OECD/European Commission/Nordic Innovation Joint Workshop

THE FUTURE OF ECO-INNOVATION: The Role of Business Models in Green Transformation

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This paper reports on progress of the OECD project on Green Growth and Eco-Innovation, in the area of business model development for radical and systemic eco-innovation. The outcomes from this workshop will be fed into a final report which is expected to be completed by the summer of 2012.

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1. Introduction

In their policies to revive industrial activity, job markets and competitiveness, while simultaneously tackling global environmental challenges such as climate change and natural resources scarcity, countries are increasingly seeking more innovative ways to promote economic activity. The OECD Green Growth Strategy (OECD, 2011a) recommends that green growth policies should encourage innovation, as this can enhance efficiency in the use of natural capital and foster new economic opportunities from the emergence of new green activities. The rapid and wider diffusion of "eco-innovation" can have a leveraging effect on environmental, as well as on economic and social improvements, by enabling win-win synergies both in OECD and non-OECD countries. As incremental innovations alone cannot achieve an absolute decoupling of economic growth from environmental impacts, increasing the market potential for more radical and systemic eco-innovations is becoming of particular importance to enable a long-term transition and transformation towards a greener economy.

The purpose of the OECD project on business models is to explore the potential of such radical and systemic eco-innovations and to examine how successes can be further extended and accelerated through the application and elaboration of innovation or other policies. In order to encourage industry to take up economic opportunities from developing and diffusing eco-innovative products and services, the study examines aspects of non-technological innovation, particularly the role of business models in supporting successful commercialisation, as well as the development of environmental technologies. Since business models and non-technological innovation are relatively unknown to policy makers and industry alike, a good number of real-life examples are being collected and will be analysed. To build upon existing knowledge and understanding, the study also reviews the existing literature and case studies in the field as far as available. This work aims eventually to help governments develop and implement policies enabling and driving green transformation through the wider diffusion of eco-innovation practices.

This report is a working draft which largely provides a theoretical underpinning of radical and systemic eco-innovation, a stock-taking of the existing knowledge in this area based on literature review and preliminary findings from some examples collected from OECD countries. The next section outlines the main industrial challenges for realising green growth and discusses the role of eco-innovation in fostering green transformation. Section 3 reviews different types of eco-innovations and discusses the relationship between radical and systemic innovation on the one hand and non-technological innovation, including new business models on the other hand. Section 4 offers a review of the empirical literature on eco-innovation and particularly refers to the role of business models. Section 5 outlines the methodology used in analysis of the case studies and presents some preliminary findings.

The final report on the case studies is planned to be finalised later in 2012, and will include detailed analysis of eco-innovation cases collected from countries. The workshop *The Future of Eco-Innovation: The Role of Business Models in Green Transformation* to be held on 19-20 January 2012 in Copenhagen will present some real-life examples of business model eco-innovations and explore the lessons to be learned from them. The outcomes from the workshop will be fed into the final report.

2. Green growth and eco-innovation

2.1. Radical and systemic eco-innovation

It is now well recognised that innovation is a driver of economic and social progress on a national (macro) level as well as a driver of business success and competitive advantage at the firm (micro) level. Michael Porter claimed that "innovation is the central issue in economic prosperity". However, if countries want to move towards a more ecologically sound and prosperous society, it is important to promote specific areas of innovation. Such innovation should allow for new ways of addressing

current and future environmental problems and decreasing energy and resource consumption, while promoting sustainable economic activity. This type of innovation is referred to as eco-innovation (or green innovation).[1]

Many governments now regard eco-innovation as part of their growth strategy. In light of the big global challenges – the economic downturn, environmental degradation, and resource scarcity – eco-innovation is seen as a way to reconcile economic and environmental priorities – and open new sustainable pathways for industry. In the European Union (EU), eco-innovation was seen as an important contributor to the objectives of the Lisbon Strategy for competitiveness and economic growth, and is also a key element of the new Europe 2020 strategy. Other governments are also promoting the eco-innovation concept (in one way or another) in their dual-goal strategies (OECD, 2010a). Examples include Japan's New Growth Strategy which includes "green innovation" as one of two core streams for future innovation, and Korea's Green Growth national strategy which aims at the creation of new engines of economic growth through green technologies, green industries and the building of structural foundations for a green economy.

Also considering the increase in demand for resources from emerging economies, decoupling economic growth by fostering resource productivity is a key pre-requisite for green growth and sustainable development. However, the present pace of resource efficiency improvements is too slow to respond to the need for decoupling and the incremental "business-as-usual" improvements alone are not likely to be sufficient to tackle the challenges. While incremental optimisation through energy saving and eco-efficiency measures are playing an important role in widely diffusing greener practices, "it's the disruptive end of the eco-innovation spectrum that is the most promising in the long term" (Future Think, 2008; Hellström, 2007).

More radical forms of eco-innovation therefore become the key to enabling a sustainable transition. Clearly, incremental improvements are very important and account for the bulk of all innovation in firms (OECD, 2011b), although they may also help lock social practices into existing trajectories and make radical solutions, which require changes in the current technological or infrastructural regime, more difficult to be deployed (Hellström, 2007). Investing in radical solutions is therefore important and can help maximise long-term gains.

To understand the basic mechanisms of different greening options from the innovation point of view, a distinction between three types of innovations can be made (Scarse et al., 2009; OECD, 2011b):

- *Incremental innovation*, which aims at modifying and improving existing technologies or processes to raise efficiency of resource and energy use, without fundamentally changing the underlying core technologies. Surveys of innovation in firms demonstrate that this is the dominant form of innovation and eco-innovation in industry.
- *Disruptive innovation*, which changes how things are done or specific functions are fulfilled, without necessarily changing the underlying technological regime itself. Examples include the move from manual typewriters to word processors, or the change from incandescent to fluorescent lighting.

[1] Based on the OECD/Eurostat Oslo Manual (OECD/Eurostat, 2005), eco-innovation can be defined as "the implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which, with or without intent, lead to environmental improvements compared to relevant alternatives" (OECD, 2010a). The EU's Eco-Innovation Observatory (EIO) project similarly 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 resources and decreases the release of harmful substances across the whole life-cycle" (EIO website, www.eco-innovation.eu).

- *Radical innovation*, which involves a shift in the technological regime of an economy and can lead to changes in the economy's enabling technologies. This type of innovation is often complex and is more likely to involve non-technological changes and mobilise diverse actors. Radical innovations could include not only the development of radical, breakthrough technologies but also to a reconfiguration of product-service systems, for example, by closing the loop from resource input to waste output ("cradle to cradle") and to the development of business models that reshape the way consumers receive value on the one hand and reduce material use on the other.

A sophisticated combination of these different types of innovation, together with new organisational and managerial arrangements, could bring out far-reaching changes in the techno-societal system and enable a long-term green transformation by affecting several branches of the economy including consumers. One of such examples is the introduction of a new urban mass-transit system which could be realised through a combination of changes to control systems (as facilitated by communications technologies), organisational practices (such as a move from hierarchical to networked collaboration), infrastructure management (such as those enabled by smart computing technologies), environmental monitoring (pushed by advances in remote sensing), manipulation techniques (as in genomics) or materials production (such as those made possible by modern industrial chemistry and nanotechnology) (Steward 2008, Scarse et al., 2009).

Such *systemic (or transformative) innovation* is more likely to take place beyond the boundaries of one company or organisation as it often requires the transformation, replacement or establishment of complementary infrastructures. From the perspective of the transition to a greener economy and the decoupling of growth and environmental impacts, there is growing attention for such systemic innovation as it could bring wider and persistent impacts in the medium to long term (OECD, 2011b; Smith, 2008; Scrase et al. 2009).

However, systemic innovation also "involves substantive risky investments by its champions, conflicts between emergent and incumbent actors, and reconfiguring traditional sectoral and policy boundaries" (Scarse et al., 2009). One of the imperative conditions for such innovation is social and cultural change, adopting new values and behaviour both on the producer and consumer side. The changes which systemic innovation brings are often difficult to predict and direct and do not necessarily follow a linear process.

2-2. Eco-innovation and business models

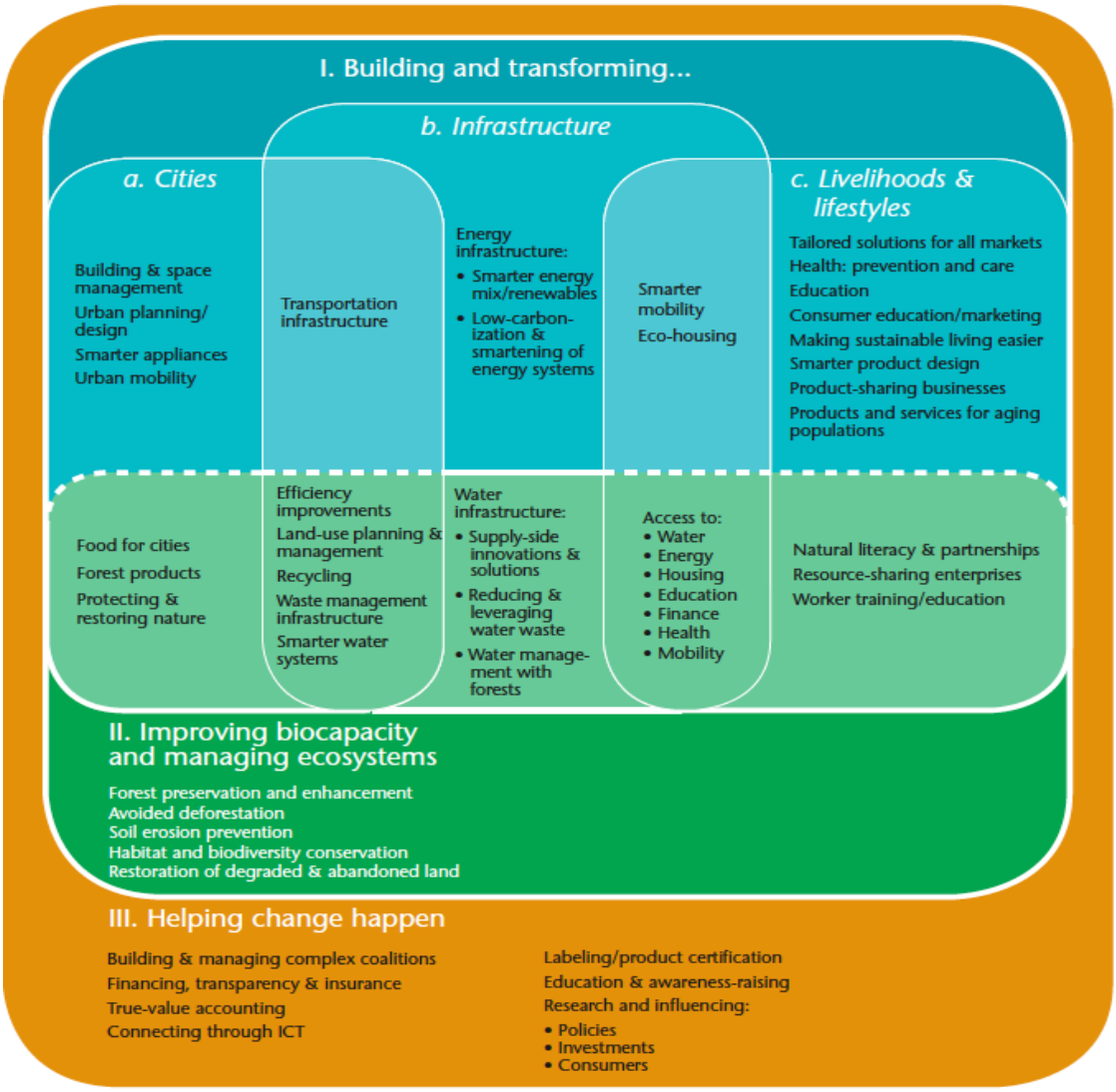
Emerging markets for greener products and services on the one hand and the rise of sustainability and green growth agendas in corporate management on the other are increasingly leading firms to integrate non-financial metrics into their decision-making processes, to revisit the concepts of value and profitability that drive their business models, and to reconsider the balance between the dual objectives of short-term profitability and long-term sustainability (Bryson and Lombardi, 2009).

Looking into how business opportunities will be developed in the long-term future, the World Business Council for Sustainable Development (WBCSD) developed the Vision 2050 jointly with member multinational companies (Figure 1). The expected economic transformations represent opportunities in a broad range of business segments as the challenges of growth, urbanisation, resource scarcity and environmental change become key strategic drivers for business in the coming decades. Opportunities range from developing and maintaining low-carbon, zero-waste cities and infrastructure to improving and managing ecosystems and lifestyles. Enabling these changes is also considered to be creating opportunities for the finance and ICTs sectors.

Overall there are a wide range of economic opportunities for leveraging eco-innovation by placing it at the core of business strategies. To capture such future opportunities, make them into a commercial success and disseminate good practices, both industry and policy makers need to better understand the social, technical and political factors enabling or obstructing eco-innovation (Figure 2). Among the

key elements in determining the success of eco-innovation, a special focus needs to be on the *business model*, which brings out eco-innovation to the market and promotes its dissemination. According to Osterwalder et al. (2010), "a business model describes the rationale of how an organization creates, delivers, and captures economic, social, and other forms of values". A business model is also understood as a holistic approach towards explaining how firms conduct business (Zott et al., 2010).

Figure 1. WBCSD's Vision 2050



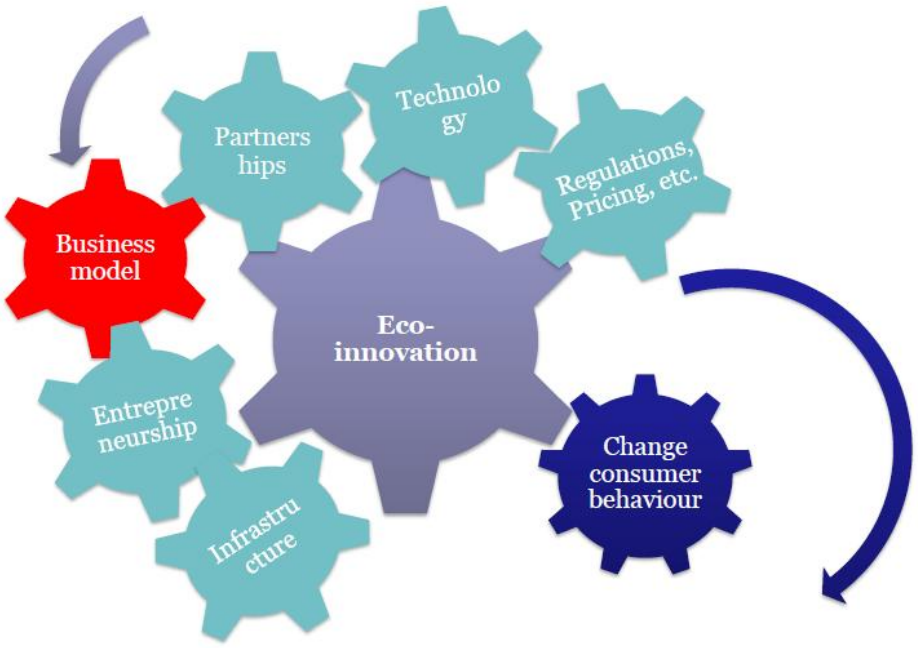
Source: WBCSD (2010).

The business model approach offers a comprehensive way to understand how value is created and distributed. Eco-innovation aims to create both economic and environmental value, and business models act as a value driver and enabler of green technologies and solutions. The focus on business models allows for a better understanding on how environmental value is captured, turned into profitable products and services, and delivers convenience and satisfaction to users. In concrete terms, the analysis of eco-innovation cases can shed light on whether, to what extent and how environmental values are reflected in firm's value propositions, customer segmentation, use of resources, collaboration patterns and the management of cost and revenue streams.

By replacing old business practices, innovative business models also allow firms to restructure their value chain and generate new types of producer-consumer relationships, and alter the consumption

culture and use practices. The business model perspective is therefore particularly relevant to radical and systemic eco-innovation, including how business models and strategies can induce and help diffuse radical eco-innovation and enable systemic changes and transformation. Moreover, it is important to understand better how policy can influence and facilitate the emergence of new business models that are effective in driven eco-innovation.

Figure 2. Various factors surrounding eco-innovation



Source: Own elaboration.

3. Understanding business models for eco-innovations: Insights from the literature

3-1. Scope for literature review

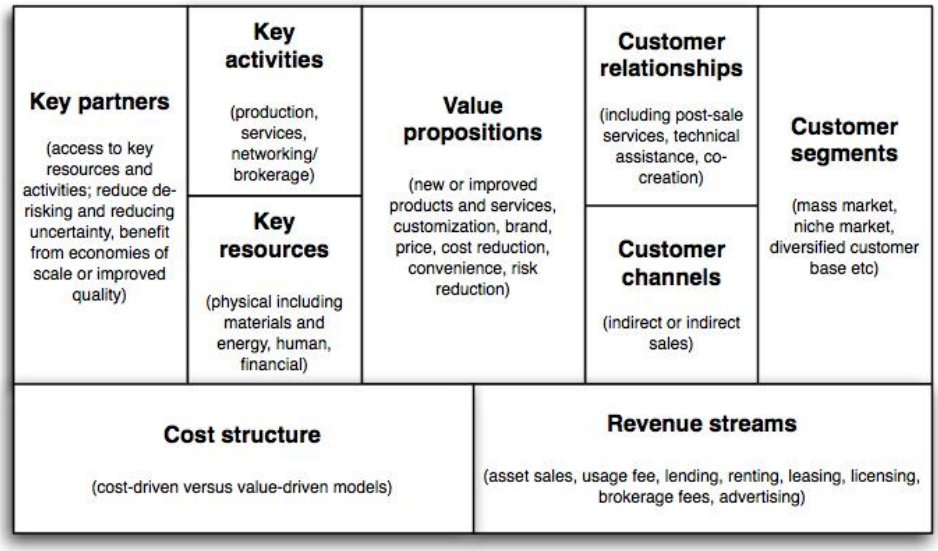
The importance of business models for understanding and promoting radical and systemic eco-innovation is increasingly recognised. However, a comprehensive understanding of this concept and structured knowledge about it are still lacking. Although the majority of the eco-innovation studies still focus on incremental innovations such as green products and eco-efficiency improvements, the focus on "radical", "systemic" and "transformative" innovation concepts has recently picked up and is discussed extensively, especially in the theoretical discourse. Systemic and transformative change is also reflected in the growing number of case studies analysing innovative solutions based on new systemic thinking like "cradle to cradle" (McDonough and Braungart, 2002) and "industrial symbiosis" (Gibbs, 2008). The literature covered in this review includes papers analysing and synthesising single or several eco-innovation cases.

3-2. Definitions of business models

Business models combine all the core components of business strategies and operations that create and deliver value to the customers as well as to the firm. The components of business models typically include strategic decisions on customer segmentation, products and services (or value propositions) to offer, business and research partners to engage with, resources to create and channels to deliver value, as well as the underlying cost structure and revenue streams to ensure economic viability of business (see Figure 3).

Business models, whether explicit or implicit, underlie all business plans and ventures. In order to strengthen or retain their market position, firms have to continuously rethink and reinvent their business models. Business models innovation is relevant for all firms and organisations as it is about staying in the game or being at the forefront of competition while assuring economic viability or sustainability of their operations. Radical changes in business models imply revisiting the customer base and value chain or redefining products and services. Such changes may involve high risk and include a degree of uncertainty, which make them difficult to pursue for most companies. Business models often change gradually and do not necessarily imply fundamental revisiting of value propositions. Instead, the changes could also focus on improving production processes or reconfiguring organisational structures.

Figure 3. Main components of business models



Source: Osterwalder and Pigneur (2010).

Business models have been well studied in the business and management literature since the 1990s but there is no unique definition or understanding across the literature (Zott et al, 2010). The business and strategic management theories suggest several ways of understanding and interpreting the business model phenomenon. The existing definitions only partially overlap, giving space to numerous interpretations. Business models are considered in multiple ways including:

- Interpreting business models as a conceptual framework, mode, or abstraction of the firm's current and future plans.
- Providing an intermediate layer of business understanding between business strategy and actual processes.
- Considering business models as a tool for managing the firm or an intangible asset for supporting strategic decision-making.
- Seeing business models as service logistics often presented as a flow chart.
- Applying business models for explaining how the firm creates value for themselves and stakeholders.

Despite these differences in conceptualisation, there is a common understanding on some issues as presented below. These aspects may help to develop a working concept of business models to analyse radical and systemic eco-innovation (Zott, et al., 2010):

1. Business model "is centred on a focal organization, but its boundaries are wider".

2. It is considered "a system-level, holistic approach towards explaining how firms do business".
3. It "seek[s] to explain both value creation and value capture".

In the typical approaches to business models, environmental sustainability is rarely at the core of value propositions. Although the business community increasingly recognises the challenges of climate change and resource scarcity, these issues are not automatically internalised in the building blocks of the firm's strategy and operations. However, the business model concept has recently been adopted in the discourse on sustainable services (Halme et al., 2007) and is also routinely utilised in studies on product-service systems (PSS).[2]

FORA (2010) presents the eco-innovation experiences in the Nordic Region and refers them to "green business models". It defines them as "business models which support the development of products and services (systems) with environmental benefits, reduce resource use/waste and which are economic viable. These business models have a lower environmental impact than traditional business models". This study further distinguishes green business models from "classical green businesses" (*e.g.* cleantech) by highlighting the difference that the former aims to create economic and environmental win-win benefits for both the supplier and the customer. In general, however, the existing literature has not yet offered a comprehensive definition of business models for eco-innovation, which could well capture both the complexity of business models and the pervasiveness of eco-innovation.

3-3. Value creation by eco-innovation

Value creation, both for the firm and the customer, is at the heart of any business model, as it can be one of the most important factors behind the viability of a new product, service or technology introduced in the market. In the traditional business model, the value proposed for the customer could include newness of the product or service, better performance, customisation, convenience, functionality, design, better price, potential cost reduction and savings, risk reduction, higher accessibility (Osterwalder, et al., 2010). The value proposition targets customers' needs or solving their problems. The value of the product is often increased by combining it with services or altered by the complete substitution of the product by a service.

Generally in the eco-innovation literature, this value proposition concept is not framed or named as such but the analysis can be translated from the discussion on the economic and social benefits of particular eco-innovations. Studies on PSS exceptionally pay attention to the discussion on value creation in service-oriented business models, highlighting the improvement in both tangible value (*e.g.* cost reduction and savings) and intangible value (*e.g.* risk minimisation, image improvement, extra comfort, other "priceless" experiences) (Tukker, 2004; EPA, 2009).

Below are major types of value propositions offered to customers by firms which are discussed in the literature:

- *Economic benefits*: The existing studies often address questions on which way the value creation and economic benefits can be delivered along with sustainability outcomes. While measuring the environmental benefits of the eco-innovation cases, it is often discovered that the firm and its customers managed to reduce internal costs or consumption of materials, or procure products that are more energy and resource-efficient or have a longer lifetime.

  Other economic benefits mentioned in the literature are related to avoidance of costs, minimisation of administrative expenses and reduced cost for safety. In service-oriented

[2] A PSS is a business model that has "tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs" (Tukker, 2004).

models, such as energy service company (ESCO)[3], chemical management service (CMS),[4] and renting and sharing, the customers' advantage is that they do not have to bear the investment costs and associated investment risks; the operation costs are known in advance and transparent. Cost saving benefits have also been demonstrated for other business models (EPA, 2009, Berhrendt, et al., 2003).

- *Offering functionality instead of a product ("Getting the job done")*: There are a growing number of more innovative business models that substitute the sales of (often unaffordable) products by offering their functionalities to customers. Among the examples are a car-sharing system which offers services by miles (Johnson and Suskewitcz, 2009; Meenakshisundaram and Shankar, 2010); lease-like "see-through insurance" instead of selling windows (FORA, 2010); selling "comfortable walking" instead of floor carpets; performance-based pest management which sells "low level of pests" or "high harvest" instead of being paid for pest control activities (EPA, 2009).
- *Comfort and flexibility*: Additional comfort and flexibility is another value that customers acquire from many business models and innovative designs which incorporate them. For example, the success of the city-wide bicycle-sharing system largely owes to its high flexibility and easy-to-use features (OECD, 2010a).
- *Increased trust and reliability*: Some business models such as functional sales, ESCO, CMS and design-build-finance-operate (DBFO)[5] also contribute to improved relationship between the provider and the customer and increased loyalty as the relationship becomes closer and lasts longer. Such trust and loyalty towards the service provider can also be considered as a value for customers (FORA, 2010).
- *Brand value and reputation*: Last but not least is that the firm adopting a new business model gains a reputation as a socially responsible company and the potentially associated higher brand value is also transferred to the customer. For example, users switching to a greener computer server may be driven by expected reputation benefits following the change (FORA, 2010).

3-4. Environmental and sustainability impacts

Environmental impacts are among the most thoroughly assessed issues in each study of new business models. Some authors suggest a structured methodology for the evaluation of environmental benefits of each type of business model. Tukker (2004) used the "sustainable design rules approach" in evaluating each type of PSS model against a set of impact reduction mechanisms (see Figure 4). The finding was that most PSS types result in environmental improvements but the level of improvement is rather modest. Improvements tend to be incremental to average at best and are "mainly related to economic efficiency gains and hence might be less relevant for [transforming the current] human-resource intensive systems". Radical improvements can only be expected in the case of promising functional results. The exception is formed by PSS systems that make users less responsible for careful use of the product, such as product leasing.

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3 Instead of the sales of energy-saving equipment, the ESCO's compensation is tied to energy efficiency improvements and savings in purchased energy costs.

4 A long-term relationship in which a customer contracts with a provider to supply and manage the customer's chemicals and related services. The CMS provider's compensation is tied to quantity and quality of services instead of the sales of chemical materials.

5 A contractual relationship between a customer and a private contractor for construction projects requiring long-term investments. This is usually arranged as a public-private partnership.

Figure 4. Relevance of impact reduction mechanisms per type of PSS

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		←----------→			

Source: Tukker (2004).

On the other hand, most other studies provide a more optimistic judgement on the environmental and sustainability impacts of new business models. These are related to: *a)* reduced energy and resource consumption and associated ecological footprints; *b)* reduced CO_2 and chemical emissions to air; *c)* reduced spills to water; *d)* reduced chemical waste and improved disposal; *e)* change in attitude towards a more sustainable behaviour, etc. For example, functional sales-based business models are estimated to reduce 50-60 % or more of the resources needed for production and lifetime use of the product. ESCO projects are found to create improvements in indoor air quality, which also improves the employees' ability to maintain concentration at work (EPA, 2009; FORA, 2010).

Furthermore, novel business models often help maintain environmental improvements in the long run. For instance, DBFO models create an incentive for efforts to reduce energy costs in the long term through their total lifecycle approach. CMS creates incentives for reduced use or substitution of hazardous chemicals, creating potential for cradle-to-cradle arrangement. Renting and sharing schemes encourage firms to design the product for improved durability and quality and to make remanufacturing possible, which in turn reduces the product volumes and associated need for virgin resources (FORA, 2010; Halmea et al., 2007).

In many of the discussed cases, the business models contribute to accelerating the introduction of environmental technologies and products. Through e-mobility services, for instance, the customers get access to electric vehicles which they otherwise might be reluctant to purchase due to high initial investment costs and uncertainties over performance (Johnson and Suskewitcz, 2009; FORA, 2010).

At the same time, many studies are aware that the environmental benefits associated with certain business models depend greatly on the way the products are used by customers. For instance, sharing of products may entail negative environmental impacts, if the access to a shared products increases the customers' use of the product (*e.g.* car sharing may increase the total use of car mobility by improving access to those who otherwise do not use cars) or if the environmental impact from logistics needed to send and collect the shared items exceeds the benefits gained from product sharing (FORA, 2010; Tukker and Tischner, 2004; EPA, 2009).

3-5. Role of enabling technologies and infrastructures

The success of radical innovation and of new business models depends on the enabling environment. In their examination on how to advance systemic eco-innovation, Johnson and Suskewitcz (2009) focus on the role of enabling technologies to help create systemic changes. For example, the emergence of railways was catalysed by the invention of steam engines; the creation of microprocessors helped launch the information age. The real effect of those enabling technologies was felt only after new systems (railways, ICT infrastructure) had evolved around them. Most case

studies point to the importance of enabling technologies and supporting infrastructures, which are often a key success factor behind the introduction of certain new business models.

The literature particularly highlights the role of ICTs that allows inconveniences for customers to be minimised and the efficiency of the system to be maximised. The Vélib bicycle sharing system in Paris, for example, is supported by an internet map showing real-time data on the availability of bicycles and parking spaces (OECD, 2010a). The software used in electric vehicles, which was designed and developed by Israel's Better Place, provides the driver with complete information by displaying the energy level in the battery, locating the nearest battery recharging and swapping facilities, and allowing the driver to handle their booking, parking and charging spots conveniently (Meenakshisundaram and Shankar, 2010). Similarly, many service-oriented business models such as ESCO and video-conferencing services are very much dependent on ICTs which enable monitoring and control of data and information (EPA, 2009).

Availability of supporting physical infrastructures is also often an important factor for eco-innovative solutions. The success of the biogas-based transport system in Linkoping, Sweden owed in a large degree to the specifically designed refuelling stations both for public buses and private cars (Martin, 2009). The Better Place electric car sharing system developed automated battery swapping facilities which can replace depleted batteries with charged batteries within three minutes without drivers getting out of the car (Meenakshisundaram and Shankar, 2010).

3-6. Corporate governance and management

The available studies highlight a number of success factors for implementing eco-innovation which are ascribed to the firm's internal governance, management strategies they adopt and societal values they promote, as follows:

- *Alliances with other firms and stakeholders*: The case studies demonstrate that many firms implemented their eco-innovations in co-operation with other firms, local authorities and other stakeholders. For instance, Better Place entered into alliances with electric car and battery manufacturers and renewable energy producers. Such alliances were seen as win-win opportunities for all the participating groups (Meenakshisundaram and Shankar, 2010). Co-operation with local authorities is often a pre-requisite for large-scale projects like industrial symbiosis and new transport systems (Johnson and Suskewicz, 2009; Martin, 2009; Yang and Feng, 2007; Berkel et al., 2009). Good communication is also critical to the success of some projects. The Kalundborg industrial symbiosis project in Denmark was facilitated by the already established acquaintance between managers of different local firms, their open, non-secretive management style and co-operation opportunities gained previously from other projects (Christensen, 2004).
- *Corporate social responsibility*: The consideration of corporate social responsibility (CSR) in the firm's management and strategies is highlighted in the literature as another important factor for driving eco-innovation (Louche et al., 2010; Carillo-Hermosilla, 2008). Many firms have started engaging CSR as a core aspect of their innovation strategy and, as a result, including social and environmental concerns in their core business models.
- *Leadership*: The dedication of the firm's leadership is an important driver for assimilating changes and introducing new eco-innovation concepts as cradle-to-cradle and closed-loop production (Confino, 2011; Louche, et al., 2010). For example, the introduction of "upcycling" water purification system and the use of bioplastics in bottled water production by Good Water Company in the United States owes largely to its leader's drive and dedication to sustainability goals (Bowden, *et al.*, 2009). Similar examples of dedicated leadership come from many other cases (Carillo-Hermosilla, 2008; Christensen, 2004).

3-7. Barriers to introducing new business models

The analysis in the literature shows that business model-related eco-innovations face a wide range of barriers (FORA, 2010; EPA, 2009), both internal and external to the firm.

Internal barriers

The barriers within the firm which intends to introduce radical and systemic eco-innovations are identified as below according to the review (FORA, 2010; Tukker and Tischner, 2004; Carrillo-Hermosilla, 2008):

- Traditional mindset among producers and lack of knowledge on sustainability issues;
- Insufficient reference cases on new models and approaches;
- Lack of knowledge on new possibilities among management;
- Lack of horizontality among different functions in a firm (*e.g.* a division between those who develop products and those who develop services, between those who make investment decisions and those who oversee operations)
- Increased development and production cost;
- Lack of competencies in R&D.

However, the most important factor in preventing firms from taking a more radical approach to eco-innovation and aiming for systemic shifts would be that even more progressive businesses remain unconsciously aligned to and locked into conventional business models. Many companies are comfortable with their existing business models and not ready to leverage the crucial systemic changes that are needed for radical innovation. In addition, there is often a reluctance of the investment community towards systemic changes and sustainability (Confino, 2011).

External barriers

The promotion of many eco-innovations may also be limited due to several factors external to the firm, including:

- Lack of market-pull forces due to the lack of (smart) regulations, low levels of eco-taxes or consumer subsidies or lacking implementation of green public procurement, and a general lack of governmental action and commitment for reform towards green growth.
- Lack of capital for initial investment often due to the fact that projects are perceived to be too risky or lacking knowledge among stakeholders on the potential economic benefits of investment.
- Difficulty of new business models in fitting in the existing systems as well as their need for supporting infrastructures and technological changes (Martin, 2009; Meenakshisundaram and Shankar, 2010).
- Regulatory barriers that may prevent firms from taking certain new approaches to eco-innovation (OECD, 2011b).
- Lack of consumer readiness on which the adoption of eco-innovations heavily depends. For example, it is difficult to change the attitudes of consumers who are used to the luxury and convenience of big, high-powered vehicles in adopting electric cars or sharing schemes (Martin, 2009; Meenakshisundaram and Shankar, 2010).

3-8. Role of policy

Governmental support has long been central in moving forward next-generation technologies and in promoting radical innovation and systemic changes (Scrase et al., 2009; OECD, 2011b). The role of the governmental policy is repeatedly stressed in the reviewed case studies. The need for policy support at national level is often differentiated from policy support at the local level.

Studies show that national policies that focus on energy and resources efficiency could encourage firms to adjust their strategies for gaining competitiveness. For example, the Eco-Town Programme promoting urban and industrial symbiosis in Japan gained its boost when the government put in place a comprehensive legal framework for a "recycling-based society" in 2002. Berkel et al. (2009) observed that the availability of subsidies for investment, ambitious recycling legislation with quantified, product-specific targets, access to the significant technological resources of the private sector, and a widespread recognition of the urgency to act on environmental issues, all contributed to the success of the programme. There are many other examples of large-scale eco-innovative projects which would not have taken place without strong political support from the national government, clear targets and high levels of regulatory stringency (Johnson and Suskewicz, 2009; Reiche, 2010; Chertow, et al., 2004; Carillo-Hermosilla, 2008).

The stability and certainty of the regulatory framework also plays a substantial role in long-term economic viability of many eco-innovations (OECD, 2011a). The economic opportunity for eco-innovative solutions and practices can only be unleashed with a sufficient level of regulatory certainty. To make long-term investments and commitments, firms require a stable regulatory environment and clear market signals, which ensures a level playing field without competitive distortions (Meenakshisundaram and Shankar, 2010; OECD, 2011a).

Implementation of many eco-innovative projects requires active support and involvement of regional or local government and municipalities. Since the start of the building of a biogas-based transport system in Linköping, for example, local politicians have continued to drive the development of biogas and supported research. The success of this system comes primarily from "political consensus and the municipalities firm belief in the project" (Martin, 2009). Creating preferable market conditions for eco-innovative firms by the local authorities also helps to sustain specific projects, as seen in case of French advertising agency JC Decaux, which was given a monopoly over the large section of billboard advertising in Paris in return for operating the Vélib' bicycle sharing system (OECD, 2010a).

The analysis of business models also has potential implications for entrepreneurship policies. OECD analysis shows that a large share of radical innovations, that will be important in achieving green growth, emerge from new firms (OECD, 2011b). New and young firms are prone to exploiting technological or commercial opportunities which have been neglected by more established companies, often because radical innovations challenge the business models of existing firms. Moreover, analysis for the United States shows that such new firms contribute substantially to the creation of new jobs (Haltiwanger, *et al.*, 2009). Policy may need to create the room for such new firms by enabling their entry, exit and growth, ensuring fair competition and improving access to finance, which remains a major constraint for the entry and growth of young firms.

In considering the role of policy, policy makers will always need to question whether the emergence of new business models and the related innovation can simply be left to the market or whether policies are needed to support it and also what such policies should look like. The rationale for policies for eco-innovation lies in several market failures (OECD, 2011*b*). First, there are the negative externalities of climate change and other environmental challenges. If firms and households do not have to pay for the climate damage imposed by GHG emissions, for example, then GHG emissions will be too high. If customers do not have to pay for the water they use, they are unlikely to use it efficiently. This particular market failure implies that policies will be needed to correct this negative environmental externality, *e.g.* through carbon taxes, tradable permits or other market instruments.

Apart from the externalities associated with the environment, there are also important market failures specific to the market for innovations. The idea that market failure leads to under-investment in innovation, mainly due to difficulties of firms to fully appropriate the returns to their investment, has been the principal rationale for public funding of R&D and public support for innovation for half a century. The lack of appropriability is reflected in positive externalities (as shown in a range of empirical studies), with social returns exceeding private returns. Traditional responses to market failure due to non-appropriability of the results of R&D include policies aimed at strengthening intellectual property rights (notably the patent system); R&D subsidies to private producers of knowledge, and policies that can help capture externalities through (horizontal) R&D co-operation.

Some market failures and barriers to innovation may be unique to, or more prevalent in, the market for green innovation (UK Committee on Climate Change, 2010), such as:

- Dominant designs in energy and transport markets can create entry barriers for new technologies and business models due to, for example, the high fixed costs of developing new infrastructures.
- Uncertainty about the prospects for success and the long timescales for infrastructure replacement and development, which may be a particularly important barrier in the energy sector, where the high capital costs of investment tend to make investors risk averse towards new technologies.
- Differentiation of products in some areas is difficult or impossible, making it difficult for new entrants to get a return from innovation on their investment. This is an issue for the energy sector where customers value electricity but may not possess the information with which to discriminate between electricity generated from a wind or gas turbine.

Other barriers to innovation may emerge from systemic failures that hinder the flow of knowledge and technology, and reduce the overall efficiency of the system-wide R&D and innovation effort. This long list of potential market and systemic failures suggests that policies for innovation will only be successful if they enhance the performance of the system as a whole, targeting weak links between elements that can hurt performance.

At the same time, however, not all potential failures in innovation systems make government intervention necessary or desirable. There is often no guarantee that government policy will be able to address a market or systemic failure in a way that effectively improves the outcome, *e.g.* in welfare terms. Even where governments may improve welfare in principle, they may lack the means or information to do so in practice. Governments' space of action may be limited: in fact, policy or government failures are often the result of the same (*e.g.* informational) constraints as those faced by private actors. Awareness of the possibility of government failure and rigorous *ex ante* evaluation of policies can help to limit the risk of costly but ineffective intervention.

4. Preliminary analysis of business eco-innovation cases

4-1. Outline of case examples

Today's community of inventors and researchers offers a number of novel ideas for solutions to environmental problems among which there are an increasing number of eco-innovative technologies, products, services, projects, organisations and business models. While their importance for realising greener growth has recently been recognised by industry and government alike, their wider diffusion is still limited. Most eco-innovations have a very slow journey to the market or even remain in prototypes, experimental and pilot projects. Little is understood on how these practices can achieve economic and business success and lead to environmental improvements.

There is a growing recognition that in order to be economically sustainable in the long run, many eco-innovative solutions require systemic and transformative changes to enable changes in the way that businesses operate and consumers make choices. However, a great need persists in better

understanding how to stimulate or drive these transformations, and how eco-innovations, especially radical and systemic ones, can achieve economic sustainability, marketability and wider applications and replace existing unsustainable practices.

As the activities and dynamics of radical and systemic eco-innovations are relatively unknown to policy makers, an analysis of real-life examples helps to improve understanding and support the replication of their success through new policy development. In contrast to tapping solely from the conceptual and theoretical discourse, learning through case studies can provide deeper insights into how and why eco-innovation has succeeded or failed, and what factors facilitate or hinder this process. Such a bottom-up approach would help to discover peculiarities of applied business models, as well as various local, cultural and social factors that cannot easily be explained by theoretical models. Insights from practical examples also allows judging the supportiveness of general regulatory regimes and framework conditions and the effectiveness of specific innovation policy instruments, and helps draw policy lessons and recommendations.

This project therefore draws on empirical case studies of radical and systemic eco-innovations with the aim to draw lessons for both policy makers and businesses and entrepreneurs and to assist them in developing their future eco-innovation strategies and business projects. Cases of radical and systemic eco-innovation were nominated not only by OECD member countries but also by many other experts as the call for cases was posted on the OECD website. As of October 2011, 490 eco-innovation examples were nominated by external parties or indentified by the OECD Secretariat from 37 countries. Aiming to select on average 5 cases of primary choice per participating country, the Secretariat has selected 95 cases as its primary choices, taking into account a national and sectoral balance (see Annex). Diverse types of radical and systemic eco-innovations have been identified as primary choices, from the areas of mobility (11 cases), green buildings (9), product improvement (9), eco-towns (8) and materials reuse and recycle (6) amongst the most popular eco-innovation areas. Reflecting the distribution of overall cases, the energy, oil and gas sectors made up 21% of all primary choice cases followed by buildings and construction (19%), water and waste management (16%), transport (10%), food and agriculture (8%), electronics and ICT (3%) and chemicals (3%).

The case studies are currently being conducted by experts nominated by participating countries through face-to-face or telephone interviews with the innovators of the cases using the questionnaire developed by the OECD Secretariat. The questionnaire and reporting template includes the following five larger sections with an extended list of guiding questions in each:

- General features of eco-innovation (covering information on types, functions, innovativeness/novelty, target users, and business model).
- Impact and benefits (including diffusion level, environmental, social and economic impact now and in future, as well as negative impacts).
- Innovation process (covering stages of idea generation, R&D, testing, business development and commercialisation).
- Factors that influence the innovation (such as market conditions, organisation and networks, knowledge and skills, finance and resources, polices, intellectual property rights, value chains, enabling technologies and infrastructure).
- Overall lessons (determinants, future policy support and plans)

The OECD Secretariat had collected 32 case reports from 9 countries by October 2011 (see Annex). The following analysis summarises preliminary findings from those 32 cases including representative business models below:

- ***New, green value-added materials/products/processes*** which, when considered as a new business model, provide potential buyers with economic and environmental benefits during

its use. This group contains a very diverse set of products. Cases presented in this study include: Caroma dual flash-toilet, CSIRO powder coating, Vanadium redox battery.

- ***Waste regeneration systems,*** which are focused on valorising waste, or using it as an input for producing a product to be sold in the market. Examples presented in cases include: Alcoa bauxite residue and Ecoera Biochar.
- ***Renewable energy-based systems*** represent a wide variety of applications, products and systems based on renewable energy applications. Relevant examples presented in case studies are Brite Solar panels-windows and Dow Powerhouse Solar shingles.
- ***Efficiency optimisation by ICT*****:** ICT solutions-based models are generally of two types: ICT service-based models, which includes companies ensuring monitoring of the consumption or redistribution of resources; and ICT products-based models, which are basically the ICT systems or software and hardware packages that are offered and sold to customers. The examples of the first, presented in the case studies are Intelen and smart grid ICT systems. Examples of ICT products are Carta Sense, TaKaDu and E-coupled.
- ***Functional sales and management services model*** is a generic model with common characteristics for all service-based business models. The simplest models are based on delivering services using the more environmentally superior materials and techniques. In the more elaborated models instead of paying for the product per se a part of the transaction is payment for the function of the product. The service provider takes over the control of the use-phase of the product and may be encouraged to remanufacture and reuse the product (FORA, 2010). A relevant example that appeared in the collected case studies is Qlean non-chemical cleaning service.
- ***Innovative financing schemes*** represent long- and medium-term investment arrangements focused often on improvement of environmental performance which is linked to economic performance as well. Among most known examples is ESCO which provides energy-efficiency-related and other value-added services and assumes performance risk for their project or product. The DBFO model is another type of the scheme; it is a contractual relationship between a customer and a private contractor used for construction projects requiring long-term investments.
- ***Sustainable mobility systems*** are alternative transportation schemes, with a lower environmental impact. Examples can include novel more efficient and cleaner public transport systems, car or bike sharing/renting models, schemes for increasing application of electric or biogas-based vehicles, etc. Examples of the new sustainable mobility systems covered in the case studies are the SkyCab transit system and the Better Place electric car sharing (and battery rental) model.
- ***Industrial symbiosis*** The core of industrial symbiosis is a shared utilisation of resources and by-products among industrial actors on a commercial basis through inter-firm recycling linkages. In industrial symbiosis traditionally separated industries engage in an exchange of materials and energy through shared facilities. The waste of one company becomes another's raw material. Cases include Kwinana Regional Synergies project, and in a smaller scale, Frito Lay's Net-Zero Plant which promotes symbiosis among different sections in a single factory.
- ***Green neighbourhood and cities*** are complex and geographically wide system combining many eco-innovative solutions and involving a large range of actors. Green neighbourhoods and cities are designed with consideration of environmental impact, inhabited by people dedicated to minimisation of inputs of energy, water and food, and waste output of heat, air, water and other pollution. Relevant cases presented are: Finland's DigiEcoCity project and Sweden's Hammarby Sjostad eco-neighbourhood.

4-2. Preliminary findings

Business model innovation

Business model innovation is about the creation or reinvention of a business itself. Whereas innovation is typically seen in the form of a new product or service offering, a business model innovation is more about introducing different business strategies offering not only new value propositions, but aligning its profit formula, resources, processes and partners to enhance that value proposition and capture new market segments. Analysis of the case studies showed that business models linked to each type of eco-innovations can go through different degree of changes. Most changes in the observed cases seem to take place in the activities component with research and development (R&D) and product/process development being the most frequent. In the service-oriented models like functional sales and car sharing, the changes are expressed in a broad shift from product to service provision (see Table 1).

Table 1. Business model innovation: change in elements

Eco-innovation / business model types	***Value proposition***	**Business operations**			**Customer aspects**		
		Key activities	**Key partners**	**Key resources**	**Customer segments**	**Customers relations**	**Customer channels**
Green value-added products	*Products with better performance, savings*	R&D	Changes of suppliers (not always)	Other resources	New customers/ market		
Renewable energy based systems	*Cheaper & cleaner energy*	R&D			New customers/ market	New relationship	New relationship
Efficiency optimisation by ICT	*Economic savings due to more efficient management of resources*				New customers/ market	New relationship	
Functional sales	*More efficient services*	R&D (not always)			New customers/ market	New relationships	
Innovative financing	*Resource saving*	Shifting to new services				New relationships	New channels
Sustainable mobility systems	*Flexibility, savings for customers*	Shifting to new services	New partners			New relationships	New channels
Industrial symbiosis	*Resource saving, higher efficiencies*	R&D	Reconfigured network of partners	New expertise		New relationship	New relationship
Eco-cities	*Improved life quality, convenience*	Development	New network of partners	New expertise		New relationship	New relationship

Source: Own elaboration.

Another observed shift is associated with reconfiguring the relationship with conventional customers or building relationships with new customers (or both). New markets and customers are targeted in such models as waste regeneration (new farmers/user of soil conditioner), ICT solutions (larger coverage of people, firms, utility companies), ESCO (new companies willing to cut energy consumption), buyers of renewable energy (biogas, biochar, etc.) Approaching new customers or changing relationships with conventional customers often also requires the transformation of channels to customers. The business model applied in waste regeneration systems seem to go through substantial transformation, affecting all components. Multi-actor business models of industrial symbiosis and eco-cities also appear to be about changing many components, while the actors stay in the same markets and service the same customers.

Value creation

The comparison of the different types of business models show that they differ in the types of the values (economic, social and environmental) they deliver to customers, focal organisation and the partners. The core value proposition of the majority of cases is linked with economic savings, new revenue streams and profits. Flexibility, convenience, better quality of life is offered in most of the cases in the areas of functional sales, sustainable mobility, eco-cities.

Economic savings are usually linked with resource efficiency and savings offered by new solutions in the models based on new products, functional sales, ESCO, mobility-sharing, industrial symbiosis and eco-cities. While it is clear that the economic value is created across almost all of the presented cases, the creation of immediate social and environmental values is limited to several models and not necessarily present in other models unless these are carefully examined, for example, through the assessment of lifecycle impacts. Flexibility and convenience are among key values offered by sustainable mobility, functional sales and innovative financing models. The growing importance of having a green image is also considered as a value that can be acquired both by potential consumers and producers of innovation (see Table 2).

Table 2. Value proposition and first-order value creation effects

Business model types	***Core value proposition***	**First-order value creation**		
		Economic	***Social/cultural***	***Environmental***
Green value-added products	*Products with better performance, savings,*	Saving and better performance for customers Profit for focal company and its suppliers	Green image	
Waste regeneration systems	*Revenue from waste valorisation, alternative products*	Revenue from waste valorisation, alternative products	Green image /bio brand	Minimisation of impact of waste
Renewable energy-based systems	*Cheaper & cleaner energy*	Cheaper energy for customers Profit for focal company	Green image	Minimisation of reliance on fossil fuel
Efficiency optimisation by ICT	*Economic savings due to more efficient management of resources*	Profit for focal company		
Functional sales	*More efficient services*	Savings for customers	Convenience	
Innovating financing	*Resource saving*	Profit for focal company	Convenience	
Sustainable mobility systems	*Flexibility, savings for customers*	Savings for customers Profit for focal company	Flexibility	
Industrial symbiosis	*Resource saving, higher efficiencies*	Resource savings	learning	Waste and emission reduction
Eco-cities	*Improved life quality, convenience*		Improved life quality, Green image	Improved environment

Source: Own elaboration.

Systemic effects

Each type of business model for eco-innovation potentially can generate wider, systemic economic, environmental, and socio-economic effects if the conditions are present for larger diffusion and application of the model. The majority of models analysed in this study offer positive environmental impacts associated with possibilities to save resources. This is often also linked to the reduced ecological footprint of consumption especially thanks to the application of novel products,

technologies and processes which have better environmental performance. Models involving waste reuse or prevention activities (waste regeneration, industrial symbiosis) enable firms to avoid hazardous impacts (air, soil, water contamination, GHG emissions) of untreated waste.

The wider economic impacts in the majority of the discussed models are linked to the creation of new economic opportunities with the proposed innovation, and the creation of new market segments and customer bases. Financial savings achieved through resource efficiency is another frequently observed economic impact across the different models. It is mostly seen on the level of individual consumers and products, but a greater, accumulated impact can potentially be achieved if the presented eco-innovative practices are diffused widely and scaled up.

Social and cultural impacts can be measured in several dimensions: job creation, knowledge diffusion, improved quality of life and change of attitudes and values. Some models have a higher potential for the creation of employment than others. The creation of new activities and services (ESCO, new renewable energy units) can lead to the creation of new jobs, while changing or greening existing practices might not provide such opportunities. The largest social and cultural changes can be expected from projects that encompass social innovation elements, *e.g.* sustainable lifestyles in eco-cities, sharing practices in the mobility schemes.

Table 3. Wider impacts of business models (second-order effects)

Business model types	Potential impacts (Second-order effects)		
	Economic	***Social/cultural***	***Environmental***
Eco-innovative products	Greener markets and economies	Change in people's preferences towards greener products	Reduced footprint due to use of greener products
Waste regeneration systems	Valorising waste and new market niche	New jobs, diffusion of knowledge and technology	Linked to prevention of waste, avoided extraction of natural resources
Renewable energy-based systems	Linked to new economic activities	Local employment	GHG emission reduction
Efficiency optimisation by ICT	Expansion of ICT sector, new business opportunities		Linked to resource use optimisation and saving
Functional sales	New service markets niche	Increased awareness of customers	Reduced footprint due to resource saving and use of greener products/services
Innovating financing	New service markets niche	Increased awareness of customers	Reduced footprint due to resource saving
Sustainable mobility systems	New service markets niche	Flexibility, change in people's preference and attitude	Linked to resource use optimisation and saving
Industrial symbiosis	Valorising waste and improving efficiencies		Linked to resource use optimisation, symbiotic activities, waste reduction,
Eco-cities	Greener markets, new market niches, services Valorising waste and improving efficiencies	High quality life, change in people's preference and attitude New job,	Linked to resource use optimisation, symbiotic activities, waste reduction,

Source: Own elaboration.

Clearly, the analysis of case studies and business models cannot provide firm insights in the overall impacts of eco-innovation and new business models. Even if new green business models are able to create new markets and jobs, other sectors in the economy may be negatively affected. This is why the work on business models is complementary to other OECD work at the sectoral and economy-wide level, this providing a more complete overview of factors and determinants affecting eco-innovation.

Lessons on policies

Public policy, particularly innovation policies, can have significant direct and indirect influences on eco-innovation based on business models. According to the case studies, supply-side policy measures appear to be relevant in promoting eco-innovations. The cases studies suggested particularly high relevance of the support measures including:

- Funding and support measures for R&D (especially for product and technology-based innovations).
- Instruments supporting testing and demonstration (except for ICT solutions);
- Measures supporting early-stage business development (except for ESCO and waste regeneration).

Regulatory and market-based instruments were also show to be an important incentive for the emergence of a large variety of eco-innovations. Environmental and carbon taxes and regulations on harmful substances and activities appear to be relevant in most of the cases. Carbon trading schemes proved to create incentives for the development of clean energy and waste related eco-innovations that potentially can generate carbon credits

The studies also showed that demand-side policy instruments are acquiring importance in creating markets and a business case for eco-innovations. Among them are performance standards, green labels and certificates that showed to have greater importance in developing new green value-added products, materials and processes. Public procurement and consumer subsidies also showed a promising potential for ensuring economic viability and diffusion of eco-innovative products and services. Arguably, one can expect a higher role of demand-side instruments for customer-related segments.

Although to a lesser extent, eco-innovation also seems to benefit from measures supporting networking and partnerships. These instruments are more relevant in cases of promoting sustainable mobility and ICT-based projects, which largely rely on provision of enabling infrastructure (*e.g.* Internet, smart grid).

Considering the possible considerable impact of policies on business models, the design of public policies supporting eco-innovation should explore how to take account of new business models as well as leverage new models. Policy makers should consider the potential wider implication of business model changes for value chains and the effects of providing support for specific components of business models for strengthening the eco-innovation capacity of companies. Moreover, as noted in section 3, it will be important to carefully consider the rationale for specific policy, and establish the most efficient mix of policies to drive eco-innovation.

5. Concluding remarks

In the coming weeks, the remaining eco-innovation case reports will be collected from participating countries and the final report will be compiled and finalised later in 2012, which will include more detailed, in-depth analysis of the cases. The workshop *The Future of Eco-Innovation: The Role of Business Models in Green Transformation* to be held on 19-20 January 2012 in Copenhagen will be a great opportunity to exchange real-world experiences between eco-innovators, experts and policy makers and to draw lessons for both industry and government for the promotion of new types of eco-innovation as one of the key green growth drivers. The OECD Secretariat would appreciate active participation of workshop participants, particularly since the outcomes from the workshop will provide an important pillar for the final report.

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ANNEX
List of Eco-Innovation Examples Selected for OECD Case Studies

(As of October 2011)

Note: The highlighted cases are those which have already been submitted by country experts to the Secretariat and which are included in the preliminary analysis in this background paper.

Country	Name of selected case	Focal organisation
Australia	Wastewater recycling plant	Water Corporation
	Dual flush toilet	Caroma
	Kwinana regional resource synergies project	Curtin University of Technology and Kwinana Industries Council
	System to process bauxite residue and produce sand for construction	Alcoa
	Value-added materials from hazardous waste	CSIRO Australia
	Vanadium redox battery	University of New South Wales
Austria	Online shop for eco-products	ECOPORIO
	Timber-made office building	GriffnerHaus
	Clean energy from raw sewage	Umbrella Organization Energy-Climate Protection
	Demonstration of a carbon-free logistic	Fronius International
Belgium	Cradle-to-cradle furniture	BMA Ergonomics
	Collaborative product packaging recycling at regional level	Interregional Packaging Commission
	Trays made from recycled materials	Roltex
	Eco-sufractant	Ecover
Canada	Eco-neighbourhood project, Vancouver	Millennium Water
	Programmable communicating thermostat	Tantalus
	Wastewater treatment system using membrane bioreactor for an apple cider factory	Altech
	Heat recovery unit	EcoInnovation
Denmark	Smart green housing demonstration project	VKR Group
	Water recycling solution	Grundfos
	Energy savings consulting services	Danfoss Solutions
	Integrated biomass utilisation system	INBICON
	Process for animal manure treatment	Infarm
Finland	"Waste refining" plants combined with operating services	Preseco
	Bio-energy generation from waste combined with DBFO business model	Watrec
	Model sustainable city unit	DigiEcoCity
	Laser welded sandwich light-weight steel structure	Kenno Tech
	MERA passive solar apartment building	VTT Technical Research Centre
France	Fleet Solutions tyre maintenance services	Michelin
	Vertical green wall garden	Greenwall
	Software for energy savings for companies	Avob
	Velib' bicycle sharing system	JCDecaux Cyclocity
	Bamboo accessories and furniture	EKOBO
	Label to help the printing industry to reduce their environmental impacts	Imprim'Vert
	New diaper system for babies	Hamac

Country	Name of selected case	Focal organisation
Germany	CAR2GO car sharing scheme	CAR2GO (Daimler)
	EcoCommercial building energy optimisation service	Bayer Material Science
	Internal contracting for financing energy and water saving measures	Wuppertal Institute
	Organic refreshment drinks developed based on beer brewing method	Bionade
	Passive house district, Freiburg	Solarsiedlung
	Waterless urinals	Waterless-Hettwer
	Home automation	EnOcean
Greece	Power producing windows	Brite Hellas
	Social network for smart energy activities	Intelen
	Sustainable tourism by organic meat production	Native Animal Farm
	Eco-apartment blocks	Raidis Arquitects
	Organic fertiliser	Humo Olea
Israel	Electric vehicles networks and services	Better Place
	Online water infrastructure monitoring system	Taka Du
	Wireless sensors for monitoring food supply chain	CartaSense
	Microbial fuel cell technology for wastewater treatment	Emefcy
Korea	Eco-industrial network for efficient steam production	Daekyung Enertech, etc.
	Steel by-product recycling network, Pohang	Pohang Industry Science Institute, etc.
	Artificial buoyant island powered by solar energy	Inhabitat
	Songdo sustainable city	Gale international
Netherlands	Amsterdam Smart Grid City project	Accenture
	Composting system for developing countries	Soil & More International
	A project to integrate process technology and industrial processes	Orgaworld
	Device to make water from air without using energy	AquaPro
	Renting of roof space to install PV cells	SunUnited
	Recyclable carpet with cradle-to-cradle approach	Desso
	Household energy saving meter	Wattcher
New Zealand	Biofuels and fertilisers from sewage effluents	Solray Energy
	Electric folding bicycle	Yike Bike
	Pure merino wool outdoor clothing	Icebreaker
	System turning industrial emissions (CO) into ethanol	LanzaTech
	Household co-generation system	Whisper Tech
	Biogas reactor	Waste Solutions
	Wireless charging technology for electric vehicles	Halo IPT
Poland	Biodegradable non-woven pots for plants	Institute of Natural Fibres and Medicinal Plants
	Catalytic regeneration of used oils	Oil and Gas Institute
	Thermal energy plant, Luban	4Biomass project with AGH University of Science and Technology
	Industrial wastewater treatment technology	PP-EKO
	Sustainably built home from natural materials	KWK Promes
	Electric Mobility Programme	e+

Country	Name of selected case	Focal organisation
Spain	CitySolver traffic optimisation solution	Bitcarrier
	Eco-friendly cleaning products for food industry	Inteman
	Smartcity	Endesa and Sadiel
	Commercial-scale plant that uses central tower receiver and molten salt heat storage technology	Torresol Energy Investments
	Environmentally friendly public housing project	Bbarquitectes
Sweden	Automatic on-demand pod-car system	SkyCab
	District heating system fuelled by renewable energy and waste heat	Borlange Municipality
	Hammerby Sjostad eco-neighborhood development	City of Stockholm
	Qlean non-chemical cleaning method	Servicestaden
	System turning bio-wastes into biochar and syngas fuel	Ecoera
Switzerland	Forest Certification	PEFC
	Mobility Car Sharing	Mobility Cooperative
United Kingdom	Airplane engine management service system	Volvo Aero
	BedZed passive house district project	BioRegional Solutions for Sustainability
	Eco-industrial park (an location to be selected)	International Synergies
	MU by Peugeot mobility sharing scheme	Peugeot
	Refillable light weight packaging	eziserv
	Shiply.com courier-sharing services	Shiply
United States	Biomimicry inspired carpet tiles and product-service system	Interface Global
	Wireless power charger for electronic devices	Fulton Innovation
	LEED-certified renovation of a old brick building	Barton Group
	Net-zero energy plant, Arizona	Frito Lay
	Point-of-sale cooling with natural refrigerants for food and beverage	Refrigerants, Naturally!
	Products from 3P Pollution Prevention Program	3M
	Sustainable cuisine at leisure parks	Xanterra Parks & Resorts