Eco-innovation in SMEs


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## Contents

1. **Introduction: SMEs and eco-innovation** 4

2. **Barriers and drivers for the adoption of eco-innovation** 8
   2.1 Barriers to the adoption of eco-innovation 10
   2.2 Drivers towards eco-innovation 12
      2.2.1 Resource efficiency innovations: do they deliver savings for SMEs? 16
   2.2.2 Multiple benefits approaches 19

3. **Accelerating eco-innovation: data-led and organisational solutions** 23
   3.1 Data-led solutions for eco-innovation 23
      3.1.1 Hybrid cloud computing and management 24
      3.1.2 Integrated digital systems and networks 25
      3.1.3 Diagnostic tools for eco-innovation 25
      3.1.4 Better modelling and data on resource use and energy flows 26
      3.1.5 Smart technologies 26
   3.2 Organisational solutions for SMEs 26
      3.2.1 ‘Open’ innovation: knowledge sharing, cooperation, networking and clustering 27
      3.2.2 Technical assistance and advice 30
      3.2.3 Training, communication and raising awareness 31
      3.2.4 Financial support, investment and longer-term eco-innovation trajectories 31

4. **Public policy solutions for eco-innovation** 34
   4.1 Types of policy approach to SME eco-innovation 34
      4.1.1 Public procurement 35
      4.1.2 Environmental management schemes 35
      4.1.3 Targeted and combined policy measures 35
   4.2 Levels of policy approach to SME eco-innovation 37

5. **Summary** 41

References 45
Section 1. Introduction: SMEs and eco-innovation

BOX 1. SME Statistics: the backbone of the European economy

In 2015, in the EU-28, there were:

- **23.4 million SMEs** in the non-financial business economy
- **Employing 91 million people**
- **Generating EUR 3 934 billion** of value added
- **92.8%** were enterprises with less than 10 persons employed


Small and medium-sized enterprises (SMEs) play a very important role in Europe’s economy. ‘SME’ is a very broad and diverse category, which encompasses both newly established service providers with just a few employees, and long-established manufacturing firms with large workforces. Together, SMEs make up over 99% of all enterprises in the EU. They account for over two-thirds of total employment, ranging from 47% in the UK to 85% in Malta, provide the majority of all new jobs and contribute about 56% of the total turnover in the EU (Papadopoulos et al., 2018).

BOX 2. SMEs are...

The European Commission defines SMEs as enterprises employing fewer than 250 people with either a turnover of less than 50 million euros, or a balance sheet total of less than 43 million euros. They are broken down further into micro, small, and medium enterprises, depending on their turnover, balance sheet total, and levels of employment, as shown in Table 1.

<table>
<thead>
<tr>
<th>Enterprise category</th>
<th>Persons employed</th>
<th>Turnover or balance sheet total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>&lt; 250 ≤ €50m</td>
<td>120-150 ≤ €43m</td>
</tr>
<tr>
<td>Small</td>
<td>&lt; 50 ≤ €10m</td>
<td>≤ €10m</td>
</tr>
<tr>
<td>Micro</td>
<td>&lt; 10 ≤ €2m</td>
<td>≤ €2m</td>
</tr>
</tbody>
</table>

Table 1: Based on Papadopoulos et al. 2018.
Innovation: turning novelty put into practice

The OECD defines innovation in their 2018 Oslo Manual, a set of guidelines about innovation data. Key components of innovation include novelty and utility, as well as the role of knowledge as a basis — and the goal of innovation is seen as value creation or preservation.

‘Innovation’ can also signify both an outcome (‘an innovation’) and the activities by which innovations come about (‘innovation activities’):

‘A new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)’ (OECD, 2018).

1. (Facing page) This statistic is also true of Norway and Switzerland. Source: Eurostat (sbs_sc_sca_r2)/Papadopoulos et al., 2018. SMEs are defined officially in EU Recommendation 2003/361 — although responses from a public consultation on this definition are currently being evaluated.
There are more than 20 million SMEs in EU countries, compared to around 40,000 large companies (i.e. with more than 250 persons employed). Though the environmental footprints of individual firms may be relatively small, their collective impact is much more significant. For example, a 2010 study showed that SMEs are responsible for about 64% of the overall environmental impact\(^2\) of businesses in the EU (Calogirou et al., 2010). Until recently, policy-makers and practitioners have tended to focus on promoting pro-environmental practices and innovations in larger firms. As a result, there is considerable scope to reduce environmental impacts in Europe by promoting eco-innovation in the SME population.

\(^{2}\) Impact measured in terms of energy use, greenhouse gas emissions, air quality emissions and waste.

**BOX 4.**

**Eco-innovation is...**

‘...the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation and which results, throughout its life cycle, in a reduction of environmental risk, pollution, and other negative impacts of resource use compared to relevant alternatives’ (Kemp and Pearson, 2007).

While eco-innovation focuses on the environmental impact of innovative activities, there are various types and means of innovation itself. These include the development of new products and technologies (e.g. insulation materials; compostable plastics); the introduction of new processes or methods of production (e.g. car clubs; substituting chemicals); restructuring and opening up new markets, working arrangements, and business models (e.g. platform businesses; decentralised workforces); developing new supply chain resources (e.g. using waste from one industry as the raw material of another; collaborative recycling); and more. They can be radical or incremental — a few types of businesses may be able to disrupt and restructure their market, while others may opt for a next-step improvement of their product based on existing R&D. This varies by sector and company, with low- and medium-technology industries more often characterised by incremental innovation (The Innovation Policy Platform, n.d.), and very large, or some small, high-tech and high growth start-ups that are introducing a radically new product or business models, more likely to be radical disruptors.

Innovation can tackle an individual component of a system, or the system as a whole. It can bring about organisational change, or promote new ideas to meet social needs and foster new collaborations. In short, there is no single path to innovation — there are many.
Eco-innovation is an important part of the transition to a low-carbon, low-emissions, and circular economy. Other elements in this transition may include firm population changes, with the exit of older, more polluting firms and entry of newer, greener ones, the decline of more polluting industry sectors, and broader political, institutional and cultural changes that may influence consumption, such as the push towards increasing self-sufficiency for raw materials; using greener principles in public procurement; minimising waste and increasing recycling, and a rise in financial investment and job creation in line with greener business strategy. (European Commission, 2018).

With eco-innovation also comes a key chance for SMEs to capitalise on their flexible nature and role within the market and position themselves as key providers of increasingly valuable green products and services in coming years. This type of innovation can create a ‘double dividend’, benefitting both businesses and broader society. For example, by developing a more energy-efficient manufacturing process, a company can help reduce carbon emissions while also making a saving on its own energy costs. Eco-innovation may be motivated by cost savings but also by a desire to reposition a company in the market, helping them to become more competitive, and perhaps open up new market opportunities, while also helping consumers to reduce their environmental impact. As one example, a cleaning service may decide switch to using plant-based cleaning products in the hope of realising a price premium from more environmentally conscious customers.

However, with diverse businesses and industries come diverse drivers and barriers. SMEs face a number of hurdles when considering eco-innovation; many of these relate to their size and comparative lack of resources, funding, personnel, expertise, and financial stability compared to larger companies. SMEs differ radically in terms of how open and able they are to engage with eco-innovation. While many SMEs are taking action to become more resource efficient, to participate in green markets, and to engage with the circular economy, many are not, and they are generally less likely to do so than larger companies. The types of eco-innovation seen in SMEs are considerably diverse, and vary by region, company size, and industry (European Commission, 2017b).

A number of actions — both ‘hard’ (i.e. financial) and ‘soft’ (i.e. non-financial, such as advice, training, networking) — could assist SMEs in overcoming the barriers they face, and help them to make the most of the innovation opportunities afforded to them by the transition to a greener economy. Solutions promulgated by public policies can also play a key role in enabling SMEs to create a ‘double dividend’ through eco-innovation. This Future Brief presents some of the latest research, evidence and trends, seeking to understand which particular measures can best help SMEs to act on their key drivers, overcome their key barriers, and innovate towards more sustainable, resource-efficient, eco-friendly business.
Section 2. Barriers and drivers for the adoption of eco-innovation

SMEs face a number of drivers and barriers — explored in this section — regarding how efficiently they use resources, the array of green products, services, or production processes they develop, and their activities relating to the circular economy (European Commission, 2017a).

The effects of these vary due to factors such as firm size, age, industry sector, and openness to, and capacity to engage with, eco-innovations, leading to differences in the pace and extent of eco-innovation across the SME population.

BOX 5. Barrier or driver? SMEs and ‘creative destruction’

The “process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.” (Schumpeter, 1942)

Firms pursue innovation to improve their performance — both financial and operational, but innovation can also be part of a larger dynamic process. The theory of creative destruction assumes that long-standing arrangements and assumptions must be destroyed to free up resources and energy and make way for innovation.

Innovative activity is important to both incumbent firms and newcomers in the market (Mount, 2012) — and SMEs that grow have a huge impact on many aspects, from competition and innovation to employment and wages (OECD, 2018).

SMEs that grow and innovate can push markets and other firms to invest and upgrade, increasing overall productivity and innovation — and, occasionally, providing the triggers that will render existing companies obsolete.

Much dynamism in the SME sector comes not from existing companies, but from the distinctive nature of new market entrants — entrepreneurial start-ups — which experience high rates of growth but also low survival rates. Periods of accelerated growth come and go within the lifecycle of an enterprise, with the most dynamic firms growing and shrinking over time in line with their innovative activity; most of the growth for new market entrants occurs within the first two to three years. While young SMEs that scale up represent just a tiny minority of all start-ups, they offer a “key source of radical and disruptive innovations” and disproportionately create jobs in the market (ibid). For example, while on average only 4% of micro-sized start-ups grow in this way, they contribute to the creation of between 22% (The Netherlands) and 53% (France) of jobs in their category.
“A dynamic distribution of firm growth is linked to innovation... as it reflects a business environment where firms experiment with new projects, scale them up when successful, and are able to back track and shrink when unsuccessful” (ibid; Bravo-Biosca, 2010). SMEs and especially new market entrants are often able to be more flexible than larger and established firms; this flexibility to grow and shrink enables SMEs to play a part in an evolutionary process of ‘creative destruction’, creating disequilibrium in the market and profiting from new opportunities.

2.1 Barriers to the adoption of eco-innovation

Eco-innovative activities span multiple areas, including resource efficiency, greening, and the circular economy. SMEs experience many barriers and misconceptions that block or slow their adoption of sustainable practices and pursuit of green business opportunities. These can often be related to their size: resource constraints, skill deficits, and knowledge limitations being key examples.

There is some evidence to indicate the relative importance of barriers that SMEs face. In the Flash Eurobarometer Survey FL456 (European Commission, 2018b), lack of knowledge about funding opportunities was seen as a key barrier. The majority of SMEs were unaware of financial incentives through government programmes for activities related to the circular economy, and only roughly one-third of SMEs are aware of at least one kind of alternative financing — such as green banks, the capital market, crowdfunding, risk/venture capital, peer-to-peer lending, and business angels — available to them (European Commission, 2017a). The larger the SME, the less likely it was to have encountered difficulties in accessing finance related to the circular economy. For SMEs that had not yet pursued any circular economy related activity, key barriers included a lack of clear ideas about costs and benefits or improved work processes; lack of clear ideas about the investment required; lack of expertise to implement activities; difficulties accessing finance; and the cost of meeting regulations or standards.

SMEs overall most often responded to say they did not encounter any difficulties setting up resource efficiency actions (37%), although there was also considerable variation across Member States. In addition to complex administrative or legal procedures, other key issues that SMEs experienced include: cost of environmental actions (24%); difficulty to adapt environmental legislation to company (22%), lack of specific expertise, technical requirements of legislation not being up to date, and difficulty in choosing the right actions for their company (all 20%).

To compare, key issues that arose for SMEs undertaking activities related to the circular economy, surveyed in the Flash Eurobarometer 441 (FL441) 2016, on SMEs and the Circular Economy, included complex administrative or legal procedures (33%); the cost of meeting regulations or standards (32%); difficulties accessing finance (27%); and lack of expertise (22%) or human resources (21%). The most-reported barrier was the complexity of administrative and legal procedures, suggesting that this is a key area where barriers could be lowered — although the variety of responses suggest that knowledge could be shared between jurisdictions on this matter.

The OECD (2018) notes that some SMEs report an unawareness of the financial opportunities available to them, and that “there is a widespread misperception that protecting the environment is associated with technical complexity, burdens, and costs … [this and other barriers] prevents firms from acting upon win-win opportunities, [and] often leads to SMEs being risk-averse and less willing to invest in new technologies, partly because of uncertainty about the payback period”.

However, the Flash Eurobarometer 456 survey (FL456) does not strongly note the same conclusion; it does, however, reinforce the importance of financial incentives in supporting SMEs to pursue actions related to greening and resource efficiency (European Commission, 2018b).

3. There is evidence that lack of access to appropriate external finance can act as a barrier to growth and innovation in SMEs, and that this constraint is most commonly reported amongst smaller and younger firms that often lack access to internal sources (Hall et al., 2016).
4. % of 7,771 SMEs that had undertaken at least one circular economy activity.
Barriers to successful eco-innovation can also be internal or external to a company. Internal barriers include ‘innovation management capacity’, including notably a mismatch between the general development strategy of the enterprise, the level of ambition and the design of the concrete project; insufficient resources are made available and poor project management leads to delayed impact. External barriers include unpredictable or unstable policy, and a lack of external sources of knowledge and information. This latter barrier is perhaps due to the suggestion that eco-innovation relies more on important external sources of knowledge than other innovations do, according to Pinget et al. (2015) in their study of 435 French SMEs.

“Environmentally innovative SMEs perceive knowledge barriers as more intense and more numerous than technologically innovative SMEs, possibly due to the higher level of complexity and novelty of the knowledge required to innovate” (Pinget et al., 2015).

Szabo et al. (2017) define the internal barriers to eco-innovation in more detail, as shown in Table 1.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Advanced lead-acid</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of time to investigate issues or locate support or tools</td>
<td>Beliefs that SMEs have a low environmental impact and thus have no issues to consider</td>
<td>Low awareness of environmental legislation</td>
</tr>
<tr>
<td>Severe time pressure in small enterprises</td>
<td>Mismatch between beliefs and action: positive attitudes towards the environment do not translate into action</td>
<td>Low awareness of support organisations and information sources</td>
</tr>
<tr>
<td>Lack of resource allocation to address environmental issues</td>
<td>Perception that the environment has no relevance to the business environment</td>
<td></td>
</tr>
<tr>
<td>Lack of investment in training</td>
<td>Skepticism about the potential cost-saving and market benefits</td>
<td></td>
</tr>
<tr>
<td>Cost constraints on investment</td>
<td>Short vs long-term business planning: Beliefs that the costs of eco-friendly measures arise quickly, while benefits accrue slowly</td>
<td></td>
</tr>
<tr>
<td>No employee allocated responsibility for environmental issues</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Internal barriers preventing SMEs from adopting environmental improvement measures (based on Szabo et al., 2017).
2.2 Drivers towards eco-innovations

A review of the literature on firm-level drivers of eco-innovation adoption in SMEs (del Rio et al., 2016) showed that regulation was generally found to be a statistically significant determinant of eco-innovativeness (a finding also backed up by studies from He et al., 2018; Antonioli, Mancinelli, and Mazzanti, 2013). Eco-innovators were found to respond to regulatory stimulus more than general innovators, and regulation had a more definite effect than subsidies. Other key determinants in del Rio et al. (2016) were size (a larger size positively affects the eco-innovative behaviour of firms), cooperation and environmental management systems. When considering whether demand from consumers is a relevant factor in eco-innovativeness, del Rio et al. found that there was mixed evidence, which they attribute to, among other things, different definitions of the demand-pull variable in different studies, and different environmental consciousness of consumers in different countries. The evidence on cost savings was also mixed — found to be statistically significant in some contexts, it was not in others. However, the researchers posit that cost savings could be a major driver towards innovation in general, and therefore should not be considered as specific to eco-innovation.

The study authors also make clear that eco-innovativeness can also be expected to depend partly on regional and sectoral factors, and that, although econometric studies allow for generalisations, they should be used cautiously due to biases. They also identify the following avenues for future research.

1. The construction of an integrated theoretical framework which coherently merges the insights from different approaches to provide a more complete picture of the drivers to eco-innovation and their interactions.

2. Effect of complex variables on model results, such as international factors, in-house knowledge, customer relationships, financial reserves, physical resources, reputation, motivation, attitude (top-management commitment), skillful human resources, personal contacts and networking. Highly imperfect proxies should be avoided.

3. Effect of demand-pull (from consumers, the market) or cost savings on eco-innovations.

4. Understanding the effect of different eco-innovation and eco-innovator types on eco-innovativeness (e.g. process vs product; new-to-the-market vs new-to-the-firm; old vs new firms).

5. Studies analysing the drivers to eco-innovation vs. general innovation.

6. Analyses in other developed country contexts and in middle-income and developing countries are lacking, as current analyses mainly concentrate on Western Europe, especially Germany and Spain.

7. The range of microeconometric methods being used could be expanded beyond logit and probit to tobit models (which can take better account of data when it is censored in some way) and beyond cross-sectional analysis to panel (or longitudinal) analysis.

8. The influence of the position of the firm in the value chain.

SMEs are highly diverse — in scope, type and circumstance — and so are their drivers. In order to provide a more differentiated look at SMEs according to their industry, another systematic review (de Jesus Pacheco et al., 2016) focused on the eco-innovation determinants of manufacturing SMEs and conducted a systemic mapping exercise to show the relationship between the determinants. It found that internal context, particularly the availability of resources
(people, technology, knowledge) was cited most frequently as a determining factor. The researchers suggest that this is related to the importance of investment to eco-innovations, expressed as qualified people or new technologies — but that SMEs are often constrained in this regard. The second most cited findings was external context, particularly government policies supporting eco-innovation, and the researchers suggest that laws or subsides for innovation and environmental actions are important elements that can mitigate the usual lack of resources characteristic of manufacturing SMEs. Other key determinants identified were top management perception of the relevance of eco-innovations, appropriate technological advice, and an adequate structure to support eco-innovation, which might involve: product and process methods; organisational structure and management support; supplier and customer relations; and an R&D department focused on sustainability/eco-innovation.

Despite this diversity, drivers can be broadly identified across four key areas that involve economy, environment, society, and politics in varying amounts, with different drivers influencing different types of innovation:

- **Supply** (of raw materials, energy, labour — and the price and availability of these; supply of incentives such as subsidies);
- **Demand** (business to business, business to consumer — supply chain pressures from large customer firms, or from end consumers; demand-pull from environmental regulations);
- **Intrinsic motivations** (staff turnover, internal attitudes, the values of owners and managers — this is important in firms that consciously position themselves as 'eco' ventures, but also in older, established firms when a younger and 'greener' generation takes over a family firm, for instance).

Public policies such as new regulations or subsidies can affect both supply conditions and demand conditions, as can economic and political events (e.g. a recession or a war/conflict). Intrinsic drivers will be influenced by an interplay between the personal values of owners and managers, organisational values or mission that may have developed over time, and acquired capabilities.

A company’s eco-innovation activities are also driven by its strategy — its approach to achieving a certain market position — and their success relies upon the internal management of innovation processes. The role of eco-innovation can manifest very differently in each of these envisaged market positions. The scale and ambition of eco-innovative activities could be seen to align with a company’s envisaged market position as follows:

- Companies that are less ambitious in terms of eco-innovation may only be reactive to upcoming legal requirements, and introduce ‘off-the-shelf’ products or processes for compliance.
- An eco-innovation ‘follower’ might be motivated by an interest in avoiding any loss of market shares due to changing client preferences, or wish to maintain competitiveness by increasing efficiency and thus lowering costs.
- A **strategic** eco-innovator (‘frontrunner’) might pro-actively develop new technologies, management practices, or business models in order to achieve a price premium in an existing market. Prizes continuous innovation — although does not aim to disrupt the whole market.
- **Disruptive** eco-innovators may undertake activities in order to disrupt the market — to broaden, change, and reformulate existing market structures (Mount, 2012).
• Normally, market disruption is associated with an ambition to achieve a dominant market position for financial gain; however, in the case of eco-innovation, some entrepreneurs are intrinsically motivated by a desire to change market structures, not primarily for their own financial gain but for non-financial objectives (such as environmental protection, pollution reduction, fair trade and working relations, inclusiveness, community development and so on).

• Cost savings can also act as a driver of eco-innovative behaviour in companies, and the role of cost savings can also vary by envisaged market positioning (see Table 2). It is important to note that one SME might move through several of these stages in their business lifetime; their chosen positioning strategy might be dependent on the current phase in their product’s lifecycle, for example.
<table>
<thead>
<tr>
<th>SME strategy (envisaged market position)</th>
<th>Key drivers of eco-innovation</th>
<th>Role of cost savings in eco-innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive</td>
<td>Introduction of legal requirements — driven by compliance</td>
<td>Cost savings are generally a driver, and also may be a side-effect of compliance with legislation</td>
</tr>
<tr>
<td>Follower</td>
<td>Fear to be left behind and reputational loss. Financial aid for investment.</td>
<td>Has the intention of being eco-innovative by cost-saving. Seeks to imitate strategic or disruptor positions — can do so successfully by squeezing costs and offering cheaper products than competitors. Cost savings may occur via the drive to increase efficiency and retain market share.</td>
</tr>
<tr>
<td>Strategic</td>
<td>Proactive enterprise development strategy. Networking and financial support for research and innovation. Recognition of superior performance through labels and prizes.</td>
<td>Not particularly motivated by cost-saving behaviour during strategic phase — aiming to lead the existing market, and realise a price premium for leadership. Generally aiming to achieve a higher price from a smaller market. An SME may only be able to maintain a ‘strategic’ position for a few years, before ‘followers’ catch up, at which point cost savings may again become an important factor to retain market share for a product.</td>
</tr>
<tr>
<td>Disruptor</td>
<td>Longer-term policies and/or equity funds</td>
<td>Motivated to change complete value chains — cost savings may play one part of the bigger picture.</td>
</tr>
<tr>
<td>Intrinsically motivated disruptor</td>
<td>Mission- or value-based innovation strategy Funds, incentives or interventions that bridge business and social entrepreneurship</td>
<td>Driven by improving public good, environmental and working conditions, not by maximising cost savings</td>
</tr>
</tbody>
</table>

Table 2. Drivers of eco-innovation and role of cost savings according to SME market strategy.
N.B. Table 2 does not represent a strict categorisation — but rather proposes a description of the importance of cost savings and different incentives in different phases of SME product cycles.

The wider context within which business takes place is strongly linked to an enterprise’s ability and willingness to take on eco-innovations. Research shows that high levels of environmental awareness in society are not significant in driving this, however; instead, Garrone, Grilli, and Mrkajic (2017) identify the stringency of associated regulation as the ‘most impactful contextual factor’.

2.2.1 Resource efficiency innovations: do they deliver savings for SMEs?

SMEs vary in their current level of resource efficiency and also in the resource efficiency possible in their type of business. Most service-based SMEs (e.g. management consultants) have relatively low material and energy costs compared to most manufacturers or primary producers (e.g. factories, quarries), though they might find other pro-environmental ways to save money, such as teleconferencing to replace international flights. However, some services can also be quite heavy users of energy and resources (e.g. hotels or hospitals). Overall, material and energy costs represent about 50% of the operating costs incurred by European SMEs (Dobes et al., 2017). A Eurobarometer survey (Flash Eurobarometer 456) of 15 019 SMEs in 2017 reported that at least half of these SMEs are minimising their waste, saving energy, and saving materials, with a proportion also saving water and recycling by reusing waste and material in-house (European Commission, 2018b; European Commission, 2015). 41% of SMEs taking resource efficiency actions decreased their production costs over the last two years — and 4% said the decrease had been significant. The proportion who say production costs have increased has been steadily declining since 2012 (see Figure 2).

The disaggregated survey data reveals further detail:

- large companies are more likely than SMEs to say production costs have decreased (53% vs. 41%) as a result of resource efficiency actions;
- the larger the SME, the more likely it is to say production costs have decreased (54% of medium-sized SMEs say this, compared to 39% of micro SMEs);
- SMEs in manufacturing are the most likely to say resource efficiency actions have decreased production costs (45%), particularly when compared to SMEs in retail (39%);
- SMEs with the highest turnover are the most likely to say resource efficiency actions have decreased production costs (56% vs. 41%-52%);
- the more resource efficiency actions an SME has taken, the more likely they are to say production costs have decreased: 49% that have taken many actions say this, compared to 34% who have taken few actions.
The wider literature on the relationship between resource efficiency and SME economic performance is somewhat mixed, limited and under-developed — although energy resources have had more attention than material resources. When Kounetas and Tsekouras (2010) modelled the overall influence of energy efficiency technologies (EETs) for manufacturers in Greece (although they did not consider firm size) they found that EETs were ‘bad or low quality input’ (in terms of economic performance), but that they positively affect the firms’ technical efficiency. In another study using data from the Spanish and Slovenian subsets of the European Manufacturing Survey, through linear and ordinal regression, Pons et al. (2013) found that the use of energy and material saving technologies did not have a clear and significant relationship with economic performance and energy efficiency, but did have a significant positive relationship with environmental performance.

However, there is some empirical evidence that there can be high cost-saving potentials from resource and energy management. One case study of a German car company found that using a framework to focus managers’ awareness on measurement and visualisation of real-time energy flows triggered company energy and carbon saving of 37% (Richert, 2017). Dobes et al. (2017) point out that existing tools for exploration of resource efficiency improvement potentials have several shortcomings: they are either tool-driven, of a solely qualitative nature or do not address all levels and inputs of a business. These researchers piloted their own tool (the ‘EDIT Value Tool’) in 18 manufacturing SMEs in six Central European countries, with the aim of identifying the most effective resource efficiency improvement potentials in enterprises.

5. www.resourceefficiencyatlas.eu/edit-value-methodology
In one SME in Poland, which manufactured men’s suits, jackets, trousers and coats, the tool helped to identify potential for increasing resource efficiency, especially related to high energy and water consumption due to outdated machinery, poorly insulated buildings and the inefficient behaviour of employees. For example, it was documented that significant amounts of waste and resulting economic losses occurred during the processes of cutting the fabrics into the right shapes. Saving of textile materials also entailed an increase in savings of water.

However, lack of specific data required for the material analysis was identified as the major challenge both for the company and for the consultants, which is a recurrent theme throughout the literature. The researchers noted that internal stakeholders (e.g. the accounting department) may require additional motivation to perform the extra work to provide the necessary information on the basis of available documentation — which provides an example where technical issues and personal and organisational values are intertwined.
The PRESOURCE project, on which Dobes et al. based their tool, found that knowing the costs of raw materials and the amount of water and energy lost in production processes (non-production costs) is a very good driver for SMEs to increase their value through resource efficiency. The project also recommended that SMEs set up resource efficiency baselines by recording performance before and after implementation of an important resource efficiency measure.

2.2.2 Multiple benefits approaches

Another way to promote eco-innovation is to highlight multiple benefits to the business, and hence to enroll a broader coalition of stakeholders into the initiative. For example, the Horizon2020 M-Benefits (Multiple benefits of energy efficiency) project (2018-2021) is seeking to increase uptake of energy efficiency investments by linking them to other core benefits beyond energy-saving, such as improved product quality, enhanced employee productivity, better indoor air quality, reduced costs, and mitigated risk. For example, in the case of an Australian aluminium producer’s efforts to reduce energy demand, MBENEFITS showed they also reduced operator workload and error and improved system stability and reliability, which allowed them to increase production by 3,000 tonnes of aluminium per year and to lower maintenance costs. The increased production had a commercial value of USD 6 million per year (USD/yr) (given a sales price of USD 2,000 per tonne) (IEA, 2014 and https://www.mbenefits.eu/why-multiple-benefits/examples-case-studies-references/).

Another example of a company creating multiple benefits is Metronome, an ‘energy intelligence company’ which has developed low-cost technology which balances demands on the national energy grid during peak times. Initially targeting UK farmers and SMEs, and based on Demand-Side Response (DSR), the business generates live data on their customers’ energy usage, and uses existing power consuming assets, to provide flexibility at almost zero cost. Metronome helps to switch assets on and off at peak times, helping to balance the grid elsewhere, all the while never interrupting supply; a flexibility that reduces the average peak energy prices, resulting in savings for all consumers.

Figure 2. Source: https://www.mbenefits.eu/why-multiple-benefits/improving-competitiveness/
BOX 6.  
Case studies of projects providing multiple resource efficiency benefits

Case box: The UK National Industrial Symbiosis Programme (NISP)

The NISP’s team in south eastern England brought together four companies in a complex collaborative working relationship. This symbiosis delivered 100,000 tonnes of recovered and reprocessed clay and other materials from water company Thames Water’s activities for reuse. This recovered material was used to renovate an old deposition site near London, which went on to generate sales of around €2 million and reduce CO2 emissions by 12,000 tonnes (EIO and CfSD, 2016).

Case box: WRAP UK

WRAP UK, a resource efficiency programme, managed to generate cost savings of around £400 million per year by improving resource efficiency via their Halving Waste to Landfill agreement. The programme introduced green innovations to the construction sector between 2008 and 2012, bringing together 800 businesses and preventing five million tonnes of waste from reaching landfill every year (WRAP UK, 2013).

BOX 7.  
Water and sewage innovations in Poland

In 2019, Poland ranks among the countries with the lowest levels of eco-innovativeness in the EU, alongside Bulgaria, Cyprus, and Estonia — according to the Eco-Innovation Observatory’s European eco-innovation scoreboard.

Flash Barometer survey 315 (EC, 2011) found that Polish SME respondents regarded lack of funds, uncertain market demand and technical lock-ins as key barriers, and the following pro-eco-innovation incentives as crucial: predicted increase in the energy costs (54%), good business partners (43%), high, up-to-date energy costs (43%), high, up-to-date sources costs (42%).

EU funding for eco-innovation has facilitated numerous investments and developments in the country’s water and sewage enterprises in recent years (Ociepa-Kubicka and Pachura, 2017), and aimed to break down the barriers facing Polish SMEs. Resulting innovations have covered technologies, products and organisational structures, and ranged from new methods of treating sewage to the use of new eco-friendly plastics to the introduction of training programs to create effective, functional teams.
Case studies: Two enterprises in Częstochowa

Company Wastewater Treatment Plant

This plant won the Jurassic Product of the Year award in 2015 for the modernisation of its treatment plants and pumping stations, an overhaul that had both economic and environmental impacts. Patented Biogradex technology was used to reduce the amount of nitrogen and phosphorus in treated wastewater; sewage disposal was redeveloped; the mechanics of the treatment plant were modernised, and sand recovered from the sandstone during this process used to make concrete roads and goods; and the central station for pumping sewage was modernised, with old, energy-intensive emergency pumps replaced by new energy-efficient equipment.

Water and Sewerage Company

This company was nominated for a European EMAS Award in 2015 for using ‘their own research and know-how [to] contribute to developing reference materials for the entire region and country’ (EMAS, 2015).

Recent efforts to reduce water losses in the public water network improved the company’s environmental activity efficiency. This was achieved using innovative methods of pressure management, and made use of new technology for active fault detection and dynamic pressure control.

When asked in FL456, nearly two-thirds of SMEs report being satisfied by the public support for their development of green goods or services. However, the majority of SMEs offering green products or services self-fund these (61%) and rely on their own technical expertise (58%), with under a third using external support. When asked what measure would best support SMEs in a) launching a range of green products and services, or b) expanding the green products and services they currently offer, SMEs indicated that their priority would be financial incentives for either developing existing products, services, or production processes (45%), or for launching them (28%). The proportion of SMEs identifying this as the most helpful factor has increased since 2015, indicating a growing need for such support (European Commission, 2017c). SMEs mostly indicated that grants or subsidies would help them most in being more resource efficient (36%).  

6. % of all 12 907 SMEs surveyed.
Beyond financing, more than 1 in 5 SMEs thought consultancy on how to improve resource efficiency (23%); demonstration of new technologies or processes to improve resource efficiency (22%); advice on funding possibilities and financial planning for relevant investments (22%); and better cooperation between companies across sectors to enable the development of new processes to reuse waste and by-products (20%) would help their resource efficiency efforts. Other elements mentioned included clearer rules on the use of secondary raw materials; a case study database to show the benefits of resource efficiency for companies; and a tool to self-assess one’s resource efficiency with respect to others (European Commission, 2017c).
Section 3. Accelerating eco-innovation: data-led and organisational solutions

There has already been some progress towards eco-innovation in the EU: for e.g., according to the EU Commission’s 2017 Eurobarometer 441 survey on European SMEs and the circular economy, almost three-quarters of SMEs in the EU (73%) already undertake some kind of activity related to the circular economy, within their current policy/legal/economic contexts. These activities included replanning their use of water (19%), using renewable energy to some degree (16%), re-planning their energy usage to minimise consumption (38%), redesigning their products and services to minimise their use of materials or use recycled materials (34%), and minimising their waste by reusing, recycling, or selling waste to other companies (55%) (European Commission, 2017).

However, there is more to be done. Section 4 will concentrate on two areas — data-led and organisational solutions. There are a range of technological innovations and data-led solutions that have been proposed or tested by researchers to overcome barriers to eco-innovation in SMEs. These can range from diagnostic tools, to information management systems, to monitoring and modelling to smart technology or AI. Underpinning and overlapping with such technological solutions are the organisational solutions that enable or frame the development of new technologies. To follow are two sections presenting evidence for combined solutions to lower barriers and increase drivers, which fall roughly into two categories for the purposes of this brief: data-driven solutions and the broad category of organizational and policy approaches.

3.1 Data-led solutions for eco-innovation

Digitisation and smart technologies can be seen as both a key driver for eco-innovation and a means by which it can be delivered. This section reviews several data-led initiatives that may be of particular relevance to European SMEs. Though they are unlikely to be applicable to many smaller firms, data-led eco-innovations could help a growing number of SMEs to address persistent business challenges (e.g. uncertain market demand, lack of expertise, support or tools) (Issa, Lucke, and Bauernhansl, 2017), while also opening up new opportunities to improve their environmental performance.
ECO-INNOVATION IN SMES

Some of the innovations below fall under the term ‘Industry 4.0’.

First proposed in relation to the German economy in 2011, the concept of Industry 4.0 aims to facilitate automated, efficient, productive, digitised, adaptive, and integrated methods and innovations for manufacturing and production, incorporating novel and dynamic technologies to optimise data sharing, communication, knowledge management, and interactions between humans and machines (Roblek, Meško, and Krapež, 2016; Lu, 2017). It is linked to innovations such as the Internet of Things (IoT), cloud-based manufacturing, Radio Frequency Identification (RFID), and Enterprise Resource Planning (ERP). Such innovations can improve resource and energy efficiency, for example via better management of production and environmental systems, eco- and resource-efficient design, and new business models (Lu, 2017). Industry 4.0 was originally conceived and applied to manufacturing, but this scope has since widened (i-SCOOP, 2019).

Key examples of innovation types connected to Industry 4.0 include automation — for example, automated data transfer along the entire value and production chain, or automated interactions between an enterprise and its clients — personalised modes of production, the gathering of real-time data from product usage, and a shift to digital supply chain models (ibid). Industry 4.0 has a potential role to play in connecting SMEs to the circular economy, by helping businesses track their activity and waste in new, accurate, efficient ways; bringing value and decreased errors via developments in robotics; and extending the lifespan and reducing the maintenance needed for their products via innovations such as 3D printing or additive manufacturing.

“Where Industry 4.0 and the circular economy meet,” write PWC7, “the waste of value is prevented, and the value of waste is recovered.”

Uptake of ‘Industry 4.0’ solutions by SMEs is subject to the same barriers as other technological innovations and could be more effective if working in tandem with other drivers.

3.1.1 Hybrid cloud computing and management

Hybrid Clouds combine on-site, public, private, and third-party services into a single cloud computing environment (cloud computing being the use of remote online servers to store, manage, and process data). Hybrid clouds allow data and application sharing between geographically distinct users, and offer SMEs a new Information and Communication Technology paradigm; they ‘couple the scalability offered by public Clouds with the greater control supplied by private ones’ (Quatari et al., 2013) with

a number of possible energy-saving mechanisms. This has the potential to improve internal and external enterprise cooperation, reduce costs, and improve the security, privacy, and accessibility of data (Vasiljeva, Shaikhulina, and Kreslins, 2017). Associated Cloud Management Software also offers potential perks for SMEs; software packages such as Computer-aided engineering (CAE), Product Life Cycle (PLM), and Open Innovation (OI) tools and platforms offer ‘innovation tools for product development and manufacturing processes in a sustainable and affordable way’ (Rocha et al., 2016).

3.1.2 Integrated digital systems and networks

Integrating various data, software, and value-added processes into intelligent networks and cooperative systems could help SMEs with limited R&D resources to overcome hurdles in problem solving, reduce their resource use and impact on the environment, and become more energy efficient, cost-effective, flexible, and creative. An example of this is IT-enriched production, which would help Smart Factories (factories with inbuilt self-optimisation, automation, and adaptation mechanisms) evolve into Linked Factories (‘factories with task-specific interlinked software solutions’) as long as new software could integrate into existing infrastructure with minimal expenditure and disruption, suggest Schlegel, Langer and Putz (2017).

3.1.3 Diagnostic tools for eco-innovation

Key identified barriers for SMEs on the uptake of eco-innovations are lack of time, resources, and knowledge. Digital tools that help SMEs calculate the cost, benefit, effectiveness, and necessity of an eco-innovation, and the associated investment and expertise required, are thus important.

One possible methodology for SMEs looking to overcome these barriers is Life Cycle Assessment (LCA), which offers an efficient way to evaluate one’s impact from beginning (extraction) to end-of-life and thus improve knowledge (Testa et al., 2017). A 2015 study assessing the relevance of LCA in the production of an automotive part found the process to be significantly improved by eco-innovation (in this case, a plasma-enhanced chemical vapour deposition treatment), and showed that LCA is increasingly relevant as a decision-making tool in SMEs (Simboli, 2015). The EU platform on LCA, established to facilitate communication on and exchange of lifecycle data and harmonise existing LCA initiatives, is in agreement about the usefulness of LCA, and concluded that LCA “provides the best framework for assessing the potential environmental impacts of [currently available] products”. However, the platform has identified a need for more consistent data, and a consensus on how to actually go about implementing an LCA (European Platform on Life Cycle Assessment, 2016).

Diagnostic tools to identify areas of potential improvement are key, especially regarding the practical implementation of eco-innovation (Cheng and Shui, 2012). A 2017 study applied a tool — the ‘Eco-innovation Diagnosis and Implementation Tool for Increase of Enterprise Value’ — to review and identify potential resource efficiency improvements for a number of enterprises in Central Europe (Dobes et al., 2017). While SMEs were generally positive about the tool’s holistic approach, they struggled with the amount of time and external assistance needed in its implementation. They suggested making the tool easily understandable at a glance, automating its usage to a higher degree, and offering a longer period of external support with associated future planning in collaboration with an expert. This ties in with a number of the aforementioned barriers often reported by SMEs (resource and cost limitations, lack of expertise and personnel).

To be effectively applied to SMEs, resource efficiency tools should cover social, economic, environmental, and technological concerns; assess all levels of an enterprise’s management and not simply be a ‘scaled-down’ version of a tool for a larger company; include diagnostic and later assessment phases; and take a holistic yet straightforward approach (ibid; Richert, 2017).
3.1.4 Better modelling and data on resource use and energy flows

More information is needed about the energy and resource use and flows throughout many SMEs; collecting high-quality data in this area is a key step in aligning policies with real-world investment decisions (Viesi et al., 2017).

Ways to do this include with the installation of energy tracking/metering technologies to enable Smart Grids (energy networks that adapt supply and react according to real-time digital ICT monitoring of energy use) (Richert, 2017). Such grids offer electricity suppliers an accurate picture of energy flow, while engaging customers with demand-side management and creating opportunities for consumer incentives and 'contributing to wider grid decarbonisation' (Rawlings et al., 2014). An identified barrier to SMEs adopting eco-innovations relating to energy flow and use was low managerial awareness and knowledge; Smart Grids, or other such visualisations of flows, offer a promising way to overcome such hurdles (Richert, 2017).

3.1.5 Smart technologies

Warren (2017) suggests that SMEs could potentially save 17% of their annual energy expenditure in the UK market via uptake of smart technologies ('the use of digital and communications technologies based on signals') and micro-generation ('technologies that produce heat or electricity from a low-carbon source and are <100 kW'). Such technologies include fleet management, integrated building management systems, and smart meters; these three innovations in particular offer the greatest potential savings to UK SMEs: a total possible annual energy saving of ~£7.5 billion from a total spend of ~£49.7 billion. Such estimations should, however, be qualified by the dynamism of energy prices, which are very responsive to supply and therefore subject to change. Barriers include initial cost and technical feasibility, with drivers comprising ethical reasons, feed-in tariffs, and the ‘green’ marketing potential of micro-generation (PINE, 2015).

While the measures listed in this section may offer some SMEs a way to overcome barriers to eco-innovation, purely technological solutions are limited in their scope; the variation among SMEs also means that such measures are not applicable to all SMEs. Moreover, the idea that only high-tech companies contribute to Europe’s economy with product innovations has been refuted. The IMP3rove II Study showed that high-tech companies can learn from low-tech companies in a raft of ways, including on how to leverage service innovations, organisational or business model innovations to strengthen their competitive position and achieve sustainable and profitable growth (IMP3rove, 2011).

3.2. Organisational solutions for SMEs

Technology will only deliver eco-innovation when it is complemented by a range of organisational and, in some cases, social interventions. For example, an audit of 140 companies across 20 EU member states, found that ‘hard’ measures for improving energy efficiency — optimising electric drives and compressed air mechanisms, automating control of lighting and cooling, thoughtful purchasing — were held back by organisational factors such as poor communication and information exchange, lack of knowledge and support, as well as economic viability (PINE, 2015).

This section reviews a number of organisational solutions that can help overcome barriers to eco-innovation and encourage its uptake. These include: knowledge sharing, networking and clustering, environmental management schemes, green public procurement, and education.
BOX 9
There’s an app for that... smart specialisation in Slovenia

RecAPPture case study on recycling discarded wood

*M SORA, a window manufacturing company in Ziri, Slovenia, developed* a mobile and web application to map and monitor resource flows, to help them to turn waste materials into raw materials for manufacturing, in line with their eco-innovative approach and progress towards the circular economy.

The app connects users who want to get rid of discarded wood with the company, who recycle the wood for the production of wooden windows. RecAPPture, a multidisciplinary project, brought together experts from the University of Primorska, InnoRenew CoE and M SORA, collaborated to apply for a public fund to develop the app. It also involved the students of the University of Primorska (FAMNIT) and the University of Ljubljana (ALUO).

*Smart buildings and homes, including the wood chain,* is one of the priority domains in Slovenia’s *Smart Specialisation Strategy,* which is a plan to boost innovation potential to facilitate the shift to a high-productivity economy and to strengthen interactions between the business community, knowledge institutions, other players and the state.

Materials recycling and recycling processes formed part of the EU’s eco-innovation initiative, which aimed to bridge the gap between research and the market under the Entrepreneurship and Innovation Programme (EIP). Current information about forms of funding available for eco-innovation available on the EU’s *Eco-Innovation Action Plan* pages.

3.2.1 ‘Open’ innovation: knowledge sharing, cooperation, networking and clustering

SMEs have flagged the lack of internal environmental or technical knowledge needed for eco-innovation, including knowledge of the issues, risks, and potential benefits of eco-innovation, and an understanding of which measures to implement. Interacting with other actors and SMEs as part of ‘open innovation’ — ‘the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for the external use of innovation, respectively’ (Chesbrough, 2006) — can help to overcome this barrier (Klewitz and Hansen, 2014; Dangelico, 2016).

*Open innovation* relies upon means such as knowledge-sharing networks, business cluster membership, meetings, conferences, and competitions. Cooperation can be with other businesses (including clients and suppliers), research organisations, and public authorities. External knowledge can take a variety of forms, such as knowledge acquired through contractual agreements, inter-organisational relationships, alliances, and joint ventures (Ben Arfi, Hikkerova, and Sahut, 2018). Additionally, social media and collaborative websites have substantially eased the difficulty of cooperation between businesses, even with ‘unlikely’ collaborators.
When companies, competitors, universities, and research institutions cooperate, levels of investment in energy efficiency rise (Solnordal and Thyholdt, 2017). This concept could be realised via measures such as the networked enterprise, a short-term partnership formed between multiple organisations that enables the reciprocal flow of services, goods, and assets without the restrictions of organisational size or structure. SMEs can suffer competitively due to their smaller economies of scale; networked enterprises thus offer a way to overcome size-related issues. This kind of collaborative working could utilise Industry 4.0 software solutions for well-maintained, secure, interoperable networks, intelligently combined value chains, and robust ICT ecosystems and infrastructure, say Lukac et al. (2017).

Research suggests that there is demand for increased knowledge sharing. Of 601 European and American SMEs in the accommodation and food provision sector, 30% said they would benefit from consultancy on how to improve resource efficiency, over one-fifth would like demonstrations of new technologies or processes, and a slightly smaller proportion desire either greater cooperation between entrepreneurs or a database with case studies showing the benefits of adopting resource efficiency measures (Becken and Dolnicar, 2016).

Technological collaboration networks, in which two or more firms agree to share technological resources, are particularly effective during weak economic periods, indicates one study of SMEs in Spain (Fernández-Olmos and Ramírez-Alesón, 2017). Policymakers should thus place more emphasis on enabling these networks during unfavourable economic periods (ibid). In periods of recession, such as the global crisis of 2008-2011, competition strongly increases between firms, and collaboration networks represent an attractive opportunity to share innovation costs and resources (which, in turn, increases innovation success). SMEs are more likely to be influenced by the wider economic environment than large firms, given that weathering weak economic periods requires substantial resources. Collaboration network policies may be more effective if they are targeted at younger SMEs, which are more flexible than older firms (ibid).

Collaboration between SMEs and larger clients is a potentially important way of knowledge sharing. A study of Denmark’s offshore wind farm industry (Brink, 2017) indicated that it is beneficial, but difficult, for SMEs in the sector to move away from an ‘arm’s length’ approach to working with large enterprises — as short-term contractors with specified goals, for instance — towards more long-term collaboration on equal terms. This form of collaboration depends strongly on building long-term relationships between firms. The study suggests that governmental authorities should support opportunities for SMEs and larger firms to meet and build relationships. An example of this is the European Cluster Observatory,9 which facilitates practical cluster policymaking so that businesses can make better use of innovation, and aims to support regional structural change and the development of emerging industries via cross-sectoral collaboration.

Eco-innovation competitions also allow best practice to be shared, while encouraging competitiveness and fostering good relationships between organisers (e.g. public authorities) and businesses. As an example, Ball et al. (2018) discuss the merits of the VIBES10 (‘Vision in Business for the Environment of Scotland’) awards for eco-innovative businesses of all sizes. Led by the Scottish Environmental Protection Agency (SEPA), this plays a key role in changing businesses’ perceptions of the EPA from ‘policemen’ to collaborators in eco-innovation. The event attracts media attention which helps promote — and ensure the success of — the innovations featured.

Although partnerships between diverse organisations can lead to innovation benefits, it can be counteractive to take on too many partners due to the limited resources available for managing these relationships. For instance, a study of large and small businesses from 11 EU countries found that the benefits of partnering on innovation drop beyond
eight partners (Ghisetti, Marzucchi and Montresor, 2015). A study of UK micro-businesses found that benefits drop beyond five partners (Hewitt-Dundas and Roper, 2018). There may, therefore, be an important intermediary role for public authorities to play in helping SMEs select appropriate partners.

Although knowledge networks support eco-innovation, studies show that they are not enough to overcome financial barriers alone. Policies that encourage research networks must thus go hand-in-hand with measures to provide financial support, suggest Cecere, Corrocher, and Mancusi (2016).

Businesses within a given sector often cluster together or geographically near to other partners — such as universities — to facilitate knowledge sharing. This is an important means of supporting eco-innovation, show Pinget, Bocquet, and Mothe (2015) in their study of French technological SMEs; clusters enable the sharing, organisation, and management of knowledge and information. In general, clusters and cluster policy provide businesses with the resources and framework they need to innovate — but the success of innovative activity within clusters depends on the industry, financial situation (high-technology clusters appear to be better than more traditional industry clusters at attracting private funding, for example), management team, support services, and long-term commitment (Uyarra and Ramlogan, 2012).

Alongside membership in a cluster, a company’s ability to combine internal and external knowledge and take full advantage of its environment for innovation, i.e. its absorptive capacity, is important, say Crescenzi and Gagliardi (2018). Due to their limited resources, SMEs often have low absorptive capacity for eco-innovation. Studies have highlighted various qualities that enhance absorptive capacity, such as a culture in which employees are willing to learn from one another; strong awareness of ecological issues among leaders (Ben Arfi, Hikkerova, and Sahut, 2018); good use of IT; and well-trained managers who are better able to take risks, analyse the environment, and make changes in the firm (Curado, Muñoz-Pascual, and Galende, 2018).

Intermediary organisations, public or private, were found to be useful in translating abstract sustainability goals into actual business practice. Good examples of intermediaries highlighted by Crescenzi and Gagliardi (2018) include the Enterprise Europe Network11, which supports the development of innovation partnerships, and the UK’s Central Technology Belt12, which brokers partnerships between local firms.

A study of open innovation among SMEs in Cyprus concludes that geographical proximity to collaborators is critical, but that SMEs also use international collaboration to access more advanced knowledge and technology that is unavailable locally. The study recommends that policymakers promote international partnerships and incentivise companies with international partners to share their knowledge nationally.

3.2.2 Technical assistance and advice

While SMEs and the private sector typically declare the scarcity of public financing support, including from public development banks, funding sectors indicate a lack of investment proposals developed at sufficient quality. While ideas may be good, commercialising and bringing such ideas to market remains an issue in European SMEs (Zubaşcu, 2015). Blundel et al. (2018) identify that there could be a lack of trusted organisations and individuals to act as brokers and facilitate the innovation process (including such actions as integrating specialists into a team, mediating between competing SME interests, and translating between academics and practitioners). To tackle this, agencies such as IRENA (the International Renewable Energy Agency13) and the Global Environmental Facility14, and initiatives such as the European Commission’s SME Instrument15, aim to support the development of ‘bankable projects’ by offering technical assistance and guidance to projects that are related to sustainable development and comprise opportunities for commerce and society.

Intermediary consultancy services are essential in triggering eco-innovation in firms with low ‘absorptive capacity’ (capacity to take advantage of their environment for innovation), suggest Klewitz, Zeyen, and Hansen (2012) in their study of German SMEs in the mechanical engineering industry. A study by Hampton (2018) investigating the role of low-carbon advisors for SMEs found that advisors could be more successful if they utilised ‘softer’ skills alongside technical expertise. Rather than approaching businesses with promises of cost savings, instead, utilising environmental messaging focusing on the development of energy audits and technical advice and engaging in values-based discussions to understand energy usage could overcome limitations in SME growth (in the context of environmental objectives). Other initiatives such as the Growing Greener project16 also advocate for a values-based approach, where advisors connect with SME owners and managers through their personal, professional, and organisational values to achieve environmental engagement (Schaefer et al. 2018).

3.2.3 Training, communication and raising awareness

As well as offering incentives, tools, and instruments for eco-innovation, intermediaries and public policies can aim to change SMEs’ perceptions of eco-innovation by raising awareness, providing information, and reducing uncertainty. In a study of French technological SMEs, Pinget, Bocquet, and Mothe (2015) demonstrate that SME managers often lack knowledge of environmental issues and practices, and must perceive viable strategic opportunities in eco-innovation before deciding to engage. In the values-based typology of SME managers outlined in Schafer et al. (2018), the SME managers assumed most likely to be dismissive or sceptical of environmental issues were those mainly motivated by power values (as opposed to a combination of benevolence, achievement and universalism values). The study’s semi-structured interviews evidenced viable strategic opportunities for this group to include those environmental initiatives that increased competitiveness (e.g. wealth and public image), especially in the shorter term, so training that orients around these values may be most appealing for this group.

A review of the barriers and drivers of Industry 4.0 implementation in SMEs and multinational enterprises (Horváth and Szabó, 2019) found that one of the major challenges to the implementation of Industry 4.0 is the lack of skilled workforce — and proposes that there is need to develop innovative forms of training that develop employee competences in a rapidly changing environment.

The cost savings achieved through eco-innovation are an important benefit to highlight to businesses, studies indicate (Becken and Dolnicar, 2016; Triguero, Moreno-Mondéjar, and Davia, 2013). Campaigns, communicators and policymakers must also use language that is relevant and accessible to businesses’ core interests in raising awareness, finds the GreenEcoNet project, which aims to connect SMEs in Europe with the green economy. For example, phrases such as ‘reduce waste’ or ‘reduce costs’, may be seen as more convincing and meaningful than terms such as ‘circular economy’ (Rizos et al., 2015).

A study of the effects of resource efficiency actions on growth in SMEs across the EU (11,336 firms) provides insight into targeted awareness-raising (Jové-Llopis and Segarra-Blasco, 2018). It found that higher investment in eco-innovation led to greater firm growth, especially in new EU Member States. Policymakers should thus raise awareness among SMEs of the advantages of making a minimum level of investment in eco-strategies, the study recommends, particularly given that low levels of investment can actually have negative effects on firm growth.

3.2.4 Financial support, investment and longer-term eco-innovation trajectories

SMEs typically rely more on loans than equity to finance their activities. However, innovation activities with unknown results, such as the development of a new product, can be unappealing for banks to finance, as levels of risk are high and they do not provide collateral (unlike a new machine purchased to expand production, for instance). Attracting investment in eco-innovations can be difficult, as they are often characterised by high technical risk and longer-term returns, report Ghisetti et al., 2017, and are still perceived by investors to be a relatively immature area when compared to other sectors (such as ICT or biotech, which have proven returns). According to this study of manufacturing SMEs in Europe, policy interventions to overcome these barriers should aim to reduce the perceived risks of eco-innovation, emphasise the positive economic returns of their investments, and facilitate SME access to credit.
BOX 10. Intermediaries and the double externality challenge

Eco-innovative activities create two types of externality: a knowledge externality (with consequences for competitiveness and regional employment), and an environmental externality (with consequences for our quality of life). They can bring about a ‘double dividend’ in that they reduce pollution and environmental harm, while also reducing overall system costs by using the revenue they produce to displace structures and taxes that obstruct and slow economic growth.

However, SMEs face difficulties in arguing for either of these public benefits, and often seek external support from ‘intermediaries’ that help them to forecast, gather information, foster partnerships, develop their branding, and more (Kanda et al., 2018). This study explored business support agencies (intermediaries) in regions of Germany and Sweden and found that these agencies largely focus on validating the environmental benefits of eco-innovation, rather than explicitly pushing for policy change.

As such, SMEs would benefit from using different types of intermediary to support eco-innovation and cover both externality aspects (ibid). A similar phenomenon — of intermediaries struggling to connect public and private sectors in an effective, scalable way to facilitate sustainability — has also been observed in the US (Gliedt, Hoicka, and Jackson, 2017).

Research results are mixed on the effectiveness of public financial support — such as subsidies and tax incentives — on eco-innovation, and demonstrate the complexity of the SME policy context. For instance, in a study of over 5000 SMEs across the EU, Triguero, Moreno-Mondéjar, and Davia (2013) found public subsidies to have no effect on eco-innovation. The authors argue that it may be more effective for policymakers to promote environmental management systems, such as EMAS or ISO14001, and to emphasise explorative activities and new organisational capabilities which trigger major changes in environmental performance.

By contrast, public subsidies were found to be the main factor influencing eco-innovative activity in a Spanish study of 4667 SMEs (Melane-Lavado, Álvarez-Herranz, and González-González, 2018). Public subsidies were also an important means of attracting foreign direct investment (FDI) to eco-innovative activities, especially during times of recession, because public financing helps SMEs develop effective systems of protection (e.g. patenting and copyrighting). Furthermore, in a study of accommodation and food service SMEs (601 firms surveyed across Europe and the USA), nearly a third reported that financial and fiscal incentives were key drivers for new resource efficiency measures (Becken and Dolnicar, 2016). Cecere, Corrocher, and Mancusi (2016) analysed the effects of funding on 2082 SMEs from 27 EU countries, and also conclude that public funding supports eco-innovation — but find

17. As described in the Schwartz Value System (Schwartz, 2012).
that **complementary private funds must also be available.** In the absence of internal funding for eco-innovation, public funds are likely to be diverted towards other needs of the firm.

The discrepancies in the research evidence around the influence of public finance may be somewhat due to the fact that subsidies that are promoted to SMEs on purely economic grounds tend to be dropped when funding runs out. However, if fiscal measures are designed with these issues in mind, it is possible to encourage firms to embark on longer-term eco-innovation and greening journeys. These longer-term trajectories are likely to result in much a deeper and more extensive transformations in industry practice and performance. This is the result of a form of ‘Penrosean’ learning (Penrose [1959] 2009). In simple terms, once a business begins to think and act in a ‘greener’ way, it will develop new, greener, ways of working, which in turn opens up new, greener, market opportunities. In other words, there is a dynamic, recursive interplay between a firm’s perceptions of its ‘productive opportunity’ and the services (or capabilities) that it can provide by drawing on available resources (Pitelis 2002). This type of learning can extend beyond the boundaries of individual firms in a systemic process of sectoral innovation, typically located in a regional industrial ecosystem (Best, 2015).

There are two further plausible, possibly connected explanations for the discrepancies around the influence of fiscal measures. Firstly, the real or perceived complexity of the paperwork involved in applying for subsidies, and/or in complying with the relevant terms (particularly for smaller firms that may lack the necessary accounting and administrative capacities) (European Commission, 2017a; European Commission, 2018b) and, secondly, the tendency for policy instruments to be changed, which poses a risk to businesses, and deters investment of time and resources; for example, during the 2009-2016 ‘backtracking phase’ or the withdrawal of the feed-in tariff in the UK (Cherrington *et al.*, 2013; Rydin and Turku, 2019). Effects on uptake from such factors may be cumulative and include the impact of previous policy changes, which may have made business owners and managers more sceptical and risk-averse.
Section 4. Public policy solutions for eco-innovation

Policies to support eco-innovation in SMEs face some of the same debates and challenges as wider innovation policy. However, policies for SMEs need to take account of their particular characteristics, which can often be related to their size—resource constraints, skill deficits, and knowledge limitations being key examples. This section deals with some of the policy considerations in creating a framework favourable to SME eco-innovation, some of the policy solutions that have been proposed so far, some of the difference between countries that might help to inform country strategies.

4.1 Types of policy approach to SME eco-innovation

SME eco-innovation support could fall under several different types of public policies; environmental, fiscal, investment, energy, digital or innovation policies, for example. Policies can try to encourage eco-innovation in several different ways (list influenced by Edler et al., 2013’s conclusions on innovation policy):

a. Augmenting innovation management skills within businesses;

b. Increasing access to finance for eco-innovative activities;

c. Investing in research and innovation or research and development;

d. Enabling access to expertise, and helping SMEs to attract specialist knowledge;

e. Strengthening access to networks to facilitate dialogue and exchange, enable collaborations and enhance system-wide capabilities;

f. Enhancing demand or company awareness of marketable solutions or customer bases;

g. Improving framework conditions for eco-innovation, for example via price signal correction to incorporate environmental costs, regulation, or voluntary standards.

Measures linked to European innovation policies and programmes were shown to successfully increase investment in innovation-related research and development (Edler et al., 2013), but have shown mixed, unclear, or highly variable results in other areas (increasing businesses’ skill bases or facilitating access to expertise, for example). While such efforts have had a strong positive impact on market growth, evidence for their effects on innovation is equivocal—especially for small- to medium-sized enterprises (SMEs), which are likely to face higher compliance and operational costs and may thus be disadvantaged by standards and regulation (ibid).
4.1.1 Public procurement

Research has highlighted the crucial role that public procurement can play in stimulating eco-innovation, by creating a reliable market and overcoming under-investment in innovative goods and activity. A study of 3001 manufacturing firms in Europe and the USA (including but not limited to SMEs) found that firms that had won an innovative public procurement (IPP) contract were 11 times more likely to have adopted sustainable manufacturing technologies, or to plan to adopt them in the next 12 months, than businesses who had not (Ghisetti, 2017).

BOX 11.
Innovative public procurement is...

When the public sector uses its purchasing power to act as an early adopter of innovative services or products that have not yet been made available on a large scale.

One advantage of using public procurement to trigger eco-innovation is that the public sector could provide a strong and stable demand that is large enough to incentivise industries to invest in commercialization, enabling them to bring innovative solutions to the market with the quality and price needed for mass market deployment. It can boost new markets, helping innovative companies reach economies of scale to grow their business.

4.1.2 Environmental management schemes

Voluntary environmental management schemes for certification, devised by a public body (such as EMAS\textsuperscript{19} or ISO 14001\textsuperscript{20}) have been linked to eco-innovation capacity for SMEs. For example, a survey of a ‘low-tech’ sector in Spain (food and beverage SMEs, 301 respondents) found that implementing a quality management system was the strongest driver of eco-innovation, and increased the probability of green innovation by around one-third (Cuerva, Triguero-Cano and Córcoles, 2014).

Environmental management systems are particularly effective in encouraging the uptake of cost-saving clean technologies, shows a study of data from large and small firms in France and Germany by Horbach, Oltra, and Belin (2013). These systems help to fill knowledge gaps within a firm and highlight the cost-saving benefits of energy or material savings, for example.

4.1.3 Targeted and combined policy measures

There are many studies and surveys indicating that flexible policy adaptations to reduce the regulatory burden (‘red tape’) are an important means of helping SMEs to eco-innovate (Calogirou \textit{et al.}, 2010; OECD, 2016) — and many of the studies cited in this brief highlight the idea that SMEs still require more support to overcome such administrative or legal barriers to eco-innovation. Via initiatives such as the EU Commission’s Green Action Plan for SMEs\textsuperscript{21} and the Europe 2020 strategy\textsuperscript{22} for smart, sustainable, inclusive growth and employment, European policy has increasingly aimed to answer this call to support and facilitate the growth and competitiveness of industry, with a focus on innovation in SMEs and a transition towards sustainability, resource efficiency, and eco-friendliness.
However, this idea also seems to disguise a range of underlying conceptual challenges: diverse needs and behaviours to satisfy, a lack of effective business models or appropriate incentives, and a diverse range of location-specific governance structures to understand. The complex, deep-rooted range of cultural, institutional and infrastructural barriers presenting to the SME population require more fundamentally integrated approaches — especially measures that are specific to the industry, location, and general context of a given SME (Blundel et al., 2018).

There are some general conclusions to be made, however. Jové-Llopis and Segarra-Blasco (2018) showed that the impact of different eco-innovation strategies on growth increases with the number of eco-innovation strategies adopted by each firm. Because few European SMEs are able to either invest heavily or undertake multiple eco-strategies at once, the study suggests that policy interventions are needed that aim to raise awareness among SMEs of the importance of a minimum level of SME investment in eco-strategies. These policies could be tailored to the economic and technological specifications of each group of EU countries, and consider not only the benefit of a particular strategy, but the possible synergies and interactions between different strategies, with a view to increasing eco-strategy investment and helping EU firms improve their performance (Jové-Llopis and Segarra-Blasco, 2018). In their study of French and German businesses, Horbach, Oltra, and Belin (2013) recommend that different areas of environmental impact require different policy approaches. Their results suggest that while environmental technology

**BOX 12**

**Mission-led or challenge-led policy?**

Eco-innovation policies can be split broadly into two types: challenge-led or mission-led. Challenge-led innovation is where a nation or region may identify a broad area as a priority, such as inequality or climate change, and then support and fund research and innovation that answers that broad call within individual sectors.

Mazzucato (2017) draws a distinction between challenge-led thinking and mission-led thinking; the latter involves setting the right conditions for different sectors to come together to tackle specific problems (such as reducing plastic waste by a given percentage over a given time period). Rather than ending up as a list of sectors which are individually funded to do their business-as-usual research and development, Mazzucato makes a case that mission-oriented policies should concentrate on creating system-wide, cross-sector transformations. Mission-oriented policy tilts the playing field in the direction of the desired goals, and uses well-defined missions to try to stimulate innovation across several sectors (ibid). Strategic decisions made towards this end could be: supporting cross-cutting technological changes (such as battery storage, or connectivity), enabling collaborations, or setting regulations or taxes that can reward behaviour that is desired and guide the direction of growth (e.g. long-term investment) (Foray et al., 2012).

sectors are more likely to be influenced by the market, efforts to reduce emissions or to reduce noise, water, and soil pollution are more influenced by command-and-control regulations.

There have been suggestions that implementing multiple complementary measures in parallel, rather than individual ones, is the most effective way to foster eco-innovation in SMEs. While there is evidence that targeted and combined measures can be effective, the wide heterogeneity of the SME population — and the numerous barriers they face — does make an approach combining targeted measures challenging to achieve in practice, and there is still much opportunity for progress in the area of context-specific, integrated governance. Two key messages emerge from the research literature: the importance of using a combination of complementary measures, and the importance of targeting measures according to the characteristics of an SME or sector. Such customisation would also likely be useful in industrial sectors, possibly offering business associations and sectoral cluster initiatives the opportunity to play an important role.

4.2 Levels of policy approach to SME eco-innovation

Policies to support SME eco-innovation can be also generated at international, national, regional or municipal levels. City-based greening initiatives can involve SMEs, for example, Ghent’s (Belgium) initiative to implement energy coaching for SMEs in 2014, or Leeds’ (UK) City Region Enterprise Partnership, which provides support and advice for SMEs to become more resource efficient (including possible 50% capital grant funding of up to £10 000 (13 330 EUR)).

At an international level, the EU has worked to increase the growth and competitiveness of industry, a cornerstone of the European economy, since its foundation, and industry is now responsible for the bulk of EU exports and investment in research and innovation (European Parliamentary Research Service, 2018). The European Commission and EU
BOX 13
Examples of targeted policy measures

There have been some examples of tailored approaches to special groups:

• Policy measures may target **ambitious, high-growth, disruptive eco-innovators**. One such approach is InnovFin, financed by the European Investment Bank Group and the European Commission. It provides a range of tailored debt and equity products and financial services, from guarantees for intermediaries that lend to SMEs, to direct loans to enterprises, to technical assistance and broader advice to the market on sustainable/unsustainable investments.

  The measures especially focus on innovative sectors covered by Horizon 2020, which include ICT, medical technologies, biotechnologies, green technologies, nanotechnologies, as well as areas addressing societal challenges such as resource efficiency, bio economy, health and demographics, climate change.

  There have been scarce examples at the Member State level so far, but France has developed bpifrance, which is a public investment bank, targeting companies and offering investment solutions in the areas of carbon-free renewable energies and green chemistry; circular economy (waste recovery, eco-design of products and industrial ecology); smart grids; and vehicles of the future.

• Other tailored approach have been trialled towards **impact driven, intrinsically motivated innovators, including social enterprises**. These companies are not necessarily profit maximising, but prefer to reinvest in a social cause.

  One example approach is taken by the RREUSE association members, which asks EU and national governments to move from just recycling and waste management to putting ‘secondhand first’. [https://www.rreuse.org](https://www.rreuse.org). By concentrating on building their own network of reuse-oriented projects, collectors and campaigners, this approach could escape the logic of traditional business support. Philanthropists are also relevant for this category of innovators, and have been mentioned as a targeted investor group in the new programme for European financial instrument InvestEU ([COM/2018/439 final](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0439)).

  Specific support infrastructures are also developing elsewhere, which could help impact-driven innovators; for example, the global Enactus students network for social entrepreneurship ([www.enactus.org](http://www.enactus.org)), which invests in and guides students to take entrepreneurial actions, or the Impact Hub Global Community, which focuses on building entrepreneurial communities for impact at scale ([https://impacthub.net](https://impacthub.net)).
Industrial Policy highlight industry as ‘crucial’ in EU competitiveness, and cite innovation as a ‘key factor’.

Alongside a suite of European innovation policies, the European Commission (EC) has numerous initiatives to specifically promote and support SMEs in their growth and uptake of eco-innovation. In each Member State — and other countries — the EC monitors SME performance in eco-innovation year on year, and reviews SME-related policies as part of the Small Business Act (SBA). Launched a decade ago, these surveys show that SMEs are experiencing good economic recovery across the EU, placing them in a good position to consider future innovation. However, motivations to invest in eco-innovation, and to do so by cooperating with partners, varies widely from country to country (Muller et al., 2018).

Other measures include the Environmental Technologies Action Plan (ETAP), which aims to promote a sustainable future and the use of environmental technologies and innovation; the Green Action Plan for SMEs, introduced in 2014 as part of the Europe 2020 strategy to work towards a resource-efficient, low-carbon European economy with sustainable, smart, and inclusive growth (EU Commission, 2014); and tools to help innovative environmental technologies reach the market (Environmental Technology Verification, or ETV, being one example).

These initiatives and others at national and regional levels are working to support SME growth, competitiveness, and innovation, and to avoid the pitfalls of ‘one size fits all’ approaches.

<table>
<thead>
<tr>
<th>The most frequent barriers to eco-innovative activities</th>
<th>Key drivers of eco-innovation</th>
<th>Role of cost savings in eco-innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of funds within the enterprise</td>
<td>Greece, Cyprus, Spain, Hungary, Poland</td>
<td>Sweden, Finland, Denmark, Germany, Estonia</td>
</tr>
<tr>
<td>Insufficient access to existing subsidies</td>
<td>Cyprus, Greece, Malta, Bulgaria, Romania, Spain</td>
<td>Finland, Great Britain</td>
</tr>
<tr>
<td>Uncertain demand from the market, uncertain return on investment</td>
<td>Spain, Greece, Malta, Poland</td>
<td>Sweden, Denmark, Belgium, Estonia</td>
</tr>
<tr>
<td>Regulations</td>
<td>Cyprus, Greece, Bulgaria</td>
<td>Sweden, Denmark, Great Britain</td>
</tr>
<tr>
<td>Lack of suitable business partners</td>
<td>Greece, Cyprus</td>
<td>Denmark, Great Britain, Netherlands</td>
</tr>
<tr>
<td>Lack of qualified personnel</td>
<td>Luxembourg, Greece, Cyprus</td>
<td>Hungary, Estonia, Denmark, Sweden, Finland, Latvia</td>
</tr>
<tr>
<td>Technical and technological lock-ins</td>
<td>Cyprus, Luxembourg, Greece, Poland</td>
<td>Sweden, Denmark, Netherlands, Great Britain, Germany</td>
</tr>
</tbody>
</table>

Table 3. Barriers to eco-innovative activities for individual EU countries. Based on European Commission, 2011.
Alongside more general innovation policy is the EU Commission’s Green Action Plan for SMEs, which was introduced in 2014 as part of the Europe 2020 strategy to work towards a resource-efficient, low-carbon European economy with sustainable, smart, and inclusive growth (EU Commission, 2014). The Action Plan aims to support SMEs to take action to turn environmental challenges into business opportunities, by raising awareness of resource efficiency and circular economy improvements and of EU resource efficiency actions under the COSME, Horizon 2020 and LIFE programmes, and the European Structural and Investment Funds. Such actions could include reducing waste via recycling or reselling, monitoring energy and water consumption, switching to renewable energy, and redesigning products, services, and processes to minimise material usage and waste.

These actions fall under the purview of eco-innovation and ‘greening’ — i.e. ‘moving towards green economy by decoupling economic growth from environmental degradation and resource depletion’ (OECD, 2018).

Policies also need to be relevant to particular country contexts; in general there are considerable differences in the barriers occurring in SMEs between different countries. While those barriers noted in Table 3 (from Flash Eurobarometer survey 315 (FL315), European Commission, 2011) frequently and markedly inhibited the development of eco-innovativeness in some European countries, they have no substantial impact in others, demonstrating the significant diversity of barriers experienced across the EU.

In another survey (Flash Eurobarometer 456 (FL456), which surveyed 15 019 enterprises on their resource efficiency actions, one-third (33%) of EU-28 SMEs found administrative or legal procedures to be prohibitively complex; at a country level this was true for over half of SMEs in France, Poland, and Czechoslovakia, but for just 9 to 13% of SMEs in Estonia, Cyprus, Albania and the United Kingdom (European Commission, 2018b) — a wide range of responses.

26. % of 11 401 SMEs that had taken at least one resource efficiency action.
Section 5. Summary

SMEs make up the vast majority of businesses in the EU. As such, their shift towards greener, more sustainable practices, activities, goods and services is very important in reducing resource use and environmental impact (Patricio et al., 2018). Embracing eco-innovation is an integral part of this ‘greening’. While a proportion of SMEs are taking up various measures relating to resource efficiency, green products, and the circular economy (European Commission, 2017a; 2017c), in general, many SMEs indicate that many eco-innovations are beyond their financial, technical, and logistical capabilities (Dobes et al., 2017; European Commission, 2017c).

Key barriers working against eco-innovation in SMEs can include lack of funds and/or costs of environmental actions, regulatory, legal and administrative barriers, lack of resources or qualified personnel, technical lock-ins, uncertain return on investment. There are many reports of lack of information, particularly difficulties in choosing the right course of action, unawareness of financial incentives, training or support programmes to implement eco-innovations, and especially difficulties in assessing costs and benefits to SME performance. To plug the information gap, data-led diagnostic tools to help model and define a business’ resource and energy usage, performance and impact could make a big difference to internal motivations to adopt eco-innovations.

It should be noted that SMEs are highly diverse in type, scope, and circumstance — and thus so are their motivations and challenges. There are Accordingly many different ways to characterise SMEs’ barriers, but the majority seem to be connected to the nature of SMEs themselves: due to their small sizes and economies of scale, smaller enterprises struggle to compete against large businesses and organisations in the market. They possess smaller teams (and thus less expertise and knowledge in their personnel base), more limited resources, and are less willing or able to take sizeable risks or make large investments.

However new and innovative ways of working offer countermeasures, bringing together cooperative, integrated systems and structures to help overcome the restrictions facing SMEs due to their smaller sizes and lesser resources — examples include novel cloud computing and adaptive management systems, integrated networks, smart technologies such as meters and automated methods of control, collaborative groups of SMEs sharing resources and knowledge, and new environmental regulatory frameworks.

However, small size can also work in SMEs’ favour — these enterprises are more flexible than larger organisations, and thus often better able to mobilise and capitalise on the eco-opportunities available to them.

Key drivers toward eco-innovation that emerge from the literature seem to be the rising price of energy, water and raw materials; environmental legislation, regulation and policy; collaboration with others; technological solutions; and the availability of financial or non-financial support. Market demand has been cited as a driver in some cases; there are also indications that SMEs can benefit greatly from a ready-made base of support, such as grants, subsidies or eco-innovative public procurement. Business-oriented economic factors (i.e. increased cost saving or profit making) are not yet widely cited as drivers, but a greater uptake of holistic methods for measuring performance and core business impacts may increase knowledge and understanding in this area.
SMEs could gain support for eco-innovation through measures such as...

**Barriers and solutions for eco-innovation in SMEs**

- **Difficult access to finance**
- **Wrong price signals (externalities)**
- **Lack of specialist knowledge**
- **Lack of awareness**

**Raising awareness**
- Networking (knowledge-sharing networks, tech collaboration); business cluster membership and policies; open innovation; participation in collaborative websites; inter-organisational alliances and ventures; networked enterprise (e.g. Industry 4.0); technical assistance and guidance (inc. developing funding proposals); strengthening system-wide capabilities

**Financing networks**
- Freeing networks; green public procurement; economies of scale/combined value chains through networked enterprise; facilitate SME access to finance; new financial and fiscal incentives (though evidence is mixed on effectiveness); financial measures to encourage firms to embark upon longer-term greening journeys; innovation vouchers

**Changing framework conditions**
- Change framework conditions (eco-taxes, grants for innovation); increased monitoring via Industry 4.0 tech; reduce the perceived risk of eco-innovation; green public procurement and public sector involvement, environmental management schemes

**Promoting national & international partnerships**
- Sharing knowledge between jurisdictions; flexible policy adaptations; supporting & facilitating diverse business models; approaches specific to an SME’s industry, location, and general context; implementing multiple complementary measures in parallel

**Risk-reducing policy initiatives**
- Risk-reducing policy initiatives and complementary funding sources

**Knowledge sharing, clustering, collaboration and open innovation**
- Partnerships, knowledge sharing, and specific, flexible approaches

**Raised awareness, intermediary support, eco-strategy policy**
- Investments in SMEs and intermediaries, training and education

**Financing networks; green public procurement; economies of scale/combined value chains through networked enterprise; facilitate SME access to finance; new financial and fiscal incentives (though evidence is mixed on effectiveness); financial measures to encourage firms to embark upon longer-term greening journeys; innovation vouchers**
Such as...

- Slow payback of innovation
- Under-investment in R&I
- Lack of innovation management skills
- Issues with administrative, legal or regulatory procedures
- Policy initiatives to reduce risk of R&I activities (e.g., living labs; Industry 4.0 software; eco-innovation competitions, public subsidies – with complementary private funds)
- Investments in SME-level capacity building; development of intermediary orgs specifically for SMEs (helping translate sustainability goals into business practice); values-based approaches; support for the development of clear internal indicators; training and education about innovation management skills
- Financial incentives or subsidies to front-load rewards; green public procurement; increased monitoring via Industry 4.0 digital tech; extending lifespans and reducing maintenance needed to translate into more immediate returns; eco-innovation competitions
- Partnerships, knowledge sharing, and specific, flexible approaches
- Risk-reducing policy initiatives and complementary funding sources
- Promoting national & international partnerships; sharing knowledge between jurisdictions; flexible policy adaptations; supporting & facilitating diverse business models; approaches specific to an SME’s industry, location, and general context; implementing multiple complementary measures in parallel

Barriers and solutions for eco-innovation in SMEs:

- Difficult access to finance
- Wrong price signals (externalities)
- Slow payback of innovation
- Lack of innovation management skills
- Lack of awareness
- Under-investment in R&I
- Lack of specialist knowledge
- Issues with administrative, legal or regulatory procedures
- Networking (knowledge-sharing networks, tech collaboration); business cluster membership and policies; open innovation; participation in collaborative websites; inter-organisational alliances and ventures; networked enterprise (e.g., Industry 4.0); technical assistance and guidance (inc. developing funding proposals); strengthening system-wide capabilities

Knowledge sharing, clustering, collaboration and open innovation:

- Partnerships, knowledge sharing, and specific, flexible approaches
- Investments in SMEs and intermediaries, training and education
- Industry 4.0 digital tech and reduced perceived risk
- Financial incentives to encourage long-term eco-innovation, green public procurement
- Change framework conditions (eco-taxes, grants for innovation); increased monitoring via Industry 4.0 tech.; reduce the perceived risk of eco-innovation; green public procurement and public sector involvement, environmental management schemes
- Promoting national & international partnerships; sharing knowledge between jurisdictions; flexible policy adaptations; supporting & facilitating diverse business models; approaches specific to an SME’s industry, location, and general context; implementing multiple complementary measures in parallel
Drivers can also be determined by a company’s management strategy and desired position in the market. While much dynamism among SMEs comes from entrepreneurial start-ups, whose flexibility and responsiveness can disrupt whole sectors, the benefits accruing from collaboration, knowledge sharing, competitive advantage and leveraging data and technology can clearly extend to all sizes of SME.

‘Open innovation’ solutions emphasise knowledge sharing, networking, and clustering, where multiple SMEs or other actors cooperate to help the exchange of knowledge and resources with broader networks. Other types of organisation and policy support involve facilitating connections and fostering long-term relationships with relevant partners; green supply chains and green public procurement; via data-led approaches; or by broader awareness-raising via intermediaries, training or voluntary management schemes.

Public policies have already been created in several areas, with numerous European initiatives to promote and support SMEs to eco-innovate. Questions remain about the best combination of measures to create a favourable environment at the right level for SMEs; indeed, there are several key differences between countries in their perception of barriers. Mission-oriented policies that aim for cross-sectoral transformation around a specific issue may help with setting an enabling framework for SMEs.

By sheer number of businesses and number of employees, but also by measures of environmental impact, the SME landscape is highly significant to Europe’s economy and environment, and many of the most exciting developments in sustainable production and consumption are happening in SME-level arenas. It is clear that SMEs cannot often eco-innovate in isolation, but also that they have a diverse range of needs, which can be supported by a diverse range of tools and approaches. Better knowledge and understanding are key components — this report explores and presents the evidence for key barriers, drivers and emerging approaches as part of the **evolving dialogue to help SMEs to grasp eco-innovation opportunities and position themselves as key players in the green transition.**
References


Calogirou Constantinos, Stig Yding Sørensen, Peter Bjørn Larsen, Stella Alexopoulou et al. (2010) SMEs and the environment in the European Union, PLANET SA and Danish Technological Institute, Published by European Commission, DG Enterprise and Industry.


European Commission (2017c). Directorate-General for Internal Market, Industry, Entrepreneurship
ECO-INNOVATION IN SMES


Horváth, D. and Szabó, R. Z. Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change* 146 (September 2019): 119-132.


i-SCOOP (2019). Industry 4.0: the fourth industrial revolution — guide to Industrie 4.0 [online]. Available at: https://www.i-scoop.eu/industry-4-0/ [Accessed 22 March 2019].


Miller, K. *et al.* (2011). First Assessment of the Environmental Assistance Programme for SMEs, ECAP.


Rawlings, J., Coker, P., Doak, J., and Burfoot, B. (2014). Do smart grids offer a new incentive for SME


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