USERS, INNOVATION AND SUSTAINABILITY

The role of end-users and policy makers in sustainable innovation

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Foreword

What is good sustainable innovation policy? And what is good governance for user-led innovation for more sustainable products and services in specific?

The basic aim of innovation policy is to promote invention and innovation that transforms knowledge and competence into long-term social welfare. Innovation policy for sustainable development asks what can be done by government to support products, processes and social innovations that spur and enable more sustainable lifestyles in specific.

From a policy maker’s perspective, there are two basic approaches to innovation policy: Either, governments engage into “horizontal industrial policy”, i.e. they design a supportive legal and economic framework, insure dynamic markets and promote a technology friendly “climate” in society. Or, governments engage in “vertical industrial policy” and opt for more active - and more intruding - efforts to develop an industry or a technology with economic incentives and industry-specific market regulation. This latter option has been criticized by market proponents since “picking the winners” by the state instead of the market is often not very efficient (“market knows best”). On the other hand, it has its merits in speeding up necessary changes in markets.

Both approaches are, however, focused on entrepreneurs and industries, hence on the supply side of the market. In times of digitalization, prosumerism and blurring boundaries between supply and demand, another focus is slowly gaining importance, namely user-led innovation for sustainable products and processes. The present report hence focuses on the question how innovation policy can spur this kind of innovation with user-entrepreneurs on the demand side of markets in the driver seat. The report identifies the key impact mechanisms as reported and analysed in the relevant literature. While admittedly this type of research is still scarce and in its infancy, we know from traditional innovation policy literature that good innovation governance
• is consistent and reliable;
• supports interaction between and offers platforms for all relevant actors: market actors (both: supply and demand), political actors, societal actors and science, also between venture capitalists and innovators/entrepreneurs;
• designs a supportive innovation infrastructure (education, physical infrastructure, etc.);
• supports a social “climate” that is open for innovation and has a culture for innovation and failure (willingness to change, open for new opportunity, trust in whom, culture of risk);
• finds the right balance of regulation and free market; and
• designs effective incentives and support programmes.

This is also the starting point for the present report that focuses on the specific requirements of user-led sustainability innovation.

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Lucia Reisch – Kristian Roed Nielsen – John Thøgersen
Summary for Policy Makers

The development of the mountain bike was achieved not by a company or firm, but by biking enthusiasts (end-users) who started tinkering with existing commercial bikes that were otherwise not suited for rough use. They developed stronger frames, balloon tires, and other modifications to make them viable for off-road purpose - creating a bike that we would later recognise as a mountain bike. The success of the mountain bike was not immediately driven by commercial gains, but by end-users’ enthusiasm and the active sharing of ideas on how to create a bike that better suited their needs. Even the current commercialisation of the mountain bike has not stopped additional end-user innovation and specialisation. On the contrary, ideas are still freely shared and mountain bikers with specialised needs further develop existing mountain bikes towards their own ends; be it high speed downhill racing, jumping or other forms of extreme mountain biking.

This example nicely illustrates that while we may perceive consumers, or end-users, as passive adopters of products and services, there is yet another trend emerging: Today, end-users are increasingly recognised as important drivers of innovation, playing an active role in the improvement and development of novel products of services. In seeking to promote sustainable innovation, we therefore propose that innovation by end-users could represent a currently under-appreciated and largely untapped resource for driving the transition towards a greener and fairer European economy.

The present report will thus explore end-user innovation from a policy perspective, exploring how policy could better encourage end-user driven sustainable innovation. We also aim to identify the current gaps in knowledge that need to be filled to better inform policy makers. As will be explained in the report, we have chosen to label this type of innovation as sustainable end-user innovation (SEI).

Independent and facilitated SEI
SEI can be broadly characterised as either independent or facilitated. Independent SEI reflects innovation on behalf of the end-user that is not facilitated by outside involvement, while facilitated SEI is characterised by the integration of the end-user into a formal company or project-driven sustainable innovation process. Even though the end-user is at the centre of the sustainable innovation process in both SEI processes, distinguishing between the two is highly relevant in order to effectively implement policy to support SEI. Independent SEI projects typically stem from end-users’ own interests, passions, and even idealism, while facilitated SEI to a greater degree operates within a market-driven framework and is driven by the interests of a company or project. The motivations, opportunities, abilities for both SEI processes thus vary greatly.

Supporting independent SEI
Independent SEI is typically driven by a limited number of persons united by their shared interests and passions for the project. They draw upon few others and are typically reliant on limited external resources, their own personal finances, and a small community of volunteers or co-innovators. In seeking to support independent SEI, policy makers should strive to ameliorate end-user competences and support the motivations for innovating in the first place.

From an independent SEI perspective, especially the utilisation of awards and competitions and DIY/self-building courses and groups represent simple and practical policy tools for supporting independent SEI with regard to increasing end-user competences, facilitating intergroup collaboration and learning, and with regards to making sustainable innovation doable and enjoyable.

At this point in time, grant funding schemes appear to be ill-matched to independent SEI. End-users particularly note the frustrating complexities of locating and
applying for grants, mentioning especially bureaucratic requirements as a constraining factor associated with the application process. Some end-users also note that their specific innovations fall outside the current funding frameworks. The literature is therefore unanimous in its assessment that current funding schemes need to be altered to better suit end-user abilities. This could be achieved by drawing inspiration from the literature on choice architecture and how these insights can be utilised to simplify existing funding schemes. An alternative could be to implement more micro-grants that are smaller in scale but require less paperwork and documentation.

Finally, a significant portion of the literature argues that ensuring the longevity and dissemination of independent SEI often depends not only on the end-user innovators themselves, but also on intermediary actors (such as cooperatives and voluntary associations) who support the independent SEI processes in a number of capacities. Policy makers should therefore not only seek to support the end-user innovators but should also consider the relevant intermediary actors.

**Supporting facilitated SEI**

Supporting facilitated SEI as opposed to independent SEI requires different types of policy interventions. Two methods that seem most favourable for encouraging end-user integration into facilitated sustainable innovation process is the lead user method and crowdsourcing.

The literature within SEI notes that certain end-users – the so-called lead users – play a more active role than others in the innovation process. These lead users take an active role in driving innovation as they experience and act to fulfil innovation needs that are still unknown to the general public; they are thus ahead of market trends. This ability arguably makes identifying lead users within sustainable innovation an appealing prospect. These lead users could, for instance, be identified via web fora and blogs; specifically by noting which end-users are the most active and by analysing their respective contributions. In identifying and co-opting these lead users into a facilitated SEI, the issue of overcoming expert scepticism towards end-user integration may be partly alleviated – in particularly since lead users, given their experience and expertise, understand technical details that average end-users would not. Lead users are also highly motivated to engage in product innovation, which is why a facilitated SEI process may also experience fewer wasted hours due to low end-user turn-out rates.

A potential alternative highlighted in the literature is crowdsourcing innovation challenges. The recent utilisation of crowdsourcing by USAID, for new protective suits for aid and healthcare workers working with Ebola, illustrates this potential. We suggest that while research and policy is still not “up-to-date” with this new type of innovation method, it has a number of potentials with regards to driving facilitated SEI. The motivational aspects of crowdsourcing arguably fit the characteristics of sustainable innovation, especially since end-users are more interested in the legitimacy of the project they are contributing to rather than the financial bottom line. In addition, crowdsourcing allows policy makers to steer innovation without dictating it, and it empowers the end-user to take part in the innovation process and to co-finance it via crowdfunding. Finally, recent literature suggests that end-users may in fact be better than technical experts in identifying viable projects. As a result, we view crowdfunding as a currently overlooked opportunity to facilitated SEI.

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Chapter 1

Introduction

The physical demands of contemporary consumptive (and subsequently productive) patterns are increasingly recognised as exceeding the Earth’s planetary boundaries (IPCC 2007; Rockström et al. 2009). Despite this, the transition towards more sustainable consumptive and productive patterns has been mired by disagreements and a general lack of progress (Fuchs & Lorek 2005; Tukker et al. 2008). Perhaps partly as a consequence of this, new actors seeking to be agents of change independent from a typically top-down policy forum have emerged. One such actor of particular interest is the (re)emergence of the individual as an active “prosumer” rather than simply a passive consumer. Rather than purely driving change via consumer action (Neuner 2000; Spaargaren & Mol 2008), some of these consumers are characterised as “being the change” by actively innovating, or co-innovating with firms, novel sustainable products and services (Heiskanen et al. 2005; Hoffmann 2007; Hyysalo et al. 2013b; Ornetzeder & Rohracher 2006). Much like classical innovation research before it, our understanding of sustainable innovation processes and actors must therefore also change. As will be illustrated in the following report, the individual consumer can be the driving party in innovation and not merely a passive onlooker (Bogers et al. 2010; von Hippel et al. 2011; von Hippel 1988).

The notion of the innovative consumer is not new (von Hippel 1976). However, while classical innovation studies have examined it in depth (Baldwin, Hienerth & von Hippel 2006; Bogers et al. 2010; von Hippel 1986; von Hippel 2001), sustainable innovation research seemed strangely lacking. Recently, this has begun to change and literature has begun to emerge from a diverse variety of fields studying innovative consumers within sustainable innovation (Feola & Nunes 2014; Heiskanen et al. 2011; Hyysalo et al. 2013b; Ross et al. 2012). However, we lack a systematic overview of this diverse, compartmentalised, and typically single case-based literature (Adams et al. 2012; Feola & Nunes 2014; Ornetzeder & Rohracher 2013).

It is a common view that bottom-up based sustainability action can only succeed if supported by adequate (top-down) policy initiatives (Kemp & Rotmans 2004; Tukker et al. 2008). Additionally, the importance of citizens and consumers as innovators within sustainable innovation conflicts with some aspects of current innovation policy, which is primarily aimed at producer-based research and development (R&D) and innovation (von Hippel 2005; von Hippel 1988).

The present report will thus explore this “new” actor from a policy perspective to find out how policy could be better tuned to encourage consumer driven sustainable innovation and to identify the current gaps in knowledge that need to be filled to better inform policy makers. This will be achieved by conducting a systematic literature review (Tranfield et al.

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1 Sustainable innovation is the development of novel sustainable products, services, and systems, which provide economic value as well as substantial social and/or ecological values (EU-InnovatE project definition).
identifying policies that support and hinder consumer sustainable innovation and assessing where policy needs to adapt to become more conducive to this alternative form of consumer rather than producer-driven innovation. First, however, we introduce the concept of sustainable end-user innovation (SEI) and define its scope.

To make this report easily accessible also for non-experts and quick readers, we offer grey summary boxes that we call “Policy Briefs” all through the text. The aim is to provide an overview of the essential issues of the respective section or subsection. An overall summary can be found in the “Summary for Policy Makers”.

1.1 The concept and scope of Sustainable End-user Innovation

**Box 1. What is Sustainable End-user Innovation (SEI)**

SEI refers to the observation that consumers (or end-users) often play a significant role in innovation, not only in terms of company and project-led initiatives, but also in terms of end-users increasingly innovating independently. The advent of Web 2.0, the continuously decreasing cost of communication, and the rise of multiple types of freeware have greatly increased end-user access to knowledge and toolsets. With the rise of 3D-printing (and other open workshops), digital user-generated content is increasingly being translated into real-world product and service innovation. This report seeks to explore how end-user innovation can be increasingly exploited to support sustainable innovation or SEI.

We define SEI as an individual or group of consumers (users of consumer goods), who engage in an innovative process within the realm of novel sustainable products, services or systems. This innovative process is initiated either via the integration of users into a firm’s sustainable innovation process or via independent user action.

To better understand the concept of SEI, traditional innovation literature is a source of inspiration. A wide range of theories exists that tries to account for why and how innovation comes about (Rosenberg 1982; Schumpeter 1942). Yet, in spite of this diversity, there was a fairly uniform perception, until recently, that innovation was typically the purview of the producer, consumers (apart from offering critical input) only playing a peripheral role in the development of product(s) and service(s) (Bogers et al. 2010). In the 1970s, however, this view was challenged, most notably by von Hippel, who showed that users represent a major source of innovation (von Hippel 1976; von Hippel 2005). The subsequent spur of research further cemented this view, identifying user innovation in a diverse range of sectors from extreme sports (Franke & Shah 2003) and semi-conductors (von Hippel 1988) to car design/mobility (Belz 1999) and scientific instruments (von Hippel 1976).

Von Hippel distinguishes between two “ideal types” of user innovation: driven either by intermediate users or end-users. Intermediate users are (professional) users, such as firms, who use equipment and components from producers to produce other products and services. End-users are conversely consumer users (or groups of consumers), i.e., final users of consumer products and services, typically identified as individual end-customers or a community of consumers. Conceptually, the consumers active in innovation are therefore in this report labelled end-user(s), in line with the user innovation literature (von Hippel 2005).

The prevalence of user innovation has, however, intensified greatly both due to the emergence of new technologies² and a generally better-educated citizen body (von Hippel et

² Low-cost, Internet-based communication and the rise of multiple types of freeware have resulted in (and resulted from) a growing collaborative innovation forum online. With the increasing availability of 3D printing (and other open workshops) digital innovation has increasingly translated into real-world product innovation (de Jong & de Bruijn 2012).
Hence, end-users are increasingly recognised as viable yet oft-overlooked actors within innovation (Baldwin & von Hippel 2011). Throughout the report we will at times draw upon the user innovation literature, referring to it as classical user innovation, given its relevance to our report’s focus.

Figure 1 illustrates the current demarcation of the systematic literature review undertaken here that will focus only on end-user innovation within the context of sustainable innovation, contrasting with classical user innovation literature, which focuses both on intermediate and end-user innovation in general.

**Figure 1: Demarcation of sustainable end-user innovation (SEI)**

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<th>Inside the paper’s scope</th>
<th>Outside the paper’s scope</th>
<th>Focus</th>
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<td><strong>USER INNOVATION</strong></td>
<td><strong>PRODUCER INNOVATION</strong></td>
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<tr>
<td>Sustainable user innovation</td>
<td>Unsustainable user innovation</td>
<td>End-user innovation as opposed to producer-led innovation</td>
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<tr>
<td><strong>End-user(s): Consumers who utilise a product and/or service in their everyday lives</strong></td>
<td><strong>Intermediate users: Firm-based users who modify equipment and components to produce specific goods and services</strong></td>
<td>Sustainable innovation within products, services and systems</td>
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<tr>
<td><strong>Review focus:</strong></td>
<td><strong>End-users (consumers) rather than intermediate or professional users</strong></td>
<td>End-users (consumers) rather than intermediate or professional users</td>
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<tr>
<td>End-user sustainable innovation via project-driven integration</td>
<td>Sustainable end-user innovation either via company-driven user integration or via independent user action</td>
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<td>End-user driven sustainable innovation</td>
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Given the nature of end-user innovation some user innovations do invariably transform into commercial products, while others do not (Baldwin, Hienerth & Eric 2006; Hienerth & Lettl 2011; Hienerth 2005). For that same reason there is a somewhat blurry transition from user innovator to “user entrepreneur” (Shah & Tripsas 2007). Consequently, this report will inevitably contain some coverage of literature focused on social and sustainable entrepreneurship. As excluding end-user innovations simply because they become a commercialised entrepreneurial activity would exclude potentially important insights from our review. Innovation without diffusion and commercial viability is hardly sustainable.

Notice that we define SEI differently from the classical user innovation literature in one major respect. The latter does not view co-creation based on consumer and producer cooperation as user innovation. Only the development and modification of products by users independent of outside involvement is classified as user innovation (Flowers et al. 2010; von Hippel 2005). However we wished to explore both how end-users could themselves innovate sustainable products and services, and how e.g. firms adopt end-users into their sustainable innovation process. SEI is, hence, seen as incorporating both independent end-user innovation and the integration of the end-user into firm-level innovation processes.

However, in the firm and project-level innovation process, the end-user needs to be an integral part of the sustainable innovation project. End-users “thus participate in the design phase (…) and not just during its refinement phase” (Weber 2003, p.153). This integration of end-users into a facilitated innovation process could reflect a type of open innovation process (Chesbrough 2003; Chesbrough et al. 2006).

An open innovation process can also involve other stakeholders and firms. This can be done via outside-in (inbound) open innovation like crowdsourcing or inside-out (out-
bound) open innovation like corporate incubators, or even via the donation of intellectual property and technology (Bogers 2014). In our literature review, however, we only focus on the co-option of end-users via an outside-in open innovation process and not the co-option of other stakeholders, firms or institutions.

1.2 Policy Framework

**Box 2. The MOAB Model**
Seeking to systematise the literature on SEI the report utilises the Motivation–Ability–Opportunity–Behaviour (MOAB) model. This model suggests that end-user behaviour is determined by three key variables: individual abilities and motivations and external opportunities. The end-users’ choice to engage e.g. in innovation is therefore supported or obstructed by these key variables. For example, an end-user may be motivated to innovate but may be incapable given a lack of technical ability. Understanding how all three dimensions support and impede SEI is arguably needed in order to better inform policy makers.

In identifying gaps in current knowledge and analysing how policy could be better tuned to encourage SEI, this paper is built conceptually on the Motivation–Ability–Opportunity–Behaviour (MOAB) model as originally presented by Ölander and Thøgersen (1995).

The MOAB model is an attempt to synthesise what is known, and what needs to be known, about the determinants of consumer behaviour in relation to sustainability. It proposes three key variables influencing consumer behaviour, both the individual-level variables Motivation and Ability, and the contextual variable Opportunity (Jackson & Michaelis 2003). The model represents an “other variables” approach to explain the “attitude – (intention) – behaviour gap” (Devinney et al. 2010; Zanna & Fazio 1982). The “attitude – (intention) – behaviour gap” referring to the observed lack of correlation between individuals’ expressed attitude or intentions and actual behaviour (Sheeran 2002). The MOAB approach suggests several effective “non-rational” behavioural based policy tools to overcome this and other gaps (Kahneman 2011; Thaler & Sunstein 2008; Ölander & Thøgersen 2014). It is thus seen as being informative from a policy perspective as it offers a more differentiated understanding of the multitude of factors influencing consumer attitudes and behaviour. Offering direct links to what areas policy tools should focus on when seeking to change behaviour – motivation, opportunity and/or ability. For example, a better understanding of limited human abilities is increasingly recognised as an important factor for achieving a more effective environmental policy (van Vugt et al. 2014). Also, behavioural policy techniques taking account of “default effects” within a sustainability context have already been suggested (Sunstein & Reisch 2014). Figure 2 illustrates the MOAB model.

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1 Consumer behaviour is understood as the “the acquisition, use and disposal” of products, services and practices (Bagozzi et al. 2002; Jackson & Michaelis 2003), in addition to the process leading up to the decision to consume, i.e. individual actors’ own reasoning for their needs and wants (Reisch 2003). ‘Use’ is understood here to also incorporate the possibility of the end-user innovating upon the given product, service or system.
While the MOAB model is not specifically tailored for understanding SEI, we contend that it is well suited for the task. The focus on the end-user and on sustainable behaviour makes it specific and relevant, and its ability to include a wide variety of potential policy insights makes it useful. Table 1 aims to broadly define the key variables (motivation, opportunity and ability) seen to influence consumer behaviour and offers examples of how policy concerning each variable could be used to influence them. Note as illustrated above there are multiple interactions and feedback loops (Ölander & Thøgersen 1995).
<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td><strong>Motivation</strong></td>
<td>Information campaigns typically seek to influence people’s motivations. By appealing to or challenging values and beliefs, information campaigns can result in intentional behaviour change in the long run. Economic interventions (taxation, subsidies) can change beliefs about behavioural outcomes and laws can change beliefs about others’ expectations. Educational interventions and interventions that make the right choice the easy choice, such as labelling, can increase perceived control. All of these intervention types can thereby influence intentions and behaviour.</td>
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<td>An individual’s motivation to act is based on his/her values and beliefs and expressed in their behavioural intentions. Some motives are personal, others social. The former are expressed in the person’s personal attitude towards the act and the second in perceived social pressure or subjective norms. Personal motivation may be undermined by a perceived lack of control over the outcomes of a behaviour. Hence, in a hierarchical structure, behavioural intentions depend on how personally and socially motivating the behaviour is, given the person’s values, beliefs and perceived control. Motivations are therefore internally derived but also influenced by external circumstances, e.g. by social norms.</td>
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<td><strong>Ability</strong></td>
<td>Educational campaigns seek to influence citizen’s knowledge and skills. Interventions that make it easier to make a green choice (like credible eco-labels) reduce the ability barrier. So does making the sustainable choices relatively cheaper (e.g., subsidized bus fares, taxing car-driving). Promotional offers can be an effective means to break bad habits (Thøgersen 2009).</td>
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<td>Ability reflects the actor’s capacity “to carry out his/her intentions” – as motivation without ability would result in a desire to act without an capacity to do so. Ability is subject to an individual’s competences (knowledge and skills) and resources (time and money). It also contains unconscious elements, such as habits. Habits strongly influence behaviour even if there is motivation to change.</td>
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<tr>
<td><strong>Opportunity</strong></td>
<td>Interventions that regulate availability and accessibility, such as providing easy access to recycling facilities, more frequent bus services, congestion charges. Interventions that make the right choice the easy choice.</td>
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<tr>
<td>Opportunity refers to the external conditions supporting or impeding the behaviour, and the connection between intent and behaviour. These objective external conditions (like availability and accessibility) may differ from the individual’s subjective perception of how easy of difficult it is to perform the behaviour, often referred to as perceived control (Ajzen 1991).</td>
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Chapter 2
The concept of SEI

Box 3. Describing and classifying SEI

We classified the literature on SEI on the basis of who is the driver of the innovation process (independent or facilitated) and what the goal of that innovation process was (incremental, novel, system). We acknowledge the vagueness of this approach, but given the lack of a coherent theory on SEI we nonetheless chose it, as it was useful for gaining an overview of the literature, especially with regards to developing policy.

Independent SEI reflects innovation on behalf of the end-user himself or herself which is not facilitated by outside involvement. Facilitated SEI is conversely characterised by the integration of the end-user into a company or project driven sustainable innovation process. The initiator of the innovation process is therefore at the heart of this differentiation. The subdivision of innovation into three ‘ideal types’ reflects the different types of innovation:

- **Incremental sustainable innovation**: Innovation in the form of an improvement of an exiting product/service. E.g. improving energy efficiency
- **Novel sustainable innovation**: Innovation in the form of a novel new product/service (including the reorientation of existing products and services in a new direction). E.g. car sharing service or electric bike
- **System sustainable innovation**: Innovation in the form of a novel new production or service that seeks to alter or change an established socio-technical regime. E.g. localised food system or community power.

In classifying the literature in accordance with the abovementioned ideal types we made the following general observation about the literature.

Independent SEI is driven by a number of factors, but most pronounced is that most of the projects reported in the literature were driven by the end-users’ interests, passions and even idealism rather than the expectation of monetary return. They therefore operate in what could be called an individual and social-need framework, seeking localised niche solutions to significant systemic issues, like energy (Hargreaves et al. 2013) or food systems (Kirwan et al. 2013). Finally, given their independent nature, they are often carried out by only a few active individuals, relying heavily on limited external resources, their own personal finances and volunteer work by community members.

Conversely, often focused on the marketability of the given sustainable innovations, facilitated SEI operates within a market-driven framework that at times limits the parameters of innovation as the given innovation often has to be applicable in a current setting, because the sustainable innovation has to be commercially viable or at least cost neutral. As a result, the innovations produced are often incremental improvements on existing products and services carried out in order to find generalisable sustainable innovations that could be applied at scale.

Failing to distinguish between independent and facilitated SEI would most likely result in ineffective policy –given the significant difference between the two. Policy therefore needs to adopt different approaches, which will be introduced in Chapter 3, to support independent or facilitated SEI.
The systematic literature review aims to contribute to the sustainable innovation literature by exploring how the (re)-emergence of the consumer as an innovator can be promoted by public policy measures. The reason why promotion of SEI can be a valuable policy field is twofold. First, on a micro level, end-users can bring critical technical knowhow and user-born insights to sustainable innovation processes and therewith contribute to more sustainable products, services and business models (Hoffmann 2007; Hyysalo et al. 2013b). Second, on a macro level, this type of innovation might facilitate and promote a socio-technical regime change that is urgently needed for a more sustainable economy and society (Jalas et al. 2014; Smith 2007).

In approaching the concept of SEI, we introduce two ideal types of SEI (independent and facilitated) and three ideal types of innovation (incremental, novel and system). This systemised categorisation allowed us to reflect on the literature and some general trends we identified during the review.

2.1 Drivers of Innovation: Independent and facilitated SEI

From the systematic literature review, two ideal types of drivers of SEI emerged: independent end-user innovation and facilitated end-user innovation (see Figure 3).

Independent SEI reflects innovation on behalf of end-user that is not facilitated by outside involvement (Hyysalo et al. 2013b). Facilitated SEI is in turn characterised by the integration of the end-user into a company or project-driven sustainable innovation process (Hoffmann 2007). Even though the end-user is at the centre of the sustainable innovation process in both ideal types, distinguishing between two types of SEI is highly relevant for policy to support SEI, since independent SEI faces different barriers than facilitated SEI, as will be illustrated in Section 2.3.

Figure 3. Independent and facilitated SEI

Independent sustainable end-user innovation

Facilitated sustainable end-user innovation

Sustainable innovation

Sustainable innovation

Independent SEI represents a more organic innovation process than firm or project-driven SEI processes, in the sense that the initiation of the innovative process is based on the user’s own needs (Bogers et al. 2010). These end-users are therefore driven to innovate not by a prospective firm’s needs, but rather based on the end-user’s everyday experience with a given good, service or system. Yet, there are additional drivers of independent SEI. Some actors are driven by a value-based aversion towards the current dominant socio-technical regime which reflects an almost idealistic approach to innovation, where the respective goal of the product or service comes first and its marketability second (Ornetzeder & Rohracher 2013; Weber 2003). Complementary to this, independent SEI approaches, in many cases, innovation from a hobbyist perspective, where enjoying the process and
the socialisation involved in improving or creating new products and services plays a role (Hyysalo et al. 2013b; Ross et al. 2012). External economic shocks like the 1970s energy crisis or the recent financial crisis (Karnøe & Garud 2012; Kirwan et al. 2013) can also act as catalysers. In fewer of the reviewed cases the trigger for the innovation is the classical conception of gap spotting, where the independent SEI spots a gap in the market and fills it (Ross et al. 2012).

**Facilitated SEI**, conversely, is defined against the backdrop of the firm/project’s needs. The end-user is a major component of the innovation process, but is not the driver of the process itself. Here, firms and projects typically adopt end-users into the innovation process to bring in external knowledge sources and partners (Chesbrough 2003). The facilitation of end-users into the innovation process provides insights into the factors enabling and obstructing the adoption of sustainable innovation, as it gives companies insights into user habits and everyday lives (Hoffmann 2012). In addition the co-option of end-users may also bridge the information gap often present between user needs and project/manufacturers’ capabilities. This gap arising as information sharing between the two is often hampered by the “stickiness” of information – “stickiness” referring to the often costly acquisition and transfer of information from one location to another (von Hippel 2005). This makes the sharing of information “highly contextual, tacit and difficult to transfer from one site to another” (Heiskanen et al. 2013, p.242). Facilitated end-user innovation helps to alleviate the stickiness of information and can ameliorate the effective sharing of knowledge and information (Hoffmann 2007; 2012). Additional insights with regards to these motivations for and drivers of SEI will be introduced in Section 2.3.

Independent or facilitated SEI refers only to whether the sustainable innovation process was initiated by an independent (group of) end-user(s), or whether it was facilitated by a project, firm or institution; it does not necessarily describe its current state. It should be noted that independent SEI can develop into facilitated SEI as end-user-innovators can and do develop into user entrepreneurs (Heiskanen et al. 2011; Shah & Tripsas 2007). In doing so these user innovators turned user entrepreneurs bring with them the same drivers that made them successful as user innovators. Resulting in continued continued co-option of end-users into the process to help drive their business model. The solar collector market in Austria (Ornetzeder 2001; Ornetzeder & Rohracher 2006) and the Slow Food movement that originated in Italy (Mayer & Knox 2010; Tencati & Zsolnai 2012) both started as independent SEI, but have subsequently achieved success by co-opting additional end-users and stakeholders, and by institutionalising themselves over the years. In these cases, the independently started SEI has become a success by facilitating additional end-user integration and innovation. The co-option of additional stakeholders (both end-users and institutions) adds value both in terms of access to tactics and scarce expert knowledge and information, but also in terms of increasing the legitimacy of the given product or service (Heiskanen et al. 2011; Hoffmann 2012).

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4 This process is not reserved solely for end-users; so-called “open innovation processes” can also involve other stakeholders and firms. In our literature review we intentionally focused on the co-option of end-users, not other stakeholders, firms or institutions.
2.2 Ideal types of innovation

Inspired by Adams et al.’s (2012) systematic review of sustainable firm innovation and Carrillo-Hermosilla et al.’s (2010) review of the diversity of eco-innovations, we adopted a similar three-stage framework for understanding the different levels of sustainable innovation. These three ideal types of innovation are characterised as “incremental”, “novel” and “system” innovation, as detailed here in Figure 4.

Figure 4. Incremental, Novel and System Sustainable Innovation

INCREMENTAL
Definition: End-user innovation in the form of an improvement on existing products/services
Example: Improving energy efficiency

NOVEL
Definition: End-user innovation in the form of a novel product/service (includes reorienting an existing product/service in a new direction)
Example: Car sharing service / Electric bicycles

SYSTEM
Definition: End-user innovation in the form of a novel new product/service that seeks to alter or change an established socio-technical regime
Example: Localised food system / community power

Source: Based on Adams et al. (2012) and Carrillo-Hermosilla et al. (2010)

Note that the subdivision of innovation types into these three categories is based solely on the level of innovation, i.e. given product, new good or service, and/or the new system approach. It does not present an evaluation of the sustainable innovation or the novelty of the approach adopted. Each type has its own value and they can be mutually reinforcing.

In the following section we highlight how combining the two previously mentioned ideal types, i.e. the driver of the innovation process and the type of innovation, provides a more ordered and structured view of the literature.

2.3 Systematizing the literature on SEI

Of the 64 articles identified by the systematic literature review, 52 – in one form or another – build on an empirical case-based approach (See Appendix 1 for more details). This result confirms Feola and Nunes’ (2014) observation that case-based literature is dominant in this field. While some of the literature attempts to place these respective cases in an overall theoretical framework – e.g. strategic niche management (Hargreaves et al. 2013) – the field remains arguably “empirically rich” but “theory poor”. This could in part be explained by the relative novelty of this literature, as 43 of the 64 identified articles were published within the last four years (2010–2014). Another contributing factor could be the diversity of academic disciplines seeking to explore the role of end-users in the sustainable innovation process. The literature on grassroots innovation (Seyfang & Smith 2007; Smith & Seyfang 2013), for example builds on a different theoretical tradition than the literature on bottom-up innovation (Ross et al. 2012) or user-led innovation (Ornetzeder & Rohracher 2006; Truffer 2003). Hence, not only is the field arguably theory poor, but the theories applied stem from different research traditions.

As a result we lack a coherent theoretical perspective on this field. The noted lack of theory or theoretical perspectives has also been identified within the general literature on user innovation (Bogers et al. 2010). Hence, it is not surprising that the more novel and less defined literature on SEI suffers from the same deficiency.
The lack of theoretical coherence is one of the reasons why we opted to categorise the literature based on the previously mentioned three levels of innovation and the two ideal types introduced in the previous two subsections, as Table 2 illustrates.

Table 2. Classification of independent and facilitated SEI

<table>
<thead>
<tr>
<th>Independent SEI</th>
<th>Facilitated SEI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incremental</strong></td>
<td>(Garuda &amp; Karnøe 2003; Karnøe 1996; Karnøe &amp; Garud 2012; Ornetzeder 2001)</td>
</tr>
<tr>
<td><strong>Incremental and Novel</strong></td>
<td>Hyysalo et al. 2013a; Hyysalo et al. 2013b; Ornetzeder &amp; Rohracher 2013; Ross et al. 2012</td>
</tr>
<tr>
<td><strong>Novel</strong></td>
<td>Lovell 2007; Truffer 2003</td>
</tr>
<tr>
<td><strong>Novel and System</strong></td>
<td>Ornetzeder &amp; Rohracher 2013; Ross et al. 2012</td>
</tr>
<tr>
<td></td>
<td>Rohracher 2003</td>
</tr>
</tbody>
</table>

The classification of articles in Table 2 is based solely on the original drivers of the innovation process and the type of innovation that they pursued. A few articles belong to more than one category as they build on previous case studies. Ornetzeder and Rohracher (2013), for example focus on three independent SEI cases, i.e. the development of wind technology in Denmark (Karnøe 1996), solar collectors in Austria (Ornetzeder & Rohracher 2006) and car sharing in Switzerland (Truffer 2003).

Of the 52 case-based articles, 20 focus on independent SEI, 29 focus on facilitated SEI and the remaining three (Heiskanen et al. 2011; Horwitch & Mulloth 2010; Ornetzeder & Rohracher 2006) cover both categories. The classification of the literature is typically straightforward. However, as mentioned some of the literature crosses classification “boundaries”: the three articles covering independent as well as facilitated SEI, and six articles that touch upon more than one type of innovation (Heiskanen et al. 2005; Hyysalo et al. 2013a; Hyysalo et al. 2013b; Ornetzeder & Rohracher 2013; Rohracher 2003; Ross et al. 2012). For example, Hyysalo et al. (2013b) noted the diversity of user innovation within sustainable home energy, identifying both incremental improvements of existing technology and novel additions and inventions. Despite these few outliers we believe that the suggested structuring of the literature is a useful tool for systematisation. The following two subsections examine the contents of the groupings in Table 2 and will share some insights regarding independent and facilitated SEI as portrayed in the reviewed literature.
Independent sustainable end-user innovators pursue a variety of innovation types but are mainly dominant in the field of system innovation. Half of the identified case-based literature focused on system innovation, which is somewhat contrary to what has been observed in other literature reviews. Carrillo-Hermosilla et al. (2010), for example noted that user-driven innovations typically “have a rather low to medium degree of innovativeness” (Carrillo-Hermosilla et al. 2010, p.1077). However, notable independent SEIs, such as localised food systems (Kirwan et al. 2013) and alternative currencies (Seyfang & Longhurst 2013), suggest a high level of user innovativeness. Evidently these system-level service innovations face severe difficulties with regards to diffusion and dissemination to the society at large. Previous niche products, like organic food, however, have shown that this transformation is possible with the necessary political will and tools behind them (Smith 2007). The development of the Danish wind industry additionally illustrates how end-users, at a product level, can, via learning by doing, facilitate the development of competitive designs and ultimately a highly advanced and successful industry (Garuda & Karnøe 2003; Karnøe 1996; Karnøe & Garud 2012). User innovation within sustainable home energy (Hyysalo et al. 2013b; Hyysalo et al. 2013a) further serves to illustrate that given the right circumstances, end-users can be very innovative. As Hyysalo et al. (2013a, p.46) note, “inventive users are not ‘born’ but ‘grow’ to have the capacities and special needs/wants that drive them towards invention.” Based on our review, system innovation seems to play a much larger role in independent SEI than assumed in earlier research.

This observation harmonises well with the observations made by a number of scholars who suggest that the strength of independent SEI is that it is driven, not by classical market-based forces, but rather by personal interests, passion and idealism. This frees the confines of innovations and allows for a more system-level change approach to innovation (Karnøe 1996; Ross et al. 2012; Seyfang & Longhurst 2013; Seyfang & Smith 2007). This idealistic (or even activist) approach to sustainable innovation, however, can also present major problems for independent SEI, specifically with regards to the diffusion of the sustainable innovation(s) (Seyfang & Haxeltine 2012). Often, independent SEIs that have sought to create a system-level sustainable innovation become a counterpoint to the mainstream and therefore do not wish to “integrate” into the dominant regime. Instead they become “a world within a world” (Seyfang & Smith 2007, p.594), resulting in multiple small-scale localised groups that remain relatively niche oriented and separate from society at large. This internal dynamic, while somewhat understandable, can act as a barrier to the dissemination of especially system innovation as any step towards the mainstream could be conceived of as ‘selling out’ (Seyfang & Haxeltine 2012).

To sum up, while independent SEI arguably does not suffer from a low degree of innovativeness, given the dominance of system innovation, it is notable that a significant number of independent SEIs remain relatively small scale and a local niche (Lovell 2007; Seyfang & Longhurst 2013). Consequently, many of these system-level innovations fail to disseminate into society at large, not only due to their uniqueness, but also due to internal group dynamics. Both the geographical rootedness of these small groups and the desire to remain “purist” challenge the ability of some independent SEI (especially within the field of system innovation) to diffuse into society at large (Seyfang & Haxeltine 2012; Smith & Seyfang 2013). The internal group dynamics in this type of SEI have been pointed out, for example with regards to the dissemination of car sharing services in Switzerland in that there were those who wished to maintain having less capitalised community level service and those who wished to develop the scheme further to make it more broadly available, but also more commercially driven (Truffer 2003).
Facilitated SEI seems to be more task specific, and rather than adopting a system-level innovation approach, it generally seeks to improve on existing products or services. This is illustrated within the energy consumption literature, where consumers are actively integrated into the innovation process to better understand end-user preferences, to draw on their “local” competences and to avoid mismatches between project management and end-user expectations and competences (Heiskanen et al. 2013; Heiskanen & Lovio 2010; Katzeff et al. 2012; Liedtke et al. 2014). The general observation from the literature is that facilitated SEI operates within another framework than independent SEI. The market-driven nature of many facilitated SEI processes seem to impact the innovation process itself in particular the direction and type of innovation conducted.

When observing the drivers of facilitated SEI, namely firms and projects, it becomes clear that these facilitators operate within clear economic constraints, which in turn fosters mainly incremental innovation. Undoubtedly, the market-driven nature of many firms and utility services makes creating a non-profitable niche innovation impossible (Hargreaves et al. 2013). Many projects also operate within a similar framework as they are typically asked to support / create solutions that are applicable and cost neutral today rather than radically challenge markets tomorrow. Independent SEI within wind power, for instance was unprofitable from a market point of view in its early stages, leaving it to enthusiasts (sometimes idealistically motivated) to drive this type of innovation (Garuda & Karnøe 2003; Karnøe 1996; Ornetzeder & Rohracher 2013).

Facilitated SEI additionally does not seem to have the same localised focus as independent SEI. While independent SEIs often act and seek to find solutions to supra-national issues (e.g. climate change, oil shock), they typically do so based on local action. Innovations created by independent SEI are therefore typically based on end-users’ personal and context-specific needs. Facilitated SEIs, on the other hand, tend to adopt a more generalised problem solving approach and incorporate local expertise and end-user competences into an overall innovation process with the general goal of creating products and services that better fit a greater number of consumer needs. This is, for example illustrated within the literature on bottom-of-the-pyramid sustainable innovation (Khavul & Bruton 2013), were facilitated SEI is targeted to make incremental gains for challenges like cleaner, more efficient cooking stoves (Jerneck & Olsson 2013) and sustainable farming systems (Chen et al. 2010; Dogliotti et al. 2014; Kiros-Meles & Abang 2008). Thus the aim is to better understand end-users and their respective needs in order to create a better overall product or service on issues like the two just mentioned.

Given the barriers often faced by persons wishing to tackle bottom-of-the-pyramid sustainable innovation, it is perhaps not surprising that these projects are typically of the “facilitated” type. Other facilitated SEI focusing on energy or green building also aim at establishing a generalisable system that draws on end-user insights to improve existing designs (Heiskanen & Lovio 2010; Rohracher 2003; Rohracher & Ornetzeder 2002). It is the aim of these projects not to be localised and a niche, but instead “workable” solutions for present goods and services.
Independent and facilitated SEI appear to operate within different frameworks that ameliorate different types of innovations and solutions to the given issue. As Seyfang and Smith (2007; 2013) note with regard to grassroots innovation, the context of the innovation strongly influences the type of innovation produced. Innovations can be driven by market needs, social needs and/or by values – as well as by a mix of all these. This is also what we have found in our systematic review.

Generally speaking, independent SEI seems to be driven by an individual and social-needs framework, while facilitated SEI typically appears within a market-driven framework. This overall framework defines the direction of the end-user sustainable innovation process. Table 3 illustrates the differentiation between independent and facilitated SEI based on the general observations made through-out this review as well as on observations made by Seyfand and Smith (2007) on grassroots innovation.

Table 3. Frameworks for independent and facilitated SEI

<table>
<thead>
<tr>
<th>Framework</th>
<th>Independent SEI</th>
<th>Facilitated SEI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Personal projects based on interests, passions and idealism. Typically facilitated by individuals or small groups.</td>
<td>Typically firm, government or university driven projects. Typically facilitated by one or more institution(s).</td>
</tr>
<tr>
<td>Solutions</td>
<td>Localised and context specific solutions to larger issues. Dominance of system innovation.</td>
<td>Generalisable solutions to larger issues, built in part on end-user knowledge. Dominance of incremental innovation.</td>
</tr>
<tr>
<td>Resources</td>
<td>Grant funding, voluntary input, crowdsourced competences via e.g. internet forums. Some commercial resources if successful.</td>
<td>Income from commercial viability of the given product or service. Larger government and university grants. Small SMEs can also seek crowd-funding</td>
</tr>
</tbody>
</table>

Source: Based on Seyfang & Smith (2007)

There are some important outliers that fall outside our scheme. Independent SEI can, for example, also be driven by extrinsic motivations (Ross et al. 2012), while facilitated SEI can and does seek novel and system innovation (Heiskanen et al. 2005; Hoffmann 2007). The studies by Heiskanen et al. (2013), Ornetzeder and Rohracher (2013) and Hyyslo et al. (2013b) illustrate that end-user innovators can also be involved in incremental and novel-based sustainable innovation. We acknowledge the vagueness of our approach in these respects, yet suggest that it is useful in particular to developing policy-relevant suggestions.
2.5 Incremental versus system innovation

The above discussion may to a certain degree give the impression that incremental innovation is less welcome than novel and system innovation. Also, in the literature on sustainable innovation, incremental innovation is typically seen as incapable of achieving the radical transformation needed to achieve a sustainable society (Carrillo-Hermosilla et al. 2010; Smith et al. 2005; Weber 2003).

While the authors agree that there is a need for radical change, in part in the form of radical technological and system innovation (Nill & Kemp 2009), there is the danger of ignoring the potential of incremental innovation by adopting a position that directly or indirectly supports only system innovation. Our literature review suggests that many of the most successful SEI innovations were incremental in nature (Hyysalo et al. 2013b; Karnøe 1996; Ornetzeder 2001; Ornetzeder & Rohracher 2013), while a number of system innovations had difficulties with regards to dissemination to a larger population (Seyfang & Smith 2007). This does not question the need for system innovations, rather it illustrates that incremental sustainable innovation within SEI should not be belittled. The development of commercial wind power illustrates this point nicely.

The utilisation of wind power as a source of energy was not a novel concept in the 1970s when Risager (a carpenter by trade) and others began to experiment with different turbine designs (Karnøe & Garud 2012). Despite of this they managed to dramatically improve on existing designs, increasing the kW production of turbines from 15-30 kW in 1974-1979 to 180-450 kW by 1989, through an incremental innovation process (Karnøe 1991). Arguably, this incrementally focused SEI created profound potential for creating a more sustainable energy future.

Bottom-of-the-pyramid innovation within the family farm system in Uruguay is another example demonstrating visible benefits of incremental innovation. Here, the co-innovation of knowledge between scientists and farmers led to some truly significant results for both the productive capabilities of the respective farms and the sustainability of those same farms (Dogliotti et al. 2014). These benefits were not due to novel or system-changing innovations, but rather due to the inclusion of the end-user in the innovation process.

The literature on SEI illustrates that a greater focus on end-users within incremental and novel innovation could result in significant (and typically easier to achieve) progress with regards sustainable innovation. We therefore warn against focusing exclusively on system innovation at the expense of incremental and novel innovation, especially given the at times significant impact that incremental innovation can have.
Chapter 3
Policy and sustainable end-user innovation

The evidence on who exactly user innovators are and why they choose to innovate remains limited to relatively few academic articles (Bogers et al. 2010; Flowers et al. 2010). This is even more apparent in the literature on SEI, where our literature search revealed no systematic attempts to characterise end-user innovators in terms of socio-demographic traits. In approaching SEI from a policy perspective we thus begin by drawing on the literature from classical user innovation to learn more about who these user innovators could be. The subsequent sections then refer to our reviewed literature on SEI, also drawing parallels to classical user innovation. In addition to exploring how policy could be better tuned to encourage SEI, these subsections will assess where policy needs to be adapted and where additional knowledge is needed to better inform policy makers.

This will be done utilising the previously mentioned MOAB model (see 1.2) as it offers direct links to where exactly policy tools should be set in to support end-user motivations, opportunities and/or abilities. Section 3.2 explores the motivational barriers and drivers of SEI from a policy perspective; Section 3.3 does the same from an ability perspective; and finally Section 3.4 does so from an opportunity perspective. Given the marked differences identified in Chapter 2, each of the sections will focus on independent and facilitated SEI.

\footnote{Note that the user innovation literature typically does not see facilitated end-user innovation as user innovation as it is not initiated on behalf of the user. See background Section (1.2) in the introduction for further details.}
\footnote{Classical user innovation, as noted in Section 1.1, refers to the traditional literature within innovation studies that focuses on user innovation in a broader context than sustainable end-user innovation.}
\footnote{Motivational barriers and drivers from a policy perspective are the individual, internally derived, reasons for pursuing, or failing to pursue, a SEI process either via independent action or in a facilitated process. Individual motivations are heavily influenced by the person's abilities and external circumstances.}
\footnote{Ability barriers and drivers from a policy perspective are the individual's knowledge, skills and other personal resources to pursue an SEI process either via independent action or in a facilitated process.}
\footnote{Opportunity barriers and drivers from a policy perspective are the external facilitating or impeding factors making it more easy or difficult for end-users to pursue a SEI process either via independent action or in a facilitated process.}
3.1 End-users within the user innovation literature

Box 4. The composition of end-users within innovation

The composition of end-users within sustainable innovation remain largely unexplored given the novelty of the literature. If we draw upon the more developed literature from classical user innovation research, however, it has been revealed that a significant number of end-users are involved in some kind of user innovation. Based on a representative survey in the UK, NESTA, for example concluded that 8% of all consumers reported having created or modified a consumer product (Flowers et al. 2010).

User innovation is significantly higher in some fields than in others. Typically, areas with high levels of user innovation are inhabited by “extreme users” who require very precise tools. Neurosurgeons, for example are highly motivated to obtain tools that are as precise as possible and are hence more prone to create or modify a given product to better suit their specific needs. Among private consumers, well-documented examples are practitioners of extreme sports, such as kite-surfing or mountain-biking.

The composition of end-users involved in the innovation process varies greatly and depends on a number of diverse factors, such as product type. Studies have estimated the share of independent end-user innovators who have created or modified existing products within the field of extreme sporting equipment, for example, to 38% of users, while this number remains negligible in other areas (Franke & Shah 2003; von Hippel 2005; Lettl 2007). A recent study on end-user innovation by Flowers et al. (2010, p.4) found that, in the UK, 8% of consumers have created or modified “one or more of the consumer products they use in order to better address their needs.” Some have suggested that user innovation will grow given the increasing availability of knowledge, tools and individual capabilities, with the emergence of low-cost communication technologies, open source freeware and increasing access to 3D-printing facilities (and other open workshops) (von Hippel et al. 2011; de Jong & de Bruijn 2012). The same team have made similar studies in Finland, the Netherlands, the US and Japan, with very similar results (de Jong & von Hippel 2013)

Based on the current literature on user innovation, inventive users tend to have a high motivation to develop a new solution and typically find themselves categorised as “extreme users” (Lettl 2007). For example, neurosurgeons are highly motivated due to the “extreme” demands of their job and are hence more prone to create or modify a given product to better suit their specific needs (von Hippel et al. 1999). This group of individuals therefore typically possesses the highest level of formal education. Gender and age also seems to influence the propensity of users that innovate, with men innovating substantially more than women and the youngest generation (15–24 years of age) innovating twice as often as people 65 years or older (Flowers et al. 2010, pp.17 – 18). Flowers et al. did not explore whether these gender and age differences are due to differing user motivations, abilities or access to products and services beyond work.

Facilitated end-user innovation is, as noted in Section 1.1, a type of open innovation process that seeks to involve the end-user in the innovation process to better understand user needs, habits, knowledge and behaviour (Chesbrough 2003; Heiskanen et al. 2013; Hoffmann 2007). The co-option of end-users depends on the specific product or service. Therefore, defining a general demographic profile makes little sense from a policy perspective.

The paucity of research on the demographics of sustainable end-user innovators is no surprise, given the novelty of the research field. To our knowledge, Seyfang and Haxel-

11 Not facilitated by outside involvement (via a firm, institution or project).
Seyfang and Haxeltine (2012) provide the only survey-based attempt to quantify some demographic traits of independent sustainable end-user innovator(s). Specifically, they report a survey of the members partaking in community-based sustainable innovation initiatives under the umbrella of the transition town movement. Over half of their respondents, however, were 45–64 years of age, which means that their sample is not representative for the whole population. Still, Seyfang and Haxeltine (2012) also found that a large proportion of the active participants had a high level of formal education (37% had a post-graduate degree), consistent with Flowers et al.'s (2010) national UK survey on classical user innovation. Seyfang and Hexeltine (2012, p.388) also found that “members were disproportionately likely to be part-time employed (24%) or self-employed (26%) compared with the general population”. However, given that their sample is not representative, generalising these results beyond this specific case is not possible.

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Seyfang and Haxeltine (2012) identify this type of community-based sustainable innovation as grassroots innovation. We incorporated grassroots innovation into the larger category of independent SEI.
3.2 Motivation and SEI

**Box 5. Motivational barriers and drivers**
From a policy perspective, the basic motivational barriers and drivers of SEI are the individual’s values and beliefs. These motivations depend on the individual’s own knowledge, skills and resources, but are also heavily influenced by external circumstances (e.g. social norms, availability, affordability). Exploring the motivational barriers and drivers for individuals to pursue an SEI process, we focus on both independent and facilitated SEI.

**Independent SEI:** It appears that “emotional involvement” in the innovation process is an important driver of independent sustainable end-user innovators. The literature generally notes that end-users typically innovate primarily for personal reasons and only secondarily, if at all, for commercial gain. Independent SEI is driven by personal enjoyment of the process, the social capital gained by doing so, and even for idealistic reasons. In certain circumstances, a financial element is also apparent. Based on the reviewed literature, policy could seek to ameliorate this emotional involvement via a number of tools, for example:

- **Awards and competitions:** Awards and competitions are effective because they offer a number of motivational drivers, including exposure and public awareness, credibility, encouragement, and of course a financial incentive.

- **DIY or self-building courses:** DIY and self-building courses and groups act as competence building facilitators, empowers end-user action and finally the disseminators of competences and the given innovation itself. Sustainable innovation thus becomes “not only doable, it might even be enjoyable” (Jalas et al. 2014, p.92).

- **Supporting intermediary actors:** Groups like cooperatives, voluntary associations and informal community groups are often important (and overlooked) actors in supporting independent SEI. They facilitate contact between end-users, empower small groups and give them a policy voice, and can support struggling niche independent sustainable end-user innovators.

**Facilitated SEI:** The most significant barrier noted in the literature to facilitated SEI is not a lack of end-user motivation, but a certain degree of (at times well-founded) scepticism from the firm or project managers regarding the wisdom of the end-user(s) involved. Identifying methods for successfully facilitating SEI is therefore in focus. Based on the review we note that potential methods for facilitating SEI include:

- **Open source:** The basic concept is that individuals, organisations and governments make a given product design and/or blueprint universally available to be used freely by anyone. End-users can subsequently utilise the given product or modify it to better suit their needs (typically making these blueprints for the given alterations freely available for others to mimic). As with the DIY and self-building community end-users find a sense of joy in the process itself and the social reputation gained from the process. An example is open source water management systems.

- **Crowdsourcing and –funding:** Policy makers could utilise crowdsourcing and crowd funding as tools for encouraging sustainable innovation, empowering end-users to partake in the process, and even co-financing it. For example, USAID recently crowd sourced a competition to design new protective suits for aid and healthcare workers working with Ebola.

See section 3.2.3 for the full overview of motivational barriers and drivers of SEI.
In exploring how policy could be better tuned to encourage SEI, Chapter 2 suggests that the motivational dynamic of end-users is an important, if not the most important component in this process. Motivation is a basic underlying reason for a given action that drives the individual’s recognition of want(s) and the subsequent action to satisfy them (Jackson & Michaelis 2003; Ölander & Thøgersen 1995). Motivations are individual in nature, but influenced greatly by external circumstances. In the context of SEI, motivations are the end-users’ own reasons for innovating on a given product or service or partake in a facilitated sustainable innovation process.

In the following, we focus on the motivational aspects of SEI with the aim of understanding how policy could be better applied to support the motivational drivers of SEI and to minimise the barriers to its success. We focus on independent SEI first and then look at facilitated SEI.

Some of the potential policy options presented in this section are also relevant when discussing ability and opportunity focused policy options. For example DIY workshops may empower end-users, and hence affect their motivations, but they may also give end-users new skills, hence affecting their abilities. Given the complexity of human behaviour this overlap is to be expected. Consequently many of the policy approaches introduced here will be discussed again in the subsequent section on ability and opportunity.

### 3.2.1 The motivations of independent SEI

The key motivational driver of independent SEI seems to be emotional involvement. As revealed already in the classical user innovation literature (von Hippel 1976), end-users typically innovate primarily for personal reasons and only secondarily, if at all, for commercial gain (Gabbott & Hogg 1999; Lettl 2007), the suggestion being that many end-user innovators never intended to achieve commercial success and only did so by accident (Shah & Tripsas 2007). Other key characteristics shared with the classical user innovation literature include innovating due to the personal enjoyment of the process (Hertel et al. 2003; Jalas et al. 2014), the social capital gained by doing so (Ornetzeder & Rohracher 2013; Seyfang & Longhurst 2013) and, in certain circumstances, the financial element at stake (Ross et al. 2012).

However, a marked difference between classical user innovation and independent SEI is the specific recipient for whom the innovation is designed. While both are motivated by personal frustrations with a given product or service, classical end-user innovators typically innovate for themselves, whereas independent (and facilitated) SEI innovate for others (Heiskanen & Lovio 2010; Jalas et al. 2014; Ornetzeder & Rohracher 2013; Ross et al. 2012). Sustainable end-user innovators tend to seek to change existing structures and aim to do so by innovating, not only for the benefit of themselves.

Consequently, the distinction between sustainable end-user innovators and sustainable entrepreneurs becomes somewhat blurry. However, the lack of financial motivation for the former is a key difference. Independent SEIs, as noted, typically operate on the basis of an individual and social-needs framework, whereas sustainable entrepreneurs, conversely and given their entrepreneurial nature have at least some form of financial bottom line (Cohen & Winn 2007; Dean & McMullen 2007). This differentiation is most apparent within the literature on systems innovation (Hargreaves et al. 2013; Hoffman & High-Pippert 2005; Kirwan et al. 2013; Seyfang & Haxeltine 2012; Seyfang & Longhurst 2013; Smith 2007), but can also be observed with regard to incremental innovations, e.g. the evolution of the wind turbine industry in Denmark (Garuda & Karnøe 2003; Karnøe 1996; Karnøe & Garud 2012) and solar collectors in Austria (Ornetzeder 2001). In addition, individual SEI typically innovates based on personal experiences with a given product or service, which is not necessarily the case with sustainable entrepreneurs.
When promoting independent SEI, policy is therefore well advised to focus on motivational aspects that are congruent with this type of innovation. Hence, it should ameliorate the emotional involvement that drives end-users to innovate and minimise the barriers for effective SEI. Possible interventions include innovation awards and competitions, DIY and self-building courses and groups, in addition to supporting intermediary actors.

Awards and competitions

For centuries, awards and competitions have been successfully utilised to overcome various challenges for innovation (Callaghan 2014; Füller et al. 2012). Perhaps the best known example is the Longitude Prize offered by the British government in 1714 for finding a simple and practical method for determining a ship’s longitudinal position.

Competitions are effective because they trigger a number of motivational drivers, including exposure and public awareness, credibility, encouragement, and of course a financial incentive (Ornetzeder & Rohracher 2013; Partzsch & Ziegler 2011). In addition, competitions typically bring together many like-minded people (and investors) and therefore present networking and innovation spill-over prospects. While there is a danger of discouraging innovation after losing a competition, the benefits still seem to outweigh the potential dangers (Ross et al. 2012). Furthermore, these types of awards and competitions allow policy makers to steer the direction of sought-after innovation. Micro-awards could in addition help drive innovation by supporting the general process rather than the end goal.

DIY/self-building courses and groups

In the reviewed literature, the distinction between DIY and self-building courses and groups remains somewhat ill-defined and the terms are at times not distinguished (Jalas et al. 2014). These courses or groups can be either organised real-world events (Jalas et al. 2014; Ornetzeder & Rohracher 2006) or online fora and websites (Hyysalo et al. 2013a). In both cases, the aim is to empower the end-user with the necessary tools and competences to repair, alter and even build various products (or services). Such courses and groups can ameliorate the end-users’ real (and perceived) lack of necessary skills, empower the end-user and foster a sense of community between participants. They also foster the dissemination of localised competences and facilitate learning by doing (Hyysalo et al. 2013b; Hyysalo et al. 2013a; Jalas et al. 2014).

It has been observed that, by integrating end-users into a group-learning process, they quickly go “from being a relative novice towards increasing mastery of a given practice” (Hyysalo et al. 2013a, p.28). This increase in technical knowhow spills over to also empower the end-user, due to success itself, the personal fulfilment from craftsmanship, and finally a sense of belonging established as being part of a DIY community (Jalas et al. 2014). As a result, individuals continue to innovate after the event. The spread of solar collectors was, for example, made possible by DIY groups disseminating competences about the product and process itself via social learning and knowledge sharing (Ornetzeder & Rohracher 2013). Another example is participation in Internet fora where end-users share experiences and where a deepening community membership and the joy of learning can drive user participation and innovation. The latter seems to hold especially true as users go from “first pupils to then teacher”, as one sustainable energy-user innovator notes in Hyysalo et al. (2013a, p.43).

Organised events include ‘repair cafes’ (repaircafe.org/), which give end-users the tools necessary to repair their products, but that also have specialists at hand to assist the end-user. Websites like iFixit (www.ifixit.com/) offer free repair guides to a variety of everyday products.
Some DIY and self-building group members go on to establish additional groups, which fosters the dissemination of the given sustainable innovation and increases its legitimacy in the eyes of potential consumers. The dissemination and acceptance of solar collectors in Austria illustrates how these self-building groups can have a marked influence on the dissemination and acceptance of a previously mostly niche sustainable innovation (Jalas et al. 2014; Ornetzeder 2001; Ornetzeder & Rohracher 2013).

Hence these DIY and self-building courses and groups act as competence-builders, empower end-user action, and facilitate the dissemination of both competences and the innovation itself. This dissemination process is made possible due to both the co-option of end-users into the overall process and to the legitimisation that is achieved by having increasing numbers of end-users accepting the product. As noted by Jalas et al. (2014, p.92), sustainable innovation (in their case renewable energy) becomes not only doable, it might even be enjoyable.

**Intermediary actors**

A large proportion of the identified independent SEI struggle with a number of significant barriers, not only to their own success but to their survival (Hargreaves et al. 2013; Smith et al. 2014). Drawing from Seyfang and Haxeltine (2012) we note that some of the biggest obstacles faced by small independent end-user innovators (or groups of innovators) include “difficulties growing the movement and attracting wider interest, limited resources of time and money, group governance issues such as maintaining momentum, managing group dynamics, developing the group, and the need to build effective links with other actors” (Seyfang & Haxeltine 2012, p.392). While some of the previous policy options could amend some of the concerns mentioned, e.g. competitions and awards can attract wider interest and money, and DIY (or self-building) courses can help maintain and develop group dynamics, additional policy options are also available.

The most notable suggestion within the literature is the role that intermediary actors can play. These intermediary actors\(^\text{14}\) work between communities to support fledgling localised independent SEI (Hargreaves et al. 2013; Kemp & Rotmans 2004). They play an important role in “consolidating, growing and diffusing novel innovations” (Hargreaves et al. 2013, p.868). Intermediary actors can broadly be defined “as organisations or individuals engaging in work that involves connecting local projects with one another, with the wider world and, through this, helping to generate a shared institutional infrastructure and to support the development of the niche in question” (Hargreaves et al. 2013, p.870). While the terminology originates from niche innovation literature (Geels & Deuten 2006), the need and importance for these types of intermediary supporting actors has also been noted in a broad spectra of the identified literature focusing on SEI (Hyysalo et al. 2013b; Ornetzeder & Rohracher 2013; Ross et al. 2012). Notably, intermediary actors can influence the motivational drivers of SEI, but they can also strengthen the ability and the opportunity of sustainable end-user innovators. Hence, intermediary actors have a variety of capabilities that, from a policy perspective, can help support SEI at large; in this section, however, we will only focus on how intermediaries can support the motivational aspects of SEI.

As noted in Section 2.3, many independent SEI face issues regarding dissemination, not only due to external constraints, but also due to given internal dynamics (Seyfang & Haxeltine 2012). The basic observation is that a significant number of independent sustainable end-user innovators (or members of the group) “have no ambition to grow and see their

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\(^{14}\) We identify intermediary actors to include a range of “organisational types, including cooperatives, voluntary associations, informal community groups, or social enterprises” (Ornetzeder & Rohracher 2013, p.858). The type of intermediary actor can depend on the specific field and/or context in which independent SEI inhabits.
aim as contributing to community life” (Ornetzeder & Rohracher 2013, p.857). Hence, there is often a motivation for independent SEI to remain a niche and a counterpoint to the mainstream. This could perhaps be attributed to the fact that many independent SEI arise out of an idealistic aversion to the current dominant socio-technical regime (Karnøe 1991; Ornetzeder & Rohracher 2013; Truffer 2003). Integrating into a system can be seen as a “purist” challenge to the overall motivational driver of the project (Smith & Seyfang 2013). What can be noted from the literature is that the wish to disseminate or not is highly contextual and depends not only on the innovation itself, but also on the changing beliefs and constellation of participants involved in the process (Seyfang & Haxeltine 2012; Truffer 2003).

Policy to encourage dissemination should therefore be wary of a too simplified or standardised approach as they could undermine the motivational drivers of the SEI process (Hargreaves et al. 2013). Intermediary actors can offer an alternative support mechanism for dissemination as they typically seek to encourage cross-community learning and knowledge sharing as opposed to attempting to force niche dissemination. The success of wind turbine and car sharing innovation were, for example, partly attributed to the traditional culture of cooperatives in Denmark and Switzerland, which “gave grassroots innovations a well-proofed means of organising action” (Ornetzeder & Rohracher 2013, p.862).

From a motivational perspective, these intermediary actors can help small, struggling end-user innovators build confidence and capabilities and to establish a social network in which the end-users can draw on one another. This might alleviate the sense of isolation that some end-users have, because they are unable to find other suitable people to network with (Ross et al. 2012). In addition they can empower small groups of end-users by giving them a voice in the policy discourse (Geels & Deuten 2006; Seyfang & Longhurst 2013). Finally, intermediaries can assist the independent SEI overcome the frustrations faced by many regarding finding the necessary funding to survive in the shifting funding landscape (Hargreaves et al. 2013; Kirwan et al. 2013; Ross et al. 2012).

These intermediary actors should have a tightly-defined topic area (Ross et al. 2012) and ideally be organised at a local level as “different kinds of intermediation might be required in different areas to achieve different ends” (Hargreaves et al. 2013, p.878). How exactly these intermediaries should be identified by policy makers or how policy makers could evaluate which ones are important facilitators of independent SEI remains an area outside academic focus. Hargreaves et al. (2013, p.879) note that intermediary actors need to drive “the development of a flexible and locally devolved institutional infrastructure that is not expected to speak with a single, common or coherent voice; and support that develops and empowers the wider space for grassroots innovations by addressing the distortions and structural inequalities that exist in current policy and market contexts.” However, how exactly this should be achieved and what constitutes an effective intermediary actor remains lacking in the literature.

The success of SEI often depends not only on the end-user(s) themselves, but also on their ability to draw on others for support. A better understanding of how these intermediaries can effectively support independent SEI could prove an important step towards getting these SEIs out of their niche and into the mainstream.
3.2.2 The motivations of facilitated SEI

End-users are typically highly motivated to take part in an innovation process, as long as their role in the process is clear and the end-users feel that their views are taken seriously (Hoffmann 2007; 2012; Rohracher 2003). Typically, the most significant barrier for end-user integration is not a lack of motivation by the end-user, but a certain degree of (at times well-founded) scepticism by the firm or project managers regarding the wisdom of the end-user(s) involved (Cornwell & Campbell 2012; Rohracher & Ornetzeder 2002). Rohracher (2013), for example, notes that some experts view end-user(s) as either “troublemakers” or “irrational” in their comments. This divergence between “expert” and “end-user” opinion can also be witnessed in citizen-led conservation, where local knowledge can be in conflict with expert knowledge (Cornwell & Campbell 2012). Identifying methods for successful facilitated SEI will therefore focus on potential platforms that can improve this gap between the “expert” and the “end-user”. In the following, we will focus on how open source platforms and crowdsourcing can be utilised to facilitate SEI from a motivational perspective.

Open source platforms

Open source platforms and projects have already been studied in depth in the open innovation literature. In practice, they have emerged as a successful means of garnering innovation within a variety of sectors15 (Chesbrough et al. 2006; Hertel et al. 2003; West & Bogers 2014). The basic concept is that individuals, organisations and governments make a given product design and/or blueprint universally available to be used freely by anyone. End-users can subsequently utilise the given product or modify it to better suit their needs (typically making these blueprints for the given alterations freely available for others to mimic). Hence, end-users often freely reveal their knowledge based strongly on intrinsic motivations stemming from the process itself. As within the DIY and self-building community, end-users find a sense of joy in the process itself and the social reputation gained from the process (Lakhani & von Hippel 2003).

The full potential of open source within sustainability remains less explored in the identified literature. However, examples including open source water management systems (Chen et al. 2010), and e-participation platforms within sustainable tourism (Chiabai et al. 2013), illustrate the latent potential that arguably has been far from fully exploited. Füller et al. (2012), for example illustrate that end-users are often strongly driven not only by potential monetary gains, but also by nonmonetary incentives, and open source sustainable platforms could take advantage of this intrinsic motivation to help facilitate sustainable innovation.

Crowdsourcing and -funding

Open source platforms are often anarchic in nature. Given the openness of the process itself, guiding the direction of innovation is therefore often difficult. A potential alternative highlighted in the literature is crowdsourcing innovation challenges. A recent example is United States Agency for International Development (USAID), which crowdsourced a competition to design new protective suits for aid and healthcare workers working with Ebola. Through this process USAID could drive the innovation process towards its specified end goal without defining the process (Norman 2014). Within sustainable innovation, similar processes might work (Füller et al. 2012; Idelchik & Kogan 2012; Lehner & Nichols 2014).

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15 These sectors include computer software, electronics, medicine and robotics (Lakhani & von Hippel 2003; Maurer et al. 2004; Pearce 2012).
Generally speaking, crowdsourcing seeks to mobilise end-users and garner innovation by encouraging them to collectively create knowledge, information and content (Füller et al. 2012; Surowiecki 2005). However, whether crowdsourcing is effective because there is access to “experts” outside the policy makers’ (or firms) general fora or because the crowd itself, through aggregated knowledge, reaches good decisions, remains contentious (Bogers et al. 2010; Surowiecki 2005). Nevertheless, crowdsourcing does have a number of motivational properties that could help the field of sustainable innovation in general by facilitating end-user innovation. Note, however, that the academic literature on crowdsourcing and sustainable innovation is scarce.

Crowd sourced funding (or crowdfunding) represents a potentially significant financier of social and sustainable innovation (both independent and facilitated SEI), specifically since “crowd-investors” typically operate within an “individual and social-need framework” rather than a “market-driven framework”. Lehner and Nicholls (2014) note that crowd investors are often driven to invest by the idea, core values and legitimacy of the given product or service as opposed to its business plan. Crowdfunding is therefore less risk averse than market-driven finance initiatives and could help support more risky sustainable product and service innovations. This in unison with the fact that crowdfunding typically draws upon many small investments or donations rather than larger single actor investments could potentially mean that there is a greater readiness to invest in risky investments – like radical innovations - on the part of the “crowd”. In addition, crowdsourcing has a strong nonmonetary incentive structure from the point of view of the end-user and it is therefore possible to get more with less if the aim of the SEI is legitimate in the eyes of the end-users participating in the process (Baeck et al. 2014; Füller et al. 2012).

Open innovation, via either open source platforms or crowdsourcing (and crowdfunding), offers policy makers a number of novel tools that could help encourage not only facilitated SEI, but also independent SEI. These types of facilitated processes both encourages sustainable innovation and empowers end-users by offering them an opportunity to support these processes. Policy makers could hence utilise these tools to encourage sustainable innovation and empower end-users to partake in the process and even co-finance it.

The research on crowdsourcing is in its infancy; however, experimental work by Füller et al. (2012) illustrates potential avenues for research. Having taken the first tentative steps, they show that a major challenge for research is to explore, in more detail, how one can “align participants’ motives with the potentially offered incentives in the context of social innovation” through crowdsourcing (Füller et al. 2012, p.156) and hence understand when, how and under what circumstances crowdsourcing is most affective in garnering end-user contributions to sustainable innovation.
3.2.3 Motivation and SEI

Increased end-user innovation itself is not from a sustainable consumption and production perspective necessarily a dividend. In fact, more end-user innovation could result in more and not less unsustainable practices as it leads to more niche products and services for consumption. Hence end-user innovation is not in and of itself a solution to our current unsustainable practices.

For example, young end-users sometimes modify their cars typically not with fuel efficiency or sustainability in mind. In more extreme circumstances end-users pursue wholly unsustainable ends exemplified by the trend known as rolling coal or rolin’ coal (Grenoble 2014). In this case, end-users modify the amount of fuel injected into the car engine combustion chamber so the fuel is only partially combusted. The result is a highly inefficient engine, with visible black soot exuded from the exhaust. While this is an extreme example, it illustrates that we should be wary of seeing end-user innovation as always a positive development. Understanding the motivations for SEI is at the heart of this issue and we therefore argue that this is an area where there is an urgent need for additional research. Not only for understanding why users innovate, but also why they innovate for sustainable ends. The literature on sustainable entrepreneurship could be a potential point of departure for this research, in addition to current behavioural science research on pro-environmental behaviour in general (Gifford & Nilsson 2014; Thøgersen 2014; van Vugt et al. 2014).

Figure 5 summarises the motivational barriers and drivers of SEI we have identified, in addition to potential policy tools that could play a supportive role.
### Motivational barriers

<table>
<thead>
<tr>
<th>Independent SEI</th>
<th>Facilitated SEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived inability to change</td>
<td>Irrational / Troublemakers</td>
</tr>
<tr>
<td>- Feeling of disenfranchisement from the “system”</td>
<td>Scepticism from the firm or project managers regarding:</td>
</tr>
<tr>
<td>- Lack of necessary skills leads to a feeling of impotence</td>
<td>- End-user knowledge</td>
</tr>
<tr>
<td>Isolation</td>
<td>- End-user intentions (end-users seen as troublemakers)</td>
</tr>
<tr>
<td>- None of “their kind”</td>
<td></td>
</tr>
<tr>
<td>- Few to share interests with leads to a feeling of irrelevance</td>
<td></td>
</tr>
<tr>
<td>- Nowhere to go for help</td>
<td></td>
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<tr>
<td>Fear of “selling out”</td>
<td></td>
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<tr>
<td>- Dissemination of their innovation will undermine their ideals.</td>
<td></td>
</tr>
<tr>
<td>- Desire to remain “purist”</td>
<td></td>
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<tr>
<td>Frustration</td>
<td></td>
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<tr>
<td>- Complexity of government e.g. in seeking grants</td>
<td></td>
</tr>
</tbody>
</table>

### Motivational drivers

<table>
<thead>
<tr>
<th>Independent SEI</th>
<th>Facilitated SEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awards and competitions</td>
<td>Open source platforms</td>
</tr>
<tr>
<td>- Exposure</td>
<td>- Free revealing information</td>
</tr>
<tr>
<td>- Credibility</td>
<td>- Intrinsic motivation to innovate</td>
</tr>
<tr>
<td>- Public awareness</td>
<td>- Crowdsourcing and crowdfunding</td>
</tr>
<tr>
<td>- Encouragement</td>
<td>- Driven by the idea and core value of the project and less by economic variables</td>
</tr>
<tr>
<td></td>
<td>- Empowers-end users to take part in the innovation process</td>
</tr>
<tr>
<td></td>
<td>- Often intrinsically not extrinsically motivated</td>
</tr>
<tr>
<td>DIY and self-building courses and groups</td>
<td>Intermediary actors</td>
</tr>
<tr>
<td>- Ameliorate perceived (and real) lack of necessary skills</td>
<td>- Foster community awareness</td>
</tr>
<tr>
<td>- Empower the end-user(s)</td>
<td>- Empowers end user(s) by giving them a voice</td>
</tr>
<tr>
<td>- Deepen community membership</td>
<td>- Builds end-user confidence</td>
</tr>
<tr>
<td>- Facilitate the enjoyment of creating and sharing competences.</td>
<td>- Ameliorates the dissemination process</td>
</tr>
</tbody>
</table>

### Figure 5. Motivational barriers and drivers of SEI
Box 6. Ability barriers and drivers

Ability barriers and drivers from a policy perspective should be seen as the individual’s capacity to pursue an SEI process either via independent action or in a facilitated process, specifically based on the individual’s own competences and resource base. Competences referring to the knowledge base of end-users and their subsequent ability utilise this knowledge in practice. Competences also include unconscious cognitive abilities such as psychological barriers to action, e.g. habits. Resources refer to the end-users’ access to either financial or time resources.

Independent SEI: In seeking to support independent SEI from an ability perspective, policy makers can enable end-user innovation in a number of ways, including, for example:

**Formal education:** Incorporating sustainable innovative ideas into a formal education is one possible avenue of approach. The introduction of organic farming techniques into the curriculum at agricultural colleges in the UK, for instance supported the growth of the organic food movement there.

**DIY and self-building courses and groups:** These courses and groups teach elementary techniques like drilling, soldering and riveting; introduce end-users to the concept(s) of sustainable innovation; and facilitate inter-group learning. They also aid the creation of toolkits, handbooks, webpages and even YouTube instructional videos.

Facilitated SEI: In seeking to co-opt end-users into a facilitated SEI, it is typically with the aim of better understanding end-user preferences and of identifying potential end-user habits that may confound current design proposals. We suggest, however, that end-user abilities could be exploited in another fashion.

**Lead users:** The literature within SEI, as the within traditional user innovation, notes that certain end-users play a more active role than others in the sustainable innovation process. Identifying these “lead users” and co-opting them into a facilitated innovation process has already been a successful technique for driving innovation within classical user innovation. We suggest a similar approach within sustainable innovation.

**Crowdsourcing / “Picking a winner”:** Generally speaking, crowdsourcing seeks to mobilise end-users and promote innovation by encouraging end-users to collectively create knowledge, information and content. However, crowdsourcing could also be used in another capacity: picking winners. Specifically, recent research suggests that crowd and expert opinion correlate well with one another and that crowdsourced insight might even be superior at times to expert opinion (see section 3.3.2).

See section 3.3.3 for the full overview of ability barriers and drivers of SEI
This section focuses on the ability of end-user innovators and how these individual abilities enable or disable SEI. As with motivation and opportunity, we also seek to identify some potential policy solutions to support ability. Ability is, as noted in section 1.2, seen as the individual’s own competences and resource base. The concept of ability thus includes elements such as end-user knowledge, the ability to carry out this knowledge in practice (i.e. process knowledge), and access to resources (Thøgersen 2010; Ölander & Thøgersen 1995).

Also habits reflect an unconscious end-user ability that significantly impacts behaviour and often acts as a barrier to more sustainable behaviour (Croson & Treich 2014; Sunstein & Reisch 2014; Venkatachalam 2008; van Vugt et al. 2014). Habits result in a lack of attention and conscious processing of a given action and arguably acts as a barrier to the first step of SEI, namely consciously identifying that there is a problem (Ölander & Thøgersen 2014). Consequently, the key difference between cognitive ability and end-user motivation is that the former refers to the end-user’s conscious and unconscious cognitive abilities to execute a given behavioural intention, while the latter reflects values and beliefs that end-users have that define that given behavioural intention (Ölander & Thøgersen 1995).

As noted in the previous section, motivation, opportunity and ability interact. For instance, the already noted example of DIY and self-building courses represents both an motivational driver and potentially an ability driver. Specifically since increased end-user abilities often also result in increased end-user motivations due to the sense of achievement arising from learning and doing something new successfully. From a policy perspective, ability barriers and drivers should thus be seen as the individual’s capacity to pursue an SEI process either via independent action or in a facilitated process. We once again begin by focusing on independent SEI before turning to facilitated SEI.

3.3.1 Ability and independent SEI

The major ability barriers to independent SEI identified within the literature review can be broadly subdivided as either a lack of end-user competences or a lack of resources.

The lack of competences includes both a lack of technical expertise (Heiskanen et al. 2011; Hoffman & High-Pippert 2005; Hyysalo et al. 2013b; Jalas et al. 2014; Ross et al. 2012), difficulties with organising and finding suitable collaborators (Feola & Nunes 2014; Ross et al. 2012), and finally issues concerning a lack of competences about where and how to access potential external resources (Kirwan et al. 2013; Ross et al. 2012; Seyfang & Smith 2007; Smith 2007; Walker 2008).

Resource barriers have also be noted within the literature as another potential barrier to end-user innovation. Heiskanen et al’s (2011) case study on heat pumps, e.g. highlights that investing in heat pump technology may cost the end-user up to EUR 20,000. Tinkering with such an expensive system would seem a natural barrier to many potential end-user innovators, especially given the immediate loss of warranty and insurance upon products or services modification (Hyysalo et al. 2013b). In addition a significant number of the independent SEI reviewed in literature depend on volunteers for their survival and consequently struggle to secure and maintain their access to a stable volunteer resource base (Hoffman & High-Pippert 2005; Seyfang & Smith 2007).

In seeking to minimise competences and resource barriers to independent SEI, policy makers could pursue a number of avenues. These include an educational approach, alternative funding schemes and identifying and supporting key intermediary actors within the given field. Although not based on the literature review undertaken in this report, we

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16 Resources primarily refers to the time end-users have available and their financial circumstances. It also refers to the end-users cognitive “bandwidth”, which highly influenced by a scarcity of resources.
suggest that a number of behavioural science insights exist that could also be adopted. As a result we begin by touching upon another ability barrier that remains largely unexplored within the identified literature – psychological or unconscious ability barriers.

**Behavioural science insights and unconscious ability**

The literature identified was sparse with regard to the psychological or unconscious ability barriers to independent SEI. Out of the 64 identified articles in the literature review only six identified a potential psychological barrier, namely loss aversion17 (Fam & Mitchell 2013; Hargreaves et al. 2013; Khavul & Bruton 2013; Seyfang & Smith 2007; Truffer 2003; Whitmarsh et al. 2009), either from the perspective of the end-user (Fam & Mitchell 2013; Khavul & Bruton 2013; Truffer 2003) or the policy maker (Hargreaves et al. 2013; Seyfang & Smith 2007; Whitmarsh et al. 2009).

We suggest, however, that the issue of psychological barriers is probably much larger than identified in the current literature, especially when reflecting on other sustainable policy oriented research. Here behavioural science insights is increasingly gaining traction (Jackson 2005; Jackson & Michaelis 2003; Sunstein 2015; van Vugt et al. 2014). The lack of a similar research focus on the psychological barriers and drivers of SEI is therefore problematic.

We argue that the application of behavioural science represents a promising tool in this regard – both in terms of identifying psychological barriers to SEI, but also with regards to proposing novel policy solutions. The utilisation of simplification literature on grant funding schemes represents one key area of potential (Sunstein 2013; Ölander & Thøgersen 2014). In addition, nudges like defaults (Sunstein & Reisch 2014) and others could also prove helpful, especially given their proven applicability to a range of behavioural issues from energy savings via utility bill feedback (Fischer 2008) to increased pension saving via default rules (Chetty et al. 2015; Thaler & Sunstein 2008). Recent behavioural research by Mullainathan and Shafit (2013) goes on to suggest that in a climate of scarcity, which many independent SEI operate, the propensity for human error increases greatly. Not due to lack of ability or willpower, but because scarcity of resources taxes our cognitive abilities thereby reducing our overall abilities. Specifically since scarcity results in a cognitive narrowing of focus taxing our cognitive “bandwidth”. Understanding how these psychological barriers and drivers impact end-user behaviour is therefore an important, and at the moment overlooked, component for creating or modifying policy that can better support independent SEI.

Utilising Steg and Vlek’s (2009) framework for encouraging pro-environmental behaviour represents a possible structure that academics (and policy makers) can utilise when seeking to identify and overcome the psychological barriers to SEI. Especially since “behavioural interventions are generally more effective when they are systematically planned, implemented and evaluated” (Steg & Vlek 2009, p.314). Their framework includes the following steps:

1. Identification of the behaviour to be changed,
2. Examination of the main factors underlying this behaviour,
3. Application of interventions to change the relevant behaviours and their determinants
4. Evaluation of intervention effects on the behaviour itself, its main determinants, environmental quality and human quality of life.

As a result, we argue that while the research within SEI is currently lacking, a significant amount research exists that academics and policy makers can draw upon.

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17 Risk or loss aversion denotes that individuals weigh losses higher than gains. Hence, individuals often seek to minimise risks or losses rather than maximise gains, hence the “loss aversion bias” (Tversky & Kahneman 1991).
Education

In seeking to improve end-user abilities, policy makers could pursue a number of approaches. These include varied educational approaches that either focus on formal education or informal (often group-based) learning.

First, policy makers can pursue the incorporation of sustainable innovative ideas into a formal education setting (Karnøe 1996; Kiros-Meles & Abang 2008; Smith 2007). An example is the introduction of organic farming techniques into the curriculum at agricultural colleges in the UK (Smith 2007), a move that led not only to increased end-user competences within the given area, but that also helped to increase the legitimacy of organic farming in the eyes of the general public (Ibid).

The second education option available to policy makers is to pursue a more informal educational approach via DIY and self-building courses and groups (Hyysalo et al. 2013b; Hyysalo et al. 2013a; Jalas et al. 2014; Ornetzeder 2001; Ornetzeder & Rohracher 2013), or by facilitating knowledge-building courses (Heiskanen et al. 2014). Typically DIY and self-building courses and groups teach elementary techniques like drilling, soldering and riveting (Jalas et al. 2014), introduce end-users to the concept(s) of, e.g. renewable energy (Ornetzeder 2001), and facilitate inter-group learning (Ornetzeder & Rohracher 2006). In addition to these physical, informal courses, online forums and blogs can also act as facilitators of competences (Hyysalo et al. 2013b; Hyysalo et al. 2013a; Ornetzeder & Rohracher 2006). Hyysalo et al. (2013b, p.499) note that policy makers could facilitate these forums either by supporting the running costs or by offering minor remuneration “to the moderators and key users for the voluntary helping behaviours these users already do.”

Alternative funding schemes

The complexity and fluidity of current funding regimes has also been noted as a significant barrier to independent SEI (Hargreaves et al. 2013; Seyfang & Smith 2007). In order to ameliorate the current resource constraints on end-users it has pointed out that a simplification of the current schemes could help facilitate independent SEI. From the end-user ability perspective, especially small micro-grants with simple application processes seem best suited to these types of projects (Ross et al. 2012). Section 3.4.1 will in more detail touch upon this.

From an alternative perspective of end-users wishing to support independent, or facilitated, SEI we once again argue that crowdfunding represents an under-explored external opportunity that could greatly increase end-user abilities (Baeck et al. 2014; Lehner & Nicholls 2014). This is the case not only because crowdfunding, from a motivational perspective, seems more conducive to sustainable innovation (Füller et al. 2012; Lehner & Nicholls 2014), but also because it empowers end-users with the ability to pick the type of innovation they wish to support (Füller et al. 2012).

Intermediaries actors

In the previous section we have noted the importance that intermediary actors can have for facilitating both independent SEI motivations and opportunities. We further note that this type of intermediary actors can also facilitate the abilities of independent SEI via, e.g. “grant funding, voluntary input and mutual exchange, but only limited commercial activity” (Ornetzeder & Rohracher 2013, p.585).

18 Toolkits refer here to a physical toolkit of materials needed to make or alter a specific product. (Not to be confused with von Hippe l’s conception of the term).
Intermediary actors can help support independent SEI achieve funding (and have successfully done so), either via direct participation or by assisting in the process (Feola & Nunes 2014; Hargreaves et al. 2013; Seyfang & Smith 2007). In addition, intermediaries can also facilitate the pooling of resources between various smaller independent SEIs. The success of the Austrian solar collector case was facilitated, for example, by the fact that the self-building groups coordinated purchases and bought in bulk and were hence “able to produce the installations at very competitive prices” (Ornetzeder 2001, p.109). This pooling of resources can also be seen with regard to attracting new members and sharing skill sets (Hoffman & High-Pippert 2005; Ornetzeder & Rohracher 2013). Consequently intermediaries often act as external opportunity-related actors who can facilitate end-user abilities by granting access to various previously unavailable resources in the form of money, equipment and even manpower.

3.3.2 Ability and facilitated SEI

In seeking to co-opt end-users into a facilitated SEI it is typically with the aim of better understanding end-user preferences and identifying potential end-user habits that may confound current design proposals. The incorporation of end-users into energy feedback designs – tools that allow end-users to track their energy consumption – is for example in place to better understand and specify users, their contextual needs and specific requirements (Katzeff et al. 2012). But it also specifically builds upon the premise the end-user habits often result in end-users ignoring potentially unsustainable energy behaviour (Fischer 2008). In this kind of facilitated SEI a broad selection of end-users is key in order to get fuller picture of different end-user wants and needs (Grønhøj & Thøgersen 2011; Heiskanen et al. 2013; Heiskanen & Lovio 2010; Katzeff et al. 2012). End-users can also be adopted into a facilitated SEI process reflecting, for example, an alternative approach scientific research known as Citizen Science (Cornwell & Campbell 2012; Riesch & Potter 2014). Here end-users abilities are utilized to collect observations, study natural phenomenon and even in the example of Cornell and Campbell (2012) assist in the documentation and conservation efforts of endangered species.

In drawing upon end-user abilities, however, a number of articles have noted that facilitator and end-user knowledge and opinions may run afoul (Cornwell & Campbell 2012; Rohracher & Ornetzeder 2002; Shandas & Messer 2008). This was also noted in section 3.2.2., where Hoffmann (2007) notes that insuring that end-user and expert motivations align is important for overcoming this potential concern.

In addition we argue that that there is an alternative approach to facilitated SEI that could draw upon end-user abilities in another way. Instead of seeking a large representative group of end-users, facilitated SEI projects could seek to identify and co-opt lead users “into the ideation of innovation support mechanisms and in identifying barriers to proliferation of local renewable energy and electricity generation.” (Hyysalo et al. 2013b, p.499). This can be achieved in one of two ways: Either via the identification of lead users and co-opting them as suggested by Hyysalo et al. (2013b) or via crowdsourcing (-funding). Both draw upon end-user abilities, however, while the lead user methodology draws upon especially inventive users (or lead users) (von Hippel 1986; von Hippel 2005) crowdsourcing seeks to potentially draw upon the aggregated knowledge of the “crowd” (Füller et al. 2012; Mollick & Nanda 2014; Surowiecki 2005). The following sections reflect briefly on how a facilitated SEI could utilize these methodologies. Arguing that these processes are facilitated, given the fact that the end goal is defined by an external actor (i.e. firm, project or policy maker) and not the end-user himself.
Lead user

The literature within SEI, as within traditional end-user innovation, notes that certain end-users play a more active role than others in the sustainable innovation process (Füller et al. 2012; Hoffmann 2007; Hyysalo et al. 2013a; Weber 2003). Apart from taking a leading role, these lead users also experience needs still unknown to the general public and consequently often drive the innovation process (von Hippel 1986). Urban and von Hippel (1988) thus propose identifying these lead users and involving them in the idea generation and development process. Contrasting to traditional market research (von Hippel & Oliveira 2010; Lettl 2007), specifically since these lead users identify market gaps before the “market” is aware of them. In many circumstances these lead users represent industrial users, but end-users can also play a role (von Hippel 1986; Urban & von Hippel 1988).

Within sustainable innovation a number of facilitating actors, for example firms or university-driven projects, could seek to identify these lead users within their respective fields and incorporate them into their projects (Carrillo-Hermosilla et al. 2010; Hyysalo et al. 2013a; Ornetzeder & Rohracher 2006; Weber 2003). These lead users could, for example be identified via web forums and blogs, as illustrated by Hyysalo et al. (2013a). Specifically, this can be done by noting which end-users were most active and by analysing their respective contributions. Traditional end-user innovation literature especially discusses this kind of end-user integration (Enkel et al. 2005; Lüthje et al. 2005). Within the literature on sustainable innovation we have, however, only been able to identify one article focusing on lead users within sustainable innovation (Lai & Shu 2014).

The utilisation of forums and blogs to identify lead users represents an opportunity for facilitators of SEI (Hyysalo et al. 2013a), while the lead users themselves represent a distinctive end-user with specialised abilities (Lettl 2007). Lead users are especially interesting as they are typically “ahead of market trends” (Hippel et al. 1999, p.4) and therefore have the unique ability of experiencing needs ahead of the market (von Hippel 2005). This ability arguably makes identifying lead users within sustainable innovation an appealing prospect.

Crowdsourcing (-funding)

An alternative approach to facilitating end-user innovation is to utilise crowdsourcing as the driver of the innovation process (Füller et al. 2012). As opposed to the previous methodology of identifying lead users (von Hippel 1986) this process instead facilitates end-user innovation via the specific proposal set by the respective institution or project. As illustrated in Section 3.2.2. it remains unclear how to most effectively motivate end-users via crowdsourcing; however, the process of innovating for social or sustainable goals correlates well with end-user motivations (Füller et al. 2012; Lehner & Nicholls 2014; Sloteegraaf 2012).

One concern noted about crowdsourcing remains, the issue of “picking a winner” from crowdsourced competions, specifically since crowdsourcing often results in a large amount of incoming information in the form of solutions to the given task. As a result picking the best proposals can become an overwhelming task. In addition to this there is also a potential conflict between mobilising the crowd to get innovative “out-of-house” ideas and then utilising “in-house” experts to pick the winner, specifically since in-house experts may have contrary standards to the creators of the respective project proposals or even the population in general (Mollick & Nanda 2014).

Mollick and Nanda (2014) illustrate a potential alternative: allowing the crowd to pick the winner, specifically since they, based on their observations, found that both crowd and expert opinion correlate well with one-another.
These observations were compiled by observing crowd and expert evaluations of theatre productions that sought crowdfunding. They drew a random sample of theatre projects from Kickstarter, a crowdfunding site, that all sought to raise at least USD 10,000 for their respective performances. Selecting 120 projects they subsequently divided them into sets of six, which had three failed projects, two successful projects and one very successful project (raising at least 110% of the original funding target). Finally Mollick and Nanda asked 30 selected experts from the U.S. National Endowment for the Arts to evaluate the projects, allowing them to identify whether expert opinion correlated or not with the respective crowdfunded projects. To a large degree there was a significant level of correlation. In addition to this high degree of correlation crowd opinion at times outperformed expert opinion as there were fewer incidences of false negatives, specifically because crowdsourced projects receive multiple evaluations and thus “reach out to receptive communities that may not otherwise be represented by experts” (Mollick & Nanda 2014, p.1).

As previously mentioned, crowdsourcing could potentially encourage sustainable innovation, empower end-users to partake in the process, and even co-finance it. On top of this, it could also effectively allow policy makers to make better decisions about picking winners. However, Mollick and Nanda’s quantitative approach (2014) represents only the first step in exploring this opportunity, which is why more research is called for.

Both the application of the lead-user methodology and crowdsourcing within sustainable innovation represents an as of yet largely unexplored avenue for engaging end-users in a facilitated SEI process. These two approaches nevertheless hold a number of potential benefits, not least the possibility of mobilising end-user abilities towards sustainable innovation. At the moment, however, we believe additional research is necessary to identify under what circumstances these respective approaches could be successfully applied to sustainable innovation.

### 3.3.3 Ability and SEI

The literature on end-user ability remains focused on end-user competences and resources, while only loosely touching upon psychological barriers affecting end-user abilities. While being understandable it remains somewhat problematic only to focus on the conscious elements of end-user abilities. Especially since individual heuristics, habits and biases have been shown to strongly influence end-user behaviour (Kahneman 2011; Tversky & Kahneman 1991; Tversky & Kahneman 1974). Ölander and Thøgersen (2014), for example, argue that current education and information regime within environmental policy has only had limited success and go onto argue that drawing from upon recent behavioural economic insight, like choice architecture (Thaler & Sunstein 2008), could alleviate some of these issues.

In line with this perspective we argue that further research into the unconscious ability barriers to SEI – e.g. risk aversion – could help minimize the barriers to SEI and could reveal ways to nudge behaviour towards SEI (Thaler & Sunstein 2008). In line with Hyysalo et al. (2013) we argue that inventive end-users are not “born”, but “grow” and it is in this respect that nudges could be utilised to not only make end-users aware of potential issues, but also highlight their potential to support that change.

The lack of focus on unconscious barriers and drivers of SEI does not, however, detract from the observation made within the literature on competence and resource barriers and drivers. As in the past section the following figure (Figure 6) seeks to highlight the key observations from this section.
Figure 6. Ability barriers and drivers of SEI

**Ability barriers**

- **Lack of technical expertise**
  - A lack of technical knowhow results in a lack of action

- **Difficulty organising and finding suitable collaborators**
  - Inability to find, identify and/or organise with suitable collaborator

- **Inability to access potential external resources**
  - Difficulty with filling out grant scheme applications results in the abandonment of projects

- **Expensive user innovation**
  - Modifying existing products and services can be a resource intensive prospect for end-users

- **Fluctuations in volunteer base**
  - Dependency on an unstable volunteer base undermines small independent SEI

**Ability drivers**

- **Incorporate sustainable innovations into formal education**
  - Increase end-user competences
  - Increases the overall legitimacy of the given innovation

- **DIY and self-building courses and group**
  - Teach elementary technical techniques
  - Increase end-user competences
  - Facilitate inter-group learning
  - Facilitate the creation of toolkits, handbooks, webpages and even YouTube instructional videos

- **Micro-grants**
  - Small monetary grants built on simplified grant structures
  - Access to resources

- **Crowdfunding**
  - Empowers end-users with the ability to pick the type of innovation they wish to support

- **Intermediary actors**
  - Facilitate access to funding or assist in the grant application process
  - Facilitate pooling of resources, including manpower
  - Help establish contact between related independent SEI and attract new volunteers

- **Lead users**
  - Draw upon inventive end-users and lead users, and co-opt them into a given project

- **Crowdsourcing**
  - Draw upon the aggregated competences of the crowd both in terms of seeking solutions to specific problems but also in terms of picking a winner
The opportunity barriers and drivers to SEI are the external conditions that limit or enable end-user behaviour. From a policy perspective, these should be seen as the conditions, external to the individual, that support or hamper independent and facilitated SEI.

**Independent SEI:** A number of significant external barriers exist to individual SEI, but there are also a number of policies that could potentially help reduce some of these barriers, for instance:

- **Simplified funding:** The reviewed literature notes current funding regimes as a considerable impediment to independent SEI. Calls for simpler grant schemes are therefore unanimous in the literature. Others have noted the need for smaller micro-grants with a less labour-intensive funding process. Finally, it has been suggested that there is a need for a one-stop shop for advice and funding.

- **No-man’s land:** A number of independent SEI, especially within system innovation, have noted issues on matching any of the currently available grant/funding schemes, especially since they fall between “the interstices of traditional social, economic, and environmental issue boundaries” (Seyfang & Smith 2007, p.596).

- **Crowdfunding:** Crowdfunding represents an entirely new source of financing for SEI – reflecting a new opportunity for financing both independent and facilitated SEI. At the moment, however, legislation remains unclear, especially when crowdfunding becomes cross-national.

**Facilitated SEI:** A number of policy tools and changes may facilitate the inclusion of end-users into a sustainable innovation process, for example:

- **Toolkits:** The utilisation of toolkits has been successfully applied in a number of fields within classical user innovation. Policy makers could encourage producers and service providers within sustainability to make available to consumers specified toolboxes to help them innovate. Granting end-users easier access to modifying, e.g. ventilation or heating systems, could be a way of overcoming some of the current barriers faced by end-users when seeking to create more efficient systems for themselves.

- **Flexible funding schemes:** End-user involvement and co-design requires a flexible project planning environment, which at the moment is not provided by government-funded projects, which require detailed plans that cannot easily be changed. If end-user innovation is truly desired, more flexibility is needed within the current funding schemes.

See section 3.4.3 for a complete overview of the opportunity barriers and drivers of SEI.
Having identified some of the major motivational and ability barriers and drivers of SEI and identified some potential policy solutions, we will now focus on the opportunity side of SEI. As opposed to motivation, opportunity reflects the external conditions supporting or impeding intended action and the connection between intent and action (Thøgersen 2010; Ölander & Thøgersen 1995). For example, complex, time-consuming funding schemes are an opportunity hurdle, which is unanimously noted in the literature as a barrier to SEI (Kirwan et al. 2013; Seyfang & Smith 2007; Smith 2007; Walker 2008). As has been shown in behavioural economics research, simplifying access is one of the most effective “nudges” to motivate people to engage in a specific behaviour (Sunstein 2013).

Again, as mentioned in the previous sections and illustrated by the MOAB model (see Figure 2), individual barriers and drivers often have multiple roots; innovators choices are complex, and motivation, opportunity and ability are closely interlinked. For instance, complex funding schemes can, on the one hand, result in innovator frustration and resignation, a motivational barrier, but can, on the other hand, be eased via increased competences, an ability factor.

From a policy perspective, opportunity barriers and drivers are the external reasons for end-users to pursue, or fail to pursue, an SEI process either via independent action or in a facilitated process. We once again focus on independent SEI first and then facilitated SEI afterwards.

3.4.1 Opportunity and independent SEI

The advent of Web 2.0 is hailed both within the classical user innovation literature and our own identified literature as the major opportunity driver for increases in end-user innovation (Füller et al. 2012; von Hippel et al. 2011; Lehner & Nicholls 2014; Ross et al. 2012). While end-user innovation is not a new phenomenon, access to increased connectivity of like-minded individuals has “opened up new possibilities for collaborative development and enabled easy and wide-ranging dissemination of ideas and innovations” (Ross et al. 2012, p.470). Hyysalo et al. (2013a, p.498) have, for example, illustrated how Internet forums and blogs can help facilitate the “rise, spread, and visibility of sophisticated DIY competences and projects.” This trend has also been noted by Jalas et al. (2014). This type of dispersed end-user innovation interconnected via Internet forums and blogs represents has interesting potential for testing dispersed installations under a variety of conditions and circumstances. The success of the Danish wind turbine case was e.g. possible, because multiple and diverse but interlinked actors tested varying designs in different locations, drawing both on their localised learning-by-doing knowledge but also on the successes and failures of others (Karnøe & Garud 2012). These multiple learning opportunities “later became an important source for industrial producers of wind technology” (Ornetzeder & Rohracher 2013, p.864). However access to the Internet alone does not result in increased independent SEI and it is therefore helpful to explore alternative policy options as well. Overcoming the “historical disenfranchisement of lay people from centralized systems”, like for example energy production, represents a central opportunity barrier identified within the various literatures (Jalas et al. 2014, p.90).

From an opportunity perspective a number of significant barriers exist to individual SEI, but also to a number of potential policies. These include in particular simplified funding schemes, crowdfunding, (un)responsive government, and intermediary actors.
Simplified funding schemes

The vast majority of the identified independent SEIs were either wholly financed by their own income and therefore viewed the process as a personal project (Hyysalo et al. 2013b; Jalas et al. 2014; Ross et al. 2012) and/or they were reliant on a shifting external funding landscape (Hargreaves et al. 2013; Seyfang & Smith 2007). As a result, funding issues represent a significant opportunity barrier to the independent SEI process for a number of reasons. These issues include frustration with the process itself, a rapidly changing funding landscape and difficulties matching the criteria set by funding programmes.

The first issue was with the grant funding process itself, which a significant number of independent SEI noted as being overly complex and the source of considerable frustration (Ross et al. 2012; Seyfang & Smith 2007). This was with regards to finding potential grants, finding out whether they were eligible or not, and finally with regards to the bureaucracy, requirements and other constraining features often associated with the application process (Kirwan et al. 2013; Seyfang & Smith 2007; Smith 2007; Walker 2008). Ross et al. (2012, p.488) suggest the establishment of a “one-stop shop for advice and funding that covers all categories of innovator” for not only entrepreneurs but also end-user and community-led projects. These facilities could also help independent SEI adapt to changing funding landscapes. Well-established intermediaries represent an alternative to this last point, as noted by Hargreaves et al. (2013). Examples highlighted within the literature include various localised cooperatives (Ornetzeder & Rohracher 2013), national organisations like Communities and Climate Action (Hargreaves et al. 2013) and the transition town movement (Seyfang & Haxeltine 2012), and international networks like Ashoka (ashoka.org/) (Partzsch & Ziegler 2011).

In addition many end-users appear to struggle with the general format of many funding schemes, indicating the need to simplify these schemes. While the SEI literature remains unclear on how this should be achieved, authoritative advice on behaviourally informed public policy could provide a starting point for further exploration (Mullainathan & Shafir 2013; Sunstein 2013; Thaler & Sunstein 2008; Ölander & Thøgersen 2014). This literature provides insights and practical advice on how policy could better “speak the language” of the end-user and how the choice architecture of a funding scheme is received by the end-user.

The simplification of college information sheets (College Scorecards) has for example been applied with affect in the US. These College Scorecards offer accessible information on respective US colleges including college costs, graduation rates, student loan repayment rates - granting prospective college students an accessible metric on which to make a more informed decision. The College Scorecards are not based on new information, but rather focused on a simplified overview of existing information (Sunstein 2013, pp.95 – 96). We propose a similar approach could be employed to simplify current funding schemes. Further research, however, is needed to explore how funding schemes can be simplified while remaining conducive to both end-user and policy maker needs. Other possibilities include micro-grants with less labour intensive funding schemes, as often “small amounts of money at the right time can make a huge difference to lone innovators and micros” (Ross et al. 2012, p.487).

Finally a number of independent SEI, especially within system innovation, have noted issues with regards to matching any of the currently available grant/funding schemes, especially since they fall between “the interstices of traditional social, economic, and environmental issue boundaries” (Seyfang & Smith 2007, p.596). Some of these end-users therefore find themselves in no man’s land, since their adopted approach to innovation does not fit into current funding frameworks. In addition Ross et al. (2012) note that early-
stage innovation projects have difficulty applying for government funding related directly to their area of interest. Hence, more open frameworks have been suggested; however, again, how this should be practically executed in policy practice remains less clear.

Seyfang and Smith (2007) have noted, with reference to Church (2005) and Wakeman (2005), that many initiatives, especially community or grassroots innovation projects, spend 90% of their time simply surviving, thus leaving little time for their actual activity. These projects remain enormously dependent on key individuals in the group, and when these individuals inevitably leave the project, the projects often fail to receive additional funding (Kirwan et al. 2013). As a result funding opportunities represent a significant reason for the failure of independent SEI. However, while the literature is clear in calling for simpler and more accessible funding schemes, it remains unclear how this should be achieved in practice. Systematic simplification, as noted by Sunstein (2013), represents a potential path, but again appears untried in practice. Another potential external opportunity for funding, which remains largely unexplored to date, is crowdfunding.

Crowdfunding

As mentioned in the motivation section of this paper, crowdsourced funding (or crowdfunding) represents an additional potential source of financing for social and sustainable innovation (Füller et al. 2012; Idelchik & Kogan 2012; Lehner & Nicholls 2014), both given the previously mentioned motivational dynamics of crowdfunding, which seem to match well with the nonmonetary driving forces of many independent SEI, and the growing scale of resources available.

The scale of alternative financing (like crowdfunding) is already significant. A recent NESTA report from the UK noted that alternative financing has “doubled in size year on year from £267 million in 2012 to £666 million in 2013 to £1.74 billion in 2014” (Baeck et al. 2014, p.7) – enabling the survival of multiple types of projects that would otherwise have been unable to survive. Crowdfunding is therefore not only a good match for sustainable innovation; there is also a growing financial potential. One could also imagine that policymakers could draw on crowdfunding as a type of co-financing for projects via end-user involvement. Understanding how potentially offered incentives align with end-users’ willingness to participate is key to tapping this potential resource for co-financing (Füller et al. 2012, p.156).

Finally crowdfunding could also help support the transitory step that some independent SEI make from government sources of finance (i.e. grants) to commercial sources (i.e. investors). Many successful crowdfunding initiatives are motivated and driven by their perceived legitimacy and the potential impact of the project, rather than their business plans (Lehner & Nicholls 2014). The smaller investment required by end-users to partake in a crowdfunded innovation process most likely also creates a greater readiness on behalf of the end-users to do so. This could also be relevant for some independent SEI who have become overly dependent on government funding schemes (Karnøe & Garud 2012). As noted by Karnøe and Garud (2012), there is the risk that government financial support schemes may create an environment where the survival of the given independent (or facilitated) SEI is possible only as long as the respective funding scheme exists. In the long run, this arguably creates an unsustainable practice in economic terms.

A final consideration for crowdfunding is the issue of investor protection policy. In the United States, for instance crowdfunding and publicly advertising investment opportuni-

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19 Alternative finance includes a range of different models, including “people lending money to each other or to businesses, to people donating to community projects and businesses trading their invoices” (Baeck et al. 2014, p.8).
ties for non-accredited investors requires a number of disclosures on behalf of the given company or start-up, including a prospectus on risks with the given company and a registering of the company with the federal government. If a given start-up or company fails to do so the respective crowdfunded investments are considered illegal in reference to the 1933 Securities Act (Securities Act 1933). The 2012 Jobs Act (specifically Title III – Crowdfunding) has sought to amend this legislation but remains in contention with regards to issues of investor protection. This specific legislation is therefore still undergoing due process at the Securities and Exchange Commission (SEC 2014). The European Commission is currently “exploring the potential and the risks of this relatively new and growing form of finance (crowdfunding), as well as the national legal frameworks applicable to it, in order to identify whether there is value added in European level policy action in this field” (European Commission 2014). European policy makers could potentially draw upon the experience of the US to ensure a smoother transition than in the US example.

As a result crowdfunding can, and arguably already does (Baeck et al. 2014), represent an entirely new source of financing for SEI (Lehner & Nicholls 2014), reflecting a new opportunity for financing for both independent and facilitated SEI. At the moment, however, both policy on this area and the academic literature tackling crowdfunding remain sparse.

(Un)responsive Government

The term “(un)responsive government” refers both to the accessibility of existing government institutions or data and the various forms of incentive (intrinsic and extrinsic) structures noted in the literature that governments could utilise to promote independent SEI. Government can play both a supportive and a responsive role in independent SEI, as well as act as a barrier by being unresponsive to the needs of independent SEI.

The inaccessibility of some government institutions has been noted within the literature as a barrier to small, independent SEI (Ross et al. 2012; Seyfang & Haxeltine 2012; Shandas & Messer 2008). Inaccessibility refers to both, understanding and garnering specific information, as well as to making end-users feel capable of bringing about change (Shandas & Messer 2008). On a practical level some end-user innovators become overly reliant on one administrator for information and when this person is gone, the individual’s access goes with them (Ross et al. 2012). Facilitating a more stable access point to government could therefore help minimise this barrier. This could be achieved through, for example intermediary actors, as reflected within the community energy sector, where intermediaries – such as the Communities and Climate Action Alliance – have been helpful in ameliorating contact between community led projects and local government (Hargreaves et al. 2013). In addition this intermediary acted as a “network of networks”, granting policy makers one organisation that could speak on behalf of the communities (Ibid).

Increasing free access to enabling data (like timetabling for busses, geographical data and pricing) has also been suggested as a means to support independent SEI – especially for the design of “smart green” travel apps. The availability of these travel data permitted end-users to make their own public transit apps, but they noted with frustration that gaining access and being given permission to use the data represented their biggest hurdle (Ross et al. 2012). In addition many government datasets are compartmentalised and non-standardised, creating additional hurdles to merging the data (Ibid). Policy initiatives that have attempted to change this include the UK Midata initiative (Gov.UK 2011) and the US data.gov project (US Data.Gov 2014).

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20 Smart green travel apps facilitate the travel by public transit by offering the user easy, one-step, on-the-spot and up-to-date access to time schedules, prices and connection information.
Co-locating independent SEI among other start-ups has also been noted as an external opportunity facilitator (Horwitch & Mulloth 2010). In co-locating various entrepreneurs and independent SEI, a number of spillover opportunities arise, including networking opportunities, increased access to a larger knowledge database, and an increased potential for collaboration (Horwitch & Mulloth 2010; Ross et al. 2012). The last opportunity is seen as particularly important as the potential for collaboration viewed “as an essential enabler for successful innovation” (Ross et al. 2012, p.481). As a positive side effect, it becomes easier for local and national government to host workshops and organise get-togethers since there is a present and identifiable target group.

Another facilitator of independent SEI are the previously mentioned DIY and self-building courses and groups (Hyysalo et al. 2013a; Jalas et al. 2014; Ornetzeder 2001; Ornetzeder & Rohracher 2013). While they can be said to primarily facilitate end-user motivation (see Section 3.2.1) and the ability (see Section 3.3.1) to innovate, the opportunity needs to exist either in the form of courses/workshops or online websites, fora and/or instructional videos. These initiatives have been shown to stimulate “user innovations, local embedding and diffusion of renewable energy technology” (Jalas et al. 2014, p.76) and offer “alternative ways to get people involved with low carbon technology and promote local acceptance and embedding of this technology” (Ibid, p.94). Organic farming courses at agricultural colleges are an example of how government can, via formal and informal education, facilitate experimentation of end-user co-producers (Smith 2007). However, at the moment it remains unclear from the literature review what makes an effective course, apart from the noted need for engaged teachers (Jalas et al. 2014; Ornetzeder 2001; Ornetzeder & Rohracher 2013).

Finally, various forms of financial incentives have been proposed in the literature to support independent SEI, broadly characterised as either tax credits or market subsidies (Garuda & Karnøe 2003; Karnøe & Garud 2012; Seyfang & Smith 2007). Based on our observations, market subsidies, from an independent SEI perspective, seem more congruent with at least efficiency focused innovations. This primarily builds upon Kranøe and Garud’s (2003; 2012) observations regarding how differing financial support mechanisms for wind power in the US and Denmark resulted in differing extrinsic motivations for driving investment in wind power. In the US, tax credits significantly increased investment in wind power in the US however doing so in an ineffective manner as tax credits were given independently of the effectiveness of the wind turbines. “In fact, tax credits were so high that profits were made even from wind turbines that generated hardly any electricity” (Karnøe & Garud 2012, p.750). Conversely, the Danish system encouraged, via investment subsidies and guaranteed high power prices, a focus on the effectiveness of the wind turbine, since the more effective the wind turbine, the greater the profit margins because power production and the government incentives were coupled together. This encouraged investors to understand the market and incentivised increasing energy production using wind turbines. In sum, the differing incentive structures, tax subsidies and energy subsidies created different investor dynamics. In the case of the US tax subsidies a separation from ownership and usage emerged and “led to dampened and delayed feedback from those operating turbines to firms that designed and produced them” (Garuda & Karnøe 2003, p.294).

The tax credits or tax deduction systems at times called for in the literature are understandable (Heiskanen et al. 2011). However, policy makers should be wary of whether it is increasing sales of a given product or service they are interested in or whether it is increasing product or service capabilities (via, for example increased energy efficiency). Increasing sales can arguably be supported by a tax credit/deduction system, but if policy makers are seeking increased efficiency, tax incentives can be susceptible to failure, especially if the
tax credit/deduction is dependent only on the purchase of the given product or service and not on the effectiveness of that same product or service (Garuda & Karnøe 2003; Karnøe & Garud 2012). While this is relevant for both independent and facilitated SEIs, independent SEIs are arguably more reliant on investments for their survival as compared to larger, facilitated SEI processes.

Finally it should be noted that monetary incentives are sometimes ineffective and often crude tools for altering behaviour. Non-monetary incentives and nudges can be both more effective and efficient approaches for changing behaviour (Thaler & Sunstein 2008). Within pensions schemes, default opt-in schemes, for instance, have been shown to be significantly more effective in garnering pension savings as compared to economic incentive structures (Chetty et al. 2015). Sustainable research similarly calls for increased focus on the power of defaults (Sunstein 2015; Sunstein & Reisch 2014) and the potential of nudging within environmental policy in general (Ölander & Thogersen 2014). We therefore argue that an increased focus on how nudging techniques could be applied within SEI represents a welcome addition to the current literature.

**Intermediary actors**

Intermediary actors, as introduced, represent a range of organisations that all operate as “boundary organisations” engaging in “relational work” between varying independent SEI (Moss 2009). The Communities and Climate Action (Hargreaves et al. 2013) or transition town movement (Seyfang & Haxeltine 2012), for example, reflect national movements that seek to ameliorate community energy initiatives and community-driven initiatives seeking a transition towards a low carbon economy. Engaging both in relational work between the respective independent sustainable end-user innovators and between them and policy makers (Hargreaves et al. 2013; Kemp & Rotmans 2004). Apart from supporting a range of motivational variables relevant for end-user action, they can also present a number of opportunities enabling actions. These include facilitating networks between like-minded end-user innovators (Feola & Nunes 2014) and lobbying policy and public opinion (Heiskanen et al. 2011).

A number of authors have noted the importance of networking for the survival of independent SEI (Heiskanen et al. 2011; Hyysalo et al. 2013a; Seyfang & Longhurst 2013; Smith et al. 2014). This includes virtual connectivity (Hyysalo et al. 2013a), but also offline contact (Feola & Nunes 2014). It is especially with regard to the latter that intermediary actors could play an important role, since face-to-face meetings generally require a critical mass of people to be meaningful and typically some form of central actor to coordinate the when, where and how (Feola & Nunes 2014; Hargreaves et al. 2013).

Intermediaries can also offer a bridge between innovators and the general policy and public opinion discourse (Heiskanen et al. 2011), both in terms of creating publicity, but also in terms of creating discussions between policy makers and end-user innovators. In addition, they can help facilitate contact between niche innovators and mainstream systems (Seyfang & Haxeltine 2012). The successful coordination of the Danish “wind meeting”, for example not only created a mutual forum for competence sharing, but offered a forum where entrepreneurs and end-user self-builders (innovators) could meet with regulators and utilities (Karnøe & Garud 2012). Lobbying utility firms and regulators to create a framework through which wind power could be effectively coupled to existing electrical grids represented another key endeavour for this intermediary actor (Karnøe & Garud 2012). Hence intermediaries can, if successful, grant end-user innovators an entity voice (as opposed to a series of lone voices), ensuring the continued commitment of policy makers (Ross et al. 2012). Intermediary actors empowering these lone end-user innovators by giving them a common voice (Hargreaves et al. 2013; Ross et al. 2012) and ideally allowing them to partake in the deliberative democratic discourse (Fishkin 1995).
In sum, these intermediary actors facilitate a number of opportunity-related factors that support independent SEI. Hence, policy makers are well advised to identify and support – or even co-create – relevant intermediary actors as well. As they have been shown to be particularly important for the often isolated independent SEI (Hargreaves et al. 2013), who – even if virtually connected (online) – “seem more at risk of being discontinued … (and)… struggle to achieve momentum and thrive” (Feola & Nunes 2014, p.248).

3.4.2 Opportunity and facilitated SEI

The facilitation of end-users into a sustainable innovation process can be supported by a number of opportunity related policy tools. These include open source and toolkits (Heiskanen & Lovio 2010; Ornetzeder & Rohracher 2006), the utilization of LivingLabs method (Liedtke et al. 2014), and more flexible government funding schemes (Heiskanen et al. 2013). With regards to “open source and toolkits” we should note that a considerable number of independent end-users also do and could benefit. We label these tools facilitators of SEI, since it is tool that firms, university and policy makers can utilize to drive an innovation process.

Open source and toolkits

In order to facilitate end-user innovation one has to ensure that the end-user has access to the necessary tools to innovate and is capable, in practical terms, of altering or changing a specific product or service (Heiskanen & Lovio 2010; Ornetzeder & Rohracher 2006).

With regard to the first point, supplying end-users with the necessary tools, the literature within open innovation has noted that end-user innovators increasingly have access to a wide variety of open source tools (Chesbrough et al. 2006; Hertel et al. 2003). These include various forms of software, from complex engineering and transportation simulation tools to simple budgeting tools (Board of Innovation 2014; Open Disc 2014; SourceForge 2014). In addition, various product designs and/or blueprints have also been made available (Chesbrough et al. 2006). Via competitions or crowdsourcing one could draw upon the motivational drivers these events facilitate and encourage open source development within a number of sustainability oriented fields. Chen et al. (2010) illustrate the potential of open source software for water management systems for developing countries, but opportunities also exist in the developed world. Software (or apps) designed to encourage sustainable energy consumption has also been mentioned as a potential source for increased resource efficiency (Katzeff et al. 2012). Policy makers and institutions could facilitate these types of innovations by bringing end-user innovators to bear on their specific area of focus.

The lack of opportunity for end-users to alter or change existing products or services in a simple fashion is currently a significant barrier to SEI (Hyysalo et al. 2013b). The immediate loss of warranty and insurance on products or services modified illustrates one of the real external constraints on end-users willing to approach user innovation (Ibid). Equipping end-users with toolkits has been proposed by von Hippel (2001, p.247) as a promising way for manufacturers to permit “users real freedom to innovate, allowing them to develop their custom product via iterative trial-and-error.” Toolkits include allowing end-users to modify, e.g. computer games by granting them tools to freely manipulate aspects of a given game exemplified by Garry’s Mod (garrysmod.com). In addition Franke and Piller (2004) illustrate how toolkits to modify and customise watches significantly increases the value of that given product in the eyes of the customer. Also within sustainable innovation has the idea of facilitating innovation via toolkits has been proposed (Heiskanen & Lovio 2010; Ornetzeder & Rohracher 2006). Currently, however, research remains centred around traditional user innovation, most typically within IT and the service industry (Franke & Hippe 2003; Franke & Piller 2004; von Hippel 2001; von Hippel & Katz 2002).
From a manufacturer or service provider point of view this approach allows them to move from (often unsuccessful) attempts to understand niche users’ needs to transferring the “need-related aspects of product and service development to users along with an appropriate toolkit” (von Hippel 2001, p.247).

While the utilisation of toolkits has been successful within a number of fields, it remains, to the best of our knowledge, untested within SEI. Policy makers could encourage producers and service providers within sustainability to make specified toolboxes available to consumers to help them innovate. Granting end-users easier access to modifying, e.g. ventilation or heating systems could be a way of overcoming some of the current barriers faced by end-users when seeking to create more efficient systems for themselves (Hyysalo et al. 2013b). The literature, however, currently remains unclear on how this should be achieved in practice.

**LivingLabs**

LivingLabs (LL) is a systematic approach to integrating end-users into the innovation process via direct end-user involvement. Specifically, LL seeks to involve end-users not within an external context, via e.g. workshops at a university, but instead within their own everyday context. LL is therefore “a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values” (Bergvall-Kåreborn et al. 2009, p.3). The aim is not to test modules against end-user requirements but instead to bring end-user “explorational learning” to bear with regards to the creation of new ideas and insights (Ibid).

Liedtke’s et al. (2014; 2012) approach to LivingLabs, or Sustainable LivingLabs (SLL), reflects a real world example of how this method can be applied in practice. In utilizing the SLL method Liedtke et al. (2014; 2012) pursue a better understanding of energy and resource efficiency within sustainable buildings, specifically by studying (and incorporating) the insights of end-users living in these buildings; studying both the technical feasibility of these buildings but also whether end-users accept the given living conditions that these technical specifications dictate in order to remain sustainable. Thereby “taking into account users’ social practices of utilising novelties” and potentially reducing the rebound effects caused by incorrect application (Liedtke et al. 2014, p.1).

In this endeavour they employ a three-phase research approach:

1. **Insight research** “involves understanding the status quo of building characteristics, heating energy consumption, and related social practices and interpretative schemes around heating” (Liedtke et al. 2014, pp.6–7).
2. **Prototyping** includes different methods for integrating project-relevant stakeholders (e.g. end-users) and testing marketable product solutions.
3. **Field testing** includes testing the prototypes in practice by utilizing the first phase measurements as baseline to test the effect of the given prototype(s).

The LL approach therefore reflects an opportunity for researchers to better understand end-user behaviour and to draw upon end-user insights via the approach suggested by Liedtke et al. (2014). From a policy perspective, SLL could offer policy makers and researchers the tools necessary to overcome behaviourally driven rebound affects.
Flexible funding schemes

Finally, some facilitated SEI projects have noted that current funding regimes are too inflexible to properly facilitate end-user integration and involvement (Heiskanen et al. 2013). Specifically, since end-user involvement and co-design requires a flexible project planning environment, which is currently not the case. Most government-funded projects require detailed plans that cannot easily be altered to fit new information or end-user feedback gained during the project. Heiskanen et al. (2013, p.248) therefore note that if “funding bodies want their projects to really make a difference, they should allow time for understanding the end-users’ perspective and flexibility to change project plans”.

3.4.3 Opportunity and SEI

In exploring opportunity-related barriers and drivers of SEI, it became clear that while some academic interest exists, it remains an area where additional work is required. Issues concerning making grant schemes more accessible and understandable, ensuring funding opportunities match the respective SEI, and understanding how, e.g. intermediaries can best be supported remain issues that have received little academic focus. They have been identified as opportunity-related barriers that should be tackled, but the issue of how remains, however, less clear from the reviewed literature. We have noted potential sources to draw upon, for example simplification of grant schemes, by understanding how the choice of architecture impacts individual decisions (Sunstein 2013). In addition there is the literature that suggests changing defaults (Sunstein & Reisch 2014) and to a greater degree utilising nudging within not only environmental policy, but potentially also within SEI (Ölander & Thøgersen 2014). As Ölander and Thøgersen (2014, p.343) note, when designing labels, or in our case e.g. funding schemes, “a minimum requirement is that one takes heed of the heuristics people use when processing information.” In addition to the academic literature, the report Warning: Too Much Information Can Harm by the UK Better Regulation/National Consumer Council (2007) reflects a potential resource to draw upon for policy makers seeking to simplify, e.g. existing funding schemes.

On the basis of the reviewed literature Figure 7 presents a list of opportunity barriers and drivers of SEI and suggests policies that could play a supportive role.
Figure 7. Opportunity barriers and drivers of SEI

**Opportunity barriers**

- **Complex and changing funding schemes**
  - Complex grant scheme(s)
  - Bureaucracy surrounding grants
  - Fluidity of the external funding landscape

- **(In)eligible funding schemes**
  - Failure to fit into classical funding criteria
  - Confusion regarding eligibility

- **Inaccessibility of government**
  - Inaccessible government agencies
  - Inaccessible and compartmentalised government data

- **Decoupled tax incentives**
  - Tax incentive decoupled from the product or service itself

- **Investor protection vs crowdfunding**
  - Conflict between investor protection and crowdfunding

- **Warranties and insurance**
  - Loss of warranty and insurance on products or services modified

- **Inflexible funding**
  - Projects focused on end user innovation require flexibility

**Opportunity drivers**

- **Simplified funding schemes**
  - Take heed of the heuristics people use when processing information (choice architecture)

- **One-stop shop for advice and funding**
  - Information centres to build-up end-user abilities (knowledge and competences)

- **Micro-grants**
  - Opportunity for small scale experimentation

- **Crowdfunding**
  - Growing external opportunity for end user co-financing

- **Data accessibility**
  - Open source-ready datasets

- **Co-location independent SEI and start-ups**
  - Opportunity for collaboration and spillovers

- **Host DIY and self-building groups**
  - Opportunity to build-up end-user competences and motivation

- **Intermediary actors**
  - Opportunity for collaboration, facilitation of advice and pooling of resources

- **Open source**
  - Access to relevant software and product blueprints
  - Encourage companies to pursue open innovation

- **Toolkits**
  - Enable end user alteration of existing products and services

- **Sustainable LivingLab**
  - Real world sustainable innovation testing
  - Activate end user explorational learning

- **Flexible funding schemes**
  - Ameliorate the participation of end users in the facilitated SEI process
Chapter 4
Conclusion

The literature on producer-led market-based innovation has to date “been the mainstay of both empirical research and theoretical development in innovation studies” (Hargreaves et al. 2013, p.869), while the involvement of end-users in the sustainable innovation process arguably remains a “neglected site of innovation for sustainability” (Seyfang & Smith 2007, p.585). The potential for drawing on end-users for innovative ideas, resources and growth represents, in our eyes, a major untapped and unexplored resource. The rapid increase in alternative finance via, e.g. crowdfunding, reflects this growing potential. As a result we argue that while largely unexplored, SEI offers a great potential for sustainable growth and innovation.

Throughout this report we have sought to systematically identify barriers and drivers to independent and facilitated SEI. In so doing, we seek to offer policy makers an overview of the field and how it relates to them, in addition to highlighting from an academic perspective some key knowledge gaps as we see it. Building primarily upon the reviewed literature (i.e., the 64 core articles identified) we have noted a number of potential areas where policy makers could intervene to create a policy environment more conducive to SEI. In relation to this we have also drawn upon classical user innovation (von Hippel 2005) and open innovation (Chesbrough et al. 2006) literature. Having noted a myriad of barriers to and potential strategies for supporting SEI from a policy perspective we will now compile, based on the background of the previous sections, an overview of the major policy options as we see them – focusing first on independent SEI and then on facilitated SEI. Finally we introduce areas that we believe need added academic focus.

4.1. Supporting independent SEI

Independent SEI is driven by a high degree of emotional involvement from end-users that is built upon their own personal needs or frustrations with a given product or service. In seeking solutions, independent SEIs challenge existing products and services in their pursuit to innovate not only for themselves but for others (Heiskanen & Lovio 2010; Jalas et al. 2014; Ornetzeder & Rohracher 2013; Ross et al. 2012).

From an independent SEI perspective, especially the utilisation of awards and competitions (Ornetzeder & Rohracher 2013; Partzsch & Ziegler 2011; Ross et al. 2012; Slotegraaf 2012) and DIY and self-building courses and groups (Hyysalo et al. 2013a; Hyysalo et al. 2013b; Jalas et al. 2014; Ornetzeder 2001; Ornetzeder & Rohracher 2013) represent simple and practical policy tools for supporting independent SEI with regard to increasing end-user competences, facilitating intergroup collaboration and learning, and with regards to making sustainable innovation doable (Hyysalo et al. 2013a; Jalas et al. 2014; Ornetzeder 2001).

Conversely, grant funding schemes appear to be an ill-match to independent SEI. End-
users note with frustration the complexity of finding and applying for resources (Ross et al. 2012; Seyfang & Smith 2007), mentioning especially the bureaucracy, requirements and other constraining targets associated with the application process alone (Kirwan et al. 2013; Seyfang & Smith 2007; Smith 2007; Walker 2008). Finally, some end-users noted that their specific innovations fall outside the current funding frameworks as they operate on “the interstices of traditional social, economic, and environmental issue boundaries” (Seyfang & Smith 2007, p.596). The literature is therefore unanimous in its assessment that current funding regimes need to be altered to better suit end-user abilities. However, it remains more unclear how this is to be achieved. Ross et al. (2012) suggest creating a “one-stop shop for advice and funding” and creating more micro-grants that are small in scale, but that require little paperwork and documentation. Drawing on inspiration from Sunstein (2013) and utilising insights from choice architecture, we suggest guaranteeing that funding schemes are simplified while remaining conducive to both end-user and policy-maker needs.

Finally, a significant portion of the literature argues that ensuring the longevity and dissemination of independent SEI often depends not on the independent SEI themselves, but also on intermediary actors. Policy makers seeking to support independent SEI should therefore increasingly also look to relevant intermediary actors, as they have been shown effective in supporting independent SEI in a number of capacities (Hargreaves et al. 2013; Seyfang & Longhurst 2013; Smith 2007).

4.2. Supporting facilitated SEI

Supporting facilitated SEI as opposed to independent SEI requires different types of policy interventions, especially since facilitated SEI is defined against the backdrop of the respective firm’s or project needs. The end-user therefore reflects a major component of the innovation process, but not the driver of the process itself. As a result we have focused on the methodology that seems most favourable for encouraging end-user integration into facilitated SEI.

The utilisation of either the lead user methodology (von Hippel 2001; von Hippel 1986) or crowdsourcing (Füller et al. 2012; Idelchik & Kogan 2012) as a facilitator of sustainable innovation is, in our eyes, an under researched, but potentially valuable approach for facilitating SEI.

From a lead user perspective Hyysalo et al. (2013a) suggest utilising identified sustainable innovation-oriented forums and blogs as platforms for identifying lead users. Given the success of the lead user methodology within traditional innovation research we second this observation (Enkel et al. 2005; Hippel et al. 1999; Urban & von Hippel 1988). In identifying and co-opting truly inventive end-users into a sustainable innovation process, the issues of overcoming expert scepticism towards end-user integration may be partly alleviated, since, for example lead users, given their experience, understand technical details that average end-users would not (Hyysalo et al. 2013b). Lead users are also highly motivated to engage in product innovation, which is why a facilitated SEI process may also experience fewer wasted hours due to low end-user turn-out rates (Lettl 2007).

Crowdsourcing innovation, as the recent USAID example illustrates, represents an alternative approach to tapping end-user innovation (Norman 2014). While the research on crowdsourcing remains in its early stages, we argue that work by, e.g. Füller et al. (2012) illustrates the potential benefits of this type of facilitated SEI process. The motivational aspects of crowdfunding, for example arguably “fit” with the characteristics of sustainable innovation, especially since end-users are more interested in the legitimacy of the project they are contributing to rather than the financial bottom line (Füller et al. 2012; Lehner &
Nicholls 2014). In addition, since crowdsourcing allows policy makers to steer innovation without dictating it, it empowers the end-user to take part in process, and even co-finance it (Baeck et al. 2014; Lehner & Nicholls 2014). Finally end-users may even be on par with experts, if not better than, when it comes to picking potential winners (Mollick & Nanda 2014). As a result, we view crowdsourcing as a currently overlooked opportunity to facilitate SEI.

4.3. Need for additional research

Throughout Chapter 3, we have sought to highlight areas that we believe are in need of added academic attention if policy makers are to be fully informed on how to best support SEI. This includes the call for more research on specific policy recommendations made within the literature, for example exploring how grants could better suit end-user ability and policy-maker needs, as well as more generalised areas where added insights could be helpful, for instance understanding how policy could best support intermediary actors. Table 4 outlines the areas where we see the greatest need for additional research.

<table>
<thead>
<tr>
<th>Policy and SEI</th>
<th><strong>Simplification of grant schemes:</strong> Practical research on how grant schemes can be simplified so that they become more conducive to end-user abilities and policy-maker needs, potentially in reference to research on individual heuristics when processing information</th>
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<tbody>
<tr>
<td></td>
<td><strong>Opening grant frameworks:</strong> Identification of where and when SEIs fall through the gaps due to being at the interstices of traditional issues; suggesting ways of overcoming this barrier by e.g. studying current SEI initiatives</td>
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<td></td>
<td><strong>Psychological barriers:</strong> Identification of the psychological ability barriers to SEI, potentially utilising Steg and Vlek's (2009) framework for encouraging pro-environmental behaviour to explore potential solutions, e.g. nudges</td>
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<td></td>
<td><strong>Lead user methodology:</strong> Identification of platforms where researchers/policy makers could identify potential lead users within sustainable innovation; application of lead user methodology within a sustainable innovation context, drawing inspiration from classical user innovation literature</td>
</tr>
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<td></td>
<td><strong>Crowdsourcing:</strong> Exploration of how “the amount of offered incentives, the combination of monetary and nonmonetary incentives, as well as the distribution of nonmonetary incentives among participants can exactly energize contestants and induce desired behaviours” (Füller et al. 2012, p.156); Desired behaviour referring to end-user project contributions to social and sustainable innovation.</td>
</tr>
<tr>
<td>General Perspective and SEI</td>
<td><strong>Scaling-up and replication:</strong> Identification of evidence or lessons learned from scaling-up and/or replicating SEI; analysis of successful dissemination of localised sustainable innovations to provide more insight (Feola &amp; Nunes 2014)</td>
</tr>
<tr>
<td></td>
<td><strong>Unsuccessful stories:</strong> More research focusing “on missed opportunities and discontinued initiatives” (Ornetzeder &amp; Rohracher 2013, p.866), specifically as it would allow us to better understand how local settings and structural conditions, also in unison, influence the success of failure of SEI</td>
</tr>
<tr>
<td></td>
<td><strong>Why sustainable:</strong> Clarification of why end-user innovation exists in the first place (Bogers et al. 2010), but also why they innovate for sustainable ends; the question remains as to why some end-users innovate for themselves and others innovate for others (in the form of more sustainable products and services)</td>
</tr>
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Appendix 1
Methodology

Box 8. The Systematic Literature Review
The following Appendix chapter introduces the methodology of the systematic review process. This section is especially relevant to readers interested in methodology.

We utilise the systematic literature review method introduced by Tranfield et al. (2003), in addition to a secondary review step, to compile the literature on SEI. The systematic review method is used to broadly scope the literature on SEI, while the second step is used to identify relevant outliers, which may have been missed in our initial review. In this way, we compensate for the rigidity of the systematic review approach while maintaining its structured approach to a novel, disjointed, widely distributed and skewed literature.

The systematic review consisted of three stages: a planning stage, a review stage, and a reporting and dissemination stage.

- The planning stage involved initially scoping the literature in an iterative process of defining, clarifying and refining the broad search parameters. This included contacting recognised experts in the field and presenting the research methodology at various workshops. This was done to insure that the search parameters of the systematic review were adequate and that they did not miss potentially relevant literature. The search parameters were primarily the keywords associated with the literature on SEI (see Appendix 2) and the platforms utilised to search for the relevant literature.

- The subsequent stage involved compiling and sorting through the literature identified in the previous stage. This included downloading all potentially relevant literature, in addition to subsequently weeding out non-relevant literature. This resulted in identifying 35 peer-reviewed articles.

Research on SEI represents a dynamic and developing research field studied by various research disciplines. Keywords and definitions are thus still in a state of flux, and while the systematic literature review method is an efficient technique there is the danger of missing potentially relevant literature, due to the often rigid guidelines that dictate the method. As a result an intermediate step was employed that involved tracking the citations of the relevant literature already identified. In that fashion we were effectively able to single out an additional 29 relevant articles.

- The final stage of the systematic review process is the reporting and dissemination reflected in by Chapter 2 and 3 of the report.

In total, this two-step process resulted in identifying 64 relevant peer-reviewed articles on which to base our review.
To the best of authors' knowledge there is at present no systematic review of SEI research few cross-country comparisons (Feola & Nunes 2014; Ornetzeder & Rohracher 2013). Policy recommendations are therefore typically based on single (and sometimes multiple) case studies. This literature review aims to compile these observations in the hope of discerning important trends regarding policy barriers and drivers for SEI.

The literature on sustainable innovation is often characterised as being disjointed, widely distributed and skewed (Adams et al. 2012; Baumann et al. 2002). It was therefore clear that we needed an orderly approach to the literature, such as the systematic literature review method outlined by Tranfield et al. (2003), which is widely used in major international policy reports (e.g. World Bank Report 2015). Given, however, the rigid guidelines of the systematic literature review method, we opted for a “two-step” process. The systematic review methodology was applied first to identify relevant articles from EBSCO databases (see: ebsco.com/about), while the second step involved the utilisation of the Scopus database to identify relevant outliers that might have been missed by our first data collection method.

5.1 Conducting a systematic literature review

A systematic literature review is characterised by a structured approach to reviewing published academic research, as opposed to a more common narrative-based review (Tranfield et al. 2003). This allows other researchers to replicate the literature review for the sake of revisions and updates, thus providing an audit trail on the reviewer(s) procedures and decisions (Cook et al. 1997). In our case this method represents a broad, ideal way of dealing with the widely distributed and disjointed literature on SEI. However, when using a broad approach, a large number of out of scope articles are also identified. In order to reduce the latter, a clear definition of the search parameters, key terms and sources drawn upon is needed.

The following section explains the stage-based approach in more detail: Stage I – Planning the Review, Stage II – Conducting the Review and Stage III – Reporting and Dissemination

5.1.1 Stage I – Planning the Review

The first stage of the literature review involved an initial scoping exercise, which is an iterative process of defining, clarifying and refining the literature search parameters. Our goal was, as stated earlier, to systematically review the literature on SEI with the aim of gaining a better understanding of how it can be enhanced by policy.

For the present paper we sought to identify literature that focuses on:
• end-user(s) and
• sustainable innovation.

In line with the definition of SEI used in the EU-InnovatE Project, we systematically excluded literature focused on:
• producer innovation\(^{21}\) and intermediate user innovation,
• unsustainable innovation\(^{22}\) or innovation with no specific focus on sustainability

The iterative process included contacting recognised experts within the field for their insights and scoping their recommended readings. For a relevant peer review the research methodology was presented at the annual Sustainable Innovation and Entrepreneurship Academy at Politecnico di Milano, Italy. A number of initial scoping literature searches (i.e. scoping exercises) were also conducted to identify search strings (or combinations of keywords) that would adequately capture relevant peer reviewed articles.

\(^{21}\) Producer innovation is characterised by an innovation process driven wholly by a producer (company or firm) for the sake of developing a new product. This type of innovation, in its ideal form, is characterised by closed R&D and patenting (von Hippel 2005).
Defining the keywords

The first scoping exercise focused specifically on the keywords “user innovation” AND “sustain*” resulting in minimal hits\(^2\). Subsequent scoping searches were broadened so that key articles identified during Stage I would be included. This resulted in multiple keywords cropping up that were associated with end-user innovation, sustainability and policy. Other systematic literature reviews within sustainable innovation have also faced similar issues as sustainability and innovation can be broadly interpreted and therefore conceptualized in diverse ways, depending on the context (Adams et al. 2012). Therefore, we also sought to clearly define the keywords we would use in our systematic literature search (see Appendix 2).

Especially, adequately capturing the myriad of terms for “end-user(s)” proved more difficult than originally expected. Multiple terms are used to denote the different characteristics and roles that end-users can assume in the innovation process. In trying to guarantee that we did not exclude important contributions, we opted to use a broad range of terms all denoting similar, but still different, user involvement in value creation innovation. The identification of relevant keywords related to “sustainability” and “policy” proved much easier given prior successful systematic literature reviews within these subject field(s) (Adams et al. 2012).

5.1.2 Stage II – Conducting the Review

Based on the scoping exercise(s) and keyword identification and definition(s) sketched above, the review was conducted utilising the criteria listed in Table 5.

Table 5. Criteria – The inclusion and exclusion parameters

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Inclusion</th>
<th>Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review scope*</td>
<td>EBSCO – Business Source Premier</td>
<td>Other databases</td>
</tr>
<tr>
<td>Source</td>
<td>Peer reviewed journal articles</td>
<td>Any other source</td>
</tr>
<tr>
<td>Empirical approach</td>
<td>No restrictions</td>
<td></td>
</tr>
<tr>
<td>Time period**</td>
<td>1992 to present (incl. articles in press)</td>
<td>Any source before 1992</td>
</tr>
<tr>
<td>Search parameters</td>
<td>Keywords appearing in the: title, abstract</td>
<td>Keywords appearing in other parts of the</td>
</tr>
<tr>
<td></td>
<td>and author-supplied keywords</td>
<td>article***</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td>Any other language</td>
</tr>
<tr>
<td>Relevance****</td>
<td>Literature focused on sustainable innovation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and end user(s)</td>
<td></td>
</tr>
</tbody>
</table>

* The EBSCO database was deemed well-suited for the task, including relevant journals like the Journal of Cleaner Production, Ecological Economics and Research Policy.
** Following Adams et al. (Adams et al. 2012), we fixed the start date for this systematic literature review as 1992, the year of the United Nations Conference on Environment and Development, or Rio Summit.
*** Keywords appearing in the full article text were rejected as it resulted in an unmanageable number of search results (also due to the broad search parameters adopted).
**** See section 5.1.1.

The adoption and utilisation of a single database – Business Source Complete by EBSCO\(^2\) – is based on two major factors: First, initial scoping exercises conducted during Stage I suggested a large number of potential articles. Using only the single most relevant database,

\(^{12}\) Unsustainable end user innovation is illustrated by e.g. the modification of SUVs/trucks in e.g. the rural US to spout black smoke. This is achieved by modifying the amount of fuel entering the engine which results in soot leaving the engine in the form only partially combusted fuel. This makes the engines highly inefficient, but does result in black smoke: this trend is also known as “Rolling coal” or “Rolin’ coal”.

\(^{13}\) Nine hits on EBSCO (25.07.2014)

\(^{24}\) Business Source Complete represents a well-established scholarly database and grants access to a large number of peer-reviewed sources (nearly 2,000 journals).
we expected to keep the number of articles collected at a manageable size. Second, many
databases limit the number of search results that can be shown and exported. EBSCO does
not. Therefore EBSCO represented not only a well-suited database for our research topic,
but was also best-suited for this type of broad systematic search from a technical and prac-
tical handling point of view.

The broadening of the search parameters (i.e. increasing the number of keywords) resulted
in more relevant articles being identified; it also had the converse effect of considerably
increasing the number of captured articles that fell outside the scope of this report. This
was seen as acceptable as it ensured that a more nuanced and inclusive picture of SEI could
be drawn.

After defining our keywords and delimited our inclusion and exclusion criteria (see Table
5) for the systematic literature review we applied the keywords to the EBSCO database
using a number of search strings for each of our themes (end-user innovation, sustainability,
and policy), as illustrated in Table 6.

Table 6. Keywords and search string themes

<table>
<thead>
<tr>
<th>Search string themes</th>
<th>Keywords (Synonyms and alternatives)</th>
</tr>
</thead>
</table>
| End-user innovation  | innov* AND (user OR "end-user" OR "user-centered" OR "lead user" OR cus-
|                      | tomer OR consumer OR participat* OR collaborat*) OR co-innovat* OR co-design* |
|                      | OR co-produc* OR co-creat* OR prosumer OR "do-it-yourself" |
| Sustainability       | sustain* OR environment* OR "eco-innovation" OR green OR renewable* OR "tri-
|                      | ple bottom line" OR eco-efficien* OR eco-effectiv* OR "cradle to cradle" OR bio-
|                      | mimicry OR frugal OR ecolog* OR "circular economy" |
| Policy               | governance OR policy OR "policy instrument" OR incentiv* OR regulat* OR "choice
|                      | architecture" OR nudge OR "behavioural policy" OR patent* OR toolkit |

Given the systematized and often rigid guidelines that dictate the systematic literature re-
view method there were some inevitable elimination of possibly relevant articles if they
fall outside the scope of the keyword, etc. To avoid this, the Scopus database was sub-
sequently applied to all identified relevant literature from the EBSCO results in order to
identify possible “outliers” by tracking cited articles.

Database Analysis: Duplicates, Title and Abstract

The keywords in Table 4 were applied in a series of search strings to the EBCSO database.
This variation in search strings insured that we gained an as full as possible overview of
the literature based on the different keywords. This was needed since, as expected, different
combinations of search strings resulted in different results. Figure 8 illustrates the respec-
tive combinations of keyword search strings.

Figure 8. Search string combinations

The initial database analysis, utilizing the three separate search strings, led to 1,471 articles
for Search string 1, 4,805 articles for Search string 2, and 5,121 articles for Search string 3.
Of these, 11,397 hits, 2973 were overlapping, reducing the number to 8,424 potentially rel-

25 Quotation marks are necessary because EBSCOhost automatically searches for plural and possessive forms of terms when they are
not used.
26 Scopus represents another large database for peer-reviewed works.
The articles were screened first by title, then by abstract, and finally by full text to exclude irrelevant articles. The initial step of sifting through titles proved to be a highly time consuming, especially since the title often only roughly reflect the content of the article (Evans 2002). In cases where we could not confidently exclude an article, we kept it for subsequent abstract and full-text review, as suggested by Jones (2004). The initial removal of duplicates and title screening narrowed the number of possibly relevant articles to 446, while the subsequent screening of the abstracts resulted in a further reduction to 93 articles. Many abstracts focused on user integration and sustainability; however, whether they also included an innovation element was harder to discern. Again, in cases where it was unclear whether the end-user had any innovative role (rather than only a participatory role), we opted to keep the articles for the full-text screening.

*The utilisation of the Scopus database resulted in the identification of 37 possibly relevant articles.

**29 of the 37 outliers proved to be relevant, resulting in 64 articles falling within the search parameters of this systematic literature review.
The 93 articles were all screened using Nvivo (qsrinternational.com/products_nvivo.aspx), a qualitative research software programme that supports systematic coding of, for instance literature. The coding nodes used were as follows:

- **Primary Code: Policy (Aggregated)**
  - Subcode(s): Motivation, Opportunity, Ability

- **Primary Code(s): Focus (Not Aggregated)**
  - Subcode(s): Energy, Mobility, Living, Food, Other

- **Primary Code(s): Driver (Not Aggregated)**
  - Subcode(s): User-driven, Firm (or Project) -driven
    - "Firm (or Project) -driven" signifies that the overall product/service/system was initiated by a top-down actor, but that it actively incorporated end-users into the innovation process. "User-driven" signifies independent end-user innovation.

- **Primary Code(s): Method (Not Aggregated)**
  - Subcode(s): Quantitative, Qualitative, Mixed Method

- **Primary Code(s): Level of User Innovation (Not Aggregated)**
  - Subcode(s): User Participation, Weak User innovation, Moderate User Innovation, Strong User Innovation
    - User Participation: Users are incorporated into the innovation process wholly to understand user needs (excluded from study).
    - Weak User Innovation: Users are incorporated into the innovation process, mostly to understand user needs. There is only a small amount of actual user-driven innovation based on their experience with the product.
    - Moderate User Innovation: Users are actively involved in the innovation process and utilise the product in their everyday lives to offer feedback on how to innovate upon it. They themselves do not, however, alter the product independently and can therefore not be said to be wholly involved in the innovation process.
    - Strong User Innovation: users are involved in all aspects of the innovation process from conceptual product development to the execution and production of the good, service or system.

- **Primary Code(s): Stage (Not Aggregated)**
  - Subcode(s): Idea, Developing, Developed
    - Idea (Innovation ÷ Diffusion ÷ Entrepreneurship) is an initial idea restricted to a limited number of end-users with no market base.
    - Developing (Innovation + Diffusion ÷ Entrepreneurship) is a developing idea accessed by a large number of end-users with no market base.
    - Developed (Innovation + Diffusion + Entrepreneurship) is a developed idea accessed by a large number of end-users and is commercialised in some sense.

- **Primary Code(s): Approach (Not Aggregated)**
  - Subcode(s): Methodology, Practical Experience (Case-based), Systematic Review, Theory

- **Primary Code(s): Type of Innovation (Not Aggregated)**
  - Subcode(s): Incremental, Novel, System
    - Product/service incremental innovation: user innovation in the form of an improvement on existing products/services
    - Product/service novel innovation: user innovation in the form of a novel new product/service (includes reorienting an existing product/service in a new direction, e.g. car sharing)
    - Product/service system innovation: User innovation in the form of a novel new product/service that systematically alters, or seeks to alter, an established socio-technical regime. This includes a restructuring of dominant regimes, i.e. A localised food system or community power.

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27 “Aggregated” means that all subcodes are registered both individually and included in the overall tally for, in this circumstance, the policy code. While “not aggregated” means that each subcode is registered individually but not aggregated at a primary code level.  
28 Variables based on the MOAB-model.
This systematic coding allowed for an orderly and efficient analysis of the literature, especially with regard to understanding how policy could help promote SEI.

The full-text screening narrowed the number of finally approved papers down to 35. These papers informed the second-step of our literature review process, where we used the Scopus database, specifically since it allows for tracking cited articles. The 35 identified relevant articles served as the basis for tracking citations, which in turn allowed us to identify potential outliers missed by our systematic review. This was highly relevant for our area of focus as the terminology and keywords identifying SEI still remain loosely defined. Based on this approach we identified an additional 37 papers of interest, 29 of which proved to be within the scope of the systematic literature review. All 37 identified articles were also screened utilizing the qualitative research software Nvivo. Chapter 2 and 3 primarily build upon the insights gained from the 64 identified relevant articles.
## Appendix 2

### Definition of keywords

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End-user innovation</strong></td>
<td>Adequately capturing the full myriad of labels used to identify end-user innovation proved more difficult than originally anticipated. The term has multiple and often interchangeably used labels to denote the different characteristics and roles that end-users may assume in the innovation process. In trying to ensure that we do not exclude important views, we chose to utilise a broad range of terms, all denoting similar, but still different, user involvement in innovation. Below is the definitional understanding of each term, some of which clearly overlap at times.</td>
</tr>
<tr>
<td>Co-creation:</td>
<td>Customers actively and explicitly enter into dialogue with manufacturers of products and services; in addition they increasingly become proactive collaborators, co-developers and competitors to firms (Prahalad &amp; Ramaswamy 2000).</td>
</tr>
<tr>
<td>Co-design:</td>
<td>A creative collaborative design process between designers and people not trained in design, from fuzzy front end to the final product (Anderson-Connell et al. 2002; Sanders &amp; Stappers 2008).</td>
</tr>
<tr>
<td>Co-innovation:</td>
<td>A collaborative network-based approach to innovation via the incorporation of multiple parties/stakeholders (both end-users and firms) (Klen 2009).</td>
</tr>
<tr>
<td>Consumer-driven innovation:</td>
<td>Often used interchangeably with user innovation, it focuses on how consumers actively innovate new ideas, goods and/or services.</td>
</tr>
<tr>
<td>Collaborative consumption:</td>
<td>A model of consumption where consumers increasingly focus on the “usefulness over ownership, community over selfishness, and sustainability over novelty” (Botsman &amp; Rogers 2010).</td>
</tr>
<tr>
<td>Co-production:</td>
<td>“Company-consumer interaction (social exchange) and adaptation, for the purpose of attaining added value” (Wikström 1996, p.363).</td>
</tr>
<tr>
<td>Do-it-yourself (DIY):</td>
<td>Consumer projects built on consumer crafting and the active and creative integration and transformation of a complex array of material goods (Watson &amp; Shove 2008; Wolf &amp; McQuitty 2011).</td>
</tr>
<tr>
<td>Lead user:</td>
<td>“Users whose present strong needs will become general in a marketplace months or years in the future. Specifically since lead users are familiar with conditions which lie in the future for most others, they can serve as a need-forecasting laboratory for marketing research” (von Hippel 1986).</td>
</tr>
<tr>
<td>Prosumer:</td>
<td>The individual acts both as a consumer of goods and as a producer of goods; increasingly becoming more proactive rather than reactive (Ritzer et al. 2012; Toffler 1980).</td>
</tr>
<tr>
<td>User innovation:</td>
<td>Users – both individual consumers (end-users) and firms (intermediate users) – actively engage in the innovation process and develop upon or make new products and services (von Hippel 2005); “User innovation implies a deeper and more fundamental participation by users. Innovative users actually come up with solutions that may later be integrated into commercial-scale designs” (Heiskanen &amp; Lovio 2010).</td>
</tr>
<tr>
<td>User (user) integration:</td>
<td>The active integration of end-user(s) by firms into the innovation process (Hoffmann 2012).</td>
</tr>
<tr>
<td>End-user:</td>
<td>Consumer users – users of consumer goods – typically identified as individual end customers or a community of end-users (von Hippel 2005).</td>
</tr>
<tr>
<td>User:</td>
<td>An individual, group or firm that utilises a given product, service or good in their everyday routines.</td>
</tr>
<tr>
<td>User-centred:</td>
<td>A method of approach to innovation focused on the active incorporation of users in the innovation process.</td>
</tr>
<tr>
<td>User participation:</td>
<td>This report defines user participation as the active integration of end-user(s) into the innovation process and not solely the passive, classical market research approach of incorporating users after the product/service is developed (via e.g. focus groups and interviews).</td>
</tr>
</tbody>
</table>
In order to insure that we did not lose relevant articles due to defining sustainability too narrowly, we chose a diverse range of keywords related to sustainability. Below is the definitional understanding of each term, some of which clearly overlap at times.

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomimicry</td>
<td>Utilises the natural world as an inspiration for developing materials, objects and processes to overcome human challenges (Bhushan 2009).</td>
</tr>
<tr>
<td>Circular economy</td>
<td>A model proposing a circular economic system where development is dependent on overcoming “current environmental and resource management problems, while achieving improvements in resource productivity and eco-efficiency” (Geng &amp; Doberstein 2008).</td>
</tr>
<tr>
<td>Eco-effective / Cradle to cradle</td>
<td>“Moves beyond zero emission approaches (eco-efficiency) by focusing on the development of products and industrial systems that maintain or enhance the quality and productivity of materials through subsequent life cycles” (Braungart et al. 2007); commonly used as “cradle to cradle” products.</td>
</tr>
<tr>
<td>Eco-efficiency</td>
<td>Based on the concept of doing more with less; creating more goods and services utilising fewer resources and creating less waste.</td>
</tr>
<tr>
<td>Ecology</td>
<td>A term related to the interaction between an organism and their environment, in this case the interaction between the human economy and the natural world. Specifically focused on “ecological innovation”, which aims to explore the integration of ecology and economy into firms (Blättel-Mink 1998).</td>
</tr>
<tr>
<td>Environment</td>
<td>A broad term with multiple meanings depending on the discipline; this report focuses on the social/philosophical meaning of the term, namely the attempt to minimise and overcome the potentially negative impact of human action on the biophysical environment (Stern et al. 1999).</td>
</tr>
<tr>
<td>Frugal</td>
<td>Is the measured attempt to minimise material and financial resource use in the entire value chain (Tiwari &amp; Herstatt 2012).</td>
</tr>
<tr>
<td>Green</td>
<td>An oft used term concerned with or supporting the environment. In the context of this report it utilized to innovations such as green innovation and green product innovation.</td>
</tr>
<tr>
<td>Renewable</td>
<td>Represents an utilisation of resources where present consumption levels do not rise above the natural level of replenishment.</td>
</tr>
<tr>
<td>Sustainable / sustainability / sustainability-oriented</td>
<td>A principle of guided action where the needs of the present are met “without compromising the ability of future generations to meet their needs” (Brundtland Commission 1987).</td>
</tr>
<tr>
<td>Triple bottom line</td>
<td>The incorporation of the notion of sustainability into the business logic; represents an equal focus on economic, social and environmental issues; coined by John Elkington (1997).</td>
</tr>
<tr>
<td>Terms</td>
<td>Definitions</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Choice architecture / nudge / behavioural policy:</td>
<td>Policy tools utilising behavioural scientific insights to guide individual and group behaviour (Jones et al. 2013); choice architecture (nudge) policies utilise existing choice structures and environments to actively influence individual behaviour but without removing actual freedom of choice via e.g. disincentives, rules or regulation (Thaler &amp; Sunstein 2008).</td>
</tr>
<tr>
<td>Governance:</td>
<td>&quot;All processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organization or territory and whether through laws, norms, power or language&quot; (Bevir 2012, p.13); this paper focuses solely on governance undertaken by government.</td>
</tr>
<tr>
<td>Incentive:</td>
<td>Any direct funding (e.g. grants) or indirect monetary support schemes (e.g. tax incentives) aimed at reducing impediments faced by individuals/firms.</td>
</tr>
<tr>
<td>Patent:</td>
<td>Patent policy is strongly impacted by the current discourse on user innovation as current patent policy tends to focus on producer-led innovation at the expense of user innovation (Henkel &amp; von Hippel 2005; von Hippel 2005).</td>
</tr>
<tr>
<td>Policy / public policy:</td>
<td>Any course of action (e.g. regulation, legislation, funding) taken on by government to either actively or passively achieve the effect it desires in a given area.</td>
</tr>
<tr>
<td>Policy instrument:</td>
<td>Methods used by government to achieve the effect it desires.</td>
</tr>
<tr>
<td>Regulation:</td>
<td>A rule, law or directive made and upheld by the respective and relevant authority.</td>
</tr>
<tr>
<td>Toolkit:</td>
<td>A method for integrating users or inspiring user innovation by allowing customers to develop their own products; ameliorated by easy-to-use tools and building-blocks (Pfitzer et al. 2013).</td>
</tr>
</tbody>
</table>
## Appendix 3

### Literature review papers

<table>
<thead>
<tr>
<th>N</th>
<th>Author(s)</th>
<th>Year</th>
<th>Title</th>
<th>Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Belz, F.M.</td>
<td>2013</td>
<td>Shaping the future: Sustainable innovation and entrepreneurship</td>
<td>Social Business 3(4), pp. 311–324.</td>
</tr>
<tr>
<td>N</td>
<td>Author(s)</td>
<td>Year</td>
<td>Title</td>
<td>Journal</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>24</td>
<td>Hyysalo, S., Junntunen, J. &amp; Freeman, S.</td>
<td>2013a</td>
<td>Internet forums and the rise of the inventive energy user</td>
<td>Science and Technology Studies, 26(1), pp.25–51</td>
</tr>
<tr>
<td>N</td>
<td>Author(s)</td>
<td>Year</td>
<td>Title</td>
<td>Journal</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>41</td>
<td>Ornetzeder, M. &amp; Rohracher, H.</td>
<td>2013</td>
<td>Of solar collectors, wind power, and car sharing: Comparing and understanding successful cases of grassroots innovations</td>
<td>Global Environmental Change 23(5), pp.856–867</td>
</tr>
<tr>
<td>44</td>
<td>Quist, J. &amp; Tukker, A.</td>
<td>2013</td>
<td>Knowledge collaboration and learning for sustainable innovation and consumption: introduction to the ERSCP portion of this special volume</td>
<td>Journal of Cleaner Production. 48, pp.167–175</td>
</tr>
<tr>
<td>45</td>
<td>Riesch, H. &amp; Potter, C.</td>
<td>2014</td>
<td>Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions</td>
<td>Public Understanding of Science 23(1), pp.107 – 120</td>
</tr>
<tr>
<td>47</td>
<td>Rohracher, H. &amp; Ornetzeder, M.</td>
<td>2002</td>
<td>Green buildings in context: Improving social learning processes between users and producers</td>
<td>Built Environment 28(1), pp.73–84</td>
</tr>
<tr>
<td>N</td>
<td>Author(s)</td>
<td>Year</td>
<td>Title</td>
<td>Journal</td>
</tr>
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<td>------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>50</td>
<td>Seyfang, G. &amp; Longhurst, N.</td>
<td>2013</td>
<td>Desperately seeking niches: Grassroots innovations and niche development in the community currency field</td>
<td>Global Environmental Change 23(5), pp.881 – 891</td>
</tr>
<tr>
<td>51</td>
<td>Seyfang, G. &amp; Smith, A.</td>
<td>2007</td>
<td>Grassroots innovations for sustainable development: Towards a new research and policy agenda</td>
<td>Environmental Politics 16(4), pp.584 – 603</td>
</tr>
<tr>
<td>56</td>
<td>Smith, A. &amp; Seyfang, G.</td>
<td>2013</td>
<td>Constructing grassroots innovations for sustainability</td>
<td>Global Environmental Change 23(5), pp.827–829</td>
</tr>
</tbody>
</table>


Dogliotti, S. et al., 2014. Co-innovation of family farm systems: A systems approach to sustainable agricul-


Flowers, S. et al., 2010. Measuring user innovation in the UK: The importance of product creation by users. London: NESTA.


