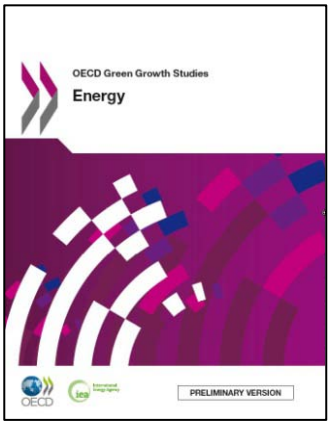
Green Growth Strategy for Energy
A Window of Opportunity

December 2011

A fundamental transformation is required in the way we produce, deliver and consume energy. The current energy system is highly dependent on fossil fuels, whose combustion accounted for 84% of global greenhouse gas emissions in 2009. Global demand for energy is rapidly increasing, because of population and economic growth, especially in large emerging market economies, which will account for 90% of energy demand growth to 2035. At the same time, 1.3 billion people worldwide still lack access to electricity.

The environmental imperative to reduce carbon dioxide (CO_2) emissions in the energy sector coincides with a new investment cycle in power generation in most OECD countries. In emerging markets, many power generation facilities were built quite recently, but many more will be built in the coming years to meet growing demand. As power plants and other infrastructure tend to have long operating lives, we must avoid "lock-in" of carbon-intensive technologies, by ensuring the latest clean technologies are used. There is a window of opportunity to transform the energy sector, including promoting innovation and creating new markets and industries, to reduce the sector's carbon-intensity, and improve energy efficiency.

The OECD and IEA have released the joint report *Green Growth Studies: Energy*, which highlights the challenges facing energy producers and users, and how they can be addressed using green growth policies.



A large-scale transformation of the global energy sector is possible. Global emissions could be halved by 2050, using existing and emerging technologies, at an additional new investment of USD 46 trillion. It is vital for governments to create the enabling policy framework to catalyze private sector investment in the transition to a low-carbon energy sector. By acting now, long-term costs can be reduced. Every US dollar that is not spent on investment in the energy sector before 2020 will require an additional USD 4.3 to be spent after 2020 to compensate for increased greenhouse gas emissions by building zero-carbon plants and infrastructure by 2035.

The Energy Challenge

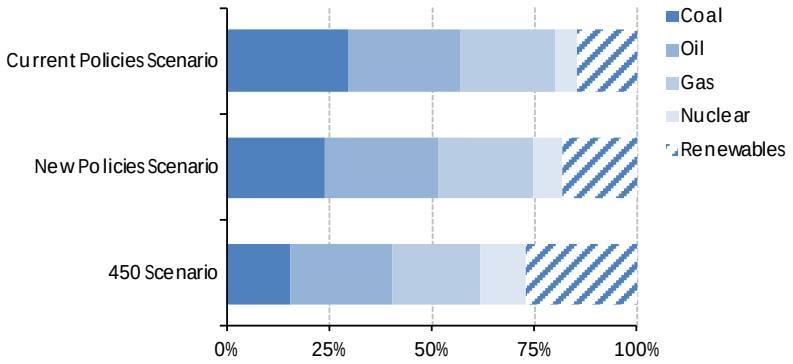
Increased energy demand and continued dominance of fossil fuels

- In 2050, a world economy 4 times larger than today is projected to use 80% more energy. This would double energy-related CO_2 emissions, without significant policy intervention.
- Current energy systems are 'locked-in' to carbon-intensive energy sources, while many consumers, especially transport, buildings and industry, use energy inefficiently.
- Transport is a critical component of the energy sector. It accounts for approximately 19% of global energy use and about a quarter of energy-related CO_2 emissions.
- Fossil fuels will account for 80% of the primary fuel mix in 2035, under a business-as-usual scenario (current policies). Under two other scenarios with incremental (new policies) and substantial (450) policy change, they will continue to dominate, though to a lesser degree, as the figure on the next page shows.

OECD

International Energy Agency

Share of energy sources in world primary demand by scenario



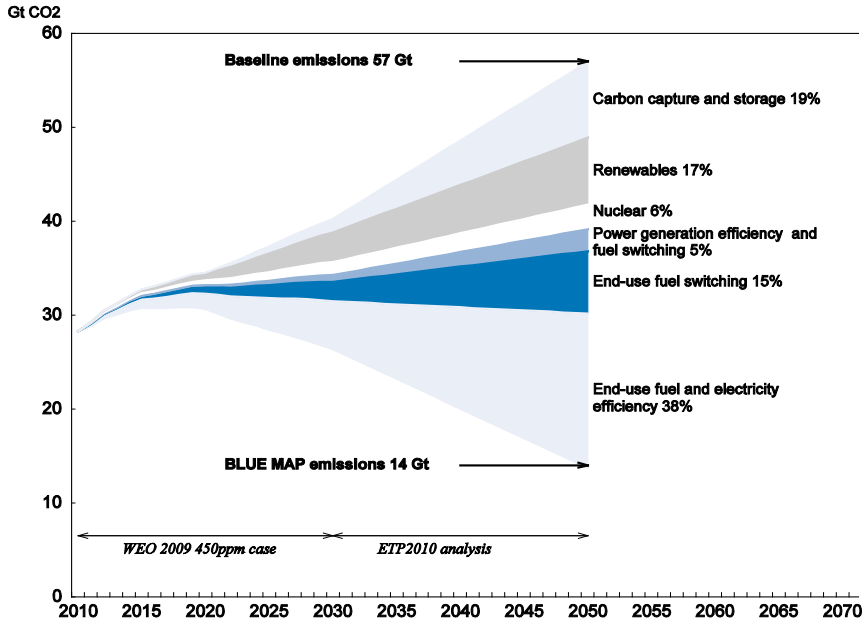
Source: IEA (2011), *World Energy Outlook 2011*.

Green Growth Policies for an Energy Revolution

A comprehensive green growth strategy for the energy sector will take into account the inter-relationships between economic sectors, transport systems, land-use patterns, social welfare and environmental integrity. A range of mutually reinforcing policies is required to address market failures and barriers, and create the enabling policy framework for large-scale private sector investment.

To achieve an energy revolution we need improved energy efficiency, widespread introduction of carbon capture and storage (CCS), increased deployment of renewable energy, continued fuel switching, and support for new and enabling technologies. All technology options are necessary. Restricting the choice of technologies would lead to increased costs. For example, the unavailability of CCS technology would need to be offset by more expensive alternatives, increasing costs by at least a third.

Key technologies for a low-carbon energy system in 2050



Source: IEA (2010), *Energy Technology Perspectives 2010.*

The role of government policy

Many low-carbon technologies are more costly than fossil fuels, although their costs are declining. Governments have an important role to play to foster innovation and support the scaling up of deployment of new technologies in the energy sector. In fact, to achieve a 50% reduction in CO_2 emissions, government funding for research and development in low-carbon technology needs to be 2 to 5 times higher than current levels.

Government support for specific technologies needs to be tailored according to the stage of technology development. For emerging technologies, for example, governments can provide financial support for research and large-scale demonstration. For more mature and competitive technologies, governments need to help tackle market, informational and other barriers to large-scale deployment.

While the overall policy mix will vary across countries and different energy sectors, the key policies for transforming the energy sector include:

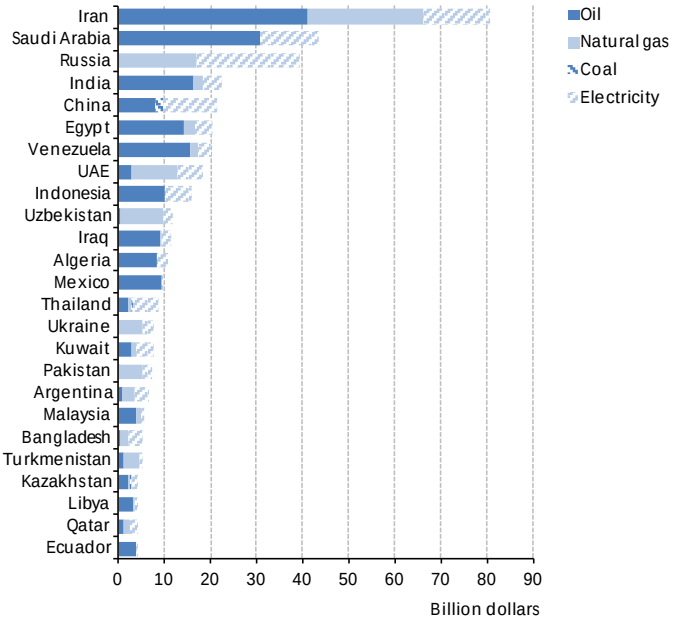
- Establishing sound market and regulatory frameworks
- Rationalising and phasing-out inefficient fossil fuel subsidies
- Providing price signal to value externalities (e.g. carbon)
- Radically improving energy efficiency
- Fostering innovation and green technology policy

Eliminate fossil fuel subsidies

One of the most powerful tools to transition to green growth in the energy sector is to eliminate inefficient fossil fuel subsidies. It represents a triple-win solution which would enhance energy security, reduce emissions of air pollutants and greenhouse gases, and bring immediate economic gains.

Fossil fuel subsidies remain commonplace in many countries and there is considerable scope for reducing the heavy burden they place on government budgets. Fossil fuel consumption subsidies in emerging and developing economies amounted to USD 409 billion in 2010. In industrialized countries, measures that support fossil fuel production had an overall value of about USD 45-75 billion a year between 2005-2010.

Fossil-fuel consumption subsidies for top 25 economies
(USD Billions, 2010)



Source: IEA (2011), *World Energy Outlook 2011*.

Reshaping the political economy

The energy sector presents a particular challenge to achieving green growth, due to its size, complexity, path dependency and reliance on long-lived assets. Structural change will involve more than simply changing the existing set of technologies. The energy system comprises a network of supply chains, physical infrastructure, user practices, markets and regulatory systems. It is not possible to change one part without changing the wider system. The value of existing fossil fuel-based energy sector assets is estimated to be approximately 15% of global GDP. Strong vested interests in the status quo and sunk capital that is at risk of being stranded will make an energy sector transformation complicated.

The transition to a clean energy system is likely to have a positive impact on employment within the energy sector, as renewable energy tends to be more labour-intensive than fossil fuel-based energy. Increased deployment of solar PV is predicted to yield the largest number of new jobs, with strong growth also expected in the energy efficiency, geothermal and solar thermal technology sectors. In terms of employment effects across the entire economy, the evidence is mixed. Most studies suggest that the impact of green structural changes is likely to be relatively small. A carefully designed package of labour market and skills policies can help address the associated adjustment costs, and enable workers to acquire the training they need to move from contracting to expanding industries and firms.

International technology collaboration is an important vehicle through which countries can share costs, increase knowledge spillovers and realise the benefits of greener energy systems. While international research collaboration has been common amongst OECD economies, energy and climate technologies inventors in many emerging countries are collaborating with partners in the OECD.

International research collaboration: The top co-inventing country pairs

	1	2	3	4	5	6	7	8	9	10
All Technologies	GB-US	DE-US	CA-US	CH-DE	JP-US	FR-US	NL-US	DE-FR	CH-FR	CH-US
Wind	DK-GB	DE-US	CA-US	DE-NL	NL-US	DE-DK	IN-US	BE-**ZA**	**RU**-US	DK-ES
Solar PV	JP-US	DE-US	GB-US	CH-DE	AT-DE	CA-US	**CN**-US	DE-FR	DE-NL	GB-IT
Energy Storage	GB-US	CA-US	DE-US	JP-US	JP-KR	FR-US	CH-DE	CA-FR	**CN**-US	KR-US
CCS	CA-US	NL-US	GB-US	FR-US	DE-US	AU-NL	DE-GB	GB-NL	NO-US	**CN**-US

Emerging economies are in bold.

Source: Kahrobaie, Haščič and Johnstone (2011), "International Research Collaboration in Climate Technologies: An Empirical Analysis of Technology Agreements" in *OECD Energy and Climate Policy and Innovation (forthcoming)*.

Key policy design considerations

A country's national circumstances will affect the low-carbon energy path it is likely to pursue. Countries with low energy access should focus on introducing low-carbon energy supply, whereas carbon capture and storage will be more of a focus in resource-rich countries. Countries with an established energy and industrial structure will focus on energy efficiency.

Policies for green growth in the energy sector will differ across countries, according to local environmental and economic conditions, institutional settings and stage of development. Developing countries have opportunities to leap-frog by employing greener and more efficient energy technologies, as well as business and regulatory models that are oriented towards low-carbon technology and energy efficiency.

Governments should pay attention to the distributional impacts of the energy transition, both within countries in terms of the effect on the poor, who tend to spend a larger share of their income on energy, and between countries, as patterns of trade related to fossil fuels change.

Monitoring Progress towards Green Growth in the Energy Sector

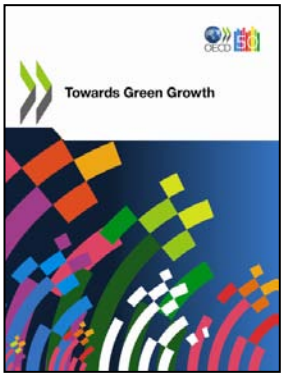
Government progress on implementing the policies for moving towards a greener energy system can be evaluated using well designed operational sets of indicators, which the IEA and OECD are currently developing in consultation with a broad group of stakeholders.

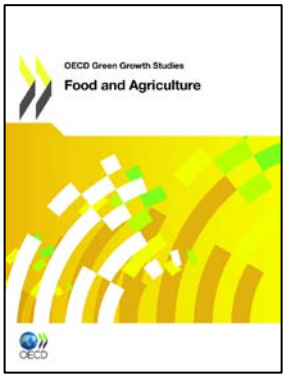
The OECD has developed a conceptual framework for monitoring progress towards green growth, including a set of indicators. While the indicators are still being refined, indicators pertinent to the energy sector are those that measure the carbon-productivity or intensity of energy production and consumption (on various levels, including national and sectoral), energy intensity and efficiency, "clean" energy-related research and development and patents, as well as measures of energy related taxes and subsidies.

This needs to be complemented with energy end-use indicators that help policy makers understand how users will respond to changes in energy prices, income, technology, energy efficiency, production patterns, and lifestyle, additional energy-environment indicators, and with indicators characterising the level of access to energy.

While energy statistics and balances are generally well established in countries and at international level, measuring energy efficiency and innovation is difficult, and coherent industry level information is scarce. More needs to be done improve data quality, methodologies and definitions, and to link the data to economic information.

Other reports in the series: OECD Green Growth Studies





The preliminary *Green Growth Studies: Energy* report is available from: www.oecd.org/greengrowth

For more information on the OECD Green Growth Strategy, email: greengrowth@oecd.org

For more information on the work of the International Energy Agency, see www.iea.org