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A European Eco-Efficient Economy

Governing climate, energy and competitiveness

REPORT FOR THE 2009 SWEDISH PRESIDENCY OF THE COUNCIL OF THE EUROPEAN UNION

Måns Nilsson, Annika Varnäs, Clarisse Kehler Siebert, Lars J Nilsson, Björn Nykvist, and Karin Ericsson

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EXECUTIVE SUMMARY

Europe and the world face a series of challenges including resource degradation, climate change, and a global economic crisis. Due to their integrated nature, they must be tackled at once, as one. The quest for an eco-efficient economy is about simultaneously addressing these challenges through an integrated policy agenda for climate change mitigation, resource efficiency, industrial renewal and innovation, and competitiveness. The aim is to exploit synergies and minimise trade-offs to help economic recovery while embarking on a more sustainable economic development path.

This report is not just about challenges. It also describes the opportunities for Europe to become a leader in the global transformation to an eco-efficient economy. It discusses the imperative for this transformation, examines achievements and on-going efforts, and advances a set of agenda items for political discussion.

Important lessons and good examples are available in many sectors, including "new" ones such as renewable electricity and biofuels for transport, cross-cutting ones such as sustainable cities and energy efficiency, and in traditional sectors such as heating, iron & steel, chemicals and automotive. The eco-efficient economy is not only about stimulating new eco-innovation; mature sectors retain very critical roles for employment and the economy, and for resolving environmental problems.

Europe's leadership is evident primarily in its climate change mitigation commitments, as well as governance initiatives in areas such as energy efficiency and sustainable industrial policy, but improvements can be made in fostering innovation and efficiency. There is potential for Europe to remain an attractive place for investment and industry while pursuing an eco-efficient economic strategy focusing on governance for innovation and industrial renewal. But efforts must be intensified.

How can EU policy makers step up efforts to foster a European eco-efficient economy over the coming years? Three strategic areas should be in focus:

- *Resource systems efficiency*, in particular energy efficiency and sustainable city planning including infrastructure improvements and transport solutions – this has a direct political and economic appeal in present times of economic crisis.

- *New technology markets,* including sustainable transportation and renewable and other carbon-neutral energies – these sectors need transforming, as they are the major contributors to climate change and resource degradation today.

- *Global carbon pricing*, to incentivise markets for investment and consumption – this is the single strongest policy action and unavoidable to yield eco-efficient development globally in the long term.

It is technically possible as well as economically viable to pursue these strategies towards far-reaching climate, resource and development objectives. However, they are by no means automatic or easy. To the contrary they require profound policy actions and behavioural responses by companies and consumers – globally. A first necessary step is to initiate political debates at national, European and global levels, about how governance systems can be orchestrated to facilitate these strategies. Several linked policy agendas must be pursued.

- *Adapting governance to innovation pathways*: This concerns how to govern a transition to an economy based more on innovation and intensified knowledge input, which requires adapting governance measures to innovation systems and technology characteristics, and enhancing the use of hybrid governance and policy packages.

- *International cooperation and carbon pricing*: Because Europe's economy (and climate) is interwoven with the rest of the world, international cooperation and global deals are absolutely central in the pursuit of the eco-efficient economy. Major challenges are ahead – both in following through on domestic commitments despite the economic crisis, and in reaching comprehensive global commitments through the international frameworks. This entails vigorously pursuing a stepwise global expansion of carbon pricing and related means such as developments of standards, R&D and early market support, trade policy, and technical cooperation.

A systems approach for informed policy debates: Policy makers' knowledge about how the eco-efficient economy can be governed is fragmented today. The agenda is complex and interconnected, and new systems analysis tools are needed to provide knowledge for informed decision making. This involves both developing new and better systems approaches to understanding technological innovation and combined policy impacts, and developing new platforms for evidence-based policy debates at national and European levels.

Summing up these agenda items, a six-point action plan is proposed.

1. **The EU needs to step up programmed interventions to induce development and diffusion of specific technologies alongside more generic policies.**

2. **The EU needs to develop more hybrid and combined governance arrangements.**

3. **The EU needs to continue pushing forward the development of a global price on greenhouse gas emissions.**

4. **The EU needs to assist and induce emerging economies to make substantive commitments.**

5. **The EU needs, even more forcefully, to make policy assessments and other forms of evidence gathering routine.**

6. **The EU needs to develop institutional platforms where the evidence can be taken up, interpreted and learned from.**

FOREWORD

A European Eco-efficient Economy has been prepared as a background report for the 2009 Swedish Presidency of the Council of the European Union. It forms a common basis for discussions at the informal ministerial meetings of the Council dealing with energy (July), environment (July) and competitiveness (October). The objective is to facilitate the alignment and coordination of these meetings' policy agendas, which range from climate change and energy efficiency, to innovation, competitiveness and employment. As will be shown, these agendas are highly connected and the European eco-efficient economy is an attempt to encapsulate them in an integrated way.

The study has been commissioned by the Swedish Government and carried out by analysts at the Stockholm Environment Institute (SEI) and Lund University. It has benefited from the advice and support of an inter-ministerial steering group with representatives from the Ministry of the Environment and the Ministry of Enterprise, Energy and Communications. However, the report does not necessarily represent positions or view points of the Swedish government. The authors are solely responsible for the analysis, proposals and opinions presented, as well as any omissions and mistakes therein. Dr. Måns Nilsson of SEI directed the study. Primary authors for case studies are: Karin Ericsson (heating), Lars J Nilsson (biofuels; energy efficiency), Måns Nilsson (renewables), Björn Nykvist (automotive), Clarisse Kehler Siebert (chemicals) and Annika Varnäs (steel; sustainable cities).

The study team has drawn upon input and advice from a reference group including representatives from the Swedish Environmental Protection Agency, the Swedish Governmental Agency for Innovation Systems (VINNOVA), the Swedish Energy Agency, Lund University and Linköping University. In addition, industrial associations and environmental NGOs in Sweden and Europe, and staff members of the European Commission, have commented on draft versions. The study team would like to thank the Steering Group and Reference Group for their helpful comments and input, as well as all commentators in Sweden and internationally who provided helpful suggestions and comments on the final draft.

Stockholm, May 2009

Måns Nilsson, also on behalf of the whole study team

1 INTRODUCTION

Climate change and fossil fuel dependency have taken a central stage in European and international politics in recent years. This has occurred in an increasingly globalised and competitive world – one faced with daunting social, political and economic challenges. The recent financial crisis and ensuing economic recession has put additional pressure on European leaders to stake out the way towards an economic development that is able to induce investment and job creation and generate welfare, while proactively dealing with increasing and sharply fluctuating energy and raw material prices, mitigating the threat of climate change, reversing natural resource degradation, and responding to increasing global industrial competition. This is what the quest for a European eco-efficient economy is about. It engages a range of policy areas that need to talk much more with each other than they do today, and envelops a common understanding of the integrated nature of the challenges ahead. The hypothesis is that such an integrated view presents opportunities and synergies that today are only partially captured in European governance. Leading the global efforts to combat climate change and resource degradation at the same time as enhancing Europe's competitiveness requires developments in technology and new directions in innovation. It also involves a stronger horizontal coordination if not integration of several important policy agendas at European and national levels, as well as coordination with and between EU's external policies, including climate change negotiations, neighbourhood policy, and trade, which so far have been treated largely in isolation. However, the opportunity for achieving a European eco-efficient economy is also shaped by a range of external driving forces, only partly affected by policy, such as energy prices, consumer preferences, and global economic growth.

EUROPE AS A LEADER FOR AN ECO-EFFICIENT ECONOMY

The EU has established itself as an international leader in the mitigation of climate change as well as in managing other global environmental issues. For good reasons, the EU is eager to retain this role. Through continuing and revamping its "soft" leadership strategy, Europe can – by example, diplomacy, and persuasion in areas such as climate change policies – not only become more eco-efficient itself, but also pull the global community towards a more eco-efficient economic development. The climate and energy package agreed in 2008 is an example of an initiative with significant potential for leadership by example. Why should Europe lead the global climate agenda? At least four strategic motives may underpin this leadership aspiration. First, climate policy has developed into an important driver of European integration overall, and to take on such important challenges in a proactive way has proven to enhance the legitimacy of the European institutions in general among its Member States and populations. Second, the question of future supply security for energy is intensifying, which reinforces important parts of the climate policy agenda. Energy imports are on the rise, and oil and gas prices are unstable. Strategies for energy efficiency and renewable energy promotion will help Europe secure its energy supply. Third, the EU's strong global voice on multilateralism internationally plays well into the climate change agenda, as being particularly suited for multilateral action.[1] Fourth, leadership on climate change and coupled issues of the eco-efficient economy could, if done right, spur innovation that enhances Europe's long-term job creation and global competitiveness.

The Lisbon agenda set forth in 2000 was an early attempt to put measures in place that would make the EU the most competitive economy in the world.[2] The first Swedish presidency of the Council (in 2001) also included initiatives in this direction, for instance through work on chemicals policy, integrated product policy, and sustainable development strategies. Further important political initiatives for an eco-efficient economy were taken during the Dutch (2004) and German (2007) presidencies, both of which examined the case for promoting sustainable innovations and green

1 Oberthür, S. and C. R. Kelly (2008). "EU leadership in international climate policy: achievements and challenges." *The International Spectator* 43(3): 35-50.

2 The EU sustainable development strategy adjacent to the Lisbon agenda sets overall objectives for seven key priority areas – climate change and clean energy; sustainable transport; conservation and management of natural resources; public health; social inclusion, demography and migration; and global poverty and sustainable development challenges.

technologies as an important overall strategy for Europe. Ideas about the need for a "new industrial revolution" were also aired in the European Commission's first strategic energy review of 2005. More recently, the Commission's High-level Group on Competitiveness, Energy and the Environment made further advances in developing an integrated agenda.[3] This report will continue to build up the case for an integrated agenda for energy, environment and industrial policy in Europe. It sets out to explain and demonstrate how, in particular, climate change mitigation can be combined with strong economic performance, while recognising that this pursuit is neither straightforward nor uncontroversial.

A global transition to a low carbon economy in order to tackle climate change presents a major opportunity for all countries to embark on cleaner development. However, there are strong – and legitimate – concerns that climate change mitigation may, if not appropriately designed, hamper economic growth, competitiveness and jobs in Europe, in particular in sectors that are energy-intensive, export-oriented and subject to unilateral policies. According to this logic, not only would European industries be hurt, but there is a further risk that the efforts will have no effect on climate change mitigation due to carbon leakage – as production moves to other countries, and imports increase so that no or negative carbon savings are achieved.[4] However, there is evidence that efficiency enhancements at systems levels are largely untapped in many sectors, suggesting that large parts of the climate mitigation agenda can be achieved at negative or low cost.[5] Furthermore, environmental regulation and policies oriented towards developing more eco-efficient technologies can actually contribute to growth and competitiveness, by catalysing European companies into becoming leaders in new markets and technologies, and developing new service sectors. The 2008 European Innovation Scoreboard shows that the EU is in many ways on the right track and catching up with main rivals such as US and Japan. Still, challenges persist in areas such as the business investment climate and bringing innovation systems thinking to R&D efforts.[6] An important adjacent agenda is to improve regulation and alleviate the administrative burden for small and medium-sized enterprises (SMEs) in Europe, even as efforts for environmental and climate governance are stepped up. EU countries have a strong position in several new technology areas and have the potential to maintain a leading position in these areas, along with coupled services sectors. Recent examples can be found, for instance, in energy systems optimisation and efficiency, combined heat and power technologies, wind and solar energy, automotive, waste management, and water management. Further efforts are advanced through new demand-side governance initiatives such as the European Lead Market Initiative[7], which aims to foster innovation-friendly market framework conditions through standardisation, labelling and procurement measures.

THE ECONOMIC CRISIS ALSO AN OPPORTUNITY

At the same time as it is pursuing this leadership role, Europe is facing important structural and policy challenges, amplified by the recent economic turmoil and signals of a serious recession. Periods of economic downturn are known to turn political attention away from long-term issues to more immediate concerns such as budgets, employment and social welfare. However, as President Barroso along with many Heads of State have noted, the economic downturn does not in any way diminish the need for concerted action towards climate change mitigation. In fact, to pursue climate strategies in the context of an eco-efficient economy can be an opportunity for economic recovery through, for instance, its potential for cost savings, job creation,

3 CEC (2007a). First report of the high level group on Competitiveness, Energy and the Environment: *Functioning of the energy market, access to energy , energy efficiency and the EU Emissions Trading Scheme*. Brussels, European Commission.

4 Carbon leakage is defined as the increase in emissions outside a region as a direct result of the policy to cap emission in this region. Carbon leakage means that the domestic climate mitigation policy is less effective and more costly in containing emission levels, a legitimate concern for policy-makers. (Source IEA; 2008: Issues behind competitiveness and carbon leakage – focus on heavy industry)

5 McKinsey (2008). *Pathways to a low-carbon economy: Version 2 of the global greenhouse gas abatement cost curve*, McKinsey & Co.

6 CEC (2009a). 2008 *European Innovation Scoreboard*. Brussels, European Commission.

7 CEC (2007c). *Lead Markets for Europe*. Brussels, European Commission.

efficiency enhancements and new systems solutions and business models.

As the recent financial crisis has slowed economic activity throughout the world, governments are turning to new spending. Herein lies a grand opportunity – through promoting and spending on for instance green cars, efficient appliances, infrastructure, better insulation, more efficient lighting, better public transport, and alternative energy. The Commission has also identified the current crisis as an opportunity which brings with it the significant public-private investment synergies necessary for climate change mitigation, and objectives such as innovation, growth and jobs.[8] The World Economic Forum has further pointed to the need for fiscal stimulus to multi-task – that is, creating jobs and economic growth at the same time as moving investments towards, for instance, sustainable energy systems.[9] The Commission's Economic Recovery Plan[10] agreed in 2008 sets out fiscal stimulus packages along with investments in infrastructure and green technologies, for instance in the car industry: *"Smart investments in tomorrow's skills and technologies will accelerate Europe's drive under the Lisbon Growth and Jobs Strategy to become a dynamic low-carbon economy for the 21st century"* (President Barroso's speech at the press conference). Synergies with a green policy agenda are visible also on the revenue side, where the European Emissions Trading System (ETS) and similar schemes are expected to generate significant public value: under full auctioning, the annual revenue under the ETS is estimated at over €30 billion annually[11].

That the eco-efficient economy agenda is a hot one internationally is clear in the recent proliferation of books and conferences on this theme; e.g. "A Green New Deal"[12], "The Green Collar Economy"[13], and "Strategies for the Green Economy"[14]. In October 2008, UNEP launched their "Green Economy Initiative" comprising three pillars - valuing and mainstreaming nature's services into national and international accounts; employment generation through green jobs; and laying out the policies, instruments and market signals able to accelerate a transition to a Green Economy.[15] In March 2009, UNEP's chief Achim Steiner proposed a "Global Green New Deal" whereby investing a significant amount of the $3 trillion-worth of stimulus packages would be invested in areas such as buildings' energy efficiency, renewable energy, and sustainable transport. This represents a true opportunity to make the transition to a low-carbon and resource-efficient society.[16]

That the eco-efficient economy agenda has a strong connection to these short-term economic recovery concerns highlights an important *time dimension*, where short-term action items are linked to the need to enable different actors to harvest the "low-hanging fruits", such as energy end-use efficiency enhancements, and use the current imperative for fiscal stimulus as an engine for eco-efficiency.[17] However, in the longer term the agenda is linked to much more fundamental socio-technical change, involving the EU's active promotion of the development, diffusion and use of the next generation of technologies. The eco-efficient economy agenda also has an *international dimension*, as Europe's own emissions of greenhouse gases only constitute about 13 per cent of the global total, and also because European industries in most sectors must be able to compete globally. There is no doubt that the competition for jobs will continue globally, and Europe has the choice and

8 CEC (2009b). *Communication: Towards a comprehensive climate change agreement in Copenhagen*. Brussels, European Commission.

9 World Economic Forum (2009). *Clean investing: toward a clean energy infrastructure*. Geneva, World Economic Forum.

10 CEC (2008b). *Communication: A European Economic Recovery Plan*. Brussels, European Commission.

11 Egenhofer, C. (2008). "*Climate change policy after the financial crisis: the latest excuse for a new round of state aid?*" CEPS Commentary: 30 October 2008.

12 New Economics Foundation (2008). *A Green New Deal: Joined-up policies to solve the triple crunch of the credit crisis, climate change and high oil price*. London, NEF.

13 Jones, V. (2008). *The Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems*, HarperCollins.

14 Makower, J. (2008). *Strategies for the Green Economy: Opportunities and Challenges in the New World of Business*, McGraw Hill.

15 http://www.unep.org/greeneconomy/

16 Barbier, E. (2009). *A Global Green New Deal*. Nairobi, UNEP.

17 Edenhofer, O. and N. Stern (2009). *Towards a Global Green Recovery.* Berlin, Potsdam Institute.

opportunity to become the leading new market for eco-efficient products and services.

Many international agreements are part of the overall governance framework of the eco-efficient economy agenda. These go beyond the global climate negotiations and touch upon agendas such as technology cooperation and standards, R&D support, development assistance, diplomatic networks and trade. A closer coordination or integration of these agendas, for instance, by integrating trade provisions in a new climate deal is under debate. In this context, it is recognised that trade provisions and penalties in climate policy would, for example, not necessarily violate World Trade Organization regulations. However, the trade agenda in relation to the eco-efficient economy agenda constantly risks capture by protectionist interests, and it is necessary to establish agreed principles for what constitutes legitimate trade provisions. In a recent report on environmental effects of international trade, Harvard economist Jeffrey Frankel suggests that border measures are possible under the condition that they follow multi-laterally agreed guidelines, that judgments about things such as e.g. carbon content are made by independent panels of experts, that measures are applied only to countries that are not participating in the UNFCCC protocol, and that penalties are directed only to few of the most fossil-intense industries, such as aluminium, steel, paper, glass and chemicals.[18]

The transitioning toward the European eco-efficient economy presents opportunities and win-win situations as well as challenges and policy dilemmas. Current political disagreements in the face of economic problems reinforce the need for a joint European vision of an eco-efficient economy. In this report our central objectives are to discuss the challenges and opportunities for an eco-efficient European economy, learn lessons from different sectors' efforts and achievements, and draw out the implications for European governance towards an eco-efficient economy. The report will not make specific recommendations, either on specific policy instruments or on particular technologies, but it will suggest key strategic areas and a set of agenda items for further political discussions.

18 Frankel, J. (2009). *Environmental effects of international trade*: expert report to Sweden's globalisation council. Stockholm, Regeringskansliet.

Below we discuss some of the terms upon which the eco-efficient economy concept is formulated.

ECO-EFFICIENCY AT THE ECONOMY-WIDE LEVEL

Eco-efficiency was coined by the World Business Council for Sustainable Development in its 1992 publication, "Changing Course".[19] There it is portrayed as a strategy for enhanced competitiveness of firms through environmental enhancements: creating more goods and services while using fewer resources, and creating less waste and pollution. This leads to reductions in environmental costs, greater resource efficiency, and improvements in image for businesses, and comes about through processes such as resource optimisation, waste recycling and new services. The term has become synonymous with a management philosophy used primarily in the enterprise context (i.e. at the micro-level). Currently, an ISO standard is being developed for how to measure and evaluate eco-efficiency in products and processes.

In this report, we adapt this primarily enterprise-related and micro-level concept to the economy-wide (macro) level, where the eco-efficient economy concept encapsulates an integrated view of economic and environmental performance and a dynamic change process in the European economy as a whole. We zoom in on climate change and resource use in the environmental dimension, and do not explicitly account for a broader range of environmental problems (although many of these are correlated to climate and resource use). The theoretical basis for the concept of an "eco-efficient economy" is of course different from the conventional firm-level connotation. This broader, economy-wide concept can be situated theoretically within the literature on ecological modernisation[20], within which we highlight four key themes[21]:

19 WBCSD (1992). *Changing Course - a global business perspective on development and the environment*. Cambridge MA, MIT Press.

20 Hajer, M. (1995). *The Politics of Environmental Discourse: Ecological Modernisation and the Policy Process*. Oxford, Clarendon Press.

21 Baker, S. and K. Eckerberg, Eds. (2008). *In Pursuit of Sustainable Development: new governance practices at the sub-national level in Europe*. London, Routledge.

- that there can be synergy between economic growth and environmental protection, not least through enhanced energy and resource efficiency;
- that there is integration of environmental policy concerns into mainstream economic policy areas;
- that there are new instruments and actor roles to influence economic activities, broadening the spectrum from public policy to governance; and,
- that there are efforts for invention, innovation and diffusion of more eco-efficient socio-technical systems in the economy.

The eco-efficient economic agenda thus entails an integrated policy response to several traditionally separate policy agendas, including climate change mitigation, sustainable energy use, resource productivity and efficiency, economic growth and job creation, innovation, and competitiveness. Furthermore, it touches on international cooperation policies including trade policy, foreign policy and development policy. An eco-efficient economy is one which simultaneously achieves positive outcomes on all these agendas by exploiting the synergies between them and minimising the trade offs involved.

As a policy paper rather than a research report, it does not apply a strict analytical interpretation of the eco-efficient economy. Efforts will be needed to evaluate contributions to or against the eco-efficient economy in more specific technology / policy assessment exercises (see Chapter 6). [22]

OTHER KEY TERMS AND CONCEPTS

Below we introduce key terms and concepts that underpin the eco-efficient economy and are used frequently. The impatient reader may want to skip this somewhat theoretical account!

Innovation

The concept of innovation has won great approval over the last decade amongst analysts and policy makers concerned with economic change, industrial transformation and technological development. The relatively recent literature on innovation systems highlights the importance of actor networks and institutional arrangements for the development, diffusion and utilization of new technology. Its "socio-technical" systems perspective recognizes that firms and technologies are part of wider social systems of actors, networks and institutions. In particular, it has been argued that the pursuit of sustainable development requires radical changes at the regime level – so called "transitions" – and that while these cannot be controlled, they can, to some extent, be governed by society.[23] Different technologies go through different phases of maturity (although not necessarily in a linear way) from basic R&D, to experiments and technology specific R&D, to demonstration, to commercialisation, take off and market accumulation, and finally through to market maturity (see Figure 1). The innovation systems approach helps to identify key "functions" of innovation, which determine how well a technological system performs in development, diffusion and societal uptake of new technologies. Functions can be promoted through public policy as well as private-public governance arrangements, and of course through purely private-sector initiatives.[24]

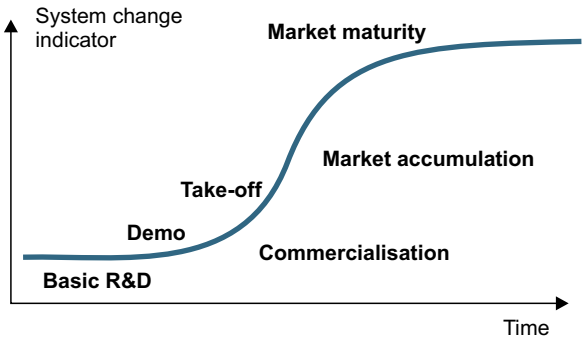

Figure 1: A stereotyped innovation pathway

22 Huppes, G. and M. Ishikawa (2009). "Eco-efficiency guiding micro-level actions towards sustainability: ten basic steps for analysis." *Ecological Economics* 68: 1687-1700.

23 Rotmans, J., R. Kemp, et al. (2001). "More evolution than revolution: transition management in public policy." *Foresight* 3(1).

24 Bergek, A., S. Jacobsson, et al. (2008). "Analyzing the functional dynamics of technological innovation systems: A scheme of analysis." *Research Policy* 37(3): 407-429.

Competitiveness

Despite wide-spread use in policy discussions and research, "competitiveness" is not a straightforward easily defined concept. One may talk about competitiveness at the product or technological innovation systems level, at the company or industry level, and at the level of entire nations or regions. Value is created within enterprises. This process may be hindered or supported through the policies of the nation or region. Thus, competitiveness of nations deals with "how nations create and maintain an environment which sustains the competitiveness of its enterprises".[25] At the industry level, competitiveness is created by superior productivity, which may either arise from lower costs than rivals or the ability to offer the better product for a particular market. Therefore this is closely linked to the innovation capacity. At the economy-wide level, like for the firm level, it is often considered that the overall economy's capacity to innovate is, together with things like education and political stability, an important long-term determinant of competitiveness. Paul Krugman, a leading scholar in the field, has however long argued that competitiveness is not an ideal metaphor for countries or the EU. Europe is not in competition with the rest of the world, but European companies are.[26]

There is often a fear that environmental regulation may hinder competitiveness. For situations where products, production processes and consumer preferences are fixed and where companies have already made their cost-minimising choices, increased environmental legislation leads to a higher cost-burden for companies. However, it has been argued that in many sectors, internationally competitive companies may not necessarily be those with the cheapest inputs or largest scale, but those that have the capacity to improve and innovate continually, based for instance on foresight into environmental challenges and future changes in attitudes and consumption patterns. Properly designed environmental legislation matching such developments may trigger innovations that can create competitive advantage.

25 Porter, M. (1989). *The Competitive advantage of nations*. New York, Free Press.

26 Krugman, P. (1994). "*Competitiveness - a dangerous obsession*." Foreign Affairs March-April.

Decoupling

Decoupling as a concept originates in the world of physics, describing the generic phenomenon of disappearing interactions between physical objects. It is used routinely also in economics for considering whether for instance emerging and developing economies will follow the Western economies into recession or not. In the field of climate policy and eco-efficiency, the term however typically refers to the debate about whether the link can be broken between continued economic growth and environmental pressures. OECD defines decoupling thus: "Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force (e.g. GDP) over a given period. Decoupling can be either *absolute* or *relative*. Absolute decoupling is said to occur when the environmentally relevant variable is stable or decreasing while the economic driving force is growing. Decoupling is said to be relative when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of the economic variable."[27]

Policy coordination and integration

Integration of policy areas has been on the agenda for at least twenty years. One may here differentiate between policies aimed at the integration of environmental issues in sectoral policy making, so called Environmental Policy Integration (EPI) and more generally enhanced coordination / integration of policy making.[28] Both have been subject to various initiatives at the European level. Apart from environmental concerns, a key motivation for integration is the concern that segmented and hierarchical institutions produce incoherent policies. The quest for more integrated public policies has gained increasing interest among governments around Europe, with programmes for "joined-up government" and other forms of joint decision making and consultation in the government offices. In the European Commission, policy coordination has been promoted under measures such as impact assessment and enhanced used of interservice consultation in the drafting of policies.

27 OECD (2002). *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*. Paris, OECD.

28 Nilsson, M. and K. Eckerberg, Eds. (2007). *Environmental policy integration in practice: shaping institutions for learning*. London, Earthscan.

In addition, many Member States' work on sustainable development strategies, and new institutions and procedures for this, has helped to enhance policy integration and handle goal conflicts and synergies. All these have been useful steps towards better coordination. However, they appear insufficient to achieve integrated policy making. Policy coordination can be unpacked in different levels, where integration is the highest "level" of coordination (Figure 2). A most basic form of coordination is when actors consult other actors who may be affected by an initiative, in order to avoid advancing suggestions that will be unacceptable. Inter-service consultation is a typical example of such coordination. A more advanced form is the mutually recognising and purposeful search for common interests and strategies across sectors, which allows the simultaneous attainment of respective goals. *Integration*, finally is the most advanced level, entailing sectors developing joint problem understandings, goals and policy objectives. This report promotes such a process, advancing an integrated view on different policy sectors.

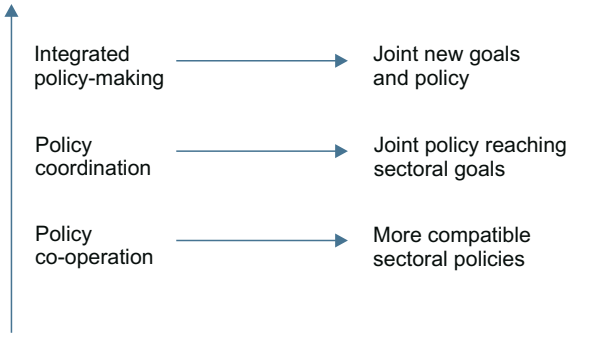

Figure 2: Policy coordination and integration

Governance

Governance has become something of a catch-phrase in recent years, used in lieu of policy or government to highlight the fact that societal steering processes increasingly involves stakeholders other than the state, such as NGOs and industries, and that the interactions between actors as well as the use of different instruments have changed over time. Principally, governance has three dimensions.[29] In the *actor* dimension, it concerns how different actors and interests are represented in the policy process. The crucial aspect is the relationship and balance between private and public actors in the policy making process. Some call it "new" governance when civil society has a stronger role, and "old" governance when the state controls activities in a coercive manner, but whether these are really old or new is a matter of debate – we would argue that they co-exist and have always co-existed. In the *institutional* dimension, it concerns how (according to what rules) different actors interact, for instance through hierarchical control, through market transactions, or through different types of networks. Finally in the *policy* dimension, governance concerns what range of instruments is used, including a) regulatory standards such as product standards, bans and regulations, b) market-oriented measures, such as market designs, deregulations, green taxing, and c) "soft" approaches including voluntary and informational processes, co-regulation and cooperative procedures such as private-public partnerships. Governance is thus a multifaceted concept, involving both the shifting rules and actors in the *process* of policy making, and the shifting policy *contents*. In this paper, we are interested primarily in the policy dimension of governance, but take considerable note of the changing roles of actors both in the development and implementation of these policies.

29 Treib, O., H. Bähr, et al. (2005). *Modes of Governance: a note towards conceptual clarification*, EUROGOV Report.

2 A BRIEF LOOK AT THE IMPERATIVE FOR A EUROPEAN ECO-EFFICIENT ECONOMY

In the following, the eco-efficient economy agenda is unpacked into three linked challenges: climate change, energy, and industrial competitiveness and innovation. These challenges set the scene for some of the issues that Europe is "up against" in advancing its strategies and measures for a European eco-efficient economy. This is in no way intended to be a comprehensive account of all sustainable development challenges in their ecological, social or economic dimensions, but it covers some central considerations.

THE CLIMATE CHALLENGE

Among the wide range of serious environmental challenges currently faced by humankind, climate change is usually considered the most urgent, and in many ways the most challenging to address. It is urgent because of the devastating effects that climate change is likely to lead to in the long term. It is challenging because emissions of greenhouse gases appear to be built into our economic systems, occurring in many human activities and are strongly connected to economic growth. Within the EU, the majority of greenhouse gas emissions come from the energy and transport sectors, and the total share related to energy supply and use across sectors is about 80 per cent (Figure 3).

The climate system is complex and the exact consequences of increasing global average temperature are therefore difficult to foresee. However, there is much research to indicate that climate change is likely to cause widespread damage to populations, ecosystem and resources. Climate change is intrinsically linked to other serious environmental and development challenges, such as water and food supply, public health, desertification, and ecosystems resilience, which need to be considered in developing mitigation and adaptation responses. It may cause severe damage to infrastructure, make large areas inhabitable, and lead to increases in diseases and in mortality. Lately, Nicholas Stern along with others have emphasised and increasingly recognised that the effects of climate change are likely to be so costly that measures seeking to avoid climate change will lead to economic gains when compared to the cost of addressing the effects of climate change once they have appeared.[30]

In order to avoid alarming effects, EU leaders have stated that global average temperature should not increase by more than maximum 2˚C, compared to the temperature in pre-industrial time. This likely requires a stabilization of the level of atmospheric CO_2 at 350 – 400 ppm and that global emissions start decrease within the next 10-15 years (see Figure 4). However, at the beginning of 2009, the CO_2 level was already 386 ppm (+2.1 ppm from last year).[31] Furthermore, in the long run, emissions of CO_2 must not exceed the carbon uptake and decomposition of the CO_2.

The United Nations Framework Convention on Climate Change (UNFCCC), now ratified by 192 countries, sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. The convention aims to achieve a stabilization of greenhouse gas concentrations in the atmosphere at a level that "would prevent dangerous anthropogenic interference with the climate system". It also states that this level should be achieved "within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." Linked to the UNFCCC is the Kyoto Protocol, which sets binding targets for 37 industrialised countries as well as for the European Union. Countries should reach their targets through national measures, but may also use three market-based mechanisms: emissions trading; clean development mechanisms, by which countries can implement emission reduction activities in developing countries; and joint implementation, by which a country can earn emission reduction units from another developed country with emission reduction

30 Stern, N. (2006). *The Stern Review on the Economics of Climate Change*. Cambridge, Cambridge University Press.

31 Trends in Atmospheric Carbon Dioxide - Mauna Loa Oberavtory, http://www.esrl.noaa.gov/gmd/ccgg/trends/

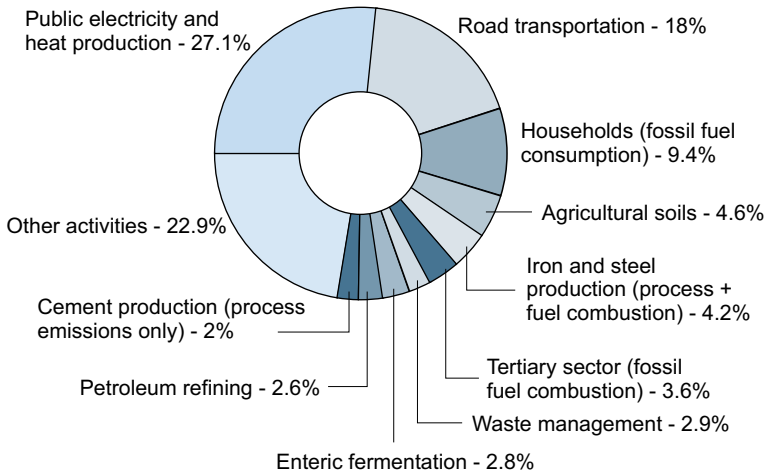

Figure 3: Share of 2006 greenhouse gas emissions in the EU-27, by main activity
(Source: EEA, 2008b)

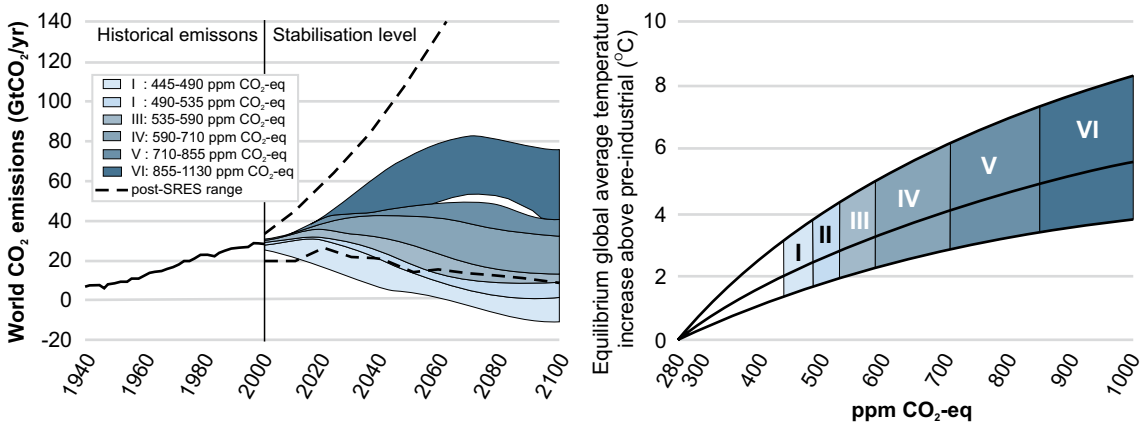

Figure 4: CO_2 emissions and equilibrium temperature changes of different stabilisation levels
(Source: Fourth IPCC report, 2008)

commitments, by implementing a project in the latter country.[32]

In December 2009, Denmark is hosting the 15th Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). COP15 is crucial for the international climate change negotiations. The parties to the UNFCCC agreed at COP13 in Bali in December 2007 that negotiations on a future agreement have to be concluded at COP15 in Copenhagen. The decision was made to the backdrop of the increased emphasis on the need for swift action made in the latest report by the UN Intergovernmental Panel on Climate Change, as well as the recognition that 2009 will be one of the last chances for a agreement if it is to be approved and ratified prior to the expiry of the commitments set in the Kyoto Protocol in 2012. International agreements are important and must lead to concrete commitments. The EU aims to be a driving force in the development of international climate agreements and a further promotion of an expansion of the ETS internationally (or by linking equivalent systems), is needed.

The EU-27 countries account for approximately 10 per cent of global greenhouse gas emissions covered by the UNFCCC. According to the Kyoto Protocol, countries that were EU members in 1997 (EU-15) should reduce

32 United Nations Framework Convention on Climate Change (1992). www.unfccc.int.

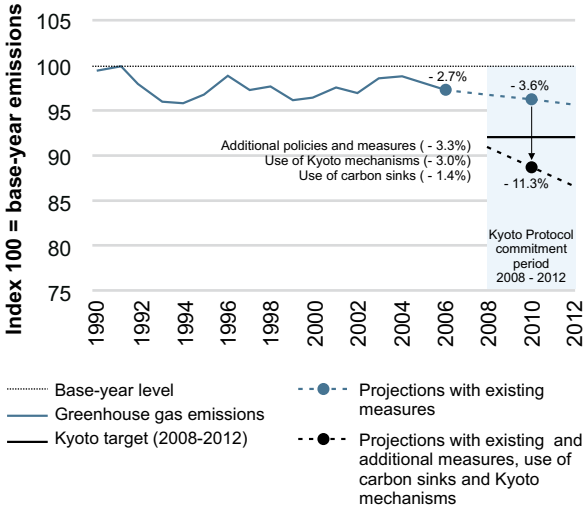

Figure 5: EU-15 Greenhouse gas emissions and projections 1990-2012 (Source: EEA, 2009)

their emissions by 8 per cent during 2008-2012 , compared to 1990 levels. By 2006, which is the latest verifiable data point, emissions had been reduced by 2.7 per cent, a shortfall by 5.3 per cent.[33] However, the target is expected to be met by a large margin given efforts in the ETS and Kyoto mechanisms (Figure 5).

The European Commission has launched more ambitious targets since the Kyoto Protocol, described for instance in the European Climate Change Programme (ECCP) 1 and 2. In March 2007, the European Council decided on the strategic goal to limit the global temperature increase by 2˚C. The EU Member States are committed to achieve a reduction of at least 20 per cent of their greenhouse gas emissions until 2020 and are ready to reduce emissions by 30 per cent under a new global climate change agreement involving comparable efforts by others. The emissions of greenhouse gases in the EU are decreasing and are projected to continue to do so until 2020. However, in order to meet the emissions target of 20 per cent reduction, further emission reductions are needed.

A large part of the eco-efficient economy agenda concerns the opportunity to decouple environmental pressure from economic development. However, emissions of CO_2 have so far been much more difficult to decouple from economic growth than, for example, local air pollution. One reason may be the diffused and differentiated locations of the environmental pressure and impact. Climate change is a problem on the global scale, caused by nearly all economic and human activity, and with impacts on people in all countries. Although the ability of a single government to address this problem is clearly very limited, certain decoupling of CO_2 emissions from economic growth has nevertheless occurred in some EU countries[34]. However, efficiency improvements in many industrial sectors are counteracted by increasing consumption. In addition, an increasing proportion of products purchased in the EU are produced in other parts of the world. Thus, emissions related to the production of goods purchased in EU states exceed the emissions of the production within the countries.

Nonetheless, there are convincing analyses which show that targeting the climate challenge does not need to lead to adverse economic effects. The investment needed to maintain the level of greenhouse gases at 450 ppm have been estimated to cost about 0.5 per cent of global GDP over the period 2013-2030, which would lead to a fall in global GDP growth by 0.19 per cent per year up to 2030. This is only a fraction of the expected annual GDP growth rate.[35] Furthermore, when taking into account future damages on social and economic systems from climate change impacts, it has been shown that these may far exceed the mitigation costs (although this all depends on the discount rate used in the calculus). The "Stern Report" provided a ball park estimate: a business-as-usual scenario may entail losses in the magnitude of ca 15 per cent of global consumption.[36]

Moreover, tackling climate change could lead to positive effects on employment, with new job opportunities being created in the new fields of eco-innovation. In a consultancy report to the European Commission, the turnover of eco-industries is estimated to €270

33 EEA (2008b). *Greenhouse gas emissions trend and projections in Europe 2008.* Copenhagen, European Environment Agency.

34 Nordic Council of Ministers (2006). *Decoupling of CO_2 Emissions from Energy Intensive Industries*. Copenhagen, Nordic Council of Ministers.

35 CEC (2007d). *Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond* [COM(2007) 2 final]. Brussels, European Commission.

36 Stern, N. (2006). *The Stern Review on the Economics of Climate Change*. Cambridge, Cambridge University Press.

Table 1: Global market value for low-carbon and environmental goods and services in billion € (Source: Innovas, 2009)

Air Pollution	31.77
Environmental Consultancy	26.54
Environmental Monitoring	4.90
Marine Pollution Control	3.95
Noise & Vibration Control	7.16
Contaminated Land	30.44
Waste Management	158.96
Water and Waste Water Treatment	267.19
Recovery and Recycling	210.82
Hydro	14.43
Wave & Tidal	2.25
Biomass	157.84
Wind	395.72
Geothermal	311.16
Renewable Consulting	16.91
Photovoltaic	160.09
Alternative Fuels for Vehicles	383.31
Alternative Fuels	635.85
Additional Energy Sources	40.59
Carbon Capture & Storage	14.99
Carbon Finance	36.08
Energy Management	82.30
Building Technologies	439.68
TOTAL ALL SUB-SECTORS	**3,432.94**

billion, equalling ca 1.4 per cent of total EU GDP, and employing directly 2.3 million people.[37] Including indirect and induced effects (such as induced demand for component parts) this has been estimated to equal ca 4.6 million jobs. A recent UK industrial analysis estimates the global market for "low-carbon and environmental goods and services at over €3,000 billion (of which roughly €1,000 billion in renewable energy), and with

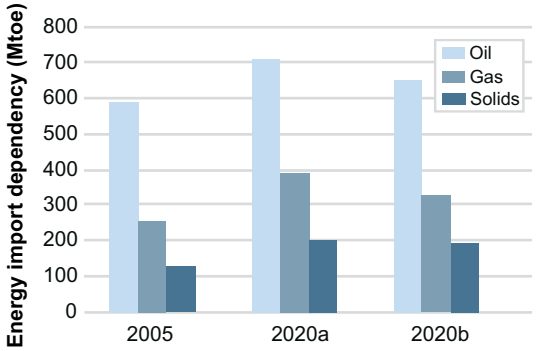

Figure 6: EU-27 energy import dependency in 2005 and projected for 2020 with oil prices at 61 and 100 $/barrel (in Mtoe) (Source: CEC, 2008f)

significant growth sustained over the economic crisis (Table 1).[38]

THE ENERGY CHALLENGE

The energy sector is a crucial sector for reducing greenhouse gas emissions. The use of energy is built into almost all parts of our society, including industrial production and the way we live our daily lives. For the energy sector, apart from the targets for reducing greenhouse gas emissions, a number of other crucial challenges can be mentioned. These include the challenge of securing the supply of energy in the risk of a new oil crisis, and addressing dependence on imported energy. The external energy dependency of the EU is constantly increasing. Between 1996 and 2006, EU-27 energy dependency increased by about 22 per cent, with imports going up from 44 per cent to 54 per cent of total consumption.[39] This is projected to continue into the future (Figure 6). In the 2008 Strategic Energy Review, it is noted that energy prices have risen by an average of 15 per cent in the European Union in the last year, and that 54 per cent of Europe's energy is imported at a cost of €350 billion.[40] The review notes that "The medium-term trends for global oil and gas consumption foresee a continued, significant and sustained increase

37 GHK (2007). *Links between the environment, economy and jobs*. London.

38 Innovas (2009). *Low Carbon and Environmental Goods and Services: an industry analysis* London, BERR.

39 EUROSTAT (2009). *Energy, Transport and Environment Indicators*. Luxemburg, EUROSTAT.

40 CEC (2008f). *Second Strategic Energy Review - an EU energy security and solidarity action plan COM(2008) 781* Brussels, European Commission.

in demand, particularly from developing countries. At the same time, remaining reserves and spare production capacity are becoming increasingly concentrated in a few hands. Recent severe price rises and volatility on oil and gas markets reflect these trends."

This energy dependency is considered to imply large economic, political as well as environmental risks for the European Union. The security of supply issue – and within this, the EU's relationship with Russia and the oil states – has gained increasing attention over the last few years. Here, the enlargement to 27 Member States has widened the diversity in the European Union, and poses new challenges on the decision-making apparatus. For instance, fossil-based energy in Eastern Europe may have Russian gas as its most obvious lower-carbon alternative. Some observers consider this an unattractive option – for political, economic and environmental reasons.

For the energy sector, two major areas are particularly critical to the eco-efficient economy. First, improving energy efficiency will be decisive for reducing costs and enhancing competitiveness, for improving security of supply and for meeting the commitments on climate change made under the Kyoto Protocol. A broader perspective on energy efficiency, than only looking at the end-use of energy, striving for increased efficiency at all levels and stages, is preferable. Thus it delivers dividends on all energy policy "pillars". Second, the sources of energy need to be switched to more sustainable, renewable forms of energy. This not only requires the development of new technologies, but also the creation of new markets for them, and capturing of related business opportunities. These two fields are both cornerstones in the European energy strategy, and they will be examined more closely in two case studies in the next chapter. It should be noted that responding to the energy challenge carries with it major opportunities for European industries. For instance, a recent industrial analysis on low-carbon technologies shows that the global market for renewable energy is above €1,000 billion (and growing rapidly), with in particular wind energy industry showing fast growth, in particular on the manufacturing and supply of components for large and small wind turbines and in the power integration systems, distribution and maintenance services.[41]

41 Innovas (2009). *Low Carbon and Environmental Goods and Services: an industry analysis* London, BERR.

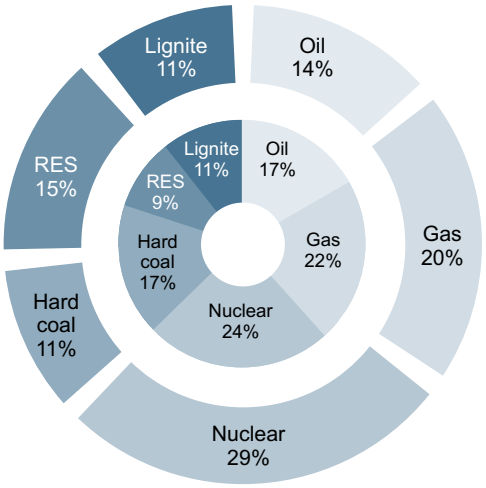

Figure 7: Primary energy production 1996 & 2006, breakdown by fuel source
(Source: Eurostat, 2009)

Figure 7 shows the ongoing transition from fossil fuels to renewable sources of energy in Europe's own production mix. Oil and hard coal production has gone down by 30 and 44 per cent respectively, whereas renewable energy has increased by 44 per cent from 1996 to 2006.

There is considerable room for improvements in energy efficiency in many areas of the economy. The European Commission has estimated that the EU is "wasting" at least 20 per cent of its total energy use, which up to 2020 may cost the Union €100 billion in financial terms, precluding the environmental costs involved.[42] Nonetheless, improvements in energy efficiency have been notable over the last decades. The Commission estimates that as compared to the 1970's, energy intensity has decreased by 40 per cent in Germany and Denmark, and by 30 per cent in France. Overall energy intensity has continued to decrease in recent years – the fall from 1996 to 2006 was from 240 to 202 kgoe/1000 euro (Figure 9)[43]. Figure 8 shows the energy savings calculated on the basis of 1971 energy intensity, measured in "negajoules".

42 CEC (2006f). *Saving 20% by 2020 - action plan for energy efficiency: realising the potential*. Brussels, European Commission.

43 EUROSTAT (2009). *Energy, Transport and Environment Indicators.* Luxemburg, EUROSTAT.

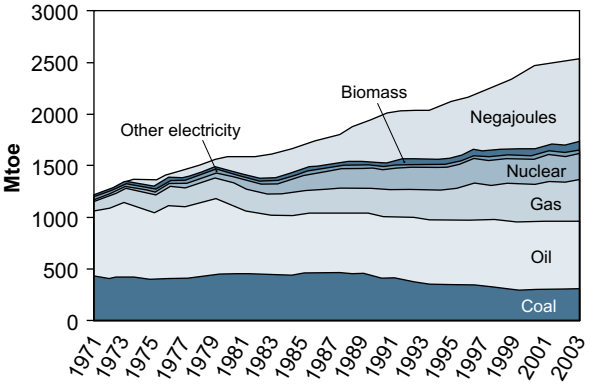

Figure 8: Development of primary energy demand and "negajoules" in EU-25
(Source: CEC, 2006b)

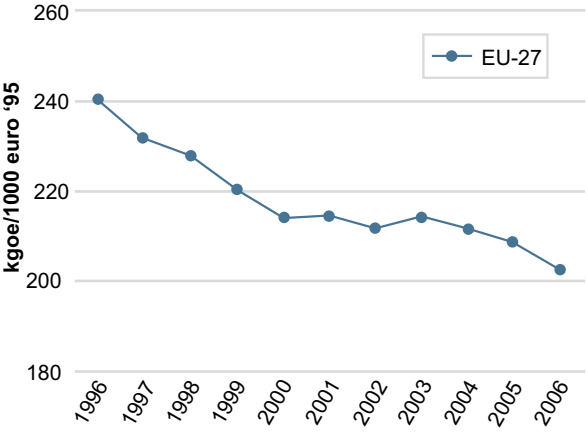

Figure 9: Energy intensity in the EU 27 from 1996-2006 (Source: Eurostat, 2009)

The European Council decided in March 2007 to reduce energy consumption by 20 per cent by 2020.[44] The transport sector is one of the sectors where there is room for significant savings. For the transport sector, energy savings are suggested to be achieved through tax schemes favoring clean and efficient vehicles, rewards to manufacturers supporting energy efficiency, by encouraging good tire pressure, use of public transportation and car pools, and improved road and air traffic management. Another significant area is energy production; between 40 and 60 per cent of the energy used for electricity production is lost in the production process, although the energy exchange varies highly between technologies. The Green Paper also points to energy savings in the buildings sector, which accounts for about 40 per cent of the energy used in the EU (see Chapter 3). In the buildings sector, significant savings can be made by actions such as retrofitting, changing to energy-efficient lighting and using better performing appliances, as well as more efficient materials technologies. For the industrial sector, although a lot has been achieved, further investments in more efficient technology are still often profitable.

Savings in energy use must be related to a wider systems approach in how resources are allocated and used. A narrow sector approach may well lead to suboptimal systems solutions when taking a wider view, and also may lead to spill over effects, such as when biofuels for transportation lead to marginal improvements or even increases in greenhouse gas emissions when looking at the wider life-cycle and indirect impacts, such as greenhouse gas releases due to land clearing for biofuels cultivation.

THE COMPETITIVENESS AND INNOVATION CHALLENGE

The increasingly global economic integration offers many opportunities for European industries. Today, the EU is the world's biggest exporter of goods and services, and international trade provides over 15 per cent of the region's GDP. The European Commission attributes a significant proportion (at least 20 per cent) of the last 50 years' wealth increases in the EU to globalization.[45] Therefore, the EU has been an ardent supporter of liberalisation and economic integration world-wide. At the same time, many European politicians, citizens and companies are concerned with job losses and downward salary pressures as a result of global competition. The rapid growth of economies like China and India on the global scene has fed into and reinforced these concerns, not least in view of the uneven commitments made concerning climate change mitigation between the EU and other states.

Concerns about competitiveness and the health of Europe's industrial economy have of course been

44 CEC (2005). *Energy Efficiency – or Doing More With Less* COM(2005) 265 final. Brussels, European Commission.

45 Denis, C., K. McMorrow, et al. (2006). *Globalisation : trends, issues and macro implications for the EU*. Brussels, European Commission.

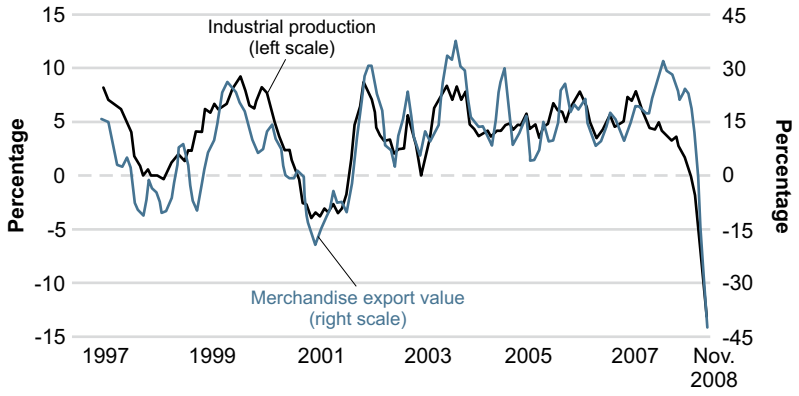

Figure 10: Growth in global industrial production and merchandise trade (annualized 3-month average percentage change (IMF 2009)

exacerbated as the economic and financial crisis continues to unroll. The unemployment rate in January 2009 was 8.2 per cent in the EU, up from 6.8 per cent one year earlier.[46] Similarly, GDP is now experiencing negative growth, with a 1.5 per cent contraction in the 4th quarter of 2008. In December 2008, industrial production fell by 12 per cent on a year-on-year basis. Many analysts and politicians see an enhanced role for states in cushioning the impact of the crisis, but also to take the opportunity to make the right economic reforms now, using the crisis as window of opportunity to ensure a more dynamic policy framework that allows Europe to take advantage of the opportunities offered by globalisation. This is of course easier said that done. We have a depressed world economy, with advanced economies experiencing the worst slump since the 1930's.[47] Interest rates and monetary policy offer little potential for help since rates are already close to zero.

Over the longer term, Europe has indeed faired relatively well in globalisation. True, there has been a major redistribution of market share between different countries since the mid 1990's, with developing countries reinforcing their position as exporters.[48] But compared to the US and Japan, the market share loss of the EU has been relatively small. While the US and Japan have lost market shares of 4.1 and 4.4 percentage points respectively, the loss of the EU market share has been only 1.3 percentage points. The comparatively stronger performance of the EU can be explained by the upgrading of EU products: half of EU exports consist of "upmarket" products, or products sold at a premium price because of quality, branding and related services. In addition, a slightly better export performance of the new EU Member States compared to the old ones has been noted. Furthermore, the EU is the largest global player in international trade in services, and EU exports of services have grown faster than the world average during the last years.

The performance of EU exports varies between different geographical regions. Exports from the EU are strong in countries with a static demand, but not as strong in rapidly growing markets – particularly Asia.[49] The loss of market share in these dynamic importing markets is worrying. Improving this situation can be seen as a key challenge for the competitiveness of the EU. Another challenge lies in the field of high-tech products. The EU holds 18.5 per cent of the world market for high-tech products and is thus the principal exporter of this product category. Considering the EU's overall economic development level, one would expect that the EU market share in the field of high-tech products would exceed that of the overall exports. However, this is not the case, with the market share for high-tech products being slightly lower than the EU's overall market share for merchandise products, 19.5 per cent. The loss of the EU market share for high-tech products

46 DG EC FIN, March 2009 indicators

47 IMF (2009). *Economic outlook update January 2009*. Washington DC, International Monetary Fund.

48 CEC (2008d). *Global Europe. EU performance in the global economy.* Brussels, European Commission.

49 CEPII-CIREM (2004). *European industry's place in the International Division of Labour: situation and prospects - a report for DG Trade*. Paris, CEPII.

is also larger than the overall market share loss – 2.4 percentage points compared to 1.3. The challenge for the EU in the field of high-tech products is therefore how to keep these products at the cutting edge of quality and innovation.

One source of vulnerability is the reliance on imports for components to production processes. Two thirds of the imports from outside of the EU to EU25 are incorporated as inputs in the production processes[50]. Russia, China, India, and other parts of Asia and South America play increasingly important roles in shaping both the demand and supply of raw materials. The past couple of years have witnessed an increasing strain on the availability of materials, while the outtake of resources often exceeds the planet's carrying capacity. Suggestions for a European resource policy, incorporating natural resources, secondary materials and waste have emerged on the agenda.[51] The eco-efficient economy as an integral part of a European resource policy can play a significant role in alleviating this combined economic and environmental strain. The dependency on component imports could become a transfer mechanism for eco-efficient solutions. If European industries through eco-efficient innovation can remain at the cutting edge while relying on imports of components from elsewhere, it can both create and exploit global market demands for environmental management and low-carbon solutions.

The debate about competitiveness and climate policy has in recent years centred on the impacts of the emissions trading system on European industries' competitiveness. This is an issue that has been of increasing concern as ETS II is being prepared with tighter allocation plans than in the first round. Based on the PACE model, DG Enterprise finds that the overall competitiveness impacts of strengthening the ETS have been moderate during the first round.[52] Still, risks of market losses and carbon leakage are a reality in some greenhouse-gas intensive sectors.[53] Such risks are influenced not only by European-level policy such as the ETS, but also by national level governance measures such as efficiency programmes, energy taxes and environmental regulations. To cope with the competitiveness concerns analysts have pointed to a) the application of sectoral approach in allocation of commitments; b) continued grandfathering of emissions permits, and c) massive investments in technology innovation and large-scale application.

Governance and regulations for the eco-efficient economy may also pose another challenge for Europe's competitiveness long term, namely that of regulatory burden, an issue of considerable concern for SMEs in Europe and frequently ranked as their most important problem in surveys. Governance for eco-efficient economy can be complicated and administratively difficult, as legislation and regulation such as ETS, permitting procedures and reporting requirements are often designed with large corporations in mind. Since SME's are widely considered to be crucial part of today's economy (representing 67 per cent of all private-sector jobs) as well as the future eco-efficient economy, efforts for "better regulation" need to be vigorously pursued, so that the net administrative burden may decrease even if instruments used are forceful. Here the European "Think Small First" principle and its 2007 action programme to reduce adminstrative burden are important development in the right direction.[54]

The governance challenge for EU leaders is to turn the potential benefits of global competition into real gains while minimising the social costs that arise from structural change. This is a multifaceted challenge. The way forward is often seen to be move towards a knowledge-based economy, whereby the intensified knowledge input, as opposed to raw materials or labour,

50 CEC (2008d). *Global Europe. EU performance in the global economy*. Brussels, European Commission.

51 CEC (2006c). *Fourth report of the high level group on Competitiveness, Energy and the Environment: Ensuring future sustainability and competitiveness of European enterprises in a carbon and resource constrained world.* Brussels, European Commission.

52 Worbst, P. (2007). *Competitiveness Effects of Trading Emissions and Fostering Technologies to Meet the EU Kyoto Targets: A Quantitative Economic Assessment*. Brussels, European Commission.

53 Danish Ministry of Finance (2008). *Økonomisk Tema: Vækst, klima og konkurrenceevne*. Copenhagen, Government of Denmark.

54 CEC (2008h). *Putting Small Businesses First*. Brussels, European Commission

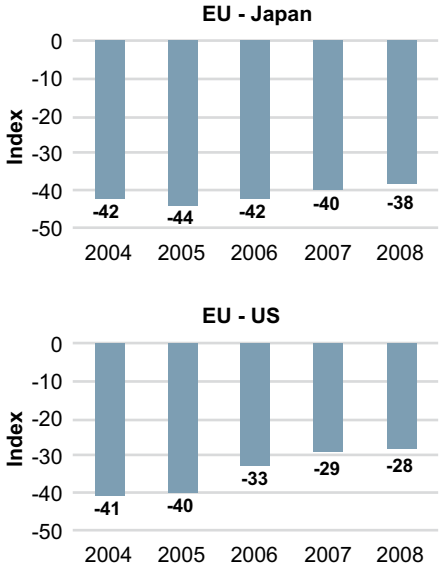

Figure 11: Closing the EU innovation gap with US and Japan (Source: CEC, 2009a)

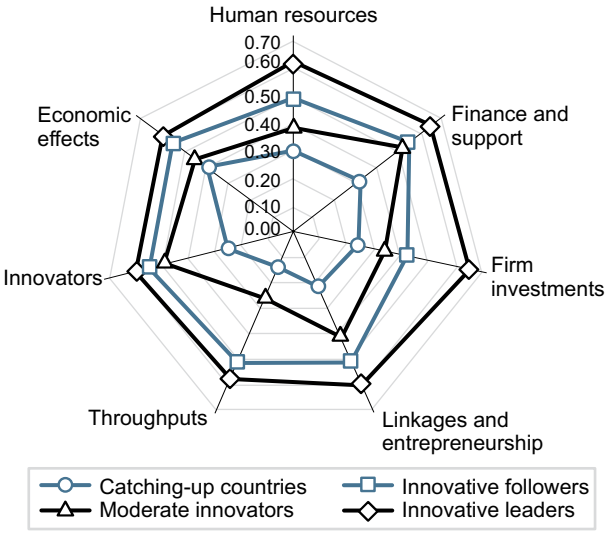

Figure 12: EU-27 country groups' innovation performance per dimension (Source: CEC, 2009a)

is the key input in production. The transition to the knowledge economy, at the forefront for example of the Lisbon strategy, is closely connected to the political interest in innovation and how to promote it. European decision makers now regularly argue along the lines that "Europe cannot compete unless it becomes more inventive".[55] It has been argued that the EU's strength in R&D has not yet been complemented with adequate governance for innovation, and that the EU has been relatively less successful than its competitors – notably US and Japan – in converting its science to commercially valuable activities. For instance, Europe is lagging behind in venture capital to help new technologies through the "valley of death" from demonstration to commercialisation. For instance, the Cleantech Group reported that in 2008 North American venture capital for cleantech totalled $5.8 billion whereas the corresponding number for Europe was $1.8 billion[56]. This trend appears to be turning course however, with Europe's volume going up from $680 million in 2006. This is confirmed by the latest European Innovation Scoreboard which shows that in recent years the gaps have been closing (see Figure 11).[57] .

The Scoreboard uses a composite index of innovation comprising 26 different indicators and traces innovation performance across the 27 Member States. Figure 12 shows the six key dimensions and how the four different groups of EU Member States, from leaders to laggards, perform on each of these.

Innovation systems can be seen as networks to efficiently distribute knowledge and information. Policies relating to science and technology, industry and education will need to place new emphasis on the role and importance of innovation systems, as well as the requirement for infrastructures, and incentives which encourage investments in research and training to support those systems. Clusters are of increasing interest as they have been shown to have a significant role in enhancing competitiveness and innovation.[58] In the broadest sense, clusters can be defined as regional concentrations of specialised companies and institutions connected through multiple linkages. Figure 13 shows the role of clusters in promoting innovation, using the

55 CEC (2008e). *Putting knowledge into practice: A broad-based innovation strategy for the EU*. Brussels, European Commission.

56 http://cleantech.com/about/pressreleases/010609.cfm

57 CEC (2009a). 2008 *European Innovation Scoreboard.* Brussels, European Commission.

58 CEC (2008c). *The concept of clusters and cluster policies and their role for competitiveness and innovation: Main statistical results and lessons learned* COM(2008) 652. Brussels, European Commission.

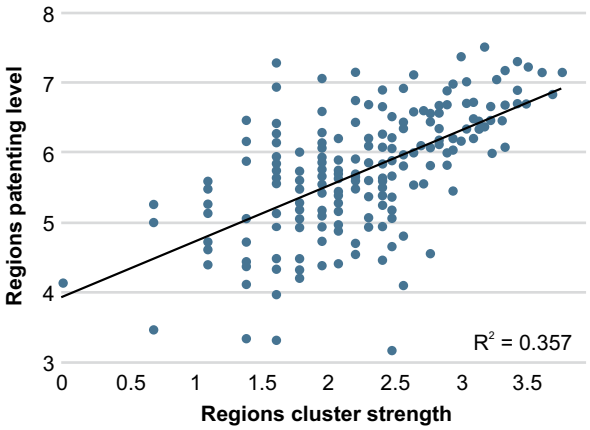

Figure 13: Patenting as a function of regions' cluster strength[59] (Source: CEC, 2008c)

level of patenting in a region as measure of innovation performance.

One benefit of the innovation perspective on competitiveness is its consideration of not only supply-side factors for industrial renewal, but also demand-side factors. Ultimately, the value and competitiveness will be determined by market conditions, and the development of long term competitiveness will rely on Europe's ability to innovate and adapt to changing market conditions. It is true that Europe has lagged behind in important new areas such as for instance biotechnology. The European Lead Market Initiative takes a positive step toward advancing demand-side measures such as regulation, procurement and standardisation to bring down barriers for innovative goods and services in six high-growth market areas. These include bio-based products, recycling, sustainable construction, ehealth, protective textiles, and renewable energy.[60]

59 Cluster strength is a composite index of size, specialization and focus developed by the European Cluster Observatory, see www.clusterobservatory.eu/index.php?id=49&nid=

60 CEC (2007b). *A Lead Market for Europe* Com 2007 860. Brussels, European Commission.

3 ECO-EFFICIENT ECONOMY CHALLENGES IN PRACTICE – SECTOR EXPERIENCES

This chapter presents eight examples of sectors and activities that are central to the eco-efficient economy. The examples demonstrate challenges and opportunities, along with past and present efforts made in different sectors to address different aspects of an eco-efficient economy. Examples can be drawn from virtually every part of society, and we have here chosen to focus on a limited selection, from different industrial sectors and domains at different stages of maturity: some are at an emerging or early-market level, whereas others are more mature. Whether directly or indirectly each example addresses energy use and climate change as central aspects of the eco-efficient economy.

The examples are presented in a particular order. The first ones are clearly the "obvious options" for eco-efficiency – that is, the ones where great gains are made at little or no extra cost, whereas the final ones represent what many consider to be the more challenging ones when it comes to advancing the European leadership. Importantly, not all examples are success stories, and some of them point to dilemmas and challenges that need to be taken into consideration in order to advance the eco-efficient economy agenda. Still, the overall picture is one of potential and opportunity, and how efforts, whether on behalf of governments or private actors, have led to achievements in the past.

We acknowledge that many more examples could have been presented. For instance, on the "heavy industry" side, sectors such as industrial minerals, cement and basic metals industries (other than steel) entail processes that are important to address in the eco-efficient economy. On the "clean-tech" side, new technologies, applications and businesses are emerging in for instance biomaterials, waste management and water. Our selection is limited by the resources of the study.

ENERGY EFFICIENCY –THE ESSENCE OF THE ECO-EFFICIENT ECONOMY

Improving energy efficiency is a strategy that resonates with all aspects of the eco-efficient economy agenda: reducing energy demand and costs, creating jobs, and avoiding CO_2 emissions. Numerous studies have shown the importance of energy efficiency for reaching climate policy targets. For example, energy efficiency accounts for more than half of the reductions in energy related CO_2 emissions by 2030 in one of the World Energy Outlook stabilisation scenarios[61].

Energy efficiency efforts have a long history in Europe, notably on the national level, initially prompted by the oil crises and more recently motivated by climate policy. Building codes and renovation programs has delivered large energy savings throughout most of Europe since the 1970's. During the period of low energy prices of the late 1980's and 1990's energy efficiency was not a political priority. The overriding paradigm in this era of market liberalism was that governments should not intervene unless there were market failures to correct, for example, external costs and lack of information, and energy efficiency was seen to be handled by the market. But energy efficiency has made a strong come-back in energy policy in recent years. The Directive 2006/32/EC on Energy End-use Efficiency and Energy Services (ESD) came into effect in May, 2006 and is one of several EU policies targeting energy use.[62] It aims at enhancing the cost-effective improvement of energy end-use efficiency in the Member States. The ESD has set an overall indicative target of 9 per cent for energy savings to be realised in EU Member States in the period of 2008-2016. The ESD is one of several EU initiatives to improve energy efficiency, but additional efforts will be needed to reach 20 per cent savings by 2020 as announced by the European Council in spring 2007. (see further Chapter 4) The idea that governments have an important role in supporting energy efficiency through regulation, economic incentives, and procurement policies, is now getting increased support – and goes beyond correcting for market failures.

61 IEA (2009). *World Energy Outlook*. Paris, International Energy Agency.

62 CEC (2006b). Directive 2006/32/EC of 5 April 2006 on energy end-use efficiency and energy services. Brussels, European Commission.

Promoting energy efficiency beyond the use of energy taxes presents many challenges. There are numerous barriers to the implementation of energy efficiency: actions that are obviously cost effective to consumers or society as a whole are not being taken. One illustration of this is the principal-agent problem – that is, that the investment in energy-using equipment (e.g. a low-efficiency refrigerator) is made by someone else (e.g. the landlord) than the user (e.g. the tenant) who pays the energy bill. Energy is used in a plethora of applications throughout different sectors in society, ranging from stand-by electricity use in DVD-players to the use of coke in steel making. For each energy end-use there may be different technical, economic, and organisational conditions that determine the barriers and potentials for energy savings, and thus the conditions for energy efficiency governance. Furthermore, the effects of energy efficiency policy are hard to pin down due to phenomena like free-riders, spill-overs and rebound effects. There are so many factors influencing an investment decision – for example, to install a variable speed drive in industry – that not even the actual decision maker can be sure about the influence of a specific policy instrument. Energy efficiency policy will always struggle with complexity, such as the issue of additionality; that is to what extent users would undertake efforts in the absence of support, but this does not make energy efficiency policy less vital for reaching important energy and climate policy goals.

The complexity and diversity of energy end-users makes it difficult to devise simple energy efficiency policy solutions. While energy taxes and consumer information may provide incentives for better informed decisions about investments in buildings and equipment, many barriers to implementation remain. Policies must often be designed or adapted to specific sectors and technologies, taking into account incentive structures and relations between various agents. In addition there are considerable differences between Member States in terms of market, organisational and administrative structures. Thus, while common EU policies are important in some areas – the fuel economy of new cars, for instance – it is necessary to stimulate and support Member States in stepping up their efforts for specific policy design and implementation at the national level.

Denmark is one of the countries that have maintained ambitious energy end-use efficiency policies and programmes since 1973. Final energy use is lower today than in 1972, despite considerable economic growth, which means there has been absolute decoupling (see Chapter 1). Denmark also has targets to reduce energy demand, in absolute terms, by 4 per cent between 2006 and 2020. An evaluation in 2008 of all energy efficiency programmes shows that programmes have delivered cost-effective energy savings with but one exception.[63] The evaluation also makes recommendations on how to adapt and intensify efforts in light of new conditions and priorities. This includes the establishment of a ten year (2010-2020) energy efficiency program operated by a new organisation with an independent board, a clear mandate and own funding.

The greatest challenge to advancing energy efficiency is how to govern development in order to accelerate energy efficiency above autonomous rates of improvement. A promising example is offered by voluntary agreements, where several countries have been successful in reducing industrial energy demand. In the Swedish Programme For Industrial Energy Efficiency (PFE), eligible industries are exempt from electricity taxes in exchange for committing to carry out audits, implementing an energy management system and investing in profitable measures.[64] The PFE will result in 2 to 5 percent electricity savings (depending on assumptions concerning multiplier effects and free-riders), with additional savings in fuel use. It exemplifies how government and industry can successfully work together toward further eco-efficiency at the enterprise as well as economy-wide level. Beyond Sweden, many countries are now intensifying their efforts to promote energy efficiency in the best possible way in different energy end-uses and across sectors.

Higher energy prices and raised environmental awareness are strong drivers for the energy efficiency market. Energy efficiency is a product characteristic rather than a product in itself which makes it difficult to distinguish market and job growth in this area. Nonetheless, energy efficiency provides market opportunities for

63 Togeby, M., Ed. (2008). *En vej till flere og billigere energibesparelser* (A road to more and less expensive energy savings), Energianalyse Report for the Danish Energy Agency.

64 Stenqvist, C. and L. J. Nilsson (2009). *Process and impact evaluation of PFE - a Swedish tax rebate programme for industrial energy efficiency*, ECEEE 2009 Summer Study, European Council for an Energy Efficient Economy.

suppliers of building materials, windows, lighting, and ventilation equipment, and creates a variety of jobs in the construction industry. It is in the market for energy efficiency services that energy efficiency becomes a product in itself, delivered by Energy Service Companies (ESCO). This is a rapidly growing business, facilitated by the development and cost reduction of ICT. Some of the major players are originally building controls and automation manufacturers such as TAC by Schneider Electric, Siemens, ABB, and Honeywell, but also power companies. However, also SMEs are taking important shares of this new market, which requires niche knowledge and business organizations that do not always fit neatly into the structure of major corporations. Rough estimates put the European ESCO market potential on the order of €5-25 billion per year – a substantial opportunity for eco-efficient economic growth.[65] The market is growing rapidly in both Europe and North America.[66] For example, in January 2009, the U.S. Department of Energy awarded a contract to TAC by Schneider Electric for up to 5 billion USD in energy efficiency projects at federally owned buildings and facilities.

DISTRICT HEATING – MODES OF EXPANSION AND FUEL SHIFTING

Heating and cooling account for about 50 per cent of final energy use in Europe. At the same time, EU energy use is associated with huge heat losses – Euroheat & Power estimates the annual heat losses to be about 5500 TWh, i.e. roughly one third of annual primary energy use, and that part of these losses can be recovered in the district heating systems (DH systems).[67] The major part of the heat losses occur in thermal power plants. If half of the heat wasted were to be used for district heating purposes, it could replace an approximately equal amount of natural gas, the main energy source used in individual heating in Europe. Assuming natural gas substitution and a natural gas price of €18-36 per MWh (€5-10 per GJ), annual fuel cost savings amounting to €50-100 billion could be achieved. Addressing heating and cooling interlinks with the energy efficiency agenda outlined above, and is central to an eco-efficient European economy. Yet, the heating and cooling sectors have to date received relatively little attention in national energy policy in most countries, and renewable energy sources (RES) account for less than 10 per cent of the energy used for heating and cooling purposes in the EU on average.[68] DH systems provide an opportunity to increase the use of RES and improve energy efficiency by recovering heat that would otherwise be wasted. DH systems are found in many European countries though with great variance in popularity. These systems are common in Sweden, Denmark, Finland and the Baltic and Eastern European countries.

This case focuses on the Swedish experience in advancing district heating as an eco-efficient solution. The DH systems in Sweden have played an important role in reducing the use of fossil fuels and expanding the use of RES – mainly biomass. These systems have also contributed to more efficient use of primary energy resources by enabling combined heat and power (CHP) production and recovery of industrial waste heat. The opportunity for energy efficient solutions has been a key driver for building DH systems in Sweden. Achieving air quality improvements has been another driver for such investments. The rationale for this is that it is easier and cheaper to control a few emission points than thousands. Positive effects on urban air quality were particularly noticeable in the 1960's and 70's. In 2007, DH accounted for 50 per cent of the delivered energy for heating of buildings in the residential and service sector. Total DH production in 2007 amounted to 56.3 TWh (47.5 TWh was delivered) and was dominated by biomass, which accounted for 44 per cent of the production. The remaining energy supply consisted of municipal solid waste (MSW) (18 per cent), industrial waste heat (10 per cent), fossil fuels (13 per cent), peat (5 per cent) and heat from heat pumps (10 per cent) (Figure 14). The industrial waste heat is mainly supplied by forest industries (the dominant process industry

65 Boza-Kiss, B., P. Bertoldi, et al. (2007). *Latest development of energy service companies across Europe - A European ESCO update.* Brussels, European Commission - Joint Research Centre (JRC)..

66 Lindgren, K. and L. J. Nilsson (2009). *Transforming the Efficiency Gap into a Viable Business Opportunity: Lessons Learned from the ESCO Experience in Sweden*, ECEEE Summer Study, 1-6 June 2009. Paris, Council for an Energy Efficient Economy.

67 Euroheat & Power (2005). *The European Heat Market*. Ecoheatcool project. Brussels, Euroheat & Power.

68 CEC (2007e). *Renewable Energy Road Map - Renewable energies in the 21st century: building a more sustainable future*. COM(2006) 847 final. Brussels, European Commission.

in Sweden), but a number of refineries, steelworks, chemical and food-processing industries, and one sugar mill also supply industrial waste heat to the DH systems.

Having proved able to quickly respond to government policies, the Swedish DH sector has twice played an important role in achieving national policy objectives relating to an eco-efficient economy. In association with the oil crises in the 1970's, the DH systems proved to be ideal for reducing oil consumption – the main objective of energy policy at that time. Until the late 1970's, there was a near-complete reliance on oil in DH production. However, prompted by high taxes on oil products that were introduced in the 1970's, there was a major shift from oil to a variety of fuels and energy sources, including coal, MSW, heat pumps, and industrial waste heat. A second major fuel shift was initiated in the early 1990's in response to the energy tax reform of 1991. This reform strengthened the environmental profile of the energy taxation system by increasing the taxation of fossil fuels in heat production, mainly by the introduction of a carbon tax. Apart from the biomass expansion, there has been a great increase in MSW incineration in recent years. This development is driven primarily by bans on landfilling combustible and organic waste. Hence, the DH sector has shown great fuel flexibility, which for example has been manifested in the accommodation of large volumes of unrefined biomass and MSW, fuels that are inconvenient or inappropriate (since they require emission control) to use in individual heating.

For countries with great reliance on thermal power production, the opportunity to produce electricity efficiently in CHP plants is probably the most compelling argument for building DH systems. Primary energy savings could also be achieved by utilising industrial waste heat, which is available in all countries that host process industries. Another argument for building DH systems is that they provide an opportunity to use deep geothermal heat. Unlike Sweden, many other European countries have favourable geophysical conditions for deep geothermal heat. The DH systems also enable the use of unrefined biomass and waste, fuels that are unsuitable in individual heating. Several European countries have untapped biomass potentials consisting of agricultural and forestry residues and MSW, and is the opportunity to grow energy crops on agricultural land. Poland is a case in point, and it also accommodates many and large DH systems.[69] About 52 per cent of the Polish households are connected to a DH system. The major part of the total DH supply is produced in CHP plants, but there is still potential for increased integration with thermal power production, whereby achieving primary energy savings. Such energy efficiency improvements would reduce the use of coal, the dominating fuel in heat and electricity production in Poland. The coal consumption may also be reduced through biomass-for-coal substitution. An attractive initial strategy is to co-fire biomass and coal – something that certain plants already do. DH production in the other Eastern European or Baltic countries is also heavily reliant on fossil fuels. However, similar to Sweden in the 1970s and 80s, the DH sectors in these countries could play an important role in reducing the use of fossil fuels while achieving environmental objectives such as emission reductions in carbon dioxide and possibly other pollutants, and reduced landfilling of waste. Fossil fuel substitution in these systems could also enhance security of supply depending on the type of fossil fuel replaced. Although the DH systems are a great asset to Poland and the other Eastern European or Baltic countries, many of these systems suffer large heat losses and are in acute need of refurbishment. Addressing the performance of these systems will be central to advancing DH as an eco-efficient solution in these countries.

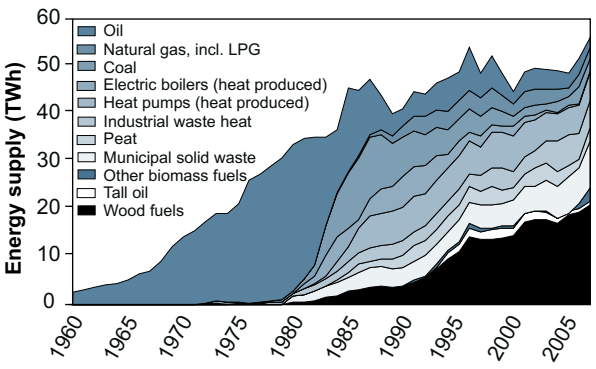

Figure 14: Energy supply for district heating

District cooling systems can, just like the DH systems, provide large energy savings. A district cooling system can reach an efficiency rate typically five or even 10 times higher than traditional local electricity-driven equipment. Switching away from the electricity-driven equipment would also cut peak electricity demand in

69 Ericsson, K. (2007). "Co-firing - A strategy for bioenergy in Poland?" *Energy* 32(10): 1838-1847.

the summer. District cooling systems are found in a number of European cities, but the systems are quite small, mainly covering business districts. In total, district cooling accounts for about 1-2 per cent of the total cooling market in Europe.[70] District cooling is often co-produced with district heat, and hence provide an additional business opportunity for energy service companies. Apart from potential energy savings and environmental benefits, the access to these systems may increase the attraction of a city or city district for investors. This was one of the arguments for the City Council of Barcelona to carefully plan for district heating and cooling in the new business district of Forum. The district heating and cooling in Barcelona is mainly produced from waste incineration. Since cooling demands are expected to continue growing in the future addressing cooling will, just as heating, be central to achieving an eco-efficient European economy.

BIOFUELS – COMPLEX RESOURCES IN A GLOBAL CONTEXT

Transport accounted for 31 per cent of final energy use in 2005 and is almost entirely dependent on gasoline and diesel from imported oil. It accounts for an increasing share of EU greenhouse gas emissions. Had the transport sector emissions followed the same reduction trend as society as a whole, total EU-27 greenhouse gas emissions during 1990–2005 would have fallen by 14 per cent instead of 7.9 per cent.[71] Options for reducing transport sector emissions include efforts to moderate growth in transport, modal shifts, increased fuel efficiency, and switching to low-carbon biofuels and electricity. Although the other options may be more important, the need for low-carbon liquid fuels in transport will remain. Current biofuels production is dominated by ethanol from sugar and starch-rich plants, and fatty acid methyl esthers, or biodiesel, from vegetable oil. Biogas from various residues is an important niche. Using manure and waste as a substrate for biogas production creates a double benefit in terms of reduced GHG emissions compared to conventional handling, through limiting the leakage of methane as well as substituting fossil fuels. There are several examples of cities that are successfully using such biogas for fuelling local fleets of buses and other vehicles.

At the European level, biofuels have recently become subject to firm policy. In 2003, the Directive for the Promotion of Biofuels and Other Renewable Fuels (referred to as the Biofuels Directive) was adopted.[72] It requires Member States to support consumption of transport biofuels as a means to achieve policy objectives as "…meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources" (Art. 1). During 2007-08, the biofuels debate reached a new peak, fuelled by high and volatile oil prices as well as an increase in food prices during 2006-07 which was often blamed on increased biofuels production. The new RES directive adopted in 2008 stipulates that 10 per cent of road transport fuel should come from renewable sources by 2020.

An important condition for EU biofuels promotion is the inclusion of environmental safeguards in the form of sustainability criteria. Biofuels bring globalisation straight into our daily lives. Decisions on how to fuel our cars can have effects on the livelihoods of poor people in a completely different part of the world. Clearing land for producing energy crops can increase greenhouse gas emissions relative to continue using petroleum-derived fuels.[73] Switching to energy crops even on existing arable land can cause displacement effects with similar but indirect effects on emissions. Without proper safeguards the expansion of biofuels may negatively affect biodiversity and water resources. Competition for feedstock, or land, can cause food prices to increase.[74] But nevertheless, increased

70 Euroheat & Power (2006). *Possibilities with More District Cooling in Europe*. Main authors: Dalin, P. and Rubenhag, A. Ecoheatcool project. Brussels, Euroheat & Power.

71 EEA (2008a). *Climate for a transport change, TERM 2007: indicators tracking transport and environment in the European Union,* EEA Report No 1/2008. Copenhagen, EEA.

72 CEC (2003a). Directive 2003/30/EC on the promotion and use of biofuels or other renewable fuels for transport. Brussels, European Commission.

73 Börjesson, P. (2009a). Good or bad bioethanol from a greenhouse gas perspective - what determines this? *Applied Energy*. 86: 589-594.

74 RFA (2008). *The Gallagher Review of the indirect effects of biofuels production*. St Leonards-On-Sea, Renewable Fuels Agency.

biofuels production need not be in conflict with high ambitions for sustainable development – what is needed is managing and governing the expansion of biofuels, including the use of proper safeguards.[75]

Biofuels are central to the eco-efficient economy agenda not only through their immediate link to climate change policy, but also in that they present an opportunity to modernise agriculture and develop a new industry. Up until the "tortilla crisis" in Mexico during 2006-07, the world market prices for food had essentially been decreasing for 30 years. Agricultural subsidies in the United States and the EU, resulting in surplus production, contributed to lower world market prices, while domestic markets and farmers remained shielded. Biofuels strategies have increased somewhat the global scarcity of land and contributed to higher food prices (which has been negative for the urban poor but frequently positive for the rural populations). However, higher food prices will also lead to new investments in agriculture, higher yields and new income opportunities – not least for the 880 million people in rural areas that live in poverty. Although the size of the potential for biofuels is debated, it is clearly significant when taking into account the amounts of idle arable land, potentials for yield increases and technology development.

Important industrial opportunities lie in the development of technologies for what is often called second generation biofuels. In this case, lignocellulosic and other feedstocks can be converted to fuels using gasification as well as biological conversion methods. The respective "thermochemical" and "carbohydrate" technology platforms are generic technologies with important applications outside the transport fuel area as well.[76] For example, gasification is a key technology for facilitating pre-combustion carbon dioxide capture for storage in geological formations (CCS). The "carbohydrate" technology platform has a wide range of industrial biotechnology applications promising lower energy demand, less residues and higher productivity in the chemicals industry.

The commercial opportunities so far in the area of biofuels have been almost exclusively in the conversion of starch- and sugar-rich plants to ethanol through fermentation. In Europe and the US this expansion has been driven by subsidies and regulation. The second generation technologies have yet to take off. But there is no doubt that there are great expectations for innovation-driven growth in this area. One recent example is the $500 million Energy Biosciences Institute funded by BP. Intensified efforts by many key players may accelerate the development. Novozymes, for example, expect that be 2010 their enzymes will make it possible to convert waste and agricultural residues into second-generation bioethanol. The market for biofuels as well as other chemicals and materials from biological sources and advanced biocatalyctic processes is expected to grow rapidly.[77]

Many developing countries have strong comparative advantages for producing biofuels, and their role in the expansion of production should not be overlooked. Countries in South America and Southern Africa strongly support an expansion of biofuels to reduce their dependence on oil imports, bring economic development to rural areas and improve their trade balance. For Africa in particular, with its vast land areas, biofuels can be the entry ticket to the global trading arena.[78] However, developing countries need to develop policies, for example to manage a variety of socio-economic issues and support the development of sustainable agriculture. The EU is not the only market for biofuels, but it can be an important one, and it can further the development of sustainable biofuels through proper trade and energy policies, including safeguards (such as sustainability criteria). European companies also have the economic capacity to invest in biofuels production around the world.

75 Börjesson, P. (2009b). *Sustainable biofuels - do they exist?*" Report No. 67, Environmental and Energy Systems Studies. Lund, Lund University.

76 Åhman, M. and L. J. Nilsson (2008). "Path-dependency and the future of advanced vehicles and biofuels." *Utilities Policy* 16: 80-89.

77 German Presidency of the Council of the European Union (2007). The Cologne Paper: En Route to the Knowledge-based Bio-Economy, available at www.europabio.org.

78 Virgin, I. (2008). *Building a Regional Network and Competence Platform for Bioresource Innovation in Eastern and Southern Africa*. Stockholm, Stockholm Environment Institute.

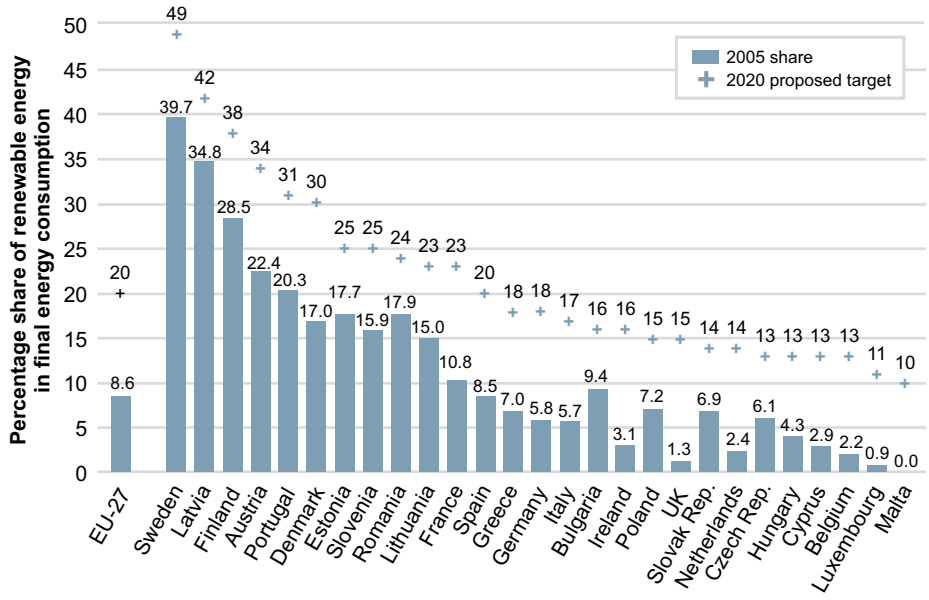

Figure 15: Renewable energy use and goals for 2020 in the Climate and Energy Package of 2008

RENEWABLE ELECTRICITY – GOVERNING FOR TECHNOLOGY AND MARKET DEVELOPMENT

Electricity production is an environmentally disruptive activity, and the sector (including heat) accounts for 29 per cent of CO_2 emissions in the EU-15. The last decade has seen a strong push to "green" the electricity sector through the promotion of renewable sources of electricity (RES-E). The electricity industry is not subject to global competition and European firms have only relatively recently become subject to market conditions, following the on-going liberalisation that started in the 1990's. Although it has been included in the new treaty, the EU has so far lacked formal competency in electricity policy. However, through internal market and environmental policies, it has still profoundly affected the sector. In the last decade there has also been a strong drive towards formulating a common European policy on renewable energy (including electricity), which today is encapsulated in the Climate & Energy Package, which contains an overall binding 20 per cent renewable energy consumption target for the EU by 2020 allocated to different Member States (Figure 15) (see Chapter 4).

Member States around Europe have put in place various support schemes and policy instruments to promote the deployment of renewable sources of energy, such as wind, solar and biomass. This support has led to major enhancements in RES-E in Europe (Figure 15). The debate as to what measure is more effective to promote RES-E is unresolved to date and has led to a stalled development in the pursuit of a harmonised RES-E policy framework in the EU.[79] In fact, the 27 Member States operate 27 different support schemes. Policy instruments that are frequently used at the national level include the permitting procedure for new and enhanced installations, taxes, R&D support, investment support (capital subsidies) and operating support (price subsidies, certificates, tax exemption on consumption). Operating support is currently the most important support mechanism, and has lead to important advances in RES-E. Within this, two principal measures are currently used:[80]

- Generic market-based instruments such as certificates trading under a quota obligation, which has been implemented in 7 Member States. This fixes a quantity of RES-E to be achieved and facilitates this by issuing green certificates that can be traded (TRECs).

79 Nilsson, M., L. J. Nilsson, et al. (2008). *Rapid turns in European RES policy*. Oslo, Fritjof Nansens Institut.

80 CEC (2008a). COM(2008)19 *The support of electricity from renewable energy sources*. Brussels, European Commission.

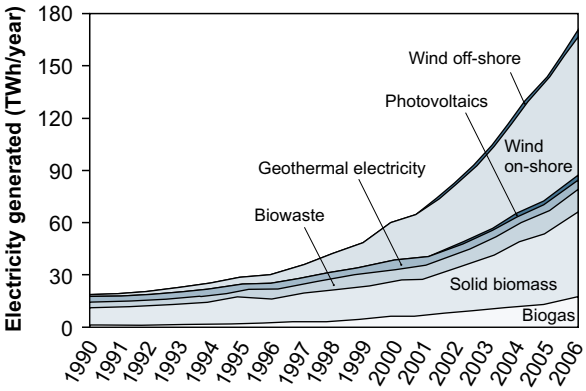

Figure 16: Historical development of RES electricity generation in the EU
(Source CEC, 2008a)

- Technology-specific support measures coupled with the obligation of distributors to purchase renewable electricity at a fixed price – so called feed-in tariffs or premiums (FITs). This system fixes a price for different RES-E categories and has been implemented in 18 Member States.

In principle, the FIT fixes the price, whereas the TREC fixes the volume. But through their designs, the measures are pursuing partly differing objectives and are based on different policy perspectives. The TREC approach is primarily concerned with European internal market efficiency by way of delivering the renewable electricity technology that has the lower production cost most into the system. The FIT approach is based on innovation promotion and to nurturing new industries through providing long-term stability and price guarantees. The difference in perspective has also been discussed in terms of static efficiency versus dynamic efficiency, in that the innovation promotion approach may be considered to lead to more cost-efficient long-term solutions.

Renewable energy does not only contribute to reduced CO_2, but has also embodied new industrial opportunities and export potentials. Spain and Germany are two of the major EU countries deploying FIT. The two countries also account for most of the growth in European wind power capacity over the last decade, accounting for 21,000 MW and 12,000 MW installed wind capacity, out of the total EU capacity of 48,000.81 In 2008, Spain accounted for 41 per cent of the world market of installed solar power, installing 2460 MW out of the world total 5950 MW (Germany installed 1860 MW and the rest of Europe 310 MW).[82] Spain's current system of FIT was put in place in 1997 through the Electric Power Act 54/1997, and updated in the Royal Decree in 2004. The current premium for wind is 40 per cent of the average electricity tariff, and for solar 250 per cent.[83] Complementary measures such as regulations requiring new housing to install solar panels provided additional triggers for the rapid expansion.

The Spanish and German systems have induced a substantive increase in renewable electricity as well as helped create a new industry. Here, the importance of a domestic market nurturing the new industries is notable. In Germany, one of the leaders in renewable electricity, where renewable sources today account for ca 15 per cent of the electricity supply, the government estimates that the employment in renewable energy in 2007 was around 250,000 up from 160,000 in 2004. Of these, 90,000 jobs are in the wind power industry. The total worth of the German RES export was €5.7 billion in 2007, of which 5.1 billion was in wind power (equalling 28 per cent of the world market).[84] The contribution to GDP and employment overall in the EU is however still small: in 2005 renewable energies constituted about 0.5 per cent of value added and 0.7 per cent of overall employment.[85] Germany introduced FIT in 1990. Later, further legislation was introduced, improving the status and demand of renewable energy, as well as green taxes, all of which led to increased consumption of renewable energy. Lately, the German government has also supported various projects to support the export of renewable energy technologies. Another wind power success is Denmark which has the highest share of wind power of overall national power production, at ca 20 per

81 EUROSTAT (2009). *Energy, Transport and Environment Indicators*. Luxemburg, EUROSTAT.

82 Solarbuzz LCC (2009). Marketbuzz 2009. www.solar-buzz.com/Marketbuzz2009.htm.

83 Ragwitz, M. and C. Huber (not dated). *Feed-In Systems in Germany and Spain: a comparison*. Karlsruhe, Fraunhofer Institut.

84 Bruttobeschäftigung 2007 by Marlene Kratzat, Dietmar Edler, Marion Ottmüller and Ulrike Lehr

85 Ragwitz, M. and e. al (2008). *Employment and growth impacts of renewable energies in Europe*

cent (compared to Spain's 10 per cent and Germany's 6 per cent)[86]. The Danish wind power business grew from ca €400 million to €5 billion from 1996 to 2006. The Danish firm Vestas is a world leader in wind power engineering with over 20,000 employees.

EU Member States who have chosen the TREC system to promote renewable energy include the UK, Sweden, Italy and Belgium. Sweden's TREC system started in 2003, in the form of a renewable portfolio standard with electricity certificate trading. Sweden's TREC system has been criticized for not inducing a strong growth in wind power. Nonetheless, as it has become clear that the system will be extended another 10 years investors have become more confident, and recent figures demonstrate that wind power investments have been taking off very rapidly (STEM; 2008). It can be observed that Swedish certificate-plus-electricity prices have been far lower than not only German wind tariffs but also German tariffs on biofuels.[87] However, it should be noted that the comparison is difficult to make: much of the certificates in Sweden were allocated to existing production capacity, where there was a great deal of unexplored capacity in combined heat and power production. Nevertheless, one can expect there to be some truth in the theoretical assertion that the TREC system induces a stronger competitive pressure between different generation technologies to stimulate cost-efficient designs. Such a pressure is not present in the feed-in system where revenue is secured. Therefore, proponents of TREC argue that maintaining FIT systems for too long may slow down technology development and forego efficiency potentials. In the FIT system the competitive pressure instead lies within each power generation technology, for instance between different equipment manufacturers and suppliers, although due to production capacity constraints the last few years, this pressure has been rather weak.

The renewable electricity case shows that it is possible to stimulate innovations and create competitive advantage by means of supporting policy initiatives. Both FIT and TREC have contributed to considerable market expansion, the emergence of learning networks and growing political strength of industry associations for suppliers and owners of renewable electricity generation. Such institutional change has cemented European leadership in renewable electricity. However, it should also be noted that this leadership comes at a cost, as it implies politically orchestrated transfers of resources between stakeholders (i.e. from electricity consumers or tax payers to renewable industries). The systems are therefore contingent on strong political support.

Like for the automotive case that follows directly below, renewable electricity demonstrates that market-based systems, whether generic or technology specific, are most effective when supplemented by a broad portfolio of support measures. Both the FIT and the TREC scheme have merits, as many countries in Europe have been able to develop competitive advantages in RES-E technologies that are now possible to build export industries around and enhance Europe's competitiveness overall as well as help mitigate climate change globally. However, they operate under different assumptions about technology maturity. The lesson is the importance of adapting governance to the different stages of evolution and maturity for eco-efficient technological systems.

AUTOMOTIVE INDUSTRY – COMBINING GOVERNANCE FOR INNOVATION

Although the automotive industry is now in decline, it has until recently been the world's single largest manufacturing sector.[88] European car manufacturing constitutes 7.5 per cent of the manufacturing sector and employs 2 million directly while indirect employment has been estimated to another 10 million.[89] Future predictions for the car industry are futile in the current state of financial crisis and great turbulence in this sector, but it is safe to say that Europe will remain highly dependant on this sector in the future. However, Europe along with the US and Japan is facing new competition

86 2006 figures from IEA statistics, at www.iea.org

87 Midttun, A. and K. Gautesen (2007). "Feed in or certificates, competition or complementarity? Combining a static efficiency and a dynamic innovation perspective on the greening of the energy industry." *Energy Policy* 35: 1419-1422.

88 Köhler, J., L. Whitmarsh, et al. (2008). *Can the car makers save the planet? Innovation for a low carbon economy: Economic, institutional and management approaches*. T. Foxon, J. Köhler and C. Oughton. Cheltenham, UK, Northampton, MA, USA, Edward Elgar.

89 European Commission, http://ec.europa.eu/enterprise/automotive/pagesbackground/sectoralanalysis/index.htm

and all of the old dominating manufacturers are losing ground globally. The industry has had a profound impact of societal and economical development and important consequences for the environment. During the 1970's and 80's, local pollution (HC, CO, and NO_x) was the key concern, spurring regulations worldwide pioneered by the US 1970 Clean Air Act (CAA) Amendments. From the mid 1990's, CO_2 emissions has become the most pressing concern.

Global competition and economies of scale have pushed car manufacturers to ever-increasing production efficiency including larger production units and firms, and smaller margins. In this sense the sector is very mature. However, new polices and consumer pressure for further improvements still induce eco-efficient technological developments. There are still energy efficiency potentials in the order of 30 per cent to be made in further developing the standard gasoline Internal Combustion Engine (ICE) (less for the diesel engine), without considering ongoing and new technological breakthroughs such as hybrid technology. Hybridisation adds an additional improvement potential of 30-50 per cent, a total improvement potential in the order of 60 per cent[90,91]. Indeed, the industry is experiencing a growing pressure to realise this room for improvement and innovation in terms of both energy efficiency and solutions that radically reduce CO_2 emissions. A wide range of polices have been applied: Corporate Average Fuel Economy standards (or corresponding standards on CO_2 emissions); differentiated vehicles taxation over environmental performance; fuel/energy taxes; market enabling support such as public procurement, R&D, subsidies, soft loans to industry etc.; and technology-forcing standards are the key categories.

One regulatory standard-setting measure that induced and shaped technology change in an entire industry, was the emissions standards applied in California. Through its early introductions of a range of standards on sulfur and lead content in fuels, ozone, and more recently CO_2 emissions and "zero-emission vehicles", the State of California is usually considered a forerunner in the US and globally on air pollution policy.[92] The range of measures implemented by the Californian Air Resource Board was replicated at the federal level technological standards in the US, and lead to technology development. Catalysts were rapidly developed and introduced at the US market due to the CAA requirements of 90 per cent reductions in tailpipe emissions and adopted technology standards on the catalytic converter (1975) and the three-way catalyst (1981). With a Swedish perspective on this example of technology innovation driven by policy, it is worth mentioning that Volvo was the fist manufacturer to introduce the three-way catalyst with the Lambda Sond in 1976.

Moving to the issue of energy and an eco-efficient economy agenda, a contrasting story emerges. At the federal level, the US has not yet forced stricter energy efficiency standards, and only recently have some states enhanced this instrument. The results of this lack of interest in efficiency have led to notable impacts on US car industry competitiveness.[93] With less domestic regulatory pressure on the US owners, smaller engines were not considered a priority in the model programs. By contrast, in the EU, taxes and standards in individual Member States are significantly higher, an EU directive on minimum taxes on motor fuel (petrol and diesel) apply to all Member States, and the voluntarily and not fulfilled commitments from European car manufactures on average emissions from new cars has been replaced by mandatory legislation. The compromise resulted in a requirement to reduce CO_2 emissions to an average of 120gCO_2/km for all cars by 2015 (phased out from 2012 with 65 per cent of new cars complying).[94] The Porter hypothesis appears to get some support in this development: combined and continued pressure on the industry appears to have resulted in European car

90 Romm, J. (2006). "The car and fuel of the future." *Energy Policy* 34(17): 2609-2614.

91 Johansson, B. and M. Åhman (2002). "A comparison of technologies for carbon-neutral passenger transport." *Transportation Research* Part D 7: 175-196.

92 Gerard, D. and L. B. Lave (2005). "Implementing technology-forcing policies: The 1970 Clean Air Act Amendments and the introduction of advanced automotive emissions controls in the United States." *Technological Forecasting & Social Change* 72: 761–778.

93 Clerides, S. and T. Zachariadis (2008). "The effect of standards and fuel prices on automobile fuel economy: An international analysis." *Energy Economics* 20: 2657-2672.

94 European Parliament (2007). "Council of the European Union Interinstitutional File 2007/0019 (COD)." Available at: http://register.consilium.europa.eu/pdf/en/08/st16/st16721.en08.pdf

manufacturers keeping up with global competition comparatively well, and for the last 10 years they have increased their market share relative to the US.

In terms of choices of policy instruments it is interesting to note that although the voluntary agreement might have contributed to this development, the mechanism was on its own not strong enough to reach the target. As to be discussed in Chapter 4, this demonstrates the important role of regulatory standard-setting to foster innovation and enhance eco-efficiency while maintaining competitiveness. However, a quick view on the Japanese car manufacturers (Toyota in particular) shows how an even more active and combined approach to governance was a factor in Toyota's successful global introduction of the hybrid electric vehicle "Prius". With 160 thousand Prius cars sold in the US during 2008 and 128 thousand in Europe in addition to the domestic market in Japan, the global cumulative sales passed 1 million in April 2008 making Prius the dominating model and Toyota the leading manufacturer. The policy regime in Japan includes the elements of standard-setting and taxation from the US and Europe, but had a greater range of support programs for battery, hybrid, and fuel cell vehicles. This involved not only persistent and strategic R&D efforts, but infrastructure, early market support in the form of public procurement, and large range of supporting projects and collaborations across industry facilitated by the government. Importantly, the government created both stricter tail-pipe regulations and actively worked with visions and targets, analysing the future development of the industry.[95] The strength of integrated policy efforts can also bee seen in the recent breakthrough of biofuel cars in Sweden. In this case the range of policy instruments (taxes, subsidies, and local initiatives in terms of free parking and exemptions from congestion charges) on road transport has had a large impact and the Swedish car fleet no longer has the worst CO_2 performance in EU.[96]

Finally, it should be emphasised that the challenges for the transport sector worldwide is huge, and a long term solution without fossil fuelled cars is intimately linked to the sustainability of the wider energy sector, as discussed in the biofuels example. Both near-term and long-term efficiency potentials are however great. For example, some scholars believe that hybrids will be a dominating platform already in 2020[97], and in addition substantial improvements would be made by further encouraging a shift to smaller-sized engines. Continued regulatory pressure for energy efficiency will most likely benefit both climate change mitigation, security of supply, innovation, and competitiveness, making the sector a centrepiece in the eco-efficient economy. In the more distant future, a new regime of cars including electrical drive trains offers significant higher energy efficiency; but it is very difficult, if not impossible, to conclude on optimal technological choices (a matter of much academic debate). Polices for eco-efficiency should therefore as a starting point be technology neutral and use a mix of instruments. However, forward-looking polices and visions have proven successful and as the Japanese dedication to pursue new solutions illustrates; commitment is necessary to foster initial developments.

SUSTAINABLE CITIES – SYSTEMS EFFICIENCY OPPORTUNITIES IN URBAN AREAS

Europe is the world's most urbanised continent, with approximately 75 per cent of the European population living in urban areas. Although many European cities are declining, by 2020 it is estimated that approximately 80 per cent of Europe's inhabitants will live in urban areas. Most human and economic activities, and thus a large share of the energy consumption and the emissions of greenhouse gases, take place in urban areas, making cities key players in tackling the climate challenge. Cities can, through their associated lifestyles, be a burden on natural resources if they are not properly planned. At the same time, cities tend to be more resource efficient than nations on a per capita basis and have substantial potential to further increase this resource efficiency.

For European cities, energy consumption in buildings accounts for the largest percentage of total energy use. As discussed previously, there is a need both for increased energy efficiency as well as a switch to renewable energy sources in order to tackle this challenge.

95 Åhman, M. (2006). "Government policy and the development of electric vehicles in Japan." *Energy Policy* 34: 433–443.

96 Nykvist, B. and L. Whitmarsh (2008). "A multi-level analysis of sustainable mobility transitions: Niche development in the UK and Sweden." *Technological Forecasting and Social Change* 75(9): 1373-1387.

97 Romm, J. (2006). "The car and fuel of the future." *Energy Policy* 34(17): 2609-2614.

Both these issues have been key targets addressed in Freiburg, Germany. In the 1970s, local opposition against a planned nuclear plant close to Freiburg led to the adoption of a series of ambitious environmental energy policies, including a support program for home insulation and energy efficiency retrofits, and a requirement that all new houses must meet low-energy efficiency standards. Such houses cost about 3 per cent more to build, but the energy costs are reduced by 30 per cent.[98] The interaction between these local policies and the national frameworks, including the national feed-in energy policy has played an important role to achieve the fruitful environment for solar power in the region.[99] Companies as well as expertise in the field of solar energy have been attracted to the region and solar technology in Freiburg has created over 1000 new jobs in 80 business operations.[100] The environmental targets have been focused even more strongly in the newly built urban extension area, Vauban, where all buildings must be low-energy and many of them are zero energy or energy plus buildings with solar and photovoltaic panels producing energy. Austria has through a private-public partnership program called "Building of Tomorrow" developed a standard for energy-efficient buildings. The standard states, among other things, that from 2015 only new residential buildings with passive house, or comparable, standard will be funded through the province housing subsidy programme.[101]

In many cities there is a growing interest for energy produced locally, which can lead to smaller distribution and transmission losses and decreases the vulnerability of energy supply. In Barcelona, Spain, a program aimed at reduced energy use and increased percentage of renewable energy sources has been implemented. This program includes promotion policies, demonstration projects, legal and management instruments as well as the integration of energy measures into the urban development. As mentioned in the case on renewable electricity, since 2006, solar panel installations are mandatory for all new and renovated buildings, to supply at least 60 per cent of the energy needed to heat water. District heating as described in the case above may be an option where appropriate – though, also as illustrated in the case, it requires initial large investment at inception.

New, innovative building designs and areas as the one in Freiburg can achieve significant reductions in energy use. However, significant improvements can often be made also to the existing building stock. In Nyíregyháza in Hungary, a number of retrofitting programmes have led to an energy saving of 68 per cent.[102] In addition to the reduction in energy use, retrofitting of existing houses have also brought about cost savings. In Berlin, energy saving partnerships between public house owners and contractors led to decreases in emissions of greenhouse gases from the buildings corresponding to about 100,000 tons between 1996 and 2002.[103] The contractor carries out efficiency measures such as central building control systems to decrease energy consumption. The investments made by the contractor are financed by the achieved energy savings. Any remaining savings are shared by the partners.

After energy use in buildings, transportation accounts for the second largest share of cities' greenhouse gas emissions. Motorized transportation in cities does not only lead to greenhouse gas emissions. It is also largely a health issue. About 550,000 premature deaths each year are related to human exposure to fine particulate matters.[104] In some cities, this means that average life expectancy is reduced by two years. In addition, exposure to noise is associated with increased risk of heart disease and impacts on mental health. In contrast to US cities, European cities are traditionally more compact since they were shaped before the emergence

98 http://madisonfreiburg.org/sustainablecity.htm

99 Hopwood, D. (2007). "Blueprint for sustainability? What lessons can we learn from Freiburg's inclusive approach to sustainable development? ." *Refocus* 8(3): 54-57.

100 Breyer, F., M. Halter, et al. (2008). Freiburg Green City Freiburg Wirtschaft Touristik und Messe GmbH & Co. KG. .

101 http://umwelt.lebensministerium.at/filemanager/download/38116/

102 EEA (2009). *Ensuring Quality of Life in Europe's Cities and Towns. Tackling the Environmental Challenges driven by European and Global Change*. Copenhagen, European Environmental Agency.

103 Berliner Energieagentur GmbH (2002). *Performance Contracting. Energy Saving Partnership. A Berlin Success Model*., Berlin Senate Department of Urban Development.

104 EEA (2009). *Ensuring Quality of Life in Europe's Cities and Towns. Tackling the Environmental Challenges driven by European and Global Change*. Copenhagen, European Environmental Agency.

of automobiles. Compact cities are more energy efficient and emit less carbon dioxide. In this way, European cities have the potential to provide public transportation and short distances that make walking and bicycling viable options.

In an increasing number of European cities, the need to reduce pollution due to motorized vehicle traffic is acknowledged. In London for example, the introduction of congestion charges reduced car use by 15 per cent. In Bologna, Italy, the historic city centre has been closed for car traffic and is open for buses only.[105] In Pécs, Hungary, a car free zone has been established in the area that UNESCO has designated as a World Heritage site. In Freiburg, in addition to energy saving activities and the switch to renewable energy sources, the city's efforts in the environmental arena covers a number of other areas. A cycling plan was drawn up in 1970, which has led to that Freiburg has now over 500 km of bicycle paths and over 5000 bicycle parking spaces. About a third of all journeys are made by bicycle.[106] The old town centre became car-free in 1973 and 30 kmph zones have been introduced for almost all residential streets. However, in many cities in the new Member States, the trend is towards increased use of private cars. This is related to the economic growth and policies that prioritize the construction of urban freeways and parking spaces. It is important to ensure that cities with lower car use and fuel use per person take a positive track and do not increase car use and instead build infrastructure that supports other modes of transportation.

The challenges faced and the potential possessed by cities is recognized by the European Covenant of Mayors initiative, in which participating cities are committed to go beyond the climate targets set for 2020, reducing their emissions by at least 20 per cent. The opportunities that cities possess are also identified by the Leipzig Charter on Sustainable European Cities, as well as by the Aalborg Commitment. An increasing number of cities have joined the Covenant of Mayors, and several cities are seeking solutions to become more resource efficient, to reduce energy use and greenhouse gas emissions.

105 German Institute of Urban Affairs (2007). *Sustainable Urban Transport and deprived urban areas. Good Practice Examples in Europe*. Berlin, German Institute of Urban Affairs.

106 http://madisonfreiburg.org/sustainablecity.htm

As in the case with the Berlin partnership programme, sustainability initiatives do not need to be costly but can instead lead to cost savings, a fact which is also recognized by for example the European Commission Green Building Programme. In addition, there is here a substantial potential for growth for companies operating in fields such as renewable energy, waste and water treatment. Reduced car use leads both to decreased emissions and improved health for citizens, thereby decreasing costs for society.

There are several promising examples that can be scaled up and applied in other cities. At the same time, geographical, economic and cultural differences, requires specific adaptations. Cities are multifaceted, and sustainable city planning entails a web of opportunities and dilemmas, involving a wide range of environmental and socio-economic aspects. Cities need to deal with efficient waste water treatment, waste handling, transportation, energy supply and use and ensuring a healthy environment for citizens. Ideally, cities should aim for a circular, rather than a linear metabolism, minimise fossil fuel use and material inputs, and maximise recycling and reuse of energy, water and materials. At the same time, cities need to ensure eco-friendly interactions with surrounding areas. To address all these aspects, sustainable city planning requires an integrated approach. Just like for many national and European wide policy areas, sustainable cities need better analytical tools and knowledge support to understand the systems implications of different planning alternatives.

CHEMICALS INDUSTRY – A EUROPEAN HYBRID GOVERNANCE APPROACH

The chemical sector presents a particular challenge from an eco-efficient economy perspective: a large sector with an inherently energy-intensive production process, a competitive global market, and comparatively weak regulation outside the EU make it difficult to couple environmental enhancements with competitiveness. These environmental and governance challenges for chemical control have, however, led to a substantively and procedurally innovative European chemicals policy.

In Europe, the chemical sector constitutes the third largest manufacturing industry, providing 1.7 million jobs and indirectly employing a further three million people. Globally, the EU is an important player,

producing 31 per cent of the world's chemicals, including both market-leading multinationals as well as around 36,000 small and medium-sized companies. As the sector is a large consumer of energy – on average, 9 per cent of the total production costs are due to energy use[107] – it is inevitably impacted by the EU's Kyoto and other climate commitments. Industry organisations point out that the chemical industry actively contributes to solutions that save energy and CO_2 emissions, and that although chemical productions in Europe have increased by more than 50 per cent since 1990, the corresponding emissions of greenhouse gases have been reduced by more than 20 per cent, which equals about one third of the EU's target under the Kyoto Protocol.[108] However, the sector is still a large energy consumer and will thus have to be creative in furthering its efforts, through for example making use of emergent carbon capture and storage (CCS) technology and actively seeking renewable alternatives.

Beyond reducing greenhouse gas emissions, the sector also faces environmental challenges related to chemical impacts. Although there was a regulatory procedure also before REACH concerning chemical uses, there is still a lack of knowledge about end uses and possible hazardous properties of most of the approximately 30,000 substances currently on the European market. During the 1990's, EU production volumes of toxic chemicals, i.e. those classified as carcinogenic, teratogenic, mutagenic and reprotoxic, increased along with the total chemical production,[109] although part of the increase was due to re-classification of some of the chemicals.

Since 2006, the main policy tool for chemicals in the EU is the REACH (Registration, Evaluation, and Authorisation of Chemicals) system.[110] The aim of REACH is two-fold: to improve protection of human health and environment from the risks of chemicals, while enhancing the competitiveness of the EU chemicals industry. In other words, REACH aspires to an eco-efficient economy agenda. REACH replaced 40 pieces of existing legislation and creates one single system for all types of substances – a level playing field for existing and new chemicals. While the two-fold aim of the REACH legislation can be endorsed by most stakeholders, the translation of the aim into specific regulations and exemptions has been intensely debated, starting already with the release of the White paper on a new chemicals strategy from the Commission in 2001, and continuing into the last discussions in the European Parliament when REACH was finally adopted in December, 2006. Industry organisations actively opposed many aspects of REACH while many civil society organisations called it under-ambitious.[111,112] While the European chemicals industry feared to lose competitiveness on the global market because of REACH, industry organisations in other regions were preoccupied with the prospect of REACH influencing regulations in countries outside the EU.

For most sectors, innovation, competitiveness, and eco-efficiency are understood as closely linked, and for some industrial processes, substantial gains may be made by adopting an eco-efficiency scheme at the company level. For instance, in the implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer, it was realised that in some industrial processes the use of ozone depleting solvents for cleaning of metal parts could be greatly reduced or even removed by changes in the production process. This is clearly an eco-efficient measure, costing less to achieve the same substantive result, with environmental benefits. Examples are also found in the chemical industry. BASF, one of the world's largest chemical groups, has developed an eco-efficiency tool which identifies processes and products that use the fewest resources to deliver a more economical product. This tool has been applied to many products and processes, such as for example the indigo dying of blue jeans. In this case, five alternative dying processes were evaluated using the eco-efficiency analysis, after which the more eco-efficient alternative was launched as a new product. BASF has also developed an "Eco-

107 Appe (2008). *Climate change and the petrochemical industry*, Position paper, Association of petrochemicals producers (appe) in Europe.

108 CEFIC (2006). *The Chemical Industry helps to protect the climate. Information material*. Brussels, European Chemical Industry Council (Cefic).

109 European Environment Agency, 2003

110 European Council Regulation (EC) No 1907/2006, adopted 18 December 2006

111 Appe (2008). *Climate change and the petrochemical industry*, Position paper, Association of petrochemicals producers (appe) in Europe.

112 CEFIC (2006). *The Chemical Industry helps to protect the climate*. Information material. Brussels, European Chemical Industry Council (Cefic).

Efficiency" label for those products that have passed the analytical process which includes third party evaluation and the publication of test results.

However, for the chemicals industry, energy savings and emission reductions are often more costly. The continued work towards reduced greenhouse gas emissions and harmful effects of chemicals then demands close dialogue between different stakeholders, to find the appropriate balance between regulation and support to the sector. This type of coordination and consultation with stakeholders has arguably been achieved in the substance and process of REACH. Between the initial White paper and the adoption of REACH, stakeholders including industry and civil society were widely consulted in the preparation and implementation of the system. While on the one hand, the outcome might appear to take a traditional command and control approach to regulation (see the discussion of governance approaches in Chapter 4), as it places a heavy burden on the chemical sector to produce data and reserves the option for top-down restriction, a second look points to more creative and diversified governance mechanisms. These include reliance on self-regulation: the data submitted in the REACH "Registration" phase and used at the "Evaluation" phase is collected and reported by manufacturers and importers themselves. REACH also emphasises devolution: in providing a framework of basic rules and procedures, it leaves many decisions including defining standards, operational criteria and procedural guidance to the national and European implementing bodies.[113]

Thus, REACH employs both traditional and new forms of steering to achieve multiple aims: environmental and human health protection, as well as economic efficiency – mitigating the cost burden on the chemical sector and thus maintaining the competitiveness of the European chemical sector on the world market. A long series of competing cost-benefit analyses were commissioned during the REACH negotiation process, by actors including the European Commission, private research firms, governments, NGOs and industry. The Commission's impact assessment assessed the direct costs of REACH for the chemical industry to be €2.3 billion from 2006-2017.[114] The same report estimated total costs including those to downstream users to reach between €2.8 and 5.2 billion for the same time frame. These costs are to be weighed against the human health and environmental benefits. The impact assessment provides a rough estimate for human health benefits at €50 billion over 30 years, while a DG Environment study suggested that less-easily quantified but nevertheless significant benefits would take the form of reduced air, water and soil pollution, as well as biodiversity preservation.[115]

In regulating the chemical sector, different variables of the eco-efficiency equation have been emphasised by different actors including governments, industry and civil society. REACH is a hybrid governance structure set out to optimise the protection of human health and the environment while maintaining industry efficiency and not disregarding economic factors. The process facilitates engagement of stakeholders and makes use of integrated impact assessment procedures.

STEEL INDUSTRY – ISSUES TOWARDS LOW-CARBON PROCESSES

The EU is the second largest steel producer after China, with a production representing about 15-16 per cent of the world output, including crude steel, finished steel products, steel tubes and iron steel foundry production.[116] In 2005, the total value of the output from the industry of the EU-25 states was roughly 2.5 per cent of the total value of the industrial production within the countries.[117] About 25 per cent of the steel produced in the world is traded internationally, and trade plays an increasing role in the steel market.118

113 Hey, C. and J. Volkery (2007). "Better regulation by new governance hybrids? Governance models and reform of European chemicals policy." *Journal of Cleaner Production* 15: 1859-1874.

114 CEC (2003b). Extended Impact Assessment of the Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH). European Commission, Brussels.

115 CEC (2003c). *The Impact of the New Chemicals Policy on Health and the Environment*. Brussels, European Commission.

116 ECOFYS (2008). *Study on the Competitiveness of the European Steel Sector*. Brussels, European Commissioin.

117 http://ec.europa.eu/enterprise/steel/index_en.htm

118 IEA (2007). *Sectoral Approaches to Greenhouse Gas Mitigation- Exploring Issues for Heavy Industry*. Paris, IEA/OECD.

Yet, the domestic market is the most important for European steel producers. Since the 1980's when a large share of the industry was state owned, the EU steel sector has undergone a transformation. During the 1980's and 1990's, the industry was deregulated. Along with this privatisation came increased emphasis on productivity and technological innovation. Today, the EU steel sector is a modern, customer-oriented industry, dominated by large, multinational companies, and with competitiveness largely linked to the markets for high quality products.

The EU as a whole has traditionally been an exporter of steel but during the last few years, the region has become a net importer – the EU is now the third biggest exporter and the first importer of steel products. At the same time, global steel production has increased in recent years driven in particular by demand in China. The increase in world steel prices has led to an increase in total EU turnover, despite the decline in global market share. The demand for steel is likely to increase over the coming years, due to demand from China, India, Brazil and Russia. However, the competition from emerging economies, in particular China, represents a major challenge for EU production. In the longer perspective, there is even a risk for excess supply when emerging economy infrastructure growth slows down.

In addition to the challenge of increased global competition, another challenge is how to achieve stricter climate targets and handle the rising costs connected to new environmental policies. As in the chemical sector, steel production processes are energy-intensive, and emissions from the steel industry represent about 6 per cent of European anthropogenic CO_2 emissions. However, significant achievements have been made to increase the energy efficiency and decrease emissions of CO_2 from the steel industry. Over the last 50 years, the European steel industry has cut emissions by 50 per cent.[119] This has been achieved by improving efficiency in the technologies used. Carbon-containing materials, such as coal and coke, are in steel production used not only as a source of energy, but also as a reducing agent to reduce iron ore to iron, a process which also emits CO_2. While the energy sources can be switched to non-fossil ones, replacing carbon for the reduction of iron ore has proven to be more difficult. In order to reach further improvements and reductions in CO_2 emissions, the industry invests in long term research and development projects, for instance in carbon capture and storage (CCS) applications, where carbon dioxide is captured and stored in geological reservoirs.

There is a fear within the industry that measures to reduce emissions due to environmental policies, in particular the European Emissions Trading Scheme (EU ETS), will lead to increased costs. In addition to the direct effects of the EU ETS on the iron and steel industry, there are also indirect effects due to increased price of electricity, since also electricity production is included in the EU ETS. The international competition exposure implies that costs of mitigating CO_2 emissions may lead to competitive disadvantages in terms of factor cost. This in may force industries to relocate production to countries outside the EU without the same constraints on emissions, or cause imports of high energy intensive production from outside of the EU to increase. The emission reductions achieved by the introduced policy may thus be offset by emissions from increased production in other parts of the world. This concept is known as carbon leakage, a problem also for other energy-intensive industries exposed to international trade, such as aluminium and (to some extent) cement.[120]

To avoid carbon leakage, as well as to achieve further emission reductions from the sector, international agreements as well as other policy measures are needed. A number of mechanisms have been suggested to deal with carbon leakage and to level the playing field between companies within and outside the EU, including a) free allocation of emission allowances to the affected sectors; b) support for investment and re-investment with state aid; c) border adjustments for carbon prices; and d) sectoral agreements to create the same carbon price for all competing firms.[121]

119 CEC (2004b). *European Steel Technology Platform*. Vision 2030. Report of the Group of Personalities. Brussels, European Commission.

120 Reinaud, J. (2009). *Trade, Competitiveness and Carbon Leakage: Challenges and Opportunities*. London, Chatham House.

121 European Parliament's Temporary Committee on Climate Change (2008). Competitive distortions and leakage in a world of different carbon prices. Trade, competitiveness and employment challenges when meeting the post - 2012 climate commitments in the European Union. Brussels, European Parliament.

Free allocations of allowances to sectors that may be affected by carbon leakage were suggested as part of the now adopted climate and energy package. However, free allowances reduce the incentive for early investments in energy efficiency. In addition, free allowance allocation and state aid may create administrative constraints that reduce the effectiveness of carbon pricing. Border adjustments have been suggested as a way to avoid leakage by adjusting imports and exports for the difference in carbon price. This could take the form of a tax or as an extension of the EU ETS, by requiring importers to purchase and surrender allowances on imported goods. However, while the idea seems simple, the politics and the implementation are more complicated. International sectoral agreements with binding targets for entire sectors could lead to emission reductions and address leakage concerns, but would in such cases be complex to negotiate and implement. However, sectoral agreements could also take the form of sharing best practices and benchmarking across regions and countries. As such, sectoral agreements could potentially lead to emission reductions and at the same time accelerate international cooperation towards a global deal. The sectoral approach has the advantage of responding to concerns regarding competitiveness of incumbent industries that are exposed to international competition while at the same time making them subject to strict emissions targets. Second, it is also promoted by emerging economies as a key for them to make commitments.[122] Third, it may enhance effectiveness of mitigation overall by taking into account from the bottom-up different sectors' potentials.[123]

Although the problem of leakage is seen as an economic threat within the industry, for the EU as a whole as well as globally, the more general concern is that relocation of emissions undermines the goal to mitigate emissions. When climate policies result in relocation rather than reduction of emissions, as well as job losses in the area with the policies, the result may be a loss of domestic and international support for such policies. Nevertheless, measures to avoid such leakage could also undermine climate policies, if they are regarded as protectionist.

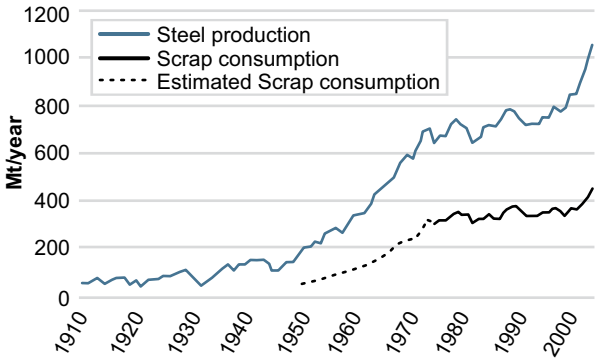

Figure 17: Source: Global steel production versus scrap consumption (Source: Eurofer)

Thus, such measures need to be chosen carefully, and preceded by analyses for each specific sector. The challenge here is for the EU not only to enhance domestic governance in the steel sector, but also to demonstrate that this is possible without the domestic industry suffering competitiveness losses.

Sectoral mechanisms, ETS and carbon leakage are important factors to consider when resolving the steel sector's contribution to the eco-efficient economy. In the long run, it is hard to escape the imperative for a global carbon pricing. However, in the short term there are still significant improvements to make in current business practices. One aspect is a stronger closing of the loop in the steel sector, through enhancing the recycling rates as far as possible – steel being a 100 per cent recyclable material that can be reused many times without losing its properties. This substitutes the use of raw material (iron ore) and saves energy. Figure 17 shows the development of the gap between steel production and scrap consumption globally. Due to longevity of steel products, this gap cannot be closed, but there is room for improvement.

122 IEA (2007). *Sectoral Approaches to Greenhouse Gas Mitigation- Exploring Issues for Heavy Industry*. Paris, IEA/OECD.

123 Schmidt and et al (2008). "Sector-based approach to the post 2012 climate change policy architecture." *Climate Policy* 8: 494-515.

4 GOVERNANCE FOR A EUROPEAN ECO-EFFICIENT ECONOMY – CURRENT STATUS

Chapter 3 identified efforts and achievements of different sectors in different stages of transformation toward a more eco-efficient economy. As shown, this transformation requires change in the way in which economic activities are carried out – through innovations in technology, systems changes, and changes in behaviour. These changes do not occur automatically. Rather, they happen as a result of governance interventions of different kinds, either through private or public initiative.

Policy is but one manifestation of the broader issue of governance. When discussing the range of available measures to influence and enhance eco-efficiency in the European economy – to ask the question, "how can we 'do' policies to enable an eco-efficient economy?" – it is necessary also to talk about "who?". As discussed in Chapter 1, in contrast to the narrower policy concept, "governance" reflects the fact that technological development and other economic processes are multi-actor processes, and socio-technical change is fuelled by millions of decisions of different actors. This is significant for several reasons. First, different actors are usually driven by different goals, interests and ambitions. Second, it is not at all certain that the state or the European Union is or should be the central actor in steering these processes.

Although two policy areas in particular are usually mentioned in the context of the eco-efficient economy agenda – environmental policy and innovation policy – a much greater variety of governance approaches affect, and may be used to promote, the eco-efficient economy. As Chapter 3 showed, the important question is not which governance measure to use – as most sectors today are in fact subject to a combination of governance measures. The choice of instrument is a complex task, and the topic of a whole academic literature. Key considerations to make relate to the problem characteristics, such as how dangerous it is, what are the possibilities and costs of mitigation, and available substitutes. Furthermore, different issues and sectors lend themselves to different levels of governance, from the EU through national-level policy down to local and regional levels. The relevant question is how to effectively apply well-balanced combinations of different governance measures. Finding these effective combinations is an immensely complex task, but also one that can draw on experiences and knowledge about policy practice in a wide variety of fields and sectors.

This chapter places a selection of existing European policies – energy and climate, efficiency, sustainable production and consumption, innovation, and external policies – within a broader governance framework. It first introduces three principal approaches: regulatory standard-setting; market-based measures; and voluntary, collaborative and information-based approaches. These co-exist in various existing EU policy areas, which are surveyed in the second part of the chapter. Drawing on the sector examples of the previous chapter, the status of policies is presented and options for moving toward a more eco-efficient economy agenda are considered.

PRINCIPAL POLICY APPROACHES

Regulatory standard-setting

Regulatory standard-setting is the traditional approach of states for addressing environmental problems. It dominated environmental governance in the 1970's and 1980's. Typical examples include environmental product standards, technology specifications, standards on production processes, permitting procedures, and bans of certain products and activities. Standards and technological prescriptions have in many cases been effective in reducing emissions of certain pollutants as an "absolute" pressure for firms to consider environmental issues.[124] However, these instruments have been criticised for being inflexible and for focusing on achieving only a minimum level of environmental protection rather than promoting new technology development. A main argument against, is that it can lead to high costs for firms and thus decrease competitiveness. There is a fear that regulations may bring too hard a pressure on firms that will cause them to move their production to other countries. At the same time, well-

124 Rugman, A. and A. Verbeke (1998). "Corporate strategies and environmental regulations: an organizing framework." *Strategic Management Journal* 19: 363-375.

designed environmental regulations may stimulate new technologies adapted to the new environmental regulations and give the home-based firms a first-mover advantage.[125] However, this implies that regulators are able to foresee international regulation trends as well as reaction patterns of companies. In addition, it may require a home market of a certain volume.

Whether to regulate products or processes is a critical thread of discussion.[126] Production processes normally affect production within the home country or region, and product standards may influence both domestic and foreign production. Past experiences show that when environmental regulations concern production processes, it often leads first to the adoption of end-of-pipe, add-on technologies. Only once it appears that the environmental regulations will remain and even become more stringent will firms start to engage in new and integrated technology development. Thus, after a first phase of retrofitting, firms may start searching for technology designs that capture energy and emissions concerns. As shown in the automotive and chemicals examples in Chapter 3, there are situations where regulatory standard-setting has played a major role in promoting technological change. Furthermore, we are now witnessing a renewed interest in standard-setting, in for instance energy-efficiency in domestic appliances and housing, and automotive fuel-efficiency.

Market-based approaches

Market-based measures harness market forces to steer actors towards certain behaviours. Economic instruments include, for example, emissions trading, environmental taxes and charges, deposit-refund systems, subsidies, green purchasing, and liability and compensation. Market-based measures may involve the adjustment of an existing large-scale market, for instance through environmental taxation to correct for externalities. They may also deal with the deregulation of a regulated market that is opening up to competition, which might induce innovation. Finally, they may add particular rules to extend an existing niche market, for instance creating a rule about the supply of ethanol or establishing a secure price for investors in renewable energy.

The EU generally considers market-based instruments to be an efficient way to internalise the costs of pollution created by economic activity, resulting in prices that better reflect the total environmental and economic costs occurring during production and consumption. At the same time, market-based approaches create incentives for companies to switch from polluting technologies to more environmentally-friendly ones and may generate revenues that can be used for environmental improvement. Compared to regulation, market-based measures are regarded as more flexible – rather than prescribing a certain technology, they leave room for the development of new technological solutions. However, market-based measures can also be steered towards particular technologies, in which case they do not only function as a way to correct markets but also communicate normatively the intentions and objectives of the state.

The use of market-based instruments, in particular taxes, charges and tradable permits, has increased in the EU since the mid 1990's. Taxes have been introduced for CO_2, sulphur fuels, waste disposal and on raw materials at national levels. At the EU level, emissions' trading has been successfully introduced for greenhouse gases – apparently easier to digest for Member State governments than EU-wide taxation. owever, designing such economic incentives for high-risk pollutants and for non-point source pollutants can be administratively difficult, slow and costly.[127] Trading emissions under a quota obligation is potentially a powerful tool to achieve environmental objectives in a cost-effective way. However, for this to happen, instrument design and implementation protocols are crucial. Taxes as well as trading under quotas work when levels are high enough to stimulate mitigation measures. Tax differentiation for low sulphur and unleaded fuels have been effective in changing producer and consumer behaviour towards innovation and purchasing decisions that reduce air

125 Porter, M. and C. Van der Linde (1995). "Green and Competitive: Ending the Stalemate." *Harvard Business Review* (Sept-Oct): 120-134.

126 Scharpf, F. (1997). "Introduction: the problemsolving capacity of multi-level governance." *Journal of European Public Policy* 4: 520-538.

127 Khanna, M. (2001). "Non-mandatory approaches to environmental protection." *Journal of Economic Surveys* 15(3): 291-324.

pollution.[128] Environmental subsidies have also proven effective for supporting new, cleaner technologies.

Voluntary, collaborative and information-based approaches

The third category of governance approaches comprises a range of measures that are voluntary and cooperative in nature, such as information provision, network creation and match-making, management and auditing systems, labelling and R&D support. Some of these are often also referred to as "self-regulation", in which case standard-setting may well figure prominently, but their development is delegated to private actors such as industry associations. Thus, discretion may be high. The incentives for the firms to participate may be to pre-empt the threat of mandatory regulations, to shape future regulations, to achieve technical assistance and/or financial subsidies, improved relations with government and stakeholders, and cost efficiency. Programmes frequently work under "a shadow of regulation" such as programs that ask firms to voluntarily improve their environmental performance in exchange for benefits such as regulatory relief (see the energy efficiency example). These approaches have become more popular due to their supposed ability to engage industry in a learning process that will enable them to change their business orientation to more environmentally responsible activities and techniques at the same time as costs are kept low, potentially providing domestic firms with first-mover advantage in the shift towards environmentally friendly techniques.[129] Environmental NGOs have often pioneered in these types of approaches, working through governance arrangements in partnership with industry to develop eco-labelling and various types of standards.

Public voluntary programs are established by environmental agencies to invite firms to voluntarily meet specific standards. Firms show that they participate by signing non-binding letters of agreements and their progress is monitored through self-reporting. Negotiated agreements between a firm and the regulator involve active negotiation between the government and the firm on abatement targets and plans. Unilateral initiatives occur without direct government involvement. Firms may develop their own plans or management systems to improve their environmental performance, they can participate in codes of conduct or guidelines developed by trade associations, and they can meet the environmental performance for registering with a certifying organization. In addition to these categories of voluntary initiatives, government and non-government agencies may provide information about firms' environmental performance, which in turn may lead to firms voluntarily taking initiatives to improve their performance. Examples of these include environmental labelling of products and "black-lists" of firms having poor environmental standards. At the European level, there has been an increased interest in the setting of non-binding benchmarking and evaluation of information as a policy instrument, called the "Open Method of Coordination".

CURRENT EUROPEAN POLICIES[130]

The governance approaches outlined above are evidenced in different combinations and to varying degrees on the current European policy landscape. What follows is a short summary of the current state of the EU policy areas most relevant to promoting an eco-efficient economy, with brief analyses of future policy options. Like in Chapter 3, the account is not comprehensive, but probes into some of the most relevant policy areas. In addition, policies such as regional development policy, tourism policy, R&D policy, agricultural policy and enterprise policy would have strong significance in governing towards a European eco-efficient economy.

EU's energy and climate policy

Europe's energy policy is based on the three core objectives of sustainability, competitiveness and security of supply. Within this context, in December 2008 the European Parliament and Council agreed on a new climate and energy package to guide policy through 2020. It includes a directive on the promotion

128 EEA (2006). *Using the market for cost-effective environmental policy. Market-based instruments in Europe*. Copenhagen, European Environment Agency.

129 De Bruijn, T. and V. Norberg-Bohm (2005). *Innovations in the Environmental Policy System: Voluntary, Collaborative and Information-based Policies in the United States and the Netherlands. Towards Environmental Innovation Systems*. K. M. Weber and J. Hemmelskamp. Heidelberg, Springer: 269-281.

130 The interested reader will find more details on the European Union's webpages which provides useful summary accounts of all policy areas; see http://europa.eu/pol/

of renewable sources of energy (including national binding targets with burden sharing between Member States and sustainability criteria for biofuels), a new directive for the EU Emissions Trading System (ETS) to extend the existing scheme, and a proposal for efforts to reduce emissions from sectors that are not in ETS, such as transports, buildings, services, smaller industrial installations, agriculture and waste. Further agreements included a new regulation setting emission performance standards for new passenger cars registered in the EU at an average target of 130g CO_2/km, a revised fuel quality directive, requiring fuel suppliers to reduce greenhouse gas emissions. An additional directive was approved in December 2008 on the legal framework for the carbon capture and storage (CCS) technology as a future means for industrial installations to "decrease" CO_2 emissions.

The EU ETS is one of the most important means of reducing greenhouse gas emissions in the EU region. This cap-and-trade system, designed to facilitate emissions reductions at the lowest possible cost, is the largest multi-country, multi-sector greenhouse gas emission trading scheme world-wide. The EU ETS became operational in 2005 and covers over 10,000 installations in industrial sectors including the energy production, iron & steel, mineral, and pulp & paper. These installations are collectively responsible for half of the EU's CO_2 emissions and 40 per cent of its total greenhouse gas emissions. According to the climate and energy package, fewer emission allowances will be granted, with the aim to reduce the emissions from the installations included in the scheme to 21 per cent below 2005 levels by 2020. For the sectors not included in the EU ETS, such as road and sea transport, buildings, services, agriculture, waste and smaller industrial installations, emissions should be cut by 10 per cent below the levels in 2005 from 2013 and 2020, through binding national targets.

The EU ETS sits within a broader set of EU-level policies to address climate change and climate change policy. The January 2009 Communication from the European Commission constitutes a proposal to achieve global agreement at the December 2009 climate change negotiations in Copenhagen.[131] The Communication identifies the key challenges to be: targets by developed countries and appropriate actions by developing countries; the need to address the financing of actions by developing countries (to mitigate greenhouse gas emissions and adapt to climate change); and the need to build an effective global carbon market. Furthermore, in March 2009, the Council (Environment) adopted conclusions on Further development of the EU position on a comprehensive post-2012 climate agreement.[132]

The European climate and energy policy as described above has employed both standard-setting and market-based governance mechanisms to achieve policy goals. These governance approaches will remain germane in the future, as the current plan to achieve a 20 per cent renewable energy mix by 2020 is to be reached through a new directive mandating national targets on renewable energy in the electricity, heating and cooling, and transport sectors.

In moving toward a more eco-efficient energy sector, the internal energy market can be seen as a strategic instrument, providing consumers with choices of different suppliers of energy and of making a major domestic market accessible for all suppliers. Other governance to encourage renewable energy use can include removing barriers, measures to promote renewable energies such as public procurement and support systems, cooperation with stakeholders in the renewable energy sector, encouraging optimal use of existing financial instruments, and ensuring continued exchange of best practice. In addition, investments in research and development projects in the field of low carbon-output fossil fuel technologies, such as CCS must be carried out. There may also be a need for considering the continued use of nuclear energy. Plans to reach the climate targets do not only concern the internal market and activities in the EU, but rather international agreements are important and must lead to concrete commitments. The EU aims to be a driving force in the development of international energy agreements, as described under external policy below, and a further promotion of an expansion of the ETS internationally is

131 CEC (2009b). *Communication: Towards a comprehensive climate change agreement in Copenhagen*. Brussels, European Commission.

132 Council of the European Union (2009). Contribution of the Council (Environment) to the Spring European Council (19 and 20 March 2009): Further development of the EU position on a comprehensive post-2012 climate agreement. . Brussels, European Commission.

needed so as to ensure an effective pricing mechanism for greenhouse gases internationally.

EU's energy efficiency policy

As discussed in Chapter 3, energy efficiency is gaining plenty of interest anew. Since 2002, the EU has introduced a series of initiatives to promote energy efficiency, targeting buildings, combined heat and energy generation, transport, end-use efficiency, and employing labelling and taxation techniques, among others. The 2002 Energy Performance of Buildings Directive includes a common methodology for calculating the energy performance of buildings, minimum standards for energy performance of new and renovated buildings, energy performance certificates and regular inspections of boilers, ventilation and air conditioning systems. In 2008, a more ambitious and innovative recast Directive was introduced for the Energy Performance of Buildings Directive, aimed at improving the energy efficiency of houses, the construction industry, and building better quality buildings. In 2005, the Eco-design Directive was introduced to increase energy savings from domestic appliances, followed by the Directive on energy end-use efficiency and energy services.[133] This Directive requires EU Member States to adopt energy saving targets of 9 per cent by 2015, mandates the public sector to adopt measures to improve energy efficiency, and promotes exchanges of good practices by engaging the business sector. Energy savings are to be achieved through financial instruments for energy savings, and purchasing energy efficient equipment, vehicles, and low-energy products. On the supply side, Member States must ensure that energy distributors engage in energy efficiency activities and that they advise customers of efficiency options.

Realising that these initiatives were insufficient to achieve concerns such as climate change and foreign energy dependency, the European Commission introduced a Green Paper on Energy Efficiency. This emphasised achieving energy savings through better enforcement of existing legislation. Furthermore, an Action Plan for Energy Efficiency was presented in 2006. The Plan describes areas where energy savings can be made, including the residential and commercial building sectors, the manufacturing sector and the transport sector along with a number of actions which could lead to these energy savings.[134] Efforts have also reached beyond the EU. The Strategic Energy Technology Plan (SET) aims to develop and deploy low-cost, low carbon technologies. This includes planning, implementing and coordinating resources and international cooperation in the area of energy technology.

Between now and 2020, the Action Plan for Energy Efficiency proposes sweeping change, including a harmonised tax regime to reduce CO_2 emissions from cars, urban transport improvement, and inclusion of aviation in the EU ETS. From a governance perspective, it embraces voluntary and information-based approaches to governance as well as market-based mechanisms, relying in part on the mobilisation of European citizens and market actors. An aspect of the Plan to be pursued in policy is engagement of the banking sector in promoting energy efficiency, by offering banking opportunities for businesses that provide energy efficiency solutions, and plans to remove national legal barriers to shared savings, third-party financing, energy performance contracting and recourse to businesses providing energy services.

EU's sustainable consumption/production policies

The transboundary nature of global production and consumption makes a country- or EU-level analysis of production and consumption policy challenging. Broadly, EU policy in this field is built on a eclectic foundation of interlinked policies including: the Integrated Product Policy (IPP); the thematic strategy on the sustainable use of natural resources; the thematic strategy on waste prevention and recycling; eco-management and audit scheme (EMAS); eco-label scheme; the environmental technologies action plan (ETAP); Green public procurement (GPP); eco-design of energy using products directive (EuP); and the European Compliance Assistance Programme.[135]

The foundations are synthesized in the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan proposed in 2008. The IPP emphasises a life cycle perspective of consumption and production, calling for all parts of a products' life

133 CEC (2006b). Directive 2006/32/EC of 5 April 2006 on energy end-use efficiency and energy services. Brussels, European Commission.

134 CEC (2006a). COM(2006)545 final. Action Plan for Energy Efficiency: Realising the Potential. Brussels, European Commission.

135 http://ec.europa.eu/environment/eussd/escp_en.htm

cycle to be taken into account when the products are designed, and creating incentives for consumers to buy eco-designed products. The external costs caused by the products' and production methods' impacts on the environment are to be internalised and reflected in the price of the product. This is suggested to be achieved for example by differential taxation or incentives. To this end, a number of EU Member States are already providing incentives for development and acquiring of energy and environmental performing products. However, the criteria that these products have to meet can differ substantially from one country to another. In order to overcome this fragmentation, the Action Plan SCP/SIP proposes to set a harmonised basis for incentives provided by the EU and its Member States. The Thematic Strategy on the prevention and recycling of waste addresses ways in which waste policies can efficiently reduce the negative environmental impacts of resources use, through preventing, recycling and recovering wastes. The European Compliance Assistance Programme provides a set of measures to help small and medium enterprise (SME) minimise the environmental impact of their activities. The programme will design instruments and policies to integrate environmental concerns into the core of SME activities.

The relatively new Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan lays out a framework for improving the energy and environmental performance of products and promote environmentally conscious consumer choices.[136] It recognises that the voluntary and regulatory instruments of earlier policies are insufficient to exploit potential synergies. The Action Plan suggests extending the ambition of various existing policies: the Directive on the Eco-design of Energy Using Products should cover all energy-related products; and the Energy Labelling Directive should be extended to cover a wider range of products.

The goals in this policy area are to maximise the business potential to transform environmental challenges into economic opportunities, to provide better deals for consumers, to foster resource efficient and eco-friendly products and to raise consumer awareness. To achieve this objective the 2008 Action Plan balances voluntary measures, soft regulation and incentive-based approaches, which appears necessary in a field so inherently complex in terms of issues and monitoring requirements. The fact that increased carbon efficiency in industrial sectors – such as chemicals and steel as examined in Chapter 3 – is counteracted by a steady increase in consumption causes a particular future policy challenge. This is compounded by the fact that an increasing proportion of the products purchased in the EU have been produced in other parts of the world, making it difficult to monitor – and therefore regulate – greenhouse gas emissions. Some of the emission reductions noted in European industries may be due to the fact that much industrial production has been moved elsewhere.

The underlying challenge is to decouple environmental degradation from economic growth. Improvement is needed for the overall environmental performance of products through their life cycle, and more eco-efficient products and production technologies are needed. Future policies will need to stimulate low carbon and resource-efficient technologies, products and services; stimulate the development of new, environmentally friendly products; stimulate cleaner production methods, promote more conscious purchasing decisions and not least help shape the international norms and standards to ensure a level playing field and more eco-efficient consumption and production world-wide.[137]

EU's innovation policies

The EU's innovation strategy provides priority actions for innovation governance at national and European levels.[138] It aims in particular to promote innovation-driven lead market initiatives, which facilitate the emergence and marketing of innovative products and services. These are areas where removing barriers would contribute to competitiveness and new market emergence. Of relevance to the eco-efficient economy agenda, eco-innovation, transport, and eco-construction are among the potential prospects for such lead markets (see also Chapter 2).

136 CEC (2008g). *Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan* Com 2008 (397). Brussels, European Commission.

137 Background document to the consultation on the action plans on sustainable consumption and production and sustainable industrial policy.

138 CEC (2006e). *Putting knowledge into practice: A broad-based innovation strategy for the EU* (COM(2006) 502. Brussels, European Commission.

On a separate agenda, the EU Competitiveness and Innovation Framework Programme (CIP), running from 2007-2013, promotes the competitiveness of European enterprises – particularly small and medium sized ones (SMEs). It further aims to promote innovation including eco-innovations, the development of the information society, and energy efficiency and the increased use of renewable energy sources in many sectors, including transport. The CIP is divided into three operational programmes: Entrepreneurship and Innovation Programme (EIP) aims to promote access to finance for start-up and growth of SMEs as well as to promote SME cooperation. The Information Communication Technologies Policy Support Programme (ICT PSP) aims to strengthen the internal market for ICT products and services, stimulating innovation through the adoption of and investment in ICT, developing an inclusive information society and more efficient and effective services in areas of public interest. And the Intelligent Energy Europe Programme (IEE) contributes to securing sustainable energy for Europe, while enhancing European competitiveness. Finally, the Environmental Technologies Action Plan (ETAP – see also sustainable consumption and production policies above)[139] was adopted in 2004 to boost the development of environmental technologies and to improve the competitiveness of the EU region in environmental technologies. Covering activities from promoting eco innovation to the use of environmental technologies, its objective is to improve European competitiveness.

As argued in Chapter 1 and 2, innovation governance is intimately connected to the eco-efficient economy, innovation being the all-embraced solution to the industrial competitiveness and environmental protection dilemma. It has traditionally relied on voluntary mechanisms, innovation being conceptually difficult to regulate. However, we now see how the issue of innovation perhaps more than any other highlights the importance of policy integration – in how it is necessary to understand how incentives and regulation in other policy areas are needed, which indirectly create market-based or other incentives to drive innovation. At the European level, ETAP might be seen as an example of policy integration in practice. Its implementation is facilitated by a High Level Working Group comprised of representatives from EU Member States and European Commission services. Open co-ordination with the Member States helps advance ETAP by exchanging ideas, developing indicators and setting guidelines and timetables. Stakeholder consultation is also built into the ETAP process.

EU's external policies: trade and "green diplomacy"

As seen above in the context of energy and climate policy, as well as the case studies on biofuels, chemicals and the steel industry, Europe's policy-making for an eco-efficient economy must extend beyond Europe. The developed countries have historically contributed most to the global greenhouse gas emissions – but as developing countries expand their economies, their emissions are increasing as well. By 2020, emissions from developing countries are expected to out-grow those of the developed world.140 In order to achieve emission reductions in these countries as well, creative and diplomatic approaches will be needed. In 2002, an initiative was launched to promote the integration of environmental issues into external relations. The result, the Green Diplomacy Network, comprises an informal network of environment experts within foreign ministries and focuses on environmental topics of relevance to the EU's external relations – such as climate change, renewable energy, and trade and environment, among others. The network is a potentially important consortium for the advancement of the European eco-efficient economy agenda.

Both adequate internal policies reflecting the external competitive challenge, and ensuring openness and fair rules in other markets are critical for European competitiveness.[141] Crucial to creating globally competitive companies in the EU was the creation of the internal market, and further steps have been taken to strengthen the EU's competitiveness by means of strengthening the EU market, including the launch of the euro currency. The EU supports strong multilateral trading systems, the WTO and its agreements, and has

139 CEC (2004a). COM(2004) 38 final. *Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European UnioUnion*. Brussels, European Commission.

140 CEC (2007d). *Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond* [COM(2007) 2 final]. Brussels, European Commission.

141 CEC (2006d). *Global Europe competing in the world. A Contribution to the EU's Growth and Jobs Strategy*. Brussels, European Commission.

also launched bilateral trade agreements with India, South Korea and the South East Asian countries among others. EU trade policy is also used currently to support an eco-efficient economy. For instance, developing countries that have ratified and implemented global environmental agreements can receive tariff rate cuts when exporting to the EU. The EU also supported an Environmental Goods and Services Agreement as part of the Doha WTO trade negotiations. Thus, the EU is not only proactive in finding climate change solutions internally, but is also active in the international arena. The EU heads of state and government have made a commitment to cut the EU greenhouse gas emissions to 30 per cent below 1990 levels by 2020, if other developed countries also commit to comparable reductions.

Countries that reach a certain level of development must make appropriate commitments. Recognizing a responsibility to support mitigation efforts of developing countries while also helping climate change adaptation, the Commission has proposed a Global Climate Change Alliance (GCCA) between the EU and the most vulnerable developing countries, in order to integrate climate change into poverty reduction strategies. The GCCA provides resources for adaptation and disaster risk reduction, works to minimise deforestation in these countries, and assists with participation in the global carbon market. Where the GCCA focuses on the most vulnerable developing countries, a wide range of bi- and multilateral EU cooperation initiatives also exist. These include projects with high-emitting countries such as India and China – respectively, the EU-India Clean Development and Climate Change Initiative, and the EU-China Partnership on Climate Change. Thus, although policy integration is normally not discussed in the field of international cooperation, the pursuit of the eco-efficient economy very much depends on it; a point to which we will return in the following chapters.

5 DISCUSSION AND LESSONS LEARNED

In the introduction to this report, we outlined four key themes that encapsulate the eco-efficient economy: synergy between economic growth and environmental protection; integration of policies, use of new policy instruments and governance arrangements, and new activities of invention, innovation and diffusion in the economy. The examples provided in Chapters 3 and 4 demonstrate that all these themes are more or less present across sectors, and that Europe in many ways is on track towards an eco-efficient economy. However, the journey has barely begun, and as the "low-hanging fruit" starts to run out, the continued pursuit is likely to entail many more challenges and the need for more active public intervention. What can be learned from recent sector and governance developments that may help set the agenda for governing towards a European eco-efficient economy?

First, **much has been achieved** across all sectors examined, and much is in the pipe-line right now. Catching the "low-hanging fruit" that is so central, i.e. where enhanced competitiveness through reduced costs or enhanced market positioning go directly hand in hand with better environmental performance, have in retrospect been quite successful despite many industries' fears of higher costs and competitiveness losses. At a general level, resource productivity and energy efficiency are improving, the transition from fossil to renewable energy supplies is on-going, and Europe is improving its innovation systems. Europe has made tough commitments for climate and energy and evidence of better policy coordination is emerging at the European level. Still there are untapped potentials across different sectors, and there is a clear role for enhanced European governance to help economic actors capturing these potentials, as well as strengthening common European visions such as the "202020" goals across Member States. Although the economic crisis undoubtedly shifts the focus to near term concerns in EU politics, public interventions for economic recovery also constitute an opportunity.

Second, **Europe can be attractive for investment**. In the global context, European governance signals institutional safety and stable markets. While some industries have raised concerns that excessive regulation or high labour or environmental costs may affect competitiveness and cause "leakage", there is evidence that these costs have tended to be exaggerated.[142] Economic research has also shown that long-term competitiveness is more about innovation capacity than input costs. Examples such as the automotive and the chemical industry support this argument. Indeed, business leaders today tend to agree that *"Competitiveness is not about labour cost – it is about availability and support in innovation; innovation capacity*".[143] Such capacity has to do with infrastructure, universities, and the supply of the right competence. Furthermore, regardless of factor costs, Europe will always be a very considerable domestic market with strong consumer power – a market which companies like to consider a domestic one, for logistical reasons but also to understand the demand of consumers. In addition, the overall European brand of a socially "tempered" market economy, a good environment and strong welfare system are increasingly attracting highly educated and skilled experts that provide the essential competitive advantage for knowledge-based growth. In this context, European governance for the eco-efficient economy can set the direction, provide the fuel, and supply the talent, and thus provide a potential lever to enhance innovation capacities and long-term competitiveness, making Europe even more attractive for dynamic industries.

Third, **Europe needs to enhance and adapt its innovation governance**. Innovation is crucial for the future of Europe and the competitiveness of the countries in the EU region, as well as for developing the new eco-efficient technologies. Europe has lagged behind in terms of innovation performance, compared to for instance US and Japan, but is today catching up. One issue concerns the conditions and potential for SME's to operate profitable, stable businesses and grow organically. To this end, alleviating administrative burden, enhancing labour market flexibility and improving access to capital are all issues that are already high on the EU policy makers' agenda. The other fundamental issue is the governance of

142 Stockholm Environment Institute (1999). *Costs and strategies presented by industry during the negotiations of environmental regulations*. Stockholm, SEI.

143 Gerard Ruizendaal, Chief Strategy Officer of Philips, speech at Conference on Industrial Competitiveness, DG Enterprise, Brussels, 17 March 2009

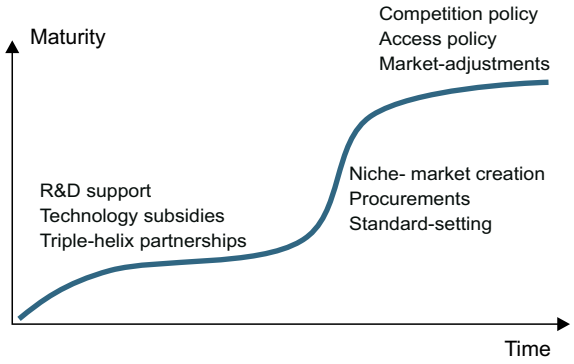

Figure 18: Adapting governance to systems"maturity"

(Source: adapted from Midttun and Gautesen, 2007)

innovation. That early-stage technologies may need to be subject to technology-specific support schemes although this to some extent is countering the liberal logic that underpins the European single market. In the first phases of innovation and product development, a dynamic innovation framework needs to put emphasis on experimentation and learning. Here, R&D investments, technology partnerships and technology-specific niche-market measures can have an important role to play. For example, in the case of renewable electricity promotion, fixing prices appears to be an important strategy for very early-stage technologies. In the more mature technology phase, governance based on broader market-efficiency appears appropriate. (See Figure 18) Here, certificate markets currently used to promote renewable energy play an important interim role. Under these schemes, different technologies will have to compete on equal market conditions, market transactions still account for external costs. It is also of importance to see the differences in international competition, the type of technology and the type of environmental problem in different sectors, in order to create incentive structures that fit the specific sector.

Fourth, **mature industrial sector are integral** to the eco-efficient economy agenda. This agenda have often been mixed up with the "green-tech" agenda and the quest to promote the emergence of new industries. However, the economic weight of mature industries such as chemicals, cars and iron & steel, and their responses to eco-efficiency challenges show that their innovation and adaptation to environmental issues and global competition are critical. In this context, the potential for efficiency enhancement needs to be fully captured, and further governance measures to facilitate this should be discussed. This industrial base is in constant change, but there is no doubt that these industries are needed in Europe: we cannot solve environmental and socio-economic challenges without their resources and value added. Furthermore, large incumbent EU industries are the main customers of hundreds of thousands of SMEs around Europe. Strengthening the SME sector and the growth of new firms, as already alluded to, is therefore closely linked to the capacities of the larger companies. The role of European governance should be to establish the best possible framework conditions and direction for this to occur along eco-efficient economy paths. Importantly, sectors dominated by mature technologies need different types of governance responses than new and emerging sectors (See Figure 18). However, not only maturity but also the level of globalisation in the specific sector has implications for how the sector is best governed. Tough policies such as ETS are warranted but needs to be coupled with adjacent measures to for instance assist basic materials industries to move up the value chain into more technologically advanced products.

Fifth, **governance "packages" are effective and politically viable**. No single support measure is universally "the best". Different cases highlight the power and potential of many different governance approaches. For instance, the district heating case shows the power of a tax and the need to advance this at national levels, in particular for non-ETS sectors. Several examples, including chemicals, cars, and energy efficiency, shows the important role of regulatory standard-setting as part of a broader package for driving industrial change (cf REACH and the Green Package). To induce investor confidence, the packages must be seen as stable and stay in place for a relatively long time period (at least a decade). Under these conditions, combinations of instruments may become much more than the sum of the individual parts. For instance, the combination of using voluntary action combined with (threats of) regulatory pressure has proven effective. In addition, such policy packages are well attuned to political processes of bargaining and deal-making. At the same time, excessive government intervention is also associated with problems. OECD has pointed out that due to the economic crisis we are now witnessing a return to massive government interventions across many sectors, and they caution that we know far too little about what will be the long term implications, and that

governments need credible exit strategies.[144] There are also inherent limitations to public policy interventions – many of the problems and opportunities in the examined sectors are determined by externally shaped market developments and consumer preferences.

Sixth, **the eco-efficient economy is a global agenda**, rather than a European one. The EU can play a true leadership role as best practitioner and standard setter being the largest integrated market worldwide. Still, industries, resources, and environmental impacts all diffuse across borders. Problems like carbon leakage or capital flight become real without global framework rules. And as Europe only represents a fraction of global pressures on resources and the climate, the scale of intervention towards the eco-efficient economy must ultimately be global. This adds an international dimension to policy integration (see Figure 19). Therefore, Europe's international policies, including environmental diplomacy, neighbourhood policies, coping with enlargement, and advancing the broader international policy agenda (including aid and trade policies) must interact more closely. The development of "packages" as discussed above should be further explored also at the international level. Importantly, the international agenda needs not be a defensive one: the chemicals case displays a more positive international aspect in the governance for an eco-efficient economy – regulatory overspill. It shows that the industry's competition fears due to strict regulation also have a flip side; that industries in other countries must oblige with regulation or that their country governments will eventually replicate policies – leading then to a potential competitive advantage for the "early movers" in the EU.

Seventh, **the eco-efficient economy requires systems thinking**. It is linked to global resource flows, and appropriate governance measures rely on balanced considerations on climate change and other critical sustainability aspects such as ecosystems management, land conservation and food production in relation to growth, jobs and welfare. In many cases, such as biofuels and sustainable cities, regulators and planners lack the necessary systems of knowledge to understand the direct and indirect effects of different courses

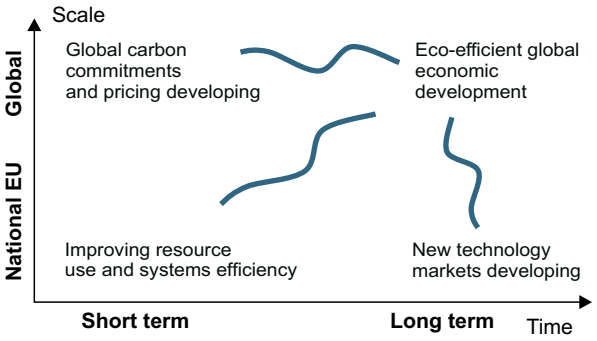

Figure 19: Time and scale in pursuing the eco-efficient economy

of action. Therefore, better systems for knowledge support, for instance through the frameworks of impact assessment (IA) and strategic environmental assessment (SEA) are needed to capture at least some of the complex chains of cause and effect around the world. Systems thinking entails being mindful of goal conflicts and dilemmas while capitalising on synergies and opportunities. Dilemmas are of course present in the "traditional" sectors such as iron & steel or chemicals, where there is a risk for carbon leakage, but they also emerge in supposedly more benign cases. Biofuels have large environmental and economic potential, but also encapsulates the central dilemma: to uphold the precautionary principle to protect natural environments versus allowing new and carbon-neutral technological innovation systems to prosper under safeguard policies.

Eighth, **the eco-efficient economy depends on policy integration**. As regards vertical integration, historical experiences show that many pieces of the eco-efficient economy governance may better be left to levels and actors below the European Union. Energy and automotive industries are two important sectors that have made significant progress through national governance. Recalling the range of governance instruments described earlier, the feasibility of these at the European level varies. For instance, when it comes to taxation or large investment projects, the European Union has limited competency today. Therefore, vertical coordination is of critical importance. It is necessary to engage and encourage Member States to more strongly articulate European perspectives on the eco-efficient economy. The EU needs to actively pursue a joint vision about what this means, in both its internal and external policies. As regards horizontal integration, the effectiveness of European governance depends on

144 Pier Carlo Padoan, Deputy Secretary General of OECD, speech at Brussels conference on industrial competitiveness on 17th March, 2009.

how well it is being tuned to the social, institutional and technological characteristics of the economic sectors in which they are being pursued, and this often means transgressing the conventional boundaries of policy making. The most glaring example in this study is the biofuels issue, which touches upon, for instance, agriculture, forestry, automotive, R&D, and energy policies as well as various aspects of international relations such as trade and climate negotiations.

6 AGENDA FOR A EUROPEAN ECO-EFFICIENT ECONOMY

Europe has in many ways been a leader globally for the eco-efficient economy in general and climate change mitigation in particular. Like no other jurisdiction, it has made hard commitments and binding resolutions on how to meet them. But now, when the new US administration and China (sometimes referred to as "G2") are beginning to set more of the agenda for global climate discussions, Europe must enhance its efforts to maintain a front-line position. To date, much of the European leadership has been developed "top-down" by way of political commitments and imposed targets. To stay at the front-line it must now also show leadership "bottom-up", by way of exploring and exploiting the industrial and economic potential for eco-efficient economic growth – in both manufacturing and services. Many of the sectors represented in this study constitute core elements of the eco-efficient economy, and show potentials for job creation, exports (if future global markets contain carbon prices), economic resilience (for instance to fluctuating resource prices) and innovation. Realising this potential requires active governance. How can EU policy makers step up their efforts to foster a European eco-efficient economy over the coming years? In this final chapter, we discuss a set of strategic areas and policy agendas that would contribute to such an effort. Among the multitude of measures that are needed across all activities in society, three overarching and strategic areas can be identified (See Figure 20).

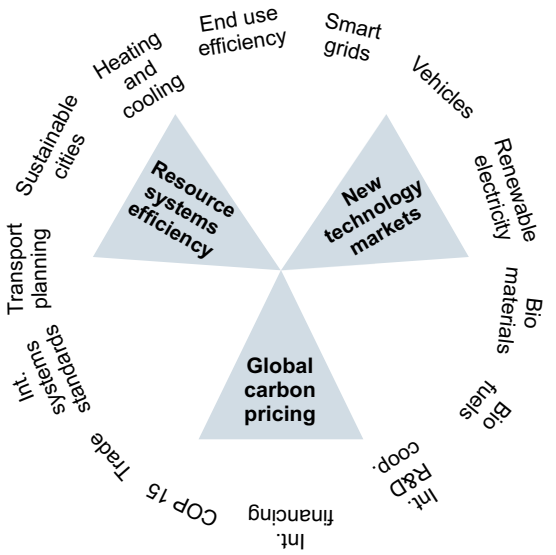

Figure 20: Three strategic areas and examples of priority action items

- *Resource systems efficiency* in various forms, which is particularly well suited in time of crisis due to its very direct double benefits, such as energy end-use efficiency, sustainable cities including infrastructure and building improvements and transport planning, as these have a direct appeal in times of constrained economies. Much of these improvements is available already today, and can be identified and implemented through more systems-oriented perspectives on policy and planning.

- *New technology markets*, with a focus on transportation and energy systems, as these sectors constitute the overriding contributors to climate change and resource degradation globally. Much of this concerns learning, diffusion and market growth of existing and pipeline technologies, such as carbon capture and sequestration, biomaterials, biofuels, electric vehicles, solar, wind and wave power.

- *Global carbon pricing* to shape demand in markets for investment and consumption globally, as this is arguably the single the strongest policy action to yield eco-efficient growth in the long term. Without a global carbon pricing in some form, competitiveness imbalances, carbon leakage and political difficulties with important constituencies will permeate the quest for the eco-efficient economy. Reaching this requires ancillary measures such as international standards, R&D cooperation, financial transfers, and trade relations.

It is technically possible[145] to pursue these strategies to achieve far-reaching greenhouse gas emission reductions, and recent research has also suggested that it makes economic sense.[146] However, such achievements

145 Recent calculations can be examined in: MacKay, D. (2009). *Sustainable energy - without the hot air*. Cambridge, UK, UIT.

146 Stern, N. (2006). *The Stern Review on the Economics of Climate Change.* Cambridge, Cambridge University Press.

are by no means automatic. To the contrary they require very profound policy actions and behavioural responses by firms and consumers. Neither the market nor governments will move towards an eco-efficient economy unless signalled to do so. For instance, energy efficiency and renewables currently attract only 12 per cent of public R&D spending in the energy sector globally.

Below we discuss six linked agenda items for the EU to initiate in political discussions at national, European and global levels, about how governance can be orchestrated to facilitate actions and responses to the eco-efficient economy. Based on our analysis of challenges and opportunities, they represent particularly important needs for improving current governance. We present them under three categories; adapting governance to innovation pathways; international cooperation and carbon pricing; and a systems approach for informed policy debates.

ADAPTING GOVERNANCE TO INNOVATION PATHWAYS

The appropriate governance responses at the European and national levels crucially depend on the technology being considered, its current environmental and economic performance, and what phase it is in. Technology-neutrality offers a guiding principle, whereby governments do not try to pick the winners, but set the correct framework conditions for the market to develop and market new technologies. This requires tackling relevant market failures due to for example positive and negative externalities such as environmental impacts or security of supply issues, lock-in effects and entry barriers. However, as has been shown, new technologies are needed to enable far-reaching emissions reductions while maintaining welfare and growth. In many cases of early-stage innovations, technology-specific support measures are needed.

1. **The EU needs to step up programmed interventions, alongside more generic policies, to induce development and diffusion of eco-efficient technologies**. Stimulating emerging technologies, such as hydrogen or electrified power trains, requires altogether different governance measures than supporting somewhat more mature technologies which may be already on the market, such as biofuels and hybrid vehicles (viable through adequate pricing of energy externalities such as carbon pricing). Crucially, it may not be a lack of R&D funding but rather support systems to move from invention to innovation – assisting in the journey through the "valley of death". Here, the EU has so far lagged behind main competitors such as the US and Japan. The importance of a strong domestic market to nurture the growth of new industries is well known, and the potential of Europe becoming a lead market for new technologies is partly unfulfilled today. Furthermore, the different governance responses need to be sequenced as technologies mature. One example to learn from is the approach in renewable electricity, supporting early-stage technologies through fixing prices and guaranteeing market access, and letting more mature technologies compete with each other under a quota system or other pricing mechanism.

2. **The EU needs to develop more hybrid and combined governance arrangements**. Considering the importance of the single market underpinning the European project overall, market enhancements and adjustments should remain at the core of European governance for an eco-efficient economy. Still, much more can be made of using governance approaches through novel combination of for instance regulatory standard-setting, taxes and voluntary programs. Private-public partnerships, voluntarism under regulatory threats and deploying regulatory standards have proven to be efficient and effective complements to market-based approaches. The automotive, renewable energy (Green Package) and the chemical (REACH) examples suggest that combined governance through "package solutions" can be highly effective, as well as politically viable, helping to induce eco-efficient development. Such packages should be further considered also on the international policy arena (see item 4 below). However, combinations of policies interact in complex ways and these interactions are typically not well understood, requiring careful systems analysis and policy evaluation (see item 5 below). Furthermore, it is necessary to carefully analyse the implications for SME's that struggle under administrative burdens, and avoid the common trap of designing governance with only large corporations in mind.

INTERNATIONAL COOPERATION AND CARBON PRICING

If Europe is to benefit from being a leader in the eco-efficient economy, the economic globalisation process needs clearer and more widely agreed rules, both for

socio-economic and environmental objectives such as climate change mitigation. The international agenda is critical to enable a European eco-efficient economy (not least considering Europe's modest share of global greenhouse gas emissions) but is often played down in eco-efficiency discussions. Furthermore, although globalisation is a real opportunity for Europe, opening for new markets and new product developments, it can also become a serious problem if rules and standards are significantly different in different parts of the world. The core issue is to develop an effective global price on greenhouse gas emissions, and to assist emerging and developing economies to participate in a pricing regime. Ultimately, firm and consumer behaviour is determined by cost, and a level playing field for greenhouse gas costing is needed. This requires integration of policies across traditionally separate fields such as development assistance, trade & investment, and international climate negotiations. Steps have already been taken in this direction but much remains to be done in removing institutional barriers for coordinated policymaking between for example government departments and between Commission services.

3. **The EU needs to push the development towards a global price on greenhouse gas emissions**. One approach is by way of an expansion of the Emissions Trading System (ETS) internationally, or by linking equivalent systems. Tested and conceptually proven in its pilot phase in Europe, ETS appears worthwhile to export as a governance approach. The EU must actively engage first with the US towards linking the carbon markets, in a first step working together on design elements to ensure compatibility of the two systems that would enable future linking and further movements towards an OECD-wide carbon market, and further on to a global accord. EU must assist developing countries in knowledge transfer and learning from experiences as well as creating institutions that have the capacity to govern such systems, including monitoring and reporting. Ultimately, however, the possibilities to develop a global pricing mechanism are contingent on ancillary measures of support, capacity building and incentives for emerging economies, which brings us to the next point.

4. **The EU needs to assist and induce emerging economies to make substantive commitments**. This involves findings ways to contributing to global greenhouse gas pricing which enables their economies and welfare to grow. To enable this, policy discussions must be broadened from global burden sharing negotiations to questions about technology transfer, financial assistance, opportunities for developing countries to access European markets with eco-efficient materials and technologies (e.g. solar energy technologies or biofuels), through to international political and economic relations more generally. The sectoral crediting mechanism recently proposed could play an important role in these discussions. A more vigorous pursuit of international technological cooperation involves R&D and innovation financing, both for technologies that are expensive and distant, but also for technologies and technical systems such as for instance efficient energy and transport solutions to be adapted to developing country needs and demands. Another category is the realization of technology standards and agreements to optimise and enhance the use of current technologies. Here, activities with neighbouring countries to enhance the compatibility between energy infrastructures are important. At the same time, EU policymakers need to consider sticks as well as carrots – preparing for different scenarios and determine its response for each. An unchartered way forward is to more strongly integrate policies and negotiations across traditionally separate sectors, such as trade, development cooperation and climate change, and develop "policy packages" at the international level much like the EU has done in the energy and chemicals sectors domestically. For instance, EU commitments to carbon pricing are not mirrored in the near future in the US and in emerging economic powers such as China and India, it cannot be ruled out that a further integration of climate and trade policy is needed, for instance through the application of price adjustments for globally-exposed industries that have high mitigation costs, such as iron & steel, chemicals, and paper & pulp. The principal argument is clear: the core reason for global market liberalisation is to create a level playing field for industries to compete on equal terms. If Europe imposes restrictions and costs on its domestic industries to mitigate climate change, this creates a distortion of the playing field. There is no doubt, from ecological, economic and political perspectives, that greenhouse gas emissions must be priced one way or the other – either at the time of production, distribution or consumption of goods and services. Policy packages reflecting this fundamental insight could be more explicit in Europe's policies towards multilateral negotiations.

A SYSTEMS APPROACH FOR INFORMED POLICY DEBATES

European and national policy makers do often not know quite enough about the sectors and industries they are intervening in, nor about the effects of different strategies and policies, in particular when they interact. This is nothing new, and the quest for more evidence-based policy making is nowadays widely agreed upon in European policy making. The Commission's own attempt at enhancing the evidence base in the regulatory process, the impact assessment (IA) procedure, has been operational for several years. Many national governments have followed suit and put in place similar systems. However, despite the strong commitment on paper to enhance the evidence base for policy-making, current assessment practices and the role they play in decision making is quite weak.[147] The complexity of advancing the eco-efficient economy requires a more active use of a stronger evidence base. Two principal agendas can be advanced.

5. **The EU should make high-quality policy assessments and other forms of evidence gathering routine**. These need to take a systemic approach to the eco-efficient economy, covering competitiveness, climate, employment, and resource use as objective functions along with the now-established regulatory burden assessments. These assessments must make use of advanced methods and tools to understand the systems implications of different policy alternatives, including both spill-over effects across sectors as well as interactions between policies. Methods and tools, including integrated assessment models, multi-criteria analysis, and advanced economic models, do exist and have been developed and tested in European Framework Programmes 5-7, but are currently not used much to inform decision making. Analyses, including model-based approaches, need to link micro- and macro-levels of the eco-efficient economy, from the level of specific technologies up to the societal level. Also, systemic studies of technological innovation systems are needed. Strategies should be designed on the basis of clear and detailed analysis of the innovation process for each system, to determine which developmental functions are in need of strengthening, what kind of governance is needed, and what roles different actors can play.

6. **The EU needs to develop institutional platforms where the evidence can be taken up, interpreted and learned from**. Although not a specific topic in this study, it is well know that knowledge and evidence to support policy making have tended to be ill-timed and often inconsequential, due to being "tagged on" to policy making rather than underpinning it. Institutional barriers to using systems-oriented knowledge in policy making must be alleviated. Assessments must be given enough time to deliver robust and relevant results, and they need to promote openness and actively facilitate participation of concerned stakeholders and independent expertise. These platforms, needed at both European and national levels, should promote learning between policy makers, experts and stakeholders about the systems implications of different governance alternatives but would also contribute to much broader aims, such as facilitating better policy coordination between sectoral departments, facilitating stakeholder interactions and encouraging civic debate. Systems such as committees that have been deployed in many Member States may be models to build upon.

147 Hertin, M., J. Turnpenny, et al. (2009). "Rationalising the policy mess? Ex ante policy assessment and the utilisation of knowledge in the policy process." *Environment and Planning* A 41(5): 1185-1200.

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