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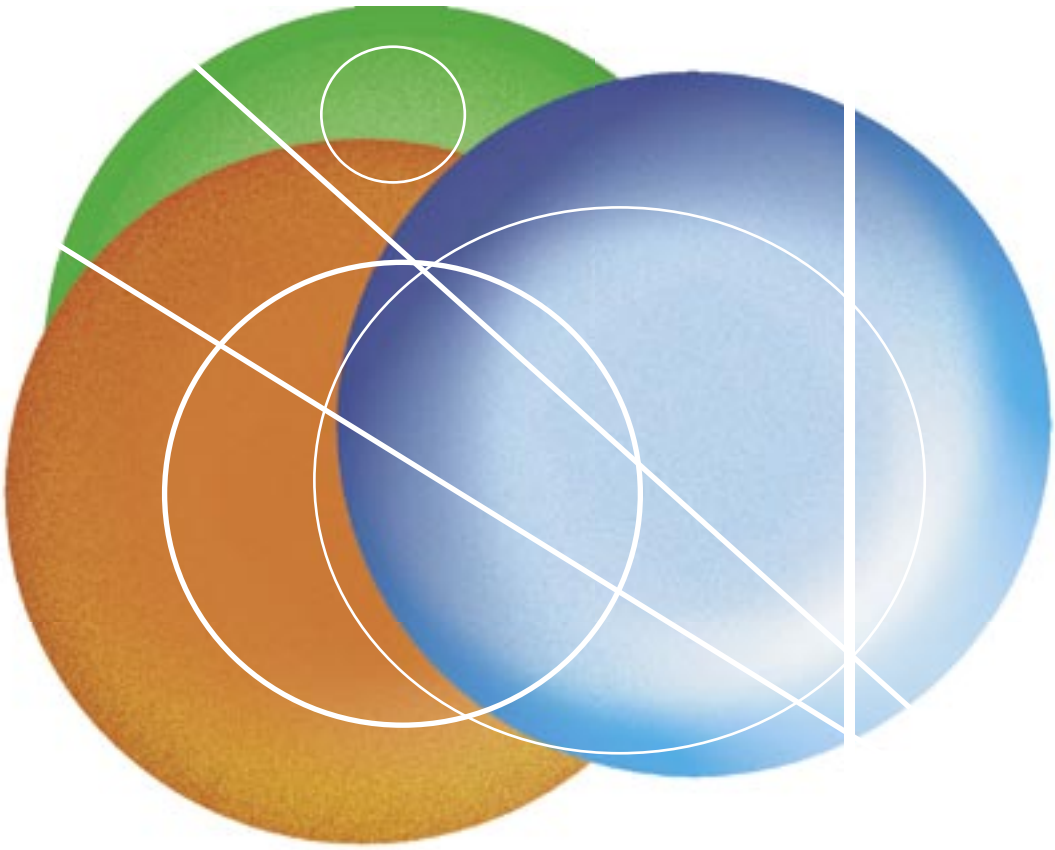
EPSD - European Panel on
Sustainable Development

Towards a ”Smart Growth” Strategy for Sustainable Development



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Foreword

At their Summit meeting in Göteborg in June 2001, Europe's heads of state and government reached agreement on a European strategy for sustainable development. The social and economic dimensions of the Lisbon strategy were complemented by an environmental dimension. Thus, the Göteborg Summit represents a breakthrough for sustainable development in the European Union (EU).

Göteborg University and Chalmers University of Technology made a commitment to serve, through the joint Centre for Environment and Sustainability (GMV), as a hub for research and scientific follow up of the EU sustainable development strategy. In order to fulfil this commitment, the two universities have established a European Panel for Sustainable Development (EPSD), together with Lund University and researchers at the Charles' University in Prague and the London School of Economics. In addition, individual members from other universities and research institutes contribute to the work of the Panel. The Centre for Environment and Sustainability (GMV) in Göteborg is the lead organisation in the EPSD.

The first report produced by the Panel in 2004 was "From Here to Sustainability – Is the Lisbon/Göteborg Agenda Delivering?". This was put forward as an independent contribution from academics to the mid-term review of the Lisbon strategy for growth, competitiveness and jobs. The second report "Make the Kok-report sustainable" was produced by the EPSD as a reflection on, and a response to, the mid-term review on the Lisbon strategy chaired by the former Prime Minister of the Netherlands Wim Kok.

The present report "Towards a Smart Growth Strategy for Sustainable Development" aims to contribute to the current re-launch of the EU sustainable development strategy. It contains a critical assessment of "A Platform for Action", the proposal for an updated strategy put forward by the European Commission. It provides an overview of resource efficient technologies which can contribute to sustainable production and consumption, discusses policies for sustainability and how the Commission's "Platform for Action" could be developed into a strategy for "smart growth". The report is backed up by a comprehensive specialised appendix: "Sustainable technology options and policy instruments".

A number of researchers have contributed to this report: Anders Ahlbäck, Sara Backlund, Iain Begg,Ola Carlson, Raul Carlson, Göran Dave, Rikard Engström, Bengt Fjällborg, Zsofia Ganrot, Lena Gustafsson, Katarina Gårdfedlt, Andreas Hagson, Fredrik Hedenus, Filip Johnsson, Christer Larsson, Jonas Norrman, Barry Ness, Jonas Nässén, Mattias Olofsson, Lennart Olsson, Magnus Pruth, Quang Tran, Frances Sprei, Dan Strömberg, Hans Theliander, Paul Weaver, Stefan Wirsenius and Johan Woxenius.
The report was edited by Fredrik Hedenus and Allan Larsson. It is endorsed by the EPSD.

A draft version of this report was presented and discussed at a seminar in Brussels April 26. Comments and suggestions given at the seminar have been included in this final version of the report.

Bo Samuelsson
Chairman of EPSD
Chairman of the Editorial Committee

Executive Summary and Policy Conclusions

Following the launch of the new initiative Energy Policy for Europe (EPE) at the spring summit in March 2006, the next challenge facing the Austrian Presidency of the European Union (EU) is to re-launch the European sustainable development strategy bringing together economic, social and environmental objectives and policies.

The purpose of this EPSD report is to contribute both to the debate on energy and to the re-launch of the sustainable development strategy. The report includes:

1) An introduction to the sustainability challenges faced by the EU and the need to integrate economic, social and environmental goals and policies into one comprehensive European strategy;

2) A broad overview of resource efficient technologies, focusing on energy technologies, which can contribute to sustainable production and consumption; and,

3) An analysis of public policies for sustainability, including a discussion of how the Commission proposal "A Platform for Action", together with the Lisbon strategy and the new EU Green Paper on "Sustainable, Competitive and Secure Energy", could be developed into a well co-ordinated investment strategy for "smart growth".

1. The challenges of sustainability

The backdrop to the report is the triple challenge facing the EU and its Member States: to stimulate economic growth, to foster an inclusive society with more and better jobs and to protect the environment – and to do all of this in a way that makes public policies in each of these three areas mutually supportive. It is a fact that these challenges have become more pronounced in the five years since the EU first adopted its strategy for sustainable development in 2001.

The EU's main authority for statistics, Eurostat, has recently conducted an evaluation of progress towards the objectives agreed by the European Council in 2001. The following are some of the main findings:

- Economic and employment developments - The rate of growth in GDP and employment has actually slowed down in the period since the year 2000. The objective of achieving an employment rate of 70% by 2010 is not within reach.

- Social developments - The number of early school-leavers has been reduced significantly since 2000, but the reduction has not been sufficient to reach the 2010 target. The old-age dependency-ratio grew during the period. While public expenditure on pensions has stabilised since 2000, the risk of poverty for persons aged 65 and over has increased.

- Environmental developments - Targets for addressing climate change and energy use have not been reached. There has been a relative decoupling of economic growth from domestic material consumption but no significant progress regarding the reduction of CO2 emissions in the transport sector.

The European Environment Agency has made a comprehensive review of environment trends and concludes that much has been done to improve Europe's environment, but major challenges remain. The most pressing is climate change. In short term, the EU is broadly on track to meet its Kyoto targets. However, its mid-term goal for 2020 will be more difficult to achieve.

The European Commission has proposed "A Platform for Action" as a basis for re-launching the sustainable development strategy. The Commission's action plan contains a broad perspective including social and environmental issues. It underlines that energy and transport policies are vital in the efforts to change unsustainable trends. However, the role of sustainable development as a "smart growth strategy" is missing from the Commission's proposal. Linked to this omission, the apparent split between the Lisbon strategy for growth, competitiveness and jobs and the Göteborg strategy for sustainable development – in terms of goals, time horizons and processes – will weaken both strategies. The proposal by the Commission falls short of the original ambitions of the European Council to "unleash a new wave of technological innovation and investment, generating growth and employment".

In this report, the EPSD emphasises the need for "a smart growth strategy", one that not only decouples economic growth from pressure on natural resources, but also does so in a way that creates new markets for cleaner technologies that European companies can exploit.

2. Technology for sustainability

Technology is a double-edged sword. It is both the cause of many sustainability problems and a key to solving them. Chapter 2 therefore includes an overview of existing and emerging technologies for production that is more resource efficient, particularly technologies for the production and utilisation of energy. The overview is summarised in the following paragraphs.

A main element in any strategy to deal with oil dependency and climate change must be increased energy efficiency. 20 % of the present energy supply could be saved cost-effectively before 2020, mainly through the application of better technologies in the commercial and residential sector, in industry and transportation.

[1] IEA (2005), data for 2002. The carbon emission and primary energy use from the electricity system is in our calculations allocated to the end-use sector. Thus, both direct use of fuels and indirect (used for electricity production) are taken into account.

- **The residential and commercial sector** accounts for 39% of primary energy use and 34 % of energy related CO2 emissions in the EU-25[1] . This sector represents the largest technical potential for energy saving, through a reduction of up to 70 % of final energy use. The cost effective potential at current price levels is estimated to 20-30% of the final energy use. Better insulation, the installation of energy efficient windows, solar heating systems and raising energy awareness in everyday life are just some examples of measures that are proven to work well.

- **Manufacturing industry** has increased output by around 2% per year during the past 20 years, while simultaneously keeping energy use at roughly the same level, largely due to the improved energy efficiency of processes. However, this sector still accounts for 32% of the primary energy use and 30% of CO2 emissions in the EU. The potential for further efficiency improvements is substantial. Iron and steel and pulp and paper, ranked among those industrial sectors that are the heaviest consumers of energy in the EU, have potentials for cost-effective energy efficiency improvements of around 20%.

- **Transportation** of all kinds accounts for around 24% of the primary energy use in the EU and for 29% of CO2 emissions. The rapid increase in the transport sector poses a huge sustainability problem. Motor vehicles account for nearly 80% of all transport related energy use; globally, the road transport sector consumes half of the world's production of oil. There are nevertheless several strategies to transform the transport sector: (i) new systems of better logistics and improved public transportation, for example intermodality and the dry port concept for cargo transport; (ii) new technologies to make cars more energy efficient, for example hybrid cars with a potential to save up to 40% of the energy compared to a conventional car and, (iii) a large variety of alternative fuels, for example fuels from gasification of biomass.

A second element in a strategy to reduce oil dependency and carbon emissions must be the exploitation of new energy sources.

- **Natural gas** has lower carbon content than coal, and can be converted to electricity with high efficiency. Therefore, substituting coal for natural gas for power production reduces the carbon dioxide emissions per produced kWh electricity by around 50%.

- **Wind energy** is one of the most cost-effective renewable energy sources and already provides around 2% of the energy supply in the EU. In Denmark, Germany and Spain wind power has gained a strong foothold. For example, in Denmark close to 20% of domestic electricity consumption is met by energy generated from wind power. Having captured 80% of the world market, the EU's wind power industries have a competitive advantage in global terms.

- **Solar energy** has a huge physical potential; each year it brings 10,000 times more energy to earth than the annual global use of energy by humans. Solar thermal technologies are regarded as fairly mature technologies, but there are still some bottlenecks hindering their widespread diffusion. Solar photovoltaic technology (PV) still represents a marginal source of electricity due to high prices.

- **Bioenergy** may be utilized for both power and heat production, and is already cost-effective for some appliances. Its potential is estimated at around 2000 TWh in 2010, in other words around 20 % of the present energy supply in the EU. The potential of bioenergy is even greater in the long term.

As it will take a long time to implement a new energy system based largely on renewable energy technologies, there is a clear need for a third element in the form of bridging technologies to reduce significantly CO2 emissions from energy production based on fossil fuels.

- One such technology is capture and storage of CO2, taking advantage of the existing power-plant infrastructure. We are currently witnessing a strong expansion in R&D activities in this field. It is difficult to predict when CO2 capture and storage could be introduced on a large scale, but it seems reasonable that pilot plants will be in place in two or three years time and that the first large scale plants can be commissioned before 2015. The development of a large network of CO2 capture and storage plants will depend on the stimulus provided by post-Kyoto targets and the effective price of emitting CO2.

The review of the energy situation in the EU included in Chapter 2 highlights that there is too much spending on energy for transport, buildings and industry and that more resource efficient technologies already exist. These can either reduce the fast growing use of energy or help facilitate a conversion to renewable energy sources. More - and smarter - investment is needed to introduce new technologies and to make a decisive shift away from unsustainable patterns of energy production and use. Public policies play a key role in promoting new technologies.

3. Public policies for sustainability

The policy discussion in Chapter 3 is based on the vision set out by the European Council that one aim of the strategy for sustainable development is to "unleash a new wave of technological innovation and investment, generating growth and employment".

In this context the European Commission's proposal of "A platform for action" includes a number of elements of good news:

- the drive for commitments to cut greenhouse gas emissions further;
- commitment to develop a second phase of the European Climate Change Programme;
- a next step in the development of a sustainable, secure and competitive European energy policy;
- an action plan to achieve the estimated energy saving potential;
- an action plan to promote sustainable production and consumption; and,
- the intention to present a package of measures to improve the environmental performance of cars.

However, there is also some bad news. The main weaknesses in the Commission’s proposal are the following:

- there is no sense of urgency concerning the challenges to be addressed;
- the role of technology seems to be downplayed;
- the synergy between economic, social and environmental policies is missing; and,
- there is an obvious lack of coordination between the strategy for sustainable development and other EU strategies like the Lisbon strategy or the Growth and Stability Pact.

The EPSD therefore provides four recommendations for the preparations of the European Council Summit in June 2006:

- **Urgency** - The first recommendation is to use the statistical evaluation made by Eurostat, and the most recent scientific reports on climate change, as a spark to liven up the proposed “Platform for Action” and convey to all stakeholders a sense of urgency and commitment to action.

- **Technology** - The second recommendation is to reiterate the commitment of Europe’s leaders to promote technological innovation and investment as the main road to sustainability, including a stable and long-term carbon dioxide emission trading scheme, abolishment of coal subsidies, a feed-in tariff system for immature technologies and a dynamic performance target system.

- **“Smart growth”** - The third recommendation builds upon the resolution of the European Parliament to bring together the Union’s fragmented growth strategies into a single, coherent and comprehensive strategy, integrating information and communication technologies and resource efficient technologies for sustainable development, for investment and “smart growth”.

- **Global leadership** - The fourth and final recommendation of the EPSD to the June Summit is that the EU should better coordinate its policies to take the leading role in the development and implementation of resource efficient technologies at home and abroad.

1. The Challenges of Sustainability

1.1 The triple challenge

The backdrop to this EPSD report is the triple challenge facing the EU and its Member States: to stimulate economic growth, to foster an inclusive society with more and better jobs and to protect the environment – and to do all of this in a way that makes public policies in each of these three areas mutually supportive.

The basic problem when addressing these challenges at the same time is the perceived tension between economic growth and employment on the one hand and environment on the other. In the past economic growth has been strongly connected with an increased use of natural resources. This is partially a consequence of increased material output, but it is also due to technological choices and investment choices made in the past.

In recent decades, however, a range of environmental policies have been developed and implemented, many with great success. For example, acidic emissions decreased by around 45% in the EU-25 between 1991 and 2002, while local air pollutants are decreasing and the use of heavy metals such as mercury is being phased out.

Carbon dioxide emissions and global warming represent the main environmental challenge – now and for the coming decades. The use of energy resources is increasing at the same time as the fight against climate change demands a drastic reduction of carbon dioxide emissions. These urgently required cuts in carbon dioxide emissions must be accomplished at the same time as sustaining economic growth. In other words, we require a strong decoupling of economic growth from pressure on natural resources.

1.2. Europe's unsustainable development

Since the EU first adopted its strategy for sustainable development in 2001 the challenges of sustainability have become more pronounced and the necessity to shift the economy to sustainable patterns of production and consumption has become even more urgent. At the same time as Europe is facing these growing challenges, the limited impact of those policies already in place or implemented during these years has been highlighted through a first comprehensive evaluation made by Eurostat, Measuring progress towards a more sustainable Europe - Sustainable development indicators for the European Union - Data 1990-2005. The statistical office has monitored recent changes on the basis of sustainable development indicators adopted by the European Commission. Eurostat's main findings are the following:

• Economic and employment developments
The rate of growth in GDP and employment has actually slowed down in the period since the year 2000. The objective of achieving an employment rate of 70% by 2010 s not within reach.

• Social developments
The at-risk-of-poverty rate increased in the beginning of the period. The number of early school-leavers has been reduced significantly since 2000, but the reduction has not been sufficient to reach the 2010 target. The old-age dependency-ratio grew during the period. While public expenditure on pensions has stabilised since 2000, the risk of poverty for persons aged 65 and over has increased.

• Environment developments
Targets for addressing climate change and energy use have not been reached. There has been a relative decoupling of economic growth from domestic material consumption but no significant progress regarding the reduction of CO2 emissions in the transport sector.

So far the Eurostat evaluation based on indicators for sustainable development. The European Environment Agency has made a comprehensive review of environment trends, The European Environment - state and outlook 2005. The EEA concludes that much has been done to improve Europe's environment, but major challenges remain. The most pressing is climate change. In short term, the EU is broadly on track to meet its Kyoto targets. However, its mid-term goal for 2020 will be more difficult to achieve. The EAA highlights the effects of global warming: "Increasing temperatures across Europe, changing precipitation patterns in different regions, melting glaciers and ice sheets. Increased frequency of extreme weather events, rising sea levels and increasing stress on terrestrial and marine ecosystems are among the most visible impacts on the environment."

A first conclusion based on these reports is that there is a gap between the present patterns for production and consumption on the one hand and the much needed new sustainable patterns of production on the other hand. The gap seems – in many fields - to be widening, not closing.

1.3 The potential of investment and technology

There is no single panacea or quick fix for achieving sustainability. This will require a long and sustained process of setting the vision, strategic planning, implementation and evaluation of outcomes to be truly effective.

This report focuses on the potential of technology, existing or new technologies, to contribute to sustainable patterns of production and consumption. It sets out the message that there are already technologies available or emerging, which can substantially reduce the use of energy and other natural resources and the emission of rbon dioxide.

Another important message is that the introduction of cleaner, more sustainable technologies has to be achieved through the ongoing process of investment in new buildings and new equipment, supported in turn by forceful public policies. Every investment decision is a choice between more or less sustainable technologies; even a decision to postpone investment involves such a choice.

In macroeconomic terms, all investment, presently around 20% of GDP, represents potential investment in a strategy for sustainable development. In other words, the potential is far greater than the 1.6% of GDP that the so-called eco-industries currently represent. Moreover, a great deal of private and public consumption, amounting to 80% of GDP, includes consumption of technology and consequently choices of great significance for sustainable development. Technological change is not only a question of investment choices - it is of commensurate importance to understand consumption patterns as a vehicle for change.

Every consumer, producer and investor has a responsibility for making choices. They should be provided incentives to contribute to the roll-out of more, rather than less, environmentally sustainable technologies. Players in the financial markets have a particular responsibility to take a more long-term perspective on investment and sustainability. However, the main responsibility lies with governments and public policy makers to create the framework conditions necessary for a shift towards technology that brings more sustainable patterns of production and consumption.

A strategy for sustainable development is a way to gradually establish a new balance between old physical capital (the investments of the past) and limited natural resources. The next chapter will describe and discuss technology and investment options that will lead the EU towards a more sustainable future.

2. Sustainable Energy Technologies and Investment Options

The European energy system stands before a major transformation in the coming decades -the fight against global warming demands a reduction in carbon dioxide emissions and at the same time the availability of cheap oil may start to decline. There are, however, technologies that address these problems that are commercially available (or soon-to-be commercially available) today. In this chapter the EPSD describes some of the most significant energy technologies that have the potential to reduce both carbon dioxide emissions and oil dependency. Many of these technologies offer ancillary benefits in that they also address other problems, such as traffic congestion or emissions of localised pollutants.

In this chapter we focus on the cost-effectiveness and supply potential of different technologies. However, it is important to note that cost–efficiency is a static concept that does not take further development of technologies into account. Most new technologies are expensive, however, as the market for a new technology expands the technology benefits from economics of scale and technological learning. Due to the initial low performance some technologies may never reach the market. Instead the prevailing technological regime remains. Nevertheless, the new technologies, if adopted on a large scale, may in the long run turn out to have both better environmental performance and lower costs than the conventional technologies. Thus, it is crucial where new investments are actually made, since it to some extent can determine which technologies will dominate the future market. From a policy perspective it is therefore important to support emerging technologies in order to be able to face the sustainability challenges in the long run.

The discussion in this chapter is largely based on the specialised appendix to this report *Sustainable technology options and policy instruments*[2] . More details about the technologies described may be found in the appendix.

2.1 The European energy system

The energy sector is a fundamental part of industrial economies and a prerequisite for most economic activities. Economic growth has in the past been closely linked to increased energy use. However, there has been a consistent decline in energy intensity, i.e. energy use divided by GDP, over the past fifty years in many countries. It should be noted, however, that this decline was much faster following the oil crises of 1973 and 1979. Since 1980 average energy use in the EU has increased by 1% per year, whereas the GDP has grown by an average of 2.2% per year. In other words, there has been a weak decoupling of energy use from GDP.

The European primary energy supply in 2002 was more than 20,000 TWh, of which 80% was based on fossil fuels as shown in figure 1. By estimating the primary energy required to supply electricity, EPSD also calculates the primary energy use by different sectors. It is clear that the European energy system is largely based on fossil fuels and that industry is the sector with the highest energy use.

Figure 1 Primary energy supply and use in EU

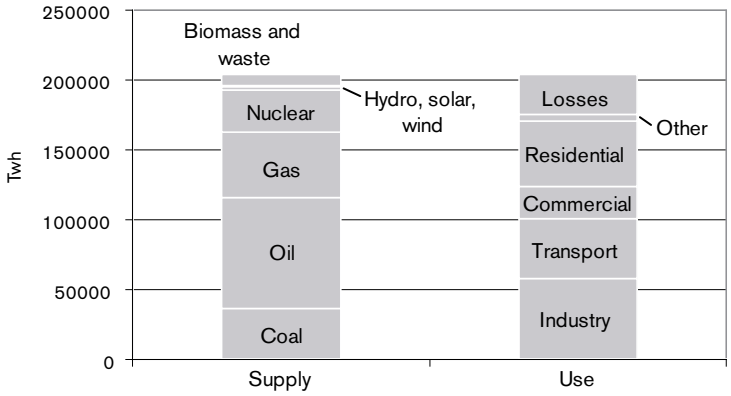

Figure 1: Primary energy supply broken down by fuel and by end-use sector (primary energy required to supply electricity is calculated from the EU average)[3] .

The energy system is also the single most important emitter of carbon dioxide in Europe, releasing around 3.8 billion tons per year, which constitutes 15% of the global fossil fuel related carbon dioxide emissions[4]. In order to reduce human-caused greenhouse gas emissions the Kyoto protocol was signed in 1997, and entered into force in 2005. The protocol imposes a first small step towards the reduction of greenhouse gas emissions. It calls for an 8% cut in total EU-15 greenhouse gas emissions by 2008–2012 with respect to 1990 levels.

Several Member States will have considerable difficulties in meeting the European Union's burden sharing agreement (e.g. Italy, Spain, Portugal and Ireland). This is largely due to a strong growth in demand for energy combined with heavy reliance on fossil fuels. However, in the long-run much lower emission levels must be reached if dangerous interference with the climate is to be avoided. While global emissions must be reduced by around 20% by 2050, this translates into even stronger obligations for developed countries. Typical estimates are that the emissions in developed countries must be reduced by 15-30% by 2020 and by 60-80% by 2050[5]. It is undeniable that global warming calls for a fundamental transformation of the energy system.

The European energy supply is also very dependent on oil, which accounts for 40% of primary energy supply in the EU. There are increasing risks associated with Europe's dependence on oil. First, less and less new resources of conventional oil are being found at the same time as demand is

[2] The appendix may be found at http://www.gmv.chalmers.se/

[3] IEA(2005), data for 2002.

[4] IEA(2005), data for 2002 and Marland,G. Boden,T.A Andres, R.J (2006) Trends online cdiac.esd.ornl.go.

[5] European Parliament (2005) "Winning the Battle Against Global Climate Change" (2005/2049(INI))

increasing. This means that the price of conventional oil is likely to rise in the near future. At the same time, while the current high price of oil may be a sign of oil scarcity, it may also trigger new investments in refineries and oil wells such that the price could drop again. Second, the remaining oil reserves are heavily concentrated in the Middle East where regional political unrest could conceivably increase the oil price in the short term as it did during the oil crises of the 1970s. Third, the transport sector is totally dependent on oil-based fuels and there are no large-scale substitutes available at the moment.

2.2 Technologies for heat and electricity

2.2.1 Energy efficiency measures

Improved energy efficiency has several benefits. If the economy uses less oil, it will be less vulnerable to oil shocks, furthermore reduced energy demand will make it easier to obtain carbon dioxide reduction. Also, since it is likely that energy prices will increase in the future, both as a result of obligations to reduce carbon dioxide emissions and increasing oil prices, energy efficiency investments may turn out to be very profitable.

Promoting increased energy-efficiency is essential for a sustainable energy system. It is estimated that 20% of the present energy supply in the EU could be saved cost-effectively, taking into account capital costs, before 2020[6] . If increasing energy prices are factored in, the savings potential is even greater. These savings potentials are found across the economy but this report only discusses a few in detail.

The technical energy saving potential in the residential and commercial sector is estimated to be 70% of its present energy use, whereas the cost-effective potential is estimated to around 20-30% in Western Europe. New technologies today allow buildings to be constructed without a heating system i.e. so-called passive house. By using solar heat, good insulation and a heat exchanger, heat from humans and electrical appliances are sufficient to keep the house warm even during winter in northern Europe. Another energy-efficiency measure is to retro-fit old multi-dwelling houses by improving both insulation and the heating system. Both these options (passive houses and retro-fitting) are presently cost-effective or would require only minor increases in energy prices to become so.

There are also various energy-efficiency options across industry. In pulp and steel production, for example, the gap between best practise and the EU average consumption of energy in these sectors amounts to energy savings of around 20%. Assuming an increase in the price of carbon to circa €40 per ton (the carbon price under the European Trading Scheme at the time of writing is around €25 per ton), the cost effective energy saving would be in the magnitude of a further 20%. Synergies can also be found between better waste management and improved energy efficiency. This is especially the case for the recycling of aluminium, where virgin production of aluminium requires around 20 times more energy than producing aluminium from recycled material.

2.2.2 New energy supply

To reduce oil dependence and carbon emissions in the long run, energy efficiency measures alone will not suffice. New energy sources are also vital. Therefore, considerable investments in sustainable energy supply technologies are also necessary. Some renewable energy technologies have already increased substantially in the EU in the last 15 years. Most notable among these are solar PV and wind, which have increased their contribution to the energy supply by 51 and 74 times respectively between 1990 and 2004[7]. Since they started off from a very low base, however, they still do not contribute significantly to the European electricity supply. The supply of energy from biomass and waste, solar thermal as well as biogas have also increased as shown in figure 2.

Figure 2 Renewable energy in EU-15

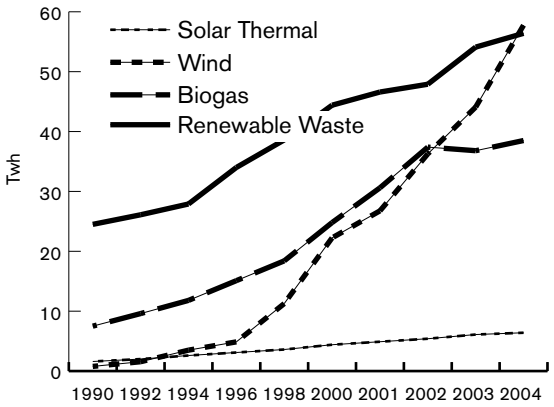

Figure 2. Expansion of renewables in EU-15 since 1990 to 2004. Renewable waste include biodegradable municipal waste only[8] .

At present most renewable energy sources remain more expensive than conventional fossil fuels. This is partly due to the fact that the technologies are currently at an early stage of their introduction and that the prevailing energy technologies, fossil fuels and nuclear power, benefits from subsidies and that the full external costs of pollutions are not reflected in the price. However, if the new technologies are rolled-out and more widely adopted, and if polices are introduced to correct for the direct and indirect subsides of the fossil fuels, the emerging renewable technologies will turn out to be much more competitive.

There are three main renewable energy sources (solar, wind and biomass) and three non-renewable sources (natural gas, coal with carbon capture and storage and nuclear) that may reduce carbon emissions as well as oil dependence. These are discussed in turn below.

2.2.2.1 Renewable energy

Biomass is energy with many sources of supply. The most competitive biomass supply comes from residue flows

[6]European Commission (2005) Doing more with less. Green Paper on energy efficiency.

[7] IEA (2005)
[8] IEA (2005)

from the forestry and agricultural sectors, but there is also a considerable potential to supply biomass from dedicated plantations. Biomass may be used for heat and electricity production without any major processing. The most cost-effective way to use biomass therefore tends to be for large-scale heat production, such as district heating, or combined heat and power plants. Furthermore, if biomass is dried and made into pellets, it serves as a good substitute for oil in residential heating.

At present, biomass constitutes 2.5% of the European primary energy supply but it is estimated that EU domestic biomass has the potential to supply around 2000 TWh by 2010, assuming no additional pressure on biodiversity, soil and water[9]. In the longer term, especially if biomass is imported from outside the EU, the potential is even greater.

Another, but more limited source of bioenergy is biogas. This is a waste by-product from landfills. Capturing and utilising biogas means that less methane (which is a greenhouse gas) reaches the atmosphere and that the amount of biodegradable waste in landfills is reduced. At present biogas is mostly used for heat and electricity production but it may also be used as a transport fuel.

Wind power is becoming an increasingly important source of electricity in some EU Member States. In Denmark, the leading country in the EU in this regard, wind power supplies 20% of the electricity supply. Larger wind mills are now being established often placed off-shore.

Solar PV plays – as yet – a very marginal role in the energy supply in Europe. It is dependent on subsidies to ensure its viability. Nevertheless, solar energy has a very large resource base as the solar radiation reaching the earth is 10,000 times greater than the present use of energy by humans. It should also be noted that the cost of producing electricity from solar PV has decreased by a factor of 10 over the last thirty years, although the cost is still around ten times higher than conventionally produced electricity. Further research is required in order to make solar PV more affordable. Even more importantly, however, further investments tend to trigger new innovations and economics of scale, which in turn reduce costs.

2.2.2.2 Non-renewable energy

The three major non-renewable energy sources that may reduce import dependence on oil, as well as cutting carbon dioxide emissions, are natural gas, nuclear power and coal (the latter only if combined with carbon capture and storage). From a sustainability perspective, these resources are finite. The natural gas production is estimated to peak before 2100, uranium resources would last less than a century if nuclear power, based on present technology, were to be adopted on a large scale globally, whereas it is estimated that coal reserves could last for more than 200 years.

Most of the reduction of carbon dioxide emissions in the power sector so far has been due to the shift from old coal power plants to new natural gas fired plants. Due to the high efficiency in a combined cycle natural gas plant, and the lower carbon intensity in natural gas, the emission per produced kWh electricity is approximately halved compared to coal fired plants.

Carbon capture and storage is a technology that allows for the continuing use of coal, while the environmental harm is reduced by capturing and storing the carbon dioxide. The technology is still under development, but demonstration plants are now being planned. The technology may therefore be commercially available in 10-15 years. In order to be economically competitive, capture of carbon dioxide must take place at large point sources, such as power facilities or large industrial plants. As the carbon dioxide is captured the gas must be safely stored for several thousand years. Promising storage options include depleted oil and gas fields and deep aquifers. Carbon capture and storage has a large potential since coal could then be used without endangering the climate.

For its part, nuclear power today supplies 33% of the electricity in the EU, although no new plants have been built in the last 15 years. Some countries such as Sweden and Germany are planning to phase out nuclear power, whereas Finland will build a new plant, which will become operational in 2009. The climate change debate has clearly renewed interest in nuclear power since life cycle analysis shows low greenhouse gas emissions per kWh of electricity produced by the nuclear industry. Nuclear power therefore remains a potentially important carbon emission abatement technology, even if the longstanding concerns regarding security, disposal of nuclear waste and proliferation of nuclear weapons have still not been resolved.

2.2.3 Which technologies will be competitive?

One important issue is obviously to assess which technologies are likely to be competitive in the next 10-20 years. The competitiveness of energy technologies for heat and electricity production will be highly dependent on the price of carbon dioxide. At the timing of writing, the carbon price under the European Emission Trading Scheme (ETS) is around €25 per ton. For a barrel of oil this translates into an additional cost of $9 US per barrel. However, all European governments have so far been rather free to allocate large quantities of emissions permits to their industries. Between 2008 and 2012, however, less permits should be allocated if the Member States are to meet their Kyoto targets. As a result, the carbon dioxide price is likely to rise.

So, which technologies are likely to be competitive compared to the present regime, taking into account the full costs of investments, maintenance and fuel? Switching from coal to natural gas was a competitive option during the 90s when the gas prices were low. However, due to the presently high gas prices, natural gas produced power needs a carbon price around €30 per ton CO2 to be a competitive alternative. Further the potential to switch to natural gas is in the short term mainly restricted by the increasing concerns of dependence of gas supply from Russia[10] .

[9] EEA(2005) EEA Briefing 2005 02

[10] European Commission (2006) Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy SEC(2006) 317

Given the present carbon price (circa €25 per ton carbon dioxide), biomass is competitive for both heat and power production. Biomass in pellet form for residential heating is already profitable today given an oil price of 60$/bbl. Nevertheless, the expansion of biomass use is restricted in the short term by the availability of cheap biomass. In the longer term, rising prices will increase the biomass supply as well imports to the European Union.

Given the current price of carbon, wind power and nuclear power also become competitive options. Similarly, carbon capture and storage from coal power production, even though still not fully developed, is estimated to be profitable at the current price of carbon. However, this technology will not be available on a large scale until around 2020. Solar PV, on the other hand will not be profitable on "on-grid applications" until carbon prices are around €100 per ton. Nevertheless, the cost of solar PV has decreased by 90% over the last thirty years, which represents a cost reduction of around 20% for every doubling of installed capacity. If this figure is possible to extrapolate, solar PV will be cost-effective for significantly lower carbon prices in the future, if the technology is adopted on a large scale.

2.3 Transportation

Transportation accounts for around 29% of the carbon dioxide emissions in the EU. It is the most oil dependent sector in the Community - for example, road transport is 99.5% dependent on oil. Furthermore, problems persist with regard to localised pollutants from vehicles, such as NOx, Volatile Organic Compounds (VOC) and particulate matter. There are of course several alternatives to the diesel and gasoline car, some of which have already been developed while others will only become available in the longer-term.

2.3.1 Energy efficiency

Just as in the case of energy supply to the residential and industrial sectors, there is a potential for energy efficiency measures in the transport sector. These measures could be seen at two levels: improving the efficiency of vehicles; and, improving the efficiency of the transport system as a whole.

One promising idea to improve freight transport in harbours is the dry-port concept. The dry-port is based on inter-modal transport, so that a common loading unit may be used for different means of transportation. Second, there tends to be a lack of space in many European ports. Thus, by introducing terminals in the inland area (where generally speaking more land is available) connected to the port by train, this innovation may decrease congestion in ports, reduce local pollutants in the port areas as well as improve the energy efficiency of the freight transport.

The fuel consumption of vehicles may also be decreased through several different measures:

- First, lighter cars require less fuel per kilometre. Lighter cars may be achieved by using lighter materials such as aluminium, or simply by making cars smaller.
- Second, further improvements can be made to the efficiency of the engine. Diesel cars emit around 30% less carbon dioxide per km than gasoline cars. While diesel cars were previously responsible for higher levels of particulate emissions, the introduction of particle filters has made the performance of diesel cars comparable to gasoline cars in this regard. There are also other measures to improve energy efficiency, such as increasing the ratio of air-to-fuel needed for combustion, the variability of valve lift and timing and turbo charging. Moreover, hybrid cars, which rely more on battery (charged by breaking energy) have a rather large saving potential.
- Third, the aerodynamic shape of the car, as well as reduced rolling resistance in car tyres, further decrease fuel consumption.

These examples illustrate the potential for making the transport system less dependent on oil through energy efficiency measures.

2.3.2 Alternative fuels

Besides improving their energy efficiency, cars may also be fuelled by alternatives fuels. Some of these are already commercially available whereas others need further development.

The most widely-adopted alternative fuel in the EU is bio-diesel and ethanol, even though they account for less than 0.5% of road fuel supply. The most common bio-diesel in the EU is RME (Rape Methyl Ester), which is produced from rapeseeds. RME is a diesel fuel that may be blended into conventional diesel and used by conventional diesel cars. Ethanol used in the EU is primarily produced from wheat and sugar beets, and may be blended into gasoline up to a ratio of 1:20. For higher levels of blending, flexi-fuel cars are required, which may use any blending of ethanol and gasoline. Even though both ethanol and RME are biofuels, life cycle analysis shows that they still cause rather large amounts of greenhouse gas emissions. These originate both from agricultural processes (primarily N2O) and the fossil fuels used in the production and distribution processes. As a consequence the reduction of greenhouse gas emissions achieved through the use of such bio-fuels is in general less than 50% compared to conventional cars.

There is also ongoing research on a next generation of biofuels, which would use wood, rather than agricultural crops as feed stock. By gasification of solid biofuels, syngas is produced and from this gas a variety of fuels may be produced, such as Fisher-Tropsh diesel, methanol, DME etc. These fuels are estimated to be more energy efficient than ethanol and RME from crops, and also have a larger supply potential since they are based on wood rather than crops. Furthermore, processes for producing ethanol from lingo-cellulosic material such as straw and wood are presently being developed.

Natural gas is also used as a fuel in the EU, primarily in Italy. Natural gas is a fossil fuel, but it results in lower carbon dioxide emissions than oil-based fuels. Moreover, natural gas vehicles produce virtually no emissions of Volatile Organic Compounds (VOC) and particles. At present, however, natural gas vehicles require significant adjustment compared to conventional cars and the necessary fuel infrastructure is not in place.

2.3.3 Advanced vehicles

In the longer-term, vehicle alternatives include fuels cell cars fuelled by hydrogen as well as plug-in hybrid cars. Plug-in hybrid cars are a combination of electric and conventional cars. They can therefore be fuelled both by electricity from the grid and by conventional fuels. Since the vehicle may be fuelled by electricity, problems associated with local pollutants are rather small. However, to be beneficial for the climate, the electricity must be produced from low-carbon intensive sources, which is presently not the case. Thus, the electricity system itself must undergo a major transformation before plug-in hybrid cars can be considered a carbon dioxide abatement option.

Fuel cell cars fuelled by hydrogen have similar benefits and problems as plug-in hybrid cars. Fuel cell cars only emit water vapour, but in order to become a true carbon dioxide abatement option, the hydrogen must be produced from sources that in turn emit low levels of carbon dioxide, such as solar electricity, nuclear power or coal with carbon capture and storage. The fuel cell vehicle is still not fully developed and faces the considerable hurdle of high costs, even though several concept cars have been manufactured in recent years.

2.3.4 Which fuels will be competitive?

The transport sector is not presently included in the Emission Trading Scheme for carbon dioxide emissions, and is also more dependent on the oil price than the electricity and industry sectors. It is necessary to calculate the oil price as well as the required carbon dioxide price to make different technologies competitive compared to conventional cars. The present oil price, at around 60$/bbl, is not sufficient to make alternative fuels cost-effective. In figure 3 we show the oil prices or carbon dioxide prices at which different alternative fuels are competitive compared to gasoline[11]. The calculations include the costs for the fuels, the vehicles, the infrastructure and all greenhouse gas emissions in a life cycle perspective. To calculate the carbon price required to make a fuel competitive, EPSD assumes that the carbon dioxide price is applied to all greenhouse gas emissions (converted using Global Warming Potential, GWP) and an oil price of 60$/bbl. Furthermore, fuel taxes of around 30c/l for all fuels are assumed in order to calculate the required oil price.

As seen in Figure 3 all biofuels, in this case assumed to be used in dedicated vehicles, require oil prices higher than 150 $/bbl in order to become competitive. This is more than twice the present oil price. Natural gas is the most competitive alternative for increased oil prices, a price of around 100 $/bbl of oil being sufficient to make natural gas an attractive fuel option. However, there tends to be a relatively strong interdependence between the oil and gas prices which may in turn prevent natural gas from being a viable alternative fuel option in the context of higher oil prices. The two most cost-effective biofuels for greenhouse gas abatement are RME and biogas. However, both these fuel have rather limited supply potentials. Full hybrid cars, with improved energy efficiency require a carbon price of roughly €200 per ton CO2 to be competitive. The second generation of biofuels, ethanol produced from cellulose and Fisher-Tropsch diesel produced from gasified biomass, have a large supply potential, since they are based on wood. These fuels require a carbon price of €150-200 per ton CO2 equivalent to be competitive compared to gasoline. These technologies are not yet fully developed and will not be commercially available until around 2020. Smaller volumes of biofuels may also be blended into conventional fuels. This option is, in general, more competitive to reduce oil import as well as greenhouse gas emissions since no alternation of the vehicles is needed.

Figure 3

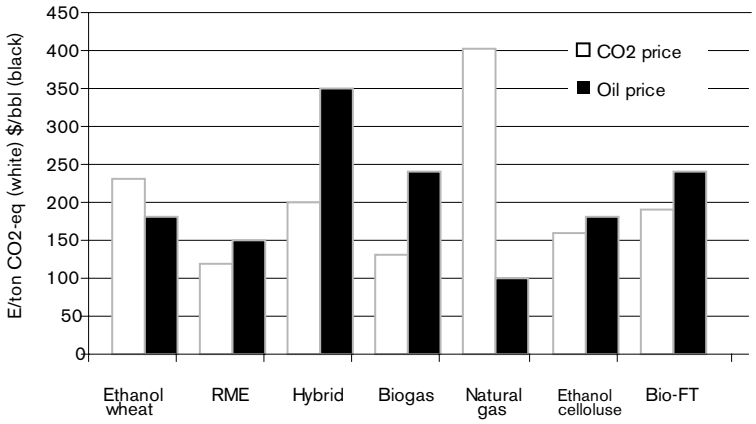

Figure 3. Oil price (given no CO2 price) or carbon dioxide price (given an oil price of 60$/barrel) required to make different transport options competitive to gasoline in the EU. All calculations are based on vehicles dedicated to the alternative fuel.

It is important to underline the difficulty of assessing costs and benefits of technologies that are only adopted on a small scale, or not even adopted at all. Nevertheless, all transport technologies discussed above have a rather long way to go to be as cost-effective as the greenhouse gas abatement technologies in the heat and electricity sector.

This chapter therefore concludes that, in the short-run, the most cost-effective carbon dioxide abatement technologies are to be found among energy-efficiency measures, biomass use for stationary purposes and power producing technologies. Reducing carbon dioxide emission in the transport sector by altering fuels is, generally speaking, more expensive in the short-term. At the same time, it should be noted that measures undertaken in the electricity sector affect industry more than measures undertaken in the transport sectors. In others words, from the perspective of international competitiveness, a strong case can still be made for taking action in the transport sector.

[11] Estimates based on Concave (2005) Well-to-Wheels analysis of future automotive fuels and power trains in the European context. Version 2a. http://ies.jrc.cec.eu.int/wtw.html

3. Towards a "Smart Growth" Strategy for Sustainable Development

3.1. "A Platform for Action" – the good news

This report focuses on technology for sustainable development. As described in Chapter 2 there are technologies available or currently under development, which can substantially improve resource efficiency, particularly in the field of energy, thereby contributing both to economic growth and to a better environment, two of the main elements in the strategy for sustainable development. Since it was agreed in 2001, however, the strategy has been reformulated at successive summits – or rather watered down - and is now subject to a policy review. The European Commission has put forward "A Platform for Action", which will be discussed by ministers meeting in the Council and also by the European Parliament during the next few months before it is put on the agenda of the European Council in June 2006.

The objective of the ongoing review is not to replace, but rather to further develop the strategy for sustainable development. "A Platform for Action" has a broad perspective, identifying six key issues for sustainable development: climate change and clean energy, public health, social exclusion, demography and migration, management of natural resources, sustainable transport and, finally, global poverty and development challenges.

The stated aim of the review is to ensure that links between European policy initiatives are exploited and trade-offs assessed in order to achieve sustainability objectives. "A Platform for Action" lists a number of policy initiatives of particular interest for the economy and environment, some of them very concrete, others more general:

- the drive for commitments to cut greenhouse gas emissions further;
- commitment to develop a second phase of the European Climate Change Programme;
- a next step in the development of a sustainable, secure and competitive European energy policy;
- an action plan to achieve the estimated energy saving potential;
- an action plan to promote sustainable production and consumption; and,
- the intention to present a package of measures to improve the environmental performance of cars.

One of these initiatives has the potential to become a platform for the development of policies and actions in many fields. That initiative is the proposal to draw up an action plan to promote sustainable production and consumption, building on ongoing initiatives and instruments such as resource and waste policies, integrated product policy and standards, environmental management schemes and innovation and technology policies. The purpose of such an exercise is to reinforce the impact of these policies, address gaps and ensure their contribution to global initiatives.

3.2. "A Platform for Action" – the bad news

However, the Commission proposal for a revised strategy also has some obvious weaknesses.

- **Little sense of urgency** - The proposed strategy does not create any sense of urgency. The evaluation made by Eurostat showed few signs of progress and highlighted many disappointing facts. That picture is not reflected in the "Platform for Action" where the main message rather seems to be "business as usual": "Europe has made a good start in applying these principles of sustainable development" and "the rapid pace of change requires the stepping up of efforts to keep Europe on a sustainable path" … "the EU has put a policy framework in place to combat climate change" etc.

- **Technology plays a minor role** - The Commission's proposed strategy plays down the main element in the transformation of the economy to sustainable patterns of production and consumption, namely the role of technology. The Commission focuses on the narrow concept of eco-innovation and eco-technologies rather than the much broader concept of technologies for resource efficiency.

- **Synergy is missing** - While the six key areas in "A Platform for Action" are all relevant for sustainable development – and partly overlapping - it is not clear how these elements will be mutually reinforcing. The Commission has not presented the underlying analysis of the interaction between policies in the six key areas. Economic growth and employment are not included and the role of these policies for the social inclusion and sustainability of pension systems is therefore missing. "A Platform for Action" does not represent a strategy where different economic, social and environment objectives are well integrated to guide policy development. On the contrary, it appears more like a list of priorities in the social and environmental fields, mirroring the organisation of the Commission in separate policy areas.. Impact assessment is prescribed for all major policy proposals to assess their contribution to sustainability, but such assessments, in order to work successfully, require more stringent overarching objectives and a measurable definition of sustainable development, for example decoupling of economic growth from environment or genuine saving.

- **Competing initiatives, not a coordinating strategy** - The EU strategy for sustainable development is one of three EU growth strategies; the others are the Growth and Stability Pact and the Lisbon strategy. Each of these has its own goals and targets, its own time horizon and its own processes for implementation. The Stability and Growth Pact includes short- and medium-term targets for fiscal stability and an annual surveillance process. The Lisbon strategy has a medium-term objec-

tive – 2010 – and an implementation process through biannual national action plans. The "Platform for Action" identifies one long-term goal – sustainable development – which is described as the overarching long term goal of the EU. However, the lack of coherence and coordination of these strategies at European level will make implementation at Member State level extremely complicated – and the process of policymaking very weak. First, the absence of an economic objective means that the positive role of sustainable development as an economic growth factor is missing. This will make the strategy less relevant as an overarching strategy for the Lisbon strategy and the Growth and Stability Pact. Second, the implementation process of "A Platform for Action" is limited to reviews by Member States of their "national strategies as appropriate in the light of the EU strategy" and a voluntary peer review process to seek to identify best policies and practices.

There seems to be no coordination between the implementation processes for the Lisbon strategy, "A Platform for Action" and other related processes, for example on environmental technology, where Member States are preparing "road maps" based on the Environmental Technology Action Plan (ETAP). There is a considerable risk that the implementation of all these good intentions and initiatives will fail, and that the failure will be even more serious than the implementation failure of the first round of the Lisbon strategy.

3.3. "A Platform for Action" – how to turn it into a "smart growth" strategy?

Since the European Commission put forward "A Platform for Action" in December 2005, the Commission has also come up with a revised Lisbon strategy, discussed and agreed at the Spring Summit of the European Council and the Green Paper on a European Energy Strategy. Both these documents represent in some respects more ambitious policies than "A Platform for Action". At the Spring Summit the European Council made Energy Policy for Europe (EPE) a top priority and highlighted the need for sustainability, competitiveness and security of supply.

With this in mind the EPSD would give the following recommendations for the preparations of the European Council discussion on sustainable development at the June Summit:

3.3.1 Urgency, not complacency

The statement that "Europe has made a good start in applying these principles of sustainable development" is inappropriate. It gives the impression of complacency and business as usual, as if the work was already done. In the Green Paper on energy the Commission took a more proactive approach: "Europe must act urgently ... a new European impetus is needed". Climate change is described as a "huge challenge" requiring "that Europe must act now, in particular on energy efficiency and renewable energy".

We recommend that the European Council should use the statistical evaluation made by Eurostat, EEA and the most recent scientific reports on climate change, as a spark to liven up the proposed "Platform for Action" and convey to all stakeholders a sense of urgency and commitment to action.

3.3.2. Focus on technologies for the future

The proposal by the Commission falls short of the original ambitions of the strategy, expressed by the European Council to "unleash a new wave of technological innovation and investment, generating growth and employment". We recommend that the European Council should reiterate the commitment to promote technological innovation and investment as the main road to sustainability, and here we see the need for at least four different policy initiatives.

First, a stable and long-term carbon dioxide emission trading scheme is required to ensure that new technologies represent profitable investments. The first steps have been taken, but for it to work efficiently the European Council must give a strong signal about the long-term development of the system. Today the system has a very uncertain status after 2012. Furthermore, auctioning of the permits rather than free allocation would lower the social costs of the system as well as more strongly promote technological innovations.

Second, the Member States should abolish the coal subsidies. The benefits of improved price signals through the emission-trading scheme may be reduced due coal subsidies in some Member States. We therefore welcome the EU directive about coal subsidies that fixes the date of abolishment of the subsidies to no later than 2010.

Third, a feed-in tariff system for immature technologies such as solar PV and wind power, as has been successfully adopted in Germany may be used at the EU level. By grading the electricity produced from certain technologies a fixed price, investments is new immature technologies are becoming more attractive. The renewable industry could thereby develop faster, reducing the costs of the technologies and leading in future to a significant export potential in renewable energy. It is important to support a variety of technologies, and not trying to "pick the winner" at this early stage, since it is very difficult to foresee which technologies that will be competitive in the future.

Fourth, we would propose a dynamic performance target system in the same spirit as the Japanese "Top Runner Programme". Focus should be on products, which have a rather long lifespan such as cars, refrigerators, washing machines etc. By regulating to ensure that the best performance of today for a certain appliance must become the average of all such products sold in five or ten years time, this system grants both flexibility for the companies (since it is the average performance that counts) and strongly promotes new technologies. Combining this system with strong enforcement would grant strong incentives for technological development in the EU. We therefore welcome the commitment made by the Commission in the Green Paper on Energy to put more focus on "rating and showing the energy performance of the most important energy-using products" as a first step in this direction.

By introducing such policy instruments, many of the technologies discussed in Chapter 2 of this report would not only be adopted but may also be mature enough for export to the rest of the world.

3.3.3. "Smart growth", not a burden on the economy

We recommend that the European Council should act upon what the European Parliament proposed in its Resolution on the Lisbon Strategy: "*to bring together the Union´s fragmented growth strategies into a single coherent and comprehensive strategy to make the European Union a global leader in a new generation of products and production methods, integrating information and communication technologies and resource efficient technologies for sustainable development".*

A first step is to integrate the economic dimension of sustainable development, now missing in the Commission proposal, focusing on the synergy between economic, social and environmental objectives and policies. A second step is to develop a comprehensive strategy on the basis of the proposal by the Commission to promote sustainable production and consumption. However, such a plan has to go beyond the idea of reinforcing present policies, addressing gaps and ensuring their contribution to global initiatives. It will have to include a number of other initiatives, particularly initiatives on energy, transport and housing.

A third step is to turn sustainable development into an investment strategy, "a smart growth strategy", emphasising the potential of the continuous turnover of the existing capital stock to phase out old technologies and phase in new resource efficient technologies. The Green Paper on a European Strategy for Sustainable, Competitive and Secure Energy stresses the urgent need for investment and presents an estimation of investment amounting to one trillion euros over the next 20 years in Europe alone to meet expected energy demand and to replace ageing infrastructure. Although Europe is already one of the world's most energy efficient regions, it can go much further. Up to 20 % of EU energy use can be saved, which will reduce the energy bill for consumers and business by 60 billion euros every year. Moreover, much more can be gained by a decisive shift from fossil fuels to renewables.

Total investment in the EU amounts to around 20 % of GDP and every investment decision is a choice between more or less sustainable technologies; even a decision to postpone new investment includes such a choice. A higher level of investment will bring more opportunities for the introduction of resource efficient technologies and will lead to more sustainable forms of economic growth. Thus, a well designed strategy for sustainable development can both build on the macroeconomic efforts to stimulate investment and give a strong contribution to such an investment strategy.

To meet the needs of technology and investment in Europe, public policies in the EU have to recognise sustainable development as a "smart growth strategy", which will require strong political support, long term commitment, stronger policies and incentives, better co-ordination and implementation. Actions to accelerate technology development and drive down the costs of new energy technologies must be complemented by policy measures to open up markets and to ensure the market penetration of existing technologies that are effective in addressing climate change, as emphasised in the Green Paper on energy. In this way economic growth can be promoted and social inclusion can be fostered, while pressure on natural resources can be reduced.

3.3.4. Global leadership, not lagging behind

The transition to sustainable technologies is of fundamental importance for global sustainability. At the global level the need to save energy and replace old fossil fuel technologies by renewables is pressing. At the G8 Summit in 2005, leaders identified that an estimated $16,000 billion will need to be invested in the world's energy systems in the next 25 years. According to the International Energy Agency there are significant opportunities to invest this capital cost-effectively in cleaner energy technologies and energy efficiency.

The World Bank has presented a report on "Clean Energy and Development: Towards an Investment Framework. One main message of the report is that the global community today is working toward a potential "double dividend by meeting the energy needs that are essential for economic growth and fighting poverty, while at the same time leaving a smaller environmental footprint. The paper recognizes that meeting developing countries' energy needs is both an urgent and difficult challenge, which requires domestic policies that provide incentives for efficiency in energy production, delivery, and use and incentives for public and private resource mobilization. The report also recognizes that climate change can undermine development and that dealing with climate change will require the development and implementation of climate-friendly technologies as well as adapting to climate change.

Thanks to environmental standards, established over the last few decades, European industries have developed and invested in more resource efficient technologies. Hence, the EU is in the lead in providing other regions with such technologies, which will become even more important with strong economic growth in China and India, huge investment in transport and energy systems, in housing and infrastructure. The new agreement between the EU and China on technology for "near-zero emissions power generation" is a good step. However, governments and enterprises, both in Japan and the US, are making big efforts in these fields, and are now challenging the EU leadership. The Japanese "Top Runner Programme" referred to above illustrates this point. Another example is provided by one of the leading US corporations, General Electric, which last year announced its intention to refocus its production strategy towards sustainability goals, doubling its investment in energy efficient and environmental technologies

The plethora of EU initiatives and programmes for environment and energy technologies and other areas of sustainability does not give the impression of a well coordinated strategy to support technological leadership There is already an Environmental Technology Action Plan (ETAP) from 2004; the Programme for Competitiveness and Innovation (CIP) from 2005, described as a "flagship programme" for the Barroso Commission, including the Intelligent Energy-Europe programme; the new Seventh Framework Programme for Research; and, finally the recently proposed Strategic Energy Technology Plan from 2006. There are a lot of good intentions, but a clear lack of leadership and coordination.

Our final recommendation to the European Council is therefore to make a strong commitment for the EU to take the leading role in the development and implementation of resource efficient technologies at home and abroad by coordinating the many overlapping and competing programmes for research and development, by allocating the necessary resources and by mobilising European industries for world leadership in this new generation of technologies and processes.

Contact EPSD

Bo Samuelsson, Chairman EPSD
e-mail: bo.samuelsson@clinchem.gu.se
telephone: +46 706 931883

Helene Bergsten, GMV
e-mail: helene.bergsten@gmv.chalmers.se
telephone: +46 31 7724950

www.gmv.chalmers.se/epsd