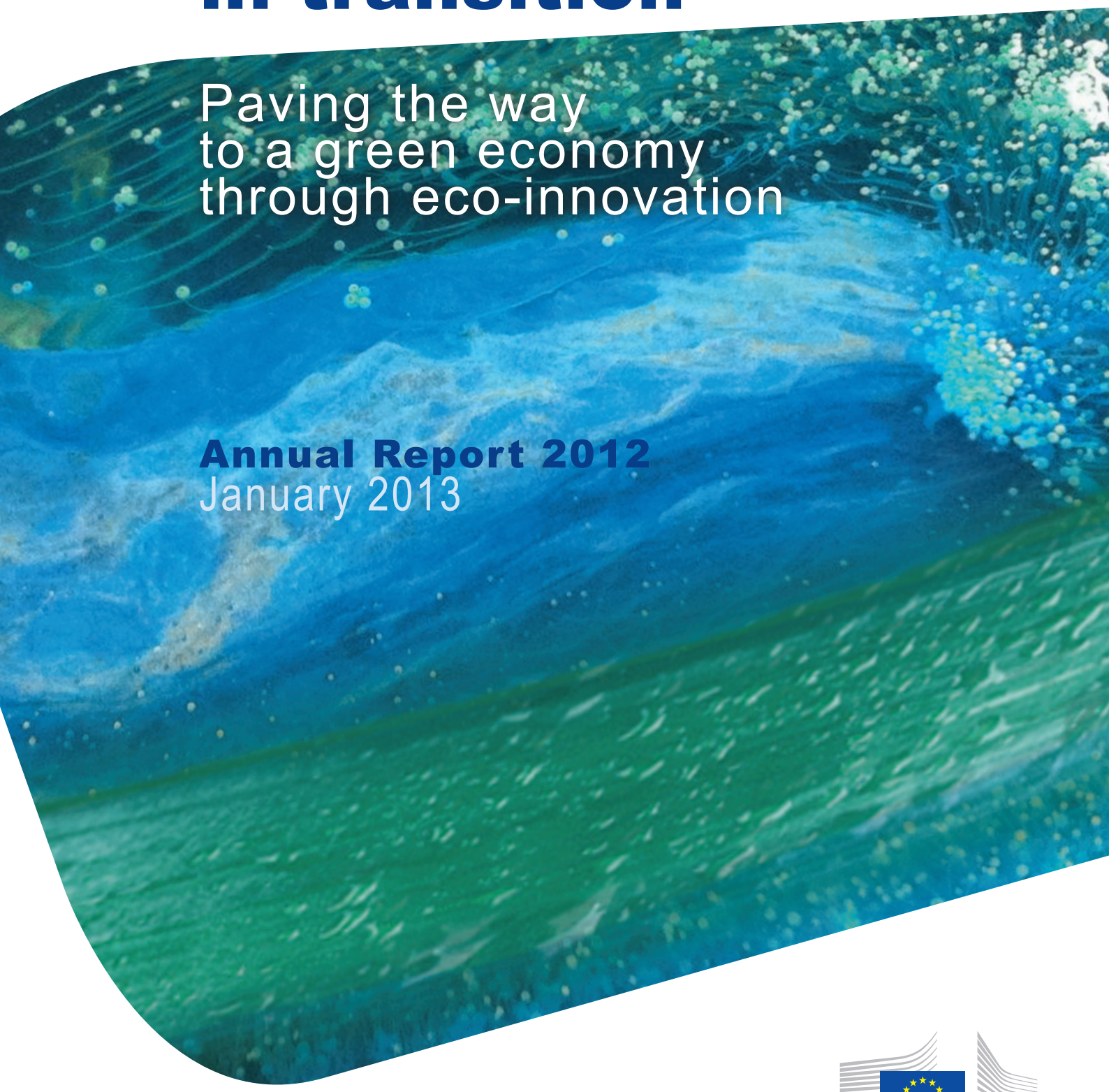
eco-innovation observatory

Europe in transition

Paving the way to a green economy through eco-innovation



Annual Report 2012
January 2013

European Commission

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List of Abbreviations

BIG	Behaviour-Impact Gap
CEO	Chief Executive Officer
CIS	Community Innovation Survey
COSME	Programme for the Competitiveness of Enterprises and SMEs
DG	Directorates-General
DMC	Domestic Material Consumption
EACI	Executive Agency for Competitiveness and Innovation
EC	European Commission
EcoAP	Eco-Innovation Action Plan
Eco-IS	Eco-Innovation Scoreboard
EEA	European Environment Agency
EI	Eco-Innovation
EIO	Eco-Innovation Observatory
EIPs	European Innovation Partnerships
EREP	European Resource Efficiency Platform
ESCO	Energy Service Company
ESF	European Science Foundation
EU	European Union
FET	Future and Emerging Technology
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLUA	Global Land-Use Accounting
GVA	Gross Value Added
HLWG	High Level Working Group
ICT	Information and Communication Technology
IEA	International Energy Agency
LCA	Life Cycle Assessment
MIPS	Material Input per Service Unit
MS	Member States
NGO	Non Governmental Organisation
R&D	Research and Development
REA	Research Executive Agency
RMC	Raw Material Consumption
RTD	Research and Technology Development
SME	Small and Medium-Sized Enterprise
TMC	Total Material Consumption
TMR	Total Material Requirement
TOE	Tonnes of Oil Equivalent
WEF	World Economic Forum

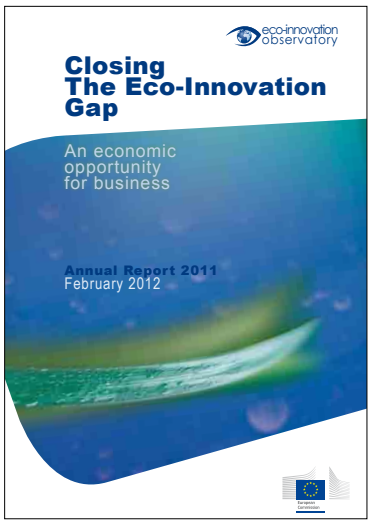
About the Eco-Innovation Observatory

The Eco-Innovation Observatory provides a platform for the structured collection and analysis of eco-innovation across the European Union and in key economic regions around the globe. The EIO website includes:

- Reports on eco-innovation
- Database with on-line charts and maps
- 27 EU Member States profiles
- 200+ good practices
- 18 eco-innovation briefs
- Eco-Innovation glossary

Annual Reports

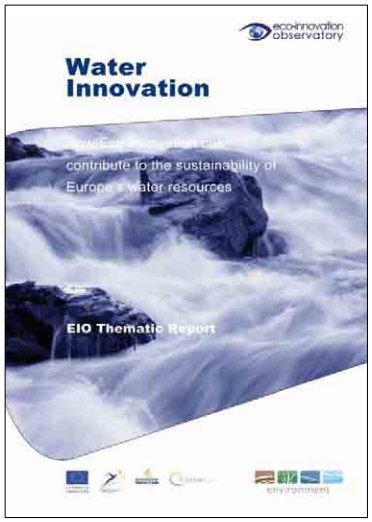
'The Eco-Innovation challenge' (2011) introduces the concept of eco-innovation, placing key findings on the state and potential of eco-innovation in the EU into the context of the resource-efficiency debate, in particular considering the flagship initiative "Resource-efficient Europe" of the Europe 2020 strategy.



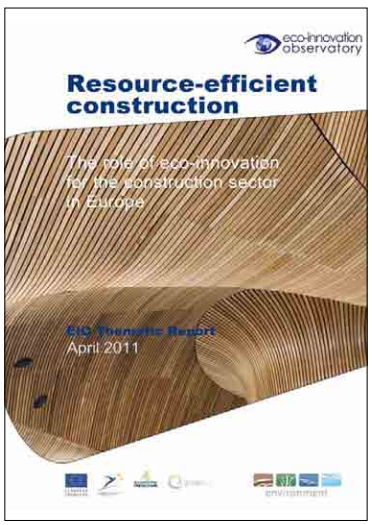
'Closing the eco-innovation gap' (2012) looks at evidence of the economic benefits from eco-innovation. It argues that eco-innovation in European companies is an opportunity for strategic investment rather than only seeking regulatory compliance. Changes introduced by companies have the potential to become one of drivers of the systemic change needed to meet the EU's vision of a sustainable economy.

Examples of thematic and horizon scanning reports

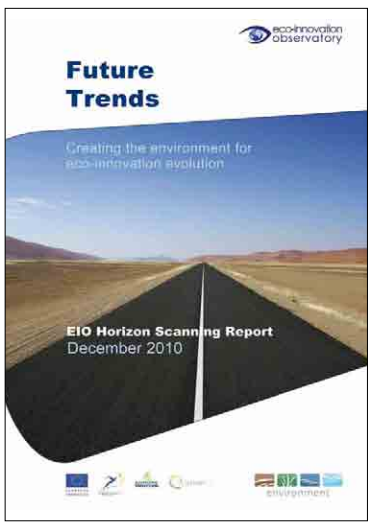
'Emerging markets' explores the role of European SMEs in promoting a green economy, not just 'in house' but also on a global scale. It analyses the challenges and opportunities for European eco-innovators that exist within the emerging markets in Asia, Africa and Latin America.



'Water innovation' considers the uses of water and how to account for water consumption throughout the economy. It emphasises the importance of considering both technological and non-technological innovation as well as addresses demand-side and supply-side policy measures relevant for water innovation.



'Resource-efficient construction' explores how eco-innovation can contribute to resource efficiency in the construction sector. It argues that a more comprehensive approach to building and renovation is needed; one that looks at how both energy and materials can be efficiently used, and considers the trade-offs between them.



'New Horizons' is the second horizon scanning report of the EIO. It explores future opportunities for eco-innovation, especially related to biomimicry, cradle-to-cradle and zero waste. It includes inspiring examples of eco-innovation.

Executive Summary

This year the Eco-Innovation Observatory has looked at how eco-innovation can lead to and create pervasive change. It argues that if eco-innovation is based on partnerships of different stakeholders working together, it can play a crucial role in the transition to a green and competitive economy.

Eco-innovation can take the form of improved products and processes, new technologies and services, and new ways of doing things, but key to the transition is the combination of cleaner technologies, new business models and sustainable behaviours. System eco-innovation -- a series of connected changes rather than stand alone innovations -- will play a much bigger role in the future. It will require developing a shared understanding of how and why systems work the way they do, and new collaborations to create functional systems that integrate environmental sustainability at their core. A system in focus can be anything from a house to a city or an entire economy.

This report especially focuses on how different stakeholders can contribute to building a green economy through eco-innovation. It defines a green economy as an economic system which prospers within the boundaries of sustainable resource extraction and use. It argues that a long-term vision needs to be co-developed in society, and that the establishment of concrete targets for resource use are needed as an orientation for both policy-makers and people engaged in eco-innovation. Using the green economy as the framework for change, strategic partnerships between policy makers, businesses, citizens and researchers can apply eco-innovation to create enjoyable alternatives to business-as-usual pathways.

Vision: eco-innovation as a means to reach a resource-efficient Europe

The recent financial crisis has brought the debate about what constitutes a “healthy economy“ into the mainstream. It has led to concepts like the ‘green new deal’, ‘green growth’, and the ‘green economy’. Numerous studies have pointed to the significant growth opportunities of environmental industries, especially as regards the creation of new jobs. Moreover, the cost savings from improving material efficiency, akin to the large increases seen in labour productivity over the last few decades, is starting to be understood. This is partly a result of rising commodity prices. Such trends appear to combine environmental and economic objectives, but economic growth has remained at the heart of such strategies so far. There is no evidence of absolute decoupling of economic growth from resource use. The vision of a resource-efficient economy goes beyond niche-like solutions to integrate environmental sustainability as the key condition for economic and social sustainability. The vision developed by the European Commission aims for an inclusive and competitive economy, which respects environmental limits. The Rio+20 vision of the ‘Future we want’, signed by 193 countries, recognises the need to ensure resource access to meet basic human needs in all parts of the world and to turnaround behaviours leading to overconsumption and pollution in, especially, industrialised countries. It is time for wider engagement with and awareness of theses visions to prepare and mobilise stakeholders for change.

Resource consumption targets for materials, land, water, and energy and climate are under discussion at the European level. Targets already established in policy (e.g. -80% GHG emissions per capita

compared to 1990) and suggested by literature (e.g. -68% Total Material Consumption per capita compared to 2008) reveal the need for substantial reductions by 2050. While establishing global targets may take more time, the EU would benefit from setting its own targets for sustainable levels of resource use now. This would not only provide an example for other countries, but also better prepare the EU economy to adapt to on-going trends and challenges. Meeting such targets requires a structural change in the way resources flow through society, lowering the EU's high dependence on imports and mitigating climate change while opening up new market opportunities, creating a skilled workforce for the long term, and fostering innovation. Operational targets should be negotiated by different stakeholders to develop a common understanding and explicit agreement on what needs to be done over the short term to reach long-term targets.

Eco-innovation and resource use across the EU

The Eco-Innovation Scoreboard compares the relative performance of EU Member States in key areas related to eco-innovation, including investments, company performance and economic and environmental outcomes. It seeks to reflect the extent to which eco-innovation has penetrated business in each country. As in the 2011 version, Finland, Denmark, and Sweden are still ranked as the EU leaders in eco-innovation. However, they are not the best performers when it comes to environmental outcomes. There is a moderate correlation between relatively high eco-innovation performance and high levels of both per capita material consumption and GHG emissions in Member States. Reasons could include a time lag between innovation and impacts, a focus on clean technologies instead of resource productivity, and a concentration of eco-innovation in niches instead of a widespread diffusion across society. Focusing on the structural conditions and underlying drivers of resource consumption and emissions in different Member States would allow eco-innovation investments to better leverage structural change.

The role of eco-innovation for the transition to a resource-efficient Europe

Past experiences suggest that structural change has been driven by "waves of innovation" converging technological potential with collective shifts in perception. The next decade will prove whether the green economy is the next "big thing" and if it can create synergies between socio-economic benefits and environmental objectives. For the green economy, structural barriers such as systemic lock-ins and market failure have a direct bearing on the strategic operations of companies and may hinder disruptive eco-innovation efforts. System eco-innovation is above all about identifying the root causes of systemic problems and targeting these levers to shift systems toward sustainability in a co-ordinated way. By aiming to improve the performance of an entire system, instead of focussing on its individual components, system eco-innovation equips eco-innovators to more easily overcome structural barriers. Transformative system eco-innovation re-arranges the way specific functions or services, such as mobility, shelter and nutrition, are developed and delivered to people. It is not a "quick fix" strategy, but aims for long-term wins.

Business perspective: delivering value in a resource-efficient way

Instead of viewing the environment as just a source of materials or as an external challenge to be dealt with separately, companies in the future will internalise environmental sustainability in how they meet customer needs. Businesses will change the rules of the game by changing how they create, deliver

and capture value. Key eco-innovations will be achieved through collaborations across the supply chain to source primary and secondary resources with less environmental impact and to substitute resource and energy inefficient products and processes with new ones. The company-customer relationship will also change as company's shift from selling products to selling the utility derived from products, thereby reducing the importance of ownership and creating new incentives to extend the life of products. Currently, a lack of incentives for change (e.g. the low price of natural resources) and an uncertain policy direction hinder eco-innovation, even as increased consumer awareness leads to many creative business models.

Citizen perspective: opting for sustainable lifestyles

Car-sharing, slow tourism and co-housing are examples of eco-innovations which enable citizens to satisfy their needs and desires with lower environmental impacts. Higher levels of engagement between citizens and businesses will be key to co-developing appropriate eco-innovative products and services in the future. Nevertheless, awareness alone will not be enough to drive social and structural change and move niche success stories into the mainstream. Society's preoccupation with economic growth shapes our underlining cultural norms and values. As long as personal advancement is based on the ideal of material wealth, resource-efficient lifestyles that involve moderation will be difficult to promote. Starting to measure 'happiness' in a more deliberate way and addressing the real reasons for promoting growth at all costs could be first steps. Policies at all levels of governance are needed to provide the structural conditions required to let people make more sustainable choices.

Research perspective: improving the knowledge base

Research will contribute to the transition by facilitating a co-creation of knowledge. In particular, sustainability research, characterised by a demand-driven, socially-oriented and transdisciplinary nature, will pay a bigger role in the future. Universities will not only conduct inter-disciplinary research, but also actively seek, expand and deepen collaboration and networks with other stakeholders in society. Bridging the traditional division of disciplines will be key to overcoming structural barriers to sustainability research.

Government perspective: leader and partner in the transition

Government is one of the key stakeholders in the transition towards a resource-efficient society and economy. It must not only adjust policy objectives to support eco-innovation, but also change how public policies responding to long-term challenges are designed, consulted and managed to set an overall direction for the transition. Key policy approaches to this end will be (1) policy deliberation to co-develop a vision and potential pathways to that vision and (2) a systemic approach to designing and setting up framework conditions and direct eco-innovation support. By engaging stakeholders in the co-development of long-term visions, instead of imposing a vision and related policies toward that vision on them, stakeholders may be more willing to welcome new polices and make changes. Beyond policy making, governments and public administrations may also need to innovate in their own organisational structures to meet the challenges of sustainability. New governance models will better allow for integrated approaches and flexible collaborations, and they will be based on the principle of subsidiarity to ensure that eco-innovation challenges are tackled on the level where collective capacity to act is concentrated.

Transition coalitions: strategic alliances for pursuing change

The roles of individual stakeholders in the transition are just as important as the new forms of collaborations between them. New strategic alliances of "fast movers" will develop and implement eco-innovations demonstrating desirable alternatives to business-as-usual. In this way, the risk of radical eco-innovation activities can be shared. The role of government will be key to safeguarding "innovation spaces", both by supporting demand for eco-innovation (e.g. through pre-commercial procurement) as well as by engaging with stakeholders directly in the process of eco-innovation.

Key recommendations to policy makers

There is no simple recipe on how to promote structural change, but there are several actions governments can consider to kick-start the transition. The European Commission's Eco-Innovation Action Plan (EcoAP) could play a key role in placing eco-innovation at the centre of this process. This report can be summarised with five key recommendations:

1. **Build a shared understanding of the eco-innovation challenge**
   Engage with key stakeholders to exchange knowledge and views to prepare the ground for future visions and policy targets of eco-innovation. Use the knowledge gained to underpin European Innovation Partnerships (EIPs) as well as major demonstration projects.
2. **Develop shared visions and scenarios with targets and milestones**
   Investing in creating a shared understanding and broad agreement on visions is one of the smart ways to assure a fundamental level of coherence. Specific eco-innovation targets and milestones should be co-developed with stakeholders and used to develop a new EU-level Eco-Innovation Roadmap to complement the EcoAP and set key eco-innovation priority areas for Europe.
3. **Measure up to the challenge: systemic policy for systemic problems**
   Design eco-innovation policies to respond to the root causes of systemic problems and use demonstrations (not only R&D projects but also clusters, cities or regions committed to a shared vision and targets) to lead by example. To this end, an "European Innovation Partnership" dedicated to system eco-innovation should be added to the EcoAP.
4. **Measure progress toward the vision and targets**
   Improve data and develop robust indicators that enable the setting of meaningful targets. In particular, eco-innovation should be made a permanent and compulsory part of the Community Innovation Survey.
5. **Keep innovating modes of governance and government models**
   To keep up with the complexity, scale and pace of future challenges, integration across ministries and across policy levels should be strengthened. As a first step toward enhanced coordination, the European Commission could establish a horizontal Eco-Innovation Competence Platform comprising staff from different Directorates-General (DGs) of the European Commission, European agencies responsible for major EU programmes, and the European Investment Bank.

1 | Introduction

Key Messages

- Eco-innovation is about change towards more sustainable economic and social models. Motivations for engaging in eco-innovation are not necessarily "environmental"; there is a clear business case for eco-innovation with both quick and slow wins.
- The focus is on resources because (1) the most prominent environmental problems are linked to human use (and overuse) of materials and energy, (2) the EU is substantially dependent on imports from other countries and (3) resource efficiency is increasingly important for creating business opportunities in a risky and resource-constrained world.
- Eco-innovation can be implemented both by companies and by people, and motivated by policy from the local to European level. By working together, the eco-innovation efforts of all stakekeholders could contribute to making the transition from unsustainable macro-economic systems of consume and dispose to 'green economies'.

Eco-innovation is about change. It is about how business, citizens, research, and government can both instigate and partake in change to co-create the kind of future we want.

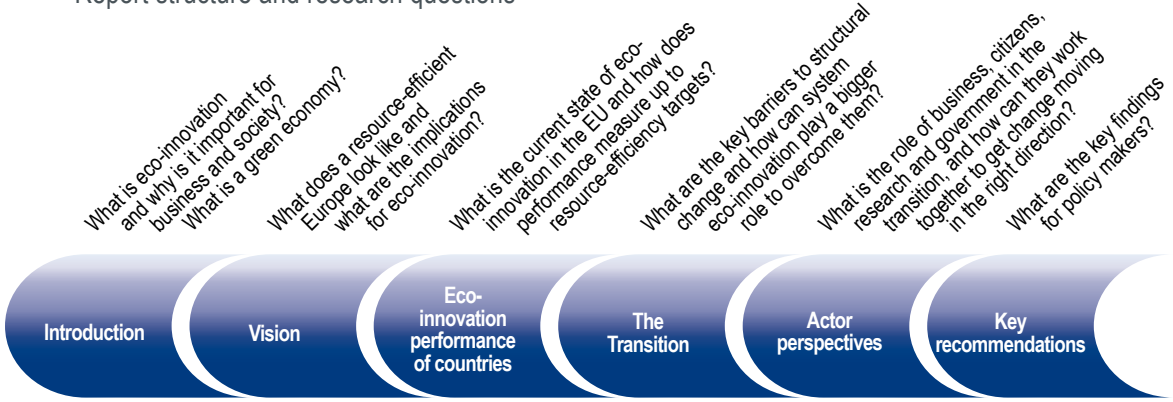
The Eco-Innovation Observatory (EIO) has been monitoring the state of and trends in eco-innovation across the EU to learn more about how eco-innovation can play a role in creating more competitive businesses, resilient markets and resource-efficient societies. This is the third Annual Report, and it brings together what the EIO has learned about eco-innovation over the past three years.

Eco-innovation can play a role in creating more competitive businesses, resilient markets and resource-efficient societies.

This report begins by shortly reviewing key findings and messages from previous reports. It then looks at where we want to go (vision and targets), presents where we are (the Eco-Innovation Scoreboard) and summarises what we have learned about how eco-innovation can get us there (the role of eco-innovation). It looks not only at how eco-innovation can promote structural change at the macro level, but also presents "actor perspectives", considering how businesses, citizens, researchers and government, as well as new and emerging coalitions of stakeholders, can contribute to the transition to a green economy. It concludes by proposing a number of policy recommendations.

Figure 1.1

Report structure and research questions



1.1 | What is Eco-Innovation?

The EIO Methodological report (EIO 2010) developed a framework for analysing eco-innovation. It defined eco-innovation as:

"... the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water, and land) and decreases the release of harmful substances across the life-cycle." EIO 2010

Eco-innovation encompasses all changes that reduce resource use across the life-cycle, regardless of whether these changes were intended to be 'environmental' or not.

In this sense, eco-innovation contributes both to environmental "clean-up" and to the dematerialisation of society. It is not just about clean technologies, but encompasses all changes that reduce resource use across the life-cycle, regardless of whether these changes were intended to be 'environmental' or not. This represented a shift in understanding about eco-innovation from belonging solely to the environmental industry to being integrated in all industries. There is now a widespread understanding reflected, notably, by the launch of the European Commission's Eco-Innovation Action Plan (EcoAP) in December 2011. The EcoAP replaced the Environmental-Technologies Action Plan (focused on promoting environmental industries) and aims to put eco-innovation at the heart of all European policies.

There are many types of eco-innovation, as can be seen from Table 1.1, ranging from product, process, organisational, marketing, and social to system eco-innovations. Hence, eco-innovation is something that happens in, and between, companies, but it can also be a change induced by people. In all cases, the producer and consumer are crucial to the successful scaling-up and diffusion of eco-innovation.

Eco-innovation leads to different degrees of change, from incremental to disruptive changes. Incremental eco-innovations concern improved components of products or services, improved processes or streamlined organisational set-ups. They are generally "quick wins" for the company, but do not lead to a systemic change alone. Over time, incremental innovations may accumulate and result in a substantial change, especially if they are applied on a large scale. Disruptive eco-innovations lead to shifts in a paradigm or in the functioning of an entire system. They can lead to reconfiguring entire markets, consumer behaviour and technological systems. Systemic changes resulting from such innovations can make some existing products or services redundant. In this case, there may be short-term costs for achieving long-term benefits, or "slow wins".

Eco-innovation should go beyond incremental environmental improvements and efficiency gains, and aim at "breaking out of locked-in systems and thinking".

Although both incremental and disruptive changes are beneficial, the scope and urgency of the challenges call for eco-innovation which leads to system-wide change in the way society uses resources. As EU Environment Commissioner Janez Potočnik stated in October 2012: "Eco-innovation should go beyond incremental environmental improvements and efficiency gains, and aim at 'breaking out of locked-in systems and thinking'".[1]

1. http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/20121015-potocnik-eco-innovation-requires-systemic-rethink_en.htm

Table 1.1

Types of Eco-innovation

Type	Description
Product	Product eco-innovation includes both goods and services. Eco-innovative goods are produced so that the overall impact on the environment is minimised, and eco-design is a key word in this area. Future product design will take into account resource constraints with a higher priority than is happening today, especially if commodity prices continue to increase. Designing a product in a manner that leads to decreased environmental impacts and less resource use during operation and that allows recovery options like repairing, remanufacturing or recycling should become key business strategies to not only save costs, but also to enhance the supply security and resilience of markets. Eco-innovative services include green financial products (such as eco-leases), environmental services (such as waste management) and less resource intensive services (for instance car sharing) (Kemp and Pearson 2007).
Process	Process eco-innovations reduce material use, lower risk and result in cost savings. Examples include the substitution of harmful inputs during the production process (for example replacing toxic substances), optimisation of the production process (for instance improving energy efficiency) and reducing the negative impacts of production outputs (such as emissions) (Reid and Miedzinski 2008). In addition, reducing material inputs, so-called 'ecological rucksacks', of production and consumption processes can also be captured by process eco-innovation. Common terms linked with process eco-innovations include cleaner production, zero emissions, zero waste and material efficiency (Bleischwitz et al. 2009).
Organisational	Organisational eco-innovation is the introduction of organisational methods and management systems for dealing with environmental issues in production and products (Kemp and Pearson 2007). Such organisational changes are *the socio-economic dimension of process innovation*, especially as it is closely linked to learning and education (see Bleischwitz 2003). It includes pollution prevention schemes, environmental management and auditing systems and chain management (cooperation between companies to close material loops and avoid environmental damage across the whole value chain) (Kemp and Pearson 2007). As such, organisational eco-innovation may also include an enquiry into various collaborative organisational forms and their potential eco-innovative qualities; this can range from business networks and clusters to advanced solutions in industrial symbiosis.
Marketing	Marketing eco-innovation involves changes in product design or packaging, product placement, product promotion or pricing. It involves looking at what marketing techniques can be used to drive people to buy, use or implement eco-innovations. In marketing terms, brand (a collection of symbols, experiences and associations connected with a product or service by potential customers) is key to understanding the process of commercialisation of products or services. While green branding is important, in practice, it is not the only or best way of selling eco-innovations. Labelling is also an aspect of marketing eco-innovation, i.e. eco-labelling.
Social	Social eco-innovation considers the human element integral to any discussion on resource consumption. It includes market-based dimensions of behavioural and lifestyle change and the ensuing demand for green goods and services. Some firms are experimenting with so-called user-led innovation, meaning that the functionality of new goods is developed with stakeholders, thereby minimising the risk of superfluous product features. Another important aspect is product sharing, which may lead to an absolute decrease of material use without diminishing the quality of services they provide to users. The social dimension also involves the creative potential of society, with examples of innovative green living concepts.
System	System eco-innovation is a series of connected innovations that improve or create entirely new systems delivering specific functions with a reduced overall environmental impact. A key feature of system innovation is that it is a collection of changes implemented by design. For example, system eco-innovation related to a house is not about just insulating windows or just using a better heating system: it is about innovating the overall design to improve its functionality. "Green cities" are another example of system innovations when innovation and planning efforts lead to a combination of changes to make the functioning of the city and city life more "green". This includes, for instance, new mobility concepts that tackle not only traditional public transportation services (e.g. buses) but also shared-bike systems (and related infrastructure like bike stations) as well as planning to reduce the need for travel (requiring that supermarkets, day care facilities, etc. are incorporated in new housing developments).

Eco-innovation good practice 1

Carbon fibre recycling

The German company CFK Valley Recycling has developed a new process for carbon fibre recycling. This process contributes both to supplying growing demand for carbon fibres and mitigating impacts related to landfilling and incineration of used carbon fibres in Europe. For the recycling, dry fibre residues and pre-impregnated fabric structures are sorted and crushed. A thermal treatment leads to the complete recovery of pure carbon fibres, which are then refined and re-made into products.

Source: http://cfk-valley.com and http://www.carbonxt.de/

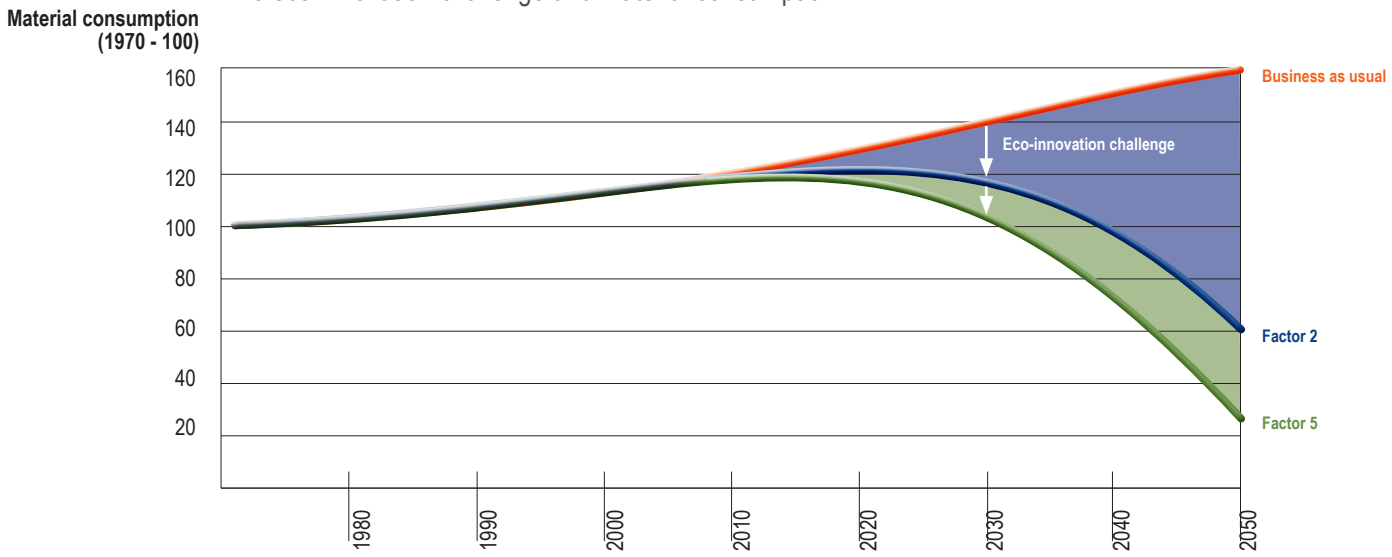
1.2 | What is the big picture context for Eco-innovation?

Resource consumption is the key focus of the EIO because the overuse of global resources is linked to the most prominent environmental problems and social inequalities today.

The EIO Annual Report "The Eco-innovation challenge: pathways to a resource-efficient Europe" (EIO 2011a) put eco-innovation into the context of global challenges. It established resource consumption as the key focus of the EIO because the overuse of global resources is linked to the most prominent environmental problems and social inequalities today, and because wealth and prosperity created by our current economic system came at a price of high throughputs of resources. In order to reduce total levels of resource use, ways to decouple economic success from resource consumption are needed. This is the eco-innovation challenge (Figure 1.2).

Figure 1.2

The eco-innovation challenge and material consumption



Source: EIO 2011A

EIO (2011a) also focused on potential transformational changes in the way resources flow through society and on the socio-technical eco-innovations empowering these transformations. It laid out a vision for a resource-efficient Europe by 2050; A Europe in which eco-innovation transformed the prevailing concepts of ownership, responsibility, functionality, design and life quality. And a Europe in which a combination of ingenuity, technical innovation, socio-institutional changes and human adaptability led to a Factor 5 reduction in resource consumption while maintaining high levels of life quality.

1.3 | What is the business opportunity for eco-innovation?

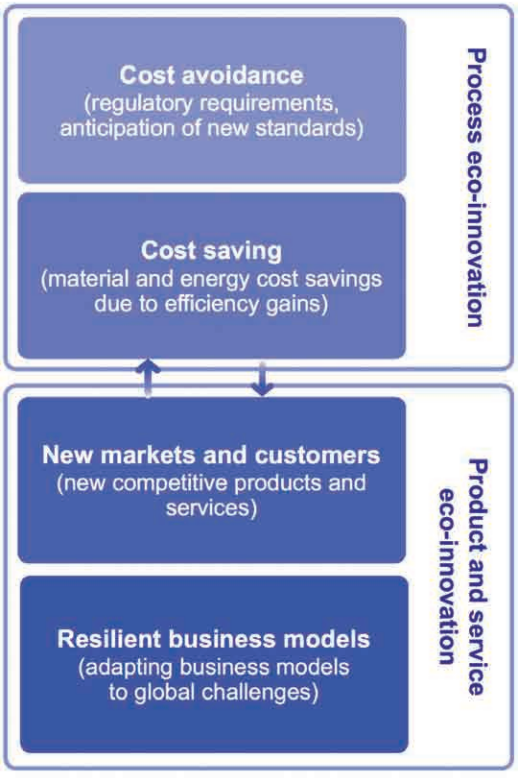
The EIO annual report "Closing the eco-innovation gap: an economic opportunity for business" (EIO 2012a) focused on the benefits of eco-innovation for companies. It identified a number of 'low-hanging fruit' opportunities for saving costs. Analysis of case studies in Germany revealed that companies could save around €200,000 annually for implementing material efficiency in the manufacturing sector. On average, these investments paid off after 13 months[2]. Nonetheless, there is an eco-innovation gap in Europe. Only around 15% of companies in the EU eco-innovate, with wide disparities in both the scale and scope of changes in different EU Member States. EIO (2012a) found that while the low-hanging fruits are probably an easy win-win solution in the short-term, more systemic changes are needed to reach a Factor 5 reduction in resource use. For business, this could mean developing new markets and innovating their business models to face current and emerging global challenges (Figure 1.3).

EIO (2012a) found that while the low-hanging fruits are probably an easy win-win solution in the short-term, more systemic changes are needed to reach a Factor 5 reduction in resource use.

EIO (2012a) also reviewed eco-innovation policies across the EU, finding that most countries view eco-innovation as a new and emerging field, but few have addressed the need for a more systemic approach to public support to eco-innovation. Eco-innovation is not yet considered as a strategy for social and economic transformation. So far, the overwhelming focus has been on providing financial support for research on and deployment of environmental technologies, without a more fundamental effort to adapt overall framework conditions and to create a level playing field for eco-innovators. There are very few public initiatives in Europe that explicitly support system eco-innovations.

Figure 1.3

The Business opportunity



Source: EIO 2012A

2. Around 100 case studies from companies which were supported by demea (The German Material Efficiency Agency) co-funding and consultancy between 2006 and 2010 were assessed by EIO 2012a. The analysis also found that micro companies achieved high relative savings (comparable to 11% of annual turnover) while large compaies had high absolute savings (i350,000 on average). Most eco-innovations were process oriented, and metal (especially steel) was the material with the highest savings potential. Such saving potentials seem replicable across the EU.

1.4 | This report: What is the role of eco-innovation in the transition to a green economy?

UNEP (2010) define a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risk and ecological scarcities". Basically, a green economy is low-carbon, resource efficient and socially inclusive. However, the concept of the green economy, as promoted by UNEP (2011), has come under some criticism. Unmüßig et al. (2012) argue that it does not go far enough. First, it is focused on finding and stimulating economic niches rather than instigating structural change. Second, the social dimension is almost exclusively limited to the labour market and potential poverty reduction, instead of considering basic human rights (like access to food and water).

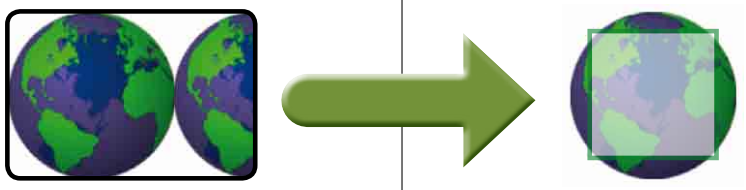
The European Environment Agency (EEA) is promoting a somewhat more nuanced definition. The EEA states, "At the most basic level, a green economy is one that generates increasing prosperity while maintaining the natural systems that sustain us"[3]. To maintain natural systems, Europe has to reduce consumption to levels which meet sustainable supply. Because this report has a resource focus, it narrows the definition of a green economy to: an economic system which prospers within the boundaries of sustainable resource extraction and use. Figure 1.4 depicts how this concept combines environmental, social and economic dimensions of sustainability.

This report considers how eco-innovation can play a role in the transition to green economies. Change will probably start gradually, but the overarching targets should not be lost sight of in the pursuit of incremental improvements. Efficiency alone will probably not be enough; the green economy will also have to find an alternative to the lack of moderation that has characterised "industrialised economies" (Jackson 2009, Unmüßig et al. 2012). Eco-innovation will clearly be a key tool for motivating and joining actors across the economy towards change. In this sense, the green economy is the framework for change, while eco-innovation is a key part of the pathway to it.

3. http://www.eea.europa.eu/themes/economy/intro

Figure 1.4

The green economy

	Current global economy	Green global economy
		
Environment	1.5 planets are needed to regenerate renewable resources and absorb the CO_2 waste at current levels of consumption (WWF et al. 2012)	Resource extraction and emissions are within the planetary boundaries. For the EU, this requires reducing total consumption levels of primary materials, land, water and energy.
Social	870 million people were chronically undernourished in 2010-12 (FAO 2012) and 1.29 billion people lived in extreme poverty in 2008 (World Bank 2012). People in industrialised countries consume up to 20 times more materials than people in least developed countries (Giljum et al. 2011).	Available global resources are more equitably distributed across the global. For the EU, this implies substantially reducing total per capita resource consumption (see Table 2.2 for preliminary targets).
Economic	Economic prosperity is coupled with resource use. Relative decoupling has been observed for the EU, but not absolute decoupling (EIO 2011a).	Economic prosperity is decoupled from primary resource consumption. For the EU, this means transforming the economy to find growth opportunities in resource efficiency, recycling, re-use and new business models.

2 | Vision: The future we want

Key Messages

- The EU has the political power to promote radical innovations increasing resource efficiency, and by doing so, can enhance material and energy security, resilience and competitiveness over both the short and long term.
- An economic system based on sustainable levels of resource use is resilient and 'green' over the long term. For Europeans, such an economy would not mean sacrifices in life quality, but a shift in how their needs are met (e.g. more services) and a change in some of their behaviours.
- Comprehensive and long-term resource use targets are needed to set both an orientation for policy development and a direction for eco-innovation efforts at the macro-economic level; operational targets and milestones are needed to promote change at different levels of society and in different sectors of the economy.

In 2012, government, the private sector, Non-Governmental Organisations (NGOs), and researchers came together in Rio de Janeiro, Brazil to discuss how we can get to "the future we want". The outcome was a document—"The Future We Want"—where 193 countries affirmed their commitment to pursuing sustainable development, rooted in the 3 pillars of economy, environment and social well being. The document states:

"We recognize that poverty eradication, changing unsustainable and promoting sustainable patterns of consumption and production and protecting and managing the natural resource base of economic and social development are the overarching objectives of and essential requirements for sustainable development" –Our common vision (UN 2012)

While this document recognises the urgency of developing more resource-efficient economies and systems, the outcome of Rio+20 is weak in terms of concrete measures and responsibilities. Rio+20 established global acceptance of the challenges facing long-term sustainable development; especially that these challenges are rooted in limited planetary resources (land, water, etc.), a growing world population, and an increasing gap between resource use of the rich and the poor. There is a need to ensure resource access to meet basic human needs in all parts of the world and the need to turnaround behaviours leading to overconsumption and pollution in, especially, industrialised countries. Commitments to pursuing pervasive change are, however, lacking.

Rio+20 established that these challenges are rooted in limited planetary resources, a growing world population, and an increasing gap between resource use of the rich and the poor.

For this reason, it is even more important that the industrialised, high-consuming regions such as Europe take a pro-active approach in un-locking the global situation and undertaking measures toward resource efficiency. Waiting for an international agreement on all issues could delay action domestically and, as this section will show, there are sound economic and social arguments for taking action now. The unsatisfactory outcomes of Rio+20 point

to the urgency of developing a multi-stakeholder vision for a resource-efficient Europe, and starting to implement it. Knowing what kind of future we want enables eco-innovation efforts and societal transformations to be directed toward that future.

2.1 | A resource-efficient Europe

Natural resources are the backbone of the economy and of society. People depend on natural resources for their every day life, not only for meeting basic human needs (food, water, shelter), but also for providing products and services (mobility, communication, etc.). The basic idea behind the resource-efficient Europe vision is that using resources better will improve life quality, in light of growing global pressures on the planet.

Efficiency is a concept that compares the inputs and outputs of a system. It can be observed across all levels of society, from the micro scale of a product, a company, or a household to a more macro scale of a city, a region, a sector, or a country. Resource efficiency at the product and company level is often associated with improvements in production processes (e.g. improving material efficiency). While there is a large potential to scale up these types of improvements across the EU (see EIO 2012a), the scope of changes needed for a resource-efficient Europe are much broader. The goal of a resource-efficient Europe is to get more value out of each primary resource input, ultimately to reduce the fast throughput of resources through society. This requires a life-cycle perspective that includes not only production-oriented processes (within Europe and other world regions), but also end-of-life considerations like re-use and recycling.

A resource-efficient Europe promotes a systemic transformation in the way resources flow through the economy and society.

A resource-efficient Europe is very close to concepts like a 'green economy' or a 'circular economy'. Both of these concepts promote a systemic transformation in the way resources flow through the economy and society, arguing that there are business and job opportunities to be had by revolutionising recycling and re-use. Recent macroeconomic modelling results suggest that as a rule of thumb average for EU Member States, a reduction of the Total Material Requirement (TMR) of the economy by 1% is accompanied by a €12b to €23b rise in GDP and an increase in jobs[4] (Meyer et al. 2012). A number of indicators already exist for measuring resource efficiency at the economy-wide level. For this reason, the concept of resource efficiency offers a way to measure progress towards a 'green economy'. Since resource efficiency is measurable, quantitative targets can also be set, if there is a political will to do so.

In 2011, the European Commission published the Roadmap to a resource-efficient Europe[5] (EC 2011a). It established the need for targets and laid out a work plan for developing targets (see section 2.2 below). It also included a vision of the EU's economy in 2050, stating:

"We recognize that poverty eradication, changing unsustainable and promoting sustainable patterns of consumption and production and protecting and managing the natural resource base of economic and social development are the overarching objectives of and essential requirements for sustainable development" –Our common vision (UN 2012)

This vision combines environmental, social and economic dimensions of sustainability under the umbrella of macro-economic resource efficiency. The following sections take a closer look at these dimensions.

4. Meyer et al. model the period between 2010 and 2030 and estimate that a TMR reduction of 1% is accompanied by an increase in employment of 0.04 to 0.08%, which corresponds to 100,000 to 200,000 people for the EU-27.

5. COM (2011) 571

Eco-innovation good practice 2

Vertical farming

The Swedish company Plantagon has been developing systems and technologies for vertical farming since 2008. The basic idea is that multi-storey greenhouses could supply especially cities with agricultural products to relieve pressure on fertile cropland and transport costs. Such systems are most suitable for high-value fruits and vegetables instead of grains. The Plantagon systems applies a transportation helix, which is a type of spiral or ramp that optimises the growing conditions in terms of space and light, making it possible to grow crops over several storeys without compromising light conditions.

Source: Plantagon. Illustration: Sweco

2.1.1 | An economy that respects environmental limits

The vision of the EU's economy in 2050 implies that targets should not only measure progress on improving EU resource efficiency, but also need to reflect the overarching capacity for sustainable supply of the global Earth system. According to Röckstrom et al. (2009), planetary boundaries are the thresholds for earth operating systems which the economy needs to respect in order to avoid the risk of catastrophic environmental change (e.g. deforestation of the Amazon rainforest which changes global weather patterns). There is a 'safe operating space' for human development within these boundaries.

For example, the rate of biodiversity loss is one of the nine planetary boundaries that Röckstrom et al. (2009) estimate as having already been surpassed. In particular, the clearing of forests to make way for agricultural land is a major cause of biodiversity loss (Boucher et al. 2011). To halt biodiversity loss, agricultural land expansion needs to be slowed down, and eventually stopped. From the planetary boundaries perspective the question is, what is the boundary for land use change? From the resource efficiency perspective, the question is, given this boundary, how can the natural resource (land) be used in a sustainable and efficient way? This also means finding ways to use the land-based product (e.g. food, biomaterial, fuel) more efficiently in the economy (e.g. reducing food waste, keeping the biomass longer in use through cascades[6]).

This perspective implies a shift in governance away from reactive approaches focussed on minimising negative externalities towards pro-active management of the use of natural resources and regulation within the framework of a "safe operating space". In other words, it combines sufficiency concepts on the demand side (recognition of limits) with efficiency concepts across the life-cycle (developing sustainable solutions).

This perspective implies a shift in governance away from reactive approaches focussed on minimising negative externalities towards pro-active management of the use of natural resources and regulation within the framework of a "safe operating space".

Eco-innovation can provide these solutions. Business, citizens, research and government can use innovation to change the way things are done, and together, create a paradigm shift in the structure of economies (see Chapter 5). To help provoke such eco-innovation efforts,

6. Cascading use means that the biomass if first used as a product, and then re-used or recycled, and eventually recovered for energy production at the end of it's life cycle.

an orientation on the global environmental limits is needed. Targets for acceptable levels of resource use could serve this purpose. Nevertheless, it should be noted that the science on planetary boundaries is normative in nature—it has to do with how society choses to deal with risk and uncertainty (e.g. setting a +2 degrees Celsius target for climate change). Scientists will probably not agree on an exact 'tipping point' with 100% certainty, but that is not the point. Acknowledgment and acceptance of the thresholds (with reasonable certainty) is needed to induce systemic change *in the right direction*.

2.1.2 | An inclusive economy

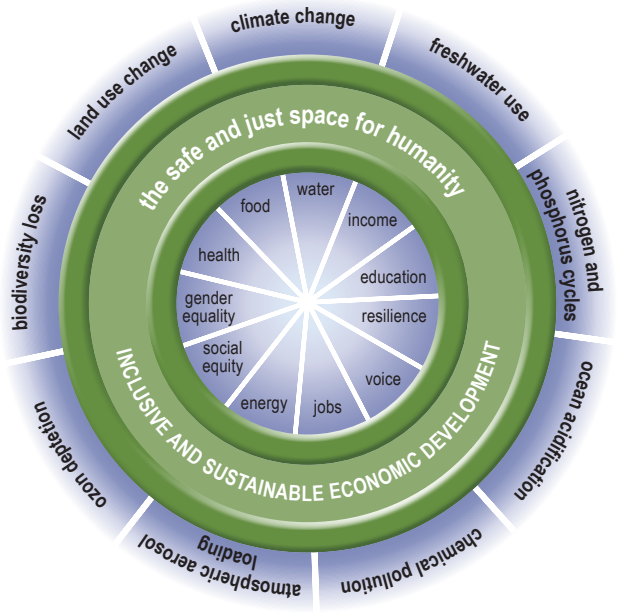
Building up to the Rio+20 Earth Summit, Raworth (2012) published a discussion paper arguing that the safe operating space for inclusive and sustainable economic development is below environmental thresholds, but above minimum social and economic requirements for meeting basic human needs. These social foundations are based on meeting the millennium development goals. The "safe and just operating space" for human development is between minimum social targets and maximum resource use thresholds. This is also the idea behind "environmental space" (Opschoor and Weterings 1994, Spangenberg 1995). Inherently, this suggests that limited natural resources critical to meeting basic human needs, like cropland for food production, must be 'shared' in a humane way. In other words, a highly disproportional 'distribution' of use is not sustainable. Currently, the EU uses one-third more cropland on a per capita basis than the global average, indicating a need to reduce consumption and calling into question a significant expansion in the consumption of biofuels and biomaterials (Bringezu et al. 2012).

For targets, the safe and just operating space implies the need to consider not just the planetary boundaries, but also the per capita availability and use of global resources in relation to those boundaries.

For targets, the safe and just operating space implies the need to consider not just the planetary boundaries, but also the per capita availability and use of global resources in relation to those boundaries. Unmüßig et al. (2012) argue that "resource-light production and consumption patterns are the basis for global resource management that is compatible with human rights". In this sense, the role of eco-innovation in high-consumption countries[7] is to find ways to reduce high levels of primary resource consumption while maintaining life quality, using *per capita resource use targets* as an orientation.

Figure 2.1

The safe and just space for humanity



Source: RAWORTH (2012)

Note: The 11 dimensions of the social foundation are illustrative and based on governments' priorities for Rio+20. The nine dimensions of the environmental ceiling are based on the planetary boundaries set out in Rockström et al. (2009)

7. High-consumption countries are not alone in the pursuit of environmental sustainability. UN (2012) states "We recognize that urgent action on unsustainable patterns of production and consumption where they occur remains fundamental in addressing environmental sustainability and promoting conservation and sustainable use of biodiversity and ecosystems, regeneration of natural resources and the promotion of sustained, inclusive and equitable global growth". While high-consumption countries need to take more responsibility for the impacts of their (over)consumption than they do today, all countries have the responsibility to manage their natural resources in a sustainable way.

2.1.3 | An competitive economy

The recent financial crisis has helped to bring the debate about what constitutes a "healthy economy" more into the mainstream. It has called conventional economic theory into question, and led to the emergence of concepts like the 'green new deal' (UNEP 2009), 'green growth' (OECD 2011a) and the green economy (UNEP 2010, 2011). While the financial crisis has opened a wider debate about green economics, the solutions to the crisis (e.g. huge bailouts) indicate a reliance on old models, at least in political circles. Moreover, while green growth concepts do merge economic and environmental arguments, they still favour niche solutions rather than systemic changes (Unmüßig et al. 2012), they do merge economic and environmental arguments. Thus, these concepts could be seen as a first step on the way towards more pervasive change.

Business seems to be starting to respond to the sustainability challenge.

Business seems to be starting to respond to the sustainability challenge. One out of three CEOs surveyed by PricewaterhouseCoopers' sustainable growth survey said that their companies have fundamentally changed strategies due to the global recession. Political instability and scarcity of natural resources are especially flagged as risks for the near future. In UNEP's report on the 'business case for the green economy' they point out that, "Conventional methods to promote economic recovery are becoming more limited and therefore business and governments are seeking new ways to create long-term prosperity in a resource-constrained world" (UNEP 2012).

One of the more readily achievable changes within the current system seems to be through energy and material efficiency. The last few years alone has seen an eruption of studies focused on the economic opportunities. While most studies have focused on energy efficiency, the benefits of material efficiency are beginning to be explored in more detail. For instance, at the company level, BIS (2010) estimate annual savings associated with resource efficiency in the UK of €21,000 to €60,000 per company with payback periods between 0.06 and 3.45 years. Similarly, Schröter et al. (2011) estimate €48 billion worth of annual savings from material savings in the German manufacturing sector. At the global level, McKinsey (2011) estimate $3.7 trillion (€2.65 trillion) in savings by 2030 from the implementation of 130 resource productivity measures and adapted legislation (no subsidies or energy taxes and a $30 carbon price). EIO (2012a) presents further examples and analysis of the efficiency potential, but also warn that few of the estimates so far have been based on dynamic modelling, meaning that for instance, possible rebounds have not been considered. The focus of these efficiency efforts is almost entirely on incremental changes without a due consideration of possible rebounds or other knock-on effects.

Another opportunity for companies under the umbrella of a resource-efficient society is the 'green market'. The German Ministry of Environment and the Federal Environmental Agency valued the world's 'green market' at around €1 trillion in 2005 (BMU and UBA 2009). It included areas such as energy efficiency, sustainable mobility, material efficiency and recycling. Growth in energy efficiency and water management markets are expected to be particularly significant in the future.

The EU is one of the global leaders in exploiting technological and economic opportunities in green markets (Ecorys 2009). This places European business in a strong strategic

Eco-innovation good practice 3

Water efficiency via smart irrigation

The Portuguese company Hidrosoph has developed a web-based application for assisting growers in deciding the best application and timing for irrigation. It integrates real time data from supporting equipment such as weather stations, soil sensors, flow meters and others. Improving the water management of fields not only reduces water use, but also diminishes the need for fertilizers. Networking between Hidrosoph and a nearby university and also farmer associations allowed a shared development that has been a driver for the development of the business.

Source: http://www.hidrosoph.com

position to help build green markets oversees, especially in Asia, Latin America and Africa. In the "Fortune at the Bottom of the Pyramid", Prahalad (2004) argues that world's poor have untapped buying power and that serving this market can generate profits for companies and help to eradicate poverty. Eco-innovation could be a way to take this strategy one step forward, by leapfrogging development through green markets. As Europe is a leader in eco-innovation, the diffusion of eco-innovation presents a significant economic opportunity for European companies. This opportunity can contribute not only to economic and technological development, but also to the ecological modernisation process taking place, or starting to take place, in emerging economies (EIO 2012b).

The diffusion of eco-innovation presents a significant economic opportunity for European companies.

Table 2.1 presents possible opportunities that European businesses (especially SMEs) could grasp along a simplified value chain--from resource extraction to end of product use—in emerging green markets. It also presents some indicative opportunities for system eco-innovations (EIO 2012b). A number of barriers need to be overcome to turn these opportunities into realities. The inclusion of local actors in eco-innovation activities are crucial to success, however, this adds costs related to time, investment and learning.

Opportunities to increase competitiveness in a resource-efficient economy may be widespread and far-reaching. A number of recent reports reveal evidence that companies who act on that opportunity will have an advantage (UNEP 2012, WEF 2012a, Sommer 2012, FORA 2010). At the same time, some existing companies, as well as industries, may not survive in a resource-efficient economy. The transition to a resource-efficient economy will see "winners" and "losers" of competitive struggles. The World Economic Forum (WEF) points out, in their report on scaling sustainable consumption and resource efficiency, "Business-as-usual approaches to supply, demand and rules of the game are likely to create a major gap between what is needed for growth and the ability of our resource base and governance and policy structures to sustain prosperity" (WEF 2012a). In short, business-as-usual is not an option. As the WEF emphasise, the imperative for change is clear, but the question is, how? "Having concrete targets for resource efficiency and sustainable supply can be a first step to achieving scale through industry associations and partnerships" (WEF 2012a).

"Having concrete targets for resource efficiency and sustainable supply can be a first step to achieving scale through industry associations and partnerships" (WEF 2012a).

Table 2.1

Green market opportunities for European business abroad, indicative examples

		Regional relevance			
Value chain	Area	Asia	Latin America	Africa	Business opportunity for SMEs
Extraction	• Cleaner extraction technologies				Exporting and/or adapting technology to the needs of emerging markets.
	• Restoration of mining sites				Consulting and re-designing mining and post-industrial sites (especially in re-adapting for urban use)
Manufacturing	• Sustainable product design				Consulting services and specific assignments on designing products (also with a view to meet requirements of the current and future EU legislation)
	• New materials and new applications of materials				Consulting on existing and developing new materials with better environmental performance
	• Cleaner production systems				Consulting on, selling existing and/or adapting/ developing cleaner production systems
	• Resource efficiency technologies (materials, water, biomass, land)				Consulting, providing services (e.g. ESCOs), developing and adapting technologies to the needs of local markets
	• Energy efficiency technologies and solutions				
	• Value chain integration				Consulting services from engineering companies
	• Training workforce				Providing specific training and consulting services on the use of environmental technologies as well as on energy and material efficiency
Distribution and transport	• Transport logistics (freight)				Developing, selling and running transport logistics systems (both road, air and water)
	• Alternative transport solutions				Promoting new solutions reducing energy intensity and emissions from transport (e.g. use of sails etc.)
Use	• Product sharing schemes				Supporting emerging markets in developing business models supporting alternative product use schemes. The product sharing and leasing approaches are already spreading in many countries (e.g. cars, tools etc.). In emerging economies they could be solution allowing the user to benefit from the product without having to purchase it.
	• Product leasing scheme				
	• LCA / MIPS / GLUA / other environmental performance assessment methods				Developing measurement methods or perform product performance assessments. This could be linked with eco-labels and other labels and certifications.
End of life (recycling, recovery, re-use)	• Waste treatment				Exporting and/or adapting technologies and organisational methods to the needs of emerging markets. It can also involve a genuine innovation collaboration taking into account specific needs of emerging regions.
	• Recycling technologies				
	• Electronic waste				
	• Urban mining				
	• Energy recovery				
Systemic opportunities	• Designing green cities and green buildings				Promoting green city concept and specific building designs. The concepts can draw on European models and be co-developed with local architects and designers.
	• Industrial ecology				Designing, implementing and consulting on industrial symbiosis
	• Sustainable mobility, including electric mobility				Designing, implementing and consulting on new mobility solutions
	• Sustainable agriculture				Designing new farming concepts based, e.g. on agro-ecology

High relevance Medium relevance Low relevance

In summary, a resource-efficient Europe links economic, social and environmental pillars of sustainability. It implies that an economic system based on the resource constraints of a safe and just operating space is resilient over the long term. For Europeans, it means no sacrifices in life quality, but a shift in how their needs are met (e.g. more services, more eco-innovative products). This is the role and challenge of eco-innovation.

2.2 | Resource use tragets

Eco-innovation contributes to a reduction in resource use, while at the same time contributing to enhanced knowledge, increased competitiveness and the provision of desirable products and services. It ties together more than just environmental objectives. Hence, resource use targets may serve as an orientation for business and policy, a direction for innovation investments and a complement to socio-economic targets.

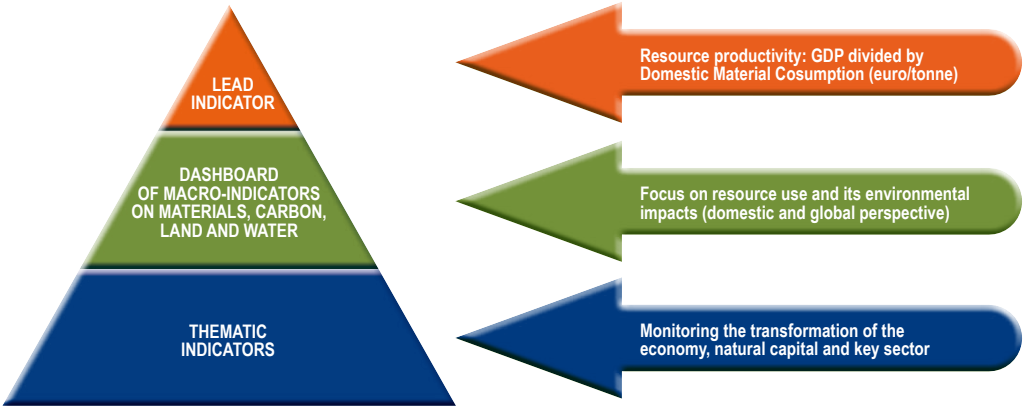
Defining resource use targets is currently being debated at the European level.

Defining resource use targets is currently being debated at the European level. In the 2011 Resource Efficiency Roadmap, the Commission proposed a three level approach to resource efficiency indicators (see Figure 2.2). Since then, an assessment of resource efficiency targets and indicators (Bio Intelligence Service et al. 2011) and a stakeholder consultation was carried out (2 July 2012 to 22 October 2012). The Commission is committed to having consulted on indicators and targets by 2013 and to making a suggestion for a set of indicators and related policy targets.

The Roadmap's approach is to develop a headline indicator on resource productivity, a dashboard of macro indicators on water, land, materials and carbon and a set of theme specific indicators for measuring progress towards specific objectives and actions. The latter includes themes like "turning waste into a resource" (suggesting e.g. recycling rate of municipal waste as an indicator), "supporting research and innovation" (suggesting the EIO scoreboard as an indicator), or "getting the prices right" (suggesting environmental taxes as an indicator), to mention a few (EC 2012a). Clearly, the choice of indicators for the resource efficiency agenda goes beyond just resource use indicators. Since discussing all of these indicators is beyond the scope of this report, the focus is on targets for sustainable levels of resource use (the dashboard indicators, middle of the pyramid in Figure 2.2).

Figure 2.2

The Roadmap's approach to resource efficiency indicators



Source: ONLINE RESOURCE EFFICIENCY PLATFORM[8]

8. http://ec.europa.eu/environment/resource_efficiency/targets_indicators/roadmap/index_en.htm

Table 2.2 depicts the dashboard categories of resources and their use targets. These targets are based on a compilation of existing policy targets (e.g. Europe 2020 targets for GHG emissions and energy efficiency), suggestions given by the assessment done for the Commission (Bio Intelligence Service et al. 2011) and literature review. This means that some of the targets are quite preliminary and should be used indicatively only (e.g. for land use). The effect of population growth on per capita targets should also be highlighted. Especially in the case of land use, if we accept a threshold for cropland expansion, it means that while the total availability remains constant, per capita availability for that resource decreases with population growth.

A Factor 5, or an 80% reduction in material consumption (DMC), was presented in EIO 2010 and 2011a. This report takes the next step towards the use of a more comprehensive indicator of resource consumption (TMC) as a target for material use. Altogether, sufficiently comprehensive and intelligible targets are needed to provide medium to long-term orientation and to be able to identify priority areas, drive sectoral objectives and choose priority measures (Schepelmann et al. 2006, Bleischwitz 2012). Eco-innovation is one of the key means to achieve the targets, in a way that it drives directional change providing benefits for the economy and the environment.

Targets are needed to provide medium to long-term orientation and to be able to identify priority areas, drive sectoral objectives and choose priority measures.

Table 2.2

Per capita resource use and climate targets, 2020 and 2050 (Including policy targets and indicative targets based on discussions in literature)

Dashboard categories	Year	Targets	Implications for Europeans	Source
Materials	2050	10 tonnes $TMC_{abiotic}$/ cap	(-68% in per capita resource use compared to 2008)	Based on Bringezu 2011
Land	2050	(0.18 ha cropland /cap*)	(-43% in per capita cropland use compared to 2007)	Based on Bringezu et al. 2012
Water	--	*Target under development*	*Water abstraction in relation to total renewable water lower than 10% by 2050*	*EEA 2010*
Energy and climate	2020	(2.9 TOE / cap)	-20% per capita Primary Inland Energy consumption compared to baseline projection for 2020	EC 2010a
	2050	(1.8 TOE /cap)	-50% per capita Primary Inland Energy consumption compared to 2000	Bio Intelligence Service et al. 2011
	2020	(8.7 t CO_{2eq}/ cap)	-20% GHG emissions per capita compared to 1990	EC 2010a
	2050	(2 t CO_{2eq}/cap)	-80% GHG emissions per capita compared to 1990	EC 2011c

Note: Numbers in parenthesis have been calculated based on the source. *Population projections based on UN Medium projections[9]. Other population statistics based on Eurostat. Calculations are based on different sources found in both literature and policy. This indicates that targets for different categories are in very different stages of development (from established to just beginning). These targets have not been developed in a dynamic manner. Reflections on how interactions between different targets may impact others (the resource nexus) needs more work.

9. http://esa.un.org/unpd/wpp/unpp/panel_population.htm

Box 2.1 | Resource targets and eco-innovation: the challenge of metrics

The European Commission has proposed material productivity, measured as a ratio of GDP over DMC, as a lead indicator of resource efficiency. However, while material productivity is a well-established proxy, it does not fully meet the requirements of a lead indicator.

The need for a comprehensive lead indicator: setting a direction for change

DMC does not take into account extraction that is unused "per se" (e.g. overburden from mining, harvest residues in agriculture and forestry, by-catch in fishing) and indirect flows (the resources needed to produce traded goods). Because the aim of the "overarching" target is to provide a comprehensive picture for policy orientation, comprehensive indicators (TMR[10] or TMC[11]) should be used as the lead indicator. This is especially important for preventing problem shifting (e.g. displacing the environmental impacts of production abroad).

The need for absolute and relative targets: benchmarking progress along the way

Resource productivity (e.g. GDP/TMR) can be used as a lead indicator to set a broad direction for action, but it needs to be accompanied by other indicators to measure and benchmark progress. Resource productivity alone is not a good indicator for comparing current environmental performance of different countries to each other. On a global scale, for instance, countries with high income have high material productivity and high absolute levels of material use (Dittrich et al. 2012). This is because productivity is a ratio, and an increase does not necessarily indicate an absolute relief of resource use and related environmental burden. Therefore, productivity indicators and targets need to be complemented by absolute indicators and targets to allow for meaningful comparisons between countries.

The need for operational targets: driving the change

Operational targets are needed to make the macro-level targets both meaningful and implementable at different levels of application. They have to take into account the actual capacity to change a targeted socio-economic system over time. Operational targets should be negotiated and co-developed by stakeholders (e.g. researchers, policy makers, business, industries, and NGOs) in the context of overarching targets. For companies, Nasr et al. (2011) state, "A key to implementing sustainable production will be application of consistent and comprehensive framework and metrics so that each company can benchmark its process against its competition and the rest of industry as a whole as well as monitoring progress toward more sustainable practices."

The link to eco-innovation?

Resource productivity indicators and targets can create a framework and suggest an overall direction for eco-innovation policy. They are not, however, sufficient as a measurement or target for eco-innovation activity of companies and countries. As the eco-innovation challenge reaches beyond efficiency improvements in industry, the system of measurement of eco-innovation has to be more comprehensive and go beyond efficiency and beyond a traditional notion of sectors. Research is needed to develop a suitable approach that captures developments on the micro (e.g. company), meso (e.g. value chain, regions) and macro (e.g. economy) levels. Eco-innovation indicators and targets which are causally linked with the overall goal of resource productivity are needed. Such a metric system would allow anticipating and acting upon findings from unwanted effects of aggregated micro-level changes, notably rebound or displacement effects. The Eco-Innovation Scoreboard (see Chapter 3) may be a first step towards measuring eco-innovation on the macro-level.

10. Total Material Requirement (TMR) is used to monitor the global resource requirement for both domestic production and consumption. Data on TMR is available for 14 EU countries: Austria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Netherlands, Italy, Poland, Portugal, Spain, Sweden and the UK (personal communication, Helmut Schütz, WI).

11. Total Material Consumption (TMC) narrows the perspective to only domestic consumption by subtracting exports. Data on TMC is available for 4 EU countries (personal communication, Helmut Schütz, WI).

3 | Eco-innovation and resource use across the EU

Key Messages

- The EIO has developed the Eco-Innovation Scoreboard to compare the relative performance of Member States in key areas related to eco-innovation, including investments, company performance and economic and environmental outcomes. It especially reflects the scale to which eco-innovation has penetrated business in different countries, ranking Finland, Denmark, and Sweden as the EU leaders in 2012.
- EU countries performing well in the Scoreboard have high environmental pressures per capita and are not on a path towards achieving the required reduction targets. There is a moderate correlation between relatively high eco-innovation performance and high levels of per capita material consumption and GHG emissions. Reasons could be a time lag between innovation investments and impacts and a focus on clean technologies and eco-industries
- Focusing on the structural conditions and underlying drivers of resource consumption and emissions in different Member States will allow eco-innovation efforts to be better targeted for achieving change.

3.1 | Measuring eco-innovation performance

This section presents the methodological foundations and structure of the Eco-Innovation Scoreboard and implications for the use of the scoreboard's results. It summarises the results of the 2012 update and also compares them with results from other thematically related scoreboards.

3.1.1 | The Eco-innovation Scoreboard

The Eco-Innovation Scoreboard (Eco-IS) is the first tool to assess and illustrate the eco-innovation performance of Member States. It was developed in 2010 by the EIO and has been updated and improved on an annual basis ever since. The Eco-IS captures different aspects of eco-innovation, ranging from "eco-innovation push" indicators (like research and development investments) to aggregated output indicators (such as eco-patents) and outcomes (socio-economic and environmental performance). The overall logic of the scoreboard implies an (indirect) link between eco-innovation inputs and activities, on the one hand, and eco-innovation outputs and environmental and socio-economic outcomes on the other hand. Figure 3.1 depicts the Eco-IS framework and the 16 selected indicators grouped in five thematic areas.

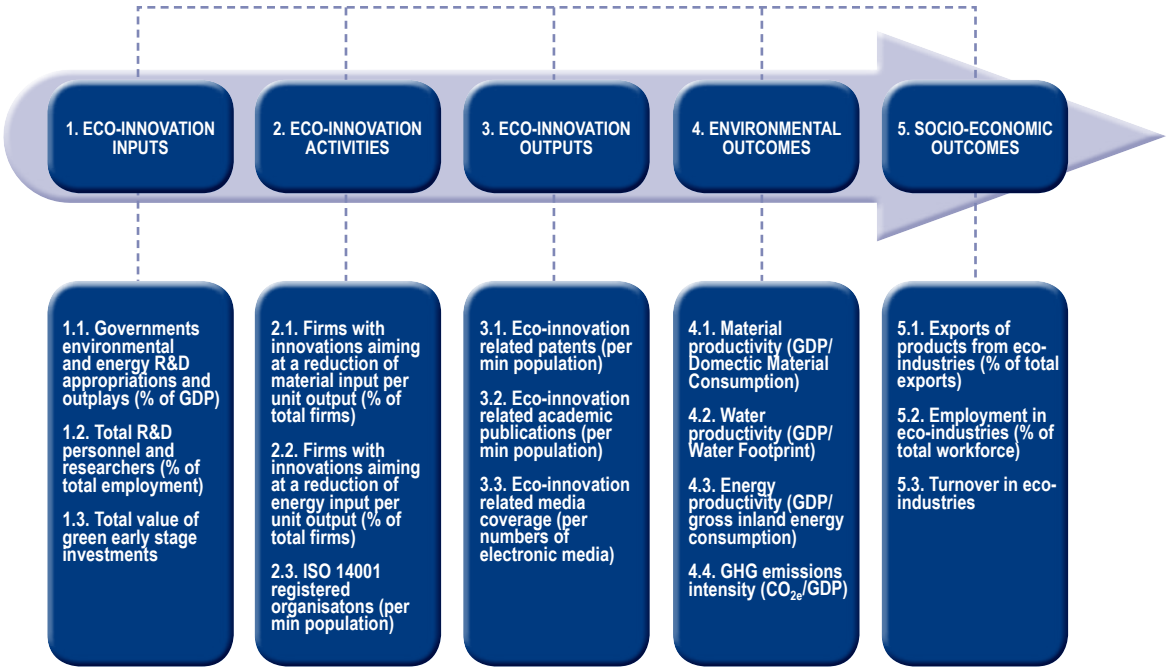
The general purpose of the scoreboard is to compare current EU country performances with regard to different aspects of eco-innovation and benchmark country results with the EU

The general purpose of the scoreboard is to compare current EU country performances with regard to different aspects of eco-innovation and benchmark country results with the EU average.

average. The Eco-IS aims to reflect the definition of eco-innovation by looking at both the on-going innovation activities and the macro-level outcomes. For the former, indicators attempt to capture eco-innovation activities (e.g. based on the Community Innovation Survey). For the latter, especially resource indicators are monitored. In this case, resource productivity indicators are used to reflect the amount of economic value generated per input of material, energy or water, and GHG emissions intensity is used to depict the amount of CO_{2eq} emitted per unit of economic value created. Productivity indicators reflect dynamic changes that may be a result of eco-innovation on a yearly basis, but for measuring progress toward environmental targets, absolute indicators should be used (e.g. resource consumption / capita)[12].

Figure 3.1

Structure and indicators of the Eco-Innovation Scoreboard



3.1.2 | Eco-Innovation Scoreboard: the 2012 results

A comparison with last year's results shows that the countries representing each group of eco-innovation performance have not changed.

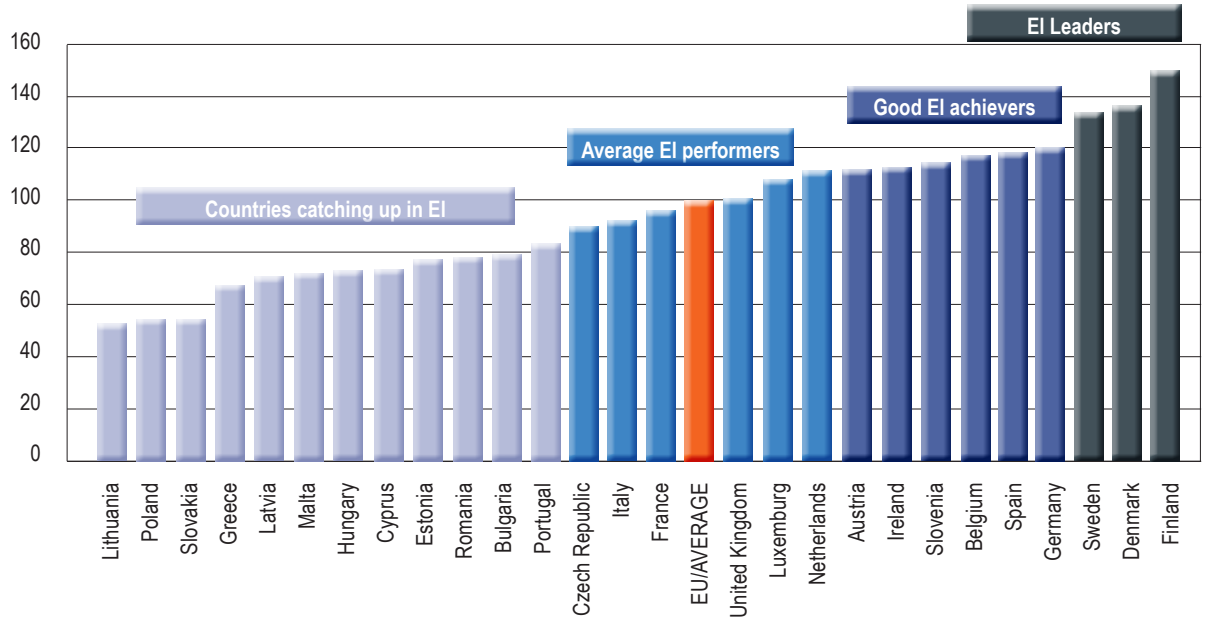
The Eco-IS was updated for the 27 EU Member States using the same set of indicators as the 2011 version. The latest year for which data were available was in the range of 2008 to 2010 for most indicators. Figure 3.2 shows the 2012 update of the Eco-Innovation Scoreboard results on the highest aggregation level.

Member States have been clustered into four groups, according to their overall eco-innovation performance. A comparison with last year's results shows that the countries representing each group of eco-innovation performance have not changed. Although 10 of the 16 indicators in the scoreboard were updated with new data compared to the 2011 version, changes to the previously available years were generally small, explaining the similarity of the overall result.

12. The scoreboard uses productivity indicators and not absolute indicators in the resource category to better reflect the change caused by eco-innovation. Absolute levels of consumption are a result of years of development, and are thus slower to change, whereas productivity increases better reflect the year on year outcomes of eco-innovation.

Figure 3.2

Eco-Innovation Scoreboard 2012: the overall index



However, some interesting variations within the groups can be found. For example, in the countries below the EU average, Bulgaria and Romania have increased their index (+13 and +11 score numbers respectively), mainly due to improved performance in the indicators of eco-innovation outputs (eco-innovation related media coverage) and eco-innovation activities (ISO 14001 registered organisations). The opposite occurs in the case of Latvia (-7 scores), Malta (-9) and Hungary (-9). In comparison to 2011 scoreboard, these countries are now performing worse and dropped in the 2012 ranking by four, five and four positions respectively. This was mainly because of the performance decrease regarding eco-innovation inputs (governments R&D appropriations and outlays) and environmental outcomes (e.g. water and energy productivity). These changes are caused by changes in the real data underlying the indicators and are not a result of the normalisation procedure.

For the countries above the EU average, some interesting changes can be observed. Compared with the 2011 Scoreboard, Luxemburg and Austria dropped by seven and three positions in the 2012 ranking. This decrease was mainly due to changes in eco-innovation outputs and eco-innovation activities for both countries. Although the rest of the EU countries have also experienced changes, there are no significant variations in the rankings. As in 2011, Denmark, Sweden and Finland are the best performing countries in the EU and thus form the group of “Eco-Innovation Leaders”.

Box 3.1 | What does the scoreboard show and how can it be used?

The Eco-IS can be used to raise awareness about eco-innovation. The aggregated index and the country rankings can be easily communicated by policy makers and can be used by the European Commission in various policy contexts. For example the Eco-IS is being considered as one of the composite indicators for monitoring the progress towards the objectives of the EU Resource Efficiency Roadmap. Country rankings are also frequently taken up by the media, which may help give the issue of eco-innovation a higher profile in public debates.

As a composite index, the scoreboard results alone do not allow drawing direct policy recommendations or pointing to specific policy measures to improve the eco-innovation performance in specific areas.

The Eco-IS can emphasise certain areas of priority action, but the response to improve the performance will vary from country to country. As a composite index, the scoreboard results alone do not allow drawing direct policy recommendations or pointing to specific policy measures to improve the eco-innovation performance in specific areas.

As the data underlying the scoreboard has been normalised to the EU average, relative comparisons of EU countries can be performed. However, the absolute performance of a country, for example with regard to a specific (policy) target, cannot be evaluated without complementing the scoreaboard with indicators indicating absolute performance and a reflection on the country specific context. The group of "Eco-Innovation Leaders" thus comprises those countries with the highest eco-innovation performance in the EU relative to other countries, but this does not mean that there is not room for improvement in those countries.

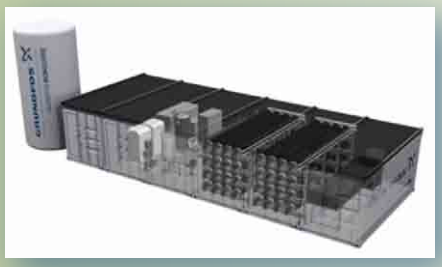
There are also some important limitations in the current Eco-IS that should be considered for a solid interpretation of the scoreboard results, including a number of data gaps and data quality and reliability. In several cases (e.g. with eco-industry turnover and employment), the indicators are based on studies where the underlying data could not be fully verified.

There is a general lack of data on eco-innovation across sectors, which explains why proxy indicators on eco-industries have been used.

Finally, in many cases, proxy indicators had to be used. The EIO defines eco-innovation as a cross-cutting issue, affecting all economic sectors. However, most statistical data is currently available with regard to sectors, which makes data gathering on eco-industries (covering the green technology branches) much easier than dealing with eco-innovation. There is a general lack of data on eco-innovation across sectors, which explains why proxy indicators on eco-industries have been used. Moreover, DMC is used as a proxy of TMC to make country comparisons possible in light of the data gaps on TMC availability.

Eco-innovation good practice 4

Decentralised wasterwater treatment



The Danish company Grundfos BioBooster provides its customers with a complete, compact, and modular wastewater treatment plant. It is based on a biological reactor with active biomass that breaks down pollutants, and an ultrafiltration membrane that prevents plant bacteria and other particulate pollutants from being discharged with the purified water. In countries or regions with water shortages, the decentralised wastewater cleaning plant could foster a re-use of treated water.

Source: http://grundfos-biobooster.com/

3.1.3 | Comparaison of the Eco-Innovation Scoreboard with other related indices

Apart from the Eco-Innovation Scoreboard, a number of other tools to measure the innovation performance of countries have been introduced recently. To compare and test the robustness of the Eco-Innovation Scoreboard results with those from other innovation indices, five different scoreboards were identified as thematically related. Table 3.1 provides a summary of the main features of the Eco-IS in comparison to these related scoreboards and indices.

Generally, it can be observed that the results of the Eco-Innovation Scoreboard show very similar country rankings to other innovation-related scoreboards, where not only the eco-innovation performance is measured, but a broader perspective on innovation is applied. As in the Eco-IS, Sweden, Finland, Denmark and Germany are amongst the highest-performing countries in all innovation-related scoreboards. This suggests a strong link between the overall innovation system and the capability to eco-innovate .

The results of the Eco-Innovation Scoreboard show very similar country rankings to other innovation-related scoreboards.

But there are also some differences between country positions in the two rankings. While, for example, the UK is usually located in the top group of innovation indices, or at least above the EU average, it ranks barely above the European average in the EIO scoreboard. In the case of Spain, it is just the reverse. These differences can be explained by a closer analysis of the EIO scoreboard indicators and the structural relationships behind them. For instance, the UK´s position in the EIO scoreboard is mainly due to relatively poor performance in eco-innovation inputs as well as socio-economic outputs. This is probably the result of changes in the British economy, with far-reaching deregulation and the transformation of the British economy to a service economy with a high share of value-added by the financial industry. Since eco-industries have typically stemmed from classical industrial sectors, one could expect that high shares of service industries are not strongly connected with a high share of eco-industries.

13. It must be emphasised that several indicators are similar in these scoreboards, for example human resources in R&D, total % of researchers, appropriations and outlays in R&D, environmental patents, academic publications, export of new products or export from innovative firms, employment in knowledge activities and in eco-industries and turnover in industries. The assessment of similar topics using similar data sources might be a main reason for the high correlation of the overall scoreboard results.

Table 3.1

Comparison of the Eco-Innovation Scoreboard with other innovation and transition scoreboards

	Year of introduction	Main objective	Geo-graphical scope	Scoreboard / index structure	Number of indicators	Top performers	Main data sources
Green Transition Scoreboard 2012	2009	Global tracking of the private financial system for all sectors investing in greenmarkets from 2007 to 2011	Global	Focus on private sector investments in five areas: renewable energy, green construction & efficiency, cleantech, smart grid and corporate R&D.	5 (aggregate financial investment in five areas)	Country ranking not available for all pillars. For R&D Germany, Japan and USA are global leaders	156 private companies, US Energy Information Administr., UNEP, Deloitte
Innovation Union Scoreboard	2010 (based on the prior European Innovation Scoreboard first published in 2000)	Assessment of the general innovation performance and the strengths and weaknesses of the research and innovation systems	EU-27	3 pillars: “Enablers” (Human resources, open, excellent and attractive research systems and finance and support); “Firm activities” (Firm investments, Linkages & entrepreneurship and Intellectual assets); “Outputs” (innovators and economic effects)	25	Sweden, Denmark, Germany and Finland	Eurostat, OECD, Scopus
Eco-Innovation Scoreboard	2010	Assessment of eco-innovation performance across EU	EU-27	5 pillars: Eco-innovation inputs, Eco-innovation activities, Eco-innovation outputs, Environmental outcomes, Socio-economic outcomes	16	Finland, Denmark, Sweden, Germany	EUROSTAT, Cleantech, ISO survey, Scopus, Meltwater
Global Cleantech Innovation Index	2012	Investigating the global state of cleantech innovation, especially in energy-related and in entrepreneurial start-up companies	EU-27 and select G20 countries	5 pillars: Eco-innovation inputs, Eco-innovation activities, Eco-innovation outputs, Environmental outcomes, Socio-economic outcomes	16	Denmark, Sweden, Finland and Germany	World Bank, Cleantech Group, IEA
Global Innovation Index 2012	2012	Measuring general innovation inputs and outputs with special emphasis on measuring economies’ ecological sustainability and online creativity	Global	2 pillars / 7 sub-pillars: “Innovation inputs” (a. Institutions, b. Human capital and research, c. Infrastructure, d. Market sophistication, e. Business sophistication); “Innovation outputs” (a. Knowledge and technology outputs, b. Creative outputs)	84	Sweden, Finland, Switzerland and the United Kingdom	World Bank, UNdata, OECD, IEA, ISO

3.2 | Resource use

This section assesses the relationship between material consumption and eco-innovation. It asks, are there structural conditions impacting high levels of resource consumption, and what are the implications of these structural conditions for eco-innovation?

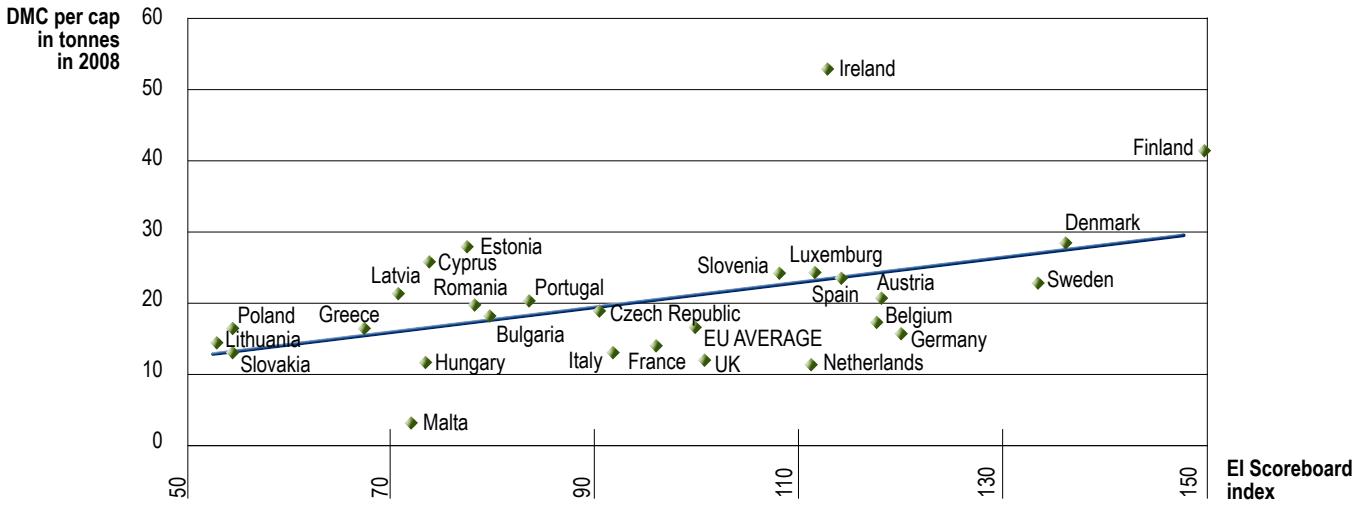
3.2.1 | Material consumption, material productivity trends and eco-innovation

Countries which rank as relatively good eco-innovation performers do not necessarily have low levels of per capita material consumption. In fact, there seems to be a slightly positive correlation between eco-innovation performance and DMC per capita in the EU (Figure 3.3). This is the case for Finland, which is at the top of the EIO ranking, but which has one of the highest per capita material consumption levels. The same applies to Sweden (3rd in the Eco-IS) and Denmark (2nd in the Eco-IS). Both have above average levels of material consumption on a per capita basis.

There seems to be a slightly positive correlation between eco-innovation performance and DMC per capita in the EU.

Figure 3.3

Eco-Innovation and per capita material consumption (DMC) in Member States, 2008



Note: 2008 is depicted as it is the most recent year data is available before the financial crisis; the financial crisis led to sometimes significant, but temporary, reductions in material consumption in Member States.

Why is there no correlation between high capability to be eco-innovative and low material use? One factor could be that the short time series of the Scoreboard cannot explain the relationship. Time-lags may occur before eco-innovation efforts lead to a reduction in resource consumption. This is especially the case when high or low consumption rates are the result of long-term trends in structure (e.g. infrastructure development) and culture (e.g. consumption behaviours), which take longer to change. For this reason, one might expect that relatively high eco-innovation performance may not, yet, be reflected in the absolute values, but in the trend. In other words, high eco-innovation performance should be correlated with a trend toward lower consumption levels (regardless of the “starting point”of those levels).

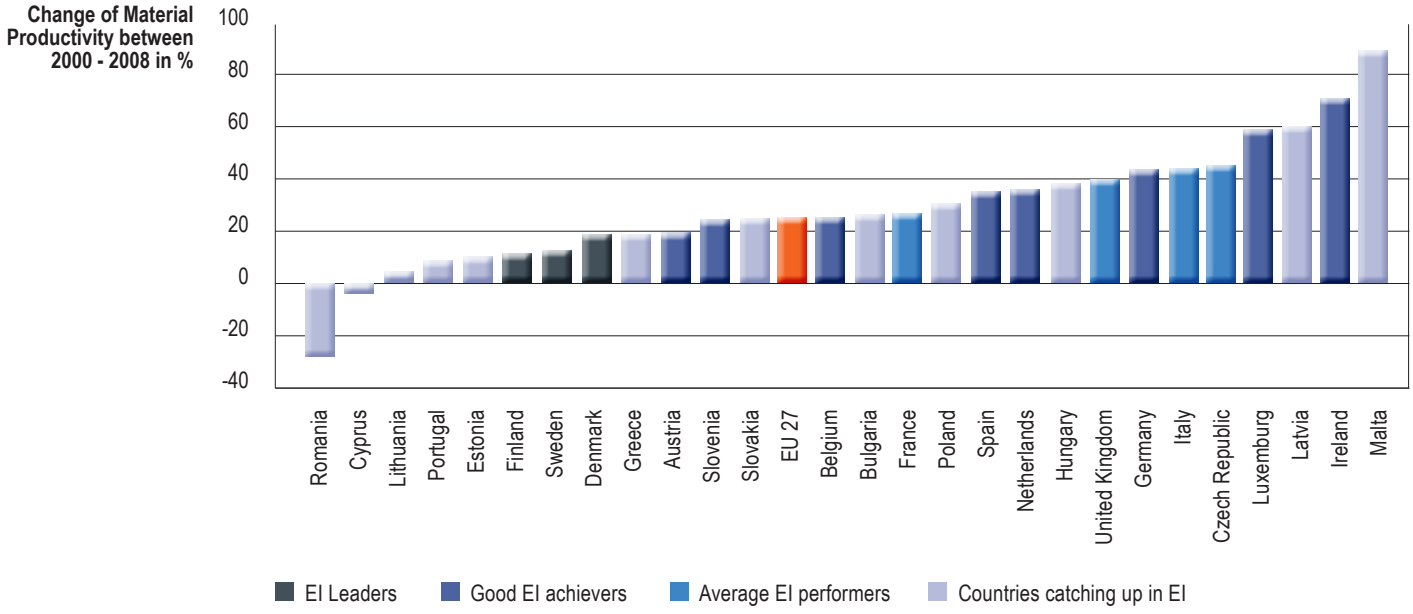
Time-lags may occur before eco-innovation efforts lead to a reduction in resource consumption.

To test this, Figure 3.4 depicts the trend in material productivity between 2000 and 2008 for all Member States. Data from 2009 were excluded to portray the trend without the impact of the financial crisis. Strong improvements in material productivity over the time period indicate that the scale of efforts made toward reducing material consumption have been substantial, whereas decreases mean that less economic value was created per material input in 2008 than in 2000.

Figure 3.4 shows that this thesis cannot be supported by the data. Countries are color-coded according to their performance grouping in the Eco-IS. Of all EU countries, material productivity grew the most in Malta (89%), Ireland (71%) and Latvia (60%). Malta and Latvia are grouped in the category of "countries catching up in eco-innovation"and Ireland is a "good eco-innovation achiever". Material productivity fell in Romania (-28%) and Cyprus (-4%) over this time period. All in all, Figure 3.4 reveals that there does not seem to be any patterns with regard to eco-innovation performance. The three "Eco-Innovation Leaders" all perform under average when it comes to material productivity dynamics.

Figure 3.4

Eco-Innovation performance and material productivity dynamics in Member States, 2000-2008



A reason for this lack of correlation could also be that the Scoreboard relies on proxy indicators, which are biased. For example, the three indicators for the socio-economic outcomes dimension are based on data for eco-industries alone. However, eco-industries are only a small area of eco-innovation, generally focused more on reducing pollution than on dematerialising the economy. As such, eco-industries are not indicative of either systemic innovation or eco-innovations in other sectors leading to lower resource use. Moreover, business strategies in eco-industries may be more about exporting capacity than applying resource efficiency at home.

The lack of correlation between the scoreboard results and resource trends points to the need to delve deeper into the causes underlying these trends for different countries. This especially means looking at the different structural conditions -- and their drivers and barriers -- to more effectively target eco-innovation at reducing resource use in the future. New policy approaches and ways to achieve material productivity improvements are probably needed to bring about greater levels of change.

The lack of correlation between the scoreboard results and resource trends points to the need to delve deeper into the causes underlying these trends for different countries.

3.2.2 | Structural conditions

Structural conditions mean the basic characteristics of different economies and societies which have been developed over the long-term. They describe the geo-political conditions that are not easy--or even impossible--to change quickly because they have to do with how those economies and societies have been built. An example is the natural resource endowment of different countries.

Five structural indicators were tested and evaluated for their relationship to both material consumption and material productivity. These include: (a) material intensity related to land area, (b) population density, (c) share of renewable energy in the electricity mix, (d) share of coal in the primary energy mix, and (e) share of manufacturing in total Gross Value Added (GVA). These indicators were selected to test whether they could explain the poor performance of especially Eco-Innovation leaders in the environmental outcomes category of the Eco-IS, but this list is not comprehensive and further structural indicators should also be tested in the future.

None of these indicators alone explain material consumption trends for all EU-27 countries, but some patterns and combinations did emerge. As regards country size and population density, countries with a small land area and high population density tend to have a relatively low level of material consumption per capita, whereas countries with a low population density and large land area, like Sweden and Finland, have typically higher per capita levels of material consumption. One reason could be that material consumption is heavily influenced by construction minerals (e.g. aggregates like sand, gravel, and crushed rock), which are used for roads . The material requirements for roads in countries with a low population density is generally higher on a per capita basis than for those countries with a high population density, like Belgium or the Netherlands. However, there are also some exceptions to this tendency. For example, France is a large country with a relatively low population density, but it also has a relatively low level of per capita material consumption. One reason could be the energy mix, in which coal hardly plays a role. For a large country, Germany has a relatively high level of material consumption per hectare, but only a relatively small DMC per capita, probably because of its high population density. Such examples reveal that it is the interaction of indicators which seem to be important. Further differences can be a result of other structural indicators. For instance, the wide gap between per capita consumption of Finland and Sweden cannot be explained by demographic or geographic reasons (both countries are very similar in both indicators) but could be a result of different energy mixes. Finland has a relatively high dependence on fossil fuels, especially coal, and nuclear power whereas Sweden relies heavily on nuclear and hydropower.

None of these indicators alone explain material consumption trends for all EU-27 countries, but some patterns and combinations did emerge.

14. Data from Germany reveals that roads are the most material-intensive infrastructure system (MaRess 2011)

Eco-innovation good practice 5

Use daylight in buildings

The Belgish company Econation developed the LightCatcher in order to enhance and spread daylight into buildings. It consists of a mirror that is integrated into different layers of polycarbonate and uses a sensor system that searches for the most optimal incidence of light. The light is captured, reflected, filtered, amplified and finally spread into the building. One LightCatcher can replace up to 12 fluorescent lights.

Source: http://www.econation.be

For Eastern Europe, countries with a low population density and high share of coal in their energy mix often have above average per capita material consumption levels. This is the case for Romania (20 tonnes per cap), Poland (16 tonnes per cap) and Bulgaria (16 tonnes per cap), in comparison to the EU average of 14.7 tonnes per capita (2009). In combination with a relatively low GDP, these countries also have the lowest material productivity in the EU.

Finally, the influence of the economic structure on per capita material consumption levels was assessed. The question is, whether countries with a high share of manufacturing industries have higher levels of per capita consumption, and conversely, whether countries with a high share of service industries have lower levels of material consumption.

No correlation could be found. For instance, Denmark has a high level of material consumption per capita, but a below average share of manufacturing in it's GVA. The inclusion of the mining and energy sectors does not change the picture significantly. France, the UK and Italy are examples of countries with a relatively low level of material consumption per capita. However, while France and the UK have a low share of manufacturing, the manufacturing sector in Italy comprises a large share of its GVA. Data on Total Material Consumption would also be important to consider here to better reflect the burden of manufacturing which takes place abroad.

Eco-innovation will not be able to influence geography and population size, but could be used to address the underlying drivers which make these factors significant.

Eco-innovation will not be able to influence geography and population size, but could be used to address the underlying drivers which make these factors significant (e.g. roads). Clearly, reducing the use of coal in the energy mix is important for not only lowering resource demands, but also for mitigating climate change. More research is needed on the resource impacts of shifting to a service-based economy. There seems to be a large potential for new and eco-innovative service-based business models (see section 5.1), but how these services are provided and delivered will have a large impact on resource trends, and better understanding these dynamics will become increasingly important for policy making.

All in all, the analysis reveals the fact that eco-innovation potential is based on different conditions and opportunities in different countries. There is clearly no one-fit all approach for the EU. For some structural considerations, probably the country level is also too aggregated. Analysis on the structural drivers of resource consumption at the regional and local level would also help to formulate targeted eco-innovation strategies for "hot spots" in those places.

3.3 | Greenhouse gas emissions

This section considers how GHG emissions relate to eco-innovation, and whether there is a correlation between eco-innovation activities and progress toward achieving targets.

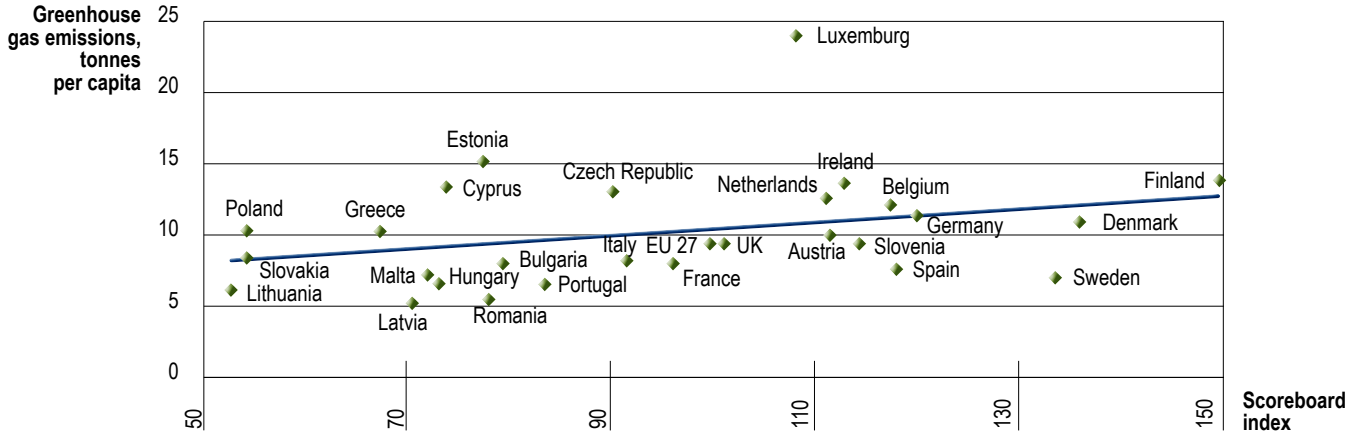
3.3.1 | Greenhouse gas emissions and emissions intensity trends

There is a modest positive correlation between higher overall scores in the Eco-IS and higher per capita GHG emissions.

Figure 3.5 illustrates how the overall scoreboard results relate to per capita GHG emissions across the EU-27. As in the case of material consumption, it shows a modest positive correlation between higher overall scores in the Eco-IS and higher per capita GHG emissions. However, there are also notable exceptions. On the one hand Sweden, from the group of EI leaders, has per capita emissions at the same order of magnitude as Portugal, Hungary or Lithuania. This good performance is probably a result of improved energy efficiency, structural changes in industry towards lower-emitting sectors and expanded renewable energy generation (Swedish EPA 2011). On the other hand, Luxembourg stands out as the country with the highest GHG emissions per capita in the EU-27. This is likely a result of its very high energy consumption, which is still largely based on oil and natural gas. Also the use of oil for road transport is around double the EU-27 average in Luxembourg (OECD 2010).

Figure 3.5

Eco-Innovation and per capita GHG emissions in Member States, 2010



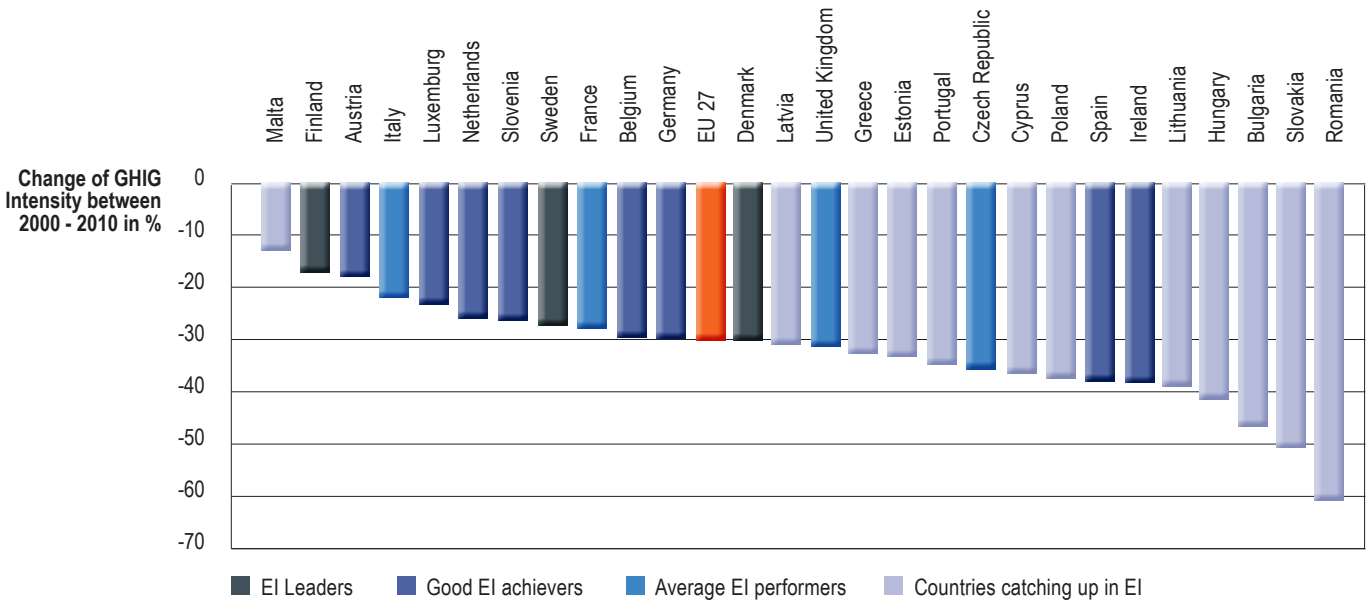
Source: Eurostat 2012 and own calculations

Figure 3.6 depicts the trend in GHG emissions intensity for all Member States. It reveals that all countries have reduced their emissions intensity—in other words they released fewer emissions per economic value in 2010 than in the year 2000. The "countries catching up in eco-innovation" have made the biggest gains in reducing their GHG emissions intensity. This indicates that cohesion countries are catching up fast. It is probably a result of environmental policy in the EU and funding to reduce pollution and emissions especially in new Member States. These results point to the potential of regulation for inducing widespread change (the emissions intensity of Romania was reduced by more than 60% in 10 years) and the need for resource regulation to achieve the same kind of changes in the resource arena. Nevertheless, the scale of change in good and top eco-innovation performers is relatively low, perhaps indicating the need for stronger policies for front-runners.

These results point to the potential of regulation for inducing widespread change.

Figure 3.6

Eco-Innovation and GHG emissions intensity dynamics in Member States, 2000-2010



3.3.2 | Greenhouse gas emissions, targets and eco-innovatio performance

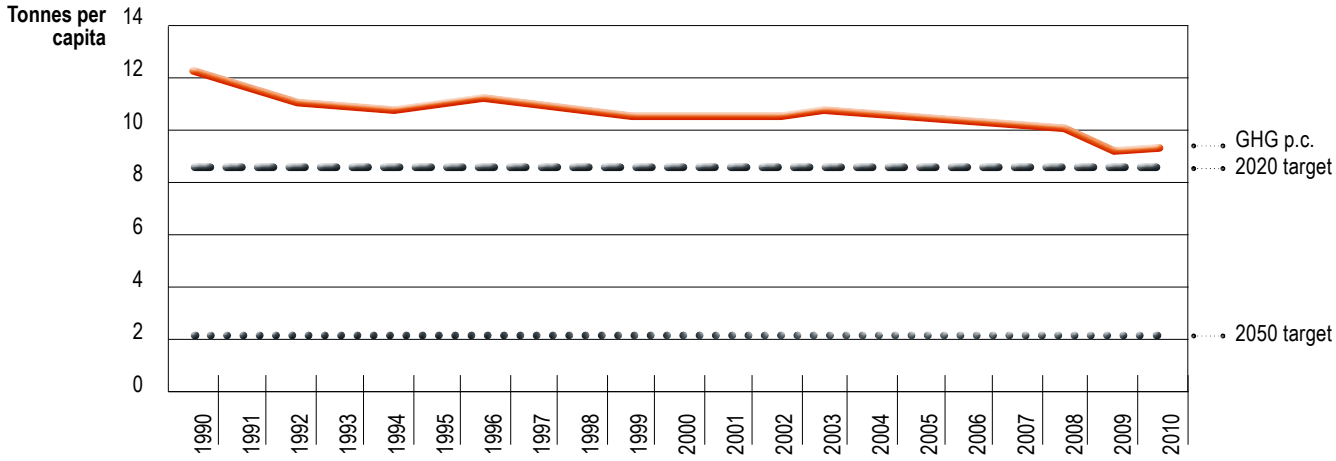
Chapter 2 has shown targets for the four major resource use categories of material, land, water and energy/climate. From those four categories, only the target for greenhouse gas emissions is already adopted on the European level. Figure 3.7 portrays the development of the EU with regard to GHG emissions (on a per capita basis) and the related reduction targets (as presented in Table 2.2).

Recent studies illustrate that the reduction of territorial GHG emissions in Europe are overcompensated by increased emissions from imports by a Factor 2.

Europe achieved a significant reduction in per capita GHG emissions from the year 1990 onwards and almost achieved its 2020 reduction target by 2009. However, per capita GHG emissions went up again in 2010, emphasising that further efforts are required to keep GHG emissions on a decreasing trend. This is particularly relevant as this indicator only reflects territorial GHG emissions, not those emitted to produce the products imported to Europe. Recent studies illustrate that the reduction of territorial GHG emissions in Europe

Figure 3.7

Per capita GHG emissions of the EU-27 between 1990 and 2010 (in tonnes of CO2 equivalents) and the EU reduction targets for 2020 and 2050



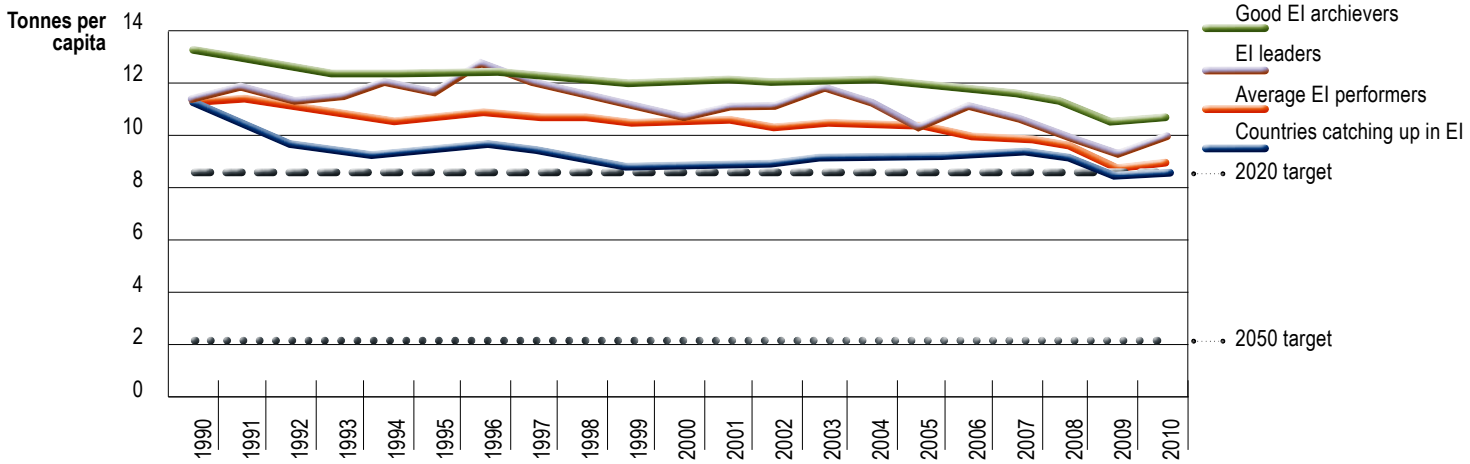
Source: Based on Eurostat 2012

are overcompensated by increased emissions from imports by a Factor 2. Including those emissions would actually reveal an upward trend since 1990 and an increasing distance to the Kyoto reduction target (Peters et al. 2011).

Figure 3.8 depicts the extent that eco-innovation performance, as measured with the Eco-Innovation Scoreboard, correlates with the achievement of GHG emission targets. It reveals an interesting pattern with regard to the different groups of eco-innovation performers. The group of relatively best-performing eco-innovation countries in Europe ("EI leaders") is not the group with the lowest GHG emissions per capita. With almost 10 tonnes per capita, EI leaders have the second highest level of GHG emissions, only topped by the group of Good EI achievers, with an average of 10.6 tonnes. The group of countries "catching up in eco-innovation" is the only group, which currently is below the average European per capita 2020 target for GHG emission reductions.

Figure 3.8

Per capita GHG emissions of the four eco-innovation groups, and the EU reduction targets for 2020 and 2050



Source: Eurostat 2012 and own calculations

3.4 | Discussion of observed trends and correlations

The analysis suggests that the overall environmental performance of countries is not necessarily correlated to eco-innovation performance in the way it is currently being measured by the Eco-Innovation Scoreboard. Thus, as a tendency, countries performing well in the Scoreboard still have high environmental pressures per capita and are not on a path towards achieving the required reduction targets. There are a number of potential reasons, with implications for both future eco-innovation efforts and policies.

First, it is important to acknowledge that the Eco-Innovation Scoreboard is a tool for relative benchmarking between countries. As targets for specific eco-innovation indicators do not yet exist, the Scoreboard results themselves cannot reveal, whether even the "Eco-Innovation Leaders" are performing well in absolute terms. Some indicators in the scoreboard allow putting the performance of countries into perspective. For example, the indicator derived from the Community Innovation Survey (CIS) indicates how many companies report having implemented innovation to save material inputs. The 2008 survey revealed that only around 15% of all companies in Europe eco-innovate. The observed correlation between high scoreboard results and high pressures per capita can thus result from the fact that eco-innovation activities have not yet spread enough or have not yet happened at an intensity large enough to realise a substantive reduction of material inputs on the macro-economic level.

Eco-innovation activities have not yet spread enough or have not yet happened at an intensity large enough to realise a substantive reduction of material inputs on the macro-economic level.

Second, a possible interpretation of the trends analysed above might be that the most eco-innovative countries as measured with the Eco-IS are so engaged in pushing eco-innovation exactly because of their high level of environmental pressures. High eco-innovation activities could be regarded as a response to the necessity to improve the absolute environmental performance of countries.

This closely links to the third possible explanation, which is the fact that time-lags can be observed between high eco-innovation activities mirrored in high Eco-IS scores and resulting positive environmental outcomes. Other authors have emphasised that the cycle from first development of new technologies to full market implementation on a large scale can take up to several decades (Huppes et al. 2008).

A final and important reason is that there are other factors that are more important than eco-innovation in its current scope that determine absolute levels of resource use in a country. Those factors include economic structures and the sectoral composition and specialisation of countries, structures of international trade, the general RTD and innovation systems of countries, issues related to consumption patterns and life-styles, as well as the general policy framework. This especially indicates the need to get to the root causes of high levels of resource use in order to promote effective eco-innovations for reversing the trend.

4 | The role of eco-innovation for the transition to a resource-efficient Europe

Key Messages

- Structural changes have been driven by "waves of innovation" converging technological potential with collective shifts in perception. The next decades will prove whether the green economy is the next "big thing" and if it can create synergies between socio-economic benefits and environmental objectives.
- Major socio-economic transitions are determined by structural barriers deeply embedded in the economic and social fabric. Systemic lock-ins and market failure have a direct bearing on the strategic operations of companies and may hinder eco-innovation efforts. Policies promoting a green economy need to address these structural barriers.
- System eco-innovation improves the performance of an entire system, instead of focussing on its individual components. This approach equips it to better overcome structural barriers. Radical system eco-innovation is not a "quick fix", but it offers frames and a direction for short-term investments.

4.1 | Eco-innovation: The next big wave of innovation?

Speaking of a resource 'revolution', McKinsey (2011) recalls the disruptive element of eco-innovation: incremental advances are insufficient to achieve a timely transition to a resource-efficient Europe (EIO 2012). Change that is systemic, multidimensional, and disruptive is needed. Paradigm change happens at the convergence of technological potential and new, collectively shared mind-sets (Polanyi 1944, Kuhn 1962/1972, Dosi 1982).

Technological innovation is not a silver bullet in pursuing structural change, but it will play an important role. According to Utterback and Acee (2005), the importance of new technologies goes beyond displacing established products; it can also be a powerful means for enlarging and broadening markets and providing new functionality. From a historical perspective, however, transitions have involved the emergence of entirely new or redefined industries and infrastructures (Perez 2010). "Waves of innovation" have been accompanied by shifts in behaviour, shifts in policy, and shifts in structure that converge with the occurrence of technological innovation. The recent ICT revolution, for instance, has been accompanied by cheap microelectronics provided by suppliers and with the establishment of new world digital telecommunications (cable, fibre optics, radio and satellite).

"Waves of innovation" have been accompanied by shifts in behaviour, shifts in policy, and shifts in structure that converge with the occurrence of technological innovation.

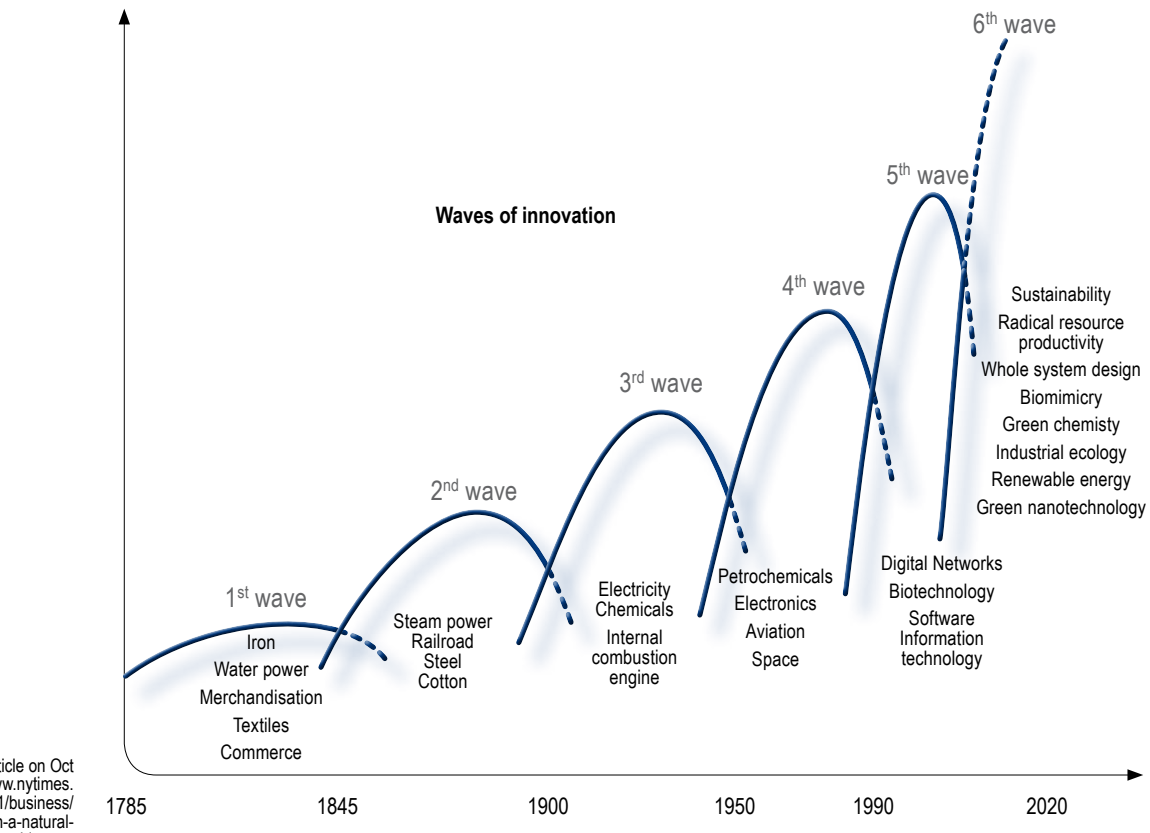
Many authors argue that the next “wave of innovation” will be “green” and concentrate innovation efforts on achieving sustainability (see Figure 4.1). The next decades will be a stress test of the potential of the green economy to exploit synergies of socio-economic and environmental objectives. One should bear in mind, however, that changes in technologies and business models are directionally open and many radical changes currently taking place may not lead to sustainability, but rather work against it.

In a worldwide perspective, the emergence of unconventional fuels such as shale gas is an example of conflicting rationales driving innovation. With more efficient drilling technologies (horizontal drilling, fracking and other techniques), the relative costs of gas in North America have been declining significantly in the past few years. In the US, utilities have started to switch from coal to gas, new gas-powered busses and trucks fill the roads, and fertilizer and chemical companies are beginning to assemble new factories to produce plastics from gas in the US. A recent report estimates the benefits to the US economy in an order of more than US$ 100 billion in 2010[15]. In other words, the spaces for innovation are driven by perceived economic opportunity rather than by overall sustainability. This case underlines that disruptive change may occur quickly and that many countries and regions of the world may follow different strategies.

Disruptive change may occur quickly and many countries and regions of the world may follow different strategies.

Figure 4.1

Waves of innovation: 1785 to 2020



Source: The natural edge project (http://www.naturaledgeproject.net/Keynote.aspx AS of Oct 26, 2012)

15. See e.g. a NYT article on Oct 21, 2012: http://www.nytimes.com/2012/10/21/business/energy-environment/in-a-natural-gas-glut-big-winners-and-losers.html?hp&_r=0

Eco-innovation good practice 6

Green-tech cluster

Source: http://www.eco.at

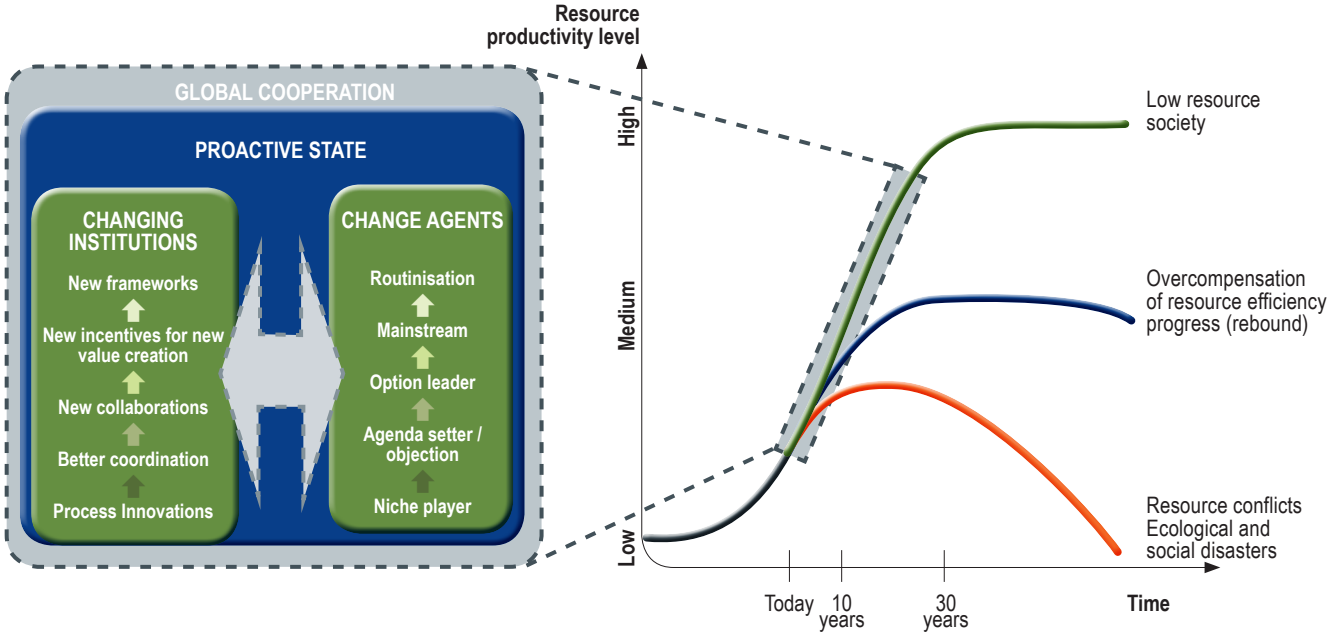
Eco World Styria is an Austrian green technology cluster with around 200 companies and research centres actively working on environmental engineering. Founded in 1998 the initial lose network evolved into a cluster of around 200 companies and research centres by 2005. The cluster focuses on a research-industry-government cooperation model to take eco-innovation to a higher level. It offers its companies a range of services such as market strategy support, innovation potential evaluation, and investor search. It supports green technology innovations in the areas of biomass, solar energy, material flow management, waste and water.

The EU 2020 strategy promotes structural change with a sustainability orientation. To get underway, the transition towards the sustainable use of natural resources needs to resonate strongly with business practice and perception in five dimensions:

- In the dynamics of the *relative cost structure of inputs* to production, which can make resource efficiency the most attractive choice for profitable innovation and investment (especially in light of commodity price volatility and expected prices increases). Reductions of material costs through process eco-innovations (in particular re-use and recycling) and material substitutions are examples.
- In the *anticipated trends for innovation*, where entrepreneurial opportunities are increasingly mapped and sought out. Cleantech clusters (Austria EcoWorld Styria, Copenhagen Cleantech Cluster, Finnish Cleantech Cluster, CleanTech North/Rhine-Westfalia, Stockholm's Miljöteknikcenter, etc., see also EIO 2012a) could become such niche actors of change.
- In the *organisational criteria and principles*, where practice shows how particular management methods and structures can take advantage of the power of new eco-innovations for maximum efficiency and profits. Organisations that seek to disseminate eco-innovation best practices and help to overcome coordination deficits support such change.
- In the *collaboration patterns*, where businesses and public organisations alike are looking for new partners for forming networks and coalitions across sectors and value chains (see Chapter 5.5).
- In the overall *business models* as firms redefine value propositions for their customers as well as looking for new ways to deliver value (see Chapter 5.1).

Figure 4.2

Eco-innovation and structural change for a green economy



Source: adapted from WBGU 2011

4.2 | Barriers and drivers to the transition

The major determinants of structural change are deeply embedded in the economic and social fabric (Figure 4.3). Especially lock-in effects will hinder reversing the business-as-usual trend. Lock-ins are conditions that favour established economic practices and actors. They stem, for example, from (1) long investment cycles in capital goods and infrastructures (with road construction and maintenance as well as fossil fuel power stations being two cases) and (2) particular arrangements in the political economy of resource-extracting economies with vested interests of asset owners that makes them less favourable to radical eco-innovations.

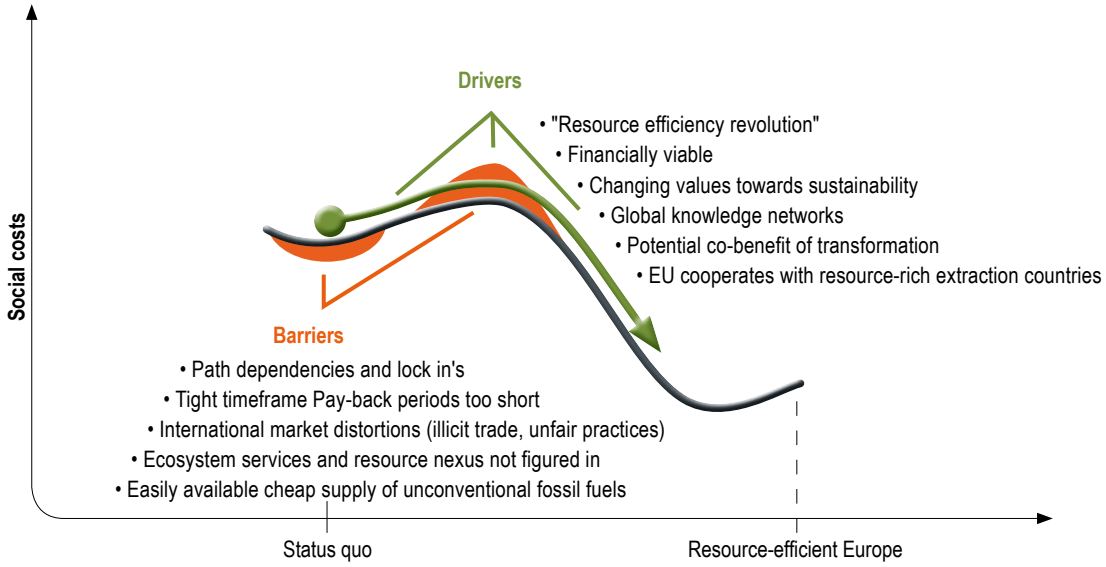
Market failures send the wrong signals to companies.

Market failures send the wrong signals to companies. They may exist in the form of externalities and collective action dilemmas. Examples preventing greater efforts toward resource efficiency are the undervaluation of ecosystem services, non-acknowledgement of planetary boundaries and price uncertainties for commodities. Strong policy frameworks can address these failures through market-based instruments (like resource taxes) and the establishment of targets for resource use (Chapter 2).

Distortions on international commodity markets increase risks for investors. This could be the result of unfair trade with asymmetrical gains, illicit trade with critical minerals from conflict areas, speculation, market power of state-owned and other emerging miners on commodity markets, and pre-emption of scarce assets (such as rare earths). For eco-innovation, increased price volatility may trigger efficiency improvements at home, but may hinder innovation across supply chains and thus, block more radical system eco-innovation efforts.

Figure 4.3

Drivers and barriers to the transition



Source: adapted from WBGU 2011

The existence and the intensity of barriers differ among sectors (Montalvo et al. 2011, EIO 2011a) and among countries. While financial barriers, for instance, are less important in the UK, lack of priority and political will is of greater relevance there. For new Member States, the lack of funds within enterprises are more important than in the old Member States. Some policies may even directly or indirectly support unsustainable trends (e.g. environmentally harmful subsidies). Addressing these barriers could be even more challenging in the EU than for countries like the US or Japan because it requires engagement and coordination across 27 Member States.

Many barriers have a direct bearing on the strategic operations of companies. A lack of top management commitment to eco-innovation might be caused by various factors: (1) uncertainty about future factor input prices (notably materials but also other resources as carbon or water); (2) lack of information from the other departments concerning the profitability of production-integrated environmental technologies, energy and materials efficiency changes and other process innovation; (3) lack of managerial capacity and capital to start doing feasibility studies on these issues; and (4) lack of orientation about long-term trends and key challenges. These factors are aggravated if national governments and the EU do not create coherent incentives for change (see actor perspectives in Chapter 5).

Eco-innovation good practice 7

Industrial symbiosis

Source: http://www.nisp.org.uk

The British Industrial Symbiosis Network helps to identify resource efficiency opportunities in terms of recovering and reprocessing waste products from one industry that can then be re-used by other businesses. The programme works directly with businesses of all sizes and sectors. It provides the tools and techniques to enable the participating firms to accurately identify in-house material streams. It is estimated that in the UK, the programme has contributed to a reduction of 39 million tonnes of carbon dioxide, diverted 38 thousand tonnes of waste from landfill, generated €1.24 billion in additional sales and created or safeguarded over 10,000 jobs.

4.3 | System eco-innovation: measuring up to the challenge

A system is a set of things working together as parts of a mechanism or an interconnecting network; a complex whole. One of the key principles of system thinking is that the parts of a system can only be understood in relationship to one another and with other systems, rather than in isolation.

A key feature of system eco-innovation is that it improves the performance of an entire system, instead of focussing on its individual components.

System eco-innovation is a series of connected innovations that improve or create new systems delivering desired functions while reducing environmental impact. A key feature of system eco-innovation is that it improves the performance of an entire system, instead of focussing on its individual components. This approach equips eco-innovators to more easily overcome structural barriers.

System eco-innovation can be applied to systems of different sizes, ranging from “complex products” (e.g. a house) to entire production and consumption social systems (e.g. a city). For example, system eco-innovation related to a home heating system is not about just using a more renewable energy carrier: it is about innovating the design of an entire house (e.g. exchanging windows, insulation, floor plan, etc.) to improve its functionality. System eco-innovation in cities happen when innovation and planning efforts lead to a combination of changes to make the functioning of the city and city life more sustainable. This includes, for instance, new mobility concepts that do not focus just on improving individual components of the transportation system (e.g. better buses, better roads), but innovate entire mobility systems based on reflection of what underlines the mobility needs. This can include connected changes in mobility systems, including combining various means of transportation, adapting infrastructure and regulatory frameworks as well as urban functions and planning. Depending on the system, eco-innovation may require a short or longer time strategy to implement.

System eco-innovation can vary from a system level adaptation to a more radical transformative system innovation. Figure 4.4 presents an at-a-glance overview of different

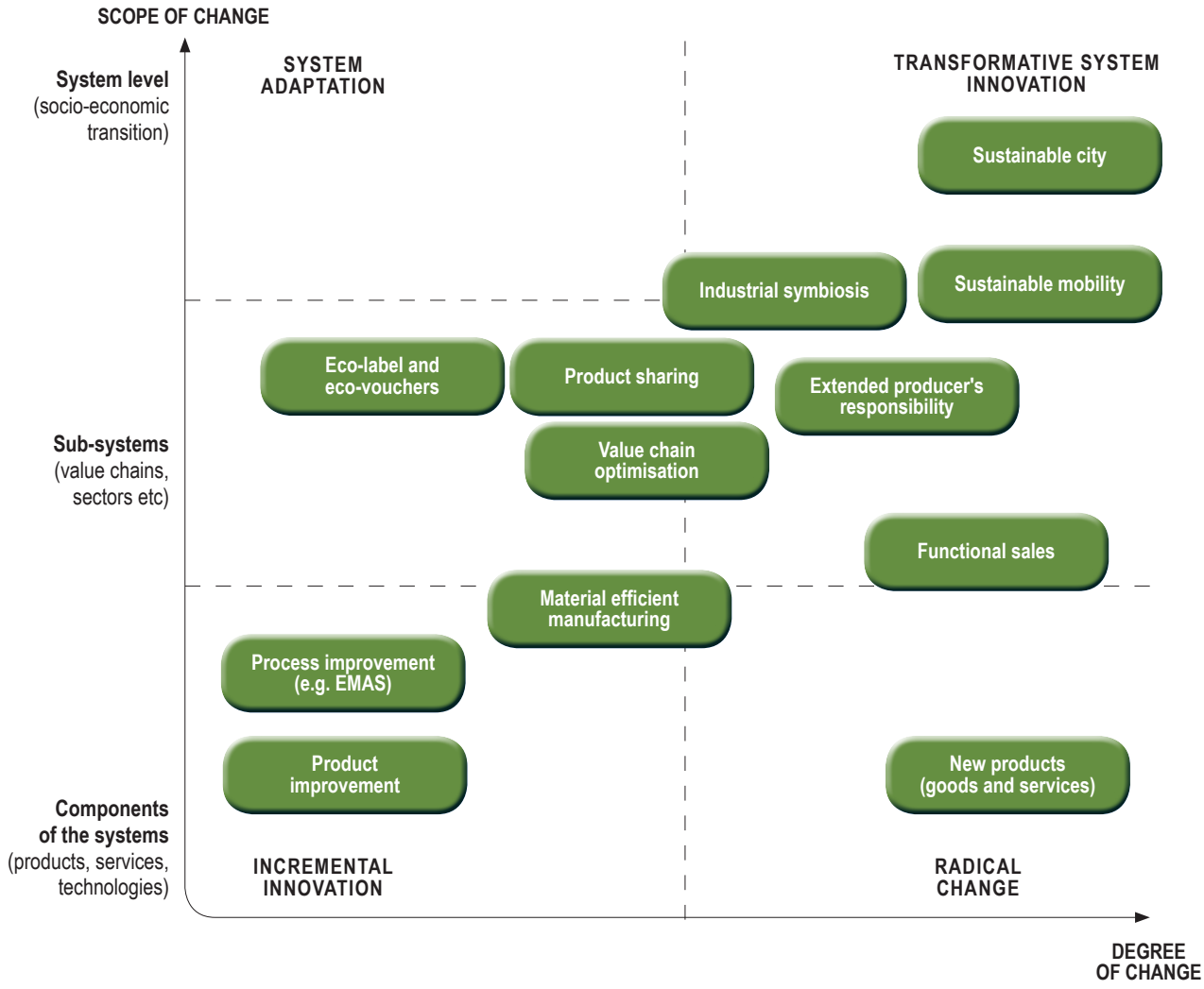
types of eco-innovation based on two dimensions: scope and degree of implemented change. System innovation happens at the level of sub-systems and systems rather than individual components (e.g. individual products or services). System eco-innovation may be incremental, when it results in the adaptation of an existing system. Transformative system innovation, on the other hand, is based on a radical redesign of established systems and leads to a transformative change.

Transformative system innovation is based on a radical redesign of established systems and leads to a transformative change.

The latter is based on a radical rethink of how to satisfy the needs of society while recognising global social, economic and environmental challenges. Transformative system eco-innovation re-arranges the way specific functions or services, such as mobility, shelter and nutrition, are developed and delivered to people. Pursuing system eco-innovation is challenging. System eco-innovation may be criticised for having too much faith in the capacity to plan and control innovation processes. The EIO consortium, however, does not promote the concept of system eco-innovation as a deterministic planning tool. System eco-innovation is above all about identifying the root causes of systemic problems and targeting these levers to shift systems toward sustainability in a co-ordinated way. As with any innovation, however,

Figure 4.4

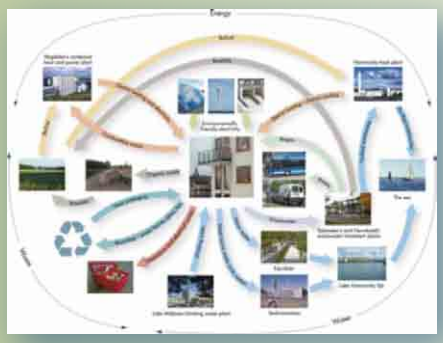
From product improvement to transformative system innovation



Source: Miedzinski (forthcoming)

Eco-innovation good practice 8

Symbiotic systems in urban districts



Source: http://www.hammarbysjostad.se/

The Hammarby Model is a Swedish green urban development project that has been developed by a water company and the waste management administration of Stockholm in 1998. The model is a systemic approach that aims to reduce energy consumption and waste generation in an urban district (Hammarby Sjöstad), whilst maximising resource efficiency, re-use of materials and re-cycling. It integrates various technical supply systems into a symbiotic system, e.g. waste heat from the treated wastewater is used for heating up the water in the district heating system, which, in turn, heats the apartments and offices in the district. A crucial condition for the success of the Hammarby Model was the collaboration between all the affected stakeholders, such as local authorities, developers and companies responsible for waste, energy, water and wastewater.

system eco-innovation faces market risks, iterations and requires sustained entrepreneurial effort. Practical examples break these concepts down and show how to overcome risks and how to be successful applying systemic thinking to innovation (see the Hammarby model and industrial symbiosis good practice examples).

While most innovation thinking concentrates on individual technologies and products, there is a need to actively pursue a system level change. However innovative clean technology or product-level eco-innovation are, they are unlikely to diffuse if approached without consideration of how they relate to other parts and players of the system they are to be a part of.

Structural barriers may significantly reduce the positive impact or even prevent implementation of individual eco-innovations. System eco-innovation, on the other hand, addresses the barriers as an inherent innovation challenge in the design stage.

Eco-innovation will probably face structural barriers and resistance from dominant market players who benefit from the status quo (e.g. traditional versus renewable sources of energy). Such structural barriers may significantly reduce the positive impact or even prevent implementation of individual eco-innovations. System eco-innovation, on the other hand, addresses the barriers as an inherent innovation challenge in the design stage, and aims to implement the change on the level of a functional system, rather than on the level of an individual component of the system (e.g. product).

Radical system eco-innovation is an investment in the future that provides a systemic response to grand societal challenges expected to grow in the medium to long term. It is not a “quick fix” strategy, but aims for long term wins. System eco-innovation offers frames and a direction for short-term investments. It could even support decisions to stop investments promising “quick wins” as they can become obsolete when system-level change is implemented. Front-runners, who research and develop the concept, however, may capture benefits already in a relatively short term if they find an appropriate market niche.

5 | Paving the way to the future we want: actor perspectivee

Key Messages

- New business models integrate environmental sustainability to meet customer needs in novel ways, leading to the development of disruptive eco-innovations across value chains and in the value propositions of companies. Strong leadership has been key to successful business cases, yet a lack of incentives to change (especially regarding price) continues to hamper widespread redefinition of business models.
- Citizens can both use and partake in eco-innovation to co-create high quality lifestyles that are more sustainable. Awareness about global problems has not led to widespread changes in behaviour, and when it has, a Behaviour-Impact Gap (BIG) problem has prevented pervasive change. Policies at a structural level are needed to provide the infrastructure, means, and information for people to be able to make more sustainable changes in their lifestyles.
- Sustainability research takes an integrated approach to understanding the interactions between humans and natural earth systems. It engages stakeholders in a co-production of knowledge about both the long-term visions and short-term solutions. To encourage a transfer of scientific approaches and greater collaboration, new ways to organise and measure academic success beyond the boundaries of traditional disciplines are needed.
- To take the challenges of sustainability into account, the organisational structure of public administrations needs to change. New governance models will be built on a shared vision, allow for flexible collaborations and be based on the principle of subsidiarity to ensure that eco-innovation challenges are tackled on the level where collective capacity to act is concentrated. Co-development of a vision is key to make stakeholders "owners" of a vision and open to change.
- The role of individual stakeholders in the transition are just as important as the new forms of collaborations between them. New strategic alliances of "fast movers" will develop and implement eco-innovations demonstrating desirable alternatives to business-as-usual.

5.1 | Business: Delivering value in a resource-efficient way

The World Economic Forum (WEF 2012a) sees establishing new forms of business to meet the needs of future citizens as a core strategic imperative for any company. Efforts, strategies, approaches and business cases have been discussed in several recent reports and case studies (e.g. COWI 2008, Johnson and Suskewicz 2009, FORA 2010, WBCSD 2010, Ellen MacArthur Foundation 2012, Nordic Innovation 2012a,b, Sommer 2012, UNEP 2012, WEF 2012a). This section draws on these, as well as on the ideas developed and

Establishing new forms of business to meet the needs of future citizens is as a core strategic imperative for any company.

Eco-innovation good practice 9

Smart freight bundling

Source: http://www.trivizor.com

In 2008, the Belgian company Tri-Vizor developed a software tool called smart bundling that allows synchronising the freight transport capacities of diverse customers from multiple supply chains. Based on shipment bundling and horizontal partnerships in transport and logistic, Tri-Vizor is able to offer pooling possibilities of transport loads to its customers. For instance, instead of sending two trucks to the same destination from two firms with a half load, the two loads can be bundled within one single and fully-packed vehicle. The software makes it possible to maximise the total community gains in terms of CO_2 emissions related to freight and other external costs of road traffic.

discussed at an EIO Focus Group dedicated to the "Future Role of Business in a Green Economy" held on the 3 September 2012 in Wuppertal. It examines how business can eco-innovate in the way it delivers value to its customers by rethinking its offer, organisational model and collaboration patterns, as well as what the internal and external barriers and drivers to these changes could be.

5.1.1 | The role of business in reaching the green economy

How value is created and how companies meet customer needs and relate themselves towards environment and natural resources may be quite different in the future.

The function of business in society will probably stay the same. Business will continue to "[do] what business does best: cost-effectively creating solutions that people need and want" (WBCSD 2010). Business will continue to create value, but how value is created and how companies meet customer needs and relate themselves towards environment and natural resources may be quite different in the future.

Instead of viewing the environment as an external challenge (e.g. eco-innovating in response to environmental regulations) or just as a source of materials, companies of the future will have internalised environmental sustainability across all their operations (OECD 2012). Integrating sustainability in how value is created and distributed leads to a restructuring of value chains and new types of producer-consumer relationships. It paves the way to radical and system eco-innovation. In this sense, business can create value in a way that is contributing to the long-term resilience of the socio-economic system operating within sustainable limits, instead of contributing to the degradation and depletion of the natural resource base society depends on. At the Rio+20 Earth Summit , Norine Kennedy (USCIB) pointed out, "business cannot succeed in societies that fail, so from that standpoint, business's long-time commitment to sustainable development is indeed in the self interest of companies, as well as that of the global community." For this reason, business has a role, and a vested interest, in making green economies work.

Thus, one of the major roles of business in the transition to a green economy will be to redefine itself and to transform the way business is done. As Sommer (2012) stated, “In addition to ordinary product and process innovations, (business) can change ‘the rules of the game’ within an industry towards environmental sustainability.” This means that the role of business in society could also change. In a more radical perspective, the value itself which business provides may be redefined. For instance, social entrepreneurs deliver goods and services, but are not profit-oriented and serve other social functions than business-as-usual. In any case, business will continue to play a key role in how society works, and thus how smoothly the transition to a resource-efficient Europe is achieved.

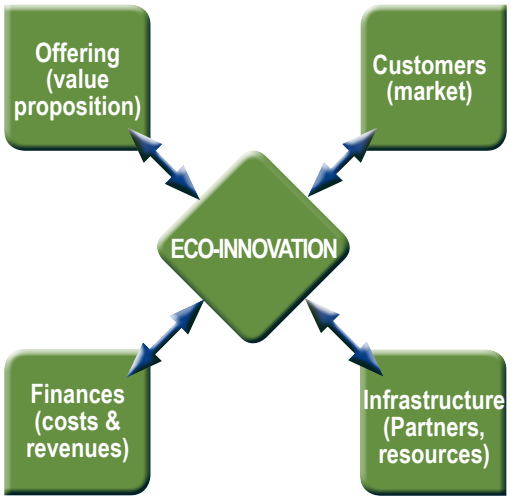
5.1.2 | Redefining business models for sustainability

A business model describes “the rational of how an organisation creates, delivers and captures value” (Osterwalder and Pigneur 2010). It is one of the basic concepts of management that guides the process of business development and design. According to the business model literature (e.g. Osterwalder and Pigneur 2010) business models of companies can be described in four general areas: 1) what they offer (their “value proposition”), 2) who their customers are and how they serve them (market), 3) what the financial viability of their business model is (cost structure and revenue streams), and 4) How they build their offer (their infrastructure—what partners and which resources). Mapping business models in these four areas allows companies to identify tensions and opportunities to design, invent and re-invent their business models. It also provides a framework for developing and implementing eco-innovation (Figure 5.1).

This section looks at eco-innovation in each of the four building blocks of the business model. It examines what the key differences between business models in a sustainable future (2050) and business models today might be. Making environmental sustainability an integral part of business models is crucial to the transition. For this to happen, however, sustainability has to deliver value for the company and its customers.

Figure 5.1

Integrating eco-innovation across business models



Source: Own compilation based on Osterwalderand Pigneuer (2010)

Value proposition: What is your business?

The focus will be on how to create the experience with a lower resource cost and environmental impact, integrating the principles of a circular economy.

Changes in the offering--the value proposition--aim at the heart of the business. Today, the most compelling business models are designed to amplify the offering. Companies like Apple, ebay, and Groupon put the experience first to create a user-centred business (IDEO 2011). This type of user-oriented thinking will continue in the future, except that the focus will be also on how to create the experience with a lower resource cost and environmental impact, integrating the principles of a circular economy.

In "traditional" linear production and consumption models products are made, sold, used and disposed over and over again. This way of doing business is leading to growing waste streams and to increasing environmental impacts. Putting the business focus instead on a circular value proposition—products are made, sold, used, reused and recycled over and over again—would better enable conservation of the natural resource base and creation of a new core activity of the business infrastructure (e.g. remanufacturing[17]) (Ellen MacArthur Foundation 2012). This could have fundamental implications for the eco-innovation strategy of a company, including:

- rethinking supply and value chains in order to source primary and secondary resources with less environmental impact;
- substituting resource and energy inefficient products and processes with new ones with lower resource and energy costs;
- selling the experience (or a performance), but not the product itself, which will provide incentives to extend the life of products.

The focus of the value proposition will change from selling a product to selling a result.

Especially a different understanding of how to serve the customer needs[18] will be more prominent in the business models of the future. The focus of the value proposition will change from selling a product (like a washing machine or a car) to selling a result (like clean clothes or mobility), which will change the impacts of "consumption" on resource use (Stahel 2010). Selling a result or a performance corresponds to special types of so-called product-service systems (see Box 5.1). Profit in such a system is not generated by encouraging a high turnover of products (every year a new mobile phone) but by either keeping products in use longer or eliminating the need for consumer-owned products altogether.

Market: who are your customers?

It is the changes in thinking and doing things differently and in making other agents in a system perform differently that bring about systemic transformation.

The attitude of citizens, their motivations and their consumption patterns play a crucial role in the commercial success of an eco-innovation. Especially when it comes to the increased offering of product-services systems, customer attitudes regarding changed product ownership structures or changed consumption patterns are important prerequisites for the viability of many new business models. The focus of such service-based eco-innovation is not purely based on the technology, but rather on changing the traditional business practices by changing customers' habits so that resources are used more efficiently, while functions or utilities are still delivered. Although the immediate environmental impact might not be so dramatic, it is the changes in thinking and doing things differently and in making other agents in a system perform differently that bring about systemic transformation (Nordic Innovation 2012a,b).

17. Turning to a circular product design affects the physical infrastructure in companies and across value chains. Such an infrastructure system would require a collection system for used products, efficient remanufacturing processes, and the demand for remanufactured products (Matsumoto und Umeda 2011).

18. Turning to a circular product desig"What we want from these products is not ownership per se, but the service the product provides: transportation from or car, cold beer from the refrigerator, news or entertainment from our television" (Hawken 1993).

Box 5.1 | Product-Service Systems

According to Tukker (2004), product-service systems describe business strategies that have "tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs". Tukker et al. (2006) note that the concept is essentially the same as the concept of "value-added services", which has been developed in business management literature. In this sense, there seems to be a merging of environmental and economic disciplines concerning ideas on future business models. There are several types of product-service systems, with different degrees of effectiveness (Tukker et al. 2006):

- Product-oriented strategies put the product into the focus of the business activity, but supply the consumer with co-product services like advice or consultancy activities, maintenance guarantees and others.
- Use-oriented strategies do not sell products, but lease or rent them. Different forms of consumption (alone, shared with others, together with others) and payments are possible (per time unit, per service unit).
- Result-oriented strategies focus on outsourcing or other forms of activity management. Instead of selling the product or selling the use of a product, the result of the product is sold.

In most cases, product-service systems are accompanied by positive environmental effects (Tukker 2004). The more the focus switches from the products to the service functions, the higher the potential for environmental savings compared to the reference situation (Figure 5.2). Not only the "short-term resource management" (maintenance and waste treatment) of business can be influenced by shifting the ownership in product-service systems from the customer back to the company, but also the "long-term resource management". Designing products in a way that they lead to a longer product durability, that they need less resources not only in the production but also in the use phase and that they can be recycled and reused (easily) could be the result of the value proposition shift from products to results. However, the total macroeconomic effect for resource efficiency of different product-service systems needs to be tested further.

The more the focus switches from the products to the service functions, the higher the potential for environmental savings compared to the reference situation.

Figure 5.2

Product-service systems and their environmental effects

PSS type	Impacts compared to reference situation (product)				
	Worse	Equal	Incremental reduction (20%)	Considerable reduction (50%)	Radical reduction (<90%)
1. Product-related service		◄	►		
2. Advice and consultancy		◄	►		
3. Product lease	◄		►		
4. Product renting and sharing		◄		►	
5. Product pooling		◄			►
6. Activity management			◄	►	
7. Pay per unit use			◄		►
8. Functional result			◄		►

Notes: • Renting, sharing: radically better if impact related to product production.
• Pooling: additional reductions compared with sharing/renting if impacts related to the use phase.
• Renting, sharing, pooling: even higher if the system leads to no-use behaviour.

Source: Tukker 2004

Eco-innovation good practice 10

Selling the performance of household appliances

In 2012, Bosch, the real estate corporation Eigen Haard and the raw materials manager Turntoo launched a joint pilot project based on the sale of performance of energy-efficient household appliances to low-income households in the Netherlands. Instead of selling the washing machine or the refrigerator, the ownership of the products is retained by the producer and cleaning and cooling functions are sold to the customers. After the lease contract expires, the user returns the appliance, which can then be reused or remanufactured for the production of new machines. The companies' pilot cooperation could lead to the establishment of a circular economy business model. It is expected to generate savings regarding raw material of the appliances, energy, water and greenhouse gas emissions.

Source: http://turntoo.com/en/2012/07/turntoo-eigenhaard-and-bosch-to-sign-contract/

For eco-innovation, it is important to also understand how customers use products and services. For highly technical and or complex eco-innovations, customers may lack the knowledge on how to effectively use new products. For instance, a new home heating concept may not function efficiently if the user does not know how to operate it. This implies that new services may be required to monitor and check up on how effective new solutions have been. This would also be an opportunity for companies to learn from customer experiences and adapt their offering accordingly.

Finally, eco-innovation may be a strategy to reach out to new markets and expand the customer base. Considering the increasing interest of customers in sustainable products and services (PwC 2010), the market can offer opportunities for new businesses that have eco-innovation in their core.

Finances: where can you save costs and generate profits?

One of the main questions for the pricing strategy of companies is whether businesses are more cost driven (leanest cost structure, low price value proposition, maximum automations, extensive outsourcing) or value driven (focused on value creation and premium value proposition) (Osterwalder and Pigneuer 2010).

On the cost-saving side, resource efficiency offers a direct opportunity for companies.

On the cost-saving side, resource efficiency offers a direct opportunity for companies. Until recently, the potential to reduce costs by saving resources was largely ignored by companies. Instead, the focus was overwhelmingly on labour productivity (EEA 2010). While resource productivity may still not have reached the mainstream, the last five years have seen a boom in studies focused on cost saving opportunities (EIO 2012a). Nevertheless, these savings are still oriented toward more incremental change (see Section 2.1).

Companies of the future might operate in a system that is characterised by ideas of sufficiency. First pioneer business efforts and several citizen movements are already pointing into the direction of consuming less and in a more conscious way. To some extent, sufficiency or de-growth strategies for business already exist, but they are discussed, researched and adopted only hesitantly (Sachs 1993, Schneidewind and Palzkill-Vorbeck 2011). How de-growth and sufficiency strategies can be implemented into business' daily life and how they can be turned into successful business strategies is a question in need of further research.

Infrastructure: who are your key partners?

Changing the value proposition will change the relationship between business and its customers. For instance, for creating a successful product-service offer, the company needs to know what the customer really needs, which requires engaging with customers in a new way. Second, selling the "use" or a "result" instead of "just a product" prolongs the relationship between business and its customers, as the service of maintenance, repair or return of the product is attended by several communication points between the customer and the company. As such, stronger customer retention and loyalty could become more common elements of business models in the future.

Stronger customer retention and loyalty could become more common elements of business models in the future.

The prospective relationship between the company and its value chain members will also become more familiar, as well as more elaborate. In a circular economy, collaborative structures are not only needed to supply primary resources, but also in the recovery and supply of secondary resources. To develop recovery mechanisms that make sense and efficient recovery processes, engineering alliances that share knowledge and experiences between all the members of the value chain will be beneficial. In this way, knowledge from other processing stages, like remanufacturing, could be collected and reflected in the product design.

Co-operation between business and public stakeholders is an important element in promoting transformative changes of businesses towards sustainability. Creating enabling framework conditions for eco-innovative business is in the hands of the government, who need to understand what will drive businesses to shift to sustainable models of operation. In this regard, a dialogue between government and the business community can help to create policies that address the market failures that are faced by new eco-innovations and new green business models. Such a dialogue also allows businesses to take part in the policy-making process and can actively influence the development to a green economy.

Joint alliances between research and business will continue to be important in the future. Business thinking has been increasingly penetrating the research institutions that are progressively linked up with business. Businesses also see the benefits, especially in collaborating in R&D activities with public research labs and with tools developed by research organisations, like life-cycle assessment.

5.1.3 | Barriers and drivers to green business model innovation

Eco-innovative business models face a range of barriers on their way to implementation and diffusion, which can be internal or external to the company.

Among the most important internal barriers encountered by companies is a lack of knowledge and skills (Nordic Innovation 2012a,b). For example, awareness about new business models, and knowledge about how to create a successful green business model, may be low. Many organisational barriers may exist due to lack of integration between divisions in companies, and missing incentives in current management practices (e.g. rewards for cost reductions but not for risk reduction) (Tukker and Tischner 2006, FORA 2010).

Furthermore, launching a new business often requires high costs for new inputs and materials, development of new products, setting up of new infrastructure, and gaining visibility on the market. It may also require new forms of collaboration and new structures. For example, closing the material loop requires development of special take back and recycling systems and relevant infrastructure.

Wider application of new business models is also hindered because many companies are comfortable and successful with their existing business models, which have worked well in the past. However, continuing to collectively pursue growth at all costs, if that growth is coupled with growing natural resource extraction and GHG emissions, will not lead to the kind of "future we want". This lack of incentive to change is a consequence of external barriers, like market failures and systemic lock-ins (see Chapter 4.2).

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Many eco-innovative businesses do not get sufficient support and stimulation because of failures in the framework conditions. There is simply a lack of incentives to internalise environmental sustainability. Getting the prices of natural resources right would help to address this barrier. According to Tukker and Tischner (2006), Carrillo-Hermosilla et al. (2008), and FORA (2010) a lack of market-pull is due to the limitations of environmental tax regulations, lack of green public procurement practices, as well as a lack of regulation and general government support for changes.

Short-term thinking that dominates in businesses could also be a reflection of national economic models that are based on promoting consumption and government policies largely lacking a long-term sustainability vision and targets. The business community will probably not change its short-term thinking until society does as well.

Another barrier Confino (2011) notes is the importance of the investment community. Investors effectively control developments in businesses and therefore their reluctance to support radical or sustainability-oriented changes is a serious barrier to the introduction of new business models. At the same time, the adoption of eco-innovations and shifts to new systems would make investors more willing to invest in new business ideas, but these are also heavily dependent on consumers' attitudes and readiness (Martin 2009, Meenakshisundaram and Shankar 2010).

Despite numerous obstacles, some companies are redefining and greening their business models. One of the most important drivers for these companies was increased consumer awareness towards sustainability. More than ever before, companies are expected to behave responsibly and offer sustainable products and services (Nordic Innovation study 2012a,b).

The dedication of company leadership to the ideas of sustainability and environmental responsibility has also proven to be an important driver. Many studies (e.g. Bowden et al. 2010, Confino 2011) have established that company leaders were the main push factor for introducing concepts and systems such as “cradle-to-cradle” or “up-cycling”.

The dedication of company leadership to the ideas of sustainability and environmental responsibility has also proven to be an important driver.

A driver of an external nature is related to increasing costs of resources and supply risk, which has forced companies to consider alternative resources for their production (Nordic Innovation study 2012a,b,). Many companies set forth processes to cut costs and create new revenue streams by sourcing from surplus materials, designing recyclable products, adding services to products or creating take-back mechanisms for reuse of products or components[19].

EC and COWI (2008), Bowden et al. (2009), and FORA (2010) suggest that branding and reputation are important incentives for companies. With the increasing awareness of consumers and the imposition of environmental standards for procurement by public service clients, these values are becoming important competitive advantages for companies.

5.2 | Citizens: Opting for sustainable lifestyles

Both total resource consumption and CO_2 emissions need to be reduced by around a Factor of 5 on *a per capita basis* to meet the targets of a resource-efficient Europe (see Chapter 2). This will have a radical impact on lifestyles and behaviours in the EU. Future citizens will not only need to learn how to act in new green economies, but are also key to creating these new economic structures and building future societies.

Eco-innovation can transform individual behaviour and also create new forms of interactions between people or change peoples’ relationship with products. This section briefly explores what needs to be considered when assessing the role of eco-innovation for future citizens and lifestyles. It especially focuses on social innovations that have an environmental benefit. According to Phills et al. (2008), a social innovation is “a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals”. Thus, this section focuses on eco-innovations which not only reduce impacts on the environment, but also re-structure social relations in one form or the other.

Eco-innovation can transform individual behaviour and also create new forms of interactions between people or change peoples’ relationship with products.

5.2.1 | Key elements of the lifestyles of the future

Future sustainable lifestyles will depend on innovations that allow citizens to satisfy their needs through resource efficient strategies and activities, while providing a high quality of life for individuals, families and communities. Co-housing projects, cooperative purchasing, local trade, community currencies, ecological holidays or volunteer tourism are examples of innovative approaches and strategies that break with the conventional division of production and consumption (see also EIO 2012a) (Rauschmayer et al. 2011).

19. See for example Desso and InterfaceFlo carpet manufacturing companies http://www.guardian.co.uk/sustainable-business/cradle-to-cradle-desso-carpet-tiles-innovation;

Future citizens will have a greater influence over the development of innovations, devices or buildings through participative processes. One example is user-led innovation. In this type of innovation the functionality of new goods are developed with stakeholders, thereby minimising the risk of superfluous product features. In some cases, the user may use the product in an unintended way (e.g. like mountain biking or using call credit for transferring funds) to create a market for new products (e.g. high-tech mountain bikes or mobile banking) or the user may directly develop a new product entirely (e.g. Facebook) (von Hippel 2011[20]). For eco-innovation, engagement between customers and business will be key to co-creating desirable products and services at less resource costs.

Engagement between customers and business will be key to co-creating desirable products and services at less resource costs.

Future citizens may also opt for a reduction of working hours in favour of more time for volunteer work or the co-production of the products they wish to use (e.g. urban gardening, slow food, open handwork workshops, eco-villages). This could lead to a higher recognition of unpaid labour and community services in society. Nevertheless, future citizens will probably not always be more aware of the environment than contemporary citizens. Many people choose, and will continue to choose, the most convenient strategies for satisfying their needs. Therefore, future citizens will only live sustainable lifestyles when they live in socio-technological environments (cities, villages, regions) that disfavour unsustainable strategies and lead to a higher transaction cost when opting for unsustainable and resource-intensive practices, products and services.

Good practice examples

There are already some good practice examples of eco-innovations today that allow reducing individual resource consumption and contributing to a higher quality of life. Some of the most resource-intensive aspects of lifestyles in Europe can be divided into the three categories of mobility and travel, housing, and food. While meeting these needs are vital to human well-being, it is the excessive behaviours in each category which will be modified with moderation in the future.

For mobility, the most popular positive example of changed behaviours is car-sharing (see e.g. EIO 2012a). In many cities today the overall objective is to offer citizens the possibility to live in their city without owning a car (UITP 2011). Eco-innovative transportation systems are organised according to the needs of citizens by making use of public transportation, cycling and walking, and car sharing as well as private automobiles. Citizens, especially in urban centres, enjoy increasing choice between different options for mobility. These mobility solutions are expected to be quick, safe and secure, convenient, reliable, clean and affordable (UITP 2011).

While car-sharing has boomed across Europe, air travel has also increased. Between 2007 and 2011 per capita passenger flights increased by around 2% (increasing nearly 9% since 2009) (Eurostat 2012). According to EC (2008) the number of long holiday trips Europeans took by airplane grew by more than 33% in less than a decade (between 1998 and 2005). These trends, especially associated with leisure time, are associated with an increased impact on the environment.

For future citizens, sustainable tourism will mean engaging in more local forms of tourism. For example, as a reaction to climatic change and a decrease in the numbers of visitors,

20. http://www.innovationmanagement.se/2011/02/21/eric-von-hippel-on-innovation/

Eco-innovation good practice 11

Slow tourism

Source: Wuppertal Institute

Slow tourism is a new philosophy of travelling that aims to slow down holiday activities by reducing the quantity of travel and focussing instead on their quality. This includes staying longer in one place to visit near-by spots (instead of only the "must-sees") and to enjoy the local food, culture and environment. Slow tourism comprises leisure activities such as hiking, cycling, horse riding and canoeing. Due to the reduction of activities and their local focus, slow tourism can provide long-term benefits for local communities, and the tourists. Because the focus is not necessarily on travelling far and fast, it can contribute to reducing the environmental impacts of the tourism.

many European regions in the Alps have developed new strategies in order to address potential visitors that care about the environmental and social impacts of tourism. Initiatives such as Slow Tourism try to combine the idea of sustainability and local traditions (Antz et al. 2011, Fullagar et al. 2012). Volunteer tourism, which involves visitors in daily activities, thereby creating sense and meaning for guests and visitors, is also increasing abroad and locally (Campbell 2006, Coghlan 2006).

Initiatives such as Slow Tourism try to combine the idea of sustainability and local traditions.

Co-housing is an example of a socially relevant and potentially resource-saving innovation in the area of housing (Kunze 2009, McCamant and Durrett 2011). Co-housing is a form of intentional community that unites private homes that share certain facilities for collective use. A spin-off are car-free housing projects, in which the tenants are contractually bound to not own a car, but can participate in a car-sharing system. Studies have shown that inhabitants of car-free housing projects have a "more sustainable" lifestyle than people living in comparable buildings (Ornetzeder et al. 2007).

In most cases co-housing projects are planned, owned and managed by the residents. The residents may share activities such as cooking, gardening, childcare and administrating the facilities. Most often common facilities are laundries, offices, guest rooms, kitchens, dining rooms, and recreational features. These facilities build on new forms of social organisations that complement more traditional forms, such as family networks. The innovative potential here does not lie in one specific innovation, but in a new form of social organisation.

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As regards the food sector, especially excessive wasteful behaviour will be minimized in the future. Gustavsson et al. (2011) found that per capita food waste in industrialized countries is almost as high as total net food production in sub-Saharan Africa[21]. In the UK, around one-third of the food purchased is thrown out, corresponding to an estimated £12 billion per year in aggregated losses (Defra 2010; WRAP 2009). To diminish the detachment a lot of consumers have on the origin of their food, innovative concepts such as 'Slow Food' bring

21. Consumers in Europe and North America waste 95-115 kg/year, compared to 6-11 kg/year wasted by consumers in sub-Saharan African and South/Southeast Asia.

forth the small-scale producers of local, traditional food and build contacts between the producers and the consumers (EIO 2012a). Such concepts will help to raise the awareness and change the behaviours of future citizens, but also cultural and structural shifts will be vital to enabling more sustainable behaviours (e.g. having the option of smaller portion sizes in restaurants).

5.2.2 | Structural barriers and drivers to sustainable life-style from a citizen perspective

Ornetzeder and Buchegger (1998) have found that environmentally aware people often initiate resource-efficient social innovations because of their values and concerns, highlighting the importance of education and awareness-raising. Other important factors for environmental-friendly behaviour besides knowledge, motivations and abilities, are values that go beyond the individual person's own immediate interest (De Groot and Steg 2007).

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Social capital in the form of social relations, organization and networks are another important driver for resource-efficient social innovations (Barrutia et al. 2011). At some point, individual innovators and small groups need to involve larger groups of the population. The critical factor here is the social capital available to these bottom-up initiatives to address larger groups and the general public.

On the other hand, today ecologically sustainable products and solutions often imply an increase in costs and time for citizens (Omann and Rauschmayer 2011). Research has shown that although citizens are conscious about the environmental impacts and the negative consequences of their actions, most often they do not change their lifestyles in order to reduce these impacts (Lorenzoni et al. 2007). Some studies explain this knowledge-behaviour gap as a consequence of perceived high costs of pro-environmental behaviour (Diekmann and Preisendörfer 2003), while others trace this back to general confusion of most citizens about the impacts of actions and lifestyles, or attribute it to inadequate communication and top-down environmental policies (García-Mira 2009). It could also be because conventional products and technologies mostly have co-evolved in form and function with citizens' use strategies. For example, in most rural regions conventional cars are the only option that allows citizens to get to work, shops, family and friends. One main barrier for sustainable life-styles, therefore, is the general acceptance of unsustainable and resource-inefficient products and the lack of affordable alternatives.

One main barrier for sustainable life-styles is the lack of affordable alternatives.

Social norms are the grammar of society and are generally accepted rules about how to behave (Biccheri 2006, EC 2012b). Social norms are an important factor and influence individual behaviour (Harris 1968). A study analysing promising transformations in consumer cultures in the UK found that the 'green consumer' has not traditionally been the tipping point for eco-innovation and change, but rather interventions by government and business to edit out less sustainable products (SDC and NCC 2006). Awareness about global environmental challenges are unlikely to motivate the levels of public engagement needed for social and structural change without also addressing underlining cultural values like social status and financial success (WWF et al. 2010).

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Eco-innovation good practice 12

Sharing own cars

The German start-up Tamyca (an acronym for "take my car") provides an internet platform where private car owners and car users can come together in order to use cars more efficiently. Car owners who do not use their car very often, can store it in the online database where it can be booked by other car users, who do not own a car. Tamyca offers a car insurance protection for users between 23 and 69 years, who have had their drivers licence for at least three years and who have their permanent residence in Germany.

Source: http://www.tamyca.de/

Welzer (2011) has argued that our economic infrastructure shapes our values, feelings and actions. Therefore a society's preoccupation with economic growth will result in the individual need for constant individual advancement. When personal advancement is based on the idea of material wealth, resource-efficient lifestyles are difficult to promote.

Even when citizens reveal the desire to want to do something good for the environment, pervasive change seems difficult to achieve under current conditions. Sustainable choices are hindered by a number of barriers, including availability, affordability, convenience, product performance, conflicting priorities, scepticism and force of habit (WBCSD 2008). There may also be confusion about and distrust in certification. Between 2005 and 2011 the number of the EU Ecolabel licenses increased by more than 500% (EC 2012c). Moreover, a 2012 survey of around 1,000 Hungarians revealed that there was no correlation between the ecological footprints of consumers who said they were motivated by the environment and those who were not (Csutora 2012). This points to a Behaviour-Impact Gap (BIG) problem. It reveals that while people might be willing to make changes, they also need the tools to be able to implement those changes in their daily lives.

While people might be willing to make changes, they also need the tools to be able to implement those changes in their daily lives.

The institutional barriers for resource-efficient lifestyles have not yet been identified in a comprehensive manner. Nevertheless, an upscaling of individual initiatives for resource-efficient lifestyles requires a broader transition in the form of "a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms" (Rotmans et al. 2001).

5.2.3 | Key changes on the way to sustainable lifestyles

Experts have argued that sustainable living needs to be reframed so that it is not related with personal sacrifices, but with an increasing quality of life (Rauschmayer et al. 2011). In this context it might be helpful to address ecological values indirectly. For example, durable goods can be appealing to consumers because of their quality and not because a longer durability might relieve pressure on overall resource consumption. Nevertheless, the rebound effect is an important obstacle for sustainable and eco-efficient lifestyles (Hertwich 2005, Ornetzeder et al. 2007).

Eco-innovation good practice 13

Data analytics to engage

The Cypriot software company Intelen combines energy efficiency analytics and information and communication technology with behavioural science. The company provides real-time smart energy metering with the analysis of consumption results and real-time social demand response services in order to raise the awareness of the end-user about energy efficiency. In comparison with the traditional energy metering that uses a once-a-month or once-a-year measuring of the energy consumption, Intelen's tool enables its customers to monitor the energy consumption on a day-to-day basis. Due to this option, the end-user is able to monitor, analyse and predict their own energy consumption and to decide for the most cost-efficient energy efficiency measure.

Source: http://www.intelen.com/

Social innovations most often start in societal niches by so-called pioneers of change, visionary leaders and groups that share a common interest.

Social innovations most often start in societal niches by so-called pioneers of change, visionary leaders and groups that share a common interest. Sometimes they start as a counter-proposal to the societal mainstream. Therefore, these initiatives may receive less visibility and struggle with a lack of political and institutional support. In some cases, they might even conflict with existing regulations, for example in the case of initiatives for alternative economies (i.e. depreciative money, local currencies, saving clubs). To better understand, support and scale-up successful bottom up initiatives, involvement of intermediary actors (enterprises, business, voluntary associations, NGOs, etc.) and networks are needed. They also need to be complemented by more ambitious and more effective policy initiatives.

Eco-innovation to make technology "smart" has enabled certain decision processes to be automated. This is the case, for example, with master switches and light sensors that automatically turn off lights and put devices on stand-by. Nevertheless, because of rebound effects, resource-efficient technologies are unlikely to substantially reduce overall consumption of energy and material or lead to significantly changed behaviours. Therefore, it is probably not enough to rely on technological innovation alone.

Most empirical evidence suggests that for fundamental changes in the lifestyles of European citizens, policy measures on a structural level are a necessary pre-requisite (EC 2012b). As long as unsustainable options in the fields of mobility, food, and housing are the less expensive and easier ones, the majority of citizens in Europe will not likely avoid them. A combination of push and pull strategies, which also include choice editing to remove unsustainable choices, are recommended (OECD 2011b, BIO Intelligence Service 2012, EC 2012b). Starting to measure 'happiness' in a more deliberate way and addressing the real reasons for promoting growth at all costs (e.g. social security) could be first steps to counteract society's preoccupation with growth and material wealth.

All in all, policies across all levels of governance are needed to provide the structural conditions required to let people make more sustainable choices. This means removing conflicting incentives (e.g. tax breaks for company cars) and providing the infrastructure (e.g. bike lanes, high speed trains), means (e.g. capacity, freedom) and information (e.g. knowledge transfer networks, reliable facts) for people to be able to make sustainable changes in their life-styles.

Policies across all levels of governance are needed to provide the structural conditions required to let people make more sustainable choices.

5.3 | Research: Improving the knowledge base

Research is key to understanding, initiating, adapting and accompanying the transition to a green economy. This section looks at the role of research. It examines key elements of the research of the future that are different to today, and asks what the barriers and drivers to achieving these future elements are.

5.3.1 | The role of research in reaching "The future we want"

The role of research for achieving a resource-efficient Europe is the development and co-creation of knowledge. In general, there are two types of knowledge relevant for eco-innovation. First, research can work together with business to develop technological knowledge to drive product and process eco-innovation in industry. For example, improved knowledge on new materials, new production technologies as well as new innovative processes will lead to increased resource efficiency. Second, working together with policy makers, citizens, business, and other scientific fields, sustainability research creates knowledge about the interactions between humans and natural systems, as well as how change can happen to create more resilient systems. The development of this type of *transition knowledge* is the focus of this section.

Sustainability research creates knowledge about the interactions between humans and natural systems, as well as how change can happen to create more resilient systems.

Sustainability research is characterised by its socially-oriented (engaged) and demand-driven nature as opposed to purely academic research. It aims to influence the socio-political decision making processes by providing knowledge gained from interdisciplinary and transdisciplinary[22] inquiry. Sustainability research does not focus on each system independently, but takes on a more comprehensive and integrated approach. Examples of emerging areas of sustainability research include ecological economics, industrial ecology, system dynamics, sustainability governance, and sustainability evaluation research (ESDN 2010).

Sustainability research has at least four roles in the transition to a resource-efficient society (ESDN 2010). First, it produces knowledge on the interactions between socio-economic and natural systems: stocks, flows and performance. Second, it produces knowledge on how to manage the transition: related actors, institutions and incentives. Third, it becomes a part of the transition by mobilising participation, empowerment and capacity building and crossing the boundary between science and policy. Fourth, it enforces self-reflection by identifying and using ways to improve its performance on the other three tasks, for instance it may relate to infrastructure, skills to conduct participatory research or networking.

22. Interdisciplinary research happens when unrelated academic disciplines work together toward a common research goal. Transdisciplinary research includes both unrelated academic disciplines and non-academic stakeholders. In other words, transdisciplinary research is the combination of interdisciplinary and participatory approaches.

5.3.2 | The key elements of future research different to the research of today

One key feature of the emerging field of sustainability research is that it is difficult to place it within existing disciplinary structures. Further, it represents neither 'basic' nor 'applied' research; rather it is characterised as 'use-inspired basic research'.

According to the EU Sustainable Development Strategy "research into sustainable development must include short-term decision support projects and long-term visionary concepts and has to tackle problems of a global and regional nature" (Council of the European Union 2006). On the one hand, this requires "frontier research", focused on developing leading edge, new knowledge for the long term. A characteristic of this type of research is that there are no boundary lines between the disciplines or between basic and applied research. It is difficult to know beforehand which approach will yield the best results (e.g. transition management; Rotmans et al. 2001, Kemp et al. 2007, Loorbach 2007). On the other hand, sustainability research also aims to provide new knowledge about the world and generate knowledge that can be useful, especially for addressing short-term problems in light of long-term visions (EC 2009b). For developing solutions that work, especially participatory processes are essential.

Sustainability research engages people in various steps of the production and usage of scientific knowledge.

Sustainability research aims for participatory processes, where achievement of knowledge is characterised by co-production. It thus engages people in various steps of the production and usage of scientific knowledge. It is distinguished by a new paradigm that takes the complexity and the multidimensional characteristic of sustainable development into consideration. Therefore, the sustainability research of the future entails different perspectives on scale (of time, space, and function), different actors (with different interests) and various failures (market and systemic) (ESDN 2010).

As follows from inter- and transdisciplinary research, a related key element of future research will be networked practices. The links between research and industries will be especially strengthened in the future. Such collaborations merge the discovery-driven culture of the research organisation with the innovation-driven environment of the company. Strategic partnerships of the future will provide secure funding to bolster academic strength and produce researchers who understand the realities of markets (Science Business Innovation Board 2012).

Box 5.2 | Horizon 2020: The European Commission's Framework Programme for Research and Innovation

The European Commission has decided to focus on three key priorities to further objectives of sustainability and resource efficiency in Horizon 2020 - The Framework Programme for Research and Innovation. Namely, excellent science, industrial leadership and societal challenges (EC 2011d).

First, one of the most important factors in reaching the vision of a resource efficient Europe by scientific and technical breakthroughs is the fostering of excellent science. To this end, the future and emerging technologies (FETs) are areas of research that hold great promise. One of the interesting pilots of the future and emerging technologies is the FuturICT flagship project. In the project, the interdisciplinary integration of engineering, social and natural sciences along with the information technology is promoted. One component of the project is the Living Earth Simulator, which analyses vast amounts of data from a wide variety of techno-socio-economic-environmental systems as well as managing complex events (EC 2011d; EC CORDIS 2012; FET11 2011; FuturICT 2012a,b).

Second, one of the key priorities for the European Commission is industrial leadership. Industrial leadership is estimated to enhance Europe's position as an attractive location for research and innovation related investments (including investments in eco-innovation). Therefore, the European Commission intends to support key industrial technologies and key enabling technologies (EC 2009a).

Third, another research related EC priority is concentrated on the challenge-based approach. Knowledge and resources are drawn from different fields, technologies and disciplines (including social sciences and the humanities) to address societal challenges. A range of activities from research to market is to be covered by the challenge-based approach with a special focus on innovation-related activities, including piloting, demonstration, test-beds, and contributions for public procurement and market uptake. The challenge-based approach will be connected to the planned European Innovation Partnerships (EIPs). European Innovation Partnerships are another way of combining forces to halt the current fragmentation of research and innovation efforts. They bring together a variety of actors starting from those whose are involved in basic research and spanning to the end. EIPs provide a forum for these different actors where they can, while united under a common objective, identify, develop and test innovative ideas (EC 2011d; EC 2010b.)

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Living lab research concept

Living lab is a research concept that analyses the long-term adoption of sustainable innovations by observing people living in a “lab”. Further, it observes other user habits, e.g. when it comes to the installation of a product. Simultaneous living lab research provides cross-cultural data on the adaption of sustainable innovations. The living lab research concept offers interesting possibilities in developing lifestyle eco-innovations for the consumers and provides a channel for ensuring the sustainability of the innovations. Source: Living Lab (2009).

Source: Wuppertal Institute

Key alliances to reach the desired targets will likely include European Innovation Partnerships, Knowledge and Innovation Communities, Future and Emerging Technology platforms and Key Enabling Technology platforms. For example, RESCUE, an European Science Foundation (ESF)-COST 'Frontier of Science' initiative and an ESF Forward Look project (2012) built its vision of knowledge creation around the idea of an open knowledge system, in which knowledge is generated in various contexts (some of which the project estimated to be scientific) and is shared throughout the knowledge development process. The problems are defined and dealt with by the society at large, not solely by the scientists or policy makers (ESF 2012).

Environmental sustainability concepts will be integrated into all research areas.

All in all, in the future, environmental sustainability concepts will be integrated into all research areas. Instead of viewing environment, economic and social dimensions as separate disciplines, maintaining resilience will be the overarching goal. This means that, for instance, economic research will focus on how to create and maintain wealth within the environmental limits. Integrating environmental concepts into all research fields will be key to making the green economy work.

5.3.3 | Barriers and drivers to establishing "The researchof the future"

Isolated individual disciplines make the transfer of approaches and solutions difficult, especially as this division provides structure for academic careers.

Currently, sustainability research is not fully able to breach the traditional division of disciplines. This is problematic as eco-innovations are frequently created at the interphases of different research and development traditions. Rigid disciplinary orientation is one example of a system failure concerning knowledge institutions because it hinders adaption to the changing environment. A barrier here is that isolated individual disciplines make the transfer of approaches and solutions difficult, especially as this division provides structure for academic careers (ESDN 2010). For instance, according to van der Leeuw et al. (2012) journals that accept embedded, participatory, and action-oriented work for publishing often have lower impact factors than traditional journals. In a growingly indicator-driven evaluation culture, in which the amount of publications in prestigious scientific journals may impact

academic careers and effect the success of obtaining research funding, keynote invitations and prizes, this is a relevant barrier. According to European Commission, the status and profile of sustainability research and the researchers conducting such research needs to be raised. To make problem-oriented sustainability research attractive to researchers and their organisations it should be stimulated by incentives, rewards, and the possibility for building a reputation (EC 2009b).

Europe lacks consistent and proactive policy designed to foster collaboration across the disciplines (ESF 2012). One goal is to integrate natural, human and social sciences to develop joint questions on global environmental change in the future. To further this aim, a common theoretical and operational framework needs to be developed across research areas (ESF 2012).

Further barriers to transdisciplinary sustainability research may include a lack of problem awareness or a lack of agreement on the problem itself. Established practices and institutional inertia may contribute to this particular barrier. Conflicting methodological standards may also create difficulties. Applying scientific quality standards and research methods is as important in transdisciplinary research as in other academic fields, but practice-oriented partners may have different expectations and quality standards. Therefore, conflicts between partners may ensue. In addition, it can be difficult to evaluate the scientific and societal impacts of transdisciplinary projects. Even if standardised approaches to evaluating scientific impacts exist, these are not sufficient in assessing the projects' impact on sustainability researches' core questions or on the grand challenges. Moreover, as sessing societal impacts may be even more challenging as they may take effect after a delay or are not, yet, easily measurable (Lang et al. 2012, Yarime et al. 2012). Sustainability research will differ from the traditional research fields in that it must also confront the reality of failure as well. It needs to move forward from the traditional descriptive-analytical knowledge generation. New intense exploration, testing and implementation of sustainability solutions need to ensue. Hence, there needs to be a shift from mere problem identification and 'solutions' towards vision building and working toward that vision (van der Leeuw et al. 2012).

Despite the current barriers to sustainability research, according to Yarime et al. (2012) there is an "academic revolution" on the horizon that will be the key driver to developing a new paradigm of research. This academic revolution is related to the potential of the universities to become both engaged with academic excellence and contribute to the urgent sustainability issues of the 21st Century. To impact sustainability issues universities will not only conduct inter-disciplinary research, but will actively seek, expand and deepen collaboration and networks with other stakeholders in society such as business, government and the civil society (Yarime et al. 2012). Sustainability research related educational programs have increased and experiments with a wide variety of methods and perspectives are being conducted. As these programs evolve and mature, they may lead to new pedagogies, incentives, and transdisciplinary collaboration. The opportunity lies in developing long-term, participatory and solution-oriented projects which provide a platform for generating the next generation of sustainability scientists. Training the next generation of scholars to address cutting edge problems and use advanced approaches in the field may enable them to be better equipped than their predecessors to address the challenges and drive the development of sustainability science (van der Leeuw et al. 2012).

To impact sustainability issues universities will not only conduct inter-disciplinary research, but will actively seek, expand and deepen collaboration and networks with other stakeholders in society.

5.4 | Government: Leader and partner in the transition

Government is one of the key stakeholders in the transition towards a resource-efficient society and economy. As a representative of citizens, government is responsible for both addressing current problems and anticipating future societal challenges. EIO (2011a) argued that the role of public policy for meeting the eco-innovation challenge is twofold. On the one hand, public policy will need to set an overall direction of transition and to establish a wide framework favourable for eco-innovation. On the other hand, government should continue providing direct support to innovation activity by supporting research, development and implementation of radical and systemic eco-innovations. Both framework conditions and direct support have to be orientated to respond to the grand societal challenges. The government will have a key role in setting innovation and environmental targets and observing that the limits of resource consumption and harmful emissions are respected.

Public policy will need to set and overall direction of transition favourable for eco-innovation and continue providing direct support to eco-innovation activity.

The challenge government and public administration is facing is not merely about adjusting the objectives of policy measures. It is also about changing how public policies responding to long-term challenges are designed, consulted and managed. This section highlights key areas of innovation in how government and public administration operate and how they make policies. The focus is on the process of building effective visions and policies, on how government and its bodies interact with other stakeholders in the overall governance system as well as on the need to revisit the internal organisation of public administration.

5.4.1 | The future role of government: innovating public policies and governance models

The future models of government and policy will be based on innovations in four key areas:

- **Policy deliberation**: co-creation of long-term visions and pathways;
- **Systemic policies**: integrated approach to designing and setting up framework conditions and direct innovation support;
- **Learning governments**: public administrations become learning organisations by design;
- **New governance models**: governments co-create and become an active part of open governance systems.

Policy deliberation: long-term visions and pathways

The process of building a vision has to be based on a common understanding of long-term challenges, including resource scarcities, climate change and loss of ecosystem services, and their implications for society, economy and the environment. Government is responsible for leading and coordinating the process of building and pursuing the vision of a future society. The government's role is to ensure that the best available knowledge is used in creating the future vision as well as that all relevant stakeholders have a say in the process.

Visions and policies should not be imposed on target groups; rather they should be co-developed with them.

The deliberation of future visions and long-term policies is a process of co-creation in a sense that relevant stakeholders have a possibility to directly contribute to the vision and policy design, and not only to express their opinion. Visions and policies should not be imposed

on target groups; rather they should be co-developed with them. In this way, stakeholders become "owners" of visions and policies and are more inclined to contribute to the overall goals of policy.

Following the vision building, the government will also need to coordinate a collective process of setting objectives and targets and be a key actor in monitoring progress. In the future, the type of targets may be different. They will be closely linked with challenges and not only expressed as levels of emissions or resource consumption, but strengthened by transition milestones setting operational goals of developing and implementing systemic eco-innovations. These milestones will be linked to real challenges of food production, urban planning and housing, public transport, and others. The milestones will provide a clear illustration of what the direction suggested by quantitative targets associated with the vision mean in practice. They will add transparency to the government's actions towards a shared vision.

The first steps on the transition pathway may bring to surface conflicting interests held by proponents of old and new order. Deliberative policies will face opposition from many actors with vested interests in the current economic and political system (e.g. sectors depending on government subsidies). It is the role of government to anticipate these and find politically, socially and economically viable ways to face negative mobilisation. One key way forward is to create strategic alliances with progressive stakeholders to safeguard "innovation spaces", which will provide examples of desirable alternatives to business-as-usual.

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Systemic policies: integrated approach to policy making

As regards policy making, the need for policies to systemically address and anticipate market and system failures will remain a priority. There are at least two roles. First, developing framework conditions favourable for innovation and, second, providing direct support to systemic innovations with a high value added for society, economy as well as the environment.

Governments will have to approach policy making in a systemic way. This means that governments will require both the means to understand the system (indicators) and capacity (knowledge) to design their policies effectively. For example, policies could especially take the form of intervention systems (or portfolios of measures) rather than a collection of individual measures.

Governments will require both the means to understand the system (indicators) and capacity (knowledge) to design their policies effectively.

Developing a systemic understanding is not only about technical capacity to collect and analyse data, but also about building a shared understanding among key stakeholders of implications of what is known and what remains uncertain about societal challenges and overall policy impacts. This calls for an integrated approach to monitoring and evaluation of policies that incorporates both a system of data collection and a pool of expertise allowing for robust interpretation of data. Designing policy as an intervention system has to take into account the overall effects of a "policy mix" on innovation systems and the wider economy and society. It has to take into account interactions of various interventions over time.

Eco-innovation good practice 15

Cradle to cradle in venlo

Source: http://www.venlovernieuwt.nl/en/stadskantoor/cradle-to-cradle

The Dutch region of Venlo is developing diverse initiatives that test the Cradle to Cradle (C2C) concept in practice. The C2C principles are applied not only in the manufacture of products, but also in the development of major buildings and organisation of living and working areas. E.g., the city's procurement criteria stimulate innovation by stating desired outcomes (e.g. building that produces oxygen, purifies water). In Venlo, regional authorities have been pivotal in creating conditions for C2C initiatives: forging public-private partnerships, supporting innovation, experimentation and demonstration, using public procurement as a powerful tool, and developing C2C principles and targets.

One of the key challenges government will have to face in this context is building a mutually reinforcing policy system that provides a clear direction and framework conditions applicable to all actors as well as offering direct support for bottom-up innovation activities. The combination of a centrally designed stable eco-innovation policy framework (including targets) on the one hand, and instruments articulating future demand for eco-innovation on the other, will offer premiums for first movers and create “eco-innovation spaces” in the innovation systems.

Long-term objectives and targets should both give an overall direction and frame short-term actions.

Another key challenge is to design policies capable of responding to both short-term problems and long-term challenges. The systemic approach means that policies need to incorporate multiple timeframes for different measures and should be regularly reviewed in terms of their temporal coherence. The long-term objectives and targets should both give an overall direction and frame short-term actions. The political influence on the short-term decisions should be limited by the system of “checks and balances” considering the overall vision as a “public good”.

Towards learning governments

The organisational structure of public administrations may need to change to take the challenges of sustainability into account.

In order to develop effective long-term visions and run systemic policies, government probably needs to rethink their organisational models. Just as businesses need to rethink their business models to create value and serve customer needs in a resource-efficient way, the organisational structure of public administrations may need to change to take the challenges of sustainability into account.

The current model of public administration does not reflect the complex and dynamic nature of challenges faced by today’s economy and society. The organisation of the public sector has to become flexible in order to be able to address emerging problems as well as to ensure stability in delivering basic functions of the state (e.g. public health, security etc.). In order to develop a capacity to adapt to new challenges and become resilient over time, bureaucracies need to become learning organisations.

The key functions of a learning government are to:

- Develop its systemic knowledge base to understand the challenge;
- Collaborate with stakeholders to share knowledge, develop a shared understanding and a future vision and agree on a shared course of action;
- Collaborate to develop and improve the policy implementation system;
- Adapt and revisit its actions and modes of policy implementation based on evidence and visions of the future;
- Adapt and revisit its own organisation structure based on evidence and visions of the future.

Public administration will have to develop a capacity to redefine itself – or in other words to implement double-loop learning (Argyris and Schon 1996) – if it is to deliver on its social mission and fulfil its potential to become a change agent.

New governance models for systemic eco-innovation

Future governance models will reflect complexity and plurality of the political and economic structure of the world with many levels, multiple hierarchies and functions. One of the key roles of governance will be the capacity to collaborate with other levels of government and other stakeholders as well as to form--or join--coalitions supporting its policies and future vision. Learning governments will proactively search for partners and operate in a close relationship with key social and economic stakeholders.

One of the key roles of governance will be the capacity to collaborate with other levels of government and other stakeholders.

Future governance will be based on the principle of subsidiarity, where challenges are addressed on the appropriate level of action by taking into account both where the problem should be tackled as well as where collective capacity to act is concentrated. The new governance models will allow for flexible collaborations.

5.4.2 | Key barriers and drivers of adapting government and governance systems

The development of new models of government and new modes of governance may be slowed down by many barriers. The barriers may include systemic failures, such as overall low awareness and information asymmetries on sustainability, as well as long-standing institutional failures, including institutional lock-ins and path-dependencies.

A typical example of the implications of lock-in is the organisation of public administrations into ministries. Government administrations are organised to serve long-standing areas or sectors, which makes it difficult to address pervasive challenges such as sustainability or eco-innovation. The latter needs to involve diverse expertise that is currently either dispersed in different ministries and agencies or simply missing. Changing the overall organisation of public administration is very complex as it implies many related changes (e.g. budget, programme implementation, etc.). These organisational barriers may result in inadequate support to and very different interpretations of eco-innovation. The current government structures do not offer a natural locus for eco-innovation and many other societal challenges.

Government administrations are organised to serve long-standing areas or sectors, which makes it difficult to address pervasive challenges such as sustainability or eco-innovation.

There are also barriers linked with the limited organisational capacity of public administrations. Due to its predominating tasks linked to administration and control, the public sector has limited capacity to innovate and to collaborate on innovation. Learning capacity of policy organisations may be further reduced by a weak evaluation culture (i.e. limited capacity to perform and use evaluations) as well as by politicisation of public administrations.

These barriers may be further aggravated by organisational culture based on risk-averseness and conservative values. In most cases, the current organization of the public sector neither encourages nor rewards innovation. Policy makers tend to use known and tested procedures and instruments that reduce risk on the side of public administration. This may compromise the most ambitious policy objectives and long-term target development.

How to overcome barriers to public sector innovation? There are many possible drivers of change, both exogenous and endogenous to public administrations. Major organisational shifts, however, are by no means easy to implement, whether in the private or public sector, and may take a long time to take effect.

Political leadership may become a strong driver of change, especially when combined with a wider societal consensus of the future vision. One of the key drivers will be the overall positive attitude towards change in society, a high level of social capital and trust, which may counteract with the risk-averse organisational culture. The latter will make it easier to build new collaborations, shared understanding and develop a vision between different stakeholders.

One of the key drivers will be the overall positive attitude towards change in society, a high level of social capital and trust, which may counteract with the risk-averse organisational culture.

In terms of indigenous drivers, the leadership of senior officials within the public administration is an important factor. This has to be supported by organisational capacity to manage change and capacity to collaborate with other stakeholders (e.g. forming public-private partnerships etc.). In the context of the European Union, a specific driver of public sector innovation may be EU policies, notably regulations, which may become an external stimulant for changing long-standing practices.

5.5 | Transition coalitions: Strategic alliances for pursuing system innovation

The actor perspectives clearly indicate the need to develop new and revisit old collaborations that go beyond “business as usual” in each area.

In order to achieve a green economy, different stakeholders need to change their own behaviour as well as to collaborate with others. Europe will require strategic alliances between all actors. Aiming at the systemic change that addresses both economic and environmental challenges involves fundamental shifts in different spheres of economy and society. This is an unprecedented challenge.

Creating transition alliances of fast movers is one way to share the risk linked with any radical innovation activity.

Even the most complex initiatives need to start somewhere. Creating transition alliances of fast movers, including business, government, science and citizens, that share the future vision is one way to share the risk linked with any radical innovation activity. This requires developing new relations between actors as well as investing in concrete milestones and demonstrators

on the transition pathway. The new alliances will need support from many actors, notably politicians and policy makers. For instance, government can devise “innovation spaces” by supporting demand for eco-innovation (e.g. pre-commercial procurement) as well as adapt strategic policies and framework conditions to support the overall direction of change.

Innovative business models based on the principles of a circular economy (e.g. industrial ecology), product-service systems (e.g. product sharing or functional sales), material stewardship (value chains) or sustainable design all require engaging in new strategic innovation collaborations with other businesses, research, and customers, as well as with public administration. These new collaborations can become an important inspiration for radical systemic innovations. The new models require stronger links with customers to respond to people’s needs and co-develop new services and products. In general, incorporating sustainability into business practice will require that businesses revisit their organisational models and collaboration strategies.

Citizens are active participants of the transition process. The innovation spaces developed for fast-movers should also include citizens and citizen groups that will actively exchange ideas with companies and researchers as well as co-develop and test eco-innovations. In fact, some eco-innovations will depend on changed collaboration patterns between both citizens and business as well as between citizens themselves (e.g. product sharing). The notion of mutual trust and social capital are an important driver for eco-innovations enabling new solutions to diffuse in the society and economy. Citizens forming large consumer groups organised in networks could become a major driver of systemic change.

The innovation spaces developed for fast-movers should also include citizens and citizen groups that will actively exchange ideas with companies and researchers as well as co-develop and test eco-innovations.

The shift towards a resource-efficient society and economy will have equally strong implications on knowledge institutions. The transversal nature of eco-innovation requires a strong shift towards transdisciplinary research resulting in new collaborations as well as in developing new research capacities. Research on eco-innovation will require engaging in close collaborations and co-creation processes with business, civil society and the public sector as future users or producers of innovations. These new processes will imply major organisational changes within the universities and research organisations as well as in the wider collaboration patterns within the research and innovation system.

Governments on all levels have a key role in co-developing and supporting new transition alliances. On the one hand, policy makers can collaborate with stakeholders to share knowledge, develop a shared understanding and future vision and agree on a shared course of action. On the other hand, they can become an active actor in innovation processes by articulating demand for system eco-innovations. In order to engage in new collaborations more effectively, government will need to revisit its organisational model to be able to engage in collaborations in a more flexible way.

The transition will require new strategic alliances as well as revisit dominant innovation collaboration patterns. New alliances bringing together first movers of eco-innovation can become the nuclei of transition coalitions. Government will support fast-movers by creating innovation support allowing new alliances to emerge and by creating a stable framework to allow new modes of collective learning to form.

6 | Key messages to policy makers

Governments, at all levels, can be change agents and join forces with other stakeholders to co-lead the process of change. There is no simple recipe on how to promote structural change, but there are several actions governments can consider to kick-start the transition. The European Commission's Eco-Innovation Action Plan (EcoAP) can play a key role in placing eco-innovation at the centre of this process.

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This chapter presents five general recommendations. In the context of each recommendation, targeted suggestions are made for (1) consideration of the High Level Working Group (HLWG)[23] and other key stakeholders of the EcoAP, (2) current specific actions of the EcoAP, and (3) actions that the European Commission (EC) and Member States can take beyond EcoAP in a broader context.

Box 6.1 | The Eco-Innovation Action Plan

The Eco-Innovation Action Plan, launched in December 2011, endorses the significance of eco-innovation for supporting the transition towards "smart, sustainable and inclusive growth". It confirms the important role eco-innovation has to play in achieving the aims set out in the Europe 2020 Strategy, and especially the flagships on "A resource-efficient Europe" and the "Innovation Union". It has been developed with insights from an extensive public consultation, giving business the opportunity to let policy makers know what is important to them.

The Action Plan aims to foster the market uptake of eco-innovation especially through seven dedicated actions:

- Action 1. Using environmental policy and legislation to promote eco-innovation;
- Action 2. Supporting demonstration projects and partnering to bring promising, smart and ambitious operational technologies to market;
- Action 3. Developing new standards to boost eco-innovation;
- Action 4. Mobilising financial instruments and support services for SMEs;
- Action 5. Promoting international co-operation;
- Action 6. Supporting the development of emerging skills and jobs and related training programmes to match labour market needs; and
- Action 7. Promoting eco-innovation through European Innovation Partnerships

For more information: http://ec.europa.eu/environment/ecoap/index_en.htm

23. HLWG is a permanant, informal Commission Expert Group with a mission to establish a good co-operation between the Member States and the Commission, and advise the Commission on the implementation of the Eco-innovation Action Plan as well as to facilitate the exchange of information, experience and good practice on the promotion of eco-innovation. See http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2781

1 Build a shared understanding of the eco-innovation challenge

Policy design and implementation should be based on a shared understanding of eco-innovation and its challenges as well as on best available evidence. Policy makers and other stakeholders, hovewer, have different understandings of what eco-innovation is and what it should aim at. Building a shared understanding is essentially about an on-going dialogue with key stakeholders preparing the ground for future visions and policy targets.

In this context, policy makers could, first, systematically map different perceptions of eco-innovation and the related challenges, and second, build a shared understanding on the different strategic opportunities eco-innovation offers for the future. The process should allow for mapping drivers and barriers to eco-innovation experienced by different stakeholders. This will highlight regional and sectoral differences, and enable better informed and more transparent policies. The process will also help to anticipate emerging coalitions that may support or oppose specific visions and scenarios.

Specific recommendations

For the High Level Working Group and key stakeholders of the EcoAP

- Collaborate with different stakeholders (business, industries, NGOs, local policy makers) to co-develop a shared understanding of eco-innovation challenges and use the knowledge gained to underpin European Innovation Partnerships (EIPs) as well as major demonstration projects.

For the European Commission on the specific actions of the EcoAP

- Include a step to define clear definitions and understanding of main problems, their causes and related needs with stakeholders at the beginning of all new projects (especially EIPs and demonstration projects), and be willing to adjust project plans and objectives accordingly.

For the European Commission beyond the EcoAP

- Establish an inter-service Eco-Innovation Competence Platform that consists of staff from relevant Directorates-General of the European Commission, agencies (notably the European Environment Agency, the Executive Agency for Competitiveness and Innovation, the Research Executive Agency and the European Investment Bank) in order to create a policy community based on a shared understanding (definitions, main needs and expected impacts).
- Strengthen efforts to raise general awareness about resource efficiency in the EU. Build European “knowledge hubs” to collect and disseminate information as well as to develop practical educational and training material addressed to regions and SMEs focussed on the role of eco-innovation in introducing new business and consumption models.

2 Develop shared visions and scenarios with targets and milestones

Eco-innovation policy is mission-driven. Long-term visions and scenarios with concrete targets, priority areas and milestones pass a clear message to stakeholders on the preferred direction of change supported by public policies. The process of developing visions and scenarios should be a practical exercise resulting in commitments towards both long-term targets and short-term milestones backed up by key stakeholders in the area. If quantitative targets cannot be agreed upon, the process should result in other forms of concrete commitments and decisions.

Continuous work on building an Europe-wide vision of the role of eco-innovation in shifting to a resource-efficient, low-carbon economy is necessary, especially for creating broad understanding and raising awareness. Vision building exercises, however, will be more effective if they focus on specific areas defined by a common concern or a strategic opportunity. Agreeing on targets and commitments in this context is a painstaking process, however, if successful, it will result in partnerships bound together by a shared understanding of an opportunity, common interests as well as emerging risks. Investing in creating a shared understanding is one of the smart ways to assure a fundamental level of coherence.

Specific recommendations

For the High Level Working Group and key stakeholders of the EcoAP

- Introduce, in collaboration with the Eco-Innovation High Level Multi-Stakeholder Steering Group, eco-innovation targets and milestones into the EcoAP and the Horizon 2020 Framework Programme for Research and Development[25].
- Incorporate visions of eco-innovation with targets and milestones into new National Eco-Innovation Roadmaps; this could contribute to the EU level discussion on targets.

For the European Commission on the specific actions of the EcoAP

- Add a reflection on the role of long-term policy targets in relation to finance and support services to SMEs (Action 4 of the EcoAP) keeping in mind that stable policy frameworks are an important factor in the investment decisions of companies.
- Promote, together with the European Parliament, building shared visions and roadmaps with concrete milestones and targets for European Innovation Partnerships (EIPs) (Action 7).
- Make sure visions, targets and milestones of different EIPs are coherent both with each other and with the overall EU vision and policy.

For the European Commission beyond EcoAP

- Establish resource use targets for the EU to provide a reference for the eco-innovation targets and milestones.
- Put forward, in collaboration with Member States, an EU-level Eco-Innovation Roadmap to complement the EcoAP and set key eco-innovation priority areas for Europe (building on and contributing to National Eco-Innovation Roadmaps and EIPs).
- Consolidate the current efforts to share information and knowledge on eco-innovation in the EU (including the EIO) by focussing support to several EU-wide “knowledge hubs” collecting and disseminating eco-innovation data and good practices as well as directly supporting specific initiatives (such as European Innovation Partnerships).

24. The High-Level Multi-stakeholder Steering Group is a new stakeholder body proposed by the Eco-Innovation Action Plan to be established in 2012. This group will be composed of representatives of Member States, business, industry, particularly SMEs, research and other key stakeholders. Its aim is to support measures for eco-innovation uptake, if necessary with the support of specific thematic multi-stakeholder expert working groups.

3 Measure up to the challenge: systemic policy for systemic problems

Governments need to measure up their policy response to the scale of the challenge. Eco-innovation policy has to be designed to respond to the systemic problems it is addressing. In this sense, focussing on the root causes of unsustainable behaviours and practices (particularly, addressing why society is preoccupied with growth) is key. A systemic approach should address the market and structural failures to eco-innovation, especially considering the undervaluation of ecosystem services and distortions on international commodity markets caused by illicit trade. Creating the framework conditions for a level playing field for eco-innovation in business, and providing the infrastructures needed to allow people to make sustainable choices, are fundamental to enabling structural change. The combination of a stable eco-innovation policy framework and policy instruments articulating demand for eco-innovation can offer strong incentives for "first movers" to take risk and invest in radical system eco-innovation.

The systemic approach to eco-innovation policy also means that it needs to incorporate multiple timeframes for different measures and should be regularly reviewed for temporal coherence. The long-term objectives and targets should both give an overall direction and frame short-term actions supporting eco-innovation. Both "quick wins" (e.g. material efficiency in companies) and "slow wins" (e.g. system eco-innovation) have a role to play, but quick wins that do not provide a clear benefit for the long-term vision should not be supported.

The scale of challenge means that many stakeholders will need to be led by example before engaging in eco-innovation. Eco-innovation policy could support and promote outstanding practices that showcase systemic eco-innovations in practice. Demonstrators need not only be R&D projects, but could be clusters, cities or regions committed to the shared vision and targets.

Specific recommendations

For the High Level Working Group and key stakeholders of the EcoAP

- Consider, in collaboration with the EC and European Parliament, how to better target and systemically integrate eco-innovation support on EU and national levels, taking into account developments notably within Horizon 2020, the Programme for the Competitiveness of Enterprises and SMEs (COMSE) and Structural Funds.
- Suggest concrete steps towards implementing an integrated approach to eco-innovation policy in the National Eco-Innovation Roadmaps.

For the European Commission on the specific actions of the EcoAP

- Include an objective to support radical system eco-innovation in the EcoAP actions, notably in EIPs (Action 7) and in demonstrations projects (Action 2).
- Consider linking establishment of European Innovation Partnerships (Action 7) and demonstration projects (Action 2) to create an innovation space for large-scale initiatives with European value added that could serve as an inspiration for EU regions and cities.

For the European Commission beyond EcoAP

- Rethink the concept of a demonstrator to consider cities, industrial districts or regions experimenting with radical eco-innovation as "system eco-innovation showcases" (e.g. path-breaking mobility solutions, urban farming, industrial symbiosis) and use them to promote the EU vision of "green economy" in the EU and worldwide.
- Develop clear guidelines, including definitions, measurement approaches and – if necessary – selection criteria guiding allocation of funds underpinning different EC programmes and policy initiatives (including Horizon 2020, COSME, Cohesion Policy).

25. See Box 5.2 for more information on Horizon 2020

4 Measure progress toward the vision and targets

A systemic approach to eco-innovation policies calls for an integrated approach to monitoring and evaluation of policies. Such an approach is based on both a system of indicators and data collection as well as on access to experts ensuring a robust interpretation of data. This will underpin and directly assist the process of building a shared understanding, visions and scenarios. Meaningful targets can be set only if meaningful data is available.

Measuring progress towards the vision and targets implies an innovative use of data, evaluations, and impact assessments in order to periodically diagnose the "health" of entire eco-innovation systems and policies. Evaluation has to become and on-going formative exercise to leverage knowledge and insight from past and on-going experiences.

Specific recommendations

For the High Level Working Group and key stakeholders of the EcoAP

- Recommend ways to improve monitoring, impact assessment and evaluation capacity supporting eco-innovation policy at the European Commission.
- Suggest steps towards developing a more robust evaluation and monitoring of eco-innovation polices, including their impacts on total resource flows and emissions, in National Eco-Innovation Roadmaps.

For the European Commission on the specific actions of the EcoAP

- Enlarge the scope of impact assessment methodology of "Environmental policy and regulation" (Action 1) to cover all relevant regulations and to consider the impacts of "policy mixes" in order to suggest workable systemic policy approaches to be used within and beyond Europe 2020.
- Include a reflection on the quality of eco-innovation jobs as well as on the difference between "green jobs" and jobs created due to eco-innovation in Action 6 ("New skills and jobs").
- Develop suitable impact assessment and evaluation methodologies, with participation of relevant stakeholders, to continuously monitor and evaluate European Innovation Partnerships (Action 7) and demonstration projects (Action 2) in order to foster an open policy-learning environment.

For the European Commission beyond EcoAP

- Invest in improving eco-innovation measurement methods and generation of new sources of eco-innovation data, notably in the context of measuring the distance to targets and year-on-year changes.
- Incorporate a permanent and compulsory component on eco-innovation activities in the Community Innovation Survey (CIS) as well as continue using other EU-level surveys such as Eurobarometer to collect data on eco-innovation.
- Mandate the monitoring of total resource flows for all EU countries to generate better information and knowledge about both the year-on-year changes and long-term trends, and their drivers.
- Establish, together with the OECD, standards on eco-innovation and green economy data similar to those put forward in Frascati Manual and Oslo Manual (definitions, data collection and quality).

5 Keep innovating modes of governance and government models

Eco-innovation is an example of a policy area that exemplifies the need for change of both governance and government models. The complexity, scale and pace of change of eco-innovation challenges mean that one ministry or one agency cannot tackle them alone. This has been recognised on both the EU and national level. Many countries are in the process of testing new organisational responses to these challenges. For this reason, closer integration across ministries and across policy levels and more radical revisiting of the model of public administration is crucial.

Specific recommendations

For the High Level Working Group and key stakeholders of the EcoAP

- Reflect, in collaboration with the Eco-Innovation High Level Multi-Stakeholder Steering Group, on the existing governance model in the area of eco-innovation in the EU.
- Propose a new governance model to underpin policies supporting system eco-innovation, including new ways of encouraging collaboration between stakeholders, mechanisms of engagement in policy making as well as ways to flexibly adapt policies based on lessons learned and external events.
- Reflect on regional and national eco-innovation governance in the context of National Eco-Innovation Roadmaps.

For the European Commission on the specific actions of the EcoAP

- Encourage that new models of governance and policy-making are developed, tested and learned from in the framework of the European Innovation Partnerships (Action 7); ensure that the principle of subsidiarity is followed in designing and testing new governance models and structures.
- Provide strong leadership in the debate and concrete steps towards redesigning global governance frameworks (Action 5); learn from cases where subsidiarity has succeeded and failed and use this knowledge to build better governance structures and channels in the future.

For the European Commission beyond EcoAP

- Promote policy coordination and coherence by establishing an inter-service Eco-Innovation Competence Platform (see recommendation 1 above) as the first step in a closer policy integration.
- Consider, in a close collaboration with the key stakeholders, internationalising the European Innovation Partnerships by including partners from outside the EU and consider the possibility for demonstrations in other world regions, if this is to develop better applications and strengthen prospects of positive socio-economic and environmental impacts of eco-innovation.
- Learn from European Eco-Innovation Partnerships to consider setting up Global Eco-Innovation Partnerships responding to global challenges.

Box 6.2 | Key considerations for business

- **Reduce your costs**: Improve your energy and material productivity to reduce both monetary and environmental costs.
- **Anticipate regulatory trends**: make sure to be ready for new regulatory requirements changing as well as for more stringent norms of business partners.
- **Think outside the box**: Re-consider how you create value for your customers and whether this value could be created in other ways (e.g. from substituting materials to completely new business models).
- **Engage with people outside your normal networks**: Engage with partners along the value and supply chain. Engage with customers. Engage with policy makers.
- **Develop a long-term vision in light of emerging and expected market trends**: Check the resilience of your business model in the future and take potential "slow wins" into consideration today.

For further business recommendations see also EIO 2012a as well as the forthcoming EIO publication: "Eco-Innovate! A Guide to Eco-Innovation for SMEs".

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About the Eco-Innovation Observatory (EIO)

The Eco-Innovation Observatory (EIO) is a 3-year initiative financed by the European Commission's Directorate-General for the Environment from the Competitiveness and Innovation framework Programme (CIP). The Observatory has developed an integrated information source and a series of analyses on eco-innovation trends and markets targeting business, innovation service providers, policy makers as well as researchers and analysts. The EIO directly informs two major EU initiatives: the Environmental Technologies Action Plan (ETAP) and Europe INNOVA.

This third annual report of the EIO looks at how eco-innovation can lead to and create structural change. It argues that strategic partnerships between policy makers, businesses, citizens and researchers are key to developing, implementing and applying eco-innovation.

This report begins with a vision of a resource-efficient Europe, presents the current state of eco-innovation in the EU, and asks how eco-innovation efforts can be both increased and intensified to play a larger role in the transition to a green economy.

In particular, this report addresses the following questions:

- What are the key barriers to structural change and how can system eco-innovation play a bigger role to overcome them?
- What is the role of business, citizens, research and government in the transition, and how can they work together to get change moving in the right direction?
- What are the key findings for policy makers?

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