile is to the innovation under discussion.

“...the projects are done within the companies on their own. We are only initiating and generating new ideas and innovations and gather interested people around it”  
(interview, Greentech cluster, NRW).

### *ii) Resource mobilization*

This support function deals with assisting firms to mobilize different resources needs for eco-innovation. Such resources include technical competence, human capital, financial capital etc. This function can be provided by the intermediary itself or by linking firms to other organizations specialized in providing the particular resource. For example, ALMI Scania provides financing to support different stages of the innovation and entrepreneurship process (interview, ALMI Scania). The support activity of ALMI Scania that is biggest in volume is financial support for preliminary studies. This support can be granted to individuals or companies with up to 250 employees from all industries. The purpose of the grant is to lower the risk of a project or to verify the risk. Thus the grant can be used for seeking support in order to build a prototype, file a patent application, getting external verification or participation at a fair. Since 2003, an employee of The Efficiency Agency in NRW was dedicated only to organizing financing schemes for resource efficiency projects and now the agency tries to translate technical resource efficiency project ideas into a banking feasible project. The support has also widened in focus from production efficiency to the development of new products (interviews, The Efficiency Agency, NRW). The local business development organizations and Sustainable Business Hub do not provide such financial resources to firms by themselves but they do serve as a hub through which firms can access relevant information on such resources and also link to relevant actors which are able to provide such resources (interview, Sustainable Business Hub).

### *iii) Networking and partnerships*

Innovation intermediaries acknowledge that innovation diffuses through knowledge networks and knowledge creation is a sophisticated, dynamic process and many innovations come from interactions with user groups, consumer channels and supplier groups outside the firm. For example, Sustainable Business Hub, Malmö Cleantech City and the Greentech Cluster provide meeting arenas and projects for collaboration and interaction purposes between various innovation stakeholders such as supplier and potential customers, researchers and financiers. The main role of Sustainable Business Hub in this support activity is to develop contacts with universities in the region with different competences and then link these competences to companies through meetings and seminars around narrow themes e.g. heat exchangers, biogas, waste management etc. Their starting point for this networks and partnerships specific for eco-innovation is universities and companies but Sustainable Business Hub plans to include private consultants and other intermediaries would be interesting developments in the near future (interview, Sustainable Business Hub). For Malmö Cleantech City such interactions and

networking activities are organised through weekly breakfast meetings and matchmaking meetings with specially invited attendants to discuss specific themes about environmental technologies (interviews, Malmö Cleantech City).

*iv) Commercialization*

This intermediation activity has to do with activities geared towards exploiting an innovation by identifying potential markets and consequent strategies for assisting firms to serve those markets both home and abroad. For example Sustainable Business Hub provides export promotion activities (e.g. business delegations, matchmaking services) for its members. Sustainable Business Hub has since 2007 focused on the support activities specified towards assisting environmental technology companies in export. This support includes taking part in trade delegations abroad, arranging meetings to meet potential customers and partners, and education and training about marketing and exporting activities. In collaboration with other agencies in North Rhine Westphalia such as the Energy Region in NRW, the Energy Agency is responsible for climate protection activities within networks for biomass, fuel cells and hydrogen, energy-efficient and solar construction, geothermics, fuels and drives of the future, power plant technology, photovoltaics and wind energy. Their support focus in this case is to initiate innovative projects and products, speed up their market readiness and exploit its economic potentials including foreign trade (interview, Energy Agency, NRW).

*v) Technical consulting*

This intermediation support focuses on the provision of technical knowledge or assistance needed for the identification and implementation of eco-innovations such as energy efficiency and material efficiency projects. Some activities also focus on eco-design of products. For example the Efficiency Agency in NRW offers free consulting on problem identification/definition and also planning appropriate measures. After initial consulting, firms can receive direct advice for the next step e.g. technical consulting. Companies are denied support in different situations for example when they already have state-of-the-art technologies and the Efficiency Agency does not have a clear idea for improvement. In other instances, companies seem not to be willing to change or improve their working practices and this can hinder material and energy efficiency measures. The Efficiency Agency, NRW strongly pointed out, that the support should not end with planning measures but rather go further into implementation. Energy consultants should stay on board for securing funds, writing tenders, evaluating bids, commenting on prices and offers and finally accompanying realization. (interview, Energy Agency, NRW).

*vi) Information gathering and spreading*

Information gathering and spreading on the environmental technology sector and on sustainability issues in general is one of the most common support activities offered by the studied intermediaries. The medium for giving this support to companies include lectures with invited speakers and companies around very specific themes and then creating a platform for people to meet and share ideas, and through the distribution of newsletters, magazines and industry proceedings. The information content can vary from general business information such as market demand and trends and also technical information on environmental technologies. For

example, the Energy Agency in NRW offers support activities including information provision on energy weak spots in companies. This covers technical systems in buildings to production processes and includes heating systems, heat recovery, insulation and energy planning. There are also continuous training seminars for companies including action weeks offered to the company workforce on energy efficiency solutions. With its Energy Knowledge Portal, the Energy Agency, NRW also provides an on-line platform on the Internet for initial vocational and continuous training (interview, Energy Agency, NRW).

*vii) Sector branding and legitimation*

Legitimacy deals with social acceptance and compliance with relevant institutions. The function covers the acceptance the support actors offer to certain entrepreneurs and technology types as eco-innovations and sustainable entrepreneurship. This could be through their membership, accreditation and other means of affiliation to the support actors. Legitimacy and the branding are important for resources to be mobilized, for demand to form and actors to gain political strength. For example the membership that Sustainable Business Hub offers to companies gives them some form of legitimacy as working with eco-innovation and sustainability related issues, in a similar fashion to Malmö Cleantech Cities and their clients. Participating in BDOs organised support programs such as Ecoprofit® and being certified can give an indication that a company is concerned and works with environmental issues. Ecoprofit® is a registered trademark about environmental improvements in companies and is popular among German speaking countries (Klewitz, 2012).

*viii) Prototyping and piloting*

Here intermediation activities emphasize on assessment of technologies and evaluating particularly their environmental performance for example in terms of energy, material and financial savings often on test beds and under laboratory conditions. For example, Sustainable Business Hub provides support for member companies for demonstrating and testing their new products and services using municipalities which are often advanced in technology use and play an active role in providing platforms for prototyping and testing purposes. Sustainable Business Hub can be a connection between companies looking for test bed and municipalities willing to show new and state of the art solutions. Sustainable Business Hub provides a meeting platform for municipalities to present their visions including challenges and companies develop new solutions to meet these demands. This test bed and demonstration activities are sometimes coupled with innovation contests, where companies compete with their solutions for a small price and publicity (interview, Sustainable Business Hub). In the case of Malmö Cleantech City, the test bed area is more of a concrete support activity provided by Malmö Cleantech City for companies in an early innovative product development phase. It follows two paths either a company with an innovative product contacts Malmö Cleantech City to help with pilot tests in the city or sometimes the municipality defines their urban sustainability challenge and Malmö Cleantech City can scan the market and bring the companies to solve the challenge. The technical departments within the municipality assist such companies to test and do measurements and continue to develop their products. E.g. a water saving shower has been tested. This is small scale activities to test the technologies and the results are open to the general public both as a review of the technology and for some publicity as well (interview, Malmö Cleantech City).

## 5 Discussions

### 5.1 Functions of intermediaries in eco-innovation

A promising approach in the technological innovation systems literature is the “functions of innovation systems” which emphasises on functions rather than on structure as a basis for analysing the dynamics of technological innovations and sustainability transitions. This approach is relevant for this study in at least three ways: (i) the emphasis on functions as a basis for stimulating the developing, diffusion and use of innovations, (ii) the number of actors, networks and institutions are generally smaller in this approach than in other relevant approaches such as the multi-level perspective, regional innovation systems, sectoral innovation systems thus reducing the complexity with greater possibility to analyse system dynamics (see Coenen and Díaz López, 2010) and (iii) the potential links between intermediary functions and the functions of innovation systems. This functional approach has been adopted in this paper and used to investigate the functions of intermediaries supporting firms in their development and adoption of eco-innovation. In the scientific literature, there are several ambiguities, confusion and redundancy regarding the functions of such intermediaries in innovation in general (Klerkx and Leeuwis, 2008). Even though no explicit attempt has been made to specify the functions of intermediaries in eco-innovation (cf. we review some literature where intermediation programs and intermediary actors have been studied in relation to energy transitions and sustainability in general-see literature review in Section 2). We anticipate the functions of intermediaries in innovation to share several similarities to the functions of intermediaries for eco-innovation we have identified above with some functions also particular for eco-innovation. This is due to their unique characteristics such as their positive environmental impact, the role of regulation in their development and diffusion, and the double externality problem – positive spillovers during innovation and diffusion (del Río et al., 2010; Rennings, 2000).

Major understanding from our studies points to the importance of functions of public support organizations as compared to the structure of the public support when it comes to the development and diffusion of eco-innovations. In this regard, certain actors could be missing in a support system to no detriment but essential support functions cannot be substituted and thus have a more direct and immediate impact on the development and diffusion of environmental technologies. For example, from the regions we studied in Sweden and Germany, the structure of the support system is entirely different in both regions even though their ultimate ambition is the same – to enhance firm level eco-innovation. Moving on we synthesis at least eight functions of intermediaries for eco-innovation as: (i) forecasting and road mapping (ii) resource mobilization (iii) networking and partnerships (iv) commercialization (v) technical consulting (vi) information scanning and distribution (vii) sector branding and legitimation (viii) prototyping and piloting. These intermediation functions, as Howells (2006) discusses can be targeted at individual firms, clusters or networks of firms, governments, and societal actors dealing with system level innovations. The functions we synthesised relate to some of the functions identified in previous innovation intermediaries literature as functions of innovation intermediaries, for example forecasting and roadmapping, assessment and evaluation, commercialization, information gathering and distribution relate to the ten set of functions provided by Howells (2006). On the other hand, we broaden the functions of intermediaries in eco-innovation as previously

understood from the studies of Klewitz et al. (2012) who investigated an intermediation program – Ecoprofit® small and medium sized manufacturing companies.

Some of the functions we identify in this paper relate well to the functions and processes identified for the creation of new niches (Geels et al., 2008), technological innovation systems (Bergek et al., 2008), supporting systemic transitions (Kivimaa, 2014). Relating to relevant literature such as the technological innovation system which forms a basis for the analytical approach used in this paper, intermediaries are expected to contribute to several of those innovation system functions. Bergek et al. (2008) define eight functions of innovation systems as: knowledge development, resource mobilization, market formation, influence on the direction of search, entrepreneurial experimentation, legitimation, and development of external economies. Innovation intermediaries notably contribute to knowledge development and diffusion through networks, guidance of the search, resource mobilization and the building of legitimacy (Klerkx and Leeuwis, 2008).

These support functions often take a “one-size-fits-all” approach with few tailored functions for eco-innovations. This can be explained by the complementarity role of public intermediaries to private intermediaries, the resource limitations of such public intermediaries and the broad nature of eco-innovation cutting across several sectors. Some functions such as technical consulting and resource mobilization are targeted at individual firms while others such as branding and legitimation or roadmapping are focused at an entire sector. Particular challenges facing such public support organizations relate to their neutrality in support (e.g. politics, technology); source of funding; functional ambiguity and the temporal limitations of the organization itself. We take up some of these challenges in the next section including an identification of some good practices of such support.

## **5.2 Challenges with intermediation in eco-innovation**

Discussions about challenges with the intermediation support activities should be approached carefully since public support for eco-innovation is intended to complement private market initiatives and thus should not be expected to fulfil every function. Overall such challenges and system weaknesses should not be treated as particularly catastrophic since the formative phase of an innovation system around a particular technology is particularly characterized by high uncertainty in terms of technologies and markets together with experimentation and variety creation (Bergek et al., 2008). Furthermore, these studies have been undertaken in Sweden and Germany, two countries which have been strong global players in eco-innovation and thus challenges identified could be contextual influenced though we abstract for some learning opportunities for regions in different countries.

However some challenges can be identified with the support functions and activities of studied intermediaries:

### *i) Functional ambiguity*

Though, most SMEs and public financiers appreciate the support activities of the studied intermediaries (based on secondary data which evaluates the activities of studied intermediaries- not displayed in this version of the paper due to agreements with intermediaries), it is often difficult to establish a concrete relation between the support they provide and eco-innovation

outcomes particularly at the firm level. This challenge is particularly pronounced for general focused intermediaries such as local business development organizations in Essen and Duisburg, and Region Scania, since their support is largely general business development which is particularly prone to the challenge of establishing a cause and effect. Assessing the impact of their activities is difficult given their sometimes indirect impact on the businesses value chain and this challenge goes a long way to affect their access to financial resources, their long term existence and the content of their support activities. However, when support activities involve firm specific technical support for energy and material efficiency, the outcomes can be followed up and measured in terms of financial, energy and material savings at the firm level.

### *ii) Reactive support*

The current support offered by many of the studied intermediaries (ALMI Scania, local BDOs in Essen and Duisburg, Sustainable Business Hub) is very reactive to the needs of companies. And from experience, company needs often fall within the current economic and institutional settings. For example when electricity and material costs get high, companies contact the energy and material agency for support. With, this reactive approach, radical innovations which go beyond current economic and institutional boundaries might be difficult to generate. A proactive approach is recognized as an essential push factor to trigger radical eco-innovations with low absorptive capacity (Klewitz and Hansen, 2013). To this end, the current intermediaries work quite well with incremental eco-innovations in products and services at the request of their firms, but as discussed in previous eco-innovation literature (OECD, 2009), it is changes in both technological and non-technological aspects encompassing both an organizational and institutional setting that can deliver radical improvements needed for sustainability transitions. However, the ability of the studied actors to provide support needed for such organizational and institutional level eco-innovations is rather a too high expectation. Kivimaa (2014) discuss such national-level government affiliated organizations labelled as systemic intermediaries who are able to provide regime destabilizing and landscape changing support.

### *iii) Resource constraints*

Another challenge with the current support activities of the studied intermediaries relates to their resource constraints in term of (e.g. personnel, financing, time, and knowledge). This challenge is of course influenced by the resources provided to the organization by its owner stakeholders and more importantly this resource limitation also influences the quality and content of their support activities. For example the mandate given most of the studied intermediaries and also the financial resources and knowledge competence available at their disposal influences how general or specific their support functions could be. In specific, the activities of cluster initiatives are often mandated towards an entire cluster and not tailored for individual companies' needs as indicated in interviews with Sustainable Business Hub, Greentech Cluster, Malmö Cleantech.

### *ii) Neutrality paradox*

Many of the studied intermediaries (e.g. Business development organizations in Scania, Essen, Duisburg) do not consider eco-innovation as different from “ordinary” innovation and entrepreneurship. Furthermore, cluster initiatives (Sustainable Business Hub, Malmö cleantech City, and Greentech Cluster, NRW) which focus on the environmental technology sector provide

largely similar support functions as intermediaries supporting “ordinary” innovations (cf Howells, 2006). Even though this generalization approach to support activities can be linked to the resource constraints on the side of intermediaries and the broad sector-cross cutting nature of eco-innovation, it has potential implications on the support outcomes. For example (Klewitz and Hansen, 2013), in their study of eco-innovation intermediation activities for SMEs established the need for some differentiation in the support provided. This varied along the lines that, some SMEs require continuous handholding during their pursuit of sustainability in general while others deal with this types of issues once they receive initial help. And therefore, different intensities of support from intermediaries from customized and individual support to more loosely held support such as networks is desired. Another form of neutral position taken by many of the studied intermediaries relates to which eco-innovations to support. Most intermediaries support a portfolio of eco-innovations using a broad understanding on their potential to improve environmental performance. While this eco-innovation neutrality can encourage survival of the fittest and tackle issues of government failures including path dependence and lock-out, the urgency of global warming, material and energy resource depletion and sustainable development in general may mean that eco-innovation specific functions may be needed together with neutral approaches.

### **5.3 Good practices for intermediation in eco-innovation**

As the studied regions i.e Region Scania and North Rhine Westphalia are located in Sweden and Germany, countries which have been consistently in the top ten global eco-innovators (WWF, 2012, 2014), there are potentially good practices on intermediation for eco-innovation. These include:

#### *i) A mix of general and specific functions*

A mix of different types of intermediaries providing different support functions to firms – those providing “hard” support (e.g. technical support on energy and material efficiency, financing) and those providing “soft” support such as networking, social meetings. The provision of different kinds of support functions goes a long way to underline the fact that, eco-innovations face different and interrelated barriers (e.g. eco-innovations also face general business development barriers encountered by any innovation and entrepreneur) and it could thus be fruitful to combine different support approaches for firms developing and/or implementing such innovations. For example, the energy-efficiency type of support is of importance for climate protection and cost efficiency of firms in all sectors, while the product-related type, is relevant for market success and competitiveness of firms in some specific “green” sectors as well as the development of regions. Some of the intermediaries for example local BDOs (e.g. ALMI Scania, local BDOs in Essen and Duisburg) are more established and have been in existence for a long time and serve as a good complement to relatively new intermediaries such as cluster initiatives which can provide fresh input needed to support eco-innovation in firms.

#### *ii) Proactive support*

When it comes to stimulating radical eco-innovations, proactive support which spans beyond current economic and institutional settings is often required (Carrillo-Hermosilla et al., 2009; OECD, 2009). In the studied regions, particularly North Rhine Westphalia, proactive support in scanning and foresighting relevant eco-innovations to firms is provided under a program called

the innovation radar. Such support is expected to trigger eco-innovation activity particularly in firms with low absorptive capacity and also when radical innovations outside current economic and institutional settings are of interest. And such radical innovations which often face more systemic barriers are expected to deliver greater environmental benefits than incremental innovations in products and services only (Carrillo-Hermosilla et al., 2010). For examples, It might be mentioned that in parallel to conducting the study a new activity of proactive support emerged in North-Rhine Westphalia: The KUER startup-competition ([www.kuer-startbahn.de/](http://www.kuer-startbahn.de/)) focused on supporting startups in climate and environmental protection as well as energy and resource efficiency was launched in 2014. Four modules accompany potential founders from business model development and business plan creation through to business start-up and financing. Within the first year about 60 firms were supported. Like the specialized agencies and the greentech cluster also KUER is an activity which the local BDOs cannot perform on their own. But they identify possible participants and advise them to take part in that competition.

### *iii) Interaction between different intermediaries*

Active interaction between various types of intermediaries to promote learning and competence sharing is particularly relevant to support eco-innovation. This is an inference from the observation that in several regions and countries, there are several initiatives and actors who stimulate firm level eco-innovation. Such a constellation of actors and initiatives can be confusing to firms, repetitive and even counteract each other and thus organic learning and interactions between such actors and initiatives is seen as a good practise. It was often observed that local BDOs did not always have in-house competence in supporting eco-innovation activities but rather had a strong relation with a large base of firms and also focused on business development activities and active interactions with other support actors such as material and energy efficiency. Universities have also proven relevant in developing support on eco-innovation as observed in North Rhine Westphalia and Region Scania.

### *iv) Support for different kinds of eco-innovations*

Support for different kinds of eco-innovations e.g. good, service, production process, organizational structure or management or business method innovations is observed as a good practise (del Río et al., 2010). The literature has already pointed out that there is a distinction between product and process eco-innovations regarding the barriers to their development and diffusion and thus tailored intermediation activities targeted at these types of eco-innovation could be considered a “good” practise from cases in the two studied regions. For example in North Rhine Westphalia, energy and resource efficiency as well as product development are object of BDOs activities and hundreds of firms make use of consulting and co-operation processes. Firms often strongly pointed out, that the support should not end with a written report but rather go further into implementation. Energy consultants, who get involved in securing funds, writing tenders, evaluating bids, commenting on prices and offers and finally accompanying realization are of extreme value for companies particularly in process innovation.

## **6 Conclusions and further research**

The departing aim of the paper was to synthesis the functions of intermediaries in eco-innovation and to provide some practical recommendations for intermediaries in eco-innovation. In doing so,

an approach based on the functions of innovation systems is used to analyse selected public-owned intermediaries in North Rhine Westphalia, Germany and Region Scania, Sweden. Our findings reveal a portfolio of intermediary functions for eco-innovation as: (i) forecasting and road mapping (ii) resource mobilization (iii) networking and partnerships (iv) commercialization (v) technical consulting (vi) information scanning and distribution (vii) sector branding and legitimation (viii) prototyping and piloting. These support functions often take a “one-size-fits-all” approach with few tailored functions for eco-innovations. This can be explained by the complementary role of public intermediaries to private intermediaries, the resource limitations of public intermediaries and the broad nature of eco-innovation. Potential good practices point to a mix between general and tailored functions together with collaborative learning between various types of intermediaries – i.e. established and new entrants. To stimulate radical eco-innovations, a proactive approach to intermediation is suggested. Further interesting research could include a deeper look at the demand side of support i.e. SMEs and how they access, utilize and perceive support. The functions of intermediaries synthesized have a good potential for further elaboration. For example, which functions are particularly relevant for eco-innovation, what are the interactions between the identified functions and how do they link to innovation system functions.

### **Comments:**

An earlier version of this paper, based on a systematic literature review and preliminary empirical findings was presented at XXV ISPIM Conference on Innovation for sustainable Economy and Society, Dublin, June 8-11, 2014.

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