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COMMISSION STAFF WORKING PAPER

**Analysis associated with the Roadmap to a Resource Efficient Europe
Part I**

Accompanying the document

**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF REGIONS**

Roadmap to a Resource Efficient Europe

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INTRODUCTION

Our economic growth has long been coupled with declining resource prices – until recently. In the last decade, the increasing affluence and size of the world's population appears to have reversed the trend of falling resource prices. An ongoing path of ever greater consumption of resources is meeting constraints in stable, secure availability of some resources. We see unsustainable over-use of environmental resources and increased price volatility in several markets.

Already, many countries and businesses have responded to these megatrends. Like them, the EU has recognised the essential role in economic stability and growth played by both mineral and environmental resources - including rare earth metals, water, climate, fish, biomass, fertile soils, clean air and ecosystem services.

So as an over-arching goal – set in the Europe 2020 Strategy - the EU has chosen to move to an economic system that is efficient in the way that it uses all resources. We now face choices on the pace of change and how to best manage transition. Good policy offers short and long-term economic, social and environmental benefits from efficiency gains. It need not create net additional costs. But there will be winners, and losers.

Noting the progress already made in resource-efficiency, this Staff Working Paper sets out the evidence behind the Roadmap to a Resource Efficient Europe. It identifies the barriers to the market delivering on its own and how to remove those barriers.

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1. CHALLENGES AND OPPORTUNITIES FOR EUROPE

1.1. Why is economic transition needed?

1.1.1. *Global resource use is increasing*

Global demand for resources is increasing, driven by population growth and improving standards of living. In the 20th Century, the world experienced a 4 fold growth in population and a 23 fold increase in economic output. We increased our fossil fuel use by 12 times, our fishing catches by 35, and our water use by 9. Globally, extraction of material resources grew by a factor of 8, ores and minerals by 23 times. Materials are now harvested at a rate of 47-59 billion metric tonnes a year.¹

Almost all predictions are that resource demand will continue upwards, given the underlying trends driving demand. In particular, the world's population grows by 200,000 people a day² and is expected to exceed 9 billion by 2050, and by 2030, there will be 3 times the current number of people with 'middle class' consumption levels in the now-developing world³.

As a result, demand for food, feed and fibre could increase by 70 % by 2050.⁴ Some predict that global food prices will increase by 120-180% by 2030, accelerating past trends in price rises.⁵ Global demand for energy and water is expected to rise by 40 % over the next twenty years, if no major policy changes are implemented. If present trends continue, 1.8 billion people will be living in water-scarce regions in 2025 and two thirds of the world population could be subject to water stress.⁶

More detail on past trends in resource use and their drivers are set out graphically in Annex 7.

As a consequence, after decades of growth based on declining real resource prices, there are indications that the world has entered a new phase, of increasing real resource prices - see Figure below.

¹ "Decoupling natural resource impacts from economic growth", International Resource Panel (2011)

² <http://www.grida.no/publications/rr/food-crisis/page/3559.aspx>

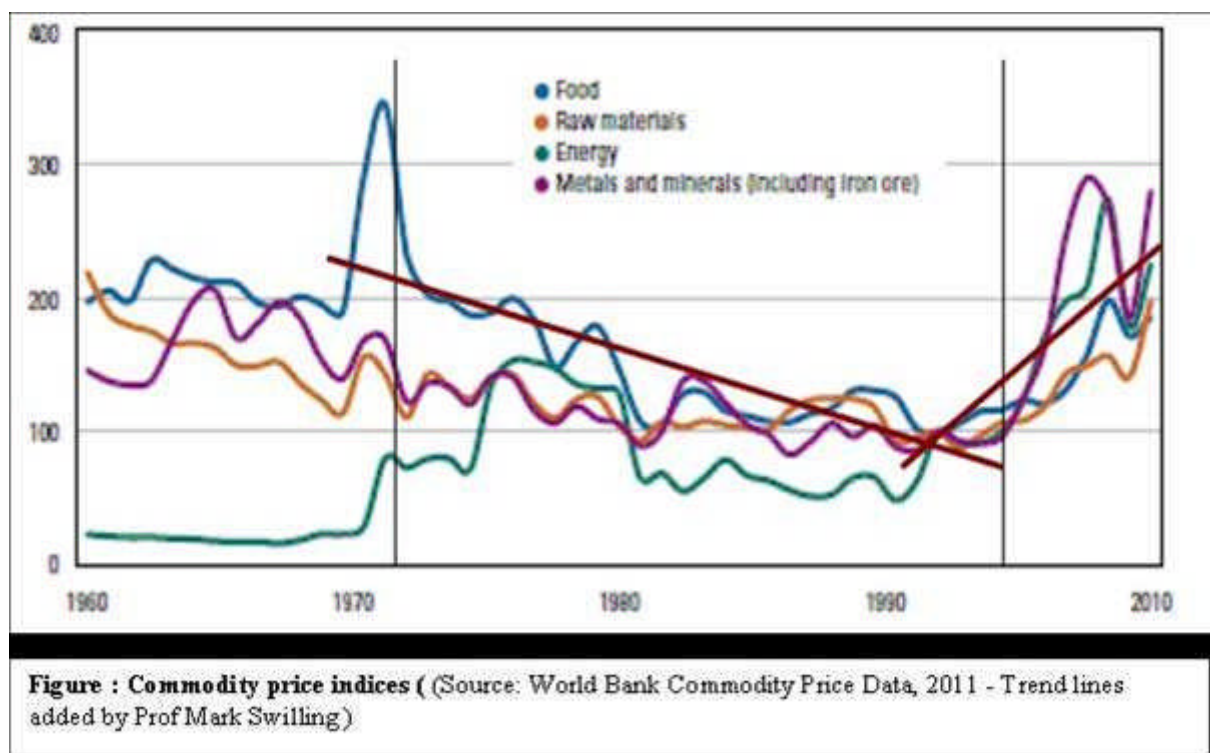
³ WBCSD, Vision 2050,

<http://www.wbcd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTYxNg&doOpe>

⁴ Food and Agriculture Organisation

⁵ "Expanding Food Price Scenarios towards 2030", Willenbroekel et al, 2011

⁶ "The European Environment – State and Outlook 2010", EEA, 2010



1.1.2. European and global resource use is interlinked

In the globalised economy, the EU is increasingly impacted by global changes in resources, including climate, material availability and food prices. We use 16 tonnes of materials per capita/year in the EU, more than 8 billion tonnes/year⁷, of which one-fifth is imported – often the higher value, less bulky resources.

Global scarcity, volatility and shocks are transmitted to the EU economy – as illustrated by component supply concerns after the 2011 Japan earthquake or price volatility in global commodity markets. Systematic figures are not available for the importance of resources to business but as an illustration 40% of total German manufacturing costs relate to material inputs, whilst the energy share of those costs is around 2%⁸.

The growth in the EU economy is also contributing to pressure on other countries (our 'footprint').⁹ Additionally, every kg of imported products is responsible for 3 to 6 kgs more materials outside the EU, amplifying pressures.

1.1.3. These global megatrends are unsustainable

We can only grow infinitely in a finite material world by reduction in the material we use to grow. Several scenario exercises back this view. However, existing trends in resource efficiency are not sufficient to reduce the material intensity of our economy, even in the EU. Measured purely by mass of material, the EU's economy's resource efficiency has improved at a rate of between 1 and 2% a year, so below the rate of economic growth.

⁷ <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc230>

⁸ "International economics of resource productivity – Relevance, measurement, empirical trends, innovation, resource policies", R. Bleischwitz in International Economics and Economic Policy, 2010,

⁹ "The European Environment – State and Outlook 2010", EEA, 2010

One result is the unsustainable depletion of environmental resources (fish, timber, water, fertile soils, clean air, biomass, biodiversity) and the environmental systems of which they form part. Some resources are already beyond their global sustainable limits or tipping points.¹⁰

Crossing of thresholds can bring about sudden changes in ecosystems (for example, in forest collapse, climate systems or fish stock collapse). This can lead to similarly non-linear constraints on growth.

60% of the world's major ecosystem goods and services - which underpin livelihoods - have been degraded or used unsustainably.¹¹ In these, economic growth has come by running down natural assets faster than the stocks can regenerate. In the absence of action, the rate of global biodiversity loss is not expected to slow. It may get worse as climate change increases pressures in some regions. For example, changing Mediterranean rain patterns will put more pressures on water resources and so biodiversity in the region.

Figure : Global environmental thresholds

Earth-system process	Control variable	Boundary value	Current value	Boundary crossed	Preindustrial value
1. Climate change	Atmospheric carbon dioxide concentration (ppm by volume)	350	387	yes	280
	Change in radiative forcing (W/m ²) since the start of the industrial revolution (~1750)	1.0	1.5	yes	0
2. Biodiversity loss	Extinction rate (number of species per million per year)	10	> 100	yes	0.1–1
3. Biogeochemical	Anthropogenic nitrogen removed from the atmosphere (millions of tonnes per year)	35	121	yes	0
	Anthropogenic phosphorus going into the oceans (millions of tonnes per year)	11	8.5–9.5	no	-1
4. Ocean acidification	Global mean saturation state of aragonite in surface seawater (omega units)	2.75	2.90	no	3.44
5. Land use	Land surface converted to cropland (percent)	15	11.7	no	low
6. Freshwater	Global human consumption of water (km ³ /yr)	4000	2600	no	415

¹⁰ "A safe operating space for Humanity", Rockstrom, et al (2009) in Nature 461, p. 472-475.

¹¹ "Millennium Ecosystem Assessment, Ecosystem and Human Well-being synthesis", 2005

7. Ozone depletion	Stratospheric ozone concentration (Dobson units)	276	283	no	290
8. Atmospheric aerosols	Overall particulate concentration in the atmosphere, on a regional basis	not yet quantified			
9. Chemical pollution	Concentration of toxic substances, plastics, disruptors, heavy and radioactive contamination into the environment	not yet quantified			

Source: "A safe operating space for Humanity", Rockstrom, et al (2009)

1.2. Challenges and Risks for Europe

Both the economy and environmental resources form part of systems in which imbalances present risks, and we now know of some severe imbalances affecting resources. These include a mismatch between the use and regenerative capacity of natural systems. Noting this, the OECD has identified risks of major systemic collapse in growth¹² due to changes in resources:

- Reduced competitiveness of firms, or sectors, subject to price rises, security of supply or volatility in their resource inputs, where competitors are more resource efficient.
- Increasing supply security implications, with future scarcity in basic resources, including water, food, climate services and soil being a threats to international stability, ie through immigration, and social unrest.

1.2.1. Volatility, Security of Supply and Price rises

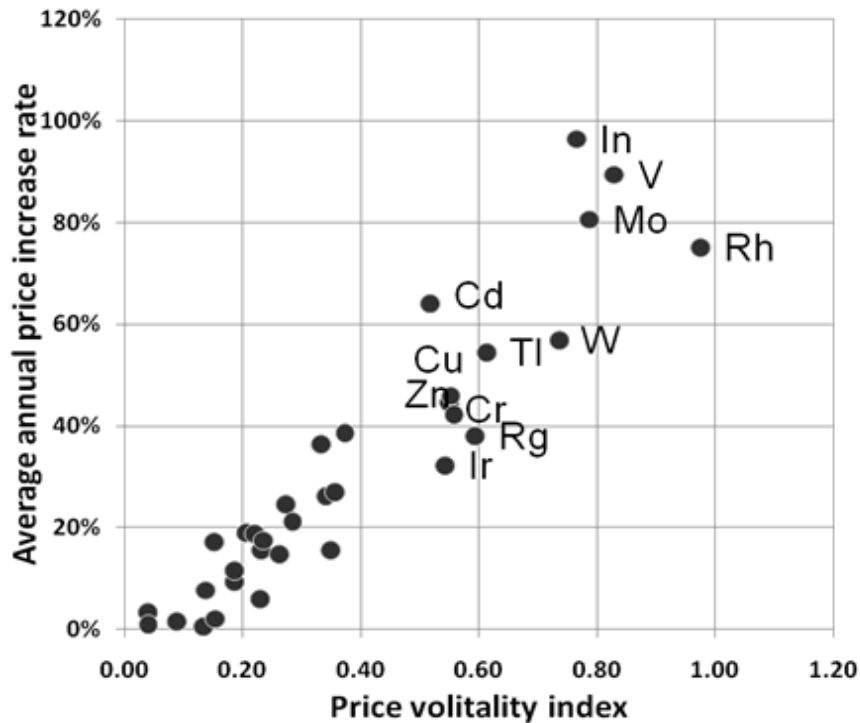
Increasing scarcity in resources can lead to price volatility in globally traded markets. Even for resources where there may not be geological resource scarcity, then scarcity may reflect reduced availability due to political issues, and closed or contracted sales of resources. This scarcity can make global markets shallower, and more susceptible to price volatility, exposing EU companies to economic shocks.

In particular, there are risks for some critical raw materials that are essential components for key industries in the EU, such as the ICT and aerospace and "green technologies"^{13 14}. For example, platinum is needed for catalysts in vehicles, yet most of the world's supply of this critical element is found in South Africa. Other examples are gallium, indium, Rare Earths (e.g. neodymium, platinum and tungsten). Their short to mid-term availability is limited, providing good grounds for distortion of the market, particularly as demand growth may be very high - for rare earth metals neodymium or germanium demand is predicted to increase more than 5 times by 2030.

¹² "Green Growth Strategy Synthesis", OECD, 2011

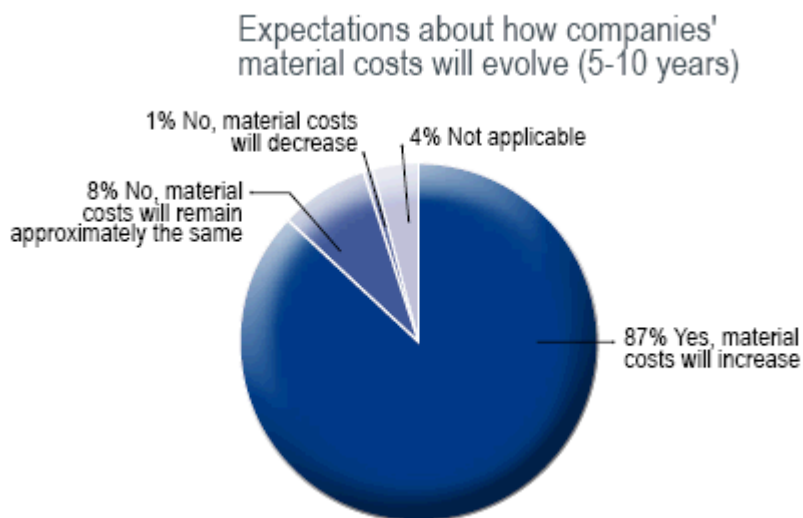
¹³ COM(2011)25, The Commission's Communication on Commodities Markets and Raw Materials

¹⁴ "Critical raw materials for the EU: report of the Ad-hoc Working Group on defining critical raw materials", Fraunhofer ISI report for DG Enterprise and Industry, 2010,.



Source: "Natural Resources Consumption and Sustainable Industrial Development", S. Suh, Sustainable Industrial Development, Fall Issue 2008. Price volatility is shown for different key elements

The Figure above illustrates both the volatility and the annual price increase for certain key materials. The one below shows expectations of future prices¹⁵. In the past five years, 75% of European businesses have experienced an increase in material costs¹⁶.



¹⁵ Eco-Innovation Observatory (EIO), The Eco-Innovation Challenge: Pathways to a resource-efficient Europe, report for DG Environment, 2010

¹⁶ Eurobarometer survey, see http://ec.europa.eu/public_opinion/flash/fl_315_en.pdf

A fuller overview of the risks associated with certain materials can be found in Annex 7

1.2.2. The Scale and Nature of the transition required

The scale of improvements in resource efficiency needed in the EU to respond adequately to global trends is very large. Whilst different resources have different trends, indications of the scale of change can be made by references to resources in aggregate:

- The World Business Council on Sustainable Development, points to the need for an increase in resource efficiency of factor 4 to 10 by 2050 (which implies that each unit of production is produced using respectively 25% and 10% of its current resource inputs).¹⁷
- Scientists researching resource trends point to similarly strong innovation needs, for example, pointing to a Factor 5 improvement¹⁸ by 2050 (20% of today's material usage/unit of production).

This level of improvement requires a step change in innovation in resource productivity. This change may be one of the future drivers of global growth. One popular view of the world economy sees growth as a series of 'Kondratieff cycles'¹⁹: periods of long-term prosperity arising from structural change. The structural change comes as a response to new conditions or new technologies. Some commentators believe environmental technology/resource efficiency to be one of the drivers of profound global structural change that will bring in the next long-term period of growth.

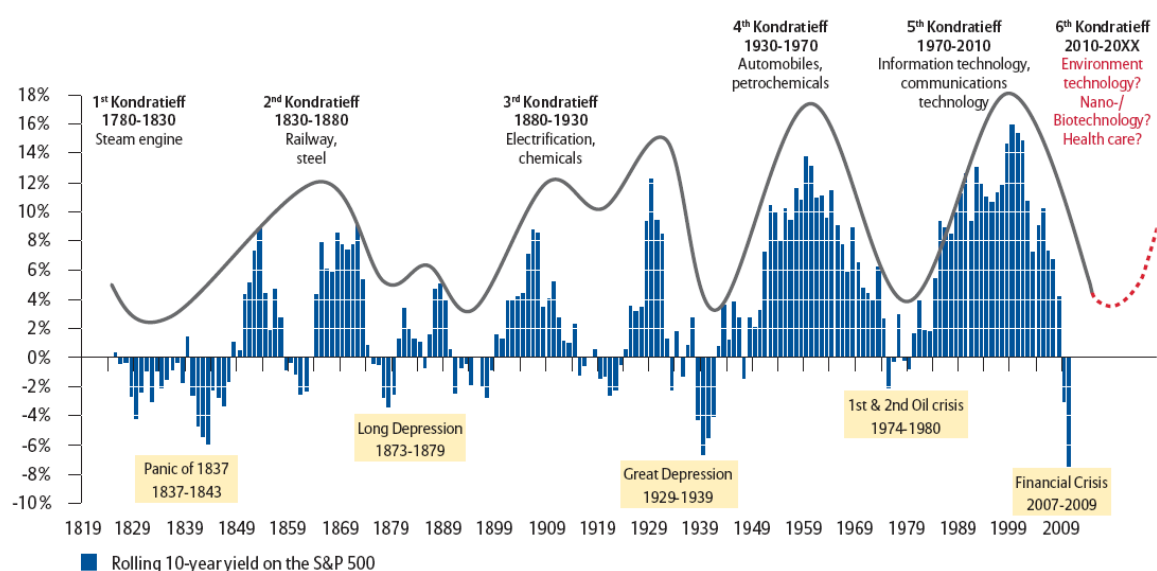


Figure: Kondratieff cycles – (Source: Allianz Global Investors 'The Sixth Kondratieff - Long waves of prosperity', 2010.

¹⁷ "Vision 2050", WBCSD, 2010

¹⁸ "Factor Five", Von Weizsacker et al, 2009

¹⁹ "As Time Goes By. From the Industrial Revolution to the Information Revolution", Freeman C, Louçã, 2001

1.3. Opportunities for the EU

Megatrends in resources also bring opportunities. They will bring relative competitive advantage for those states and those firms that adapt fastest, most fully and most efficiently. Resource Efficiency is one route to adaptation. It involves the spread of technologies, business models and behaviours that allows the production of greater value for the EU with fewer resource inputs.

Definitions

Resources: are all the resources that are inputs into our economy - metals, minerals, fuels, fish, timber, water, soil, clean air, biomass, biodiversity and land and sea. (See Annex 7)

Resource efficiency: is a way to deliver more with less. It increases aggregate economic value through more productive use of resources over their life cycle. It requires using those resources in a sustainable way, within the planet's long-term boundaries. This includes minimising impacts of one resource's use on other resources, including the environment.

Resource efficiency can allow the EU to reduce vulnerability to future resource volatility or scarcity, whilst reducing costs through productivity savings. Many of the win-wins from improved resource efficiency arise from the inter-linkages between different resources that are frequently ignored.

For example, McKinsey Global Institute looked at the strong linkages between resource use and greenhouse gas emissions. They estimate that resource productivity improvements in land, water, energy (excluding any changes in primary energy mix) and steel would achieve in 2030 around 50% of the gap between our current GHG emission path and the path needed to keep atmospheric concentrations to 450ppm.

1.4. International, Business and other Stakeholder viewpoints

1.4.1. International

The EU is one of many to identify the benefits of a transition to a more resource-efficient economy. At the international level:

- the OECD's Green Growth Strategy²⁰ states how economic growth can be combined with avoiding unsustainable pressures on the quality and quantity of natural assets.
- the G20 has committed to phasing out inefficient fossil fuel subsidies as a way to reduce budget deficits, deliver growth and reduce environmental harm.
- the United Nation's Environment Programme (UNEP) Green Economy Report²¹, makes the case for investing two per cent of global GDP in greening ten central sectors of the economy in order to shift development onto a low-carbon, resource-efficient path.

²⁰ OECD, Towards a green growth strategy, forthcoming

²¹ UNEP, Towards a green economy - Pathways to sustainable development and poverty eradication, 2011

At the national level too, many countries have launched strategic plans that put resource efficiency as their major priority. For example:

- Japan has introduced a number of visions and laws that represent a conceptual turn from a throwaway society in order to become a Junkangata Shakai (sound material-cycle society)²² and has reduced its resource use by 14% from 2000-05 on top of previous periods of reduction.
- China's latest Five Year Plan (11th) represents a change in development philosophy, aiming for an ecologically viable society, with greater industrial efficiency. China's investment in the green economy has been estimated by some to be greater than that of the US and EU combined.²³
- The Republic of Korea's 'Framework Act for Low Carbon Green Growth' establishes a legal framework to foster green technology and industries, to create new green jobs, to respond to climate change, to control energy targets, to promote a green lifestyle for citizens and to promote sustainable development.

In Europe, several Member States have set out strategies and goals for improving resource efficiency. Several reports summarise the wide range of resource efficiency strategies and policy actions taken.^{24 25 26}

1.4.2. Business Action

Corporate action highlights the belief of companies in greater resource efficiency to generate financial savings, and reduce exposure to future risks of scarcity. Many multinational companies have set ambitious goals regarding resource efficiency and eco-innovation. For example:

- one consumer goods multinational has committed to halving the resource impacts of its products over the next 10 years and source 100% of its agricultural supplies from sustainable sources.²⁷
- a large retailer expects to save \$3.4 billion from its 5 year plan to reduce packaging.²⁸
- two international chemical firms have estimated that, respectively, they have saved \$9 billion over 15 years and \$5 billion over 20 years from energy efficiency.

However, many businesses are not fully aware of the potential risks of potential advantages from natural resource scarcity on their futures.

The World Business Council for Sustainable Development (WBCSD) and the World Economic Forum are representative of many leading international business organisations. These organisations see resource efficiency as a strategic response with short-term benefits.

²² "Dematerialisation and resource efficiency in Japan", Wuppertal Institute

²³ "Systemic Tools for an EU Resource Efficiency Roadmap", The Resource Efficiency Alliance 2011

²⁴ "Economic Analysis of Resource Efficiency Policies", COWI 2011

²⁵ <http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency>

²⁶ "Analysis of key contributions to resource efficiency", Bio Intelligence Service 2011

²⁷ <http://www.growingforthefuture.com/index.php>

²⁸ <http://walmartstores.com/pressroom/news/5951.aspx>

The WBCSD Vision's for 2050 (see Annex 1) sets out the steps for transition businesses need, with significant changes by 2020.

1.4.3. Stakeholders' views on resource efficiency expressed to the European Commission

The Commission sought and received the views of many businesses and interest groups during the development of its Roadmap, through position papers, personal interactions, debates and a public internet consultation. Broadly, the views of stakeholders are:

- Resources are under pressure: the exact nature of this pressure varies from resource to resource, including the groups affected and whether the impacts are local, national or global.
- Pressures are increasing: there is wide recognition that growing demands and threats to supply make this a timely moment to have a more strategic view of Europe's resource performance.
- Resource efficiency is central to many objectives: different stakeholders put the stress on different issues though, business of the potential for it to improve competitiveness, NGOs on the potential for it to improve environment.
- Industry groups are concerned about the access to raw materials and proper management of primary and secondary resources. Businesses called for the development of a sound knowledge base, more policy coherence, indicators to measure progress and the application of a full life cycle perspective.
- Different stakeholders recognise different possible synergies and different possible trade-offs, in particular business is wary of possible impacts on current business plans of environmental policies. However, there is broad consensus that more coherent policy can be beneficial for meeting a wide range of policy objectives.
- Many of the policy tools are already in place or in the pipeline, and focus is needed on improving their operation and cross-cutting gap-filling and consistency.

More details can be found in Annex 2.

2. COSTS AND BENEFITS OF THE TRANSITION TO A RESOURCE-EFFICIENT EUROPE

The benefits and costs of the transition depend on how smoothly the EU economy adapts to the changing megatrends and how the speed of response compares to international competitors. For example, waiting for sudden or forced change, induced by crisis, or slower adaptation than competitors would be likely to impose more costs than gradual change.

Our economy is in constant change as innovation introduces new technologies, consumer preferences change and competition encourages some firms to grow at the expense of others. The EU's Industrial Policy for the Globalised Era discusses how the technologies, firms and sectors which are most successful now will not all be those which are most successful in the future. A transition to a resource-efficient, low-carbon Europe is part of this ongoing process of renewal.²⁹

To assess the benefits and costs of a transition to resource efficiency, we have to make comparisons between different growth paths, any of which has costs from continuous renewal and competition in the economy.

²⁹ "Impacts of Structural Change: Implications for transition to the Green Economy", GHK, 2011

2.1. Potential benefits of improved Resource Efficiency

In the short to medium term³⁰, a resource efficient growth path would bring:

1. **Improved productivity:** as businesses reduce costs and so improve their competitiveness.
2. **Growth and job creation:** a faster pace of technological and organisational change will benefit the EU and open new global markets, supporting new jobs.
3. **Environmental benefits and resilience:** improved management of resources can, for example, be an efficient way of reducing carbon emissions at the same time as strengthening EU resilience to the effects of climate change.
4. **Macroeconomic stability:** by reducing security of supply issues, market volatility in important resources and so reducing pressures from asymmetries within the Eurozone. It can also support fiscal reform.

2.1.1. Improved productivity

There is significant untapped potential for resource efficiency to quickly increase the productivity of the economy by cutting costs for businesses and consumers. The values of such gains vary from resource to resource, from business to business. Given this, the potential can only be shown based on examples:

At the level of individual countries:

- UK business could save around £23bn per year from resource efficiency measures that are either no or low cost³¹. The majority of these savings come from using raw materials more efficiently and generating less waste (c. £18 billion). The sectors with the greatest potential identified were chemicals / minerals (c. £4 billion), metal manufacturing (c. £4 billion), power and utilities (c. £3 billion), construction (c. £3 billion) and road freight (c. £2 billion). A further £33bn per year of annual savings could be realised from expenditure with payback periods of longer than 1 year.
- Empirical evidence suggests that a 10-20% reduction in resource and energy use in Germany is possible, with annual cost savings of 20-30%³². The payback period was one year in the case of materials, with estimated increase in resource productivity of 2.9% per year. For materials, this saving would be worth up to €160bn/year in Germany alone.

At the European level:

- The Union's energy efficiency target of saving 20% of energy by 2020 could cut consumers' bills by up to €1000 per household a year and improve Europe's industrial competitiveness creating up to 2 million new jobs by 2020.
- 20-40% of Europe's available water is being wasted. Losses of water in the supply network are often substantial in water-scarce regions in Europe. For example, in

³⁰ The impacts (positive and negative) will be felt over time, and there is a natural blurring between what are sometimes termed short-term (direct) and medium-term (indirect) impacts.

³¹ "Further Benefits of Business Resource Efficiency", Oakdene Hollins, 2011

³² Distelkamp, M., Meyer, B., Wolter, M.I. (2005) in: Aachener Stiftung Kathy Beys (Hrsg.) Ressourcenproduktivität als Chance, and MaRes Final Report, Wuppertal et al 2010

France and Spain up to 34% of water is lost before it reaches the consumer, but in Denmark only 7%. Water efficiency might be improved by nearly 40% through technological improvements alone.

Resource efficiency is an important issue for EU industries, and a study found that some industries have improved substantially in recent years, although there is still room for improvement, though the ease of these improvements varies.³³ Many of the gains from resource efficiency for businesses and consumers can be achieved at low or zero cost or where there are costs they are not large investment costs. For gains with longer-term payback periods, investments would be necessary. The absence of available finance is one of the barriers addressed in Annex 3.

2.1.2. Growth and job creation

Resource efficiency that encourages (or is based on) eco-innovation and improves the productivity of the economy will improve growth and job prospects at the macroeconomic level.³⁴ For example:

- estimates of the impact of improved resource efficiency in Germany suggest that the economic benefits would include a creation of more than 1 million jobs and an improved growth rate.³⁵
- economic modelling³⁶ points to the possibility of policy measures bringing about resource efficiency that could eventually boost GDP by 4% (after 15 years) and significantly reduce unemployment.³⁷

Particularly high employment growth potential has been identified in construction, ecosystem and resource management, renewable energy, and recycling sectors. In order to build a sustainable future growth, employment in these sectors needs to be of high quality and move away from precarious and low-paid working conditions. In this respect, jobs created in sectors linked to sustainable growth are often more secure, with high potential for exports and economic value creation.

First-mover advantage in resource efficiency can capture growing markets. The EU holds roughly one third of the world market for environmental technologies. Currently, the global market for six market segments in eco-industries has been estimated at €1.7 trillion per annum,³⁸ and is growing by around 5% per annum³⁹.

The nature of this advantage is continually shifting. For example, the EU used to be the dominant producer of solar cells but now China's solar cell industry is the world's largest. According to a recent report by the World Wildlife Fund for Nature, China's green technology sector growth is outstripping all other nations. While Denmark earns the biggest share of its national revenue from clean technologies, China's sector has grown by 77% a year. China

³³ "Competitiveness of European Companies and Resource Efficiency", Ecorys, 2011

³⁴ "Studies on Sustainability Issues – Green Jobs; Trade and Labour", GHK, 2011

³⁵ Fischer, H., K. Lichtblau, B. Meyer and J. Scheelhaase (2004), 'Wachstums- und Beschäftigungsimpulse rentabler Materialeinsparungen [Growth and employment impulses of profitable material savings]', *Wirtschaftsdienst*, 84 (4), 247-254.

³⁶ The EU Commission funded MOSUS project: <http://www.mosus.net/>

³⁷ Other modelling results are summarised in 'The Economic Benefits of Environment Policy', GHK, 2009

³⁸ "Green Tech Survey", BMU, 2009

³⁹ Roland Berger Consultancy

earns more than 44 billion Euros each year (more than any other country), or 1.4% of its gross domestic product from clean technology.

This creates competition, but also particularly strong export markets as China and other developing countries move to better manage their resources. Parts of the EU have moved up the value chain: for example, exporting the equipment used to make thin-film solar cells rather than the cells themselves, as in the past.⁴⁰

2.1.3. *Environmental Benefits and Improved Resilience*

Improving resource efficiency will help safeguard the environment, and reverse the unsustainable trends documented in Europe's State of the Environment Report 2010⁴¹. It will reduce pressure on our 'natural capital': such as biodiversity and ecosystems, which provide goods and services that benefit the global economy and are essential for key economy sectors, for example food and drink, raw materials, medicine, cosmetics. For a number of other resources (mainly renewable resources), resource efficiency can help reverse unsustainable trends, for example from pollution.

Decreased material use reduces harm to environmental resources, and therefore improves the resilience of ecosystems and ability to cope with natural hazards. This will have economic benefits, as Member States' exposure to future fiscal risks depends on the resilience of the natural and man-made infrastructure to extreme events (flooding, storms and sea-level rise) amongst other factors.⁴²

Protecting these resources does not necessarily mean lost short-term opportunities:

- In Scotland, the public benefits of protecting the Natura 2000 network of protected areas are estimated to be more than three times greater than costs, including direct management and opportunity costs.
- A programme to restore several wetlands in Danube (37 sites in the Lower Danube Green Corridor) will cost €183 million but will retain vital adaptive functions of the ecosystem and will likely lead to earnings of €85.6 million per year. Without restoration, the 2005 flood damages were €396 million.

Much EU eco-innovation should stimulate greater resource efficiency outside the EU (for example through the sale of technologies) and so reduce the depletion of global resources. PBL⁴³ estimate that *global* energy use could be reduced by over 30% in 2050 without major changes in consumer habits through such dissemination, halving the gap between baseline greenhouse gas emissions and the 450 ppm CO₂-eq mitigation scenario.

On the other hand, increased productivity from technology also frequently leads to a 'rebound effect' as improved efficiency translates into higher demand for resources. Without a well-designed policy mix this offsets the environmental benefits (and those from reduced resource exposure) (see Annex 5).

⁴⁰ Economist, 3/2/2011

⁴¹ "The European Environment – State and Outlook 2010", EEA, 2010

⁴² "The fiscal implications of climate change adaptation" CEPS and ZEW, 2010

⁴³ PBL (2011). EU Resource Efficiency Perspectives in a Global Context: A fast track analysis. Forthcoming, will be available at: <http://ec.europa.eu/environment/enveco/studies.htm>

2.1.4. Macroeconomic stability

Terms of trade and resilience

Decoupling economic growth from the use of natural resources improves the terms of trade and eases current account pressures. A shift to energy and commodity-efficient production patterns would also strengthen the resilience of the EU towards price shocks in commodity markets.

Single Market and Eurozone tensions

It can also reduce the impact on the single market and eurozone of commodity price developments asymmetrically affecting European economies due to the different weight of energy and food in EU Member State's expenditure.

Security of supply and market volatility

Resource efficiency is a route to tackling security of supply issues and market volatility in important resources, including critical metals and minerals, fresh water, fish and food commodities. These issues affect many sectors of industry, including manufacturing, water and energy supply and their customers and place strain on the single market and eurozone through asymmetric impacts of resource price developments.

Productivity gains and support for fiscal reform

As well as such relatively direct benefits for growth from productivity gains, resource efficiency can also support fiscal reform and help balance public finances by finding new sources of revenues and promoting employment.⁴⁴ This can occur both through providing a new source of revenues, and through the reforming of subsidies cutting public expenditure.

2.2. Potential Costs around Transition

2.2.1. Costs of slow or retarded transition

If the EU economy adapts too slowly, costs arise from exposure to the risks and volatilities of resource scarcity. Competing firms or countries with relatively better resource productivity or resilience to resource shocks will gain competitive advantage, which may slow EU growth. Developing countries may develop strategic advantage over the EU, as they are less locked into physical infrastructure and institutional rigidities based on old growth models.⁴⁵

Slow transition now suggests more sudden transition later, in response to crisis or lack of competitiveness which is likely to incur greater transition costs. Slow change presents increased damage to environmental resources, making their recovery more difficult. The opportunities mentioned above are lost.

⁴⁴ A permanent one percentage point reduction in the average tax burden on labour is estimated to increase the employment rate by about 0.4% in a typical country. OECD 2006.

⁴⁵ International Resource Panel (2011) Decoupling report

The OECD has argued the processes of economic restructuring ultimately strengthen the competitiveness of economies. As part of this, new industries will grow at the expense of others, implying a reallocation of resources from old industries to new industries.

2.2.2. *Costs of the process of change*

Adaptation to resource megatrends over time will involve structural economic change. Structural change brings costs from frictions in people or capital investments moving from one activity to another. It involves updating of technologies, innovation, skills.

The costs of transition will also crucially depend on three factors: **how well change is predicted**, the **pace of change**, and the **flexibility of the economy**.

A) *How well the economy predicts and meets change*

If businesses and economies are able to predict changes, they can reduce costs by avoiding investments that are soon obsolete. Instead, they can pick investments that will thrive in the changed conditions. An example of a stranded investment would be energy infrastructure that did not factor in future switches in energy sources. There are short-term actions that are relatively risk-free, but long-term investments depend on a good understanding of future resource prices and constraints.⁴⁶

B) *Pace of change*

Overly-fast rates of change can exceed capacity to adapt and innovate, leaving firms or countries stranded with mismatching assets and skills to the new conditions. The ideal rate of adaptation is one that matches the capabilities of the economy as a whole to adapt.

C) *Flexibility of the Economy*

If an economy is more flexible – if it can more easily move workers and investments into new ways of production – it suffers lower costs from change than economies that have more inbuilt rigidity. Flexibility comes from many factors: including labour markets, modernity of infrastructure, the degree of entrepreneurship and the ability to finance investments.

Box : Transition costs in labour markets

The transition to a low-carbon and resource-efficient economy will involve change as:⁴⁷

- (1) Substitution of employment will take place, for example due to shifting from fossil fuels to renewable energy sources or from waste land filling to recycling;
- (2) Particular jobs may be eliminated without direct substitution (e.g. when the use of certain packaging materials is discouraged and their production ends);
- (3) Additional jobs will be created in several areas, such as in the manufacturing of pollution-control devices which are added to existing production equipment;
- (4) Many existing jobs (i.e. plumbers, electricians, metal workers, and construction workers) may need changed skills due to changed best practice working methods.

⁴⁶ "Competitiveness of European Companies and Resource Efficiency", Ecorys, 2011

⁴⁷ "Environment and labour force skills", Ecorys, 2008

The net effect is expected to be either no or a slight positive impact on the employment level. However, the overall impact could be negative if structural employment increases due to workers' existing skill sets not matching future needs.

The costs from structural unemployment will depend significantly on:

- How well workers and firms look at future skills needs and train for their future opportunities.
- Whether change in any region or sector is gradual, allowing progressive adaptation of skills by individuals or whether the labour market is suddenly flooded with redundant workers⁴⁸; and
- How easy it is for workers to re-train or move to different employment.

Where economies face costs, governments can choose to reduce these by helping in any of these areas, for example: **easing of transitions** and the **support of workers during transition**. Policies should focus on preserving employment in the economy, not particular jobs.^{49 50} They can, for example, anticipate future skills needs for green and greener jobs and adapt education and training systems accordingly.

2.2.3. *Comparison with the past and other potential futures*

The costs from adaptation through greater resource efficiency need to be compared against the costs to the economy from structural change in the past, and compared to other realistic scenarios of future growth.

Structural change is an ongoing process. Any economy is in constant change with growth and relative decline of different sectors and skill sets, generating constant costs from change. Past structural change has shown that new jobs associated with new businesses are generally more productive than those that have been lost as a result of new ideas and adaption to market demands.⁵¹

The table below illustrates this trend of structural change by showing how labour has shifted between the primary, secondary and tertiary sector between 1980 and 2008. Over the same period the aggregate size of these economies increased substantially, with annual average growth rates in GDP of 1.5-2.5%. This indicates that the 'business as usual' of an economy is not to stay static, but to undergo change, and the costs that come with it.

⁴⁸ "Employment in Europe 2009" European Commission, 2009

⁴⁹ "Green Growth Strategy Synthesis", OECD, 2011

⁵⁰ "Studies on Sustainability Issues – Green Jobs; Trade and Labour", GHK, 2011

⁵¹ "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?", Foster, L., J. Haltiwanger and C. Syverson in American Economic Review 2008,

Table: Sectoral Structural Change in Selected Economies (% of Gross Value Added)⁵²

Selected economies	1980			2008		
	Agriculture	Industry	Services	Agriculture	Industry	Services
Poland*	8.2	39.4	52.0	3.7	32.0	64.2
Spain	6.3	37.0	55.7	2.6	28.4	69.0
UK	2.0	40.7	57.2	0.9	23.6	75.2
Germany	2.4	41.1	59.9	0.9	29.8	69.3
US	2.9	33.3	63.7	1.3**	21.8**	76.9**

The ‘baseline’ levels of adjustment could be taken as the levels that have been seen in past decades – for example, in the UK some 25% of private sector jobs are lost every year but another 25% are created⁵³.

Whether the costs of adaptation to resource trends are higher or lower than the costs of continuous structural change in the past will depend on the factors mentioned in 2.2.2 above. Yet, it seems likely that the transition to resource-efficiency could be achieved through a change in the focus of innovation in the economy, rather than in the rate of structural change.

2.2.4. Identifying winners and losers

In any growing economy there are winners and losers. Policy makers can help facilitate transition by identifying potential winners and losers, to help target policy. Potential losers are likely to be particularly visible, seeking to preserve the status quo to postpone short-term costs:

*"The short-term negative consequences of structural change, i.e. those enacted through the downsizing (or closure) of enterprises, are relatively identifiable, publicly visible and often strongly concentrated in particular sectors. The positive effects of structural change, both in terms of new companies and the expansion in existing companies, are generally less visible, much less publicised and more evenly spread throughout the economy"*⁵⁴.

The potential losers from the transition to resource-efficiency can not be easily grouped by sector. In any sector, winners will be those firms that adapt successfully. This will often include those that make investments in innovation earlier rather than later, even where this implies short-term costs.

For example, greater efficiency in the use of metals (eg, in construction) in the economy may reduce the mass of a metal sold but simultaneously make the metal more valuable, as it

⁵² Note: The three sectors do not add up to 100%, due to minor errors in original data. *Polish data are for 1992 not 1980. **Data is from 2007, no data is available for 2008 (Source: OECD Factbook, 2010 (World Bank data))

⁵³ "Job creation and destruction in the UK: 1998-2008", Anyadike-Danes et al., 2011 (forthcoming)

⁵⁴ "Restructuring and employment in the EU: Concepts, measurement and evidence", European Foundation for the Improvement of Living and Working Conditions, 2006

achieves its purpose (for, instance structural support) with less. Those firms which adjust to capture the added value will thrive at the expense of those that have a mass based business model.

In general, the losers will be those firms or individuals who have heavily invested in capital that is not well adapted to a resource efficient economy, either in terms of their production processes, infrastructure or the products and services that they offer.

In terms of individuals or regions, those facing short-term losses will be immobile employees without the skills sought in the future economy, and regions which have invested in resource intensive industry and which do not have a suitable policy mix to support adaptation. Policies for managing transitions may require particular support for low-skilled workers.

At the same time, the aim of being more resource efficient is not to drive resource intensive sectors out of Europe. On the contrary, it is important to keep industry and its supply chain in Europe to maintain growth and jobs. Policy can respond to changing conditions by altering the distribution of costs. For example, removing artificially low resource prices provides the right incentives for productivity gains, but creates winners and losers between competitors within an economic sector. It changes the basis of competition – giving added advantages to those firms which adapt best.

3. MAKING EUROPE RESOURCE EFFICIENT

Some progress on resource efficiency is already happening as businesses, households, Member States and international institutions are taking action. Resource productivity has improved by around 2% per annum (if measured by Euros per kg of Domestic Material Consumption); in many contexts we have relative decoupling of economic growth from environmental harm; and we are reducing our reliance on fossil fuels by increasing energy efficiency and developing alternatives.⁵⁵

Yet there are a number of problems that reduce the economic system's ability to predict change and its flexibility to respond to that change. These artificially slow the EU's rate of transition to greater resource efficiency. They constrain the EU's natural ability to respond to changing conditions: either to seize the new opportunities and avoid the costs and the risks to growth, security and future well-being identified above.

3.1. Several problems hold back the EU economy

3.1.1. *Constraints on the ability to predict*

Knowledge gaps about future risks constrain firms and policy makers from planning for the future. For example, there are significant uncertainties how environmental systems (like weather-linked water supplies) will change and the impacts they will have. Many firms are not aware of risks up their complex, global supply chains.

Consumers, firms, policies and parts of the economic system (e.g. financial markets) are often shaped by **short-termism** in decision making. Firms and households can have short pay-back periods for investments, which could lead to underinvestment for the future. For example, one study found that in a particular context firms are so risk averse that returns on investment

⁵⁵ "Competitiveness of European Companies and Resource Efficiency", Ecorys, 2011

must be perceived to be ‘air-tight’⁵⁶ with figures of 27% needed⁵⁷. Policies often focus on short-term goals.

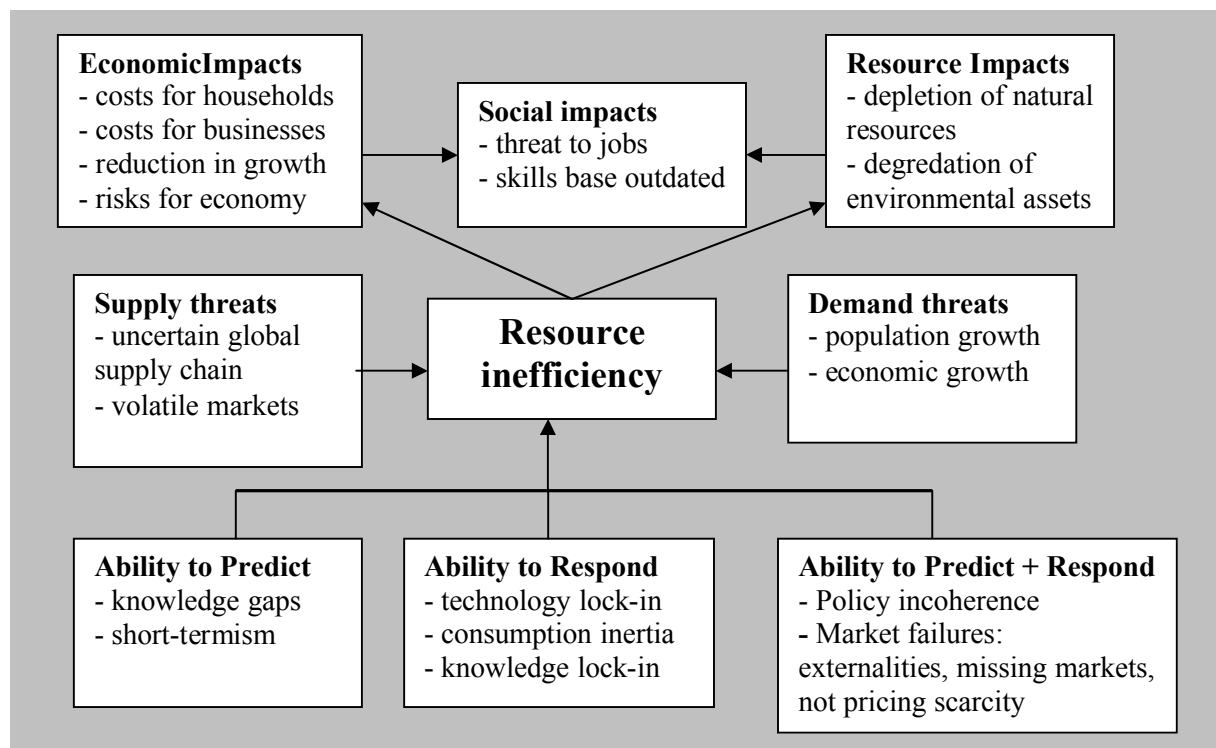


Figure: Resource inefficiency: barriers, threats and impacts

3.1.2. Constraints affecting the ability to predict and respond

Market Failures

Market economies are good at making the right purchases and investments when they are working well, for example, when the price of a good matches its real cost. Surprisingly often, there are still barriers - **market failures** - that hold back markets from working well. This is particularly the case for decisions or purchases which affect quality of life in the future, or direct or indirect effects on environmental resources (like climate or ecosystems). The globalisation of resource supplies has made many impacts and risks more remote, so less well reflected by markets. These include:

- Failure to reflect future scarcity of resources in prices, leading to unsustainable use.
- Misalignment of incentives along a value-chain. For instance, the landlord-tenant problem, where the person responsible for investments (landlord) will not benefit from any increases in energy or resource efficiency, so will under-invest. This can also apply within supply chains.
- Indirect costs or 'externalities': Where there are indirect consequences of resource use, they are often not considered in public and private decisions. Many resources are economically valuable, but under-priced and usually off firms' balance sheets. This leads to the mis-management of these resources, with weak incentives to improve

⁵⁶ "Maintaining a Strong Innovation Culture During a Downturn", Arthur D. Little 2008
⁵⁷ <http://www.bankofengland.co.uk/publications/quarterlybulletin/qb940308.pdf>

efficiency of their use or management.⁵⁸ Many of these are the impacts from the life-cycle (eg. extraction, processing, use, waste) of one resource on another (for example of metals on the climate system, or of agriculture on water availability).

- Problems with management of open access or shared resources, or 'missing markets'. There are resources with unclear property rights (e.g. fish stocks, forests) where people have very weak incentives to collectively manage the resource well for the future.

This means that market signals, particularly price, often point decisions away from resource efficiency.

Policy Inconsistency

Some policy interventions do the same, whilst **inconsistency between policies** reduces predictability. Policy – made for good reasons in one field - can have unintended consequences that hold back efficient use of resources, for example:

- Subsidies that promote resource use can be very large and have significant indirect impacts.
- Market rules and regulatory structures can unintentionally hold back innovation. For example, bidding systems for power sales that are conducted one-day ahead hinder the participation of wind-power generators, who can more reliably predict their output around 3 hours ahead.⁵⁹

As external conditions change, policy is sometimes hard and slow to reform, leading to policies that hold back transition. For example, tax policies put in place for one reason, may have increasingly costly distortions on the market that slow adaptation, but these indirect effects are often not considered by segmented policy-making governmental structures.

Policy inconsistency often also arises from the complexity of trying to remove market failures, which can cause high costs of intervention. It also comes from policy being shaped in favour of groups for whom policy change brings short-term loss of income, rather than longer time period, more diffuse but larger income gains.

3.1.3. Constraints affecting the ability to respond

Economies have a tendency to respond slowly to some changes, because they (and the firms and consumers that form them) are partly 'locked-in' to paths determined by past investment decisions, existing economic structures and prevailing institutions. In addition, firms and people tend to be risk-averse, which can constrain the ability of firms, consumers and societies to adopt new innovations⁶⁰. Some examples are:

- **Technological lock-in** when established technologies have a price advantage over innovations, or where the technology forms part of a physical or social system of which the other parts are not changing. Examples are technologies linked to infrastructure, as with transport (eg. electric vehicles lacking charging points) or

⁵⁸ "Green Growth Strategy Synthesis", OECD, 2011

⁵⁹ OECD Smart Grids and Renewable Energy, Competition Committee Roundtable 2010

⁶⁰ OECD Green Growth Synthesis 2011

networks (the advantage of communication technologies is their ability to communicate with the technologies that other people already have).

- **Lock-in to consumption and behavioural patterns** (eg. food choice, or waste disposal behaviour). Behavioural studies observe that people tend to stick to habits, social norms or past behaviours. This holds back diffusion of product and organisational or social innovation, hindering the creation or expansion of new markets.⁶¹
- **Skills and business models** may continue to be strongly based on techniques and information learnt in previous years.
- **Insufficient incentives for innovation** in resource efficiency on the scale required in particular to stimulate greater financial and human resources in these areas

3.2. Policy Objectives in the transition to a resource-efficient, low-carbon economy

3.2.1. *The Europe 2020 Strategy*

To secure smart, sustainable and inclusive growth into the future, EU governments have agreed on an economic strategy to take the EU to 2020. The Europe 2020 strategy recognises that a good transition to resource efficient Europe requires policy to remove the barriers described above. Across the EU, a very wide range of policies aiming at improving resource efficiency are already in place^{62 63} However, even with these policies, current trends – e.g. in the environment - are failing to meet EU objectives.⁶⁴

The OECD argues that leadership is needed from finance and economic ministries, without which the transition goals will be impossible to achieve, although environmental policies play a central role.⁶⁵ To help deliver the necessary policy change, one of the Europe 2020 Strategy's key initiatives⁶⁶ established resource efficiency as the guiding principle for EU policies on energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development.

3.2.2. *Objectives of the Roadmap to Resource Efficient Europe*

The Roadmap aims to remove the barriers holding back transition that are not yet tackled by sectoral policy. It also aims to create a framework that improves coherency across existing and new policies. This is partly done by agreeing the long-term goal set out in the Roadmap:

⁶¹ "Lags in the EU Economy's Response to Change", Ecorys, 2011

⁶² "Economic Analysis of Resource Efficiency Policies", COWI, 2011, and "Review of the Natural Resource Thematic Strategy", BIO Intelligence Service, 2011

⁶³ <http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency>

⁶⁴ "The European Environment – State and Outlook 2010", EEA, 2010

⁶⁵ "Green Growth Strategy Synthesis", OECD, 2011

⁶⁶ "A Resource Efficient Europe", COM(2011) 21

By 2050 the EU has grown in a way that respects resource constraints and within planetary boundaries, thus contributing to global economic transformation. Our economy is competitive, inclusive and provides a high standard of living with much lower environmental impacts. All resources are sustainably managed, from raw materials to energy, water, air, land and soil. Climate change milestones have been reached, while biodiversity and the ecosystem services it underpins have been protected, valued and substantially restored.

The Roadmap aims at removing the following barriers:

Barriers to the ability to predict

- Deliver research to fill the gaps in our knowledge and provide the right information.
- Creating clear milestones, indicators progress in resource efficiency and targets to provide guides on the future direction of the economy and policy.
- Increasing the flow of information on resource risks and cost-effective efficiency opportunities between commercial partners in supply/value chains that leads to the uptake of new sustainable practices and stimulates breakthroughs in innovation.
- Encouraging more long-term innovative thinking in business, finance and politics, including information exchange within government develops that forward thinking, cost effective regulation.

Barriers that hold back both the ability to predict and respond

- Removing market failures, including improving management of open access resources.
- Reduce uncertainty on future returns through providing clear, consistent, credible market signals on direction of relevant policies.
- Promoting exchange of information between government ministries toward common goals, to improve policy coherence, find synergies between policy goals and resolve trade offs.
- To tackle lock-in to existing consumption patterns and behaviours through policy that take into account most recent science on the influences on consumer behaviour.

Barriers to the ability to respond

- Addressing taxes and subsidies that distort the real costs of resource use.
- Increase public and private investment in technological innovation, including through increasing the priority and funding for research and innovation on resources.
- Increase flexibility in labour markets, supporting training in the right skills.
- Ease short-term adaptation cost concerns, with complementary, transitional policy measures to facilitate policy reform, - including international short-term competitiveness concerns of less-adaptive firms and costs for particular social groups - and seeking a consensus with international partners to move in a supportive direction.

4. TRANSFORMING THE ECONOMY

4.1. Actions in an interconnected world

Very large opportunities for cost savings coupled to reduction in resource use and impacts remain, despite past progress towards more resource efficient supply. Seizing these opportunities could allow the EU to transform its economy whilst improving competitiveness.

The Resource Efficiency Roadmap covers a wide range of areas - energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development. The solutions are proposed to be taken at all levels of society, by individual businesses, business associations, consumers, regions, Member States and, where there is added value, at EU level.

The majority of areas already have some targets or objectives that are the product of longstanding policy discussions between stakeholders. The Roadmap sets out actions to help these objectives to be met more easily (i.e. at lower social cost), more quickly or with less chance of failure. Many of the means to do this lie in exploiting synergies inherent in the inter-connections between economic sectors and policy areas.

There are interlinkages across the economic system, the use of resources and environmental impacts: supply is related to demand, investment is related to perceived opportunities, prices for one resource depend on prices of its potential alternative. Indirect impacts and feedbacks create complex relationships. The box below illustrates one example, of the important interlinkages between resources and the economy.

Box: Interlinkages between resources and the economy – Water

Water: a central resource in a strongly interrelated system

As a connecting system water is exposed to many different pressures. It also links the effects of some economic activities to others. For example sulphur dioxide and nitrogen emissions from industry react with the water molecules in the atmosphere and end up disturbing land, water and marine ecosystems and biodiversity through acid rain. Furthermore greenhouse gas emissions from all key sectors contribute to climate change, which has an impact on both the supply and demand for water.

Water and energy: a mutual dependency

Water makes vital contributions to economic activities including agriculture and energy production. Data for the US for example that 40% of industrial water use is for power-station cooling for energy generation. On the other hand the water supply and sanitation sector is a large consumer of energy, especially to transport it over long distances. In California for example it is estimated that the water sector consumes 19% of the state's electricity and 30% of its natural gas.

How resource efficiency can create positive feedback loops

Using resources more efficiently would not only reduce environmental pressures, it would also reduce energy demand leading to further reductions in water.

One of the main conclusions in EEA's State of the Environment Report 2010 states: 'environmental challenges are complex and can't be understood in isolation'. This applies

equally to most issues around transition to resource efficiency.⁶⁷ Within the web of interconnections, changing one resource (or policy) may either cause other consequences - e.g. unexpected impacts elsewhere, or achieve little change to the system. This leads to many potential **synergies**:

- a number of feasible dematerialisation strategies such as increased recycling, lean manufacturing and prolonging product lifetimes could save up until 5162.5 PJ of energy. These energy savings would not only entail a reduction in the EU's GHG emissions of 15.6%, they would also reduce the need for water for energy generation, reduce the need for land to produce biofuels, and reduce the pressures on biodiversity from acidification and eutrophication.⁶⁸
- a number of strategies including reducing food losses, improving agricultural practices and reducing power savings in farming could lead to a reduction of 25% of global warming and respiratory organics, a reduction of aquatic ecotoxicity of 68% and a reduction of 31% of acidification and terrestrial eutrophication.⁶⁹
- mitigating climate change would halt adverse effects on ecosystems, whereas undisturbed ecosystems have been proven to play a crucial role for climate change mitigation and adaptation.⁷⁰

Many of the interlinkages can also lead to **trade-offs**:

- the production of biofuels: on the one hand the production and use of biomass can lead to greenhouse gas savings and have potential benefits to the environment, but on the other hand it can also increase other environmental pressures.⁷¹
- deployment of 'green' vehicles reduces the use of fossil fuels but increases the demand for electricity and certain raw materials, some of which are subject to supply restrictions and concentrated in a few geographical areas (e.g. rare earth elements for electronic components and fuel cells, lithium for batteries).
- land used to produce food may compete with land use for energy and both may compete with land which supports biodiversity or provides ecosystem services such as absorbing carbon from the atmosphere.
- some additives used in plastics can extend the preservability of packaged food, but pose serious challenges to plastics recycling.

4.2. Target Areas for Action

The actions to help smooth transition can be grouped into 6 areas for easier explanation, corresponding to the main barrier they seek to remove. This can tend to hide the inter- very significant connections between them. These areas of action are:

⁶⁷ "Globalisation the environment and you", EEA, 2011

⁶⁸ "Links between dematerialisation and energy use", Bio Intelligence Services, 2010

⁶⁹ "Environmental Improvement Potentials of Meat and Dairy Products (IMPRO)", B.P. Weidema et al., JRC, 2008

⁷⁰ "The European Environment – State and Outlook 2010", EEA, 2010

⁷¹ "Climate change impacts on water quality and biodiversity", European Topic Centre, 2010; "The European Environment – State and Outlook 2010", EEA, 2010

- Improving products and changing consumption patterns
- Boosting efficient production
- Turning Waste into a Resource
- Supporting Research and Innovation
- Phasing out inefficient subsidies
- Getting prices right

Issues between resources differ. The application of these actions is particularly needed on the where the existing barriers have the greatest effects. In Annex 3 to this Staff Working Document, the rationale for areas of action and their application to key resources are described. These are:

- Ecosystem Services
- Biodiversity
- Minerals and Metals
- Water
- Air
- Land and Soil
- Marine Resources

Co-ordination of actions becomes important because each action has direct and indirect effects that pass further through the economic and environmental systems.⁷² For example, a change in consumer purchasing has effects on suppliers' behaviour and, in turn, on their input suppliers. As these indirect effects can be very significant, bringing coherence would need the most important of these indirect effects to be considered in policy making.

In economic systems, the primary flow of interactions runs up and down from the final consumer through intermediary economic actors to raw materials suppliers. (This is sometimes called the 'value chain'.) Consideration of interactions in these value chains is a necessary step to finding synergies and new ways to remove long-standing barriers. The Roadmap considers what would be needed for three key areas of economic value:

- Food and Drink
- Buildings
- Mobility

Annex 3 describes the rationale behind working with these value chains.

5. GOVERNANCE AND MONITORING: A NEW PATHWAY TO ACTION ON RESOURCE EFFICIENCY

5.1. Consequences of Existing Governance Arrangements

Uncertainty around future policy and incoherence between policies are one of the barriers that hold back the economy's ability to predict change in resource scarcity and in its ability to respond. Weak coordination can lead policies to be working against each other. This can happen where policy is formed on the basis of different information or different prioritisation of political interests, and can leave business and citizens facing contradictory policy and

⁷² "Green Growth Synthesis", OECD, 2011

market signals.⁷³ Several policy bodies have pointed to the removal of these barriers as essential. At EU level, the Council has called for integrated approaches working over the life-cycle of products and materials from extraction to end of life.⁷⁴

The OECD in its 'Towards Green Growth' strategy refers to broad recognition that further progress can only be achieved if governments turn to more integrated policy approaches⁷⁵. Business stakeholders have called for clear, unambiguous, credible and reliable market signals to give security to investment. Experience with existing structures for integrated policy development at EU level suggests that a change is needed to steer the transition to a resource efficient economy.

Weak coherence has been found to come from:

- 'Silo-based' policy making arrangements - policy responsibilities relating to the economy's transition to resource efficiency are spread among different departments with governments and decentralised to the appropriate level.⁷⁶ Departments or regional administrations can form divergent objectives.
- Political emphasis on short-term, direct effects, particularly reactions to negatively perceived change.

Together, these reduce the predictability of change for firms, weakening belief in announced strategic policy and the implementation of the policies which would deliver it. These factors also affect the scope of relevant knowledge within policy making bodies. Knowledge of the existing and future potential for greater efficiency between sectors in value chains often falls outside the expertise of policy makers. The focus on particular areas and direct effects tends to reduce knowledge of indirect effects on systems and the optimal rate of change for area of the economy.

5.2. Governance change for facilitating transition

Governance arrangements are a key factor in the level of policy. The Roadmap sets out actions to change governance in 3 areas:

5.2.1. Sharing information on future opportunities, milestones and targets

Bringing together information from different parts of the supply/value chain can identify short-term win-wins that each sector or organisation could not realise without the co-operation of other parts of the value chain. It can also provide information for policy makers that allow them to identify the packages of policy that would need to be provided to give the right market signals and incentives to support further opportunities.

The Roadmap considers structures that would bring business representatives from across supply/value chains together with policy makers. These platforms would facilitate information exchange about resource supply risks, possibilities and barriers for greater efficiency. The exchange of information can help set commonly agreed goals for the optimal

⁷³ "Green Growth Synthesis", OECD, 2011

⁷⁴ December Council conclusions on Sustainable Materials Management: Council Document 17495/10

⁷⁵ "Green Growth Synthesis", OECD, 2011

⁷⁶ "Making reform happen: Lessons from OECD countries", OECD, 2010 - P. Ekins, Chapter 5

rate of transition in any particular area of the economy and identify the most appropriate set of policy reforms to drive innovation.

The discussion of potential common objectives, for 2020 and beyond, and knowledge of the potential of increased innovation to achieve them may help change expectations of future markets (e.g., for innovation) and to lead to increased investment by reducing barriers to predictability. It can also serve to bring policy makers with different expertise together in the formation of common goals.

Within Europe, many organisational structures have been set up which attempt to improve policy coherence and exchange with business with varying success. In Member States' policies some transition is taking place to integrated resource-efficiency policies (e.g. in Finland) from past segregated policies (energy efficiency, water, waste, etc.) A few Member States apply a holistic approach to focus on greening the whole economy, instead of giving attention to particular resources (e.g. United Kingdom) In a few cases, the whole life-cycle is considered and impacts abroad are taken into account, through e.g. focusing on sustainable trade (the Netherlands) or the impacts of consumption (Sweden).

There are many examples, at EU and MS level, of structures to shape policy and business action through co-ordinated discussion. For example: CARS 21 (an EU level grouping of the vehicle supply chain and policy makers), Member State transition platforms (eg. in the Netherlands which brought together 5 ministries⁷⁷), civil society initiatives (eg. the European Re-Building Forum⁷⁸). Positive and negative experiences with the reform of environmentally harmful subsidies have demonstrated the importance of this approach.⁷⁹ The successful Covenant of Mayors, which has driven energy efficiency in over 2000 cities and regions, can expand its scope to realise the synergies between energy efficiency and wider resources efficiency in urban settings.

International round tables bringing together the wide range of relevant stakeholders to promote resource efficiency along the life-cycle have been established for several internationally traded goods, notably palm oil, soy, and cocoa.

At EU and MS level, existing structures can be used, with changes where needed. The nature or participation and engagement in these organisational structures defines their success. For instance, the technological and organisation potential for efficiency gains is often outside the knowledge for some companies, in particular of SMEs⁸⁰. For this reason, the World Business Council for Sustainable Development (WBCSD) points to the importance of making new alliances to bring trust between government, academia, business consumers and civil society).⁸¹ It uses the example of the construction industry, where developing energy efficient buildings on a large scale needs the co-ordination of professionals along the value chain.

Small, progressive businesses are likely to be under-represented as they do not have the time to invest in such processes, but their voice is essential for an understanding of the potential

⁷⁷ The Dutch government put in place 'transition management' as national policy in 2001, with five ministries jointly developing transition policies for mobility, food production, energy and biodiversity. Referenced in "Towards Resource Efficient Economies in Asia and the Pacific", Asian Development Bank

⁷⁸ <http://www.epe.be/Default.aspx?p=112&n=134>

⁷⁹ "Competitiveness of European Companies and Resource Efficiency", Ecorys, 2011

⁸⁰ "Competitiveness of European Companies and Resource Efficiency", Ecorys, 2011

⁸¹ Vision 2050, WBCSD, 2010

opportunities. Views from business associations may tend to represent a consensus view influenced by the least progressive companies. Information on the existence of barriers to change is also needed, so that these can be reduced.

Agreed targets would take time to discuss. In the meantime predictability can be increased by the formation of strategies that indicate the direction and pace of transition. Milestones within these strategies – such as the Roadmap – provide guidance on appropriate stages for a smoother transition.

5.2.2. *Economic governance*

The effect of policy strategies in reducing uncertainty and incoherence is dependent on their credibility. This credibility rests on a number of factors, including their political strength, their incorporation into existing governance arrangements and their monitoring.

Member States have the lead in defining their economic strategies for greater resource efficiency. To support those strategies, the Commission will highlight progress in resource efficiency within its surveillance of economic governance of Member States. This 'European Semester' monitoring of Member State policy reforms can help strengthen co-operation with Member States, increasing chances of policy change and the adoption of appropriate governance structures at Member State or regional level. It will focus initially on prioritising sustainable growth friendly expenditure and savings.^{82 83}

Agreements on goals and setting up of governance structures are not a panacea to overcoming obstacles to reform⁸⁴ and experience with the Sustainable Development Strategy and Lisbon Strategy points to the need for complementary policies and political leadership if policy reform is to be successful. However, an additional benefit from EU governance change derives from one of the barriers to progress. A lack of co-ordination between Member States has given rise to perceived competitiveness concerns for those who act first. Improving discussion and analysis can help to overcome this perceived barrier.

As part of its efforts, the EU will add a review of a small, suitable, selection of indicators for resource efficiency into the European Semester monitoring exercise during 2012 for full use in the Annual Growth Survey. Those indicators will complement the existing carbon transition targets.

5.2.3. *Indicators*

The identification of indicators enabling Member States and others to measure progress in how resource efficiency contributes to economic goals would support political action and goal setting on resource efficiency. Major barriers to policy integration are strongly rooted in

⁸² Areas such as research and innovation, education and energy; eliminating environmentally harmful subsidies or tax exemptions; "green tax reforms"; exploiting the EU's first mover advantage on competitive environmental goods and services.

⁸³ One tool the EU can use to do this is the indicator-based assessment framework iGrowGreen, currently being developed by the Commission with Member States. It examines the shift to a competitive and greener economy by evaluating Member States' performance in domains reflecting the key links from environmental performance to macroeconomic and fiscal considerations. Quantitative results are qualified by country-specific qualitative information. Detailed information is provided at: http://ec.europa.eu/economy_finance/db_indicators/igrowgreen/index_en.htm

⁸⁴ "Fostering structural reforms in industrial countries", IMF, (World Economic Outlook Chapter 3), 2004

differing stakeholder perceptions of the issues involved and indicators can help harmonise understanding. The indicators will provide additional information on the competitiveness of European nations.

Resource productivity can be estimated by GDP/DMC^{85} (euro/tonne). However, as an indicator this has some shortcomings: for example it measures resources by weight, whilst the economic value, scarcity and environmental impact of some natural resources is only not strongly correlated to their weight. It also takes a national production perspective, which implies that it is insensitive to changes in environmental pressures that occur outside the national borders. In addition,

Resource Efficiency covers many different uses of different resources with different economic and environmental impacts. High level aggregate indicators must be based on assumptions on that aggregation, and therefore any single indicator has some weaknesses. The recommendations of the Stiglitz-Sen-Fitoussi Commission⁸⁶ point to the benefits of complementing a headline indicator with a concise dashboard of macro-indicators on water, land and carbon. A range of thematic indicators can also provide additional information. Further work on indicators would allow agreement on an indicator on natural capital and environmental impacts of resource use. A technical discussion of indicators that Commission proposes to use can be found in Annex 6.

In addition, progress to resource efficiency would be supported by the use of complementary measures of societal and economic progress in political and economic debate. The Commission, several Member States and international commentators have pointed to the need to complement GDP (which measures only some aspects of the economy). Further integrating environmental externalities into national accounting and developing a composite index on environmental pressures to help complement GDP would help align political goals with the policy needed to remove barriers to transition.

5.2.4. *Factoring knowledge of interactions into policy decisions*

Many economic policy decisions are informed by modelling results. A review of models carried out for the Commission highlights the need for economic models that better factor in (1) the impacts of limits to stocks and (2) the kind of large scale change or unexpected shocks that the EU faces from changes in resources in the rest of the world. In particular, given the interactions between resources, models tend not to factor environmental change into economic growth, for instance though the feedbacks from climate change, water shortage or air pollution.

Often, computable general equilibrium (CGE) models are not well set up to model the dynamics of transition.⁸⁷ Whilst some models link energy production and use, agriculture and land use and related GHG and air emissions⁸⁸, and whilst the two way linkages between the economy and energy demand are common in economic models, most models do not factor in

⁸⁵ Domestic Material Consumption

⁸⁶ "Report of the Commission on the Measurement of Economic Performance et Social Progress", 2009

⁸⁷ European Economy. Economic Papers 413. June 2010.

⁸⁸ See for examples the modelling work done by the Joint Research Centre and others for COM(2011)112/SEC(2011)288, or the work on linkages between different models done by the EU funded European Consortium for Modelling of Air Pollution and Climate Strategies (www.EC4MACS.eu)

material demand in the same way. This requires greater understanding of the linkages from land use, climate and material use back into the economy.

These models of interactions will be able to be improved through increased scientific knowledge about resources, how environmental systems respond to pressures, potential thresholds and interactions between resources. They can use different modules that treat specific sectors in detail, perhaps using a common interface. Work can be developed by the research and development programmes including international, European, national and industrial programmes, as well as the European Environment Agency (EEA), the Joint Research Centre and Eurostat.

Improved models will assist firms and policy makers to shape policies for the transition to resource efficiency. The Commission's most recent work on this, including a 2011 study by PBL⁸⁹ is described in Annex 8.

5.3. Other key areas of governance

The application of more integrated governance is a key factor in finding solutions to barriers in the areas of: finance, skills, policy action outside the EU and good implementation of existing policy. Action in these areas is needed as part of the policy mix.

For example, in finance: UNEP estimates that the annual financing needs for making the world economy more resource efficient are between US\$1.05-2.59 trillion - around 10% of annual global capital investment⁹⁰. In the EU, and elsewhere, this financing will need to come mainly from private sources⁹¹. Yet, for the scale of financing necessary, the current financial systems bias towards the short-term would have to be reversed, and some unfamiliarity with investments in resource efficiency would need to be reduced. Public and private sector action to achieve this may be identified from discussions with EU, and Member State level, round tables on finance.

Meanwhile, the costs of current environmental legislation not being fully implemented are estimated at around €50 billion per year.⁹²

The significance of barriers and solutions in finance, skills, international action and implementation is described in Annex 3.

⁸⁹ "EU Resource Efficiency Perspectives in a Global Context: A fast track analysis", PBL, 2011

⁹⁰ "Green Economy Synthesis", UNEP, 2010

⁹¹ "Green Growth Synthesis", OECD, 2011

⁹² "The costs of not implementing the environmental acquis", COWI, 2011 (forthcoming)