Interim Report of the Green Growth Strategy: Implementing our commitment for a sustainable future

Meeting of the OECD Council at Ministerial Level

27-28 May 2010

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GREEN GROWTH STRATEGY INTERIM REPORT: IMPLEMENTING OUR COMMITMENT FOR A SUSTAINABLE FUTURE

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Foreword

The gravest crisis of our lifetimes is now receding, but this doesn't mean that we are going back to normal. Policy makers around the world are now confronting a triple and very delicate challenge: record unemployment, unsustainable fiscal deficits and low growth. All this in a context where environmental and climate concerns are becoming an increasingly important component of economic policy.

Tackling these challenges efficiently will require a "policy hat trick" to generate the proper conditions for a sustainable growth path. But how can we achieve this when our traditional engines of growth are moving in slow motion? We need to rely on new sources of growth. There is no easy answer, but there are two clear opportunities that we can harness: innovation and green growth.

In this challenging context, the decision taken by Ministers of 34 countries last year at the OECD Ministerial Meeting to develop a Green Growth Strategy was visionary. The mandate was clear: *growth* can — and should — go hand-in-hand with *green*. The multidisciplinary policy experience of the OECD made it the right place to begin.

The OECD has been working on tackling environmental degradation and climate change from an economic perspective for several decades. Our experience points to the need for a broad, integrated mix of policies in order to achieve strong green growth. Market mechanisms will be crucial within such policy packages. Some of the most effective tools include getting the prices right, encouraging investment in green technologies and eliminating harmful policies, like fossil fuel subsidies. Promoting these instruments is among the smartest options. Broader policies to foster innovation will also be critical for creating new green industries, businesses and jobs.

The OECD Green Growth Strategy will identify the key barriers that we need to overcome. It will develop practical policy tools for securing the shift to a greener economy. It will seek to be useful and accessible to OECD and emerging economies in their joint and individual ways to build a new sustainable growth path.

This Interim Report provides first insights to better understand the challenges and opportunities that lie ahead and assesses some of the measures taken in the context of the crisis. It is the result of the work of OECD and partner countries. It has benefitted from the perspectives of business and civil society stakeholders. The 2010 Ministerial Council Meeting will be key for taking the Strategy forward, thus making a substantive contribution to promoting growth and well-being in a sustainable, "green" way.

Angel Gurría
OECD Secretary-General

Overview

1. Growing concerns about the environmental unsustainability of past economic growth patterns and increased awareness of a potential future climate crisis have made it clear that the environment and the economy can no longer be considered in isolation. At the same time, the financial and economic crisis has provided the opportunity for policy interventions aimed at encouraging recovery and renewed growth on more environmentally and socially sustainable grounds. A strategic vision is necessary to ensure that, during the crisis exit and beyond, the policies that governments will implement are the most appropriate from an economic efficiency, environmental integrity and social equity point of view, as well as coherent both at a national and an international level.

2. Within this context, green growth is gaining support as a way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use. It builds on existing sustainable development initiatives in many countries and aims at identifying cleaner sources of growth, including seizing the opportunities to develop new green industries, jobs and technologies, while also managing the structural changes associated with the transition to a greener economy. Managing the employment and other distribution effects of change in more traditional sectors will also need to go hand in hand with exploiting new opportunities. New indicators and data will be needed to measure progress towards green growth, including to reflect environmental quality, natural resource scarcity and quality-of-life beyond material well-being.

3. Green growth policies need to be embedded in a coherent, integrated strategy covering demand and supply aspects, both economy-wide and at the sectoral level. This will ensure that green growth is not a just a short-term response to the crisis but a transforming dynamic for both production processes and consumer behaviour. While green growth is relevant to all countries, the policies and approaches used will have to be tailored to specific national circumstances. The overarching priorities for most emerging and developing countries are still poverty eradication, the provision of basic education, ensuring food security, and delivering essential services such as water supply and sanitation. At the same time, a large share of their economies is dependent on natural resources and they are often particularly vulnerable to the impacts of climate change, especially in terms of security of food supply and access to water resources. As such, their economic development will depend on timely adaptation and the sound management of the natural resources that are such a critical base for their economies.

4. The OECD will deliver a Green Growth Strategy Synthesis Report to the 2011 Ministerial Council Meeting, which will elaborate specific tools and recommendations to help governments to identify the policies that can help achieve the most efficient shift to greener growth. The 2010 Interim Report highlights preliminary findings on a number of key issues that policymakers are currently facing in transitioning to greener economies. These reflect only a sub-set of the broader range of issues that will be addressed in the 2011 Synthesis Report.

5. The Strategy will develop a framework to help ensure that green growth policies contribute to greater economic integration, technology co-operation and reduced pressure on scarce environmental resources. It will highlight the importance of ensuring that green growth policies are not a source of increasing green protectionism.

6. Green growth strategies will require a mix of policy instruments, including market-based approaches, regulations and standards, measures to incentivise R&D, and information-based instruments to facilitate consumer choices. Correctly pricing pollution or the exploitation of a scarce resource through taxes, natural resource charges or tradable

permit systems should be a central element of the policy mix, most notably to provide a clear market signal. However, market-based instruments alone will not be enough to bring about a shift to greener consumption and production patterns. Regulations will be needed in cases where market failures result in weak responses to price signals or when a complete ban on certain activities is necessary, for example in the production and use of toxic chemicals. Other approaches, such as voluntary instruments and information-based measures such as energy efficiency ratings and well-designed eco-labelling can play an important supporting role in raising consumer and producer awareness on the environmental impact of specific activities as well as on the availability of clean alternatives.

7. Innovation will be a critical driver of green economies and job creation. Policies to accelerate the development and diffusion of clean technologies and related knowledge will be another key part of the policy mix. As identified in the OECD Innovation Strategy, this will involve a broad approach, comprising price-based instruments and incentives for firms to engage in green activities, as well as public procurement and the funding of basic research. It will be essential to remove barriers to trade in clean technologies as well as to the entry of new firms, and improve the conditions for entrepreneurship, especially in light of growing evidence that young firms represent a large source of more radical innovations. There is also the need for more effective and inclusive multilateral co-operation on science, technology and innovation. The Strategy will address this issue and consider challenges relating to co-operation across countries, funding arrangements, capacity building and international technology transfer. Analysis by the International Energy Agency (IEA), for example, shows that there is considerable potential for the further development and deployment of renewable energy, energy efficiency and other low-carbon technologies. Tapping into this potential will be critical for greening the energy sector.

8. As part of their stimulus packages to respond to the crisis, a number of countries increased public investments in green infrastructure – particularly in terms of public transport, low-carbon energy production, smart electricity grids, energy efficiency of public buildings, and water and sanitation infrastructure. Given that one likely effect of the crisis has been to raise risk premia and therefore lower private investment in higher-risk projects, governments could further build on these measures to move forward investments that would facilitate the development of green technologies and industries. Some countries have also invested in basic R&D to support green innovation and increased their use of environmentally-related taxes. However, not all of the stimulus measures will have been good for the environment, and some may have encouraged investments which could lock in more traditional polluting activities. For example, unless carefully designed, the significant support provided to the automobile industry in some countries, investments in road building and car-scrapping programmes, may have exacerbated pressures on the environment by increasing incentives for private car use.

9. Beyond the crisis, it will be essential to remove policy barriers that hamper the transition to green growth. This involves the reform of environmentally harmful subsidies, the removal of barriers to trade in environmental goods and services, and rationalising conflicting policy instruments. The Interim Report includes a focus on the reform of environmentally-harmful fossil fuel subsidies as an important 'win-win' strategy for green growth and briefly presents some recent developments in greening agricultural support. OECD analysis based on IEA data finds that removing subsidies to fossil fuel consumption in emerging and developing countries could reduce global greenhouse gas emissions by 10% in 2050 compared with business-as-usual. It would also make these economies more efficient, reduce the burden on government budgets, and alleviate the potentially distortive effects of subsidies on competition.

10. The Interim Report also presents recent OECD analysis on the use of environmentally-related taxes, charges and emission trading schemes. While their use is spreading across OECD and emerging economies, there is considerable scope for expansion in the use of green taxes. Wider use of these market-based instruments can also be an important source of government revenues. For instance, OECD analysis shows that if all industrialised countries were to cut their emissions by 20% by 2020 relative to 1990 levels,

via taxes or emission trading systems with full permit auctioning, proceeds generated in 2020 could be as high as 2.5% of GDP across countries.

11. Revenues from carbon taxes or auctioned permits can offset more distortive forms of taxation, to generate welfare gains. They could also be used to help meet the financing commitments in support of climate change adaptation and mitigation in developing countries. Given the urgent need to reduce government deficits following the crisis, revenues could also be used for fiscal consolidation. In emerging economies, such revenues could finance other pressing priorities, such as education, health care and poverty alleviation.

12. While green growth will create opportunities for technological advances, jobs and skills development, one of the main challenges will be to facilitate the re-allocation of capital and labour across economic sectors while minimising the adjustment costs that result. Many governments have highlighted the potential employment impacts of the green elements of their stimulus packages. In the current context of low economic activity and a slack labour market, some of these measures can have an important short-term, positive impact on employment, while accelerating the transition to green growth. However, the long run impact on net employment is uncertain across most green growth scenarios, and will be examined in more depth for the 2011 Synthesis Report. Initial OECD analysis suggests that reallocation of labour across sectors, firms and regions/localities is likely to be considerable and there will be significant changes in job skill requirements.

13. The Interim Report presents initial analysis areas across the issues highlighted above. The 2011 Report will build on this to develop an integrated framework to guide government intervention across broader green growth policy areas, covering fiscal, innovation, trade, labour and social policies, and in key sectors such as energy, transport, agriculture and fisheries. It will address the key issues requiring international co-operation, including the financing of global public goods (e.g. to help address climate change and biodiversity loss), enabling pro-poor growth, international technology transfer, and the potential leakage and competitive effects of policy action. A new accounting framework and a new set of green growth indicators will be developed to identify gaps and to measure progress.

I. Why a Green Growth Strategy?

1. Two main factors underpin the demand and rationale for green growth. First, there are growing concerns about the environmental unsustainability of past and current economic growth patterns and the risk of irreversibly altering the environmental base needed to sustain economic prosperity. Increased awareness of a potential future climate crisis has made it clear that the environment and the economy can no longer be considered in isolation. These concerns point to the need for substantial transformation of consumption behaviour, industry structures and technologies. Without a global shift to a low-carbon, resource-efficient economy, the world is on track for increasing greenhouse gas (GHG) emissions by 70% by 2050, and temperature increases of 4-6°C by the end of the century, far from the target countries recently agreed in Copenhagen of staying within a 2°C increase (Table 1)[1] . To feed the expected world population in 2050, food production will need to be increased by 70% (FAO, 2009) putting additional pressure on already over-used natural resources. A further 1 billion people are expected to live in severe water-stressed areas by 2030, raising a challenge in terms of the policies and financing needed to ensure access to clean water. The costs of inaction on these challenges to the economy, to human health and welfare and to the environment would be high (OECD, 2008a).

2. Second, the financial and economic crisis creates room for public policies aimed at encouraging recovery and renewed growth on more environmentally and socially sustainable grounds. The high level of economic slack implies that the opportunity cost of green growth investments is temporarily depressed and indeed the fiscal stimulus packages put in place by governments in response to the crisis contain a number of measures specifically aimed at greening the recovery. A strategic vision is necessary to ensure that, during the crisis exit and beyond, the implemented policies are the most appropriate from an economic efficiency, environmental integrity and social equity point of view, as well as coherent from both a national and an international perspective.

3. Within this context, green growth can be seen as a way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss and unsustainable natural resource use. It aims at maximising the chances of exploiting cleaner sources of growth, thereby leading to a more environmentally sustainable growth model. This will involve seizing the opportunities for development of new green industries, jobs, and technologies, as well as managing the transition for greening the more traditional sectors and the associated employment and distributional effects. It will require adopting new technologies, developing new products and supporting new patterns of demand from households, companies as well as governments.

4. Green growth policies will require an integrated strategy that effectively combines economic, environmental and social policy objectives covering demand and supply aspects, both economy-wide and at sector level to insure coherence in policy design and implementation as well as to maximize the synergies among different policy actions. Green growth will also necessitate the development of new measurements covering dimensions of quality-of-life above and beyond material well-being.

5. A strategy for green growth will provide renewed direction to environmental and economic policy in the tradition of sustainable development. Sustainable development, first enshrined in the Rio declaration nearly 20 years ago, is an important antecedent for green growth. At the same time, a green growth strategy which leverages off the substantial body of analysis and policy effort that has flowed since Rio can be used to create a clear and focused agenda for delivering on many of its aspirations.

6. Green growth is relevant to both developed and developing countries. For the majority of developing countries providing basic education, ensuring food security, and delivering essential services such as water supply and sanitation will remain overarching

1. See OECD (2009a). The baseline scenario examined in the study suggests that, on the assumption of unchanged policies, GHG emissions could rise by over 50% between now and 2050.

priorities. At the same time, developing countries also have a larger share of their economies directly dependent on natural resources and are particularly vulnerable to the impacts of climate change. Adaptation to the impacts of climate change will be critical for development, while sound management of natural resources offers considerable economic opportunities. While green growth strategies will be articulated at the national level, the international dimension should be fully considered in developing any related policy approaches. International co-operation and co-ordination will be critical for ensuring overall effectiveness.

Responding to the Ministerial mandate

7. At the OECD Ministerial Council Meeting (MCM) of June 2009, ministers from all 30 OECD countries as well as Chile, Estonia, Israel and Slovenia endorsed a mandate for the OECD to develop a Green Growth Strategy, bringing together economic, environmental, social, technological, and development aspects into a comprehensive framework. As one of the Organisation's horizontal priorities, the Strategy draws on the work of more than 25 OECD Committees involved in its development as well as on the insights of the Innovation Strategy and the Reassessed Job Strategy. The Strategy's Synthesis Report will be delivered at the 2011 MCM and will provide specific tools and policy recommendations to help OECD and non-OECD governments to identify policies for the most efficient shift to a green economy. The policy framework will be flexible enough to adapt to different national circumstances.

8. The Strategy will also aim at developing measures and analytical tools for identifying the potential effects of green growth on levels and nature of employment, trade, well-being, the value of material income, fiscal balances and income distribution, comparing these to developments otherwise expected if historical economic and environmental trends were to continue. Moreover, the Strategy will examine how OECD countries can better support green growth in developing countries, including by strengthening development co-operation and through ensuring increased coherence in OECD country policies that affect development (Box 1).

Box 1. Contribution of the Green Growth Strategy

- Creating a common understanding of green growth;
- Developing a conceptual framework for green growth;
- Assessing countries' green growth measures taken since the crisis and future plans;
- Quantifying the potential effects of green growth;
- Describing the new issues raised by green growth;
- Identifying key policy principles and providing a toolkit for green growth policies;
- Developing a set of indicators covering economic, environmental and well-being aspects;
- Strengthening performance through peer reviews of green growth policies;
- Addressing the political economy considerations of green growth;
- Identifying lessons learned and best practices;
- Providing a platform for international co-ordination and dialogue through the International Green Growth Dialogue initiative;
- Promoting co-operation between OECD and non-OECD countries on issues relating to green growth.

The Interim Report

9. As a first step towards the 2011 MCM, this Interim Report provides a framework for understanding green growth and some preliminary findings on a number of key challenges that policy makers are facing in promoting green growth. This selection reflects the shorter-term challenges that countries will need to address to sustain a green recovery, as well as areas of OECD work where initial analytical results are already available. The Interim Report therefore only addresses a small sub-set of the broader range of issues that will be covered in the Synthesis Report of the Green Growth Strategy.

10. Section II presents a broad framework for understanding green growth, outlining the key parameters and policy approaches needed to move towards more sustainable economies. Section III considers a number of challenges that countries are facing in exiting the crisis and moving towards greener economies, as well as selected issues in the broader policy framework. Section IV identifies the need for new measurements for green growth and presents the key indicators that will be developed by the Strategy. Section V closes with a discussion of the next steps for delivering the Synthesis Report and the directions of ongoing work in this regard. Appendix I to this Report includes an indicative compendium of existing OECD indicators related to green growth. Appendix II highlights a few examples of work areas that are being further developed as input into the Synthesis Green Growth Strategy.

Box 2. Progress on key environmental challenges

A number of environmental targets have been agreed internationally that reflect the carrying capacity of the environment. Surpassing these targets poses risks of irreversible damage to the environment and the ecosystems that support life on earth. However, sizeable gaps remain with respect to the targets that the international community has endorsed to tackle the risks associated with environmental degradation. For certain environmental challenges, knowledge gaps and uncertainty suggest that precaution may need to be applied in the management of the potential risks.

In the case of climate change, while the Copenhagen Accord noted at the United Nations Framework Convention on Climate Change Conference of the Parties at its fifteenth session (COP 15) represents an important international step in addressing climate change, the emissions reductions that countries have put forward are not yet enough. Since Copenhagen, 113 countries have associated themselves with the Accord, responsible for about 85% of greenhouse gases worldwide. The Accord lists both emission reduction targets put forward by industrialised countries (Annex I countries) and specific emissions reduction actions from most emerging and a number of developing countries. Recent OECD analysis suggests that the most ambitious industrialised country targets on the table following the Copenhagen meeting would amount to an 18% reduction in their emissions by 2020 from 1990 levels. While this is significant, it is less than the 25-40% reduction that the Intergovernmental Panel on Climate Change (IPCC) suggests is needed to stay within a 2oC temperature increase (Table 1). If industrialised countries reach only the lower bound of their declared targets, they will reduce emissions by only 12% in 2020 compared with 1990. According to the IPCC, significant deviation from business-as-usual is needed by developing countries; their current targets would amount to an 8% reduction in emissions in 2020 from business-as-usual levels.

Similarly, concerning biodiversity and ecosystems services, there is widespread acceptance that countries have failed to meet the 2010 target to achieve a significant reduction in the rate of biodiversity loss globally as was agreed in 2002 by Parties of United Nations Convention on Biological Diversity. This loss is driven primarily by land use changes (conversion to agriculture and infrastructure expansion), unsustainable use of natural resources, invasive alien species, climate change and pollution. Although governments have increased the scale of their responses to the loss of biodiversity, for example by expanding protected areas, the OECD projects continued biodiversity loss in the coming decade unless there is a significant policy shift. For example, recent data from the FAO indicates that on a global scale, 50% of fish stocks are fully exploited, 25-30% of stocks are over-exploited and about 20% of the world's fish stocks are viable for further exploitation.

Enhanced action is required to reverse the trend of unsustainable use and pollution of water resources. UN estimates suggest that the world is not on track to meet the Millennium Development Goals related to water, including halving by 2015 the proportion of people without access to safe drinking water and sanitation. Despite their pledges to develop integrated water resources management and water efficiency plans by 2005, the vast majority of countries (including OECD members) have yet to implement such plans.

Table 1: Declared country targets and actions to reduce GHG emissions and their revenue potential

Region /country	Declared targets and actions	Ambitious action scenario (with linking and offsets[1]); year 2020			
		Simulated target as % deviation from base year[2]	GDP % deviation from BAU	Real income[3] % deviation from BAU	Potential revenues (billions of USD)
Australia & New Zealand	Australia -5% to -25% from 2000; New Zealand -10% to - 20% from 1990	-12.0	-0.8	-1.7	24
Canada	-17% from 2005	0.0	-0.4	-2.7	24
EU27 & EFTA	EU27, Lichtenstein, Switzerland -20% to -30%; Norway -30% to -40%; Iceland -30%; Monaco -20%; all from 1990	-30.0	-0.4	-0.7	167
Japan	-25% from 1990	-25.0	-0.2	-0.2	44
Non-EU Eastern Europe	Ukraine -20% from 1990; Belarus 0% to -10%; Croatia -5%	-16.5	-2.1	-2.8	39
Russia	-15% to -25% from 1990	-25.0	-2.8	-3.5	73
USA	-17% from 2005	-5.5	-0.3	-0.7	253
Brazil	-36% to -39% from BAU	-20.8	-2.0	-5.3	94
China	Carbon intensity of -40% to -45% from 2005	62.3	-0.3	-0.3	81
India	Carbon intensity of -20% to -25% from 2005	66.8	0.0	0.6	0
Oil Exporting countries	Indonesia -26% from BAU; Israel -20% from BAU	32.6	-0.9	-2.9	33
ROW	Korea -30% from BAU; Mexico -50% by 2050; South Africa -34%; many other pledges (incl. Costa Rica, Maldives)	28.6	0.0	-0.1	57
Annex I	-12% to -18% from 1990; (-23% to -29% from BAU)	-18.1	-0.4	-0.8	624
non Annex I	+43% to +49% from 2005; (-5% to -9% from BAU)	43.2	-0.3	-0.7	265
World	+12% to +18% from 2005; (-12% to -17% from BAU)	12.2	-0.4	-0.8	889

1. Due to the limited information available on what offset policies might be in the future, a default value of 20% of the target is used for Annex I countries, with two exceptions. First, Canada has previously informally indicated it would limit companies to buy offsets to a maximum 10%. Secondly, for Russia, the Low & Fragmented scenario assumes no offsets, as the domestic target is not binding and thus there is no demand for offsets.

2. Due to data availability constraints, the base year is 1990 for Annex I regions and 2005 for non-Annex I regions (Brazil, China, India, Middle East, and Rest of the world). Global deviation is based on 2005 data for all regions.

3. Hicksian "equivalent real income variation" defined as the change in real income (in percentage) necessary to ensure the same level of utility to consumers as in the baseline projection.

Source: OECD ENV-Linkages model; updated analysis based on Box 7.2 and table 7.3 of OECD (2009a).

II. A framework for green growth

11. Moving towards green growth will require targeted government intervention across a number of policy areas in order to address the existing externalities and market failures characterising environmental goods and services (Box 3), to accelerate green innovation, and to manage the transition to a green economy. This will help to put green growth on an even playing field with conventional growth. It will establish the market certainty and incentives that businesses need to make long-term investment decisions. It will also help providing stable, long-term support for research, development and deployment of clean energy, for innovation throughout the economy, and for the sustainable use of natural resources while supporting the rise of household and private sector demand for green products and services. A broad range of policies can and have already been introduced to this end.

12. With a view to bring policy mixes closer to best practice from a green growth perspective, the OECD is identifying the key elements of an economic framework to help determine the economic efficiency and environmental integrity of different policy mixes, as well as their coherence at both a national and an international level. The framework identifies a set of criteria and principles against which policy instruments can be assessed. It also discusses the public policy challenges to be met during the transition towards a greener growth path, which is likely to be characterised by clean technology development, industrial and job restructuring, and changing consumer habits.

Box 3. Environmental externalities and market failures

A. Externalities

Production and consumption activities lead to various environmental side-effects that impact negatively on welfare. Correcting for these externalities can improve welfare and is therefore desirable. From this perspective, there is thus not necessarily a trade-off between promoting wellbeing and ensuring environmental quality. Externalities can be distinguished according to the nature of the trade-off they entail, which depends in part on whether they primarily impact on material or quality-of-life aspects of wellbeing:

Externalities on material wellbeing are defined as the by-products of production and consumption activities that lead to a reduction in current and future production capacity. They mainly concern side-effects on the stocks of environmental, physical or human capital, as well as on productivity. Road congestion is an example of an externality having an impact on current GDP that can be substantial. However, externalities that take several years to materialise tend to be more common and addressing them may involve policy trade-offs between current and future GDP. For example, an excessive level of soil exploitation would entail erosion, thereby reducing future agriculture yields and GDP. Climate change is another environmental externality that is expected to imply large destruction in physical capital through more intense and frequent storms, droughts and floods, and a rise in sea level.

Externalities can also affect the quality of life independently from any direct impact on current or future productive capacity. Examples are the various forms of pollution that would affect the health of individuals who may be outside the labour force, or changes in the environment that would affect the perceived quality of life. Addressing this type of externality often involves trade-offs between material and quality-of-life aspects of well-being, as maintaining a level of quality of life may bear an economic cost. In general, externalities involving trade-offs between current and future well-being may raise issues of inter-generational equity and sustainability.

B. Market failures

Externalities arise from a number of market failures and imperfections inherent in the nature of environmental goods and services. These include:

- **The "public good" nature of environmental assets:** It is often impossible for individuals or countries to fully appropriate the benefits of their own actions to protect the environment, giving rise to free-riding incentives. This is particularly acute in the case of the climate, given that regardless where GHGs are emitted they contribute equally to global climate change, but it is also relevant for a number of natural resources, as illustrated by problems of over-exploitation of water basins and fish stocks as well as other biodiversity and ecosystems services.
- **Monitoring and enforcement costs:** These can be large, as for example in the case of GHG emissions from deforestation or from pipeline leakages. All GHGs other than carbon involve significant monitoring and enforcement costs.
- **Information asymmetry and split incentives problems:** When information is not fully available and the cost of acquiring it is high, as is often the case for households or small businesses, incentives might not suffice to prompt efficient behaviour. Problems of split incentives arise when, for example, information about energy efficiency of electrical appliances or thermo-isolation of buildings is mainly disseminated to home owners while it is tenants who pay the electricity and heating bills. Again, standards may be more effective than incentives.
- **Market incompleteness:** Both the benefits and costs of action to reduce pollution and unsustainable resource use often materialise with long time lags and therefore their evaluation is subject to risks and uncertainties which cannot be fully addressed by establishing contracts covering the whole set of market contingencies.

There are also knowledge externalities in innovation that reflect the public-good nature of ideas, with the result that private investment in innovation falls short of the socially desirable level because innovating firms cannot prevent other firms from benefiting from the knowledge they create. While this positive externality affects technological innovation in general, there are reasons to believe its impact may be exacerbated in environmental areas, in particular climate change given the uncertainty of future policy action. Together, these market failures may have adverse effects on the functioning of financial markets, limiting access to finance for investment in green technologies. More generally, the presence of learning-by-doing and forward R&D spillover effects provide a comparative advantage to existing technologies at the expense of cleaner technologies that are in their infancy and whose commercial viability and future profitability are therefore more uncertain.

13. The tools to promote green growth include instruments covering both demand and supply. A first set comprises market-based instruments aimed at promoting green growth through pricing signals, including environmentally-related taxes, charges and fees, tradable permits, and removal of environmentally harmful subsidies. Another set entails instruments that seek to influence the behaviour of firms, households or individuals through means other than price signals. These include command-and-control regulations, policies to support green technologies and innovation, and voluntary approaches based on the dissemination of information and on negotiated agreements between the government and particular industrial sectors to address a specific environmental concern. An effective policy mix will have to draw on both sets according to the circumstance.

14. Given the range of market imperfections as well as political economy considerations, green growth policies should be evaluated on the basis of their cost-effectiveness, the adoption and compliance incentives, and their ability to cope with uncertainty, notably to provide a clear and credible signal to investors. Another important

criterion is their effectiveness in stimulating innovation and the diffusion of green technologies so that the cost of abating pollution can be lowered in the future. Finally, as many environmental externalities, spill across national borders (*e.g.* climate change, water management, fishing stocks), the extent to which instruments can be designed and implemented in a way that facilitates international coordination also needs to be considered.

15. OECD review of the relative strengths and weaknesses of the different instruments with respect to the above criteria (De Serres, Murtin and Nicoletti, 2010), indicates that the best choice of instruments will vary by environmental issue as well as across country- or region-specific circumstances. Indeed, given the presence of several interacting market failures, the most appropriate green growth policy response will, in most cases, require a combination of instruments. This combination may be influenced by the weight put on environmental concerns. This is partly a matter of social preferences that are expected to increase with income levels, thereby differing across countries and stages of development. Market conditions may also have an influence on the choice of instruments. For instance, intergenerational transfers that could improve the wellbeing of both current and future generations may fail to take place in countries with less-developed financial markets. The introduction of green technologies in their early stages of development may have to be supported by specific measures to avoid paths dependency in "dirty" technologies. Furthermore, the design and implementation of policies often raise governance issues that differ across countries. Difficulties in monitoring environmental performance, collecting green taxes or setting up new markets may influence the choice of policy instruments in countries with large informal economy areas and/or weak capacity in environmental policy design or implementation.

16. Despite such differences, conditions that seem particularly favourable to the use of specific instruments are reported in Table II.1 and lend to the following policy considerations:

- Putting a price on a pollution source or on the over-exploitation of a scarce resource through mechanisms such as taxes, natural resource charges, or tradable permit systems should be a key element of a policy mix.
- Regulations will be needed when market failures result in a weak response of agents to price signals. This is the case when pollution emissions cannot be adequately monitored at the source – at least not at a reasonable cost – and there is no good proxy that could be subject to taxation. Regulation may also be the only option applicable when a complete ban on certain activities is deemed necessary. Regulation should be designed with a view to minimize the additional administrative burden and compliance costs for businesses and consumers.
- A combination of taxes, tradable permits and/or performance standards may be an optimal option in cases of multiple and varied sources of pollution. For example, GHG emissions which originate from very different types of agents and economic sectors. Instruments should be set so as to minimise the differences in the implicit or explicit pollution prices across sectors.
- Policies to support green technologies and innovation may be appropriate in areas characterised by strong market size and learning-by-doing effects and which involve high entry costs. They could also support the development of technology infrastructures in areas where network considerations are important. In general, where the development and diffusion of clean technologies are hampered by specific innovation failures, overall cost-effectiveness can be improved by combining pricing instruments with R&D, innovation and technology adoption policies.
- Subsidising green activities should generally be avoided, given the potentially large budgetary costs, their limited impact on incentivising reductions in the environmentally harmful activities and potentially distortive effects on competition and trade. However, it may be an effective option in cases where

pricing instruments would be difficult or very costly to enforce and when the subsidised activity is a strong substitute for the dirty activity that is targeted. When they are used, subsidy programmes should be time-bound and closely monitored.

- Other approaches, including voluntary instruments and information-based instruments such as energy efficiency ratings and well-designed eco-labelling, can complement other policies in the environmental policy mix. For example, eco-labels can be effective in strengthening the responsiveness of agents to price signals by raising consumer and producer awareness on the environmental damage caused by specific activities as well as on the availability of cleaner alternatives. Voluntary approaches can help to reveal information about abatement costs and environmental damages. However, in order to ensure that they achieve emissions reductions beyond business-as-usual, they are most effective when combined with regulations.

17. Ensuring coherence between the different tools of the policy mix to promote green growth will be critical for their overall efficiency (Box II.1). Policy mixes that result in counter-productive overlaps of instruments should be avoided. As a general rule, policies overlap when the same emission source (*e.g.* individuals, firms, public administrations) is covered by at least two instruments that essentially address the same environmental externality. For instance, once a total emission-reduction objective is set through a national emission-trading scheme, additional targets, such as for renewables or biofuels, will not necessarily reduce emissions beyond the cap-and-trade target. Thus, potentially overlapping policies should only be used in situations where they can be justified on other grounds, for example, as a way to boost low-carbon technologies or improve energy security.

Managing the transition towards green growth

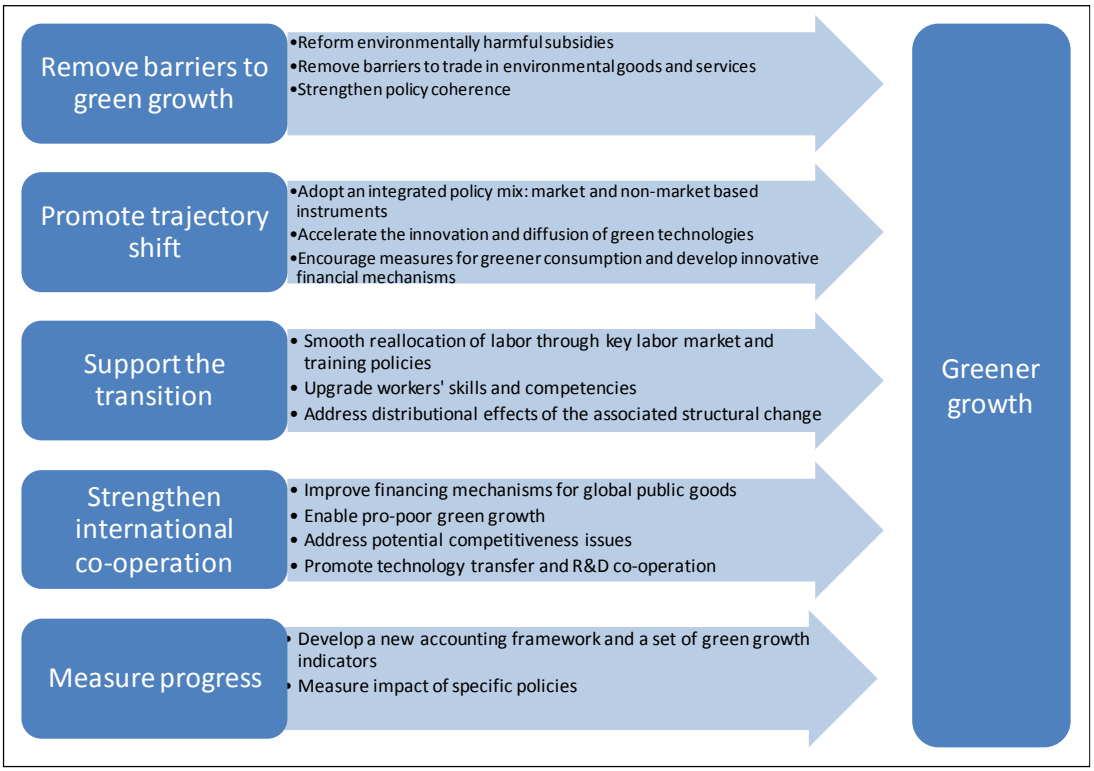
18. The transition to a green economy will require dedicated policy approaches to foster the development and diffusion of green technologies, and to facilitate the re-allocation of capital and labour resources across sectors while minimizing the likely adjustment costs that such processes entail. While green growth will offer many new opportunities in terms of technological, sectoral and employment developments, it will also involve a careful management of the potential decline and job losses in more polluting or environmentally-damaging activities. The economic environment that will prevail in the next few years will make such transition particularly challenging. The consequences of the recession on potential output as well as the need in many countries to embark on fiscal consolidation will exert additional pressure to selectively use public resources. At the same time, a transition towards green economies will open new opportunities for growth, jobs and skills development. Some of the key strategies for addressing these transitions issues are discussed in more depth in Section III.

III. Preliminary results on key elements of the green growth toolkit

19. The toolkit developed in the Green Growth Strategy to help countries transition towards green growth will need to be flexible, so that it can be adjusted and tailored to fit differing national and local circumstances and stages of development. It will include:

- An understanding of green growth, elaborating its short-term and long-term objectives, and covering four priority environmental challenges: biodiversity and ecosystem services, climate change, sustainable materials management and sustainable use of natural resources, including forestry and water.
- Approaches to overcome the policy barriers to green growth, such as the reform of environmentally-harmful subsidies and inefficient regulatory interventions, the removal of barriers to trade in environmental goods and services, and strengthening policy coherence.
- The policies that can bring about the necessary shift towards green growth, including the correct pricing of environmental goods and services, measures to foster green technologies, innovative financing mechanisms and policies to move towards greener consumption and production patterns.
- Policies to smooth the transition to green growth, including key labour market and training policies to facilitate the reallocation and re-skilling of labour towards greener activities; and initiatives to foster a better matching between workers and the rapidly evolving demand for labour. Measures to address other distributional effects of the transition, for instance in terms of inequality, will also be covered.
- International co-operation for green growth, including for financing global public goods (climate, biodiversity), enabling pro-poor green growth (Box 4), addressing potential leakage or competitiveness effects of policy action, and for international co-operation on green technology development and transfer.
- A new accounting framework for identifying gaps and measuring progress towards green growth, based on the development of green growth indicators to measure the transition to a more sustainable economy as well as the impact of specific policies.

Figure 1. Overview of the Green Growth Strategy Framework



20. This section provides initial analysis of some of the key challenges facing policy makers in the transition towards green growth. First, it presents an assessment of some of the lessons learned from the green elements of the recent stimulus packages. Second, it discusses one of the policy barriers hampering the transition to green growth – environmentally-harmful subsidies – and what can be done to reform these subsidies. Third, while a broad range of policy instruments will be needed to support green growth, a key element of such a policy package -- the appropriate pricing of environmental goods and services – is discussed, and some recent developments with market-based instruments are highlighted. Fourth, measures and trends to strengthen green innovation are examined, as a critical element of the green growth toolkit, taking into account inputs from the Innovation Strategy. To illustrate how green growth might be understood at the sectoral level, the next section provides an example of the energy sector drawing on analytical results of the International Energy Agency (IEA). Finally, as a key concern in implementing policy measures will be ensuring a smooth transition for affected workers and sectors, some initial insights on the structural impacts of green growth and how to manage the transition are presented.

21. This section presents only a small selection of the initial results stemming from the first stage of the Strategy's work, in order to provide preliminary insights and guidance. As such, this selection should not be seen as projections of the broader range of topics that will be addressed in the Synthesis Report. Appendix II contains a number of boxes to provide an overview of some of the additional ongoing work at OECD that will contribute to the Green Growth Strategy.

Box 4. Key pillars for pro-poor Green Growth

For developing countries, green growth and poverty reduction must go hand in hand and the international community can provide critical support to make it happen. In this regard, the Strategy will focus on three critical pillars of pro-poor green growth: (1) encouraging sound natural resources management and governance; (2) shaping climate resilient growth; and (3) promoting low-carbon growth.

Encouraging sound natural resources management and governance

As compared with OECD countries, many developing countries are heavily dependent on natural resources. Forests, fisheries, lands and wildlife are critical for the livelihoods of the poor. Therefore, natural resource degradation is a threat to both environmental sustainability and poverty reduction. Sound governance is critical to ensure sustainable and equitable management of natural resources. In many countries perverse incentives encourage rapid depletion of the resources base. Institutional and regulatory reforms are therefore often needed to address such perverse incentives. These include securing property or use rights and strengthening the institutions that govern the resources.

Shaping climate resilient growth

Climate change poses a serious risk to lives and livelihoods, particularly for the world's most vulnerable people and countries. According to the most recent UN estimates, the livelihoods of one-third of the world's population could be affected by water scarcity by 2025 and, by the end of the century, half the world's population could face severe food shortages due to rising temperatures. The impacts of climate change may reverse progress towards achieving the Millennium Development Goals. Adapting to climate change will be a critical prerequisite for pro-poor green growth. Climate change adaptation needs vary widely across countries. Therefore, climate change adaptation responses should be country-driven, led by national and local governments, as well as private businesses and civil society actors including at the community level. Recognising climate risk in development planning at all levels allows to minimise the risk of "maladaptation", which increases climate vulnerability.

Promoting low-carbon growth

Although today most developing countries contribute only minor shares to GHG emissions, they will increase their emissions if they follow conventional economic growth patterns. Moreover, deforestation and forest degradation are in many developing countries already a major source of GHG emissions. Less developed countries, therefore, can play an important role in mitigating climate change. Fortunately there are many opportunities for development – climate change mitigation co-benefits. In particular, a shift away from traditional, highly polluting, energy sources (*e.g.* direct burning of biomass) towards modern energy sources provides a host of benefits ranging from enhanced health and safety to improved gender equality. Similarly, combating deforestation, if done right, can generate new income opportunities for forest dwelling communities.

Lessons learned from the stimulus packages

22. The current crisis has provided an opportunity for governments to kick-start efforts towards a greener economy. The stimulus packages that were put in place in a number of countries included measures aimed not only at stimulating the economy, but also moving towards a cleaner, low-carbon, resource efficient economy. While hard to evaluate in practice, many governments have also emphasised the potential job creation from some of the green stimulus measures (Box 5). Many stimulus packages included public investments in green infrastructure – including public transport, low-carbon energy production, smart electricity grids, and water and sanitation – as well as in basic R&D to support green innovation. Some included the introduction or strengthening of environmentally-related taxes. While this range of measures contributes to progress towards green growth, concerns have been raised that they should not lead to protectionism. At the same time, not all of the measures in the stimulus packages will have been good for the environment, and some may have encouraged investments which could lock-in more traditional polluting activities. For example, the large support provided to the automobile industry in a number of countries, investments in road building, and programmes put in place to pay consumers to discard or scrap old cars and buy new ones, may have increased pressures on the environment if not carefully designed (Box 7).

23. Stimulus measures need to be carefully designed if they are to foster both macro-stabilisation in the short-run and the transition to green growth over a longer time horizon. Macro-stabilisation requires that stimulus packages be timely, targeted and temporary. While the considerable potential for green stimulus measures should be exploited fully, governments need to bear in mind that there are limits to the contribution that macro-stabilisation measures can make to fostering greener growth. [2] Some of the green fiscal measures appear to score well on the three criteria. For example, programmes to retrofit existing public and private buildings for greater energy efficiency have a considerable capacity to generate new jobs quickly (timely) that many currently unemployed workers can be quickly trained to fill (targeted) and the fiscal stimulus related to these measures can be phased out as the economic recovery takes hold (temporary). However, many of the policy initiatives required to bring about a transition to green growth do not satisfy the "three Ts". For example, public subsidies to stimulate eco-innovation likely involve a long time lag before many new jobs are created. Furthermore, few currently unemployed workers will be qualified for the R&D jobs eventually created.

2. As was first formalised by Jan Tinbergen, it is advantageous to have at least as many policy instruments as policy goals. While fiscal stimulus packages should contribute as much as possible to making the economy greener, most of the work will need to be done by dedicated green policies, such as those included in the green growth toolkit discussed above.

Box 5. Employment potential of green components of stimulus packages – some examples

Many governments have highlighted the job potential associated with the green investments made as part of the fiscal stimulus packages. For example, some of the official government estimates include:

- The United States Council of Economic Advisers estimates that the approximately USD $90 billion of Recovery Act investments will save or create about 720 000 job-years by the end of 2012. Projects in the renewable energy generation and transmission, energy efficiency, and transit categories would create the most job-years. Approximately two-thirds of the job-years represent work on clean energy projects, either by workers employed directly on the projects or by workers at suppliers to the projects.
- Korea has been implementing its "Green New Deal" policy since January 2009 as a part of an economic recovery package. The policy's aim is to overcome the financial crisis in the short-term as well as to ensure growth potential over the long term. 50 trillion KRW have been invested to create 960 000 jobs from 2009 to 2012 in, for example, an environmentally-friendly transportation network, water management and river rehabilitation, clean energy, green IT, and waste-to-energy.
- China's stimulus package includes the largest green stimulus programme enacted by any country, accounting for almost 40% of the total USD 586 billion package. Although no official estimates of the expected jobs creation are available yet, the potential gross increase in employment in green activities is undoubtedly large.
- France is another example of a country taking the opportunity of the crisis to transition to a greener economy. Its stimulus package totalled USD 33.1 billion, 21% of which was designated for green measures, which are estimated to create 80 000-110 000 jobs during 2009-2010. Along with the fiscal stimulus, the French government announced a longer-term "Green Growth and Employment (Croissance verte et emploi)" plan. The plan is notable for its emphasis on skill development, including a goal of training 360 000 green technicians, including 70 000 youth, every year.

However, caution has to be exercised when assessing the jobs potential of green measures in the stimulus packages. First, these employment gains are in many cases likely to be temporary, in that they involve the employment of some of the cyclically unemployed rather than raising equilibrium employment in the long run. Second, it is clear that the implicit employment multiplier used in the assessment of the jobs potential of the green components of the stimulus packages varies significantly across studies and countries, Finally, while moving towards green growth is likely to involve the development of new growth, employment and innovation opportunities in some sectors, it is likely to involve down-scaling and employment losses in the more traditional, polluting and resource-intensive sectors.

24. Many fiscal stimulus packages have included infrastructure investments to enhance green activities, such as renewable energy production, the upgrading of public building stocks, the expansion of public transport systems or the upgrading of water supply and sanitation infrastructure. In total, infrastructure investments are planned to be large in several countries, as for instance Canada will invest 1.3% of GDP, Australia 0.8%, the United States 0.7% and France 0.5%. In many cases, infrastructure investments have explicit green objectives, with the construction of energy-efficient buildings being particularly common. The French package included investment by public enterprises on rail and energy network developments. Governments in nearly half of OECD countries have also invested in ICT infrastructure, including to foster broadband deployment and to accelerate the development of a digital economy (notably in public services), in many cases with expected green applications such as 'smart grids' and efficient transport systems.

25. These targeted efforts take place in a broader context where the economic and financial crisis has modified the general outlook for infrastructure investment in important ways, re-shaping some key features while exacerbating others. When economic activity and world trade fell sharply in 2009, earlier concerns in many countries about expected shortfalls in infrastructure capacity subsided somewhat. In several sectors – notably natural gas, liquid natural gas, maritime ports, airports – concerns pointed more in the direction of capacity oversupply in the short term. As a result, many infrastructure projects have been deferred and some shelved indefinitely. As recovery and growth gain momentum, infrastructure use is expected to recover over the next two to three years. But the outlook for funding and financing has been adversely affected by the financial crisis. Governments are facing large deficits and increasing debt and the private sector's contribution is also under threat, given the larger risk aversion of potential infrastructure investors and the more binding restrictions on the availability of longer-term finance from the banking system. Under these circumstances, risk of insufficient investment in infrastructure in the medium to longer-term should not be overlooked given the key role infrastructure can play in facilitating and promoting growth (Egert, B et al, 2009).

26. Against this background, there are reasons to believe that the current context of low activity provides an opportunity for new investments in infrastructures that would facilitate the development of green technologies and industries by anchoring beliefs into their commitment to green growth (Box 6). Major projects are being put on hold or are being subjected to close scrutiny to ensure that they inject added value where it is most needed. Such more careful appraisal and prioritisation is an opportunity for reviewing the planning process and attributing more weight to green considerations in project selection. Projects that might benefit from such a shift in perspective include: the choice between improved road or rail connections to economic activity centres, hubs and gateways, absorbing additional air or sea traffic demand through the creation of new secondary facilities, rather than by expanding airport or maritime port capacity in the existing locations, and thereby exacerbating urban congestion, entrenching high fossil fuel use and CO_2 emissions.

Box 6. The scope for moving forward public infrastructure investment

Considering that one likely effect of the crisis has been to raise risk premia and therefore lower private investment in higher-risk projects, governments could consider the possibility of moving forward investment in infrastructures that would facilitate the development of green technologies and industries by anchoring beliefs into their commitment to green growth. One example would be to encourage power infrastructure providers to invest more rapidly in the transmission capacity that greater use of renewable energy sources will most certainly generate in future years, even if this were to lead to temporary excess capacity.

Some tentative indications of the effect of the crisis on the opportunity cost of public investment can be derived from estimates of the employment impact of recent fiscal stimulus packages. Indeed, most OECD countries have introduced large fiscal stimulus packages, which represent on average about 4% of GDP, the largest discretionary fiscal packages being adopted in Korea (6.5% of 2008 GDP), the United States (5.6%), Australia (5.4%), and Japan (4.7%). The average effect of fiscal stimulus on employment in 2010 was estimated to lie between 0.8 to 1.4 percentage points, with a particularly strong magnitude in Australia, Japan and the United States.

Assuming for instance that a stimulus of 4% of GDP would be accompanied by a reduction of 1% in unemployment, savings in social spending could reach 1/4% of GDP, or around 6% of the stimulus. Taking these numbers at face value – and abstracting from other considerations would suggest that moving forward public investment might pay off as long as the cost of government borrowing does not exceed 6%. These estimates are based on average effects, and the scope for bringing forward infrastructure investment would vary across countries, notably according to differences in the size of the labour market gap, in the employment intensity of such investments and the potential mismatch between the skills requirements. In this regard, the sluggish labour market also lowers the opportunity cost of training and hence there could be a case for raising public support for on-the-job training through existing active labour market policy programmes.

Source: De Serres, Murtin and Nicoletti (2010).

27. Yet the bulk of infrastructure that will be present in developed countries in the next twenty years is already in place. Hence, much of future infrastructure spending will be on maintenance and upgrading. Still, there is room to strengthen the green component of such spending while also seeking the most cost effective basis. Examples range from efficiency enhancing improvements of intermodal transport linkages and upgrading of track with intelligent traffic management systems, to the reduction of CO_2 emissions at ports by replacing diesel driven cranes with electric ones.

28. There is also much scope for the development of a greener infrastructure generally, focused on using new approaches for their operation and management. This includes smart metering in water, smart grids that enable users to track electricity consumption and enable small producers to contribute to electricity supply, the use of sensor networks to improve and optimise traffic flows, and strategies to persuade users to adopt environmental-friendly attitudes and technologies that will contribute to the greening of infrastructure use. Within this context, countries could consider increased use of ICT applications, building on the 2010 OECD Council Recommendation on Information and Communication Technologies and the Environment.

Box 7. Car-scrapping schemes and green growth

In most countries with a significant automobile producing sector, governments introduced a "car-scrapping" scheme as part of their policy response to the crisis, including 16 OECD countries. Among the ten largest car-producing countries, only Brazil and India did not introduce one. Car scrapping schemes, also referred to as "cash-for-clunkers" incentives, are time-limited public subsidies for the purchase of a new vehicle to replace old energy-inefficient ones. Clearly, the main objective of these programmes has been to cushion the impact of the crisis on the automobile industry by shifting forward household demand for new cars. In most cases, however, they have also been promoted on environmental grounds. While these measures can help to remove older, less efficient vehicles, from the roads, they may also encourage greater material consumption, vehicle use, and ultimately increased emissions. Their overall economic efficiency also remains questionable.

The schemes have contributed to a substantial boost in new car sales around mid-2009 in both the United States and throughout Europe. In the latter case, there are even indications that car producers in countries with small or no incentives benefited from spill-over effects, in particular from the German programme. And these incentives appear to have contributed to the economy-wide recovery observed in many countries in the latter half of 2009, especially in the United States where motor vehicles output added 1.5 and 0.4 percentage points to third and fourth quarter growth in real GDP.

Even so, the final impact on economic activity is likely to have been lowered by the crowding-out effect on the demand for other household consumption products. Furthermore, since the programmes consist mostly in moving forward car purchases, their full impact on the car industry will depend on the timing and magnitude of the so-called payback effect, *i.e.* the temporary setback in sales that can be expected as the scheme is terminated. Recent estimates suggest that sales appear to be either close to or below trend, with the notable exception of Germany where recent sales may have been pushed far above medium-term prospects. In any case, since most programmes ended in late 2009, a strong payback effect – should one materialise -- could be felt as early as during the second or third quarter of 2010.

Meanwhile, subsidising the premature withdrawal of vehicles that could have rendered useful services for a few more years represents an economic cost to society. However, insofar as these vehicles are replaced by more energy-efficient models, there is also a benefit for society in the form of reduced health-related costs as well as other potential damages caused by climate change. The expected net reductions in greenhouse gases and other pollutants induced by car-scrapping schemes are estimated to be simply too small for the environment-related benefit to offset the cost.

Sources: Haugh, Mourougane and Chatal (2010), and Schweinfurth (2009).

Overcoming barriers to green growth: Addressing environmentally harmful subsidies

29. A number of policy barriers are hampering countries in the move to green growth, including environmentally harmful subsidies, tariff and non-tariff barriers to trade in environmental goods and services, inefficient regulatory interventions and conflicting policy instruments. Policy-induced distortions can lead to a misallocation of resources that affects the transition towards green growth. One example is the absence of, or an inadequate pricing of, natural resource use. For instance, under-pricing of water can lead to wasteful use of water, and reduce the incentives for wide take-up of water-saving technologies or practices such as drip irrigation in agriculture. In addition to distorting resource allocation within and between countries, environmentally-harmful subsidies can also contribute to air, water and land pollution. Their reform or removal could benefit both the economy and the environment and, as such, addressing these distortions is commonly viewed as a "win-win" opportunity.

30. This section presents initial analysis on the opportunities for reforming environmentally-harmful subsidies and highlights some recent developments in countries with regards to fossil fuel subsidies and in the agriculture sector. Fossil fuel subsidies remain high particularly in a number of developing and emerging economies, while agricultural and fisheries subsidies are particularly pervasive in many OECD countries (Box 8 and Table 2).

Reforming Fossil Fuel Subsidies

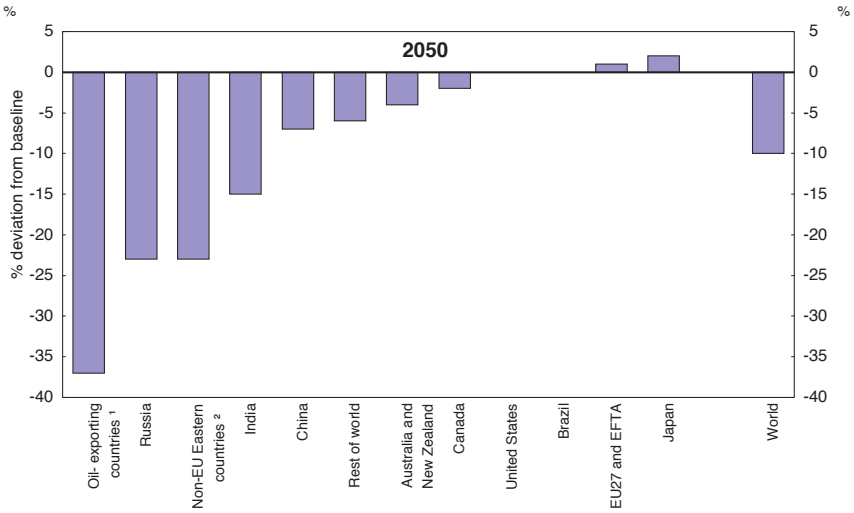
31. Environmentally-harmful subsidies to fossil fuel energy consumption or production amount to a *de facto* reward for carbon emissions. Estimates by the International Energy Agency (IEA) using the price gap methodology suggest that subsidies to fossil fuel energy consumption in 20 developing and emerging economies amounted to USD 310 billion in 2007. Removing these subsidies would lower the global costs of achieving a given goal to reduce greenhouse gas emissions, and would constitute an important contribution towards addressing climate change (OECD, 2009c). For example, new analysis by the OECD suggests that phasing out fossil fuel subsidies by 2020 could reduce GHG by over 20% in 2050 in non-EU Eastern European countries, Russia and the Middle East. As a result, global GHG emissions would be reduced by 10% in 2050 compared with business-as-usual (Figure 2).

Table 2. Some estimates of subsidies to selected sectors

Fossil fuel and electricity subsidies in 20 non-OECD countries *(as measured by the IEA price-gap approach)*	USD 310 billion (2007)
Agricultural subsidies in OECD countries *(as measured by the Producer Support Estimate)*	USD 265 billion (2008)
Fisheries subsidies in OECD countries *(as measured by Government Financial Transfers)*	USD 6 billion (2005)

Sources: OECD (2009b), OECD (2008a) and IEA (2009).

Figure 2. The effects on greenhouse gas emissions of removing fossil fuel subsidies in emerging and developing countries combined with caps on emissions in developed countries

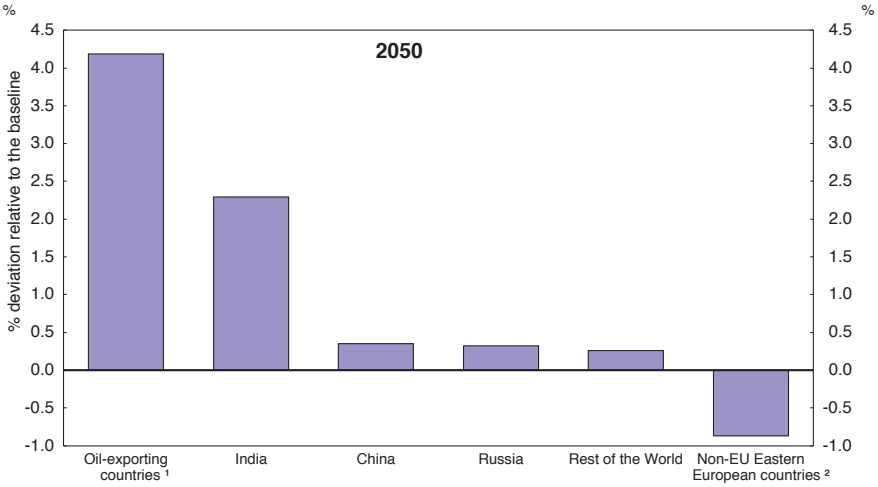


1. The region includes the Middle East, Algeria-Libya-Egypt, Indonesia and Venezuela.
2. These non-EU Eastern European Countries together form the 'Rest of Annex I 'region of the OECD ENV-Linkages model.

Source*: OECD ENV-Linkages model based on subsidies data from IEA for 37 emerging and developing countries in 2008.*

32. Removing the subsidies would also increase the efficiency of economies, reduce the financial burden on government budgets, and alleviate the potentially distortive effects of subsidies on competition. Thus, the analysis suggests that most countries or regions would record real income gains from unilaterally removing their subsidies to fossil fuel consumption, as a result of a more efficient allocation of resources across sectors. These real income gains could be as much as 4% in oil exporting countries and more than 2% in India in 2050 (Figure 3).

Figure 3. Impact of unilateral removal of fossil fuel subsidies on the real income of selected countries and regions



1. The region includes the Middle East, Algeria-Libya-Egypt, Indonesia and Venezuela.

2. This region includes Croatia and the rest of the former Soviet Union (integrated by the following countries: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan) according to the data aggregation in the GTAP database.

Source*: OECD ENV-Linkages model based on IEA data.*

33. If all countries that subsidise fossil fuel consumption were to remove these subsidies multilaterally, this would reduce energy demand at the world level, thus inducing a drop in international fossil fuel prices. The changes in international trade, measured both in terms of volume as well as terms-of-trade, associated with this would lead to a distribution of real income gains and losses across countries, favouring fossil fuel importing countries but with losses for fossil fuel exporters. While a multilateral removal of fossil-fuel subsidies brings some real income gains at the world level, these gains would be unevenly distributed across countries (Figure 4). Some oil-importing OECD countries would experience real income gains of around 1%. Most fossil fuel exporting countries, particularly Russia and the non-EU Eastern countries, would incur real income losses. With the exception of Russia, however, the reductions in GDP growth compared with the baseline scenario would generally be marginal (Figure 4).

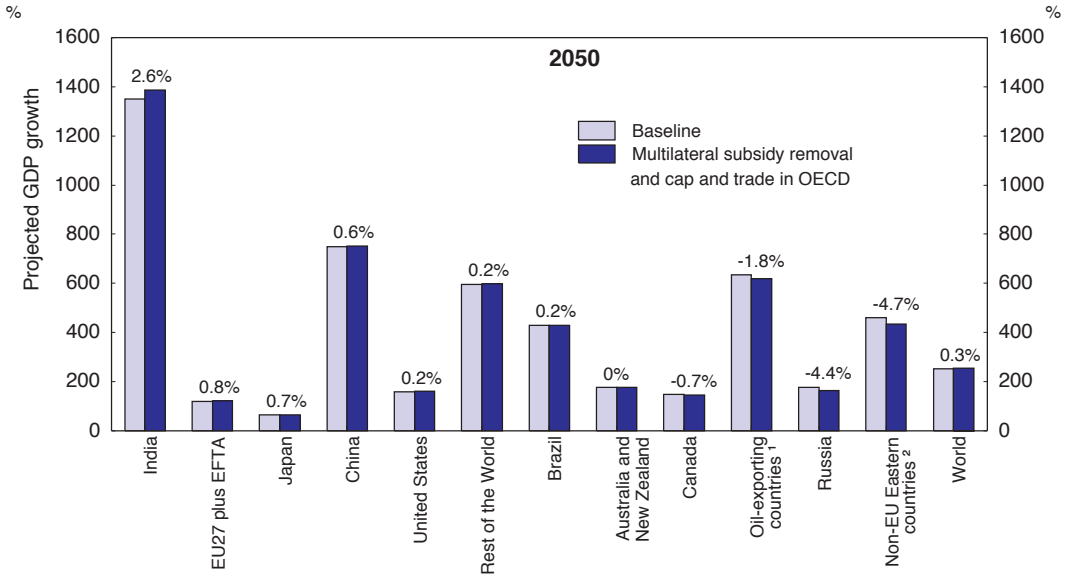
34. Often subsidies to fossil fuel consumption are provided through across-the-board reduced prices for electricity or fuels, which may primarily benefit middle and higher income households (*e.g.* those that can afford cars). Reducing these across-the-board subsidies would generate large budgetary savings, with OECD analysis suggesting that the suppression of fossil fuel subsidies could lead in 2020 to extra government revenues equal to almost 6% of the GDP in Russia, 5% of GDP in the Middle East region, 1.8% in India and 0.4% in China. The funds from these budgetary savings could be used to reduce other distorting taxes, which would increase the real income gain from subsidy removal, to contribute to fiscal consolidation, or they could be used to reduce poverty in a more targeted and efficient way than through an across-the-board subsidy to fossil fuel consumption.

35. Subsidies that create a differential between the domestic price and a (higher) world-market price are not the only subsidies being provided to fossil fuels, of course. Several OECD countries provide assistance to low-income households that enables them to pay their heating bills in the winter. A number of countries also fully or partially exempt their farming, forestry, fishing and mining sectors from excise taxes on fossil fuels. Many countries, both OECD and non-OECD, also support the production of fossil fuels (or

electricity based on fossil fuels), through grants, loans and loan guarantees, or targeted tax concessions. The total value of this support has never been estimated.

Figure 4. Impact of multilateral fossil fuel subsidy removal on GDP

Percentage deviation from 2005 levels[1]



1. Percentages noted on top of the columns indicate GDP change in 2050 relative to baseline.
2. This region includes Croatia and the rest of the former Soviet Union (integrated by the following countries: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan) according to the data aggregation in the GTAP database.
3. The region includes the Middle East, Algeria-Libya-Egypt, Indonesia, and Venezuela.

Source: OECD ENV-Linkages model based on IEA data.

36. Experience shows that it is not easy to reform or phase-out environmentally-harmful and costly subsidies, given the vested interests of those that benefit from them and limited available data on these subsidies. Some of the key elements of successful subsidy reform include: availability of good quality data on the magnitude of the subsidies, who benefits from them, and who pays; a strong communications effort to raise awareness of the benefits of subsidy reform; packaging of subsidy phase-out in broader structural reforms; and well-targeted, time-limited compensation for those that might be adversely affected by the subsidy phase-out (OECD, 2007).

37. Following a request by G20 Leaders in September 2009, and discussions in OECD Committees, the OECD is working on *(i)* establishing methods for estimating subsidies to fossil fuel production and consumption, and gathering data on fossil fuel subsidies in OECD countries, *(ii)* using modelling-based analysis to better understand the economic, trade and greenhouse gas impacts of phasing-out fossil fuel subsidies; and *(iii)* providing advice on how to phase-out fossil fuel subsidies, based on lessons learned from country experiences and taking into consideration the importance of addressing potential social impacts of subsidy phase-out. First results of the analysis will be made available through a joint IEA, OPEC, OECD and World Bank report to the G20 Finance Ministers meeting in April 2010 and the G20 Leaders Meeting in June 2010.

Box 8. Agricultural subsidies and green growth

Although agriculture plays a relatively minor role in most OECD countries in terms of its contribution to GDP and employment, a wide range of government policies provide significant support in many OECD countries. The OECD has been annually monitoring and evaluating policies since the mid-1980s and a key indicator in the evaluation is the OECD's Producer Support Estimate (PSE). Support to farmers in OECD countries has fallen in the last two decades as measured by the percentage PSE, from 37% of farmers' total receipts in 1986-88 on average to 23% in 2006-08. In total, it amounted to an estimated USD 265 billion in 2008.

Agricultural policies and the resulting support are relevant to green growth. Support influences the amount of agricultural production and the allocation of resources between agriculture and the rest of the economy (the "growth" dimension), and environmental performance (the "green" dimension). However, it is not only the overall amount of support but also the way in which it is provided and implemented that influence production, the allocation of resources and environmental performance.

Agricultural support tends to keep more resources in the agricultural sector than would be the case in the absence of support and, from an economic growth perspective, diverts some resources from more productive uses elsewhere in the economy. Moreover, the closer the link between support provided to inputs used in agriculture and outputs produced the greater the impact on production. Over recent decades, as a consequence of policy reform in many OECD countries, there has been some shift away from production-linked support (decoupling) which has thus enabled the sector to respond to a greater extent to market signals, with potentially positive implications for growth in the economy. But support for commodity production and unconstrained input use is still the most significant element, accounting for around 55% of overall support in OECD countries. However, overall support, as measured by the percentage PSE, varies from under 5% in Australia and New Zealand to over 50% in Iceland, Japan, Korea, Norway and Switzerland. In Japan and Korea, around 90% of support is production-linked whereas in Norway and Switzerland the share has declined over time to around 50% at present. In the US and EU – which account for the largest share of OECD agriculture support – the production-linked share is respectively 30% and 40%.

The effect of policies and policy reform on the environment is more complex and varies across and within countries. Policies to subsidise inputs (such as water) or outputs (such as price support) can maintain or increase production above what would otherwise be the case, using greater amounts of inputs that have harmful environmental effects – causing water pollution from greater use of fertilisers and pesticides (and from manure run-off due to higher numbers of livestock), soil erosion, loss of biodiversity, and increased GHG emissions. But in some regions such policies can maintain production, farming systems and practices that are associated with the preservation of environmentally sensitive land or valued ecosystems, or the maintenance of flood, drought or soil erosion control.

Not all forms of agricultural support are environmentally-harmful, and some support measures are linked to achievement of specific environmental objectives. Some support, for example, pays for research and development, information and advice, food inspection services or the provision by farmers of non-marketed environmental services, such as biodiversity, flood and drought control, sinks for greenhouse gases and carbon storage. In some countries, income support is conditional on the respect of environmental and other regulations. A key message from OECD work is that targeting policies to specific objectives is likely to achieve greater economic efficiency and better environmental performance. Further work is underway or planned in the OECD on deepening the understanding of the linkages between agricultural policies, support and green growth.

Sources: OECD (2010a), OECD (2010b), and OECD (2009c).

Getting the prices right for green growth: Environmentally-related taxes and tradable permits

38. Taxes and other market-based instruments are key policy instruments for providing clear and sustained incentives to reduce environmental damage. Businesses need a reasonable degree of certainty that innovation and investment to reduce the scale of environmental damage will be worthwhile. Similarly, a clear and sustained price signal can provide an important incentive for households, for example to reduce their energy consumption or to increase the extent to which they recycle waste, and underpin other policy instruments such as information campaigns (*e.g.* on the fuel efficiency of new cars or white goods) or the wider use of 'smart' meters for water, gas and electricity.

39. Preliminary findings of an ongoing OECD project on Taxation, Innovation and the Environment further highlight the ability of environmentally-related taxes to induce innovation (Box II.5). By imposing a direct cost on the polluter, taxes, in addition to providing incentives for pollution abatement, also encourage innovation to seek out new products and processes that can reduce the polluter's tax burden. This innovation both reduces emission levels for a lower economic cost as well as lowering the tax burden on the polluter (or provides a revenue stream to a third-party inventor).

40. The use of environmentally-related taxes, charges and emission trading schemes is spreading across OECD and emerging economies. Charges for water use, waste disposal, and the use of natural resources are used in many countries, although under-pricing remains common. Taxes are applied to NO_x emissions, packaging waste, pesticides and fertilisers in some countries. However, the majority of environmentally related taxes in OECD countries are those related to motor vehicles and fuel use.

Designing market-based instruments

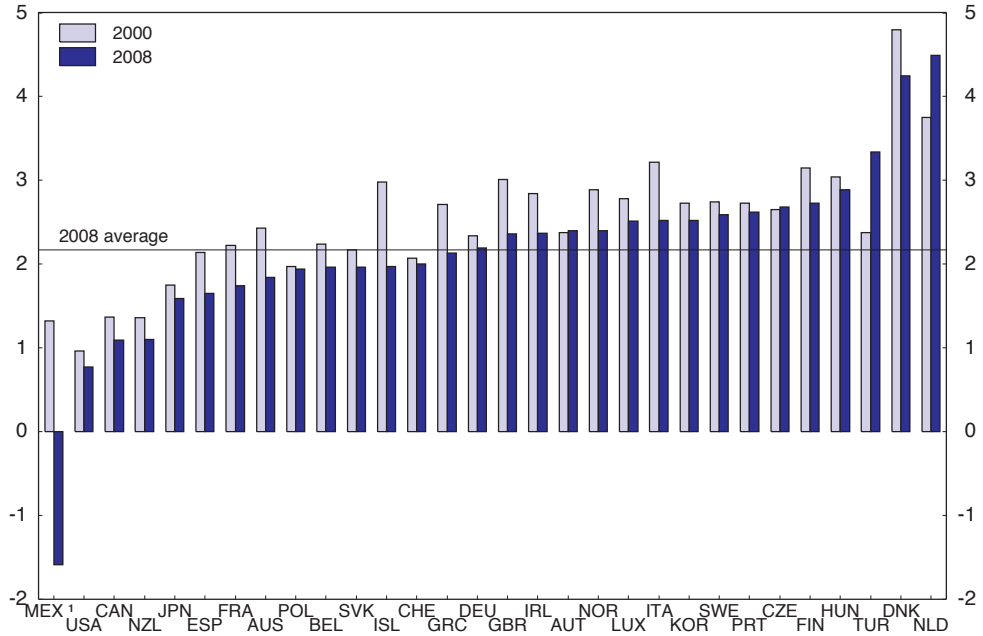
41. Implementation of market-based instruments requires consideration of a number of factors. First, the base for the tax, charge, or emissions cap needs to be defined. The more closely it can be applied to the actual polluting activity, the better. In the case of carbon dioxide emissions this can be relatively straightforward, as the tax can be directly related to the carbon content of fossil fuel inputs. Second, the rate of the tax or charge or the level of the emissions cap should reflect the amount of damage done at the margin. In some cases, this can readily be measured, while, in other cases, there are practical problems in quantifying the costs of environmental damage, such as for a loss of biodiversity.

Environmentally-related taxes

42. Across OECD countries, revenues from environmentally-related taxes amount to about 1.7% of GDP, varying from about 0.7% on average in North America to 2.5% in Europe. Over 90% of these revenues come from taxes on fuels and motor vehicles. While the number of environmentally related taxes has been increasing in recent years, revenues from these taxes have been on a slight downward trend in relation to GDP (Figure 5). In part, this reflects the drop in demand for fuel in response to recent high oil prices, which in turn has led to a reduction in total revenues from taxes on energy products. Preliminary analysis suggests that in the long-term, the reduction in fossil fuel consumption induced by a rise in carbon price would potentially lower revenues from various taxes applied on fossil fuel consumption in many countries.

Figure 5. Environmentally-related taxes revenues

As a percentage of GDP



1. In Mexico, fluctuations of consumer prices on motor vehicle fuels are smoothed out. In 2008, when world market prices were particularly high, the excise tax on fuels turned into a subsidy – equalling 1.8% of GDP.

Source: OECD/EEA database on instruments used for environmental policy and natural resource management.

43. A number of countries are considering the introduction of carbon taxes as part of their national climate change policies. CO2 taxes have existed for a number of years in a few countries, such as Sweden. More recently, countries like Iceland and Ireland have decided to introduce CO_2 taxes as part of their fiscal consolidation measures, and CO_2 taxes are also under consideration in, for example, France, Japan as well as several emerging economies (Box 9). The scope for the expanded use of green taxes in OECD countries still remains considerable, including for addressing climate change.

Box 9. Examples of renewed interest in CO_2-related taxes

Canada/ British Columbia

The province of British Columbia introduced an explicit Carbon Tax in 2008. It applies to energy products that are commonly subject to excises, such as diesel and petrol but the tax base also includes natural gas, heating oil, coke and aviation fuel for flights within the province. The rate is equivalent to CAD 15 per tonne of CO_2 emissions and is set to rise to CAD 30 by 2012.

Ireland

A tax of EUR 15 per tonne of CO_2 emissions was introduced with the 2010 Budget covering petrol, diesel, heating oil, natural gas, peat and coal used by households and businesses not covered by the EU ETS. The tax will contribute to fiscal consolidation with revenues of 0.2% of GDP.

Japan

A wide set of tax measures have been introduced and are now under preparation to reduce GHG emissions. Vehicle taxation has been reformed to create incentives to replace old cars with high fuel efficiency vehicles or new low-emission vehicles like natural gas, electricity or hybrid vehicles. Tax incentives for home insulation and industrial investments in energy efficient or renewable energy facilities have also been introduced.

Sweden

Sweden introduced a CO_2 tax already in 1991 covering the same energy carriers as the existing energy tax. Although the energy tax was reduced by 50% for affected fuels, the reform implied a net tax increase for all fossil fuels. For households, where the CO_2 tax is fully applied, the rate has risen from the equivalent of EUR 40 in the late 1990s to over EUR 100 per tonne of CO_2 emissions in 2009. Further reforms legislated in December focus on scaling back reductions for agriculture and industry not covered by emission trading, where the tax would rise from EUR 23 in 2009 to over EUR 60 per tonne in 2015.

Source: Presentations by national authorities to the Joint Meeting of Tax and Environment Experts and the OECD Database on environmentally related taxes.

Cap-and-trade schemes for emissions and natural resource use

44. Cap-and-trade schemes put an upper limit, or "cap", on the total amount of emissions or resource that can be used, and then individual permits or rights are issued up to this limit, which can be bought and sold among the cap-and-trade scheme participants. Cap-and-trade schemes have mainly been used to reduce air pollution, GHG emissions and, in some cases, for fisheries management. In the United States, such schemes were put in place in the 1990s to mitigate acid rain by limiting sulphur dioxides (SO_2) emissions and to limit ozone formation by lowering nitrogen oxides (NO_x) emissions. Outside the United States, emissions trading schemes to control air pollution have been used in Chile, Canada, Korea, Netherlands, Slovakia and Switzerland.

45. However, the majority of systems that have been recently introduced or that are currently planned aim at reducing GHG emissions, in particular CO_2 emissions, as part of policy strategies to mitigate climate change. The most important in terms of market size and participation is the EU emission trading scheme which began in 2005, but similar systems are now either in place or under development in most OECD countries. In the long term, the gradual linkage among different cap and trade schemes could lead the market to deliver a common world price for carbon that should level the playing field of the energy-intensive manufacturing sectors whose competitiveness might otherwise be affected by different carbon tax policies in different countries (Box 11).

46. Trading systems have also been used to a more limited extent to address other environmental concerns, such as water management (Australia, Chile and the United States), fisheries (Australia, Canada, Iceland, Netherlands, New Zealand and the United States) and agricultural nutrients (Canada (Ontario), Netherlands and the United States).

Pricing greenhouse gas emissions could be an important source of financing

47. Putting a price on environmental externalities, for example through carbon taxes or auctioned permits in emissions trading schemes could be an important source of government revenues. Many countries that have successfully implemented environmental tax reforms have used these revenues to offset reductions in other taxes, such as taxes on labour, in a revenue-neutral setting. Recycling the revenues in a way that reduces more distortive forms of taxation can result in welfare gains. In emerging economies, revenues from environmentally-related price instruments could be sources of finance for other pressing priorities, such as education, health care, and poverty alleviation.

48. Following the recent economic crisis, many countries will in the coming years have to tighten expenditures and raise government revenues in order to reduce the debt accumulated as a result of the fiscal packages adopted in response to the crisis . Revenues from carbon taxes or proceeds generated from auctioned permits could contribute to fiscal consolidation.

49. The revenues that can be raised by such instruments are substantial. For instance, if all industrialised countries were to cut their emissions by 20% by 2020 relative to 1990 levels, and this was done via emission trading systems with full permit auctioning – the amount of proceeds generated in 2020 could be as high as 2.5% of GDP on average across countries (OECD, 2009c). As indicated in Table 1 above, there is considerable potential for revenue-raising in many countries if the climate targets or actions they declared following the Copenhagen Conference were to be achieved through auctioned permits or taxes. Only a fraction of this would suffice to meet the financing commitments to support adaptation to climate change and mitigation efforts in developing countries. Germany is already using some of the proceeds from auctioned permits under the EU Emissions Trading Scheme to provide financing for climate action in developing countries (Box 10).

Box 10. Proceeds from auctioned emissions trading permits: some examples

Under the EU Emissions Trading Scheme, Germany will be auctioning the largest amount of emission allowances. Between 2008 and 2012, 200 million allowances will be auctioned equivalent to almost 10% of total allowances for the period. For 2008, 40 million allowances were auctioned with a valuation of EUR 933 million. Germany has indicated that at least 50% of the projected annual revenue will be spent on climate initiatives, EUR 120 million of which will be allocated internationally to developing countries through their International Climate Initiative (ICI). The ICI fund will support sustainable energy supply projects, climate change adaptation and forest protection. The ICI already supported 112 projects in 2008-2009 in emerging economies, disbursing an estimate EUR 151 million. Some of the revenues from the auctioned permits are also used to cover the administrative costs of implementing the emissions trading scheme.

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory, market-based effort in the United States to reduce greenhouse gas emissions. Ten states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont) have capped and will reduce CO_2 emissions from the power sector by 10% in 2018. RGGI states have decided to auction at least 86% of allowances for public benefit. As of April 2010, the auctioned revenues had generated USD 583 million. Auction proceeds are being used for a number of activities that vary among states, but include energy efficiency programs, low-income weatherization, low-income heating assistance and clean energy research and development.

Putting green tax reform in place in practice

50. Implementing environmentally-related taxes or charges can elicit significant political economy challenges. Concerns about the potentially regressive nature of taxes, particularly taxes on water and energy use for heating, have made it difficult to implement these taxes in many countries or have led to modifications in the tax design in order to reduce the burden on low-income households. While progressivity is a consideration, it is the progressivity of the entire tax/social system that is important. Therefore, such concerns are best addressed through other means -- such as lower personal income taxes, tax credits and increased social benefits -- rather than by reducing or exempting low-income households from the environmentally-related tax, and thus removing their incentives to use water or energy more efficiently. OECD country experiences show that strong communications and credible institutional arrangements, such as a green tax commission, can help to overcome some of the concerns regarding green tax reform.

51. There are also concerns that environmentally-related taxes can encourage trade-exposed, pollution-intensive firms to relocate their production to countries where such taxes are lower or non-existent. To address these concerns, many countries have provided significant tax breaks or even tax exemptions to their energy-intensive industries. Thus, the OECD/ European Environment Agency database on environmental instruments lists more than 1,500 exemptions to environmentally-related taxes in OECD countries and about 200 tax refund mechanisms. A better approach to overcome potential competiveness concerns is international co-operation (Box 11).

Box 11. Addressing carbon leakage and competitiveness impacts of climate policies

Many countries fear their industries may lose competitiveness if they take on ambitious climate action without similar efforts by other countries. This fear is perhaps the greatest political obstacle to the introduction of the policy measures needed to achieve ambitious emissions reductions. To protect their energy-intensive industries, a number of countries have exempted these industries from emissions reductions or provided them with relatively less ambitious targets, or allocated emission permits for free. Yet exempting energy-intensive industries from carbon pricing could raise the cost of achieving global emissions targets substantially, making achievement of a given emissions reduction target as much as 50% more costly than if these industries participated in action according to OECD analysis.

Fears of competiveness losses or "carbon leakage" - the risk that emission reductions in one set of countries are partly offset by increases in other countries - are a major concern in many OECD countries, making it difficult in some cases to put in place the policy measures needed to meet ambitious climate goals. However, analysis by OECD and others suggest that these concerns may be exaggerated. Unless only a few countries take action against climate change, carbon leakage rates are almost negligible. For example, OECD analysis found that in an illustrative scenario whereby the EU acted alone to reduce GHG emissions (by 50% in 2050), about 12% of their emission reductions would be offset by emission increases in other countries. However, if all industrialised (Annex I) countries took action, this leakage rate would be reduced to below 2%.

Despite this, a fear of competitiveness losses or carbon leakage is a major concern in many countries implementing ambitious climate policies. In addition to measures such as those that exempt the trade-exposed industries from carbon taxes or emissions caps, or allocating emission permits to these industries for free, a number of countries have also started considering other measures to address competitiveness effects, such as through the use of border tax adjustments (BTAs) which place a carbon tax on imports from countries that do not restrict carbon emissions. OECD analysis finds that while BTAs may reduce carbon leakage if only a few countries take action on climate change, they could be costly to both the country implementing them and their trading partners, while doing little to address competitiveness impacts. In the scenario described above whereby the EU achieves a 50% reduction in emissions by 2050, adding a BTA would have negligible effects to prevent the output losses of the EU energy-intensive industries and would raise the cost of action in the EU to achieve these emissions reductions from 1.5% of GDP to 1.8% of GDP in 2050. In addition, BTAs would be administratively burdensome to implement, and could raise trade issues.

Other targeted and time-bound measures are also being used in a number of cases to help ease the transition for sectors and industries affected by competitiveness concerns. For example, revenues from carbon taxes or auctioned emission permits can be recycled back to the affected sector in compensation, but in ways that would not undermine the incentive to reduce emissions. In a number of cap-and-trade schemes with auctioned permits, the trade-exposed and energy-intensive sectors have been provided with free permits.

However, by far the most effective way to tackle carbon leakage is to ensure broad participation in action to reduce emissions by all large emitters. The more comprehensive the coverage of climate policy, in terms of countries, sectors or emission sources, the lower the costs of achieving ambitious climate policy targets and the less likely that carbon leakage or competitiveness concerns might arise.

Source: OECD (2009a).

Green innovation

52. Increasingly, industry leaders and policy makers are looking at innovation as a key to making radical improvements in corporate environmental practices and performance. Continuous improvements in economic and environmental efficiency are a large part of the effort of a transition towards a green economy, and the spread of existing best available technologies is important. However, more radical innovation of new goods and services and alternative ways of consuming and disposing of products are also essential. These aspects are considered of particular importance by many countries, as innovation and the accompanying creative destruction could lead to new commercial ideas, new entrepreneurs and new business models; while also contributing to the establishment of new markets and new industries.

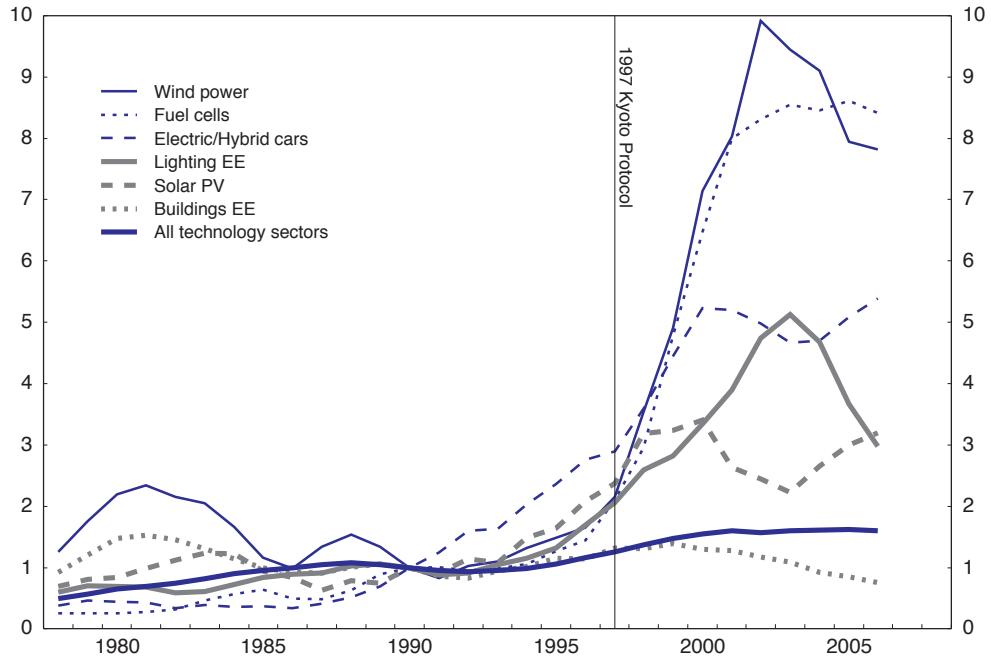
53. There are indeed signs that investment in green technologies and innovation is taking pace. For example, Deloitte's 2009 survey on Global Trends in Venture Capital reports that 63% of surveyed venture capitalists anticipate an increase in their investment in clean technologies over the next three years, the highest percentage among all sectors considered. Similar venture capital surveys confirm this trend (*e.g.* NVCA, Deutsche Bank/Bloomberg New Energy Finance).

54. The crisis has affected the flow of funds to innovative ventures in clean technologies, but less so than it has in other areas of investment. Venture capital flows to clean technologies dropped by around one third in 2009, with strong declines in solar, wind, agriculture, biofuels (Cleantech Group, 2010). At the same time, other clean technology areas attracted more investments than before, such as electric and hybrid cars, battery technologies, energy efficiency and smart grids. Moreover, the global volume of mergers and acquisitions (M&As, an indicator of commercial activity) in clean technology sectors declined only marginally between 2008 and 2009, while the overall volume of M&As was cut by half (OECD calculations based on data by Cleantech Group and Dealogic).

55. Beyond the context of the crisis, there has been longer-term evidence that green innovation is accelerating in certain areas. Figure 6 presents trends in high-value patents for a number of clean technologies relative to the rate of innovation in general. It indicates that there has been a sharp increase in some of these innovations since the late 1990s, coinciding with the signing of the Kyoto Protocol. OECD empirical work has shown that, in the past, increases in fossil fuel prices, targeted R&D expenditures, as well as policy measures such as feed-in tariffs, investment grants and obligations have been a significant inducement to innovation with respect to renewable energy technologies.

Figure 6. Innovation trend in climate change mitigation technologies, compared to all sectors

Number of patent applications by Annex I ratification countries, 3-year moving average, indexed on 1990=1.0



Source: OECD Project on Environmental Policy and Technological Innovation (www.oecd.org/environment/innovation).

56. OECD analysis also shows that the scope of green innovation is increasingly broadening and involves both technological and non-technological innovation. For example, efforts in industry to reduce environmental impacts have shifted from "end-of-pipe" pollution control to a growing focus on integrated environmental strategies and responsible management practices, which involve a large amount of non-technological changes and innovations. Some businesses have started to explore more systemic and radical green innovations involving new business models and alternative modes of provision. Businesses that perform well on radical innovations are also better aligned towards green innovation.

57. New technologies contribute to improving environmental performance and achieving green growth targets by replacing resource-intensive and polluting activities or improving the environmental and economic efficiency of existing ones. Incentivising the development and use of new technologies is also important in view of the positive spill-over effect on society. These include, for example, ICTs for smart urban transport and power systems. Biotechnology, particularly industrial biotechnology, can play an important role in delivering eco-efficiency and tackling green growth issues. Nanotechnologies for renewable energy production and storage as well as water management offer a wide range of environmental benefits under the provision that potential safety issues are being addressed at the same time as the technology is developing. Non-technological innovations will also contribute to sustainable growth and, for example, changes in the way production is organised may be just as important as changes in technology.

Fostering green technologies

58. Accelerating the development and diffusion of clean technologies, which are safe and sustainable, will be crucial within the overall policy mix to promote greener economies. This is primarily due to the fact that most of the low-carbon technologies available today are too costly to compete in the marketplace against today's incumbent fossil fuel technologies.

59. Both environmental and knowledge externalities may however stand in the way of moving towards economies based on greener technologies. Without public intervention, the related market failures, *i.e.* market prices that do not fully reflect the environmental degradation generated by economic activity, learning-by-doing and R&D spill-over effects, can generate path dependency and delay or even prevent the development and diffusion of clean technologies. In some cases, private investment may not occur at all, especially in areas such as basic research, where it takes considerable time to deliver outputs, which are often not immediately marketable. Furthermore, in sectors such as electricity, network effects arising from existing infrastructures create additional barriers to the adoption of alternative ways of provision, further hampering incentives to invest in new technologies.

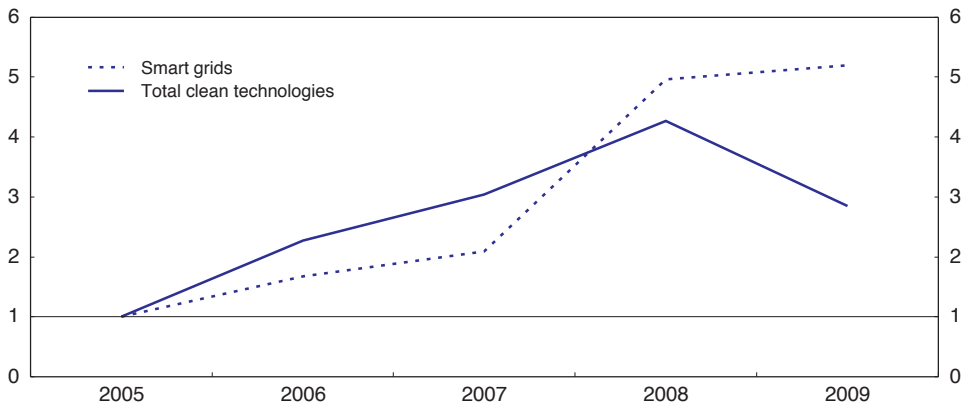
60. Unleashing green innovation requires a policy response on several fronts, which will need to build on a sound overall framework for policies for innovation, as set out in OECD's Innovation Strategy. This will entail a choice of different policy tools including, but not limited to, *e.g.* environmental taxes and incentive policies, such as R&D tax credits or direct subsidies to firms engaging in green activities, as well as public procurement and the funding of basic research.

61. As demonstrated in a range of OECD work, green innovation will greatly benefit from clear and stable market signals that may result from carbon pricing or other market instruments. Such signals will enhance the incentives for firms to adopt and develop green technologies and enhance efficiency in allocating resources by establishing markets for green innovation. Market-friendly approaches that avoid "picking winners" and encourage competitive selection of investments using, for instance, outcome-based tax incentives rewarding the best observed practices and performances, are likely to be the most efficient.

62. Policy signals, for instance, stimulate private investments in "smart" electricity grid technologies. The "smart grid" is an umbrella term for a large array of mostly ICT-based technologies to radically lower the environmental impacts of energy generation, distribution and consumption (Box II.6). In the United States, legislation such as the Energy Independence and Security Act (2007) and the American Recovery and Reinvestment Act (2009) provide government support and funding for a nation-wide modernisation of the electrical grid – and stable mid-term prospects for private investors. This contributed to continued growth of commercial investments in innovative smart grid ventures, even during 2009 when overall clean technology investments tumbled by 33% (Figure 7). Three of the top five VC investments made that year (each over USD 100 million) went to smart grids companies in the areas of smart metering, smart energy storage and smart grid communications (Cleantech Group, 2010). These investments are expected to generate high value-added jobs in OECD countries and emerging economies.

Figure 7. Global venture capital amounts: smart grids vs. overall clean technologies

Indices: 2005 = 1.0



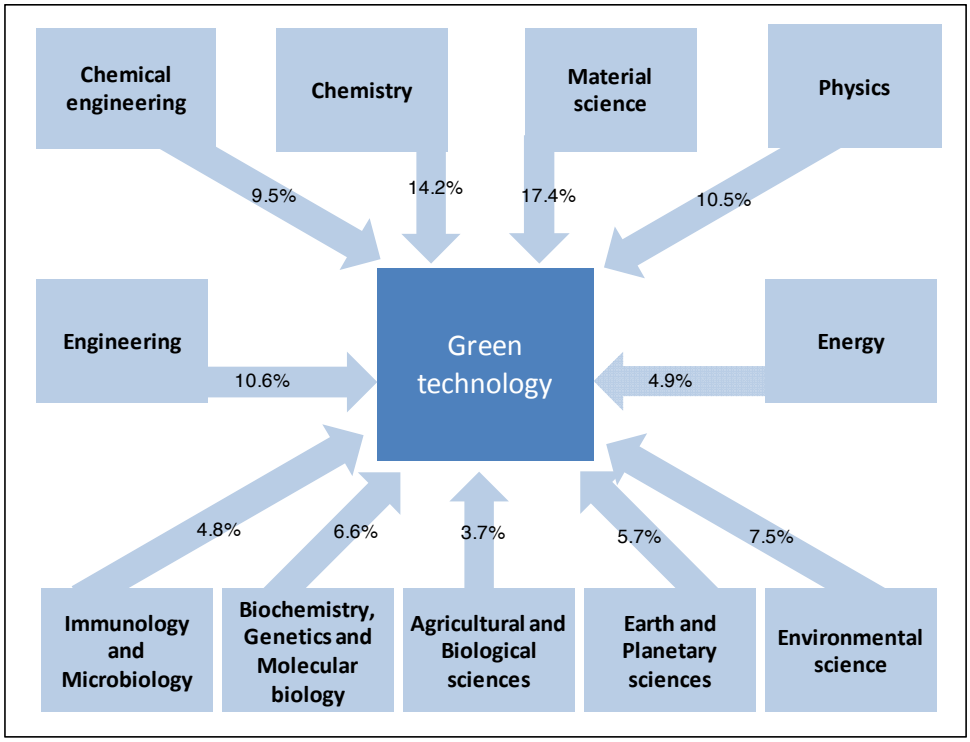
Source: OECD calculations, based on data by Cleantech Group.

63. Appropriate pricing of externalities and general innovation policies can go a long way in stimulating green innovation, but the emergence of new technologies – especially breakthrough technologies is a process that generally requires considerable and long-term investment, often initiated in public research institutions before being picked-up by firms. More specific and possibly temporary support for clean technologies may therefore be needed to demonstrate their applicability and to break path dependence effects that favour existing, dirtier technologies.

64. In order to reach ambitious emission reduction targets, for example, the high development and deployment costs of largely untested zero-carbon emission technologies - such as fuel cells or advanced biofuels– will require large R&D investments at the initial stage. However, government spending on energy R&D and on environmental R&D have not kept pace with the growing urgency of the energy and climate challenge, and government spending on environmental R&D is typically less than 4% of total government spending on R&D. In addition, considering the recent spending trends in energy-related R&D over the 30 years, average public energy-related R&D expenditure has declined dramatically across the OECD since the peak of the early 1980s. Supporting the emergence of breakthrough green energy technologies will require, in addition to a carbon tax, a high level of R&D subsidies up-front, but that should be phased out over time. Indeed, model simulations show that policy intervention would help redirecting private research towards untested clean technologies early on, while learning-by-doing effects would then gradually decrease their investment cost, subsequently making policy intervention less relevant (Acemoglu, 2009).

65. Radical innovations and breakthrough technologies will require investment in public research to address fundamental scientific challenges and develop technologies that are considered too risky or uncertain for the private sector. Such research will need to cover a wide range of areas, as green technologies draw on a wide range of scientific fields (Figure 8). Policies for public research will need to be well-designed to complement private investments in research, should provide stable signals for long-term research investments, and should aim for areas in which social returns are likely to be greatest.

Figure 8. The innovation-science link in "green" technologies, 2000-07



Note: The figure shows the degree to which green patenting between 2000 and 2007 draws on specific areas of scientific research, as measured by references to scientific research in patent documents.

Source: OECD calculations, based on Scopus Custom Data, Elsevier, July 2009; OECD, Patent Database, January 2010; and EPO, Worldwide Patent Statistical Database, September 2009.

66. Public procurement can also play a role, particularly in markets characterised by network externalities such as infrastructures for electric/hybrid vehicles or where "demonstration effects" (*i.e.* consumption externalities) are important. In such cases, initial barriers to market creation are high, and can be overcome through public demand. However, it has to be ensured that the introduction of obligations on contracting authorities (to take into account energy efficiency criteria or other environmental criteria in their public procurement decisions) does not eliminate competition in procurement markets (*e.g.* because of the lack of sufficient market development for products satisfying the requirements imposed).

67. OECD analysis shows that a large share of radical innovations for greener growth emerges from new firms. 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 new firms contribute heavily to the creation of new jobs (Haltiwanger, *et al*, 2009).

68. Both firm creation and destruction will accompany the experimentation process that leads to the development of new green technologies and markets. However, most OECD countries face significant challenges in fostering the growth of new firms. Simplifying and reducing start-up regulations and administrative burdens can reduce the barriers to entry. Costly exit also discourages firms from entering the market. Bankruptcy laws can be made less punitive to entrepreneurs and should offer more favourable conditions for the survival and restructuring of ailing businesses, with due regard to risk management and the need to avoid moral hazard. Arranging a proper environment for promoting

entrepreneurship to accelerate green growth will also contribute to enhance the activities of innovative SMEs.

69. Access to finance is a key constraint for business-led innovation, in particular in the aftermath of the economic crisis. Green innovation is inherently risky and investments may require a long-term horizon. Financial constraints are especially high for new entrants into the innovation process, since they have no history of success and often only limited access to internal finance. Well-functioning venture capital markets and the securitisation of innovation-related assets (*e.g.* intellectual property) are key sources of finance for many innovative start-ups (Box 12). Policy can take steps to ease the access to finance for new and innovative small firms, both with respect to debt and equity finance. This could involve risk-sharing schemes with the private sector.

Box 12. Patents and international technology transfer

Enhancing international transfer of green technologies will be a key aspect for ensuring that the benefits of green growth, both from an economic and environmental standpoint, are reached at a global level. Especially for environmental concerns that are international in nature, there are significant advantages to technology and knowledge transfer, since both source and recipient countries (and others) benefit environmentally from the transfer. Moreover, the deployment of green innovations to emerging and developing countries will be a strong driver of expanding markets for eco-innovation and ensuring sustainable economic development.

Various new mechanisms to accelerate the diffusion of innovation to developing countries are being explored. Knowledge markets and knowledge networks could potentially play a key role in this transfer, *e.g.* innovative collaboration mechanisms in intellectual property (patent pools are but one example) which allow for a greater flow of research, development and adoption of green technologies in the developing and developed world alike. Some good practice already exists (for example, in networking R&D for emerging infectious diseases) but significant scale-up will be required. Governments can support this development by supporting the development of a knowledge networking infrastructure; implement measures, such as the OECD Guidelines on Access to Research Data from Public Funding, to share public-sector knowledge; and foster the development of collaborative mechanisms and knowledge brokerages to encourage the exchange of proprietary knowledge and help ensure a fair return on investments made.

The role of patents is significant in fostering innovation and entrepreneurship, which need to be sustained for shifting to a green growth pathway. IPRs provide an important incentive to invest in innovation by allowing firms to recover their investment costs. Patents are particularly important for small firms, as they can facilitate entry into new markets and enable competition and collaboration with other firms. Policies in this field should aim at enhancing the diffusion of new technology while encouraging investment in research and development; and they should address tech transfer beyond patents (*e.g.* know-how, which is often important for users in addition to patents themselves).

Proposals have been made for significantly weakening patents (compulsory licensing, patentability exclusions, etc.). However, while IPR-weakening measures could enhance the diffusion of certain currently patented technology in the short-term, they would significantly reduce the incentives for firms to invest in innovation or would lead them to keep their inventions secret (not patented), which would in turn harm diffusion. Patent pools (bundles of complementary patents) can be efficient for facilitating the access to new technology. To do so, they would need to be operated on a voluntary basis and compensate contributing businesses adequately. Broader technology transfer agreements (*e.g.* involving local universities and companies of the recipient country) may also be helpful. In fact, the limited absorptive capacity of recipient countries is often a stronger obstacle to technology adoption than the price of patented inventions itself: co-operation aimed at building local capacities to adopt and adapt new technology might be more effective than purely patent-centred measures for boosting the use of environmental inventions.

Green growth policies in the energy sector[3]

70. The greening of the energy sector will be a key element of green growth strategies, providing a unique combination of benefits, including enhanced energy security, reduced CO_2 emissions and lower energy costs. The IEA World Energy Outlook 2009 (WEO-2009) shows how these objectives can be achieved in its "450 Scenario", which reduces CO_2 emissions by 34% compared to the Reference scenario in 2030.[4] The WEO-2009 also shows that the path to green growth in the energy sector will require an integrated mix of policies, ranging from pricing carbon to energy efficiency policies as well as support to low-carbon technologies, including renewables.

71. Energy efficiency, renewable energy, carbon capture and storage, nuclear power and new transport technologies will all need to be deployed to achieve the IEA 450 Scenario. Improved energy efficiency accounts for over half of total abatement by 2030, while renewable energy provides a further 20% of abatement.

72. The cost of the additional investments needed to put the world onto a 450-ppm path is at least partly offset by economic, health and energy-security benefits. The WEO-2009 calculates that energy bills in transport, buildings and industry are reduced by USD 8.6 trillion globally over the period 2010-2030, while the corresponding investment is USD 8.3 trillion. The undiscounted fuel-cost savings over the lifetime of these investments exceed USD 17 trillion. Using a discount rate of 3% or even 10% there are still net savings over the lifetime of the capital stock. In the IEA 450 Scenario, energy security is enhanced compared with the Reference Scenario. In OECD countries, oil and gas imports and their associated bills in 2020 are lower than in 2008. Other implications include the reduction in emissions of air pollutants mentioned above. By 2030, SO_2 emissions are 25 million tonnes, or 29% lower than in the Reference Scenario. NO_x emissions are 19% lower.

Energy Efficiency

73. Studies show that investing in energy efficiency provides several important advantages: increasing energy security, reducing energy costs and improving the environment. According to IEA analysis, governments are engaging in a wide array of energy efficiency policy activity, from national strategies to minimum energy performance standards for appliances and equipment. There are also signs of energy efficiency policy innovations, including the development of markets to trade energy savings and innovative financial instruments to encourage energy efficiency investment. However, OECD countries have not captured the full energy efficiency potential of the possible suite of policies. Untapped energy efficient potential is hidden across all sectors (*e.g.* buildings, industries and transport).

74. Energy efficiency continues to face pervasive barriers including lack of access to capital, insufficient and asymmetric information and externality costs that are not reflected in energy prices. Countries' commitment to maximising implementation of energy efficiency policies may also have been challenged by the current economic crisis. In addition, energy efficiency programmes must compete for funding with other priorities such as employment, health and social security. In making decisions about how to allocate limited resources, it should be kept in mind that the benefits of implementing energy efficiency extend beyond energy security and climate change mitigation. Experience shows that energy efficiency investments can deliver significant co-benefits – including potentially net job creation[5] and health improvements.

3. This section was contributed by the International Energy Agency.

4. The 450 Scenario is so named because it is designed to limit the long-term concentration of greenhouse gases in the atmosphere to 450 ppm CO_2-eq.

5. See for instance ACEEE (2010).

75. The 25 IEA recommendations to the G8[6] can guide countries in addressing the need to significantly increase the rate of energy efficiency improvement. Indeed, there is great room for further energy efficiency action in countries. IEA estimates that 40% of the potential energy savings from the IEA 25 recommendations, or from measures that achieve similar outcomes, remains to be captured. If implemented globally without delay, these recommendations could save an estimated 8.2GtCO_2/yr by 2030. On a sectoral basis, across all OECD economies, policies for transport stand out as having the least substantial implementation – although a number of policies have been planned.

76. Recognising that more needs to be done to improve energy efficiency, a number of countries established the International Partnership for Energy Efficiency Cooperation (IPEEC) in 2008.[7] This aims to facilitate those actions that yield high energy efficiency gains, while allowing participants to take action in the areas of their interest on a voluntary basis.

Renewable Energy

77. Greater deployment of renewable energy is another important component of a green growth strategy for the energy sector. As with energy efficiency, renewables can contribute to multiple policy objectives including reducing CO2 emissions and local pollution and improving energy security.

78. Renewable energy currently accounts for 18% of global electricity generation and 1.5% of global transport fuel consumption.[8] In OECD as well as emerging countries, there are significant possibilities for improvement of policy design and considerable realisable potential across all renewable energy technologies (RETs). If effective policies were adopted at a more global scale, this potential could be exploited more rapidly and to a much larger extent.

79. While some RETs are commercial today, others are close to being commercial and both groups should be deployed on a massive scale. Other RETs, which have a large potential, are less mature and require a long-term vision. Reducing their costs will require a combined effort in research, development and demonstration (RD&D), and technology learning resulting from marketplace deployment. Thus far, only a limited set of countries have successfully implemented support policies that effectively accelerated the diffusion of renewables.

80. A wide variety of incentive schemes can be effectively applied depending on the specific technology and country. However, non-economic barriers have significantly hampered the effectiveness of renewable support policies and driven up costs in many countries, irrespective of the type of incentive scheme. It is therefore necessary to move beyond discussions over which specific incentive scheme functions best to an assessment of the entire policy framework into which incentive schemes are inserted. Overall, the effectiveness and efficiency of renewable energy policies are determined by the adherence to key policy design principles outlined below, as well as the consistency of measures.

6. For the full set of recommendations, see www.iea.org/textbase/papers/2008/cd_energy_efficiency_policy/index_EnergyEfficiencyPolicy_2008.pdf

7. The founding members of IPEEC were Canada, the People's Republic of China, France, Germany, India, Italy, Japan, the Republic of Korea, the Russian Federation, the United Kingdom, the United States of America, and the European Community, represented by the European Commission

8. IEA Energy Statistics.

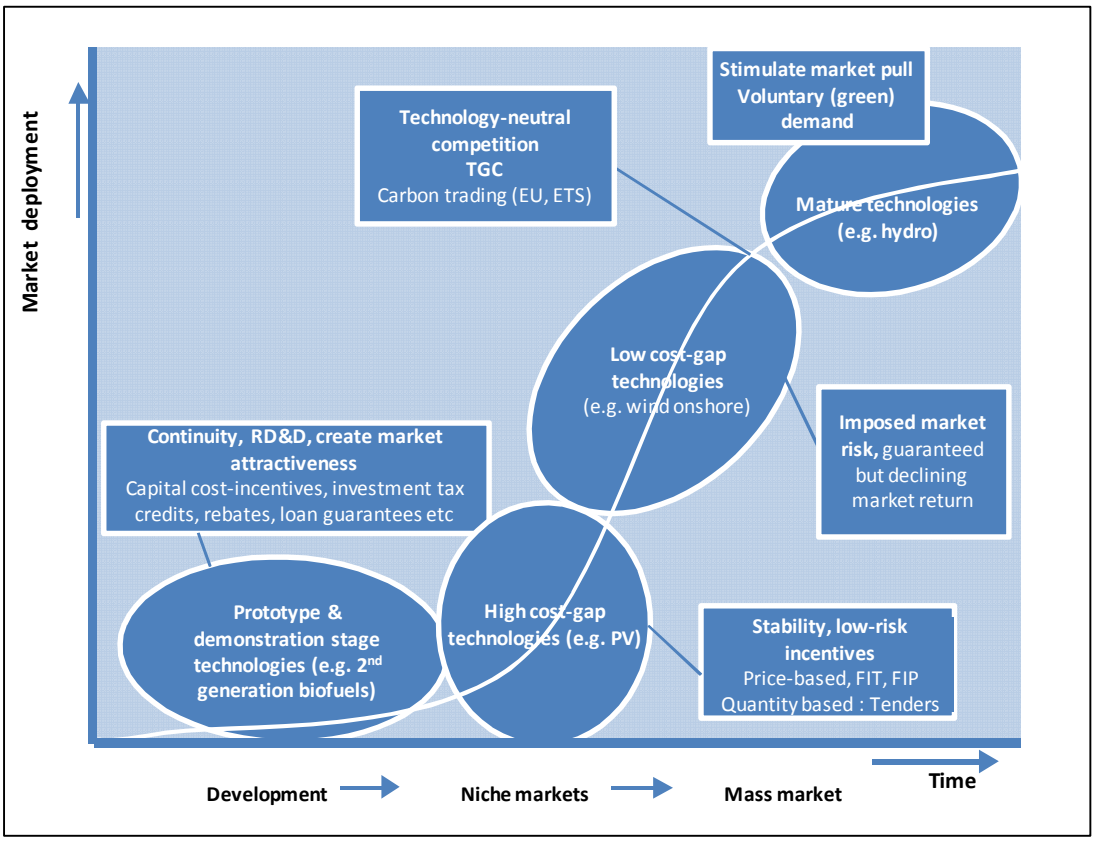
81. Renewable policy design should reflect five fundamental principles:

- The removal of non-economic barriers, such as administrative hurdles, obstacles to grid access, poor electricity market design, lack of information and training, and the tackling of social acceptance issues, in order to improve market and policy functioning;
- The need for a predictable and transparent support framework to attract investments;
- The introduction of transitional incentives, decreasing over time with eventual phase out, to foster and monitor technological innovation and move technologies quickly towards market competitiveness;
- The development and implementation of appropriate incentives guaranteeing a specific level of support to different technologies based on their technological potential, degree of technology maturity and scope for cost reduction, in order to exploit the significant potential of renewable energy technologies in the future at the lowest-overall cost; and
- The due consideration of the impact of large-scale penetration of renewable energy technologies on the overall energy system, especially in liberalised energy markets, with regard to overall cost efficiency and system reliability.

82. Reflecting these five principles in an integrated approach allows two concurrent goals to be achieved, namely to exploit the abundance RETs which are closest to market competitiveness while preserving and implementing the long-term strategic vision of providing cost-effective options for a low-carbon future.

83. Achieving a smooth transition towards mass market integration of renewables will require a profound evolution of today's markets so that RETs can compete with other energy technologies on a level playing field. The evolved market should place an appropriate price on carbon and other externalities as well as help to develop an infrastructure to accommodate large-scale RET integration. Once this is achieved, specific support for RETs should be phased out leaving their deployment to be accelerated by consumer demand and general market forces (Figure 9).

Figure 9. Combination framework of policy incentives as a function of renewable technology maturity



Source: IEA (2008a) Deploying Renewables. Principles for Effective Policies.

84. The deployment of renewables will require the development of a combination policy framework increasingly applying market principles as technology maturity and deployment increase. This is possible with a range of policy instruments, including price-based, quantity-based research, development and demonstration (RD&D) support, support to innovation and technology transfer and regulatory mechanisms. As a general principle, less mature technologies further away from economic competitiveness will need, beyond continued RD&D support, very stable low-risk incentives, such as capital cost incentives, feed-in-tariffs (FITs) or tenders. For low-cost gap technologies, such as on-shore wind or biomass combustion, other more market-oriented instruments like feed-in premiums (FIPs) and tradable green certificate (TGC) systems with technology banding may be more appropriate.[9] Depending on the specific market and resource conditions as well as on the

9. FITs and FIPs are granted to renewable energy producers for the electricity they feed into the grid. They are preferential, technology specific and government regulated. FITs take the form of a total price per unit of electricity paid to the producers whereas the FIPs are additional to the electricity market price. An important difference between the FIT and the premium payment is that the latter introduces competition between producers in the electricity market. TGC are used where a government sets a particular target for renewables and put a corresponding obligation on producers, suppliers or consumers to source a certain percentage of their electricity from renewable energy. Under this scheme, an obligated party failing to meet its quota obligation has to pay a penalty. This provides the incentive to either directly invest in new renewable electricity plants or to buy green certificates from other producers or suppliers. The certificates are finally used to prove compliance with the obligation.

level of market integration across countries, technology banding may be necessary only in a transitional phase or may be bypassed in favour of a technology-neutral TGC system. Once the technology is competitive with other CO_2-saving alternatives and ready to be deployed on a large scale, and when appropriate carbon incentives are in place, these RET support systems can be phased out altogether.

85. National circumstances (RET potential, existing policy framework, existence of non-economic barriers, degree of market liberalisation, and energy system infrastructure) will influence the actual optimal mix of incentive schemes. The choice of when to complement R&D support with deployment support will be critical to the overall success of support policies. All RET families are evolving rapidly and show significant potential for technology improvement. Renewable energy policy frameworks should be structured to enable the pursuit of technological RD&D and market development concurrently, within and across technology families, in order to address the various stages of development of different renewables and markets.

Other low carbon technologies

86. Enhanced research, development and demonstration will also be crucial for other low carbon technologies that are not currently commercial. Examples include carbon capture and storage and electric vehicles. The IEA has been developing roadmaps for the most important technologies that can guide environmental and energy decision makers on the path to needed innovations. At the request of G8 leaders and IEA energy ministers, the IEA is also developing an international low carbon energy technology platform that will bring together policy makers, business representatives and technology experts to discuss how best to encourage the spread of clean energy technologies.

Box 13. Transport – a growing source of CO_2 emissions[1]

While there seems to be a consensus that countries should reduce GHG emissions from fossil fuel use, there is rather less consensus on which instrument would best achieve that goal. This issue is briefly discussed for different passenger land transport and international aviation and maritime transport.

A carbon tax is the most direct and least-cost method for addressing CO_2 emissions from fossil fuel use because it directly targets the externality (CO_2 emissions) that may not be captured by market prices. A carbon tax has multiple impacts. It acts as a signal to manufacturers on what level of fuel economy might succeed in the market, it guides consumer choices for new vehicles and it may influence travel behaviour. However, most fuel taxes were not designed as externality-capturing instruments, but as a stable and significant source of government revenue since demand for fuel is relatively price-inelastic, at least in the short-term.

Elegant in its simplicity, direct in its application, carbon taxes (and its proxy – fuel taxes) are nonetheless highly contentious and difficult to implement. This is partly because of potential regressive effects of such taxes as lower-income households are more exposed to its burden. There is also a clear political aversion to increasing the fiscal burden on such a wide voter base. However, there is strong evidence that the level of fuel prices has an impact on overall new vehicle fuel economy.

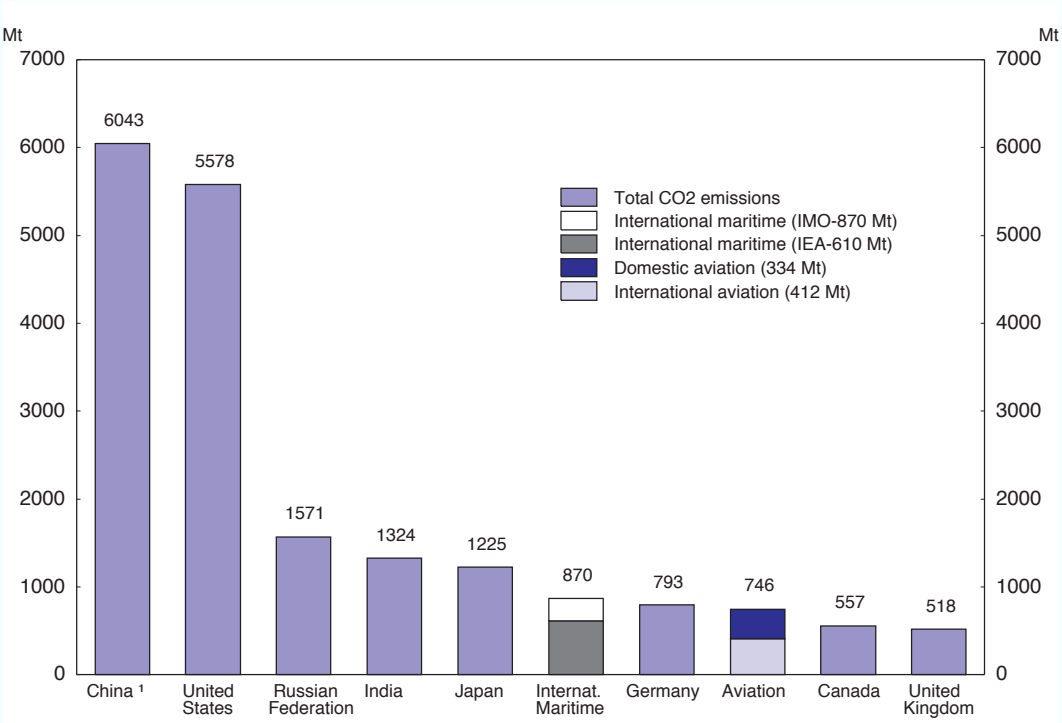
This has led countries to deploy a number of complementary instruments to guide fuel economy investments and lower carbon emissions. Foremost among these are standards, which have the benefit of providing a strong signal to manufacturers on societal preferences for fuel economy. Other instruments include CO_2-related feebate schemes (as in France), CO_2-differentiated vehicle purchase, registration and/or circulation taxes. These policies do not address emissions from the rebound in use-based emissions stemming from lower per-kilometre fuel costs. Thus, many non-carbon tax-based policies will require flanking instruments in order to replicate the theoretical impact of a well-designed carbon tax. These flanking instruments, however, may better target the supply-side innovation necessary for a move to a radically different energy base for transport

because they hit much closer to technology innovators than a carbon tax would.

At a minimum, CO_2 policies for transport should be based on as close to an externality-capturing carbon-tax and flanking instruments should be as least distorting as possible. There are two important transport sectors that, for historical reasons, are exempt from any carbon-price signal since their fuels are untaxed: the international maritime and aviation sectors.

International Maritime and International Aviation emissions have been growing at approximately 3% per year since 1990, outstripping the global rate of growth in CO_2 emissions (~1.9% per year). They represent a significant and rapidly growing source of CO_2 emissions, which remain largely devoid of any CO_2-internalising fiscal mechanism.

National CO_2 Emissions (minus Domestic Aviation) Compared to Aviation and International Maritime Emissions: 2007



1. Including Hong-Kong.

Source: *International Maritime Organisation, IEA and ITF.*

This increase is largely the result of the international nature of these two sectors combined with various practical, regulatory and/or historical artefacts. For one, no one "owns" these emissions (and related fuel sales) since there is no international agreement on the allocation of emissions from international bunker fuels. This is largely because some countries with large ports and airports and/or share of international bunker sales would be disproportionately impacted by allocation on the basis of national fuel sales. Against this backdrop, non-sector-wide taxation of international bunkers in these countries would distort competition. Furthermore, the risk for leakage would not be inconsequent, especially for ocean-going vessels, which can bunker large amounts of fuels and thus could potentially evade taxation. For aviation, there is a widely upheld interpretation that the Chicago Convention's restriction on taxing fuel in arriving aircraft represents a prohibition on the taxation of all international aviation fuel, although the Convention allows waiving this tax exemption on a bilateral basis. Finally, there is the complicating matter of a CO_2-internalising tax potentially contravening the "common but

differentiated responsibility" clause of the UNFCCC, even though the Convention does not have application in the IMO and ICAO. Developing countries have maintained that any carbon tax on international bunkers should only apply to Annex I countries, rendering such a tax ineffective and hard to apply given concerns regarding competitive distortions and the relative ease with which assets, especially ships, can be re-domiciled in non-OECD countries.

Both the IMO (International Maritime Organization) and ICAO (the International Civil Aviation Organization) have sought to address a global fuel tax or levy, but have, thus far, failed to reach an agreement on a global fiscal framework. Thus work on "second-best" options has moved to the forefront. Focus on new vessel and aircraft standards has progressed and both bodies have investigated operational improvements without, nonetheless, determining a binding framework for these. IMO and ICAO are actively exploring the development of a global emission trading regime (with emission trading for flights arriving and departing in the EU already an obligation from 2012 on), though this is contentious for some countries. On the other hand, key players in both industries clearly favour such an approach. ICAO is also actively pursuing the development of "drop-in" biofuels, though, as with many biofuels, questions remain as to total lifecycle impacts and elevated marginal abatement costs. The outcome of COP 15 has provided no guidance to parties regarding emissions from international aviation or shipping and it is currently unlikely that there will be any pressure to accelerate emissions reduction or deviate from the strategies already underway.

The risk with the above approaches outlined is that none (possibly with the exception of a well-designed and open emissions trading scheme) provide a comprehensive signal leading to reduced CO_2 emissions from international aviation and maritime transport and may even lead to increased emissions rates if efficiency improvements lower transport costs and generate additional travel. While many countries have achieved environmental policy outcomes with these approaches, they are an inefficient way forward and may generate welfare losses countries cannot afford.

1. This Box was contributed by the International Transport Forum, an inter-governmental organisation within the OECD family: for more information see www.internationaltransportforum.org.

Greener jobs, labour market transition and skills development

87. Achieving ambitious environmental goals, notably in the climate change area, raises important transitional issues as OECD and emerging economies have to adjust to new patterns of growth (OECD, 2010c). In particular, the transition towards green growth may lead to an intensification of structural economic changes, including significant reallocation of labour and other factor inputs within and across broad economic sectors (*e.g.* power generation, transport, construction and agriculture). Moreover, the application of new technologies and production practices throughout the economy suggests that job skills requirements are also likely to change significantly across the board. This raises the possibility of skill mismatches that could slow the expansion of green activities or become a source of rising structural unemployment. Labour market and training policies can play a key role in facilitating the structural adjustments required by the transition to green growth, while at the same time minimising the associated social costs.

Labour market implications of the transition to green growth

88. In the current context of high economic slack, the green investments included in many recent fiscal stimulus packages can have a significant short-term, positive impact on employment, while also accelerating the transition towards green growth. The long-run impact on total national employment is however uncertain across most green growth scenarios. One likely outcome is that in advanced countries, where the share of the working-age population that is employed is already relatively high, the impact will be relatively small. In the case of developing countries, which are often characterised by large

reserves of unemployed or under-employed persons in the informal sector, there will be relatively more scope for green growth initiatives to raise overall productive employment.

89. The reallocation of labour across sectors, firms and regions/localities required by the transition towards green growth may well be sizeable. OECD modelling work on the economic impacts of climate change mitigation indicates that employment in renewable energy sectors will tend to grow at the expense of employment in fossil fuels and coal mining while the employment patterns in other sectors is more variable depending on the country and policy scenario.[10] Table II.2 provides an indicative disaggregation of the types of green industries and services that stand to gain from the implementation of green growth policies, while Box 14 describes how OECD modelling of long-run labour market adjustment is being extended.

90. How the transition to green growth will affect job reallocation across firms within the same sector has yet to be studied. However, OECD evidence suggests that job flows between firms in the same industry are an order of magnitude larger than sectoral reallocation.[11] Furthermore, the acceleration of eco-innovation and the diffusion of green production technologies will further intensify these within-industry flows as new technologies often diffuse via the displacement of existing firms by innovative start-ups.

91. OECD work shows that the employment impact of green growth will be uneven across geographical areas. Localities that have specialised in what will become declining sectors (*e.g.* fossil fuel production) will face the challenge of developing new specialisations, but green growth will also provide new opportunities for local economic development initiatives (Box 15). Many workers in declining regions and sectors may require public assistance to relocate or acquire new skills.

92. While it is clear that the transition to green growth will significantly change job skill requirements, much remains to be learned about the types of skills that will be in increased demand. Evidence from a number of countries shows that skill shortages have already developed in certain sectors or occupations where green growth policies have created a need for new skills, or new combinations of familiar skills. For example, a report to the French government recently identified a number of emerging occupational specialties in the construction sector (*e.g.* energy auditors and solar panel installers), which are not well served by traditional training institutions and hence face potential recruitment bottlenecks (COE, 2010).

10. OECD calculations based on ENV-Linkages simulations.

11. On average in the OECD countries 15 to 20% of the jobs are created or destroyed every year as new firms are created while other exit the market and incumbent firms are engaged in a continuous process of adaptation to changes in demand and technology.

Box 14. An extension of the OECD ENV-Linkages model

As part of the new analysis being conducted for the Synthesis Report to the 2011 MCM on the OECD Green Growth Strategy, the Secretariat is extending its capacity to analyse the labour market impacts of the transition to green growth. One focus of this work is to enhance the ENV-Linkages simulation model — which the OECD has used to analyse the economic impact of climate change mitigation (OECD, 2008; 2009a) — so as to enable the long-run, general equilibrium impacts of green policies on labour markets to be analysed in more detail.

The current version of the ENV-Linkages model does not distinguish between skilled and unskilled workers. The size of the labour force is also assumed to be exogenously determined and the labour force to be fully employed in every period. Although the exact specification of a more elaborate labour market will only be decided after a survey of the literature and available data, the main extensions foreseen for the model will be to relax these assumptions by differentiating workers by skill level and taking account of both frictions in the reallocation of workers across sectors and endogenous changes in labour supply behaviour (*e.g.* in response to changes in wages or the risk of unemployment). While simulation of specific labour market policies may remain beyond the reach of the extended model, their effects on different mitigation scenarios can be investigated indirectly to clarify important policy questions, including:

- Can increased labour market adaptability in reallocating workers across sectors, such as that associated with structural economic reforms, significantly lower the overall economic cost of a transition to green growth or the distribution of costs and benefits across the workforce?
- How will the demand for skilled workers evolve in different industries? Will skilled or unskilled workers face the greatest pressures to change industry?
- How will the wage premium for skill be affected by the transition to green growth? Can (exogenous) increases in the share of skilled workers, such as what could be achieved by strengthening education and training policies, significantly lower the overall economic cost of a transition to green growth or the distribution of costs and benefits?
- Can the net employment gains from green growth be significantly increased if revenues from environmental taxes or auctioning carbon quotas are used to lower the taxes on labour use? Will such a tax reform simultaneously improve household welfare?

An active role for labour market and training policies in managing the transition

93. Labour market and training policies can play a key role in facilitating the structural adjustments associated with green growth, while at the same time minimising the associated social costs. The Re-assessed OECD Jobs Strategy provides a suitable framework for identifying policies and institutions that by facilitating a continuous redeployment of labour from declining to growing industries and firms can help to achieve a high level of employment and shared prosperity. This framework is also relevant to identify specific policies to promote a transition towards green growth. In general, a strong skill development system and active labour market programmes that facilitate a quick re-integration of jobseekers into employment will be key supply-side policy elements for reinforcing the structural adaptive capacity of labour markets. On the demand side, moderate employment protection and strong product market competition are important. OECD work also highlights the need to combine policies that increase the adaptive capacity of labour markets with flanking measures, such as unemployment insurance and in-work benefits, which assure that dynamism is not achieved at the cost of excessive insecurity or inequality for workers and their families.

94. A number of more specific measures can also help to meet the labour market challenges occasioned by the transition to greener economies. In particular, pro-active short-term policy initiatives to foster green employment will be useful to jumpstart job creation, while also accelerating the transition -- especially in the current context of high labour market slack and the risk of prolonged labour market stagnation in many countries. Where there is fiscal space to do so, this may be an opportune time for a surge of public investment in green infrastructure or initiatives to train unemployed workers to meet anticipated or existing skill shortages in strategic sectors for making progress towards green growth (*e.g.* retro-fitting buildings for greater energy efficiency). Additional options such as immigration, settlement and skill recognition policies, which can help ensure an adequate supply of skilled workers may also be considered.

95. Dedicated labour market programmes could help workers to participate fully in the emerging green economy, such as initiatives to overcome specific shortages of "green skills"[12] or special measures for declining sectors or large plant closings. However, as in earlier debates about the labour market impact of globalisation, previous OECD work suggests that general programmes should be relied upon as much as possible. There is considerable scope to enhance the effectiveness of these general programmes, particularly the coordination of educational and training institutions to upgrade the job skills of an ageing and increasingly diverse workforce. Governments should also encourage multi-stakeholder strategies for achieving green growth, as exemplified by the "Green Workplaces' initiative in the United Kingdom, the "Grenelle de l'Environnement" in France and social dialogue where this is consistent with national institutions and practices.

96. Ensuring that small and medium sized enterprises (SMEs) fully participate in the efforts towards green growth and benefit from policy changes to promote it is a key challenge for the transformation ahead. SMEs are often unaware of the technological and operational adaptations required by green growth and do not have easy access to that information. For example, results from an OECD survey of SMEs in New Zealand and the UK indicate that most SMEs have little awareness of the impact of environmental regulation in their industry and future needs for new green skills. Furthermore, their investments in green training and knowledge-intensive activities are very limited.

12. For example, the French government is setting up regional action plans (Contrats de Plan État-Région) to provide a framework for cooperative efforts related to meeting economic development and vocational training needs.

Box 15. Regional and local implications of a transition towards a low-carbon economy and green growth

Adjustment pressures might put additional strains on several local economies badly hit by the crisis. In recent years, local governments in many countries have already opted to invest in renewable energy utilities and photo-voltaic installation, resource-saving, recycling activities and green area management in order to spur job creation (IEA, 2009). Major long-term infrastructure investments are expected over the coming years to increase the energy efficiency of buildings, transport and power generation and large-scale building retrofit program have taken a dominant role within local policies for sustainable recovery.

Forward looking regional skill strategies will be needed to anticipate what the employment effects and labour reallocation across industries will imply in terms of future skill needs and absorption of laid-off workers. Efficient co-ordination between actors at different level to implement effective education and training policies will also be necessary. The rising demand for green products will require the simultaneous development of very diverse skills. For example, the rising demand for low-emission residential estates will require developers knowing the building materials with low-embedded energy use, engineers and designers able to embed energy efficient products in the building, manual workers with the technical capability to install and maintain these products, and salespeople able to promote such estates in the market.

Renewable energy options should integrate the policy package for regional development, including for lagging-behind regions in need of finding new development pathways. Venture capital investments in renewable energies might target areas with lower prices for land. Areas having suffered the largest manufacturing job losses, such as the "rust-belt in the United States, might have the right endowments of trained labour to attract investments in renewable energies. The effects on employment are likely to be relevant, since jobs in installing, operating, and maintaining renewable energy systems tend to be local in nature. Moreover, the investment in skills to sustain renewable energy production is likely to raise the overall level of human capital and reduce pressures for out-migration of the young. To sum, renewable energy development should be suited to local characteristics, as there is not a one-size-fits-all technology or strategy.

Against this background, local authorities have a role to play in the creation of opportunities for the expansion of green activities and investments; and the reduction of emissions levels within their localities. Designing an integrated strategy for managing and enabling green growth requires taking into account a multiplicity of policy fields and target groups. Successful experiences have shown that re-skilling of the workforce, while keeping up productivity levels in the greener economy and expanding to new economic activities, requires the public sector to adopt a multi-stakeholder approach, working in partnerships with unions, the business sector, the education sector, and other local institutions.

Source: OECD (2009d), and Martinez-Fernandez, Hinojosa and Miranda(2010).

IV. How do we measure progress towards green growth?

97. Developing and implementing framework conditions that promote green growth requires a good understanding of the determinants of green growth and of related trade-offs or synergies. It also requires appropriate information to support policy analysis and to measure progress.

98. Progress can be measured through indicators that monitor trends and changes, and levels and that attract attention to issues that require further analysis. The indicators that are being developed capture major aspects of green growth in line with the Green Growth Strategy, and pay particular attention to efficiency and productivity issues, as well as to past and future developments. The focus is on the environmental performance of production and consumption, and on drivers of green growth such as policy instruments and innovation activity. In addition, it is important to measure whether green growth actually delivers reduced pressure on the environment and whether environmental quality is improving as a result. Interactions of environmental quality with people's well-being are also being captured. The challenge will be to go beyond conventional measures at hand and develop indicators that capture the long-term implications of current policies and production and consumption patterns.

A pragmatic approach

99. The indicators and the underlying measurement framework are being developed on the basis of existing work and experience[13] in the OECD, the IEA, other international organisations, and in member and partner countries (Box II.9). The indicators are selected according to their policy relevance, analytical soundness, and measurability (Table 4). The work is closely coordinated with the project on "Measuring and fostering well-being and progress" and is steered by a horizontal Task Force led by the Statistics Directorate.

100. The indicators and the measurement framework are kept flexible enough to adapt to different national contexts. As the indicators' relevance may vary across countries and circumstances, they will be supported by additional information to put them in a broader context and facilitate interpretation. This would cover both information about countries' ecological, social, economic, structural and institutional features, and information to explain the factors behind changes in the indicator values. For certain indicators, it may also be possible to explicitly control for economic structure with a view to distinguishing between structural and other effects in cross-country comparisons. Furthermore, an effort will be made to present both cross-country comparisons at a given point in time and evolutions of indicators over time to track patterns of convergence or divergence for example in resource efficiency.

A measurement framework combining production, consumption and the environment

101. The framework used for organising the indicator development builds on an extended growth accounting approach and on a selection of the most pressing environmental issues that are of relevance to green growth.

At the core of the framework is a production process that relates economic output (made up of goods and services) to economic, social and environmental inputs that are used to produce it. Inputs comprise traditional inputs (for which there are market prices that more or less reflect society's valuation) in the form of labour, capital, energy, materials and

13. Examples include experience with: decoupling indicators, resource productivity indicators, energy efficiency indicators, policy integration indicators, core and key environmental indicators, innovation indicators, sustainable development indicators, etc.

a set of inputs that are not normally accounted for, in particular environmental services: flows of natural resources (water, fish, certain materials) and sink functions for air emissions and discharges into soil and water (Figure 10). In addition, there are wider ecosystem services, such as a stable climate/weather patterns, water regulation and purification services, services from biodiversity such as pollination and general resilience of ecosystems.

The environmental issues that will be given prominence include: (i) climate change, (ii) ecosystems and environmental media (in particular biological diversity, air, soil and water quality); (iii) environmental resources (water, fish, forests), and (iv) waste and material resources (*e.g.* metals and other minerals).

A set of indicators capturing major aspects of green growth

102. Five groups of interrelated indicators will be distinguished: (i) indicators reflecting the environmental efficiency of production as well as the absolute pressures associated with production, (ii) indicators reflecting the environmental efficiency of consumption as well as the absolute environmental pressures associated with consumption (iii) indicators describing the natural asset base of the economy, (iv) indicators monitoring environmental quality of life, and (v) indicators describing policy responses and instruments.

Monitoring the environmental efficiency of production and changes in production patterns

103. The environmental efficiency of production can be measured by the use of environmental services per unit of output (expressed in monetary and/or in physical terms). A declining use of environmental services per unit of output is a necessary condition for decoupling environmental pressure from economic growth and an indication of substitution processes where environmental inputs are replaced by other inputs or by more efficient production processes. The first group of indicators thus includes resource productivity and environmental efficiency measures that track quantities of residuals such as pollutants or waste in relation to conventional outputs or ratios of the natural capital input (water, energy, biomass and other materials) over quantities of conventional output. Such indicators would be based on a domestic perspective and rely on data by industries, activities or sectors[14] (*e.g.* agriculture, manufacturing, energy, transport). Given that efficiency gains in resource use and improvements in pollution intensities can be offset by the volume effects of increased production and consumption levels, the set of indicators would also include measures of absolute changes in resource use and pollution emissions so as to indicate the environmental burden.

Monitoring the environmental efficiency of consumption and changes in consumption patterns

104. The second group of indicators will look at the environmental efficiency of consumption and at changes in consumption patterns. This is important because many policy instruments, for instance price signals through taxes and subsidies or regulations, are directed at consumers, and changing consumer demand structures will affect the supply structure of our economies. This group also includes indicators that lie at the interface between production and consumption and that go beyond the domestic perspective. The resource productivity of a country's production system can rise when products that are environmentally inefficient are imported and resource extraction and residuals arise abroad so that there is a displacement effect: domestic environmental services are replaced by imported inputs. Such indicators can build on input-output tables, data from life cycle analysis used with trade data and information on the environmental

14. Note that no attempt is made to define green industries or green production statistically. The indicators would rather reflect changes in the environmental efficiency or in the resource productivity in key sectors or activities.

content of certain products. This permits tracking the international flows of residuals or natural resources that are embodied in consumer products.

Monitoring the natural asset base of the economy, including natural resource and material stocks, and biodiversity

105. It is necessary to not only track whether there is decoupling of environmental pressures from economic growth, but to ensure that pressures on the environment and extraction of renewable resources are at a level compatible with available stocks, and with the environment's carrying capacity. Hence, a crucial ingredient to measure progress is to look at stocks, along with flows, and to identify indicators that reflect the extent to which the asset base is being maintained in terms of quantity, quality or value. Tracking stocks and their changes empirically implies monitoring cumulative effects of extraction and renewal for a given type of natural resource. This group of indicators will thus monitor important stocks of natural capital and material resources[15], with focus on key natural resources and on biodiversity**,** supplemented by selected information on environmental quality (air, water, soil).

Monitoring the environmental quality of life

106. Closely associated with the consumer perspective is how pollution and changes in environmental services affect people's quality of life. This group of indicators would include measures covering (i) people's exposure to various pollutants and the associated health effects, (ii) people's exposure to environmental risks; and (iii) the access that different groups have to environmental services (water, green space, etc.). Such objective indicators could be complemented by subjective measures of environmental quality of life reflecting (i) people's perceptions about the quality of the environment they live in, and (ii) environmental quality as one of the determinants of overall subjective measures of well-being.

Monitoring policy responses and instruments

107. The fifth group of indicators looks into the responses (policies, measures, instruments) put in place by economic actors to promote green growth, including economic and fiscal instruments, social and regulatory instruments. Response indicators would include:

- Indicators on *green innovation and technology*, covering aspects such as technology development and uptake, patents, R&D expenditure, etc.
- Indicators on *public and private expenditure and transfers*, including capital expenditure, taxes, fees, subsidies.
- Indicators on *international transfers*, including technology transfers, international investments, and development aid.

108. They could be complemented with selected indicators reflecting training policies and skill development measures.

15. A statistically challenging question is how to reflect in-use resource stocks (*e.g.* materials contained in existing buildings and equipments) and stocks contained in waste that can potentially substitute for natural stocks (in particular non-renewable ones) through improved recovery, recycling etc.

Box 16. Key principles in selecting indicators to monitor progress with green growth

Policy relevance

The indicator set should have a clear policy relevance, and in particular:

- provide a balanced coverage of the key features of green growth with a focus on those that are of common interest to OECD member and partner countries
- be easy to interpret and transparent, *i.e.* users should be able to assess the significance of the values associated with the indicators and their changes over time
- provide a basis for comparisons across countries
- lend itself to being adapted to different national contexts, and analysed at different levels of detail or aggregation.

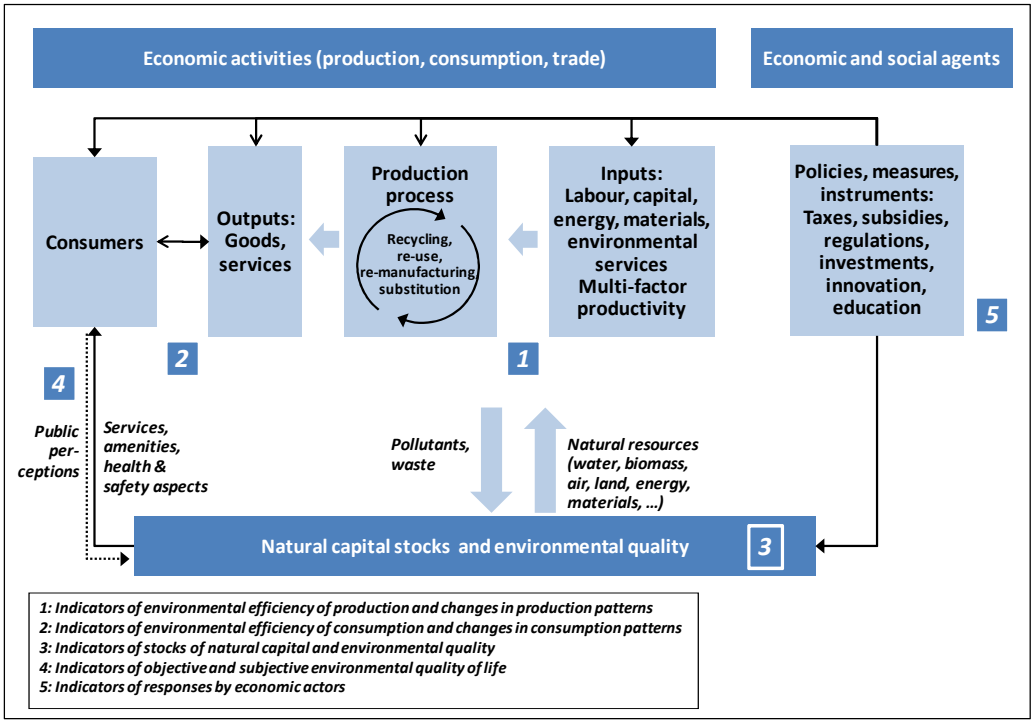
Analytical soundness

The indicators should be analytically sound and benefit from a consensus about their validity. They should further lend themselves to being linked to economic and environmental modelling and forecasting.

Measurability

The indicators should be based on data that are available or that can be made available at a reasonable cost, and that are of known quality and regularly updated.

Figure 10. Framework for Green Growth Indicators



V. Delivering the OECD Green Growth Strategy and beyond

109. The delivery of the Strategy's Synthesis Report in mid-2011 will mark the starting point of OECD's commitment and ambitious agenda to support countries' efforts to move towards greener, more sustainable economies and to fully mainstream green growth across OECD activities. As such, it would lay down the foundations for a longer-term programme of work, defining intermediate targets that could be built upon in subsequent years.

110. Further analysis is expected to be needed in the following areas to deliver the Green Growth Strategy and beyond:

- **Creating a coherent and effective policy framework:** Building on initial work, the Synthesis Report will deliver a more comprehensive framework that is essential to prevent environmental degradation and enable long-term economic growth and development. Further work would be required beyond delivery of the Strategy to help countries address the practical and policy challenges of implementing a green growth policy mix and tailoring the toolkit to the specific needs of OECD and partner countries. This would also require further analysis of political economy considerations.

- **Overcoming barriers to green growth:** The Synthesis Report will be deepening initial analysis on policy-induced distortions such as policy barriers to cross border trade and investment in environmental goods and services, inefficient regulatory interventions and environmentally-harmful subsidies to fossil fuels, agriculture, forestry or fisheries.

- **Expanding markets for green goods and services and developing green policy instruments:** the Report will identify the most appropriate policy tools to expand markets for greener goods and services and to achieve lasting systemic and behavioural change. This will include a systematic and in-depth analysis of: pricing instruments, including GHG emission trading systems and green taxes; the tax treatment of tradable permits; tax incentives for private R&D, innovation and the adoption of green technologies. It will also cover financial mechanisms (such as loan guarantees, insurance products, green bonds and green funds) directed at supporting investment in green activities, consumer policies, the role of education and the conditions under which governments intervene in markets to promote sustainable consumption; regulatory quality and policy coherence for green growth.

- **Assessing the labour market impacts of the transition to green growth:** The Synthesis Report will include an assessment of the expected long-term net employment changes associated with a shift towards green growth; possible effects on the composition of employment and the required labour mobility across firms and sectors; key policies to facilitate net increases in sustainable employment including labour market and training policy which will also take into account the need to provide existing workers with new skills.

- **Encouraging green innovation on a large scale:** the Strategy will work towards identifying new opportunities for eco-innovation across the economy as well as the policies that can support business in unlocking the potential for new value creation. It will also look at both the environmental and economic benefits that could be derived from the use of manufactured nanomaterials; further analyse the contribution of ICTs to green growth; and encourage green growth and innovation in the area of biotechnology. It would also examine new approaches to international cooperation on science, technology and innovation. Further work would develop advice and guidance on the design and implementation of green innovation policies as a follow-up to the Innovation and Green Growth Strategies.

- **Green growth for development:** in line with the Strategy's objective to mainstream green growth in development co-operation, work on the following

three policy areas will provide the key pillars of an approach for pro-poor green growth in developing countries: encouraging sound natural resource management and governance; shaping climate resilient growth; and promoting low-carbon growth. This will also include the role of donors in supporting sound natural resource management as well as analysis of the official development assistance (ODA) activities that target and those that support the objectives of the Rio Conventions.

- **Greening key sectors:** the Strategy's policy findings will be applied to enable an analysis of green growth in the case of specific key sectors including agriculture (as mandated by the 2010 OECD Committee for Agriculture at Ministerial Level - Appendix B below), fisheries, transport and the energy sector.
- **The regional and local dimension of green growth:** the Strategy will specifically consider how to foster green innovation and support the creation of green jobs in cities as well as in the context of rural development. In the latter case, work will focus on favouring the development of the renewable energy industry in rural areas and explore local initiatives to tackle climate change.
- **Moving the measurement agenda forward:** Some elements for further work would include the development of a comprehensive set of green growth indicators to measure progress towards green growth in countries and monitor the results of green growth policies. These would also cover defining and evaluating green foreign direct investment (FDI) flows in order to better understand and facilitate such flows.
- **Strengthening international dialogue:** As part of the efforts to ensure international co-ordination, the OECD will be launching an International Green Growth Dialogue, with the participation of international organisations (*e.g.* UNEP, ILO, World Bank), NGOs, the private sector and other stakeholders. This initiative will contribute to ensuring a more open and inclusive approach to fostering green growth, while providing a platform for participation and exchange between a wide range of stakeholders from OECD and partner countries.

Bibliography

ACEEE (2010), *North Carolina's Energy Future: Electricity, Water, and Transportation Efficiency*, American Council for an Energy-Efficient Economy, Washington, D.C.

Acemoglu, D. *et al* (2009), *The Environment and Directed Technical Change*, mimeo, Massachusetts Institute of Technology, Boston.

Blackman, A. and R.T. Woodward (2010), "User Financing in a National Payments for Environmental Services Program: Costa Rican Hydropower", *Resources for the Future Discussion Paper* No.09-04-REV, Resources for the Future, Washington, DC.

Cleantech Group (2010), *Cleantech Investment Monitor 4Q09/FY2009*, Vol. 8, Issue 4, Cleantech Group, San Francisco.

De Serres, A, F. Murtin and G. Nicoletti (2010), "A Framework for Assessing Green Growth Policies", *OECD Economics Department Working Paper,* (forthcoming) OECD, Paris.

Egert, B *et al* (2009), "Infrastructure and growth: Empirical evidence", *OECD Economics Department Working Papers,* no 685, OECD, Paris.

FAO (2009), "Feeding the World in 2050", ftp://ftp.fao.org/docrep/fao/meeting/018/k6021e.pdf.

Haltiwanger, J., R. Jarmin, and J. Miranda (2009), *Business Dynamics Statistics Briefing: Jobs Created from Business Start-ups in the United States*, Ewing Marion Kauffman Foundation, Kansas City.

Haugh, D., A. Mourougane, and O. Chantal (2010), "The Automobile Industry in and beyond the Crisis", *OECD Economics Department Working Papers,* no. 745, OECD, Paris.

IAEA (2005), *Energy indicators for sustainable development: guidelines and methodologies*, IAEA, UNDESA, IEA, Eurostat, EEA, Vienna.

IEA (2008a), *Deploying Renewables: Principles for Effective Policies,* IEA, Paris.

IEA (2008b), *Energy Technology Perspectives*, IEA, Paris.

IEA (2009), *World Energy Outlook*, IEA, Paris.

Kamal-Chaoui, L. and A. Robert (eds.) (2009), "Competitive Cities and Climate Change", *OECD Regional Development Working Papers*, No. 2, OECD, Paris.

Martinez-Fernandez C., C. Hinojosa and G. Miranda (2010), "Green jobs and skills: the local labour market implications of addressing climate change", 8 February 2010, Working document, CFE/LEED, OECD, Paris.

Mowery, D., R. Nelson and B. Martin (2009), *Technology Policy and Global Warming: Why New Policy Models are Needed*, NESTA Provocation 10, National Endowment for Science, Technology and the Arts, London.

Nemet, G. F. (2009), "Demand pull, technology push, and government-led incentives for non-incremental technical change", *Research Policy*, Volume 38, Issue 5, pp. 700-709, Elsevier, Amsterdam.

OECD (2003), *OECD Environmental indicators: development, measurement and use*, Reference paper, OECD, Paris.

OECD (2005), *Environment at a glance: OECD Environmental Indicators*, OECD, Paris.

OECD (2007), "Subsidy Reform and Sustainable Development: Political Economy Aspects", *OECD Sustainable Development Studies*, OECD, Paris.

OECD (2008a), *Review of Fisheries in OECD Countries: Policies and Summary Statistics 2008*, OECD, Paris.

OECD (2008b), *Costs of Inaction on Key Environmental Challenges*, OECD, Paris.

OECD (2008c), *Environmental Outlook to 2030*, OECD, Paris.

OECD (2008d), *Environmental Performance of Agriculture: At a Glance*, OECD, Paris.

OECD (2008e), *Environmental Performance of Agriculture in OECD Countries since 1990*, OECD, Paris.

OECD (2008f), *Measuring material flows and resource productivity: Synthesis report* and *Volume I. The OECD Guide*, OECD, Paris.

OECD (2008g), *OECD Key Environmental Indicators*, OECD, Paris.

OECD (2009a), *The Economics of Climate Change Mitigation: Policies and Options for Global Action beyond 2012*, OECD, Paris.

OECD (2009b), *Agricultural Policies in OECD Counties: Monitoring and Evaluation*, OECD, Paris.

OECD (2009c), *Environmental Cross-Compliance in Agriculture*, OECD, Paris.

OECD (2009d), *Competitive Cities and Climate Change*, OECD, Paris.

OECD (2009e), *OECD Science, Technology and Industry Scoreboard 2009*, OECD, Paris.

OECD (2010a), *Stocktaking of Policy Measures Addressing Agri-environmental Issues*, OECD, Paris.

OECD (2010b), *Sustainable Management of Water Resources in Agriculture*, OECD, Paris.

OECD (2010c), *Development Aid at a Glance 2010: Statistics by Region*, OECD, Paris.

OECD (2010d), *Economic Policy Reforms 2010: Going for Growth*, OECD, Paris.

OECD (2010e), *Ministerial Report on the OECD Innovation Strategy: Fostering Innovations to Strengthen Growth and Address Global and Social Challenges – Key Findings* (forthcoming), OECD, Paris.

OECD/European Environment Agency Database on instruments used for environmental policy and natural resources management

OECD Project on "Environmental Policy and Technological Innovation (www.oecd.org/environment/innovation).

Schweinfurth, A. (2009), "Car-scrapping schemes: An effective economic rescue policy?", *The Global Subsidies Initiative Policy Brief*, International Institute for Sustainable Development, Winnipeg.

Smith, K. (2009), "Climate Change and Radical Energy Innovation: The Policy Issues", *TIK Working Papers on Innovation Studies*, No. 20090101, Centre for Technology, Innovation and Culture, University of Oslo, Oslo.

UNECE, OECD, Eurostat (2009), *Measuring sustainable development*, UNECE, Geneva.

Wunder, S. (2007), "The Efficiency of Payments for Ecosystem Services in Tropical Conservation", *Conservation Biology,* Volume 21, No. 2, Wiley-Blackwell, New Jersey.

Appendix I. Illustrative indicator examples

Extracted from recent OECD work

- Air and climate
- Waste and materials
- Energy supply and efficiency
- Water resources
- Development aid
- Research and technology development

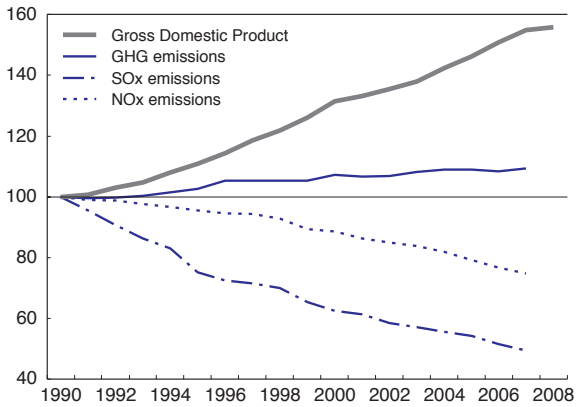
The indicators presented here are extracted from recent work.

They are included in this document for illustration purposes only.

Illustrative indicator examples extracted from recent OECD work

Air and climate

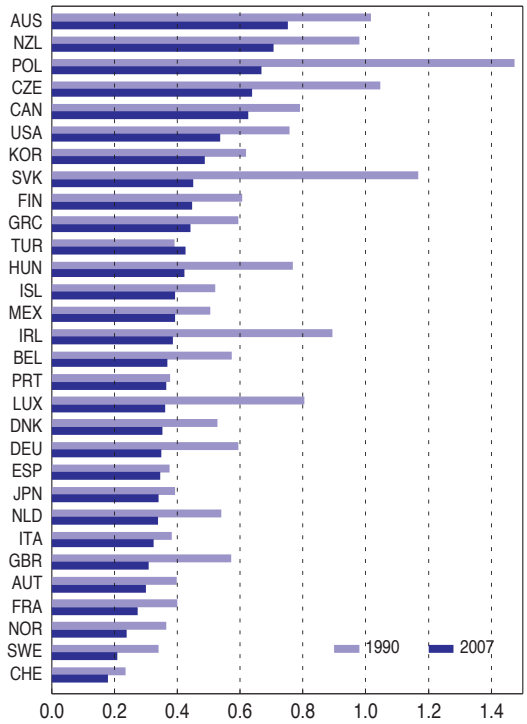
Figure I.1. Emission trends and GDP growth
OECD (Index 1990=100)



Source: OECD Key Environmental Indicators.

Emissions of acidifying substances show absolute decoupling from GDP. Many countries have also decoupled their GHG emissions from GDP growth, but have not succeeded in meeting their national commitments. The main challenge is to stabilise the concentration of GHG in the atmosphere at a level that would limit anthropogenic interference with the climate system, to limit emissions of other air pollutants and to limit population exposure to air pollution.

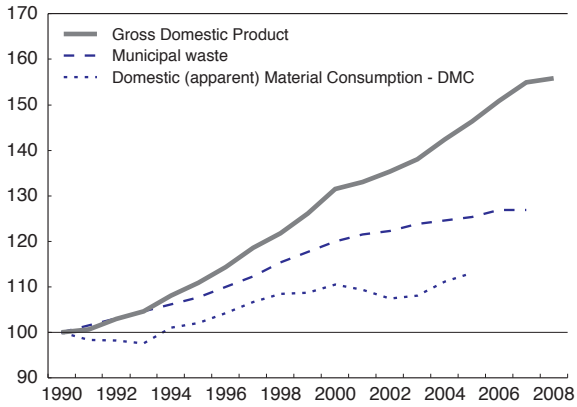
Figure I.2. Emission intensities
Greenhouse gas emissions per unit of GDP
(tonnes CO2-eq/1000 USD)



Source: OECD Key Environmental Indicators.

Waste and materials

Figure I.3. Waste generation, materials use and GDP growth
OECD (Index 1990=100)



Source: OECD Key Environmental Indicators.

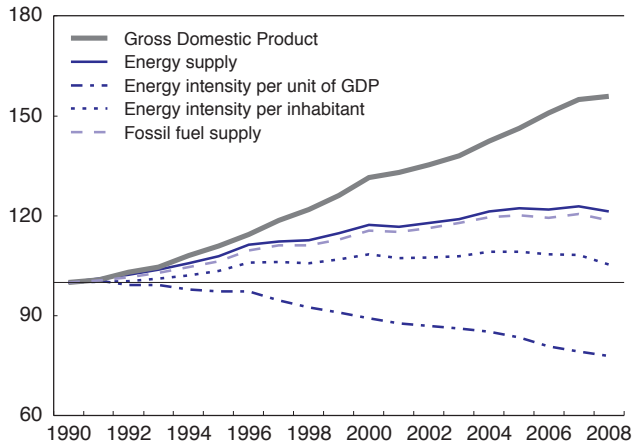
Despite achievements in waste recycling and relative decoupling of municipal waste generation from economic growth, many valuable materials contained in waste continue to be disposed of and are potentially lost for the economy.

The main challenge is to strengthen measures for waste prevention and recycling, and to move further towards integrated life cycle management of materials and products (circular economy approaches).

Illustrative indicator examples extracted from recent OECD work (continued)

Energy supply and efficiency

Figure I.4. Energy use and GDP growth
OECD (Index 1990=100)

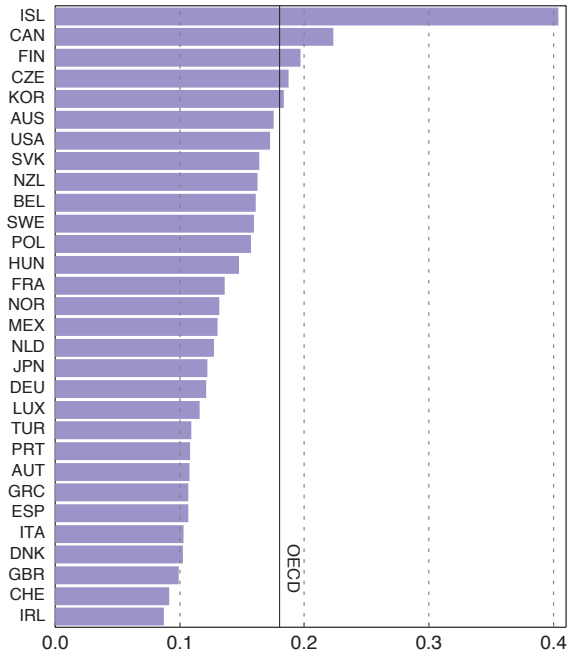


Source: IEA, OECD.

During the 1990s, energy intensity per unit of GDP has generally decreased in the OECD, as a consequence of structural changes in the economy, energy conservation measures, and in some countries decreases in economic activity.

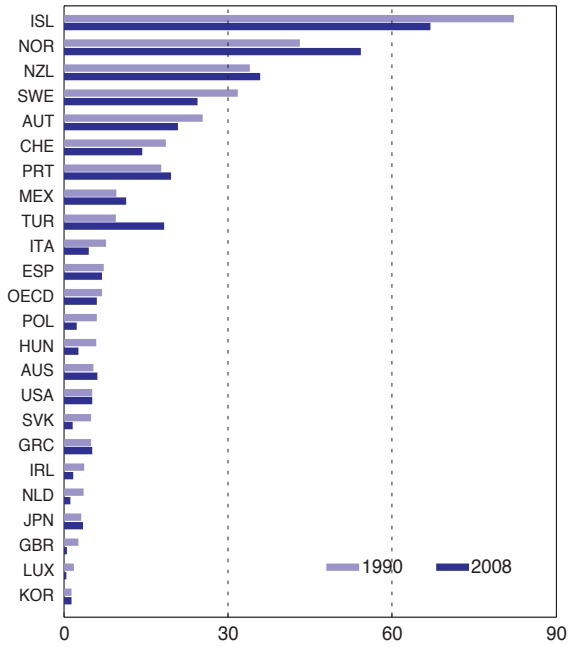
The current rate of energy efficiency improvements is however not enough to overcome other factors driving up energy use. The main challenge is to further decouple energy use and related air and GHG emissions from economic growth, through additional improvements in energy efficiency and through the use of cleaner fuels.

Figure I.5. Energy intensity, 2007
Energy Supply per unit of GDP (TOE/1000 USD)



Source: IEA

Figure I.6. Share of renewable energy[1]
As a percentage of energy supply



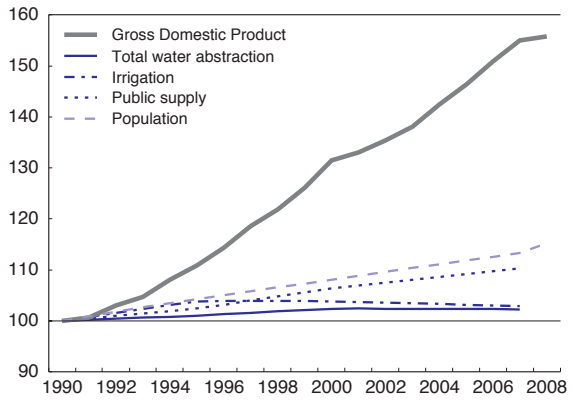
1. Hydro, solar, geothermal and wind energy.
Source: IEA

Illustrative indicator examples extracted from recent OECD work (continued)

Water resources

Figure I.7. Water abstractions and GDP growth

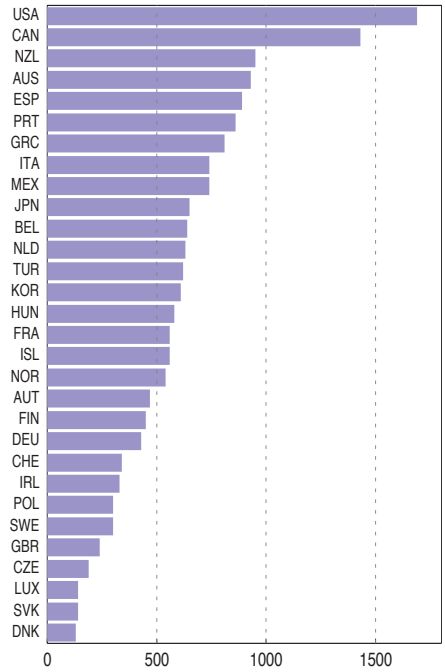
OECD (Index 1990=100)



Source: OECD Key Environmental Indicators

Figure I.8. Water use intensities, mid 2000s

Abstractions per capita (m3/person/year)



Source: OECD Key Environmental Indicators

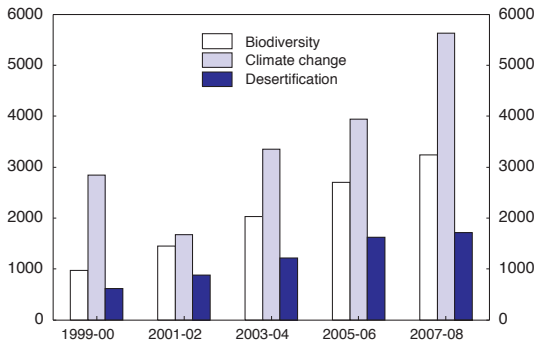
Though many countries have stabilised their abstractions through more efficient irrigation and cleaner production technologies, most of them face seasonal or local water quantity problems and several have extensive arid or semi-arid regions where water is a constraint to economic development.

The main challenge is to ensure a sustainable management of water resources, avoiding overexploitation and degradation, so as to maintain adequate supply of freshwater of suitable quality for human use and to support aquatic and other ecosystems.

Development aid

Figure I.9. Aid[1] targeting the Rio Conventions

USD million



1. Members of the OECD's Development Assistance Committee (DAC), two-year averages, commitments, constant 2007 prices.

Source: OECD-DAC: CRS Aid Activity database.

Trends in aid targeting the objectives of the Rio Conventions show an increase since the late 1990s. In 2008, DAC members allocated approximately USD 3.4 billion for biodiversity-related aid, USD 8.4 billion for climate-change-related aid and USD 2.4 billion for desertification-related aid.

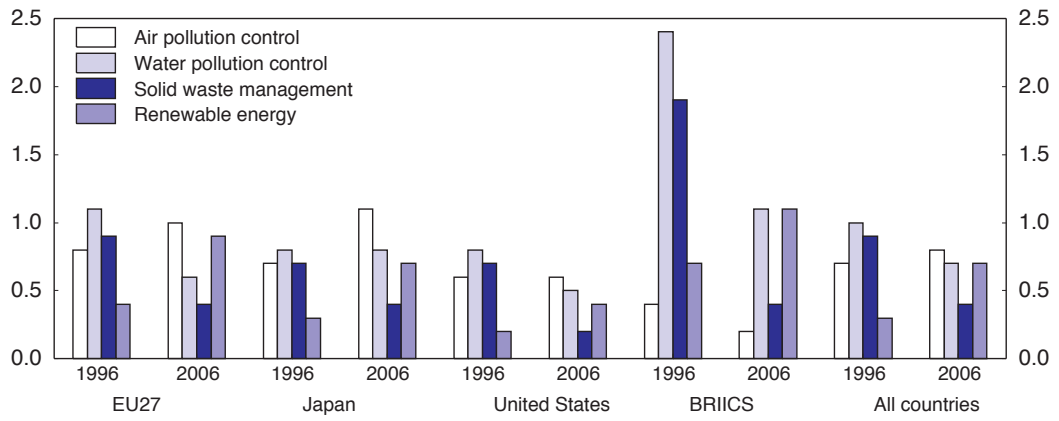
In 2008, total net official development assistance (ODA) from DAC members amounted to USD 119.8 billion, i.e. 0.30% of members' combined gross national income.

With foreign direct investment and other private flows to low-income countries on the decline, aid has a role to play in countering the development impact of the crisis.

Illustrative indicator examples extracted from recent OECD work (continued)

Research and technology development

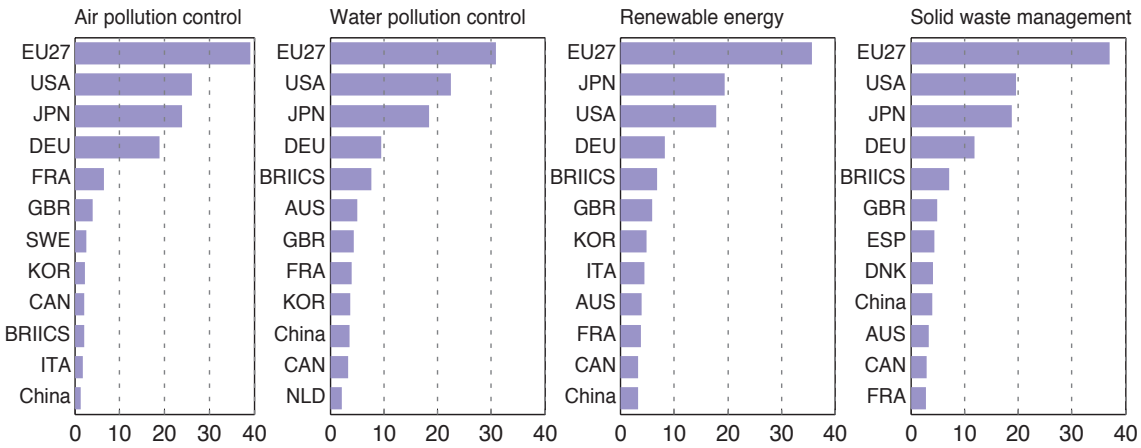
Figure I.10. Patents in selected environmental technologies
As a share of total PCT[1] patent applications (%)



1. The number of Patent Cooperation Treaty (PCT) applications is used as the main indicator of inventive performance.

Source: EPO/OECD Worldwide Patent Statistical Database.

Figure I.11. Share of countries in environmental technology patents filed under PCT[1]
Top 10 countries, 2004-06 (%)



1. The number of Patent Cooperation Treaty (PCT) applications is used as the main indicator of inventive performance.

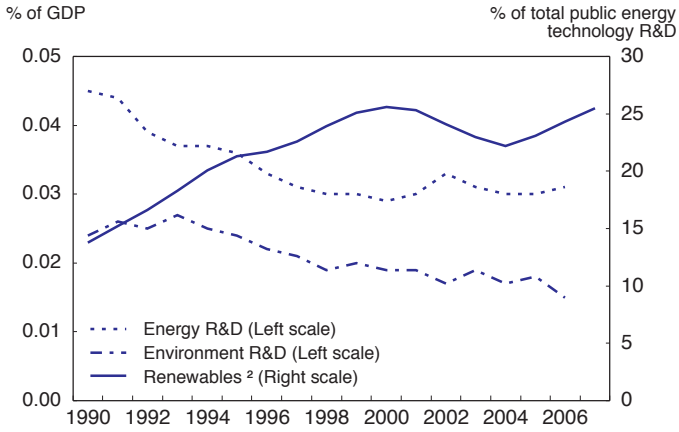
Source: EPO/OECD Worldwide Patent Statistical Database.

In the last 10 years, in most regions and countries there has been an increase in the share of total patents related to air pollution and renewable energy, while for water pollution and solid waste management the share has fallen. Japan, the United States and Germany are the most important inventor countries. Other countries such as Sweden (air pollution), Australia (water pollution) and Spain (renewables) are also important sources of invention in specific fields, as are the BRIICS (Brazil, Russian Federation, India, Indonesia, China, South Africa), and in particular China.

Illustrative indicator examples extracted from recent OECD work (continued)

Figure I.12. Public spending in energy- and environment-related R&D

OECD[1]



The development and diffusion of clean technologies is crucial for moving to resource efficient, low-carbon economies.

While the share of GDP dedicated to public environment- and energy related R&D expenditure has slightly decreased since 1990, the amount dedicated to renewable energy and energy efficiency has gained in importance.

1. Data on energy related R&D refers to IEA averages. Non-IEA members (Iceland, Mexico, Poland, Slovak Republic), Belgium and Luxembourg are excluded.
2. Energy technology R&D expenditures directed towards "Renewable Energy" and "Energy efficiency" measures.

Source: OECD.stat (R&D statistics), IEA database.

Appendix II. Examples of ongoing work

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Tables

Boxes

Table II.1. Conditions favourable to the use of specific instruments

	Market-based instruments Circumstances Under Which Instrument Works Best	Examples / Common applications
(1) Cap-and-trade permit systems	- Public-good market failure is not dominated by monitoring and information costs. - Sufficient institutional capacity (experience) and potential size of market sufficiently large to function properly. - Environmental damage depends on overall amount of a pollutant and not on specific location or timing of emission sources - Precise control over emissions is available at reasonable cost - Cross-border spill-over effects are important	- GHG emission reductions (EU-ETS) - Air pollution (SO_2, NO_x, VOC) - Fishing quotas
(2) Baseline-and-credit permit systems	- Public-good market failure is not dominated by monitoring and information costs - Insufficient capacity or scope to set-up a cap-and-trade system - Baselines can be set and verified at reasonable cost - Cross border spill-over effects are important	- Clean Development Mechanism - Lead content of gasoline
(3) Taxes or charges on pollution or exploitation of natural resource	- Public-good market failure is not dominated by monitoring and information costs. - Pollution sources are small and diffuse - Environmental damage depends on overall amount of a pollutant and not on specific location or timing of emission sources - Temporary deviations in emission levels from target have little consequences for environmental damage (*e.g.* flat damage function) - Precise control over emissions is available at reasonable cost	- Water effluents - Water abstraction or consumption
(4) Taxes or charges on a proxy (input or output)	- Control of direct pollution discharge difficult or costly - Close and stable relationship between use of input or output used as proxy and targeted pollutant - Several pollutants associated with single input or output	- Fuels and coal - Motor vehicles - Fertilisers
(5) Subsidies	- Enforcement of alternative pricing instruments is difficult or very costly - Activity to be subsidised is a strong substitute for targeted “dirty” activity - Subsidy programme can be designed in a relatively simple way, for a time-limited period and with minimal secondary effects	- Forest management and conservation - Purchase of environmental-friendly house energy equipment
(6) Deposit-refund systems	- Control of pollution source impossible or difficult - Solid wastes involving simple and relatively homogeneous products or heavy metals	- Beverage and chemical containers - Lead acid batteries

Table II.1 continued over page.

Table II.1. Conditions favourable to the use of specific instruments

(continued)

	Non market instruments Circumstances Under Which Instrument Works Best	Examples / Common applications
(7) CAC Performance standards	- Pollution control at the source of emissions is infeasible or very costly - No adequate proxy for pollutant that could be object of taxation - Weak response of agents to price signals - Pollution emissions can be measured from application of technology	- Limits on CO_2 emissions of a passenger vehicle - Energy efficiency standards for various manufactured goods.
(8) CAC Technology standards	- Pollution control at the source of emissions is infeasible or very costly - No adequate proxy for pollutant that could be object of taxation - Administrative costs of performance standards are too high - Abatement costs are relatively homogeneous across agents	- Minimum percentage of a low-carbon source in the overall fuel mix of passenger vehicle - Specific housing building codes for energy-saving purposes
(9) Active technology support policies	- Technology areas where market size and learning-by-doing effects are dominant - Infrastructures in areas where network considerations are important	- Feed-in tariffs for electricity generated by renewable sources - Renewable energy portfolio standard (green certificate)
(10) Voluntary approaches	- When the authorities can put strong pressures (credible threat of follow-up actions) - Where information is not too costly to provide	- Agreements to encourage energy efficiency in energy-intensive industries - Publicly-available inventories of various pollutants

Table II.2. Green industries by broad sector of activity and broad environmental area

Production sectors	Environmental sectors				
	Climate change			Other environmental areas	
	GhG emissions from: Fossil-fuel power generation	GhG emissions from: Building energy consumption	GhG emissions from: Transports	Bio-diversity / air, water and land preservation	Waste management
Electric/ Utilities	- Wind power - Geothermal power - Solar power - Hydroelectric power - Nuclear power	- Electrical power distribution (energy conservation and planning)		- Water supply and irrigation system	- Sewage treatment facilities
Agriculture	- Bio-methane production (energy from animal waste)		- Bio-fuels crop production (especially non-food)	- Organic farming - Aquaculture	
Construction	- Renewable energy plants - Power lines and related structure construction	- Roofing contractors - Electrical and wiring installation contractors - Retrofitting of existing buildings (insulation) - Plumbing and air-controlling contractors			- Waste water and sewer line
Transport			- Public transit systems (urban and inter-urban) - Fluvial transport - Rail freight transport		
Manufacturing	- Wind turbines - Solar panel components (semi-conductors) - Storage battery equipment	- Smart systems and equipment - Electric lamp bulbs - Solar panel components - Automatic environmental control equipment	- Transportation technology (electrical, hydrogen, bio-fuels, hybrid) - Processes for bio-fuel production - Fuel efficient vehicle manufacturing - Transportation and logistics equipment	- Monitoring equipment for fishing stock - Water metering equipment	- Automatic environmental control for commercial, residential and appliance use
Services	- Engineering services - Plumbing and heating equipment wholesalers - Environmental consulting services	- Architectural services - Engineering services - Residential and non-residential property managers	- Repair and maintenance of fuel-efficient vehicles - Logistic consulting services - R&D in biotechnology	- Eco-tourism activities, conservation and wildlife organisations - Watershed conservation and management - Emissions and pollution control - Environmental consulting services - Survey and mapping services	- Solid waste collection - Hazardous waste collection - Engineering services

Source: Centers of Excellence of California Community Colleges and OECD.

Box II.1. The role of regulatory policy and reform

Regulation, together with taxation and expenditure, is one of the key levers governments can use to promote green growth. But without proper oversight and sound regulatory policy, there is a risk of regulatory incoherence and overlap, between both new regulatory proposals and the stock of existing regulations. This can impede the entry of new firms and exit of older, inefficient, ones, a process which is necessary to transform economic activity and stimulate growth. While regulation may be necessary to stimulate the uptake of green technologies, the careful selection of instruments is important to ensure that regulatory proposals are targeted, efficient and do not constrain market dynamics.

Market-based instruments need to be complemented by regulatory measures that encourage the adoption of low carbon technologies through, for example, updating building codes and higher energy efficiency standards. Regulatory failure, as demonstrated by the creation of unintended distortions or unnecessary administrative burdens impedes dynamic economic efficiency, which will in turn slow green growth. Country experiences can guide regulatory management and reform to target those areas where efficiency gains for green growth are greatest. This involves selecting an appropriate instrument among a set of regulatory and non-regulatory approaches, taking account of the incentives for firms and consumers, and the promotion of a coherent regulatory framework.

Coherent regulatory policy increases confidence in the entire regulatory system and underpins investment certainty, while ensuring that regulatory policies do not overlap and potentially waste scarce resources. Coherent regulatory policy requires multilevel regulatory co-ordination, across departments and policy areas and at the national and sub national level. The adoption of new regulations as part of a green growth strategy must be accompanied by a thorough vetting of the extant regulatory stock to eliminate those that are in conflict or those that may inhibit the growth strategy. *Ex ante and ex post* assessment of the costs and benefits of different instruments can assist in selecting the optimal approach to achieve desired policy goals.

Although the tools for regulatory policy are well-tested in developed countries, the pursuit of a green growth agenda is likely to challenge regulatory management systems. The transition to a green, low-carbon and resource efficient economy that creates new sources of growth is a long-term process and will require fundamental shifts in regulatory approaches and institutions.

Achieve positive environmental and economic outcomes

Integrating both economic and environmental considerations in regulatory decision-making is a key feature of green growth strategies. Existing tools and methods, such as Cost-Benefit Analysis (CBA), Regulatory Impact Assessment (RIA) and ex-post evaluation provide a framework to consider economic, social and environmental costs and benefits of proposed regulation. However, while almost all developed countries have implemented some form of RIA for new regulatory proposals, countries nonetheless find it administratively and technically challenging, particularly with ensuring the use of these tools early in the policy process. To improve both the uptake on these tools and quality of the analysis associated with major policy and regulatory initiatives, formal agreements between central regulatory oversights and regulating departments could be considered. Canada has implemented such agreements such with some success. Similar agreements could be specifically targeted towards attaining green growth objectives.

Strengthen evidence-based decision-making to foster support

OECD research indicates that a reliance on particular modes of regulation is often more a case of habit than sound design. Traditional command-and-control and end-of-pipe type regulations often lead to input substitution and sub-optimal allocation of

resources that are counterproductive for green growth. Among alternatives, performance-based regulations may work better but can be difficult to enforce without paperwork and inspections. As explained in section II, market-based instruments on the other hand can improve both environmental quality and optimal allocation of resources, but are not always considered by regulators. To increase the likelihood that alternatives to regulation are considered and adopted, a broad range of potential instruments should be considered early in the policy planning and regulatory process, including market-based measures and voluntary approaches.

Sound analysis, *ex ante* and *ex post* evaluation are not only important for decision making, but also facilitate consultation and garner both public as well as political support and acceptance. Industry, NGOs, think-tanks and other stakeholders are more likely to support - or not oppose - initiatives that are transparent and present a solid rationale and analysis that can be independently assessed. Quantitative analysis and results in particular can prove an effective way to communicate complex issues. For example, improved compliance outcomes can be achieved through the communication channels of Web 2.0 technologies which can empower civil society to advocate greener industry performance beyond the limits that may be achieved through direct regulatory measures.

Ensure coherence of analyses and policies

Green growth initiatives are inherently complex. Climate change related regulatory proposals typically involve a wide range of independent regulators which may lead to diverging policies and incoherent outcomes that undermine a national strategy. Some countries, such as the US, have had success in engaging and co-ordinating between regulators at the planning stage to ensure that different regulatory initiatives are assessed against a common analytical framework. More work needs to be done in this area, as countries are not all at the same level in terms of analytical quality and scrutiny of regulatory proposals.

Global issues, including climate change, also highlight the importance of international regulatory co-operation and the need to ensure a global level playing field in terms of environmental regulation. Failure to do so could result in "regulatory arbitrage" by firms, which could choose to operate where regulations are the least stringent. Global dialogue on the application of regulatory policies and regulatory initiatives is required if we are to achieve the necessary convergence in both analysis and policy design for green growth initiatives to be coherent on a global scale.

Box II.2. Markets and competition

Green growth policies and competition policies are complementary. Effective and well functioning competition supports the achievement of environmental goals in a cost effective way including in setting an appropriate price on pollution; lowering barriers to starting new businesses; favouring exit of obsolete firms; and fostering innovation and the development of new green technologies.

Market solutions to promote green growth are often sought through a government intervention designed to recognize an externality, such as a tax on carbon that allows open competition between energy sources afterwards; creation of a regulated product (tradable emission permit) that is traded in a market; or organisation of a new market (such as recycling programs). The view underlying many government interventions for green growth is that once externalities are priced appropriately, markets are likely to promote the most effective use of resources. For markets and competition policy to operate well, policy makers need to understand the consumer and efficiency impacts of different policies in order to ensure that government restrictions are appropriate.

The OECD is examining competitive effects in markets related to renewable energy, standard setting and emissions trading. The approach is to examine the purpose of the government intervention and seek to identify the best, practicable alternatives for achieving government objectives taking into account effects on competition in markets.

In the 2009 Council Recommendation on Competition Assessment, the OECD recommends reviewing and revising regulations to promote better market structure and operation. To help with such reviews, the OECD has developed a Competition Assessment Toolkit that provides a framework to guide policy makers in deciding how to assess and address competition concerns that may arise in government interventions. It draws on cross-sector regulatory experience across many countries. Further work is needed to customise the framework for achieving green growth with market outcomes that deliver efficient and effective outcomes. The Toolkit focuses especially on three principles.

Promote the starting of new businesses

Green growth policies can promote entry of new competitors. Without new competition, individual businesses may also have a greater ability to raise prices. This can hurt government purchasers or other consumers. Examples of policies which may restrict the entry of new businesses include: those that grant exclusive rights over a good or service; establish a license, permit or authorisation process as a requirement of operation; or create a geographical limit to the ability of companies to supply goods or services, invest capital or supply labour.

Ensure businesses can take a broad variety of actions to compete

The actions that businesses take to compete with each other can be limited by regulations that set standards; control prices; favour particular firms or production processes; and restrict advertising and marketing. When businesses are restricted in how they can compete, the vigour of rivalry between businesses is reduced, potentially yielding higher prices for consumer and government purchasers and less product variety.

Maintain the incentive of businesses to act as vigorous rivals

Regulations that reduce the incentives of businesses to act as vigorous rivals may facilitate co-ordination between suppliers. Co-ordination between suppliers over terms of competition can restrict output and raise prices, leaving consumers and government purchasers worse off. Examples include regulations that create a self-regulatory or co-regulatory regime; require or encourage information on business outputs, prices, sales or costs to be published; or exempt the activity of a particular industry or group of businesses from the operation of general competition law.

Box II.3. Consumer policy

Well-informed, empowered consumers are a powerful ally in supporting and driving green growth. For example, they can contribute to the reduction of carbon emissions by using available energy more efficiently or moving to innovative climate-safe technologies. Similarly, consumer demand for green goods, such as alternative-fuelled vehicles and energy-efficient appliances, will play an important role in the development of new generation green goods. To play this positive role, however, a major behavioural change is required by consumers, but also in markets and society as a whole. On the policy side, to support this behavioural change, there is a need for understanding how consumer behaviour is changing and to provide information and ways to expand consumer choices that can lead to sustainable consumption and green growth.

Consumer policy regimes and consumer education and awareness-raising can support consumers in making informed and environmentally-responsible choices, therefore strengthening competition and fostering green innovation. An essential element of this process is ensuring that the information available to consumers is readily understandable, reliable, easy to compare and presented in a manner that takes into account how people process information. Results from an OECD survey on household behaviour confirm that information-based measures can be very effective complements, allowing consumers to make informed decisions reflecting their underlying demand for environmental quality. Yet, information alone is not necessarily sufficient for consumers to make well-informed choices. Studies from behavioural economics show that much potential consumer decisions for green products and services is prevented due to a lack of empowerment and motivation.

To respond to these challenges and opportunities, policy makers need to understand what changes in consumer behaviour are taking place, and what policy interventions are most effective in underpinning green consumption. Against this backdrop, the OECD is addressing consumer protection and empowerment for green growth, through work on green claims, consumer economics and consumer education.

Central to enabling consumers to make informed choices for green products and services is consumer trust in green claims, defined as information presented by business about a product or service concerning its environmental impacts. Such claims have the potential to play an important role in encouraging consumers to make choices that support green objectives, while rewarding innovative companies for their efforts in this regard. The impact of claims will be reduced, however, to the extent that they are unclear, unsubstantiated, confusing, deceptive or fraudulent. When this occurs, there is a risk that consumer interest and confidence in green and innovative products and services will diminish.

The OECD is examining current practices in consumer protection against fraudulent and misleading environmental claims, with an aim to identify the steps that policy makers and other stakeholders can take to enhance the value and effectiveness of these claims for consumers. Differences and similarities across countries with regard to defining sustainable products, requiring company sustainability reporting, and monitoring, advertising and labelling will be highlighted.

Further work is needed to select and implement the most appropriate policy interventions to promote green growth and achieve lasting systemic and behavioural change. The OECD has developed a Consumer Policy Toolkit, which provides a framework to guide policy makers in deciding when and how to intervene in markets to address consumer problems. It draws on what has been learned in the field of behavioural economics, as well as in neoclassical and information economics. The Toolkit can be applied to reviewing the conditions under which governments may want to intervene in the markets to promote sustainable consumption, foster innovation and green growth.

Box II.4. Responsible business conduct in support of a low carbon economy

An increasing number of companies is taking initiatives to address climate change, but levels of corporate action vary significantly, depending on companies' size, industry and region. The Guidelines for Multinational Enterprises are recommendations to companies by forty-two OECD and emerging economies on responsible business conduct, including in the area of environment. They have an important role to play in helping build international consensus and spread knowledge about advanced management practices in support of a low carbon economy. This box documents business practices in light of selected recommendations of the Guidelines.

Disclosing information on GHG emissions: Enterprises should provide the public and employees with adequate and timely information on the potential environment, health and safety impacts of the activities of the enterprise, which could include reporting on progress in improving environmental performance. (Chapter V of the Guidelines, Environment).

Increasingly, leading companies both in OECD and in emerging economies estimate and publicly disclose greenhouse gas (GHG) emissions relating to their operations (in 2009, 70% out of Global 500 did so). GHG emissions accounting is an essential step in companies' assessment of their impacts on climate change and of the risks of climate change on their operations, and constitutes a key element in the development of corporate climate change plans. Public disclosure of GHG emission information helps consumers, investors and other stakeholders assess companies' performance and risks, and can assist governments in developing climate change policies and monitoring progress. The variety of reporting methodologies currently in use, however, makes it difficult to compare companies' progress in meeting their commitments.

Establishing emission reduction plans: Enterprises should contribute to economic, social and environmental progress with a view to achieving sustainable development". (Chapter II, General Policies). Enterprises should establish and maintain a system of environmental management appropriate to the enterprise, including: establishment of measurable objectives and, where appropriate, targets for improved environmental performance, including periodically reviewing the continuing relevance of these objectives (Chapter V, Environment).

A key step for companies' contribution to a low carbon economy is setting quantitative emission reduction targets and developing plans to reach those targets. Here also, the trend is upwards: over 50 % of Global 500 companies disclose emission reduction targets. By implementing corporate emission reduction plans, many companies are also saving energy costs, increasing efficiency and reducing climate change related risks. For leading companies, fighting climate change and making profits have proved to be compatible, and many have seized new business opportunities, *e.g.*, in the renewable energies sector.

Engaging suppliers and consumers: Enterprises should encourage, where practicable, business partners, including suppliers and sub-contractors, to apply principles of corporate conduct compatible with the Guidelines. (Chapter II, General Policies). Enterprises should continually seek to improve corporate environmental performance, by inter alia, promoting higher levels of awareness among customers of the environmental implications of using the products and services of the enterprise. (Chapter V, Environment).

Often, the most significant amounts of GHG emissions relate to supplies and to use and disposal of products. More and more companies are revising their logistics and interacting with their suppliers to ensure that emissions are reduced throughout the supply chain. This is a challenging task but it also provides additional benefits, such as reducing overall risks and costs, increasing efficiency and providing additional experience in managing emissions. Leading companies are also making efforts to better engage with consumers, by raising awareness to climate change and responding to consumer demand for low carbon goods and services.

Box II.5. Taxation, innovation and the environment

Case studies undertaken as part of an ongoing OECD project on Taxation, Innovation and the Environment highlight the ability of environmentally-related taxes to induce innovation. By imposing a direct cost on the polluter, these taxes, in addition to providing incentives for pollution abatement, also encourage innovation to seek out new products and processes that can reduce the polluter's tax burden. This innovation both reduces emission levels for a lower economic cost as well as lowering the tax burden on the polluter (or provides a revenue stream to a third-party inventor).

Looking, for example, at the innovation impacts of the United Kingdom's Climate Change Levy on fossil fuels and electricity, it was found that firms patented significantly more when they were subject to the full rate of the levy compared to firms that were subject to a rate only 20% of the full rate, suggesting that the tax had powerful impacts. In Switzerland, the imposition of a tax on volatile organic compounds (VOCs) – quickly vaporising substances that contribute to smog – affected a wide range of small producers, such as printers, paint makers, and metal cleaners. Most of these firms did not have dedicated R&D units or develop patentable ideas. Nevertheless, interviews with the firms highlighted that the adoption of existing technologies coupled with small, firm-level innovations discovered through trial and error produced significant reductions in VOCs use.

Preliminary findings of the project suggest that:

- Taxes are effective at encouraging the adoption and diffusion of existing green innovations across economies and within firms. Even for firms that do not have the resources or inclination to undertake formalised R&D activities, the presence of environmentally related taxation provides increased incentives to bring in the latest technologies that have already been developed elsewhere. In Sweden, for example, the introduction of a tax on NO_x emissions led to a dramatic increase in the adoption of pre-existing abatement technology: only 7% of firms had abatement technology in the first year of the tax but the fraction rose to 62% by the following year.
- The overall setting in which taxes are levied plays a significant role too: a country's intellectual property rights regime, the system of higher education and cultural norms towards innovation all contribute to a country's innovation capacity. In the case study of Israel, innovations in the water sector may be considered representative of an innovative culture spanning several decades, in addition to the presence of high water prices and taxes.
- Firms are impacted by environmentally related taxes not only in relation to their incentives but also in relation to their profits. Since the imposition of taxes increases firms' costs, it may negatively impact the amount of resources that firms have free to dedicate to innovation. In the case study of the United Kingdom's energy tax, firms having an 80% reduction in tax rates were less innovative, suggesting that the tax did not adversely impact the innovation resource constraint. In Switzerland, taxes on Volatile Organic Compounds and CO_2 have been proven to stimulate day-to-day innovations.
- A conductive environment for innovation, characterised by general predictability and credibility in tax rates, is also a critical ingredient to encourage investment in innovative activities. Unlike market uncertainty (such as oil prices), policy uncertainty is more difficult to hedge against. As seen with Japan's SOx charge, the unpredictability of the rate and the uncertainty surrounding the viability of the overall scheme had negative effects on patenting, despite very high tax rates.
- As with many green policy instruments, there are concerns over levying policies that are too stringent and that can cause emission-intensive

firms to relocate to other jurisdictions. International co-operation and co-ordination in setting environmental taxes can significantly minimise this possibility. Doing so also provides an additional benefit for innovation: the use of environmentally related taxation maximises the international movement of innovation.

- Consumers may not be aware of the full impact of their purchase over the long-term and taxes may not encourage some agents to take mitigation measures when it is others who have to pay the tax. Thus, information campaigns and regulations may help complement green taxes and increase their impact. Such complementarities can help reinforce each instrument, provided that similar instruments do not overlap.

Box II.6. "Smart" ICT applications enabling green growth

Governments are increasingly investing in R&D and encouraging applications to reap environmental and economic benefits, as well as to create employment in new areas. The potential environmental benefits include increased energy efficiency, but they can go further. The "smart" grid is a good example of how ICT-enabled applications can contribute to limiting GHG emissions from the energy supply industry – one quarter of all man-made emissions. ICT firms are partnering with utilities to roll out smart electricity meters that enable final consumers to closely monitor their electricity consumption. Microsoft, Siemens and Google are, for instance, working with utilities in the United States (Xcel Energy), Italy (Enel) and Germany (Yello Strom), respectively. Pilot projects indicate instant feedback on energy use can reduce household electricity consumption by up to 20%. Even higher reductions can be achieved when smart meters are integrated with home automation systems.

ICT applications are beginning to impact the entire energy sector value chain (generation, transmission, distribution, consumption) and traditional business models. Broadband networks, smart sensors and software management systems are building blocks for integrating decentralised energy generators into the central grid, linking different energy storage systems and efficiently managing plug-in electric vehicles on a national scale. Energy sector challenges are different in emerging economies, but in countries such as India, where one third of electricity is lost along distribution, intelligent grid technologies have major potential to contribute to economic growth.

Governments can act to enable environmental and economic opportunities:

- Governments can kick-start initial long-term deployment where private investors are hesitating. The US Recovery Act funding for smart grid R&D and deployment is an example.
- Government policy can complement private investments in areas with potential long-term socio-economic benefits. The private US-Israeli venture "Better Place" (electric vehicle deployment) has established cross-industry partnerships to integrate renewable energy generation, sustainable personal transport and improved grid management. It has raised over USD 700 million in venture capital since 2007 and has backing from the Israeli and Danish governments for national roll-outs.
- Joint programmes with emerging economies are important to adapt new technologies to specific conditions and requirements. Scientific co-operation and technology transfer can be fostered by government policy, but must be coherent with development goals.

Despite the potential for ICTs to contribute to green growth and employment, most government programmes and industry initiatives have focused narrowly on improving the efficiency and performance of ICT equipment itself, most recently in the area of data centres. ICTs contribute only about 2-3% to global greenhouse gas emissions and the potential of ICTs to enable improvements across the economy has been relatively neglected. Although this has been partly remedied in some national economic recovery packages, there are still considerable efforts to be made, not only in designing policies and programmes, but also in developing tough but achievable environmental and economic targets and in evaluating and measuring programme impacts.

Box II.7. Regional innovation systems for eco-innovation

Embedding green innovation policies with in a regional framework can help maximize their impact and effectiveness. OECD analysis shows that much of eco-innovation is concentrated in space and occurs in "green clusters". In addition, systems organized around regional networks can better address commercialization challenges and early stage capital constraints for business start-ups. While it is hard to design effective policy packages that can replicate ex-novo the most effective innovation ecosystems, public policy can accelerate their development, by directed R&D, enabling infrastructure, and institutional platforms for collaboration.

Regional cluster policies can stimulate innovation

While there is a need for a comparative overview of policy options, there are certain concrete steps that governments could consider to spur the growth of regional green innovation clusters. The most ambitious ones involve a radical decentralization of innovation policies in the energy and environmental domains. Another, more promising, route rejects the central-regional dualism in favour of coordinated public policy to enable local, endogenous innovation dynamics. Multi-level and multi-agency policy coordination will be needed to put in place hard technology infrastructures, such as science parks, that can encourage new private investments in R&D for eco-innovation. Other instruments to enable private investments are publicly sponsored research and joint ventures between public and private laboratories within a region. Complementary policies that are more suited to the local scale include environmental technology verification schemes, development of marketing tools, demonstration tests, and simplification of red-tape regulation for technology adoption.

Increasing the eco-efficiency of production relies on regional systems

Regional responses are also warranted to improve the eco-efficiency of existing industrial production and of large incumbent energy service providers. One of the most promising phenomena in this field are eco-industrial parks, another example of organizational and process innovation producing both efficiency and environmental benefits at the regional level. Kalundborg in Denmark is the most well known example of the economic gains that can be achieved by connecting waste and energy exchanges in an eco-industrial park, with annual estimated savings of US $ 12-15 million.

The capacity of Small and Medium Enterprises (SMEs) to innovate and reduce their carbon footprint will also depend even more on knowledge flows and institutional support available within their region. Even if technologies to increase energy efficiency are available "globally", SMEs can fail to adopt them without "locally" available public services to facilitate access. In particular, there is the need to consolidate the effort of universities and public research centres to engage with SMEs, providing problem-solving and auditing services. Several tools, such as innovation vouchers, are being developed at the regional level and should be analyzed with a comparative approach.

The large-scale deployment of low-carbon technologies will depend not only on advanced scientific research but also on how fast firms and people learn to appreciate their added value. As discussed above, behavioural changes are as important as end-of-pipe solutions. These changes and learning processes happen at the local level. Better understanding what drives the demand for green goods and services as well as the main resistances behind slow adoption of new technologies is thus of critical importance. Strengthening the regional dimension of innovation policy would thus provide an opportunity to exploit real differences between regions with respect to capacity to adapt and to push forward systemic changes.

Box II.8. New models for international co-operation on eco-innovation

In strengthening international co-operation on green technologies and innovation, the key will be to identify and implement policies, frameworks and governance mechanisms that can deliver rapid scientific and technological progress as well as lead to a quick and wide diffusion. Existing schemes of co-operation on science, technology and innovation may have to be evaluated and improved, while new mechanisms that enhance green transfers to developing countries (*e.g.* patent pools and other collaborative mechanisms for leveraging IP) will need to be developed. This issue will be explored further for the Synthesis Report for the 2011 MCM.

Moving towards this new model will require focusing on priority setting for work, funding and institutional arrangements, procedures that ensure access to knowledge and transfer of technology, capacity building, as well as delivery of new innovations into widespread use. The OECD, in co-operation with non-members, is working to bring forward agreed principles underpinning such governance.

As an important consideration, such a model should give priority to the development of indigenous eco-innovation capabilities. Preliminary research indicates that the majority of existing policy mechanisms fail to recognise the critical importance of developing such innovative capacity amongst developing country firms. Indigenous eco-innovation capabilities are essential to facilitating both the diffusion of existing eco-innovations within developing countries and sustainable economic development based on the adoption and development of green technologies that fit with the bespoke conditions faced by developing countries.

Building up eco-innovation capabilities in developing countries will require a shift away from the current focus on large project based approaches that emphasise the transfer of the hardware aspects of clean technologies, towards approaches that emphasise flows of underlying knowledge (know-how and know-why) and tacit knowledge. Policy also needs to be improved to better respond to the context-specific technological and cultural requirements, both across as well as within countries. Development assistance can play an important role in this regard and may be instrumental to support regionally tailored programmes and policies that stimulate green innovation that meets local needs.

The shortfalls of current international policy processes must also be addressed by putting in place institutional and funding structures that achieve maximum leverage from public investment, both in terms of maximising the impact on indigenous eco-innovation capabilities, and maximising the potential to attract sustained private sector investment in eco as opposed to conventional innovation. Precedents do currently exist, such as the Carbon Trust's proposed network of Low Carbon Technology Innovation and Diffusion Centres, and Fundacion Chile (a not for profit organisation geared towards facilitating access to relevant international innovations and increasing indigenous innovation capabilities). These provide potentially viable models for a more focused, needs-based approach to developing eco-innovation capabilities in developing countries than can be achieved by the centralised, large project based approach that tends to characterise current international efforts. Some guiding principles derive from these analyses for informing the post-Kyoto approach to technology transfer to developing countries.

Box II.9. Enhancing the cost-effectiveness of biodiversity policies

Despite the significant economic, social and cultural values of biodiversity and associated ecosystem services, biodiversity worldwide is being lost, and in some areas at an accelerating rate. The OECD projects continued biodiversity loss to 2030, driven primarily by land use changes (*e.g.* conversion to agriculture and infrastructure), unsustainable use and exploitation of natural resources, invasive alien species, climate change and pollution (OECD, 2008b). Given these trends in biodiversity loss, enhancing the cost effectiveness of biodiversity policies is an increasingly important issue. There is an urgent need for both (i) greater application of incentives, including Payments for Ecosystem Services (PES), to address biodiversity and ecosystem service conservation and sustainable use, and (ii) more efficient use of available finance in existing programmes.

PES or PES-like programmes are being increasingly applied across developed and developing countries to help internalise the local and national public good benefits of biodiversity and associated ecosystems services. PES provide direct payments to private landowners or users to support the conservation and provision of ecosystem services. PES are defined as "a voluntary, conditional agreement between at least one 'seller' and one 'buyer' over a well defined environmental service – or a land use presumed to produce that service" (Wunder, 2007).

There are more than 300 PES programmes implemented worldwide (Blackman and Woodward, 2010) at both national and local scale, with payments estimated to channel over USD 8.2 billion per year for biodiversity and ecosystem service provision, increasing by 10 to 20% a year.

Work of the OECD, which will input into the Green Growth Strategy, is examining the following issues:

- What are the key features and criteria that must be addressed in PES programme design to maximise their cost-effectiveness?
- What are the different potential sources of finance for PES programmes, and how can they be secured? In particular, how can private sector engagement in PES be leveraged?
- How can PES be best targeted to channel the available finance most cost-effectively? How can other socioeconomic objectives be addressed within PES design?
- How can the use of inverse auctions contribute to this?
- What are the lessons learned from existing PES programmes and insights for current and future programmes, including international PES?

Twelve key features identified to enhance PES cost-effectiveness are:

1. Remove perverse incentives
2. Clearly define property rights
3. Clearly define PES goals and objectives
4. Identify buyers and ensure sufficient and long-term sources of financing
5. Identify sellers and target ecosystem service benefits
6. Consider bundling or layering multiple ecosystem services
7. Establish baselines to ensure additionality
8. Reflect ecosystem providers opportunity costs via differentiated payments
9. Address leakage
10. Ensure permanence
11. Deliver performance based payments
12. Develop a robust monitoring and enforcement framework

Box II.10. Outcome of the February 2010 OECD Agriculture Ministerial Meeting

Ministers from OECD countries, Chile, the EU, Estonia, Israel, Romania, the Russian Federation, Slovenia, Argentina, Brazil and South Africa met in Paris to identify policy actions to address the challenges and opportunities facing the agri-food sector over the next two decades and the role of the OECD in supporting these efforts.

In their Communiqué, "Ministers recognised that green growth offers opportunities to contribute to sustainable economic, social and environmental development, that agriculture has an important role to play in the process, as do open markets that facilitate the sharing of technologies and innovations supportive of green growth, and that, in this context, care needs to be taken to avoid all forms of protectionism. Climate change presents challenges and opportunities for the agricultural sector in reducing greenhouse gas emissions, in carbon sequestration, and the need for adaptation".

"Ministers asked the OECD to identify policy options and market approaches that would encourage "green growth," including mitigation of the food and agriculture system's contribution to climate change, as well as adaptation to its impacts".

Some of the key implications of the Ministerial discussions in terms of green growth and agriculture include:

- Providing enough food for an increasing global population while reducing the carbon footprint of the agri-food sector and sustainably managing scarce natural resources - especially land and water - presents formidable policy challenges.
- Historically, agriculture has shown an impressive capacity to meet growing demands for food, feed and fibre through significant productivity increases, although this has often been achieved at the cost of environmental damage and greater pressure on scarce natural resources.
- Moreover, one billion people remain undernourished due to poverty and there are long-standing problems in the food distribution system.
- However, green growth can be enhanced through improvements in the functioning of global food markets and institutions, technological innovations, and the dissemination of knowledge, which are key elements in the pursuit of a more sustainable and resilient agriculture and food system.
- A mixture of public policy and private actions will be needed, including policies to improve the efficiency of natural resource use, minimise waste in the food supply chain, foster innovation and productivity growth in both OECD and non-OECD countries, and harness the benefits of open markets.
- Adjustments required in the agri-food supply chain leading to green growth should be economically and environmentally sustainable, as well as equitable.

Source: www.oecd.org/agriculture/ministerial

Box II.11. Relevant work for green growth measurements

The indicators needed to measure progress with green growth are founded on existing OECD work that will be refined to suit the Green Growth Strategy. Continued co-operation is taking place with other international organisations, the European Commission, and international institutes.

Measuring environmental performance and resource productivity	The OECD has developed several sets of **environmental indicators** to support policy analysis and country reviews: key and core environmental indicators to track environmental progress; sectoral environmental indicators to monitor policy integration; and indicators to measure the decoupling of environmental pressures from economic growth. The indicators are supplemented with environmental data, including on environmentally related **taxes** and **expenditure**. Recent work has been focusing on the measurement of **material flows and resource productivity** in support of an OECD Council recommendation and of the G8 Kobe 3R Action Plan.
Monitoring trends in energy use and efficiency	The IEA maintains several databases, including energy balances, energy statistics, energy prices and taxes, and publishes various types of **energy indicators**. Recent work has been focusing on the measurement of **energy efficiency** in support of the G8 Gleneagles Plan of Action for Climate Change, Clean Energy and Sustainable Development and on improving the mandatory reporting of energy efficiency-related data.
Monitoring technology developments and innovation	The OECD maintains several databases and indicator sets keeping track of developments in technology and industrial performance: main science and technology indicators; indicators on the information economy, globalisation, and entrepreneurship; international patent database, input-output tables and estimates of carbon embedded in trade. Recent work has been focusing on indicators in support of the OECD **Innovation Strategy**, and on an indicator toolkit to promote and monitor **sustainable manufacturing** at corporate level.
Measuring the environmental performance of agriculture	The economic and environmental performance of agriculture is monitored through a set of **agri-environmental indicators**, supported with the measurement of producer subsidies.
Monitoring international transfers	The OECD maintains two major databases monitoring international monetary transfers: international **investment** flows and official **development assistance**. Recent work aims at developing indicators of "green" foreign direct investment flows and at mapping relevant international investment flows by country and sector of destination.
Measuring sustainable development	The OECD has been promoting the development of indicators and coherent approaches to measure sustainable development. Recent work has been focusing on improving the measurement of different types of capital with emphasis on **human and social capital**.

Measuring well-being and progress	The OECD promotes the development of better measures and indicators of people's well-being and societal progress, to be used alongside standard economic measures such as GDP. Recent work aims at implementing the recommendations of the Stiglitz-Sen-Fitoussi Commission with emphasis on **well-being and sustainability**.
Other relevant work	To underpin its socio-economic analysis, the OECD further maintains databases on a wide range of other topics that are important to characterise economic growth and its outcomes. Examples include: national accounts, international trade, balance of payments, prices and taxes, productivity, government debt, employment, education, health, etc.

Green Growth Strategy

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