


Sustainable Industry: Going for Growth & Resource Efficiency

 **European Commission**
Enterprise and Industry



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What is this brochure?

This brochure presents a synthesis summary of two recent research studies produced by Ecorys for the European Commission. The first study, "EU industry in a sustainable growth context", provided input for the forthcoming 2011 European Competitiveness Report, and focuses on the overall eco-performance of EU industry in the last 10-20 years. The second study, "Study on Competitiveness of European Companies and Resource Efficiency", looks at resource efficiency performance, with much more focus on the company and sector level. The findings from both these studies are interesting and highly relevant to future EU competitiveness, growth and environmental performance.

The full technical reports and annexes will be published soon on the DG Enterprise and Industry website http://ec.europa.eu/enterprise/index_en.htm

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Introduction

1

Economic growth and resource efficiency are two sides of the same coin. They are both prerequisites for the sustainable growth of our modern societies and are essential to face the current environmental, social and economic challenges. Growing global scarcity and competition for resources has raised their importance on the EU development agenda. It has also highlighted the interdependency between economic growth, resource use and the environment. As such, Europe places substantial emphasis on the importance of natural resources and their efficient use.

What is sustainable growth and resource efficiency?

1.1

Sustainable growth is embedded in the concept of sustainable development, which evolved from environmental concerns, and is based around development that “meets the needs of the present without compromising the ability of future generations to meet their own needs”. In industrial terms this means growing industry while keeping the environmental, and also the social and economic, impacts at a sustainable level.

Resource efficiency is less well defined. Resources in this context include all material resources, living and non-living, so in addition to materials this also includes land, soil, air, water, biodiversity and ecosystems. Resource efficiency involves improving the efficiency and effectiveness of how we use these resources, i.e. using less to do more, and causing less impact from those resources we do use.

Why do we measure sustainability and resource efficiency?

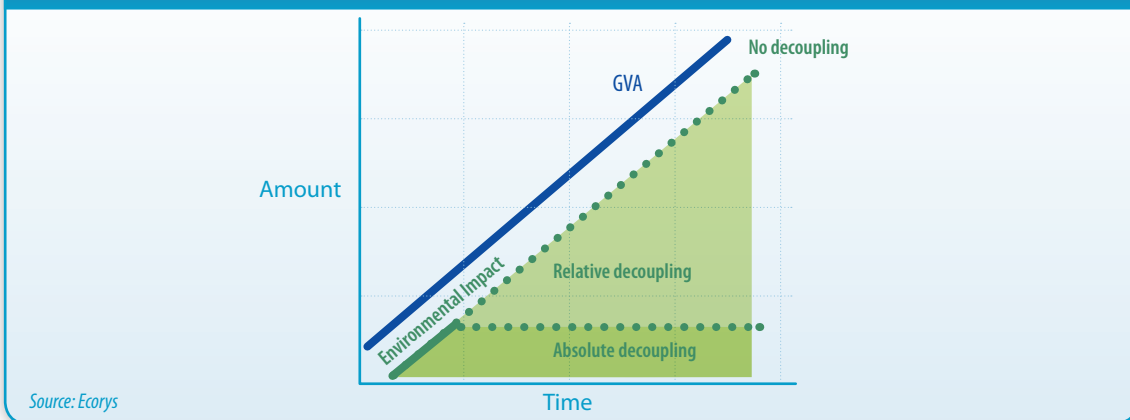
The first goal of measurement is to understand where we are and where we have come from. In

this way, progress, and its speed and direction, can be understood. It is necessary to measure so that effective management can take place. By having a clear understanding of progress, appropriate strategies and measures can be developed and implemented to continue to drive improvements.

How is sustainability and resource efficiency measured?

The key indicator of positive trends in sustainability and resource efficiency is decoupling. This represents a separation of the impacts from an activity, to remove the link and interrelationship between variables. Decoupling is an objective for sustainability in de-linking economic growth and activity from environmental impacts. Examples include weakening the link between an increase in GDP (or GVA) and an increase in Greenhouse Gas (GHG) emissions, or the link between increasing industrial output and increasing resource inputs. Two types of decoupling are defined, based on the extent to which this de-linking occurs.

Figure 1. Relative and Absolute Decoupling



Relative decoupling of impacts from economic activity occurs when, relative to changes in economic activity, impacts change at a proportionally slower rate - the intensity of use falling, relative to the quantity of output produced.

Absolute decoupling of impacts from economic activity occurs when not only does the intensity of the use of resources fall relative to increasing output but, this fall is sufficient to reduce the overall quantity of resources used.

1.2

Why is resource efficiency and sustainable industrial growth important?

Our economy and our quality of life depend on sustainable growth and using resources

One of the biggest societal challenges facing the EU currently is how to deliver needed growth and jobs while doing the right thing by the planet. There is an increasing need to do more with less and create the optimal conditions for industry to improve its own performance – notably in terms of economic, environmental and social sustainability - and deliver innovative solutions to environmental challenges. The EU needs to exploit the business opportunities resulting from the transition to a more sustainable, resource efficient and low carbon economy. To that end, policies need to provide the necessary coherence, consistency and certainty, creating the conditions for success. As only successful companies, developing eco-innovative products, will be able to contribute to effective environmental protection and social progress. And the EU will only be able to realise its potential in this field if it successfully shows that it is indeed realistic and feasible to combine optimal levels of resource efficiency with industrial competitiveness.

Economic growth brings many benefits, providing

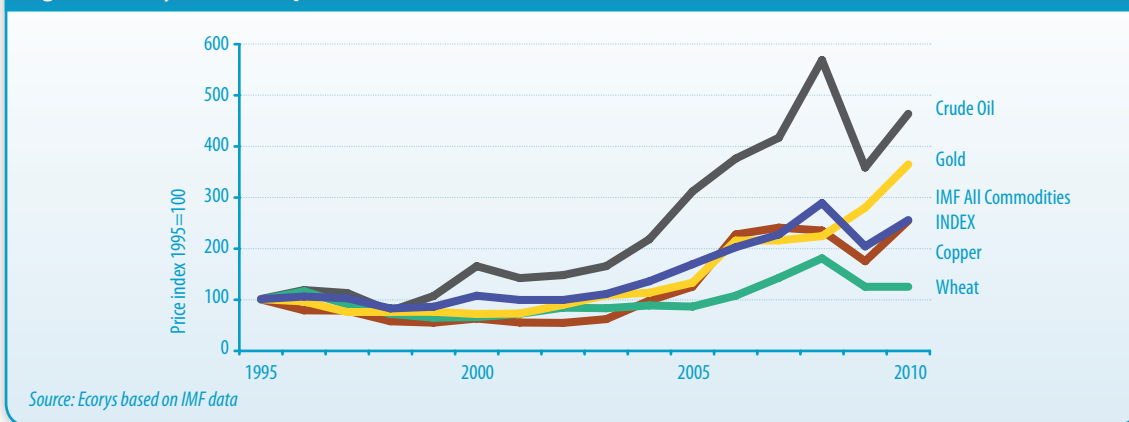
employment and wealth, enabling the people of the European Union to enjoy one of the highest standards of living in the world, and much better in almost every way than in previous generations. The most commonly used measures of economic activity are measures of consumption, with economic growth indicating an increase in consumption, and increased consumption equated with higher quality of life. In all major economies, consumption is dependent on the use of natural resources to provide the energy and raw materials for production. This makes increasing resource consumption an inherent feature of economic growth.

But many resources are finite and increasingly demanded by industrialising economies

The finite nature of many key resources presents a challenge to continued increases in our standard of living. There is an increasing perception of the scarcity of resources, driven by a variety of factors, not least the rapid expansion of developing economies such as the BRICS countries. This economic globalisation has increased the demand for resources and this has been reflected in price increases of many strategic resources.



Figure 2. Key resource price indices 1995-2011



The IMF All Commodity index is maintained by the International Monetary Fund (IMF) and tracks prices of internationally traded primary commodities, including industrial metals, foodstuffs, beverages, agricultural raw materials and fuels. It reports benchmark prices that are representative of the global market, determined by the largest exporter of a given commodity.

This is leading to increasing prices

Prices of key resources such as oil, gold, copper and wheat have all increased rapidly in the last 10 years, following (and triggered in part by) the growth and new demand from the industrialising economies. The increase in the all commodities index, which is now 158% higher than in 1995, demonstrates that these trends are representative over most commodities, including other metals, mineral, fuel and food resources. While speculation may play a role in some price increases, and the financial crisis also caused a 'blip', the trend is clearly upwards and these increasing trends may continue as demand for some raw materials and commodities increases faster than supply.

Which can impact our competitiveness and jobs

Increasing prices impact on the competitiveness of industry. Industry tends to have smaller margins and increasingly has to compete in other dimensions such as labour cost and productivity. This can lead to knock-on effects in reduced employment as firms cut

costs or lose market share. For consumers, increasing prices affect disposable incomes, leading to changed, and typically reduced, consumption patterns.

Not forgetting the environmental impacts of resource use

While economic and competitiveness concerns are being increasingly raised in relation to resource use, the environmental repercussions also remain important. The challenges and potential consequences from increased resource extraction and use are now on a scale not seen before. By its nature, and as a result of economic globalisation, pollution to air, land and water are problems that require cross-border and often global solutions and responses. Climate change being the foremost example of this, but equally, deforestation, over-fishing and biodiversity loss remain important concerns that are pressing towards a more sustainable and resource efficient industry. It is notable that in each of these facets progress has been made but deterioration has not stopped.

Sustainable growth and resource efficiency are opportunities for EU industry

1.3

It is something the most successful countries, sectors and firms already do...but there is a need to do more

The move to more sustainable industrial growth and resource efficiency does not necessarily involve wholesale change to what industry already

does. Many of the best performing industries and firms already focus on resource efficiency as a way to reduce their costs and increase productivity. There is a need now to step this up a level to meet the new competitive and environmental challenges.



It can open new markets and increase competitiveness, bringing significant opportunities for industry

Resource efficiency improvements based on extended life cycle approaches, taking into account the full environmental and economic impacts of products and supply chain activities, can reduce the EU's dependence on resources, promote innovation and make companies more competitive. New technologies to improve resource efficiency, or improve sustainability by reducing environmental impacts, can create new markets for goods and services. Application of improved resource efficiency can translate into cost savings for firms, improving their competitive position. New products, with a more sustainable profile can be designed, exploiting and reinforcing the awareness of businesses and consumers of the gains they can derive from more sustainable consumption choices. This can all contribute to supporting sustainable industrial growth and employment.

Relative performance matters

Globalisation has provided access to new and growing markets, but also growing competition. These new competitors do not have to wait to develop the latest technologies, they can now leapfrog ahead to match the best global performers. It is necessary for the EU and its firms to maintain the lead they have, and continue to improve performance to stay ahead of rivals.

Industry must remain a driver of growth and competitiveness

The overall economic trend over the past 10-20 years, until the recent financial crisis, had been one of steady and continuous growth, but one where the growth of services significantly outpaced that of industry across developed economies. However, industry still makes, for almost all countries and EU as a whole, a highly significant contribution to overall economic productivity increases, private sector R&D and exports. The aftermath of the most recent financial crisis is a further call for the key role of industry in overall economic performance. Along with other factors, such as stable and judicious macroeconomic conditions and policies, a strong and competitive industrial base can be a core driver for sustained growth and overall competitiveness in the long term. Sustainability and resource efficiency are crucial areas for the reinforcement of EU industrial competitiveness.

Resource efficiency is essential for sustainable growth

Reconciling the need for economic growth, to continue to improve our lives, while balancing the detrimental impacts of production and consumption, is one of the most important challenges for the European Union over the coming decades. Environmental protection must be seen as an area that can contribute to growth, rather than a burden.

1.4

What is the EU doing to support this?

The challenge of sustainable industrial growth and the importance of resource efficiency are clearly recognised by the European Commission and are now at the forefront of strategy and policy. The Europe 2020 strategy recognises the global challenges and opportunities presented, interpreting sustainable growth as "building a resource-efficient, sustainable and competitive economy, exploiting Europe's leadership in the race to develop new processes and technologies, including green technologies, accelerating the roll-out of smart grids using ICT, exploiting EU-

scale networks and reinforcing the competitive advantages of our businesses, particularly in manufacturing and within our SMEs as well as through assisting consumers to value resource efficiency". To implement this, the EU has developed 7 high-profile flagship initiatives, including the Industrial Policy¹ and Resource Efficiency² flagships under the sustainable growth priority. Sustainable growth and resource efficiency are supported by many other policies, initiatives and activities from the European Commission, Member States and industry itself.

¹ EC COM(2010) 614, An Integrated Industrial Policy for the Globalisation Era – Putting Competitiveness and Sustainability at Centre Stage – available at http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/index_en.htm

² EC COM(2011) 21, A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy – available at <http://ec.europa.eu/resource-efficient-europe/>

How sustainable and resource efficient is EU industry?

It is vital that industry in the EU becomes more sustainable and resource efficient in the coming years. To date the EU has been successful in this, by many measures ahead of the US, and closing the gap on Japan, who are world leaders in many aspects of industrial efficiency. This section presents the main industrial, sustainability and resource efficiency trends in the last 10-20 years to demonstrate the progress that has been made.

EU industrial growth trends

To understand the performance of industry in improving its sustainability and resource efficiency, it is important to understand the economic performance and structural changes in industry over the same period. This provides a basis to measure the extent to which decoupling has taken place. The key measures of economic impact are GDP/GVA and employment:

Gross Domestic Product (GDP) or Gross Value Added (GVA) are the primary indexes of economic performance. Gross value added (GVA) is the difference between output and intermediate consumption for any given sector/industry, or simply, the difference between the value of goods and services produced and the cost of raw materials and other inputs which are used up in production. GVA is used as the primary measure of economic performance in this brochure and the source studies³.

What do we mean by 'industry'?

Industry in the context of this brochure is defined under the standard NACE industrial classifications revision 1.1 and covers categories A-F. This includes Manufacturing and its various subsectors, construction, energy and the water utilities, the extractive industries and agriculture, forestry and fishing. The full category definitions used for industry were as follows:

A & B – Agriculture, Hunting, Forestry and Fishing

C – Mining and Quarrying

D – Manufacturing

15-16 Food, Beverages & Tobacco

17-19 Textiles, Leather & Footwear

20 Wood and products of wood and cork

21-22 Pulp, Paper, Printing & Publishing

23-25 Chemical, Rubber, Plastics and Fuel

26 Other Non Metallic Minerals

27-28 Basic Metals and other Fabrication of Metal

29 Machinery not elsewhere classified

30-33 Electrical and Optical Equipment

34-35 Transport Equipment

36-37 Manufacturing not elsewhere classified & Recycling

E – Electricity, Gas & Water

F – Construction

³ Data for GVA has been sourced from the EU KLEMS dataset (see <http://www.euklems.net/>) and the OECD STAN database. Data is presented in each case in 1995 constant euros (EUR), through the application of Member State and industry specific price deflators. N.B. unless stated otherwise, all monetary values in this document are denominated in 1995 constant EUR.



Industrial growth since 1995

Industry grew...

The overall trend over the past 10-20 years, until the recent financial crisis, had been one of largely steady and continuous economic growth. Industrial GVA increased in all EU Member States and by a total of 22.1% across the EU between 1995 and 2007. Changes varied over time, while the most developed EU-15 Member States experienced slow but steady industrial GVA growth, the picture was much more mixed in the newer Member States. As Figure 3 shows,

in the former Eastern bloc, many countries experienced double digit percentage growth in industrial GVA, as they took advantage of the opportunities in EU membership and the single market. Other notable performers in the period 2000-2007 include Sweden and Finland; both achieved high growth partly tied to the mobile telecommunications revolution. The first effects of the financial crisis on industry can also be observed in some countries, with large falls of around 10% in industrial GVA recorded in most.

Figure 3. EU 25 Industrial GVA growth 1995-2009



Source: Ecorys based on the EU KLEMS and OECD STAN statistical databases. EU-25 is EU-27 – less BG & RO, where GVA data is unavailable. Due to the unavailability of EU-27 data for all series; different groupings are used in this brochure. These are always clearly indicated in the text or table label.



...at a slower pace than services but the two sectors are increasingly intertwined

While industry grew, so did the rest of the economy, with the services sectors experiencing even higher rates of growth. This meant that although industry as a whole remained a positive contributor to the EU economy it was declining in relative importance, becoming a smaller share of the total. By measures of GVA, industry declined from approximately 32.7% of the EU economy in 1995 to 30.4% in 2007. This trend was not unique to the EU and was experienced in other developed countries such as the US, Japan, Australia and South Korea.

However, the importance of industry goes beyond simply its GVA figures and relative performance with services, as the size and extent of the economic links between the two sectors increased significantly over time. Sustainability and integration of environmental effects over product life cycles is one of the reasons why more and more industrial firms develop and offer services along with their traditional physical products. Similarly, services, in particular knowledge intensive services, are increasingly used as direct and indirect inputs by industry, particularly in high-tech innovation intensive sectors.

Industry drives and diffuses innovation...

A large share of innovation activities, particularly research and development are carried out by industry. Industry has the most R&D intensive sectors in the whole economy, a relatively high patenting activity and many industrial sectors exhibit the highest shares of innovative firms in the Community Innovation Surveys and are at the forefront of the increasing internationalisation of R&D and innovation activities.

These are vital to continue to drive technical and technological progress.

...and overall productivity increases

While EU industry has expanded, employment trends have followed the decline in the relative importance of industry. Total EU industrial employment declined by 9.8% between 1995 and 2007, falling from 26 million to 23.4 million. The increase in industrial GVA and decline in employment, decline in employment, represented in most Member States and sectors, mark the achievement of significant increases in productivity per worker. This being the result of technological progress, increased globalisation, associated market developments and EU industry increasing specialisation into high-value products, value-chain segments, increasing levels of innovation, production automation and technological intensities.

The growth of EU industry remains vital to economic performance, employment and competitiveness.

Sector growth trends

Manufacture of electrical and optical equipment and transport equipment were major growth areas...

The biggest GVA growth was achieved in the manufacture of electrical and optical goods sector, which almost doubled over the period. The automotive sector, represented by the manufacture of transport equipment, also recorded significant growth of over 50%. The

other sectors experienced GVA growth of around 10-30% over the full period.

...while mining and quarrying and textiles fared less well

Textiles and mining and quarrying experienced the weakest economic performance, both seeing declines in GVA and also employment over this period.





The impact of the financial crisis

Only partial data but...significant declines in industrial GVA experienced in all Member States...and sectors...

It is clear that the financial crisis has had a significant and wide-ranging impact on EU industry. However economic and employment data relating to this time is available with only partial coverage. Where data is available, every member state in the EU recorded a decline in industrial GVA. Of 12 Member States with data available, an overall 11.5% decline in industrial GVA was recorded between 2007-2009, the biggest falls, of over 10% were recorded in the EU-15 Member States (in Finland, Sweden, Austria, Germany and Italy), while smaller declines were felt in other Member States such as Slovakia and Slovenia. All industrial sectors experienced GVA declines, although some sectors held up better than others as a result of policy support (e.g. transport and car scrappage schemes) or the nature of markets, i.e. strong exports (chemicals) or inelastic demand (food, drink and tobacco). One of the most timely data sources for the effects of the crisis is the emissions data from the EU Emissions Trading Scheme (ETS), the results of which are presented in Figure 8.

Implications for sustainability, resource efficiency & competitiveness

Industrial GVA growth required proportionally more inputs in most sectors

At the same time as productivity and specialisation have increased, it is notable that the pace of consumption of intermediate inputs also increased. Increases in industrial GVA have been achieved with proportionally higher increases in volumes of intermediate inputs. This relationship points at reduced marginal added value per unit of output, reflecting longer and more complex value chains, often involving increased global competition and the complex blend of inputs needed to meet consumer demands. Only two sectors, electrical and optical equipment and agriculture run counter this trend, and then only by a small amount.

Decline in some industrial sectors is being partly offset by expansion in eco-industries

The structural change taking place in traditional

industry is particularly noticeable in terms of the decline in employment, which averaged almost 250,000 jobs per year. Eco-innovation and the transition to a more sustainable economy and industry offer ways to partly offset these job losses. In recent years, the 'eco-industries' have been expanding rapidly in the EU, growing to become a sector equivalent (in terms of employment) to chemicals or electrical and optical equipment. Annual employment growth between 1999 and 2008 has averaged approximately 180,000 jobs per year in this sector, representing over 7% annual growth, and in 2008 it was estimated to employ 3.4 million people across the EU. However, eco-innovation and sustainable industrial growth are not the exclusive domain of certain sectors. Rather, they have the potential to create new jobs and increase efficiency and productivity across all firms, sectors and the whole economy.

Eco-innovation and the transition to a more sustainable economy and industry are the pathways to future EU growth and competitiveness





EU industry - sustainability and resource efficiency performance

2.2

Introduction

The economic performance data shows that industry grew by over 22% in the EU from 1995-2007. Without improvements to the sustainability and resource efficiency of industry, it would be expected that associated environmental and resource use indicators should chart a similar course, increasing by over 20%. This section presents the actual progress made, evidencing decoupling of impacts of varying extents and the improvements made by EU industry. Evidence for decoupling is examined in terms of key sustainability and resource efficiency indicators such as energy use, Greenhouse Gas (GHG) emissions, resource use, waste generation and treatment, water use and air pollution.

Significant progress has been made and is continuing

The overall picture from the EU industrial eco-performance is one of a significant progress towards decoupling of economic growth and environmental impact over the past two decades, with greater sustainability and resource efficiency in industry playing an important role within this. Overall, there is a large body of evidence pointing to, at least, relative decoupling, and in many cases absolute decoupling, of GVA from environmental impacts across industry. This is particularly true in respect of energy, GHG as well as other emissions and water use.

Changes in the energy sector have led the way... improving resource efficiency is the next step

Changes in the energy sector have been important to improvements, with energy use being a major factor in sustainable performance. Policy intervention has been important in driving positive trends in this sector. Relative decoupling is also apparent in material consumption, but not to the same extent as in the other aspects, with consumption continuing to increase, although at the same time resource efficiency is also improving, as are waste generation and treatment trends.

The financial crisis reduced environmental impacts, but with recovery these are growing again

Most data sources for sustainable industrial performance only run to 2007 or 2008, this means a clear picture of the effects of the financial crisis is not yet visible. The data that is emerging, suggests that environmental impact has tracked the falls in economic output, with declines of 5-10% estimated by some measures of fossil fuel consumption and emissions. The latest preliminary data from the EU ETS for 2010 suggests that this effect is quickly being eroded as industrial production recovers. This reinforces the need for action, with particular attention on how industrial sustainability and resource efficiency can go hand-in-hand with improved industrial competitiveness and employment.

Changes in the energy sector have been important to improvements, with energy use being a major factor in sustainable performance

Energy use

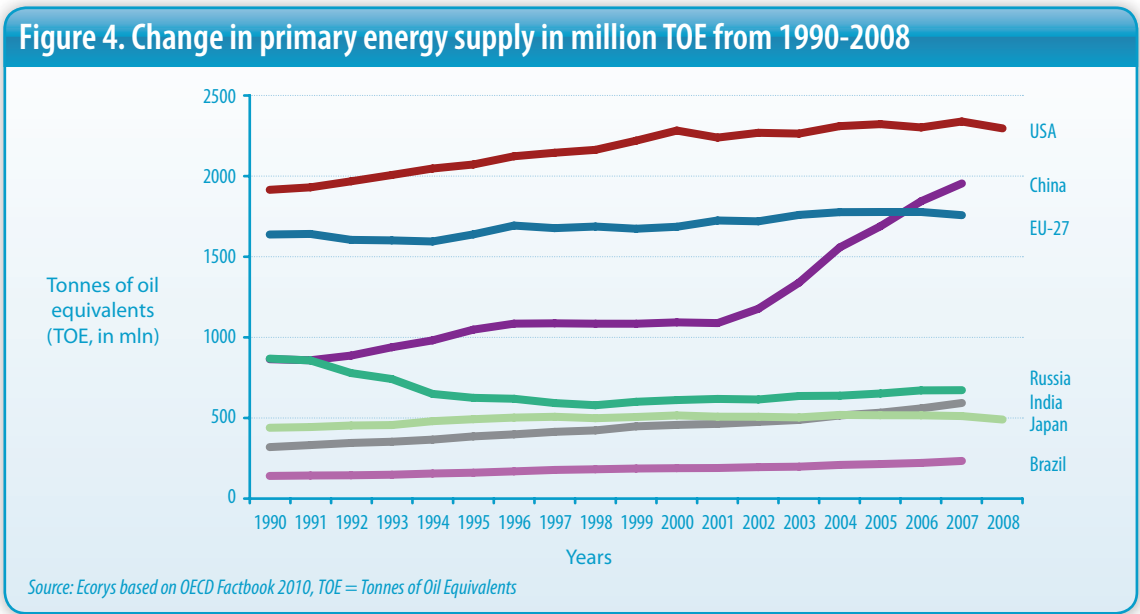
Energy is necessary for the functioning of the economy and industry; it also contributes directly to a variety of environmental impacts such as GHG emissions, air and water pollution, making sustainability a key concern. Resource efficiency is also highly relevant to energy use, through the consumption of fossil fuel and other resources in energy generation, and the indirect effects attributable to their extraction, use and waste. These and other factors have made energy an increasingly important subject of policy action and objectives, with decoupling of energy use from environmental impact, a core objective.

Energy use is measured in terms of either Primary Energy Supply or Final Energy Consumption (FEC), both typically measured in terms of tonnes of oil equivalent. This is based on the calorific value of a tonne of oil, and through various conversion factors, all forms of energy consumed in an economy, such as electricity, transport fuel and heating fuels, can be measured in this way. Primary energy supply measures the input of all fuels into energy use and therefore includes energy lost in generation and transmission, while final energy consumption is a measure of the energy delivered and used by end-consumers.

EU energy consumption is relatively stable...but global consumption is increasing rapidly

The primary energy supply (consumption) of selected global economies is shown in Figure 4 and this demonstrates that since 1990 the picture among leading economies has generally been one of growth. The biggest change by far has been the massive increase (+87%) in energy

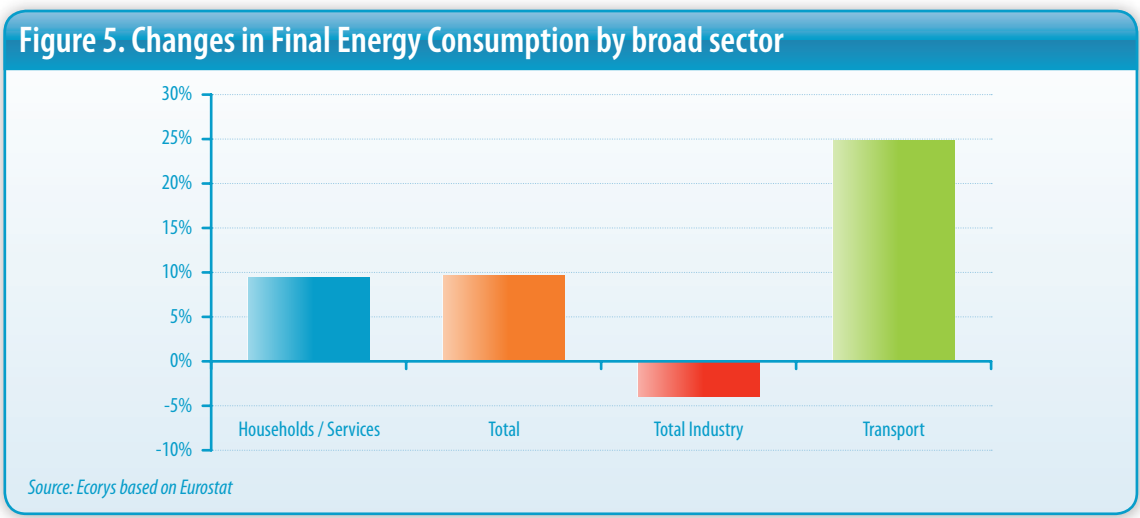
consumption in China, particularly since 2001. The US and India (+54%) have also exhibited strong growth trends, while EU-27 energy consumption has grown slowly, increasing by 7.4% from 1995-2007, although it has been relatively stable in recent years. These changes are likely to reflect a level of 'export' of energy intensive production from the EU to countries such as China.



EU industry has been leading energy saving and efficiency trends

EU industry is a driving force behind increased energy efficiency and saving in the EU. With energy a significant input into many industrial processes, it also becomes an important area for firms to address. Overall, this has resulted in a decline in industry final energy consumption of

4% between 1995 and 2008. This is in stark contrast to increasing overall final energy consumption (+9.7%), driven by increased households and services (+9.5%) and transport sector (+24.9%) energy use. This should be seen in the context of industry being responsible for approximately 27% of total final energy consumption, transport 32% and households and services 41%.





The energy mix and the role of renewable energy

All in all, the extent to which energy consumption is unsustainable or resource inefficient is a factor of the energy mix. Choices for fuels and energy sources within an energy mix are affected by many factors, including local resource availability, energy prices and public policies.

Consumption of renewable energy has increased by over 70% in the EU since 1995

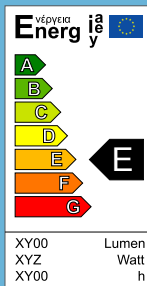
The promotion of renewable energy has been a major element of public policy in the EU and most Member States for the last 10-20 years. Energy from renewable sources stood at 357

TWh in 1995, this had risen to 608 TWh by 2008, representing an increase of 70%. This growth has been driven from a base that was derived largely from hydro-power and some biomass to expand to include significant wind, solar, geothermal and other sources. For example, EU wind energy capacity had risen to 65,247 MW by 2008, a massive increase and one that is continuing with double digit growth in most years. Overall, this growth in renewables, alongside growth in the overall energy supply has translated into the share of renewable energy in the EU-27 electricity generation energy mix increasing from 13% in 1995 to 16.7% in 2008.

Public policies can promote energy efficiency and sustainable growth through a broad range of instruments (such as energy taxes and subsidies, regulations and standards, eco-design, eco-labels).

Energy labelling for light bulbs: promoting sustainable consumption, production and eco-innovation

Energy labelling is a regulation that sets out mandatory labelling requirements for light bulbs, cars, and most electronic appliances in the EU, and is designed to provide a consumer-oriented approach towards more sustainable consumption and production. In the case of lightbulbs the energy-efficiency labelling scheme has achieved clear positive effects on both eco-performance (energy-efficiency improvement) and economic performance (higher-value added products and stimulating innovation).



As of December 2008, minimum energy-efficiency requirements on light bulbs have been enforced with the goal of phasing out incandescent bulbs by 2012. Compared to incandescent bulbs ('E-G' level lamps), Compact Fluorescent Lamps (CFLs) (level 'A' lamps) can save up to 80% of energy for the same light output and have a lifetime that is six to fifteen times longer.

The development and market penetration of Compact Fluorescent Lamps (CFLs) ran ahead of the regulation, with sales of CFLs increasing by 340 percent from 2003 to 2007 (Bertoldi and Atanasiu, 2009). Industry has also taken up a proactive role in developing and marketing more sustainable lighting alternatives.

Energy intensity

The EU and Japan are global leaders in energy efficiency

Energy intensity is a measure of FEC relative to changes in GVA (or GDP) and useful for measuring how efficiently energy use is made economically productive. Traditionally Japan has been the leading global economy in terms of lower energy intensity, a factor of its highly efficient and high value industry and

other socio-economic factors in energy use. The US on the other hand has typically been much more energy intense, with the EU in between the two. In recent years, the EU-27 has successfully narrowed the gap with Japan, improving its energy intensity considerably; indeed it has achieved the biggest relative improvement to its energy intensity of these 3 major economies.



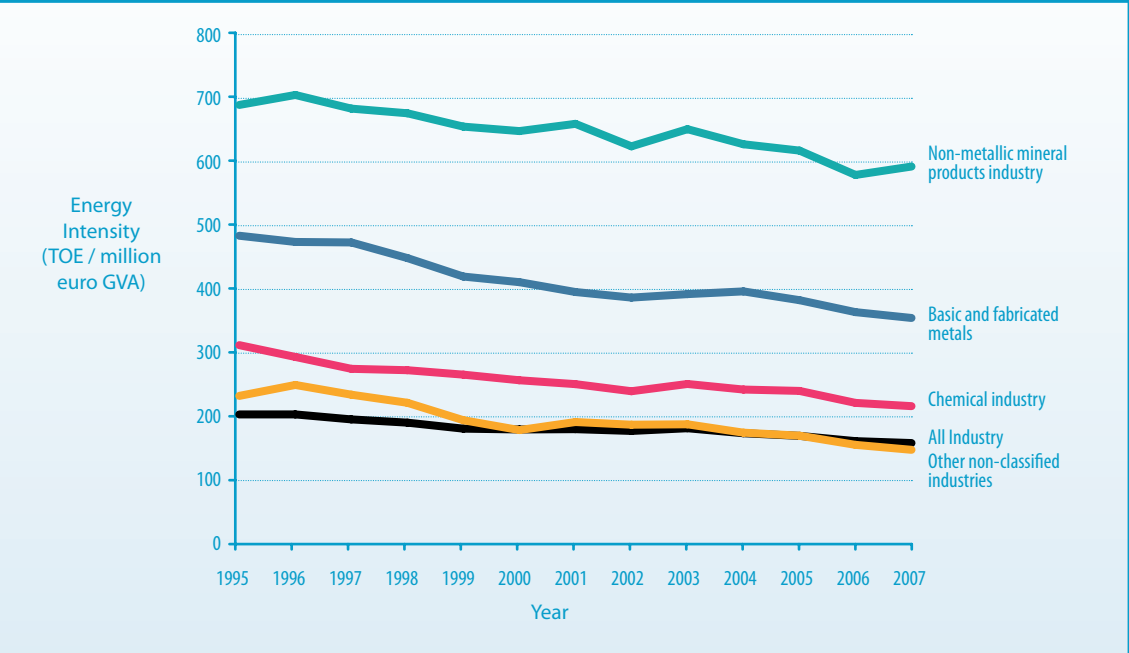
Sectoral energy intensity trends are largely positive

Within industry itself, it is possible to distinguish intensity trends for certain manufacturing sectors. Figure 6 presents these trends between 1995 and 2008 for the EU. This shows a favourable overall picture, reflecting the fact that most sectors, except for the paper, pulp and publishing, the food, drink and tobacco and the ore extraction sectors (not displayed), were able to improve their energy intensity.

Interestingly, some of the sectors with the highest initial energy intensities achieved some of the largest improvements, for example the basic and fabricated metals sector (i.e. iron and steel and non-ferrous metals industries) saw an improvement in its energy intensity of 22.2% from 1990 - 2008, with the downward trend continuing until 2007-8, when a significant fall in GVA led to an increase in intensity. The chemical industry noted a 25.7% improvement over the whole period, although this has somewhat levelled off in recent years.

The first effects of the financial crisis on industry can also be observed in some countries, with falls of around 10% in industrial GVA recorded in most.

Figure 6. Energy intensity per sector (final energy consumption (in TOE)/GVA in millions of Euros (1995 constant prices)) between 1995-2007



Source: Eurostat and EU KLEMS data (Ecorys calculations)





An example: changes to production processes in the steel industry

Primary steel is produced by reducing iron ores to iron. Converting iron into steel accounts for about 75% of world steel production. Among the main environmental concerns for the steel industry is energy consumption and the resulting CO₂ emissions. Energy requirements for the production of primary steel vary from 19.8 GJ/tonne to 41.6 GJ/tonne. The actual Figure depends on the steel grade produced and the technology used. The energy intensity averages for the main primary production routes are shown in this table:

Production route	Energy intensity	% of steel production
Blast furnace – basic oxygen furnace (primary steel)	19.8 – 31.2 GJ/tonne	66%
Blast furnace - open hearth furnace (primary steel)	26.4 – 41.6 GJ/tonne	3%
Direct reduction – electric arc furnace (primary steel)	28.3 – 30.9 GJ/tonne	6%
Electric arc furnace (secondary steel)	9.1 – 12.5 GJ/tonne	25%

Source: World Steel Association, 2008.

As energy constitutes a large portion of the production costs of steel (20-40%), manufacturers have strived to improve the efficiency of the production process. Consumption of reducing agents has been drastically reduced in the past decades. The most efficient steelmaking processes have optimised energy use by enhancing control of each step of the production chain. The process improvements (and the increase of recycling) have led to a reduction of about 50% in energy requirements and 60% in CO₂ emissions in the production of a tonne of crude steel over the past 40 years.

Greenhouse gas (GHG) emissions

Climate change is recognised as a major challenge for the world, requiring a move to a more sustainable and low-carbon economy. The role of industry in this is important as both a direct emitter and also as a major energy consumer, from which a large share of GHG emissions arise. Industry also has a vital role to play in developing innovative products and technological solutions to environmental challenges.

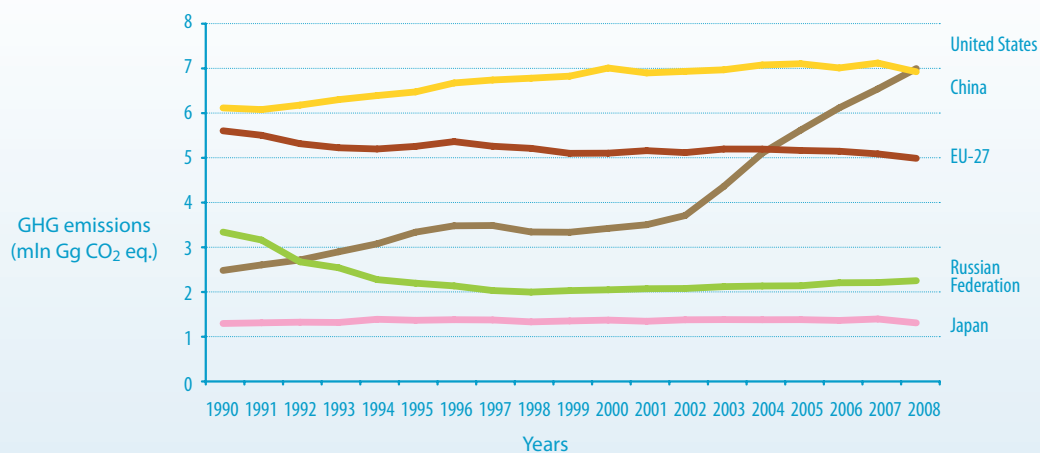
Global emissions are increasing...EU emissions have fallen...displaying absolute decoupling

Reflecting the changes in energy consumption, the biggest mover in global GHG emissions since 1990 has been China (see Figure 7) which has more than doubled its emissions since 1995, surpassing the EU-27 total, and by most estimates also the US,

to become the world's biggest GHG emitter. For the EU and US, the trends in total GHG emissions differ from the primary energy used, the EU-27 recording a decrease in emissions of 5.1% since 1995, while primary energy supply increased (+7.4%) and the US recorded slightly lower increases in emissions (+10%) than primary energy supply (+13%). This represents a decoupling of impacts, absolute in the EU and relative in the US, and is a result of measures in these economies to promote the use of renewable energy, energy efficient processes and trends to switch the fuel mix away from coal, the most carbon intensive energy source. Similar to these trends, and those in energy use, EU emissions intensity has improved over the period, closing in on Japan.



Figure 7. Total GHG emissions in millions of Gg of CO₂ equivalent from 1990-2008



Note: Data for China is based on CO₂ emissions data only as they are not obliged to report CO₂ equivalents data to the UNFCCC. It is estimated that CO₂ equivalent data would increase their emissions by approximately 8% based on proportions of the other countries.
Source: Ecorys based on UNFCCC. 1 Gigagram (Gg) = 1000 tonnes.

EU improved rapidly in the late 1990s...now continuing but more slowly

Trends in EU emissions showed the biggest improvements in the 1990s, this is a result of a variety of factors including the structural change in the former Eastern bloc economies and fuel switching from coal to gas in many Member States. While overall positive trends are continuing the improvement is slower, since the 'low hanging fruits' have now mostly been taken and some sectors are approaching technological limits in further reducing emissions.

There is some concern that the conditions in the 1990s presented one-off gains that may not be repeated. Although it was also noted from the analysis that while changes in GVA are likely to be a factor in emissions, the role of the energy mix and transport are both significant at the whole economy level.

12 EU Member States achieved absolute decoupling of emissions from GVA growth

This is an impressive achievement and is also interesting as the twelve include both EU-15 and EU-10 Member States, showing that EU-10 Member States can undertake a more sustainable economic transition in terms of emissions. In addition to this every Member State achieved either absolute or relative decoupling of economic growth from GHG emissions.

A result of more sustainable performance...but possibly also 'offshoring' of industrial emissions

The observed decoupling effects are the result of various factors and successful policy implementation, including improved efficiency, cleaner power generation and more renewables in the energy mix. A further factor is the potential export or offshoring of emissions, as heavier manufacturing is relocated outside the EU, presenting a domestic emissions decline, although the production may still then be imported and consumed within the EU.

Industrial emissions

EU industry achieving absolute decoupling of industrial emissions from GVA growth in majority of Member States

The primary GHG emissions data reported to the UNFCCC does not align with the standard economic sectors and industrial classifications,

so it is not possible to form a clear view on GHG emissions and intensities on a sector basis. At the broad industrial level, covered by the UNFCCC category 'manufacturing and construction' emissions it was evident, by comparing to equivalent changes in GVA, that the EU, as a whole



and 17 of the 23 Member States for which data was available, achieved absolute decoupling of industrial GHG emissions from industrial GVA.

EU ETS confirms most Member States achieved industrial emissions reductions

It is possible to draw a more nuanced view of sector level emissions in the EU by drawing on data from the CITL database, compiled as part of the EU ETS. This records and verifies emissions from the largest energy generating and industrial installations across the EU, representing around 40% of total EU-27 emissions and with around 98-99% of the data being for industry as defined here. Data is available from 2005-2010, although data analysis for 2009 and 2010 is provisional at this stage.

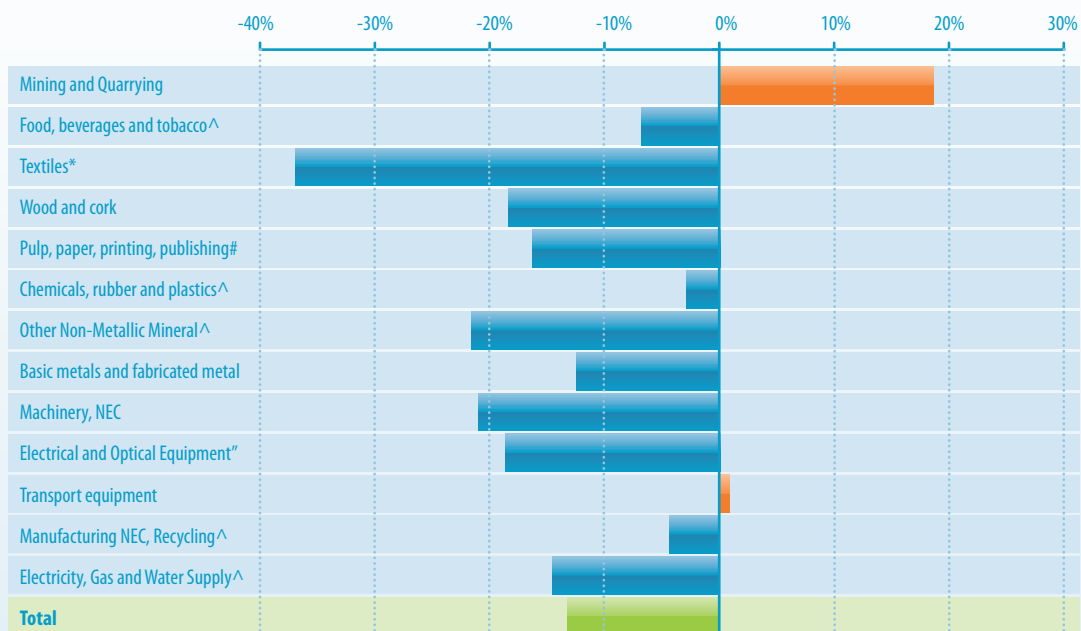
Sector emissions down strongly, particularly in electricity generation sector, although recession may be a factor

Analysis of the data at the sectoral level shows (see Figure 8) that overall industrial emissions under the EU ETS declined by an estimated 13.1%

between 2005-2010, though the financial crisis and ensuing recession may account for part of this. The biggest emitting sector by far is the electricity sector, accounting for around 65% of all emissions under the EU ETS. The decline in emissions from this sector of 14.4% is a major factor in the overall decline in emissions. The move to partial auctioning in some Member States (for example in the UK) of EU ETS permits for the energy sector and continuing expansion of renewable energy are among the factors at work. Other sectors such as the manufacture of basic metals, non-metallic minerals, optical equipment, chemicals and food, drink and tobacco all also saw emissions decreases.

Two sectors saw emissions increase in this period, mining and quarrying (+18.7%), and the manufacture of transport equipment (+1.1%), although together these account for only 1.9% of total emissions. These increases in emissions are centred on increased emissions from the oil and gas extraction industries and a significant increase from a major vehicle manufacturer.

Figure 8. EU-25 ETS Change in industry sector GHG emissions 2005-2010



Source: Ecorys based on CITL data, unless noted below all data estimated to be within 5% margin of error.
 * - Significant data concerns (estimated >5% of installations/emissions non-reported) in all years.
 # - Data concerns in 2009 & 2010 data ^ - Data concerns in 2010 data " - Data only for 2007-2010
 N.B. in 2007, approximately 98.7% of total emissions were allocated to a specific sector, in 2010 92.9% were allocated.

Material Resources

The way in which industries use and dispose of raw materials is a critical component of their environmental impact and sustainability. The extraction of each raw resource material places environmental pressure on the location from which it is sourced. It is therefore important to consider the impact of material flows, resource efficiency and then through the lifecycle, how the resources or materials are disposed of. A variety of measures have been developed for this purpose, although this type of statistical analysis is relatively new and the different characteristics of resources in volumes, toxicities, etc; impact upon the ability to reasonably measure them.

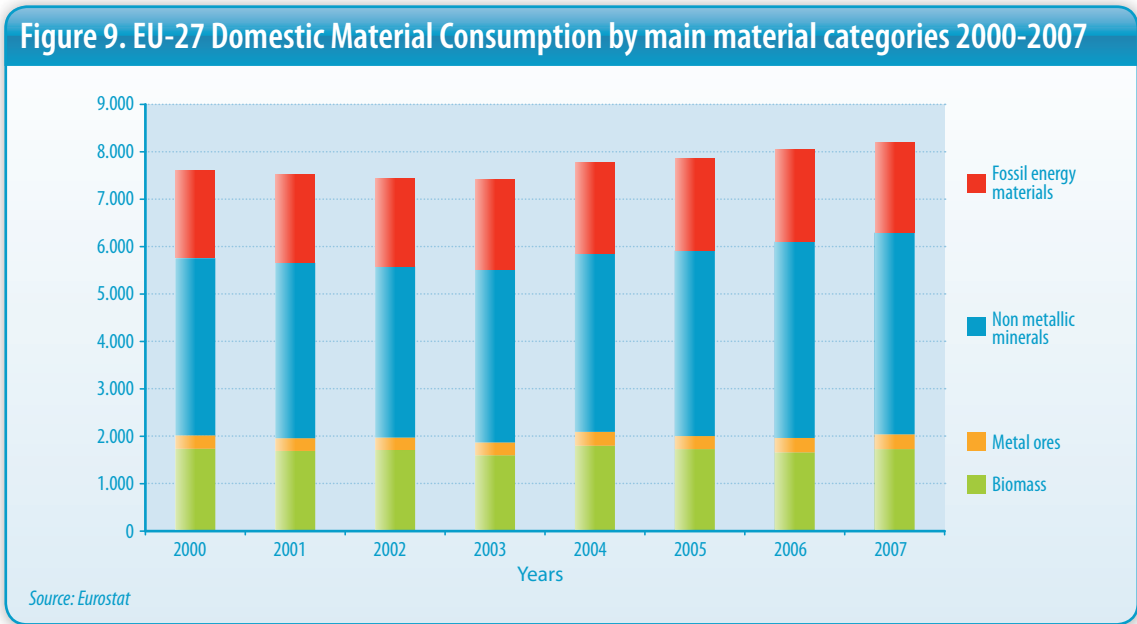
Domestic material consumption (DMC)

DMC is a measure of the volume (in tonnes) of materials directly consumed in an economy, and is a sum of all materials extracted domestically plus those materials in physical imports, minus those materials in physical exports. This indicator is far from perfect: as a volume measure, it is important to note that DMC

does not differentiate the type of material consumed, although it is important to note the differences between, for example, consuming one tonne of wood versus one tonne of mercury, as obviously the potential environmental implications of the latter are far more significant. DMC can be reduced through greater re-use and recycling of materials.

EU DMC increased by 7.9% between 2000 and 2007...

As shown in Figure 9 DMC has been increasing in the EU since 2000, rising by 7.9%, or approximately 1% each year. The figure presents DMC over the four main materials categories: fossil energy (carrier) materials, biomass, non-metallic minerals and metal ores; and shows that consumption of biomass declined by 0.4%, but metal ore consumption increased by over 10% and non-metallic mineral consumption by 13.9%. Fossil fuel consumption grew by 3.2% in keeping with overall growth in energy consumption in the EU-27 over this period.



...but six Member States may have achieved absolute decoupling of DMC from industrial GVA growth

When comparing DMC against industrial GVA changes, Italy, Germany, the UK, the Netherlands, Luxembourg and Hungary, all achieved a reduction in materials consumption with increasing industrial GVA, pointing towards an absolute decoupling of material use. 11 other

Member States achieved relative decoupling by this measure, while the remaining eight Member States saw their DMC grow faster than industrial GVA.

Resource (materials) productivity - Industry

This is a measure of productivity derived by measuring the EUR of GVA from industry, per tonne of DMC for the whole economy.



EU industrial materials productivity improved by 5.2% between 2000-2007

Materials productivity for the EU-25 was 0.32 Euros of industrial GVA per tonne of DMC and improved by 0.02 EUR or 5.2% from 2000-07 (see Figure 10). This improvement represents limited evidence of a relative decoupling of industrial GVA from material use.

Significant differences in performance exist between Member States

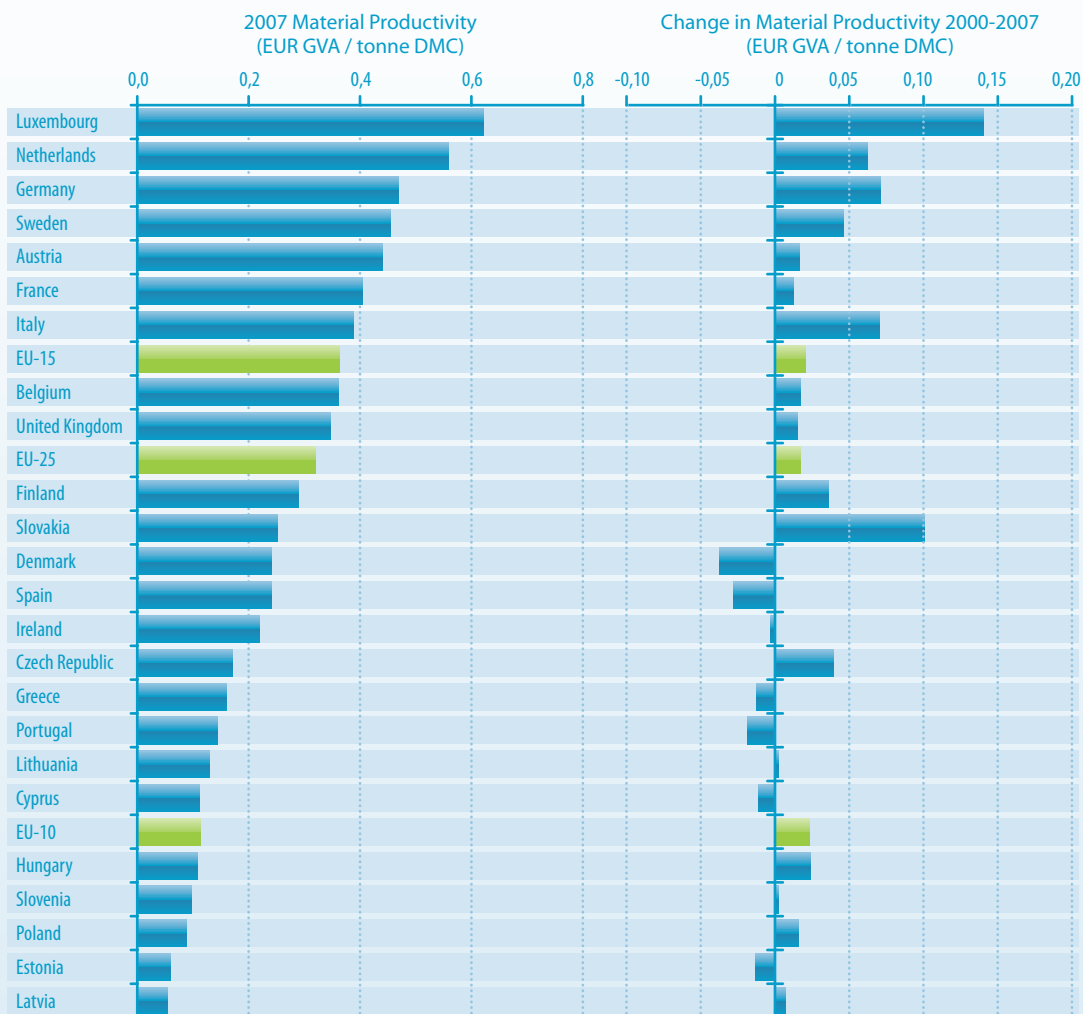
One of the major differences evident from the figure is that between the EU-15 and EU-10 economies, with materials productivity being more than 3 times higher in the EU-15 (0.36)

than in the EU-10 (0.10). The best performing economies by this measure are Luxembourg, the Netherlands and Germany, broadly consistent with the data on DMC. Strong expansion in the construction sector was the primary factor in the eight Member States that experienced a reduction in material productivity.

Newer Member States are improving quickly

The biggest relative improvements in materials productivity, of greater than 20% over the period, came in Slovakia, Czech Republic, Hungary, Luxembourg, Italy and Poland, illustrating the catching up process in some of the newer Member States.

Figure 10. 2007 EU-25 Material productivity – EUR GVA Industry (1995 constant prices) per tonne of DMC in 2007 and Change in Materials Productivity 2000-2007



Source: Ecorys based on Eurostat (DMC) and EU KLEMS (GVA) data

Waste

Waste generation

The production process in industry creates waste at various stages, examining trends in the volume of waste generation by industry provides insight into changes in the absolute and, by relating back to GVA, relative impact of industry. Waste is no longer being seen as something one gets rid of by landfilling; it is increasingly being recognised as important resources for industries, which is important to ensure that proper framework conditions exist for waste and by-products to be used as inputs to other industries whenever possible.

EU industry is leading the way in reducing its waste generation - down 8.6% between 2004 and 2008

Total waste generation data for the EU-27 industry⁴ are presented in Figure 11, this shows that the total amount of waste generated in the EU fell by 8.6%, from 2 441 million tonnes, to 2 232 million tonnes, between 2004 and 2008. This compares to total waste for the whole economy of 2 394 million tonnes in 2008, and a decline in waste generated of 8.1% in the same period, indicating industry is reducing its waste generation faster than the wider economy and leading the way in resource efficiency.

Construction and mining and quarrying are by far the biggest waste generating sectors

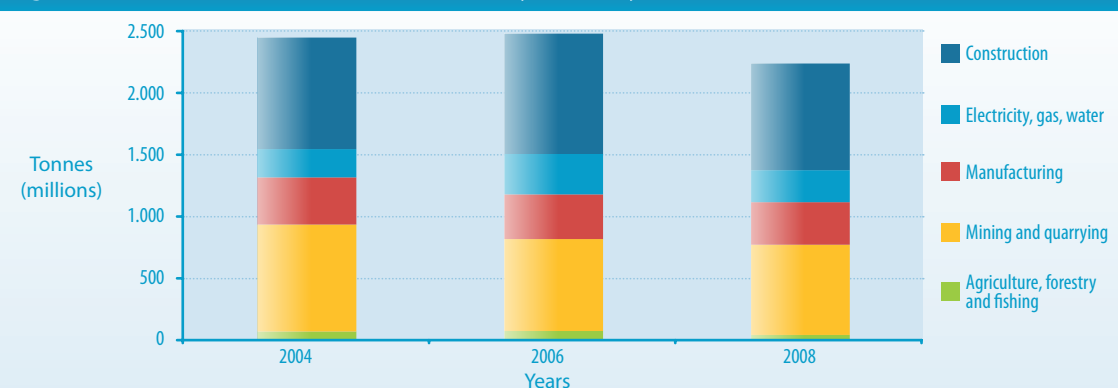
The figure also shows clearly that the two sectors that generate the largest amount of waste are

construction and mining and quarrying. The overall trend is interesting, with a 4.8% rise in the total waste generated from 2004-2006, fuelled by an increase in waste generation from the electricity, gas and water sector (+42.7%) and the construction sector (+7.9%). Over the same period a decrease was experienced in the volume of waste generated from the mining and quarrying (-14.1%) and manufacturing (-5.2%) sectors. From 2006-2008, there was a significant decline (-11%) in the volume of waste generated, with the biggest declines arising in agriculture (-41.4%) and electricity, gas and water (-20.8%).

Decoupling of waste from GVA is evident across the manufacturing sectors...

Looking deeper, and comparing the change in waste generation by sector, against GVA change, for the period 2004-2006, it is possible to detect some evidence for an absolute decoupling of waste generation in certain sectors. This includes Manufacturing as a whole and the Electrical, Optical and Transport Equipment, Basic and Fabricated metals, Food, Beverages and Tobacco (FBT), Chemicals and Wood and Wood Products (WWP) sectors. While relative decoupling, with the generation of waste increasing at a slower rate than GVA, is evident in all but four of the other sectors, including construction which is noted as being one of the most resource intensive industries.

Figure 11. EU-27 Total Waste Generation by industry (NACE rev.2 A-F) 2004-2008



Source: Ecorys based on Eurostat data

⁴ This is for NACE rev.2 categories A-F. While the category headers are similar to NACE rev.1.1 there are differences in their composition. The focus on solely the industrial sectors A-F represents 93-94% of waste generated across all NACE categories and 83.8%-86.3% of all NACE category and Household waste generated in this period across the whole EU-27.



Waste treatment

The way in which waste materials and products are disposed of has an important bearing on the sustainability of society. The waste hierarchy as laid down in the Waste Framework Directive (2008/98/EC) defines the preferred approach to waste treatment. The preferred option is to reduce the amount of waste generated. If this isn't possible then the hierarchy ensures that no down-cycling takes place and that disposal / landfilling is limited as much as possible.

Data on waste treatment represent the final three stages in the waste hierarchy - recycling, recovery (as energy) and disposal (to land, air or water).



Total waste treated increased by 1.6% between 2004-2008

Overall from 2004-2008, the total amount of waste sent for treatment increased by 1.6% from 2,353 million tonnes to 2,391 million tonnes. An increase in waste treatment could be regarded as a positive change, especially as waste increasingly is being seen as an input for manufacturing industry. Proper collection and re-use or recycling of waste holds an unlocked potential for businesses and for more resource efficient use of materials.

Recycling rates and energy recovery increased – disposal was reduced

Changes between the main treatment and disposal methods over the period were highlighted by a move towards greater recycling, increasing its share of waste treatment from 41.7% to 45.7% between 2004 and 2008 and an increase in energy recovery from 3.1% to 3.4%. At the same time, the disposal of waste through landfill decreased from 51.9% to 47.3%.

Water Use

Water is important to industrial processes

The efficiency with which industry uses water is important, although agriculture and residential use are the larger sources of demand, accounting for around 80% of demand in most Member States, industry accounts for the remaining 20%. Water is an increasingly precious and scarce resource in most Member States, it is also crucial to many industrial processes, therefore it is important that industrial needs are balanced against agricultural and domestic requirements, particularly in Member States

with high water scarcity, such as those in Southern Europe.

Water abstraction by industry has fallen by 24.2% between 1995-2007

The data in Figure 12 present total water abstraction – fresh surface water and groundwater – by the EU manufacturing industry between 1995 and 2007, and shows a decline of 24.2% from around 23 000 million m3 to 16 000 million m3. It should be noted that due to incomplete data sets, only 16 Member States are included in this figure.



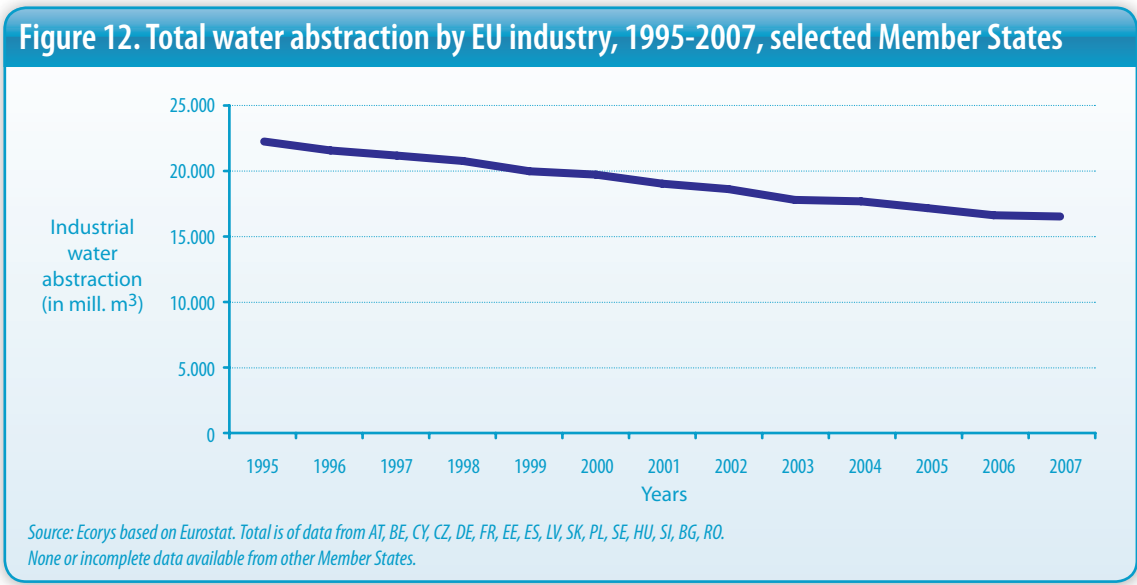


Decoupling of industrial water use was achieved, in almost all cases absolute decoupling

Absolute decoupling of water use from industrial GVA was achieved in all but 1 of the 16 Member States, Austria – with the reasons understood to be linked to strong industrial

growth in water intensive sectors such as Food Beverages and Tobacco, Chemicals and Paper, or Pulp and Publishing.

In Germany and France, the two biggest abstractors, abstraction fell by around 20% in this period.



Industry has achieved absolute or relative decoupling of growth from impact and resource use in almost every case

Other evidence of sustainable industrial performance

There are various other aspects affecting the sustainability of industry including its impact on land use, biodiversity and air pollution. Measures of these are of mixed quality. For air pollution, there has been a significant improvement in industrial emissions in the last 10-20 years. Since 1995, there have been falls of around 50% in particulates (PM10),

which are responsible for human respiratory problems, and over 50% falls in nitrogen oxide (NOx), ammonia (NH4) and Sulphur dioxide (SO2), the main pollutants responsible for acid rain. Reductions in these emissions are continuing, although they have slowed since the early impetus given by EU air pollution legislation.



How progress has been made

3

The progress made at the EU, Member States and sectoral level is an accumulation of a large number of measures adopted by the EU companies at a micro level. Looking at various sectors in Europe, one could observe that companies have taken the issue of resource efficiency seriously and translated that into their daily operations and strategies. Whether it is a deliberate or non-deliberate approach to resource efficiency, companies' strategies to increase efficiency followed two main strategies:

Strategy 1 using the material "right" → efficiency

3.1

Using the materials right means maximising the use of the materials available at hand. Although the measures undertaken by companies in this direction varied considerably among sectors, they were guided by three key principles:

Reducing the use of resources

Reduction of the use of resources is part and parcel of companies' strategies to increase the efficiency of their production and to reduce costs. Industries have reduced the use of resources by a variety of means, including introducing incremental measures, such as the use of end-of-pipe technology, training of staff or creating improved audit systems to monitor their performance with regard to resources.

End of pipe technology reduces impact

Companies used what is called in technical terms "end of pipe technologies", which consist of measures such as the introduction of waste water treatment plants, filters to reduce dust emissions or tightening water pipes, these mitigate against the negative environmental impacts of production.

Water consumption reduced... example from the food and drinks industry

A UK based food company "Burton's food" (UK), carried out a water use investigation in 2008, and found anomalies in water consumption which deserved further analysis. The analysis was done through a detailed sub-metering of water usage, and resulted in the identification of possible savings of 73,000 cubic meters of water, and the reduction of 42% in water used per tonne of product.

(Source: Food and Drink Federation - UK, Our Five Fold Environmental Ambition - Progress report 2009)

Increasing the efficiency of the material used and avoiding waste

Several industries in Europe managed to introduce new “green” business models that are more supportive to the efficient use of resources. Though they are not totally new ways of work, they are innovative in how they address the organization of work and management of business and divert the emphasis from “increased sales” towards “the increased added value” delivered by the service provider. This is typified by moves beyond simple product unit sales, to sale of products to customers defined by the services they provide, for example, not selling engine units but being contracted to provide the services of an engine (vehicle power), as this is what the consumer ultimately buys an engine for. As such, for the producer, the optimization of material usage and increasing efficiency are more valid targets than increasing the sales of resources, as, in this way margins can be increased against the agreed service contract price. This approach to business provides resource efficiency incentives that result in increased competitiveness and reduced environmental impact.

Example: The Chemical industry changed its business model

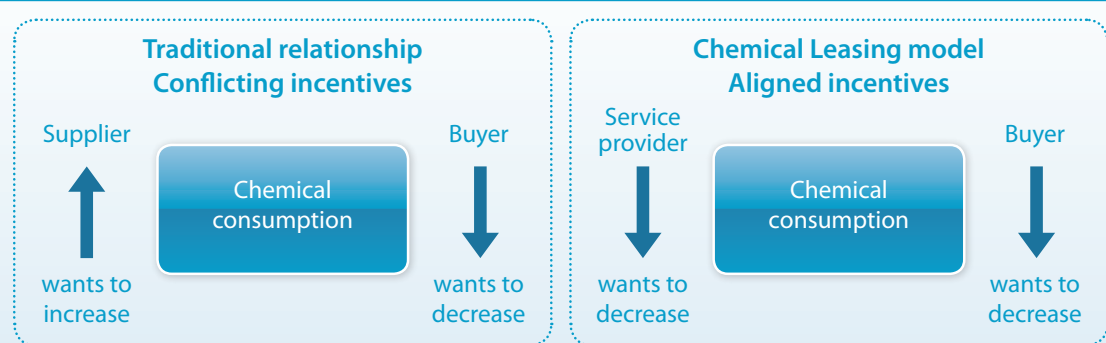
In order to increase efficiency and diversify into wider services, the concept of Chemical Leasing (ChL), a service related to the supply and use of chemicals, has evolved. Under ChL, the customer

pays for the chemical services and not for the physical chemical input itself. When applying ChL business models, the producer not only provides the chemical materials, but also his know-how and expertise on how to reduce the consumption of chemicals and how to optimize the conditions of use. Against this background, ChL can be seen as a key element of sustainable chemicals management systems, with best practice spread from producers, resulting in more efficient use of resources and decreased environmental impact and with cost saving incentives and benefits to both consumers and producers. Figure 13 shows a simplified scheme of how it works.

Example: The use of green IT in the production process in the automotive industry

An overarching approach by the automobile industry to reduce resource use (material and natural resources as well as waste) along the entire production cycle includes Green-IT which helps to make the production processes more efficient and less resource intensive. Research focuses on the standardisation of components and the modularisation of sub-systems during production stages. Tools and methods for virtual manufacturing and engineering are seen as one option to improve

Figure 13. Scheme of chemical leasing



Source: Ecorys adapted from A. Priyadarshi (2005)

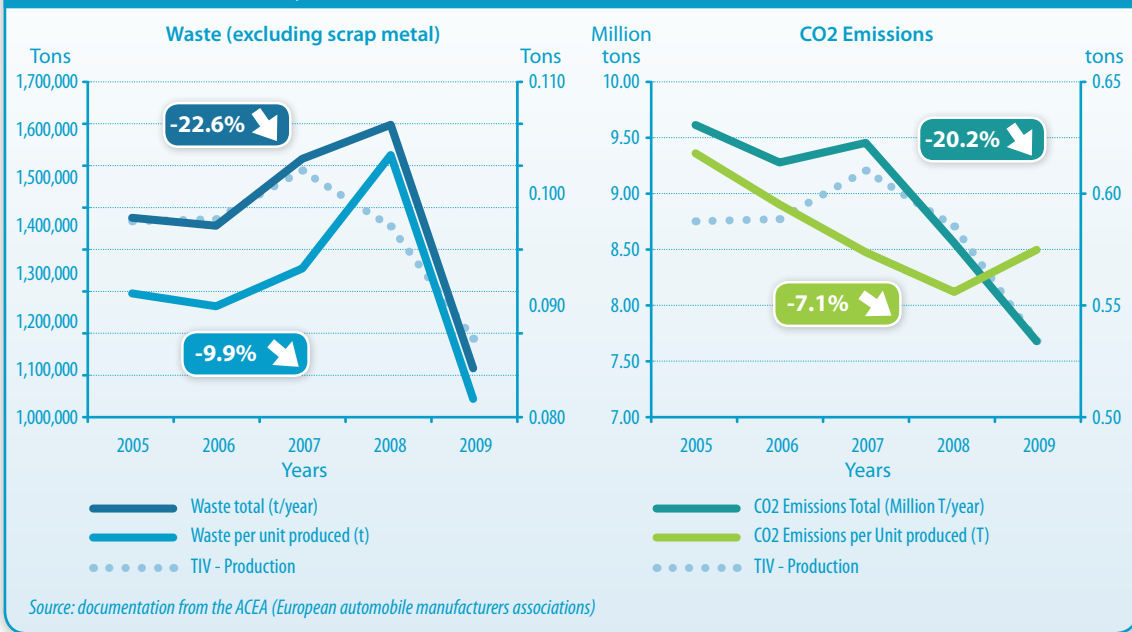




time to market, supplier integration and distributed engineering footprint. Resource efficiency is achieved at various levels of the industry. For

example, it reduced the amount of waste produced by a single unit of production by 9.9% and CO2 emission consumption by 7.1% from 2005 to 2009.

Figure 14. Reduction of waste and co2 emissions per unit of production. EU automotive industry



Waste from production is recycled and re-used in production wherever possible

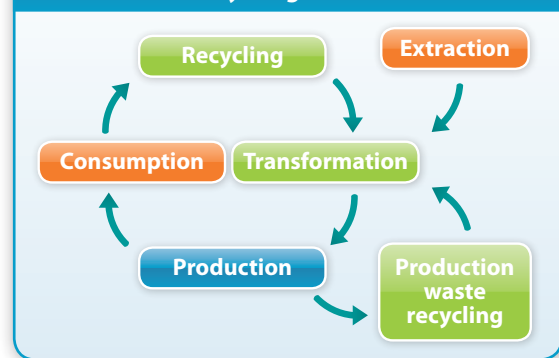
Many industries in Europe place substantial emphasis on the recycling of material and the reuse of material in production whenever technically possible and desirable from an environmental perspective. This reduces the need for, usually, more expensive new raw materials.

the waste created can be immediately recycled back to the furnace. Hence, the lifecycle of glass describes a loop where glass rejected in the production stage is redirected to the transformation stage where it is melted again and reintegrated back into the production process, as shown in Figure 15.

The Glass industry recycles, achieving substantial energy and resource savings

Glass making is a high-temperature, energy-intensive process. The energy used in production is provided either directly by the combustion of fossil fuels, by electrical heating or by a combination of both techniques. The use of recycled glass leads to substantial reduction in energy consumption, i.e. for every 10% of cullet, or recycled glass, used in the production process, a producer saves 2-3% energy compared to using raw materials. In many ways glass is an ideal recyclable material as it can be recycled 100% and endlessly without impact on the quality of the material. In the production process itself, all of

Figure 15. The glass production process and material recycling





Glass recycling in the Netherlands

In the Netherlands, glass recycling has substantially improved and reached from 87% in 2008 to 92% in 2009, thus exceeding the national goal of 90% recycling. There are a few factors that contributed to this progress:

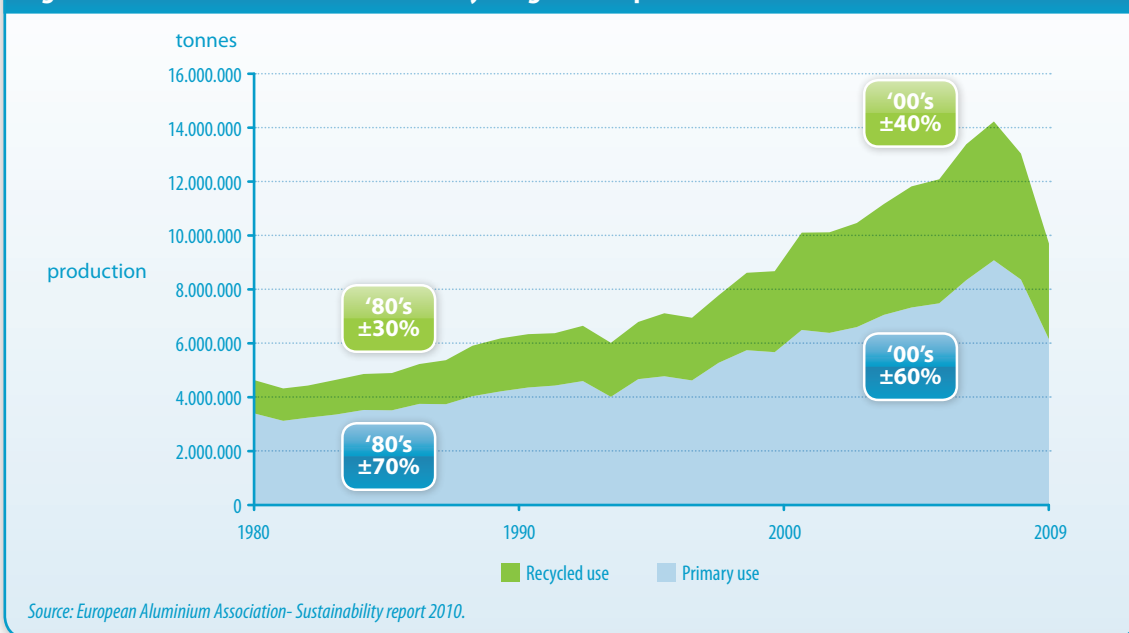
- The positive attitude of Dutch citizens towards recycling, stimulated by marketing campaigns that increased the awareness of Dutch citizens about recycling and improved their attitudes;
- The collaboration among partners in the recycling process such as the industry and municipalities, which led to a higher percentage of products recycled;
- The limited geographical space and early legislative measures taken by the Dutch government led to a higher percentage of waste recycling;
- Incentives for companies and citizens to recycle;
- The creation of organizations, such as Nedvang, which increased awareness and collaboration in the Dutch glass market;
- Over the years, the collection of glass underwent several innovations, including the separation by colour;
- The industry associated itself with networks such as 'Stichting Vlakglas Recycling Nederland' and 'Stichting Kringloopglas' that guide the glass recycling process from collection to processing and re-use;
- The collaboration between Dutch technical universities and recycling companies led to the use of state-of-the-art systems, giving the Netherlands a leading role in European glass recycling.

The Non-Ferrous Metal Industry also recycles and achieves substantial energy and resource savings

Non-ferrous metals include a large range of metals such as aluminium, copper, zinc, lithium, gold, tungsten and cobalt. These are vital resources in the production of several products which have become essential for modern society, from cars, to medical equipment and mobile phones. The non-ferrous metals industry is resource intensive; it is a heavy user of energy, of raw materials and of water.

Similar to the glass industry, the use of recycled material instead of virgin materials contributes significantly in reducing both the need for virgin material and the amount of energy used in production. In the case of the aluminium industry, for example, the use of secondary aluminium in production is equal to using up to 20 times less electricity compared to primary consumption. The recycling of aluminium in Europe has substantially increased from 1980 to 2009.

Figure 16. Evolution of aluminum recycling in Europe





But there remain limitations to what efficiency measures alone can achieve...

All the measures described above, which are aimed at increasing the efficiency of material use or “using the material right” are important strategies followed by companies. However, due to the nature of “natural resources”, there will always be a need for a minimum amount of virgin/primary material for production. For example in the case of the paper industry, the

use of recycled paper affects the quality of the paper produced, due the shortened length of fibres after recycling. Therefore increasing the efficiency of material is not sufficient to guarantee a long term vision for resource efficiency in the EU. Many industries have already gone beyond the technical limitations in efficiency of their current/available material and are exploring different ways to become more efficient...

*The efficiency approach to resource management achieves substantial benefits...
but there are limitations*

Strategy 2

Thinking outside the box...

using the “right” material → effectiveness

3.2

Many companies have gone beyond the limitations of existing materials by focusing on the opportunities created by thinking “outside the box” and by investigating the use of new substitute materials to reduce costs and improve production processes, with the added benefit that this can reduce reliance on primary natural resources. Let’s look at some examples.

New materials in the automotive industry have improved efficiency and safety for drivers and reduced resource use

The use of light, smart and innovative materials is essential for the automotive industry to meet environmental, safety and price demands. More and more customers are demanding better performance and better fuel efficiency, in effect, lighter and faster cars. This, combined with the environmental challenges to reduce the use of material, drives research in the automotive industry to develop new materials such as: carbon fibres, natural/glass fibres; high strength steels and aluminium; magnesium technologies; and hybrid materials. This, in turn, reduces the heavy reliance on natural resources.

New product designs in the electronics industry are a step-change in resource thinking

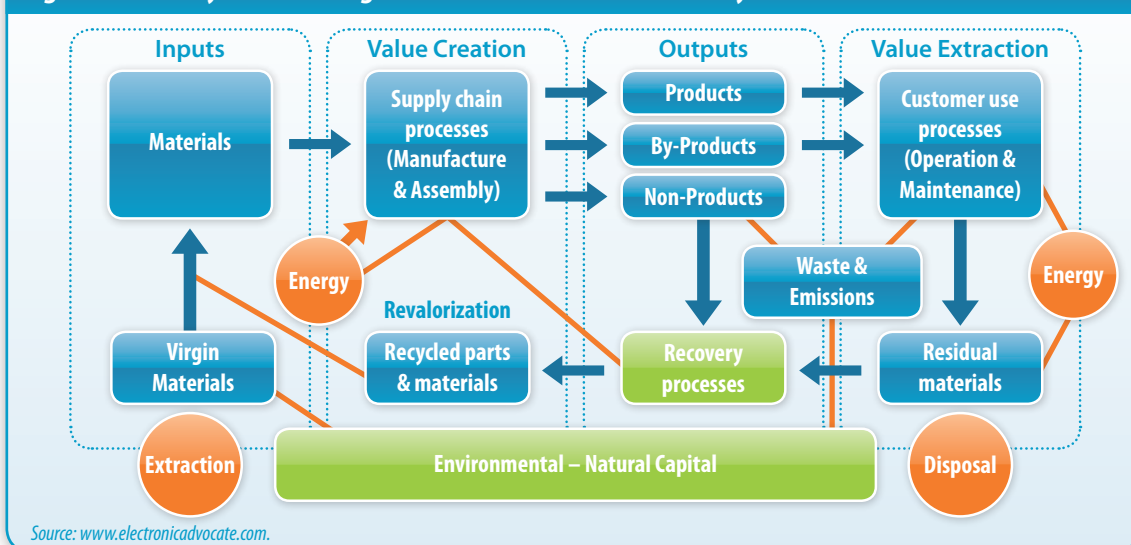
Leading electronics firms have adopted a business

practice called Design for Environment (DfE), aimed at taking the entire product life cycle and environmental impact into consideration when producing a new product. DfE focuses on four major aspects of product design:

1. Design for dematerialisation → aiming at minimising the material input as well as the associated energy and resource consumption at every stage of the life cycle;
2. Design for detoxification → aiming at minimising the potential for adverse human or ecological effects at every life cycle stage through the replacement of toxic or hazardous materials;
3. Design for revalorization → aiming at increasing the recycling rate of materials and resources in order to limit the extraction of virgin materials;
4. Design for capital protection and renewal → aiming at assuring that human, natural and economic capital stay available for production.

These are reflected in the product lifecycle in Figure 17. The implementation of these processes, embedding them into product thinking has the potential to significantly reduce costs to firms and also resource use.

Figure 17. Lifecycle flow diagram of the electronics industry



Source: www.electronicadvocate.com.

Alternative energy sources in the cement industry

Cement is one of the most important building materials used across the globe. In total, three billion tonnes of cement were produced worldwide in 2009, of which approximately 7% were produced in the European Union. The cement industry is a resource intensive industry. Energy and the atmosphere are the most important resources affected by its operations. The atmosphere is affected by CO2 emissions which result from the processing of both primary material and the use of energy during the clinker burning, thus making cement is a high emissions process, given the high carbon content materials and energy needs. Energy costs and CO2 emissions permit costs amount to 40% of the cost of cement production. As such, the cement

industry has moved to increasingly use waste as a substitute for primary materials and as fuel for energy generation. This ensures that both, natural primary materials and fuels are preserved and CO2 emissions are reduced.

Converting to alternative sources of energy has resulted in substantial progress in this area. In 2006, an estimated 5 million tonnes of coal were saved by using alternative fuels as fossil fuel substitutes, which counted for 18% of the energy requirements of the EU cement industry. This substitution rate is much higher than in other parts of the world, for example in North America, Japan, Australia and New Zealand the use of substitutes material accounts for around 11% of energy requirements, while the rest of the world had even lower substitution rates.

The Netherlands: ENCI

The ENCI plant in Maastricht (the Netherlands) has been working with the Limburg Purification board since 2000 for the purpose of the re-use of sewerage sludge as an alternative material for fuel. Eighty thousand tonnes of dried sludge are co-processed annually in the cement kiln.

Germany – CEMEX

The CEMEX plant in Rüdersdorf/ Germany is located in an area that produces close to three million metric tonnes of garbage per year. The plant uses alternative fuels such as animal meal and domestic wastes which represent 53% of total fuel and supplies 48% of total energy needs of the plant.

Italy- Italcement

Recently, the Italian company Italcement has introduced a type of transparent cement. The new product is expected to contribute to environmental sustainability as it allows more light in buildings and can save on the use of energy.



Drivers of sustainability and resource efficiency in industry

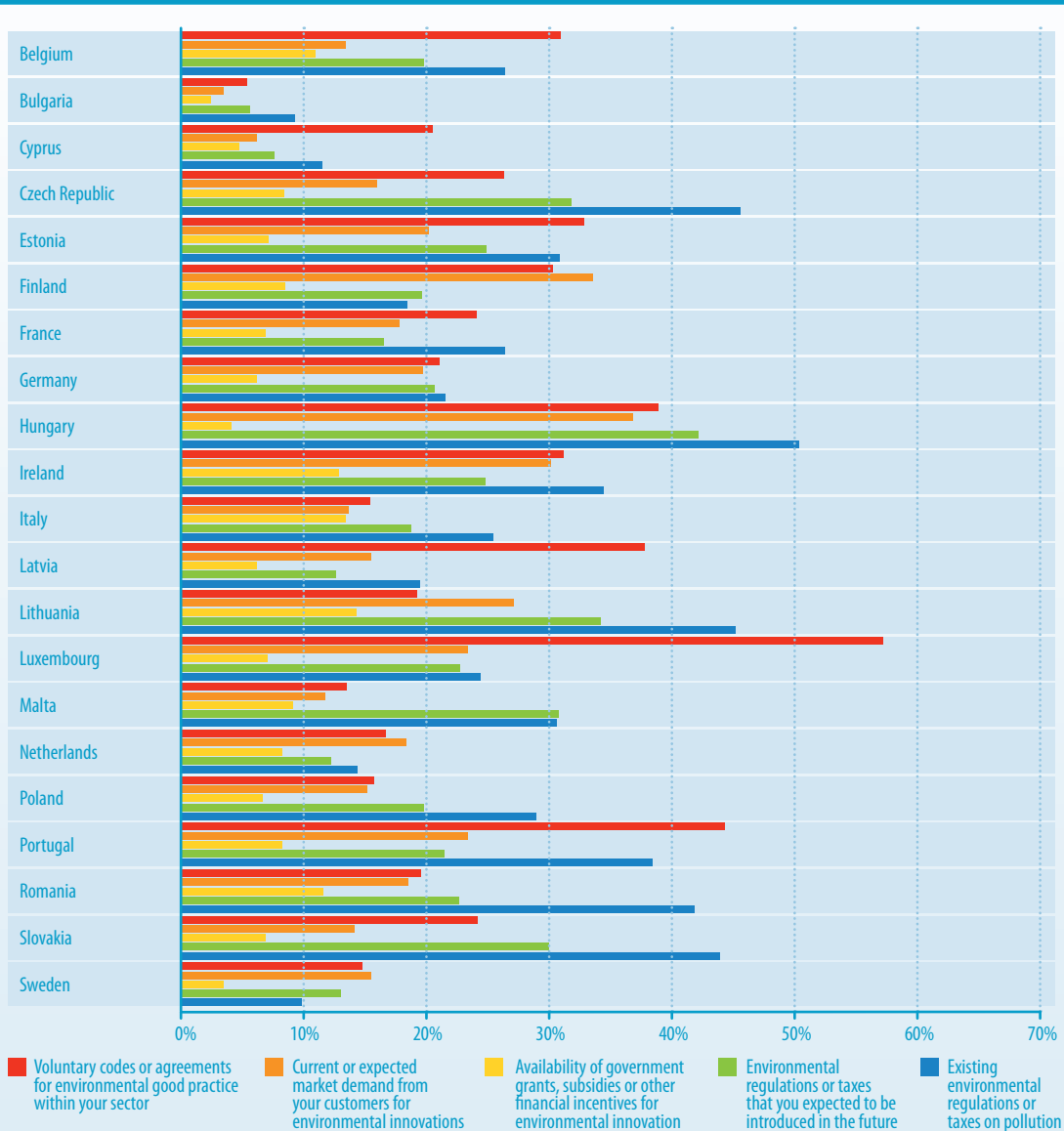
In short, industries adopted various measures towards improved sustainability and resource efficiency, but what was behind their actions?

EU regulations – remain a powerful driver

The current political context in the EU is characterised by rising political and societal pressures resulting from the increasing awareness about resource efficiency and the

accompanying regulations. Compliance with environmental regulations is a strong driver to resource efficiency and a push factor for firms towards more efficiency. The analysis of the Community Innovation Survey (CIS) 2008 (see figure) in relation to motivations for eco-innovation shows that firms' expenditure on environmental protection is strongly driven by compliance and regulation.

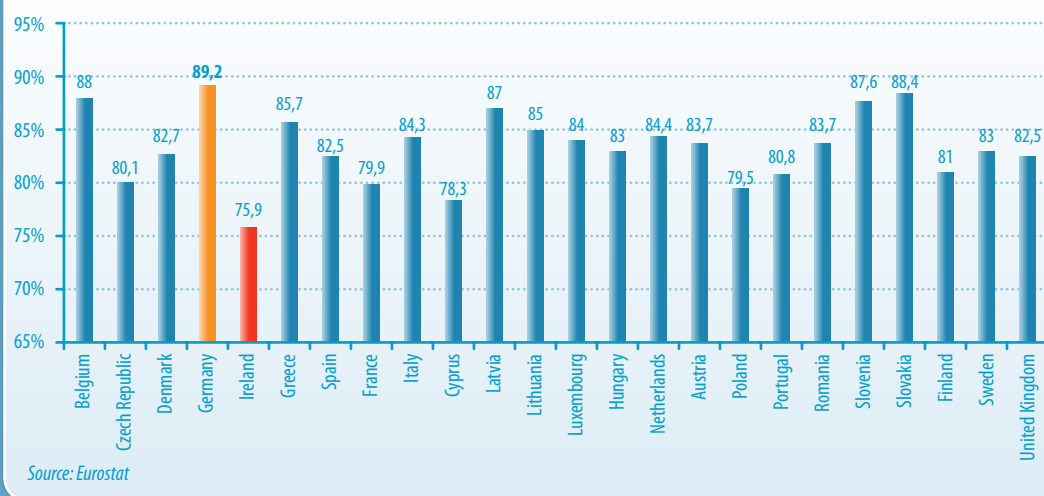
Figure 18. Community Innovation Survey 2008 results to question on motivations for adopting an environmental innovation



Regulation a success in achieving higher vehicle recycling rates

The effect of regulations can be clearly seen in the performance of industries at the EU level. The results of the End of Life Vehicle (ELV) directive are clearly seen in the re-use and recycling of end of life vehicles. The figure below presents the reuse and recycling rate of ELVs by Member State based on 2010 data for the year 2008. The highest recovery rates of end of life vehicles is in Germany (89,2 %) whereas it is lowest in Ireland (75,88%). The countries with high recycling rates are those with industry-led recycling systems (e.g. Netherlands) and those with free market approaches (e.g. Germany).

Figure 19. Reuse and recycling rate of ELVs by Member State in 2008



Although industry is often opposed to further regulation due to costs...

In general terms, for the industries directly affected, policy imposed changes were generally felt to be negative as they tend to increase costs. Many industries see potential risks with more stringent and rapidly changing EU regulations, producing higher levels of uncertainty and creating challenges for long term investments for industries.

...effective design of regulation can also be beneficial to industry

Yet in some cases, such as with energy-efficient Compact Fluorescent Light bulbs, a regulatory approach has helped create a market for products, that the producers had developed, that had significant environmental benefit but could not find purchase with consumers.

Increasing profit... reducing cost and improving productivity

The increasing competition over natural resources arising from industrialising economies and the

increasing prices of primary materials have triggered EU industries in moves towards resource efficiency as part of their strategy to cost reduction.

Investment in resource efficiency measures is part of the natural sequence of organizational learning

Looking at the two strategies adopted by companies, one could observe that the first strategy, which aims at maximizing the use of the existing material, i.e. using the MATERIAL RIGHT, and the second set of strategies which aimed at using the RIGHT MATERIAL are two sequential processes. They represent a natural process in organizational learning, where organizations start first to exploit the resources (resources here refers to financial, human, technological, and also the natural resources used in production) they have, and once they have achieved all potential gains from this exploitation they start a higher level process. This higher level process involves the "exploration" of alternative solutions, which usually happens through the increased emphasis on R&D.



What factors influence investment decisions?

One of the goals of resource efficiency is to manage and decrease production costs with a view to maintaining competitiveness. In their calculation of costs and benefits, investors consider a number of factors that interact together and affect either positively or negatively their decisions. These include:

1. The financial situation of the firm and financial aspects of the investment, including size, cost and return on investment;
2. The time horizon and uncertainty of an investment; in the case of an uncertain business environment, investors grow cautious about their long term investments and tend to focus on the short term;
3. The environmental regulations and standards in place related to the investment;
4. The cultural setting in which an investment takes place;
5. The market structure

Understanding and accommodating these factors can help in successfully designing policy measures.

A better corporate image

The competitiveness of firms does not only include the financial dimension, but also includes issues like the “corporate image” of the firm and “corporate social responsibility” aspects. More and more companies are placing a higher emphasis on their corporate image by demonstrating their respect to the environment and by taking measures towards that objective. In doing so, they ensure that this socially responsible image is well reflected through facts and figures on their websites.

Supply chain pressure is an increasingly important driver

The position of firms within the supply chain can, in many situations, induce the application of resource efficiency measures. For instance, buyers in the value chain, through the exercise of buyer power, drive suppliers to adopt measures or standards that would contribute to increasing sales of products or improve the corporate image of the retailers.

Biodiversity

Climate change

Environmental issues

Safety, Health & Environment Principles

SUSTAINABILITY

SUSTAINABILITY ISSUES

Climate change

Harnessing further potential

The analysis of trends and developments in the sustainability and resource efficiency of European industry has shown important improvements in the last 10-20 years. However, there are also signs that as efficiency levels increase, the pace of increase slows as further improvements become more difficult to achieve (low hanging fruit and the law of diminishing returns). It is therefore important to reassess the challenges, in light of the experiences discussed in previous sections, and the mix of policy instruments available to support these further improvements. The progress has also been a little uneven across sustainability measures:

Energy and climate change have been the main focus of sustainability policy...

To date over half of the major sustainability policy initiatives identified at Member State level have focused on energy efficiency and climate change. The number of policy initiatives identified in other dimensions of resource efficiency such as water and land is much lower.

...this trend has been changing more recently

With attention shifting towards sustainable consumption and production, green public procurement and, even more recently, resource-efficiency, these differences have been reflected in the trends in the sustainability of industry, with energy and emissions improvements running ahead of improvements in materials usage and resource efficiency.

What are the challenges to further improve sustainability and resource efficiency?

Incentives ... does everybody have the same incentives to increase resource efficiency?

The analysis of the value chains of various sectors in Europe showed that incentives along the supply chain are not necessarily aligned. For example, although the lifts industry can produce a highly resource efficient lift, for the lift's installation in a building, the developer who installs it may not be necessarily interested in a more "resource efficient" lift or escalator. For him, the criterion for the selection of a product is cheaper procurement or product familiarity and ease of installation, rather than a more environmentally friendly product.

In addition, financial incentives such as tax breaks and

subsidies, although evident in some sustainability aspects such as energy and emissions, are important elements largely missing for resource efficiency at EU level.

Also, there are two important challenges for SMEs; firstly, of being too small to qualify for eligibility for EU funding; and secondly, risk aversion among financial institutions reducing their willingness to support SMEs.

Existence of financial barriers can stifle progress

Financial barriers are particularly relevant for industries dominated by SMEs, such as the food and drink and chemical industries. Investment in



resource efficiency measures usually requires large upfront investments, which may not be affordable by SMEs, except through obtaining financial assistance from public or financial institutions. This is particularly true following the financial crisis in 2008-2009, where SMEs reported difficulties in access to credit. Accordingly, for SMEs, when loans applications are cumbersome or present unfavourable conditions to them, they have difficulty in making substantial investments in resource efficiency measures.

Long payback times on investments can also be problematic

The long pay back time for large investments is a challenge for firms of all sizes. The large capital investments sometimes required to fund sustainability or resource efficiency improvements often need to be passed onto product prices, these price increases may negate the commercial gains from improved image or reduced resource use. This can sometimes translate into a loss of market share and competitiveness.

Demand for more sustainable and resource efficient products can grow quickly but remains generally low

Trends in industries are evolving and certain products may not necessarily gain wide public acceptance, which may slow down resource efficiency improvements. For example, new technologies (e.g. electronic and paperless ticketing and payments via mobile phones) applied in some parts of the world (e.g. in Japan) have lower market penetration in Europe and are not widely used due to the lack of public acceptance. This latter is highly attributed to differing cultures

and people's habits across the EU. At this point in time, there appears only weak market demand for more resource efficient products, although the automotive industry illustrates a sector where, as fuel prices rise, efficiency is becoming increasingly important to consumers. Overall, consumer choices remain strongly influenced by considerations such as performance, price and their existing habits. As such, consumers' choices may not necessarily coincide with the more sustainable solutions.

Is our technology fulfilling our needs and ambitions?

Currently, the best available technologies (BAT) are not always widely used or adopted industry-wide. This happens for many reasons, including lack of access to finance, long pay back time and access to knowledge. For some industries, technological limits are beginning to be reached, such as for example in energy efficiency in the non-ferrous metals industry. When technical limits are reached there can be little incentive for further investment in sustainability and resource efficiency measures.

For other sectors, such as automotives, steel and cement, the problem is largely the opposite, in that there are promising sustainability and resource efficiency technologies in the pipeline, but these are unlikely to be fully deployed in the short term due to cost, sunk investments in existing technology or a variety of other factors. Therefore, even for industries that have access to BAT, there are challenges for significantly improving sustainability and resource efficiency. Further technological development is important to continue to push the boundaries of possibilities and reduce costs of existing technologies.



Do firms know enough about best practices?

This is an area where SMEs can be disadvantaged compared to larger enterprises. SMEs in general terms often lack the resources to actively seek access to knowledge, technology and best practices. This leads to sub-optimal sharing of best practice, resulting in firms only having limited information and knowledge on how to improve their resource efficiency. This problem is compounded by the fact that important information relevant to sustainability and resource efficiency is often missing from the EU context, such as:

- Data on the Life Cycle Analysis (LCA) of products;
- Sound methodologies to assess resource efficiency implications at the product and supply chain level; and
- Reliable data on waste collection, recycling and end-of-life.

How is the global market affecting this?

Thinking globally and acting locally...is an important notion for global sustainability and resource efficiency performance, but due to the nature of "natural resources", Europe is not a sole actor...its actions and measures affect and are affected by other global actors as well. Therefore, trade activities, particularly with regard to recovered materials and their export, affect the resource efficiency performance of the EU.

The relatively high cost of recycling for some industries- when the separation of recyclable material involves high labour costs (e.g. in the case of separating precious and non-ferrous metals from electronic goods) can make the export of scrap material more profitable than local recycling. Although the price of recycled material is lower than virgin material, increased competition over recycled material can result in price increases and can create difficulties for EU industries to access recycled material resources. This has already been occurring for copper scrap.

Potential gaps, duplication and overlaps in policies

There are various policy instruments addressing resource efficiency in the EU, they differ however by government level; at EU-level, regulatory instruments are widespread and powerful; fiscal instruments are strongest at Member States level, while subsidies are widespread at both Member States and sub-national (regional, local) level. Each type of policy instrument has its advantages and disadvantages. Waste legislation is an important example of this, with industry making the point that multinational firms face difficulties exporting waste to other countries (intra EU) as they have to comply with different technical specifications.

EU Member States focus on fiscal instruments – taxes and subsidies

The policy instruments used by Member States are dominated by fiscal market-based instruments (taxes and subsidies) as well as public investment, followed by regulation and self-regulation. Often times, overlaps and duplication exist between these policies, particularly regulation, within EU and across Member States. Conflict can also exist with fiscal instruments, for example, exemptions or rates reduction may work against increased investment in resource efficiency. This can prove a challenge to maintain and continue improvements in sustainability.

Weak enforcement can also be an issue

To some extent regulation is only as effective as its enforcement, if not adequately enforced non-compliance will proliferate. Lax enforcement was raised as an issue by industry in the case of light bulbs, where their compliance with new regulation on sale of incandescent bulbs was being undermined by weak enforcement. This created market space for non-compliant products, usually produced outside the EU.

Improvement is still possible and desirable...

Despite these challenges, the core arguments in favour of EU industry becoming more sustainable and resource efficient remain. Expressed in a simple





equation: improved sustainability and resource efficiency = improved competitiveness = economic success and improved environment = improved quality of life. This equation should be looked at as

an “ideal” situation. One must acknowledge that improvement in sustainability and resource efficiency incurs costs. These costs will only be affordable as long as companies still perceive benefits to them.

*...Challenges to further resource efficiency are faced within industry and also policies
...but there are also opportunities*

Opportunities for improvement in industry and policy

4.2

So how can industry, supported by policy, overcome these challenges and take advantage of the opportunities offered through improved sustainability and resource efficiency?

New ways of thinking in industry

The efficiency approach to resources, has been proven a successful means to manage resources and increase sustainability. However, for the long term vision of resource efficiency in the EU, there is a need for an approach that goes beyond this and develops opportunities and potential by thinking “outside the box”.

For companies, thinking outside the box means that they should be asking themselves these questions:

1. Are we using the right resources in our production process? Can we use different materials?
2. Can we change our products/ product design to make them more sustainable?

The practical examples presented in this brochure show the range of ideas and good practices emerging from industry. Part of the emphasis is on the introduction of alternative materials in production, as a way to change the sustainability profile of the final product. Eco-innovation and the importance of investment in research and

development are key factors in achieving these transformations.

Industries can work together better through industrial symbiosis

The by-products and other waste materials from industrial processes can often prove valuable resource inputs for other industries. By linking one firms’ resource demand to another firms’ waste streams, an industrial symbiosis can be created, thus reducing the need for new primary material use. In the food and drink industry, this happens as by-products are used as animal feeds. In the steel industry, the slag by-product can be used in cement production, road construction, and even as fertilizer in coastal marine blocks to facilitate coral growth. This type of dependency between industries is known as “industrial symbiosis” where industries should be able to find synergies and harmony in the way they operate, generating new income streams for waste producers and cost savings for users.

Industrial symbiosis has the added benefit of underpinning local and regional growth, creating clusters of firms in symbiosis that are unified in their interest in resource efficiency. The figure below is a simplified version of what constitutes “industrial symbiosis” in practical terms, using the real case example of the municipality of Kalundborg in Denmark.

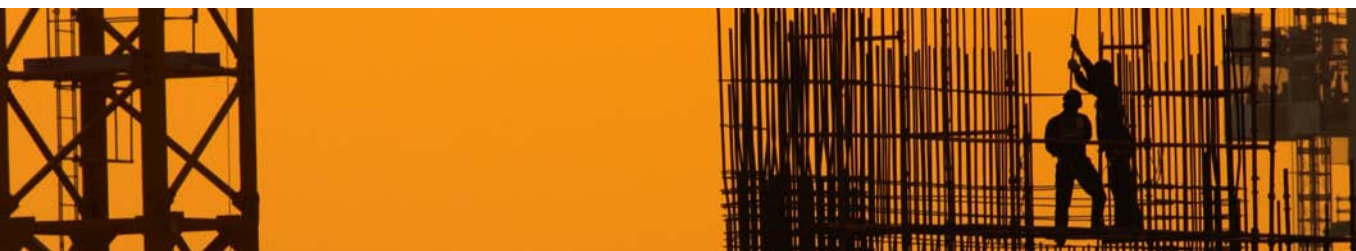
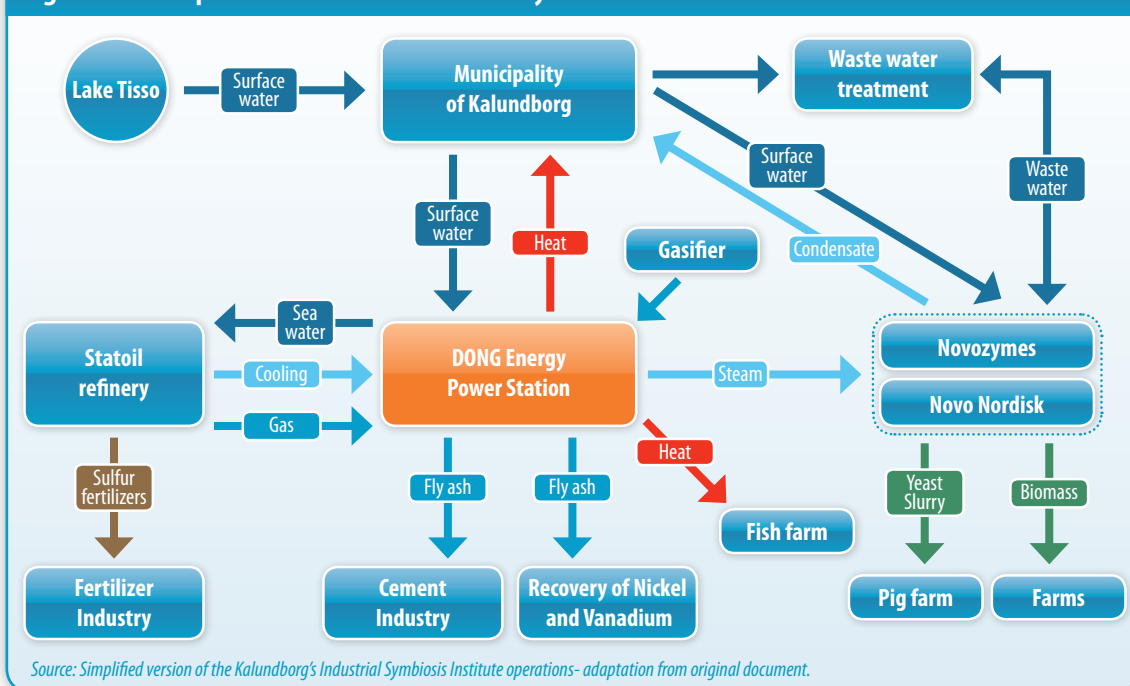


Figure 20. Simplified model of Industrial Symbiosis



Empowering and enhancing this industrial symbiosis, to improve synergies and harmonies in the way industry operates, requires a number of issues to be addressed:

- Information: is a major challenge, there is a need to support or provide networks and tools to bridge the information gaps between firms and match waste streams to resource demand;
- Improved market function: enhancing moves towards a single market for both waste and recycling would unify incentives across Member States and provide substantial benefits to industries and intra-EU trade.

In the same line of thinking, improving the systems of waste separation at source is an important element in improving industrial symbiosis and increasing the efficient use of material. This can be achieved through the installation of effective waste management systems and the appropriate infrastructure at municipal levels. This would be beneficial as part of wider moves to a circular economy, embracing cradle-to-cradle thinking.

Environmentally friendly product design... Cradle to cradle!

Product design can be improved, to design-in greater resource efficient characteristics, to make sure that whenever environmentally and

economically reasonable, the resources used by or embedded in products are minimised. Policy measures strengthen the ecodesign of products, improving the products and their resource consumption over their lifetime without hampering their functionality.

Extra attention to strategic resources...including waste as a resource

Additional attention should be given to strategic resources and to viewing waste as a resource stream: waste legislation can be streamlined to better take into account the important materials currently disposed of as waste, as this wastes what could, and increasingly will, be valuable resources (e.g. PVC for the chemical industry, recovering phosphate from landfill). Along the same lines, policies should consider the materials of strategic importance to the EU and which are exported to third countries for reuse as part of "second hand objects" such as the precious metals or rare earths in cell phones, computer screens, etc.

Improving access to finance

Improving access to finance, particularly for SMEs, is an important challenge to overcome and can involve several areas of action:

- Include resource efficiency in the 9th principle of the SBA (Small Business Act) instead of the focus



on only energy efficiency and introduce actions towards integrating the concept in the SBA as a whole;

- Influencing banks;
- Introduce financial means to promote sustainable consumption and production including early markets; and
- Involve the public sector for risk mitigation.

Using benchmarks and performance measures

This can be an important measure to help the further adoption of efficiency measures, i.e. the measures directed at using the material right; and enhance their up-take by industries. This is related to standardising measures and methodologies and providing easily accessible information resources, to reduce confusion and misleading claims and improve understanding of what is possible. Such measures can also help industry to help itself by giving it tools to assess and improve its own performance.

claims); and labelling schemes can bring about desirable results (such as in the case of the glass industry in the Netherlands)

Research, development and innovation are vital to continue to push the boundaries of what is possible

Given some of the limitations inherent in the efficiency measures as explained earlier, research, development and innovation are key factors in defining the future of sustainability and resource efficiency. Further R&D&I are needed to address the limits and break through them. They are also important to achieving further breakthroughs in the introduction of new business models, improved eco-design and to introduce alternative materials in production, that would render not only the production process and its input material more sustainable but also the product.

Industry, eco-innovation and eco-expenditure

Industry remains one of the core driving forces behind the technical and technological innovation required for greater sustainability and resource efficiency. Eco-innovation is the emerging term for innovations specifically directed at this area. To date measures of eco-innovation are limited, as it is difficult to define a subset of all innovation. Energy related research and development has commonly been used as a proxy and analysis of this shows both public and private investment in the EU in these areas has been increasing over the last 10-20 years.

Equally evident of the impact of industry and the efforts it makes to support moves towards sustainability are its environmental protection expenditures. These totalled over 50 billion EUR in 2006, representing over 2.5% of industry GVA and a significant investment in new processes and technology. There is little doubt that these consistently high levels of investment have supported the observed improvements in sustainability performance, particularly in air and water pollution.

Consumer choice is a crucial factor... improved information and awareness are important steps

Consumers are very important partners in achieving sustainability through their consumption choices. Increasing consumer awareness and knowledge of sustainable practices and consumption is a vital step in improving demand in this area. The adoption of measures towards changing consumers' behaviour can be addressed through actions such as information campaigns, marketing (including control on green commercial

Information and dissemination

Dissemination of good practices through industry platforms and networks to address the lack of access to information and knowledge problem through closer linkages between all actors including technology suppliers and enlarged industry platforms and networks are key to improve value chains relations and enhance industrial symbiosis.

Making more use of Market Based Instruments

The focus of national level schemes on market based, particularly fiscal, instruments suggests



that the focus of EU-level policy should continue to be on enhancing and standardising the framework conditions for market based policies in Member States, supported by regulation and other tools where appropriate.

Subsidies and other incentives can be useful in specific circumstances

These can be necessary and useful to enforce industry learning curves. Yet their introduction should consider the often significant budgetary implications – i.e. feed-in-tariff systems have been successful in achieving improved sustainability but they are also expensive. To protect against costs spiralling, subsidies should be time limited so that they address temporary, rather than structural market failures. It should also be considered that subsidies are also not necessarily the most important motivators for firms' adoption of environmental innovations.

Voluntary agreements can play a useful supporting role

Self-regulation of industry through voluntary agreements can be effective and less burdensome for both industry and policymakers. By anticipating changes in consumer demand, industry can stay at the cutting edge and mitigate the need for policy action and the associated costs and burdens. In general terms, they work well when larger firms possess large market shares, involve common consumer products, in situations where other policy instruments are inappropriate and / or when information gaps exist. They are not recommended in markets with higher concentrations of SMEs, where they may reduce competition and particularly in situations where sustainability benefits are abstract to consumers, e.g. energy use and emissions reductions.

Regulation remains a powerful and effective tool and driver... but should be carefully designed

EU industry has shown that it responds well to regulatory policy measures, when these are carefully designed and take a long-term perspective. In general terms, regulation tends to work well with performance targets, if these can be anticipated and then gradually introduced. However, standards which are too ambitious and/or introduced too early can run the risk of being counterproductive. Furthermore, implementation can be unequal across the EU Member States – thus influencing EU-industry in one location more or earlier than in other locations. To its disadvantage, direct regulation can be considered less cost-effective than market-based instruments as it tends to impose uniform targets that may not fully take into account the settings and competitive environment of industry. This is particularly true in the aftermath of the crisis, where the industry sector cannot always afford new costs that can make it less competitive internationally.

For Member States, well designed fiscal measures (taxes) can support sustainability, resource efficiency and employment

Within Member States, fiscal (tax) measures can be usefully deployed, but efforts should be made where possible to recycle the benefits to industry, to reduce negative competitiveness impacts. For example environmental taxes could have its revenues recycled to industry in the form of reduced labour taxes or social security contributions. This simple shift of burden can provide a powerful effect, a double dividend, boosting employment, while incentivising more sustainable and efficient behaviour.





Policy lessons to overcome the challenges

Moving from instruments and policy measures choice to policy design and implementation there are a number of important factors to be considered:

Complementarities of policies should be enhanced

Policies should be designed to be complementary to the national and regional level policy framework that exists. Care should also be taken to ensure that policy measures are not duplicated and that overlaps are minimised where possible to reduce the compliance burdens on EU industry. Policies should provide a supporting framework for industries creating the conditions and supporting industry to move towards eco-performance benefits by creating a link between economic competitiveness and eco-performance.

Enforcement needs to be credible

The effectiveness of policy implementation is closely related to enforcement. As, “only

implemented legislation is good for the environment”, it is important to give attention to how a regulation is to be implemented, while considering the associated burden. Particular attention needs to be paid to the mechanisms through which policies intend to influence EU-industry, and whether such policies are effectively doing what they intend to do.

Impact assessment, monitoring and evaluation are crucial aspects of good policy design

This is particularly important for the competitiveness of EU industry, so that policy action is made proportional to the environmental benefits that result. Absolute bans and limits can place significant burdens on producers, with high marginal costs for only small environmental gains. Evaluation and monitoring of public policies are vital to ensure that lessons are learnt from policy that can lead to improvement in policy designs and implementation.

Meeting the challenge of sustainable industrial growth requires concerted efforts from industry and policy makers – to continue to work together towards effective approaches to resource efficiency



European Commission
Enterprise and Industry



Sustainable Industry: Going for Growth & Resource Efficiency

Glossary

BAT	Best Available Technology
BRICS	Brazil, Russia, India, China, South Africa
CFL	Compact Fluorescent Lamp
ChL	Chemical Leasing
CIS	[EU] Community Innovation Survey
DfE	Design for Environment
DMC	Domestic Material Consumption
ELV	End of Life Vehicle [Directive]
ETS	Emissions Trading Scheme
EU-27	Full 27 Member States of the European Union: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and the United Kingdom (UK), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (RO), Slovakia (SK), Slovenia (SI).
EU-25	EU-27 less Bulgaria (BG) and Romania (RO)
EU-15	Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and the United Kingdom (UK).
EU-12	The latest 12 Member States of the European Union: Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (RO), Slovakia (SK), Slovenia (SI).
EU-10	The EU12 Member States less Bulgaria (BG) and Romania (RO)
EUR	Euro (currency)
FBT	Food, Beverages and Tobacco
FEC	Final Energy Consumption
GDP	Gross Domestic Product
GHG	Greenhouse Gas(es)
GJ	Gigajoule
GVA	Gross Value Added
GWP	Global Warming Potential
ICT	Information and Communications Technology
IMF	International Monetary Fund
LCA	Life Cycle Analysis
MW	Megawatt
NACE	Nomenclature Generale des statistique des activités économiques dans la Communauté européenne (Statistical classification of economic activities in the European Community)
OECD	Organisation for Economic Co-operation and Development
R&D&I	Research, Development and Innovation
SBA	Small Business Act
SME	Small and Medium Enterprise(s)
TOE	Tonnes of Oil Equivalent
TWh	Terawatt hour
UNFCCC	United Nations Framework Convention on Climate Change
WWP	Wood and Wood Products

