CLIMATE OPTIONS FOR THE LONG TERM

COOL Europe

Report of Workshop 3

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18-19 September, 2000

De Reehorst, Ede, the Netherlands

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COOL 01/E03

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Programme

18 September 2000

9.00-10.00 Registration and coffee.

10.00-10.15 Welcome and introduction (Dr. Arthur Mol, Wageningen University)

10.15-10.45 The strategic visions - a presentation of the end products of COOL Europe (Prof. Leen Hordijk, Wageningen University)

10.45-13.00 Sectoral path analysis (sector groups).

Energy group
Presentation of two pathways by Prof. Kornelis Blok, Ecofys. Discussion.
Presentations of input papers from participants: biomass potential in CEE, the new economy and solar power in southern Europe.

Backcasting exercises on:
- Infrastructure development
- Public awareness and participation
- Internalisation of external costs

Transport group
Presentation of the pathway by Dr. Graham Bennett, Syzygy. Discussion.
Presentation on ICT (A. Slob, TNO)

13.00-14.30 Lunch.

14.30- 19.00 Sectoral path analysis (sector groups).

Energy group
Presentations on input papers by participants : analytical framework for sustainable energy transitions, the electricity price in the EU, energy efficiency in CEE.
Backcasting exercises (continuation).

Transport group
Backcasting exercise on ICT

Presentation and discussion on
- Aviation
- Globalization and transport (Dr. Xander Olsthoorn, Institute for Environment Studies, Amsterdam)

20.00 Dinner and evening programme.

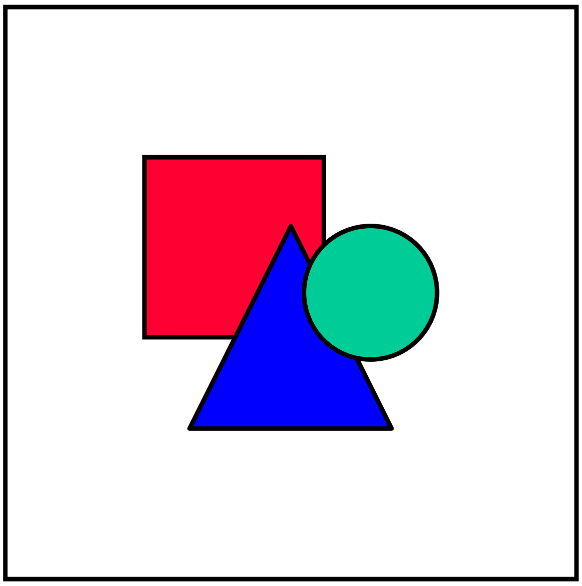
19 September 2000

09.00-09.30	EU leadership: between ambition and reality. Presentation by Dr. Joyeeta Gupta, Institute for Environmental Studies, Vrije Universiteit, Amsterdam.
09.30-09.45	The role of European institutions. Presentation by Dr. Graham Bennett, Syzygy.
09.45-10.45	Discussion on the role of EU and Europe.
10.45-11.00	Coffee break.
11.00-12.20	Work in sector groups.
12.20-13.30	Lunch.
13.30-15.30	Towards strategic visions (sector groups). Agree on priorities for the strategic vision: define addressees, outline, and key issues.
15.30-16.00	Plenary reporting by sector groups. Discussion led by Prof. Leen Hordijk, Wageningen University: What have we learned? What is still missing? Wrap up. Evaluation.

Summary

The third COOL Europe workshop was held in Ede, the Netherlands, and 18-19 September 2000. Policy-makers, scientists and representatives of the private sector and environmental organisations from eight European countries (Belgium, Denmark, France, Germany, the Netherlands, Poland, Sweden and UK) met to discuss climate options for the long term, with a particular focus on the European setting.

Discussions in sector groups: energy



The energy group first discussed two pathways, prepared by the Dutch consultancy firm Ecofys, towards 80 per cent reduction of the carbon dioxide emissions in Europe by 2050. Pathway A is based on a future image of 2050 which assumes that biomass can contribute with 35 per cent of the fuel mix. Pathway B is based on a future image of 2050 which is less dependent on biomass and in which hydrogen produced from large solar PV plants (i.e. solar hydrogen) plays an important role. Key issues for both of these pathways are:

- Costs and learning curves. Each doubling of cumulative production is assumed to lead to a certain percentage decrease in costs.
- Security of supply and required land
- Energy systems infrastructure
- Expansion rate of the production capacity
- The role of current stakeholders

Five backcasting exercises in sub-sector groups were organised covering the following topics: biomass, the establishment of infrastructure for a hydrogen economy, green electricity schemes, carbon pricing and the dynamics of the transition from the current situation to a situation in 2050 in which the 80 per cent reduction target has been realised.
A major conclusion emerging from the discussions in the energy group was that 80 per cent emission reduction is feasible from a macro-economic perspective.

Discussions in sector groups: transport

The transport-group discussed a pathway, which was structured around four key means of reducing CO_2 emissions from the transport sector:
1. Improved efficiency
2. Fuel substitution
3. Changes in structures and patterns
4. Changes in awareness, values and lifestyles.

The Path Analysis brought together all these elements in a structure, which presented an indicative path for each of the four means of reducing CO_2 emissions. A time path for implementing each of the relevant facilitating measures was shown and the relevant issues were listed under obstacles, opportunities, pre- and boundary conditions and uncertainties.

Two backcasting exercises were done. One on the use of ICT in transport of goods, and one on the role of ICT in passenger transport. As most challenging problems were mentioned: the realisation of most effective economic instruments to give transport a price; perception of individual freedom; rebound effects. Some policy-strategies were identified: R&D on rebound effects, "getting the prices right", spatial planning, development of common standards to integrate personal and public transport. Furthermore regional development and European integration were mentioned as important pre-conditions

In the final session of the transport group, the group already reflected on one of the final products of the COOL-process: a strategic vision for the transport sector. The question was raised how such a vision, being a product of discussions and exchange of ideas in a certain group of a limited amount of people, and not meant as a complete overview or plan, still could have a maximal outreach. Some suggestions were: 1) Tailor the outcome to specific stakeholders: it has to be relevant to companies (opportunities for business, the problems which need to be solves to realise the challenges, etc.); 2) Appeal to the contribution of the transport-sector to the climate problem; 3) Show good examples from different countries.

The added value of the strategic vision would be that it shows what you need in the short term to realise the long-term goals. Long term ideas can remove barriers for action.

Introduction

At September 18-19 2000, the third Climate OptiOns for the Long term (COOL) Europe Workshop took place at Hotel de Reehorst in Ede. In this workshop, European stakeholders, policy-makers, and scientists of the energy and transport sectors gathered to proceed with their discussions on long-term (2050) options for substantial CO_2 reduction. The workshop, the third in a series of four, was organised within the framework of the Dutch COOL project, financed by the Dutch National Programme on Global Air Pollution and Climate Change. This project runs for 2.5 years (1998-2001) and involves discussions between policy-makers, scientists and stakeholders on the national (Dutch), European and global levels. The European part of the COOL project is organised by Wageningen University in the Netherlands.

The four workshops focus on the connection between strategies for Climate Change Policy in Europe with long term sector strategies (Transport & Energy/Industry). The COOL project is not about predicting the future or planning the future. It is about learning about obstacles and conditions for a sustainable future; to deepen the understanding about what is required to achieve far-reaching emission reductions; to explore the long-term consequences of short term actions. Most important of all, the participants, coming from different backgrounds and countries, learn from each other: exchange views on the future. What are the expectations of colleagues in different countries; what are the different views on desirable actions, are there possibilities for collaboration?

In order to accomplish this, the four workshops are organised in four steps: (1) the exploration of images of the future; (2) implementation trajectories connecting these images to the present; (3) formulation of short-term actions needed to reach long-term goals; and (4) elaboration of strategic visions integrating all these steps.

The third COOL Europe workshop focused on the exploration of certain options as well as on key issues and boundary conditions. The participants gathered in plenary sessions and worked in smaller sector groups and sub-groups.

This report summarises the outcomes of this third workshop and has the following structure: Part I describes the presentation and the discussion in the plenary sessions; Part II contains the minutes from the two sector groups, energy (Section 2.1) and transport (Section 2.2). In the annexes the input material for the workshop can be found.

PART I: Plenary Sessions

1.1 Introductory Plenary (Day 1)

Leen Hordijk, overall project leader of the COOL project introduced the COOL project and the scope of the final products of the project. Putting the project in the context of the coming meeting of the UN FCCC 6th Conference of the Parties in the Hague he stressed that COOL is special because of its focus on the long term and substantial emission reductions. The project focuses on strategies and learning. Not only technology plays a role, also behaviour, attitudes, politics and institutions are important.

The final products of COOL will have the shape of a "Strategic Vision", which are not meant as a blue print but meant to stimulate thinking:

- Being a short readable paper, 20 pages max
- for a lay-public
- high-lighting most promising options on the long term
- including boundary conditions (obstacles)
- including short term actions
- identifying possible coalitions
- being useful for the energy and transport sectors in Europe

The discussion that followed, focused on the acceptability and the feasibility of aiming for 80 per cent reduction. A long-term perspective makes a big target more acceptable. The acceptability will depend on the (short-term) measures, which are derived from the 80 per cent reduction target. The COOL project should make clear what kind of opportunities exist. The pathway from the future to the present should be both credible on the longer term and feasible and acceptable on the short term. Including insights in macro-economic effects would be useful. Expenditures could turn out to be only a very small fraction of GDP on the long term.

1.2 Plenary on EU dimensions (Day 2)

The plenary session on day two focused on the role of Europe in the Global climate regime and the issue of institutional change in Europe in connection with Climate Control Measures.
Two presentations by Dr. Joyeeta Gupta, Institute for Environmental Studies, Vrije Universiteit, Amsterdam and Graham Bennett, Syzygy, Nijmegen, the Netherlands were followed by a discussion.

1.2.1 EU leadership: between ambition and reality. Presentation by Dr. Joyeeta Gupta, Institute for Environmental Studies, Vrije Universiteit, Amsterdam.

Summary[1] of Joyeeta Gupta's presentation

Joyeeta Gupta gave a presentation about European leadership in the climate regime. She gave the following recommendations for the EU. For the short term: build a coalition with Russia, Japan, the key developing countries and like-minded groups and actors within the US to create the conditions for early ratification of the Kyoto Protocol. For the medium term: improve the credibility of the EU's own climate policy by way of sectoral integration. For the long term: elaborate a vision about how the climate policy regime should develop and how to use economic and material incentives to foster global industrial transformation and promote

[1] The full text of the paper on which this presentation is based, can be found in annex VII.

sustainable development. Joyeeta Gupta claimed that so far a bunker-room mentality has characterized EU climate policy: the EU has been so busy hammering out its internal position that it has had too little time to develop the dialogue with the other key negotiation blocs, JUSSCANNZ and G-77/China.

How can the EU show leadership on the climate change issue?

Joyeeta Gupta distinguished three types of leadership:

- Structural leadership: using economic and political power.
- Instrumental leadership: using diplomatic skills to build coalitions
- Directional leadership: developing ideas and having credible domestic implementation (a demonstrative effect)

Potential for structural leadership

The European Union have several resources that make it capable of exerting structural leadership in the international climate negotiations:
- It has 15 Member States with 370 million inhabitants and a GDP at a level of 5,690 bn Euro.
- The 15 Member States together with the European Commission constitute 16 diplomatic channels.
- The EU has many related co-operation programmes with non-EU countries.

Potential for directional leadership

The possibilities for the EU to exert directional leadership include the following channels:
- A common carbon tax (?)
- SAVE
- ALTENER (a big budget for ALTENER was adopted in 1998)
- The monitoring mechanism
- More than 300 voluntary agreements
- Internal burden-sharing agreement
- The combined emissions of the Member States are now close to the 1990 level.

In addition, the dialogue between the national and supranational level in the EU is better than in Japan and the USA.

The optimist would emphasise that the EU is improving and that there is an ongoing learning process. The pessimist would say that the EU's internal and structural problems are deepening.

Potential for instrumental leadership

In the UNFCCC process, the EU has been pushing for targets and time-tables, policies and measures (if targets and time-tables would fail) and supplementarity and additionality.

The EU’s influence so far has been far-reaching but not uncontroversial. The EU has opposed large emission allowances for Russia and Ukraine. But the EU is not sufficiently involved in a dialogue with other countries. In the international negotiations the EU has had a bunker-room mentality. It is also lacking fall-back strategies.

The EU raised the moral standard against which others were judged.

Potential for future structural leadership

- For the short term: interaction with G77.
- For the medium term: co-ordination strategies in other issue areas/other regimes.
- For the long term: use economic and material incentives to foster global industrial transformation and sustainable development.

A World Environmental Organisation, recently proposed by France, is not feasible because it would reduce the transparency of different environmental regimes.

Potential for future directional leadership

- For the short term: strengthen implementation of existing policies.
- For the medium term: enhance credibility and strengthen sectoral integration.
- For the long term: promote industrial transformation.

Potential for future instrumental leadership

- For the short term: build a coalition with Japan, Russia and G77 to ratify the Kyoto Protocol as soon as possible.
- For the medium term: adopt a target for the second commitment period.
- Long term: build coalitions with developing countries.

Conclusion and recommendations

- For the long term: elaborate a vision for (1) how the climate regime should develop and (2) a programme for global industrial transformation .
- For the medium term: improve the credibility of EU climate policy.
- For the short term: build a coalition for a quick ratification of the Kyoto Protocol.

1.2.2 The role of (EU) institutions. Presentation by Dr. Graham Bennett, Syzygy.

Summary[2] of Graham Bennett's presentation

Graham Bennett started with pointing at the special challenges of European climate policy and enfeebling some "myths" about Europe and its institutions. He proceeded with showing that there are several driving forces that may result in institutional changes in the EU. These changes are of great importance for the EU's ability to control its carbon dioxide emissions in line with the long-term reduction target for the COOL project. Graham Bennett argued that globalisation leads to a greater need for harmonising policies. It will also lead to a growing demand for environmental restrictions on free trade and a greater willingness by business to take environmental protection initiatives as a means to strengthen consumer trust. Another driving force for institutional change is EU enlargement. It is likely that after the enlargement the EU will have to attach increasing focus to general framework policies at the strategic level. According to Graham Bennett, new institutional mechanisms for long-term policy-making could emerge as a result of this.

Key driving forces

1. Globalisation

[2] The full text of the paper on which this presentation is based, can be found in annex VIII.

- Increasing power of economic interests and declining power of policy institutions
- Business is increasingly aware of its responsibility to consumers

Lead to:

- Greater need for harmonisation of policies and laws of the main trading blocs
- Greater need to agree upon rules for environmental restrictions on free trade
- Greater potential for business initiatives on environmental protection

2. EU Enlargement
- Greater diversity: cultural, political, socio-economic, institutional, environmental
- Larger number of EU actors further complicates decision-making
- Greater implementation challenges

Lead to:

- Increasing focus on strategic and framework policies and institutional mechanisms for long-term policy-making
- Greater need for differentiated policies and instruments, "flexible co-operation"
- Continuing EU institutional reforms = opportunity

3. Science
- Improved models will clarify relation between emissions and climate change
- Demonstrable examples of climate change impacts?

Lead to:

- Greater awareness by public and business of climate change
- Institutional change to be able to develop more effective policies
- Greater readiness by business to take action

4. The Public
- Further liberalisation / individualisation
- Stronger civil society
- Increasing awareness impacts of climate change
- Increasing consumer power

Lead to:

- Greater direct pressure on government, social institutions and business and institutional change.

Implications for institutional change in Europe

1. Internal Relations
- Greater emphasis on framework policies
- Improved frameworks for long-term policy-making
- Greater differentiation of policy measures and instruments
- More effective, more democratic, more responsive EU institutions
- Science, public opinion and vulnerable regions will push climate policies and promote institutional change
- Increasing role and initiatives by business
- Greater use of societal mechanisms

2. External Relations

- Greater harmonisation of policy strategies and frameworks with major trading blocs and new institutional mechanisms
- Establishment of a global regime on environmental restrictions on free trade
- New international enforcement regime

1.2.3. Discussion

In the discussion that followed, several issues and questions were raised.

One question related to the possibilities to establish a level-playing field. Joyeeta Gupta said that the Clean Development Mechanisms is likely to provide baseline standards for projects. These standards may be seen as some sort of global standards. They could prevent dumping from taking place and minimise the room for manoeuvre for industries with a very low environmental performance record.

One participant argued that the UK government has been a major opponent to the establishment of a level-playing field in Europe. One example is its opposition to the EU carbon dioxide tax. Furthermore, the UK is the only country that has questioned the need for a monitoring mechanism in the EU.

Another question related to the future EU member countries' impact on the EU bubble for a burden-sharing of the emission reductions. Joyeeta Gupta said that if a country like Poland would join the EU it would not become a part of the bubble. Instead Poland's commitment under the Kyoto Protocol would be placed on top of the existing bubble.

One participant pointed out that in both Joyeeta Gupta's and Graham Bennett's presentations it was tacitly assumed that the EU will continue to exist for a very long time. However, the enlargement could cause a melt down of institutions. The question is: what happens if the EU ceases to exist?

The candidate countries in Central and Eastern Europe would benefit from better opportunities and clearer rules to learn from the EU experience. Joyeeta Gupta agreed to this and said that developing countries have a similar problem. She emphasised the need to enter into a deeper and more structured dialogue with these countries. Individual EU Member States should build upon and extend their historical links with countries in the developing world to improve the opportunities for climate policy co-operation. For example, in Africa France can play an important role in French speaking countries in Africa and the UK has the same potential in the English speaking countries of the African continent. Co-ordination and co-operation between UK and French aid agencies is desirable.

Joyeeta Gupta claimed that the EU Working Party for Climate Change, which is the key body for EU climate policy, has devoted zero per cent of its time to strategic issues.

Part II: Sector Group sessions

2.1 Report from the energy group

Participants
Magnus Andersson Wageningen University, the Netherlands(notes)
Kornelis Blok, Ecofys, the Netherlands
Jean-Paul Boch, Total Fina Elf, France
Jorgen Henningsen, Belgium
Ewaryst Hille, Poland
Leo Jansen, DTO, the Netherlands
Tomas Kåberger, Chalmers University of Technology, Sweden (Chair)
Marleen van de Kerkhof, IVM, Free University of Amsterdam (notes)
Tom Kram, ECN, the Netherlands
Simon Minett, COGEN Europe, Belgium
Arthur Mol, Wageningen University, the Netherlands
Ruth Thomas, Shell Foundation, UK

Day 1, 18 September

2.1.1 Presentation of two pathways by Kornelis Blok, Ecofys, the Netherlands[3]

<u>Pathway A based on a biomass-intensive image</u>
Pathway A is based on a future image of 2050 which assumes that biomass can contribute with 34 per cent of the fuel mix.

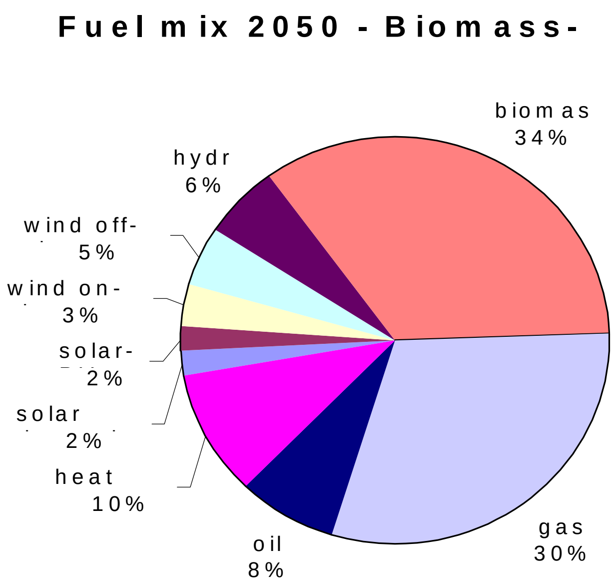


Figure 1. Fuel mix in 2050 in the biomass intensive image. For comparison, the fuel mix in 1990 consisted of 23% coal, 41% oil, 17% gas, 14% nuclear power,

[3] The full text of the path analysis for the energy group can be found in Annex IV.

To reach the biomass intensive image, the growth rates for all sources except hydropower need to be high. For biomass and natural gas the electricity production needs to grow with almost 4 per cent each year, for 60 years in a row. Solar thermal and wind energy have to experience an annual growth rate of 8-10 per cent, while PV (solar electricity) even has to grow with 17 per cent per year over this 60 year period.

If production capacity grows at the same rate (in terms of number of doublings) for all sources PV electricity will remain the most expensive all the way through 2050. The market share of PV can therefore not be enlarged on the basis of production costs. However, the image assumes PV electricity production to grow by 17 per cent per year, on average, while other sources ‘only’ experience 1-9 per cent per year in production. From this it is obvious that PV can only play the role foreseen in the energy image if PV is forced into the market (e.g. through regulation or heavy subsidies) or in case major breakthroughs in costs are achieved (i.e. even larger than already required to follow the learning curve).

Currently costs of renewable energy production are usually higher than that of conventional sources. The cost of wind and biomass electricity may become competitive on the relatively short term, perhaps even within 2-3 doublings of production capacity. This means that an increase in consumer preferences for green energy and energy tax exemptions for renewable energy may go a long way in reaching the required capacity increase and price reduction. For PV, however, cost differences are so large that much stronger incentives will be needed if it is to play the role foreseen in the image.

Biofuels are currently not competitive, when production costs are compared to those of gasoline. However, taxes can increase the gasoline price paid by the consumer by a factor of 2-3 in a number of Member States. Exempting biofuels (partly) from those taxes would make them competitive on a relatively short term (not taking into account the infrastructure side of the problem).

Besides biomass wastes, energy crops are expected to require 17 per cent of total land area in Europe (for comparison: cropland currently covers 140 Mha, or 30 per cent of total crop land, with forests and woodlands covering another 33 per cent). About 80 per cent of the land demand for energy crops can be met using excess croplands, starting with currently set-aside land. This would require an adjustment of agricultural policies. Currently, EU agricultural policy provides a subsidy to farmers that set aside land in order to decrease over-capacity in food production. Farmers loose this subsidy if the set-aside land is used for energy crops. This, in combination with currently low potential prices for the energy crops, forms a barrier for farmers to (partly) switch from food crops to energy crops. The remainder of the required land (almost 20 per cent of 17 per cent, i.e. 3 per cent of total land area in Europe) needs to be found elsewhere, e.g. through energy plantation forests. This may lead to competition for land, e.g. with more extensive (‘biological’) farming, recreation, etc. A solution might be the combination of different activities, e.g. energy plantation forests and recreation, in the same area.

On the other hand, biomass-fuelled plants will have difficulties starting up if the supply of fuels is not sufficiently large and stable. Insecurity in the supply of biomass will lead to lower plant utilisation or higher fuel prices. Closing a deal with surrounding farmers for guaranteed supply/demand of biomass at fixed prices may benefit both parties involved.

Current stakeholders that might be threatened by the developments foreseen in the energy image and the path leading up to it are large-scale electricity producers, electricity distributors, and oil companies. Other stakeholders that need to play an important role are farmers, car manufacturers, architects and building contractors.

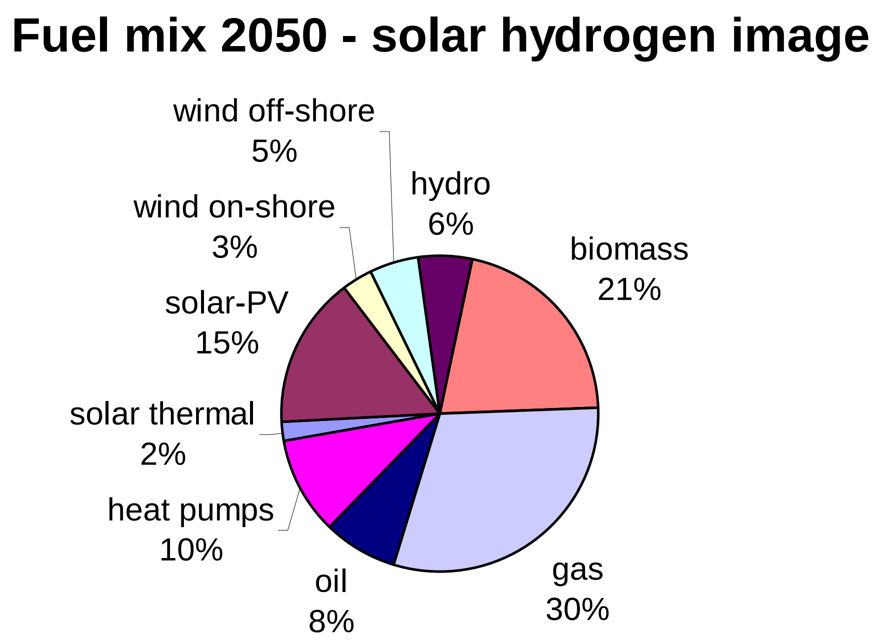


Figure 2. The solar hydrogen image

The participants of the second workshop feared that the biomass-intensive image could pose too high demands on the available space in Europe because of the high biomass demand for energy purposes. Large-scale PV plants were suggested as a less land-intensive route for energy production. Therefore, a second, alternative image and path has been developed, which is less biomass-intensive. We have assumed that the amount of land area used for energy crops in this alternative image is limited to 75 per cent of the excess farmland (about 50 Mha, compared to 80 Mha in the biomass-intensive image). This leaves room for other land uses, such as recreation, extensive farming, etc. Since the majority of the biomass in image 1 was used to produce transport fuel, the PV-generated electricity in image 2 will be used to produce hydrogen, which can also be used as a transport fuel. The image is therefore referred to as the solar hydrogen image.

Pathway B based on the solar hydrogen image

To reach the desired image, the growth rates for all sources except hydropower need to be high. For biomass and natural gas the electricity production needs to grow with almost 3-4 per cent each year, for 60 years in a row. Solar thermal and wind energy have to experience an annual growth rate of 8-10 per cent, while PV (solar electricity) even has to grow with almost 22 per cent per year over this 60-year period. It must be clear that with such high growth rates the rate with which production capacity for e.g. PV modules can be constructed can be a limiting factor. A high absolute growth occurs in wind and, especially, gas-based electricity production, but by far the largest relative growth occurs in solar electricity.

If production capacity grows at the same rate (in terms of number of doublings) for all sources PV electricity will remain the most expensive all the way through 2050. The market share of PV can therefore not be enlarged on the basis of production costs. However, the energy image assumes PV electricity production to grow by 22 per cent per year, on average, while other sources ‘only’ experience 1-10 per cent per year in production. From this it is obvious that PV can only play the role foreseen in the energy image if PV is forced into the market (e.g. through regulation or heavy subsidies) or in case major breakthroughs in costs are achieved.

The amount of land required in the solar hydrogen image is smaller than in the biomass-intensive image. Since the land demand is limited to 75 per cent of expected excess croplands, there will also be room left for other activities with a demand for land. Land demand is therefore not expected to be a problem in the solar hydrogen image. Biomass will, however, still contribute a substantial part to the energy supply in 2050. Therefore, the intermediate steps will still be needed.

The introduction of PV has to be much larger in the solar hydrogen image than in the biomass-intensive image. Therefore, technological breakthroughs, substantial cost reductions and strong policy actions have to be attained to an even larger extent than in the biomass-intensive image.

Security of supply is a bigger issue in the solar hydrogen image, since the contribution of intermittent sources is larger than in the biomass-intensive image. However, large part of the PV capacity will be used for fuel production, which is, in a way, a storage system. A sufficiently large amount of fuel would need to be kept in storage to be able to act as a buffer for transport purposes alone (to make sure fuel demand can be met at times with less sunshine). To flatten out fluctuations in electricity supply (e.g. from wind), additional storage capacity and quickly adjustable capacity (coming on/off lone quickly) will still be needed.

Key issues for both of the above-mentioned pathways are:

- Costs and learning curves. Each doubling of cumulative production is assumed to lead to a certain percentage decrease in costs. (But: the learning curve is not a law of nature so there may be surprises.) It is a robust prediction to say that the pathways based on solar hydrogen will be more expensive than the pathway based on biomass. The costs for infrastructure are not included in the pathways. The infrastructure may double the costs. Kornelis Blok assumes that the costs for solar PV will be halved every ten years. It is not clear in the scientific literature whether it is most effective to develop the solar PV option via research and development or via market introduction. In 2050 there are no big differences in the costs for the options mentioned in the two pathways.
- Security of supply and required land.
- Energy systems infrastructure.
- Expansion rate of the production capacity. Solar PV will have the by far highest growth rates.
- The role of current and future stakeholders.

<u>Discussion after Kornelis Blok's presentation</u>

Solar PV

Kornelis Blok was asked about the pathways' assumptions about global solar PV developments. His answer was that the assumption was that the rest of the world will behave in the same way as Europe.

What part of the solar PV equipment does the learning curves apply to? The answer is that they apply to the panels.

The learning curve on solar PV as shown in the paper was considered by one participant to be unrealistic. The graph could be too vulnerable to criticism to be published in the final document.

One participant pointed out that if one follows the logic of the pathway for solar PV, it appears that the most important carbon dioxide reductions will be achieved in the last 4-5 years. It would be wrong if COOL Europe would convey such a message.

Kornelis Blok referred to the second assessment report of the IPCC according to which the price for carbon amounts to 5-125 USD per ton. This is only a few cent per kilowatt hour. Hence, a carbon tax may help wind power and biomass options but it will *not* help solar PV. Other approaches will be needed, especially in the beginning.

Natural gas
Regarding the capacity of the natural gas network (both pathways assume a sharp increase for natural gas), Kornelis Blok said that a stronger natural gas network will be needed in Europe.

Costs
Kornelis Blok drew the conclusion that in absolute terms, the costs will stay the same. The relative costs (that is, costs in relation to GDP) will be reduced substantially provided that economic growth continues in the same rate. If this will be the case the costs for the energy system will go down from 6-7 per cent of GDP today to 2-3 per cent of GDP in 2050. In the long term, the costs will not be the problem. Kornelis Blok pointed out that the transition costs for the next two or three decades are more important.

Decentralisation and efficiency issues
With respect to the topic of heat infrastructure, a participant argued that it is more likely that decentralised rather than large-scale heat systems will be the future. There is already a trend towards decentralisation. In a liberalised market, a centralised system is quite unlikely. The same participant also had the opinion that the grid losses in a centralised system are quite big at the domestic level (7 per cent). Kornelis Blok doubted whether the losses are smaller in a decentralised system. One of the participant replied that it all depends on how the term efficiency is defined.

Addressing the topic of *heat infrastructure*, Kornelis Blok presented three fuels for the biomass intensive image: methanol, Fischer-Trops Liquids and hydrogen. One participant asked why he did not take into account the fuels that are produced from biomass today. According to Kornelis Blok, these existing technologies are useful in the transition period. On the longer term, considering the demand for land, a shift is likely to happen to the three mentioned bio fuels. The participants had their doubts about the fuels mentioned. A justification (with numbers) is needed here. Kornelis Blok emphasised that a distribution system for hydrogen can be decentralised.

One participant argued that from both environmental and economic viewpoints it is better to produce methanol from natural gas than from biomass. Kornelis Blok agreed with this comment and added that it is most efficient to use biomass for production of electricity.

On the topic of *electricity infrastructure*, Kornelis Blok addressed issues such as the location of supply and demand, the fluctuation of supply, the possibility to use hydropower for storage, and a high-voltage DC transmission network throughout Europe.

Kornelis Blok argued that the preference for a decentralised system implies that the optimum efficiency cannot be achieved.

2.1.2 Presentation by Ewaryst Hille: analytical framework for sustainable energy transitions[4]

[4] The full text of this paper can be found in Annex X

In designing strategies for sustainable energy transitions it is important to pay due attention not only to the energy system itself but also to social aspects. For example, in Poland the high unemployment rate is a barrier for a reconstruction of the energy economy.

A key issue for the short term is to design a strategy to deal with stranded assets (a special problem in Poland is the hard coal mines) and to avoid the creation of stranded assets in the future.

Ewaryst Hille argued that the interest for solar PV is quite low in Poland. The capacity to take up new technologies is much higher in the Netherlands than in Poland.

2.1.3 Backcasting session 1: biomass and hydrogen infrastructure

The group split up in two subgroups to do two backcasting exercises. The first subgroup backcasted a large increase in biomass use, with reference to the biomass intensive image. Subgroup 1 consisted of: Jorgen Henningsen, Ruth Thomas, Tom Kram, Simon Minett, Ewaryst Hille, Tomas Kaberger (chair) and Marleen van de Kerkhof (notes). The second subgroup backcasted the establishment of an infrastructure for the hydrogen option, with reference to the solar hydrogen image. Subgroup 2 consisted of: Magnus Andersson (notes), Arthur Mol, Kornelis Blok and Jean-Paul Boch.

Backcasting exercise on the biomass option

In the biomass-intensive image it is assumed that the energy from biomass is 12.0 EJ in 2050 compared to 1.6 EJ in 1990. In the solar hydrogen image it is 1.6 EJ in 1990 and 6.5 EJ in 2050. Hence, in both images the growth factor is quite big.

The group decided that the biomass from land use also includes waste disposals and liquids. One can also refer to this as bio energy.

Identification of obstacles in implementing the biomass option

The group fully agreed that the availability of land will be the most crucial obstacle. Already at workshop 2 one of the core issues had been the different demands for land (recreation, living, biomass etc.). The demand for land to reach the growth rate for biomass, as assumed in the biomass-intensive image, is enormous and, according to the group, beyond what is reasonable. Another problem is that it will mainly be the marginal lands that become available for the growth of biomass. These lands will never have a high crop density and due to this the demand for land will increase even more.

It was concluded that solar PV will be a good option in areas where biomass will not grow so fast.

Another obstacle for biomass is public perception. Hectares of energy plantations, perhaps monocultures, may not get broad public acceptance.

The group mentioned the location of the energy demand as a problem. The demand of energy will cause transportation and gasification of biomass/bio-energy.

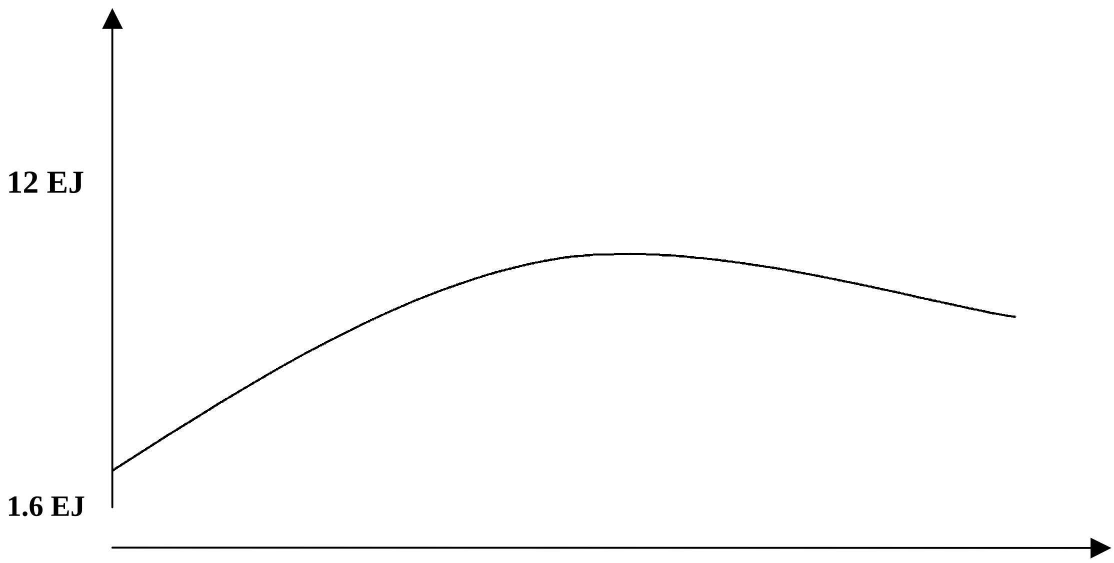
Another constraint is the needed legislation around waste and public perception. There should be acceptance of waste incineration.

The group expected that the use of biomass as a energy source will increase in the first ten to twenty years. After that, the group expected a decrease because of the entry of other competitive options.

The most challenging problem(s)
According to the group the availability of land and the lack of policy co-ordination are the most challenging problems. It is necessary that co-ordination is achieved with EU waste policies and with the Common Agricultural Policy (CAP). Co-ordination with CAP is needed, *inter alia,* to set-aside land for energy crops.

Solution strategies
The group identified the following solutions: (1) A higher crop density per hectare; (2) development of other, competitive, technologies (e.g. PV); and (3) new technologies to solve current problems (such as the waste problem).

The time line



2000	**2030**
2050	
Key issues:	Key issue:
- Co-ordination with CAP	Competition for land. Resolved by
- Co-ordination with EU waste policy	improved agricultural productivity and/or
	other more efficient sources of energy

It was concluded that 12 EJ will not be reached. This goal will require 80 mln hectares and this is, according to the group, not possible.

The graph shows that in the first thirty years, the amount of energy generated from biomass will increase (up to 2030). After that, it will decrease somewhat because of a bigger competition for land, the entry of new energy sources and improved productivity.

Backcasting exercise on infrastructure for hydrogen

Identification of obstacles for the hydrogen option
Several obstacles for the hydrogen option were identified. First of all, the group argued that it is extremely important to show that hydrogen is a safe option. In the public perception, the Hindenburg accident in the 1930s is still linked to the hydrogen option. Another accident could have a disastrous effect.

The hydrogen option may not yet have sufficient public acceptance. People may be sensitive to new large-scale infrastructure projects. Because of this the NIMBY syndrome may appear.

Profound political belief in the option is missing.

The establishment of a European infrastructure for hydrogen may require 20-30 years.

The fuel cell car is not yet available at a large scale and at a low cost.

On board storage of hydrogen (in cars and other vehicles) is not yet possible. A great deal of technological development is needed here. [5]

Co-ordination will be required between investment policies in four key areas: (1) hydrogen production, (2) the establishment of a pipeline system for long-distance transport of hydrogen, (3) the development of an infrastructure for refuelling of vehicles, and (4) the development of fuel cells cars which can make use of hydrogen. It may be very difficult to achieve sufficient co-ordination.

In creation of a market for hydrogen there are several chicken and egg problems that need to be overcome. For example, without cars that can use hydrogen there will be few incentives to have a pipeline system for hydrogen.

Presently there exists no natural political constituency for the hydrogen option. There are no really strong actors who are very much in favour of the option. For example, the environmental movement has not really taken the option on board.

No feasible carbon dioxide tax will make this option economical. It is very hard to design a tax that can serve as a driving force for the development of the hydrogen option.

Furthermore, climate policy is hardly a driving force for the hydrogen option. The hydrogen option will not help the EU to meet its obligations for the first three commitment periods.

Chances and opportunities
The following chances and opportunities were mentioned:

- The technology is partly on its way.
- Hydrogen can be made from biomass, oil, natural gas, coal, solar and wind.
- Transport is not a cost problem.
- In the medium term it may be possible to use the natural gas pipeline system for distribution of hydrogen.
- A new Edison could appear and bring about an unexpected technical breakthrough.
- The oil industry and the natural gas industry are potentially strong supporters of the hydrogen option.

[5] Earlier in the COOL Europe process one participant in the energy group pointed out that the leap to a hydrogen economy is likely to go via hybrid solutions on the energy supply side. These solutions could delay the transition to a full-fledged hydrogen economy.

The most challenging problem(s)
The group decided to create two clusters of challenging problems. The first cluster includes: safety, public acceptance and political will. The second cluster includes problems related to the establishment of a pipeline system. The key problem is: how to achieve effective co-ordination of investment policies? How to make sure that the market develops?

Solution strategies for cluster 1
In the period 2000-2010 safety procedures should be improved. Also pilot projects to improve safety should be carried out. The group said that "an overkill on safety procedures" should be achieved by 2010.

Solution strategies for cluster 2
The only way to push the hydrogen option forward seems to be through political decisions at the European level. It is the European Commission who should take the lead and have the main responsibilities. The hydrogen option is a typical task for the European Commission because (1) the establishment of the hydrogen infrastructure will take long time and (2) it will require co-operation and co-ordination between many countries and private actors in Europe.

The European Commission should take the lead in creating a constituency for the option. For this purpose it could initiate a dialogue with oil and gas industries and car manufactures in Europe. Tentative agreements should be agreed with the most interested parties before 2010.

The first vehicles to use hydrogen could be trucks in the public sector. The trucks should begin their operation by 2015. EU should launch a programme to make this possible.

The European Commission should ensure that there is a sharp increase in R&D activities related to the hydrogen option.

The European Commission should create a consortium for the technical preparations. It will take about ten years to prepare the establishment of a pipeline system for hydrogen distribution. This preparatory phase will include technical studies, legal work and definition of the trace through Europe.

Partnerships between EU (both the Commission and national governments) and the private sector are essential. The investment costs should be shared by the private and public sectors. In the first phase it is the EU (European Commission and national governments) which should have the main financial responsibility.

The time line

Time period	Political and economic aspects	Technical aspects
2000-2010	Creation of a political constituency for solar hydrogen. EU Commission takes the lead: (a) by initiating a dialogue with the oil and gas industries and car manufactures; (b) by facilitating the establishment of public-private partnerships to share investment costs. In the first phase the EU (Commission and national governments) takes the main financial responsibility; (c) by initiating a programme aiming at large-scale use of hydrogen by trucks in the public sector in 2015; and	Demonstration and improvement of safety. Tests and pilot projects. "Overkill on safety procedures."

	(d) by increasing the R&D activities related to the most strategic aspects of the hydrogen option.	
2010	Information campaign by EU Commission about the hydrogen option. Public acceptance assured due to improved safety performance. Creation of a consortium for technical preparations of hydrogen pipeline system.	
2010-2020	Detailed negotiations between the European Commission, national governments and the most interested actors in the private sector about their specific roles (especially with respect to financing).	
2015		Hydrogen is used as a fuel for trucks in the public sector.
2015-2020		Latest period to initiate preparatory work for hydrogen pipeline system: legal work, definition of location, address land use issues, etc.
2030		Latest year for start of construction of network for hydrogen distribution.
2050		Operation of a standardized European infrastructure for distribution of hydrogen.

Plenary session

Discussion after the presentation of the biomass group

One of the participants stated that biodiversity can be one of the long-term constraints for biomass. It could be indirectly damaging by not giving space to other functions. Another participant addressed the risks of other emissions than carbon dioxide (e.g. NOx) in connection with the production of biomass.

One participant stated that some scenarios for EU agriculture (based on research conducted at Wageningen University in the Netherlands) suggests that within 30-40 years all food can be produced at 1/7th of the area currently used by agriculture. This scenario would drastically reduce the conflict between the biomass option and food production. It was noted that the productivity of food production doubled between 1960 and 2000.

One participant claimed that land will always be used for purposes that will generate most money for the land owner. This is a rule of thumb that at least will apply at marginal land.

Discussion after the presentation of the solar hydrogen group

One participant made the remark that the testing and pilot projects on solar hydrogen have already started. According to the timeline however, the period of 2000 until 2010 should be used to do pilot projects. A representative of the hydrogen group explained that this concerns more advanced projects, which are also more directed at the safety issue than at technological development.

One participant argued that the hydrogen economy will be much more expensive than the current energy economy. This is clearly an obstacle for the transition to a hydrogen economy.

One participant argued that it is most useful to explore the link with the transport sector. However, the first generation of fuel cells may very well be stationary.

2.1.4 Backcasting session 2: carbon pricing and green electricity schemes

The energy group once again split up into two subgroups. The first group (Simon Minett, Jorgen Henningsen, Ewaryst Hille, Tom Kram and Magnus Andersson) did a backcasting exercise on carbon pricing. The second group (Ruth Thomas, Arthur Mol, Jean-Paul Boch, Leo Jansen, Tomas Kaberger and Marleen van de Kerkhof) did a backcasting exercise on green electricity.

Backcasting exercise on carbon pricing

Identification of obstacles in implementing the carbon pricing option
There is strong opposition from some EU Member States for a common EU carbon dioxide tax. Taxes are unpopular per se. The UK's opposition has been particularly strong.

Emissions trading has a dubious connotation because of the hot air issue.

There is a risk that emission trading will be designed in such a way that environmental integrity will not be respected. For example, there may be dubious baselines, inclusion of sinks etc. The reason for this is that industry is much stronger than environmental organisations.

The most challenging problem(s)
The obstacles to carbon pricing were categorised into two clusters. Cluster A has to do with the monetary value of carbon: this includes setting the price, fuel differences, price changes over time etc. Cluster B relates to the public and political acceptance of carbon pricing (including issues such as the public’s perception about taxes and the business community’s perception about competitiveness). Cluster B was identified as the biggest obstacle. It was agreed that he higher the value of carbon, the more need for political acceptance.

Chances and opportunities
EU enlargement is a window of opportunity for a common carbon dioxide tax in the EU. A common EU tax on carbon dioxide has so far been blocked by certain Member States in the EU who have used the decision-making rules (i.e. unanimous voting) for taxation and energy policy, to block the introduction of this tax. Enlargement of the EU may require a shift from unanimous voting to majority voting in several policy areas and hence may also offer a window of opportunity for EU climate policy around 2005.

One participant presented his own calculations to illustrate that 80 per cent emission reduction is feasible from a macro-economic perspective. His calculations showed that 80 per cent reduction will not entail excessive burden on the economy. Assuming annual growth in GDP at 2-2.5 per cent and greenhouse gas emissions growing half of that (1 per cent per year) with no particular policy action (business as usual scenario) one could arrive at the numbers presented in the table below.

	2000	**2010**	**2030**	**2050**
GDP, bn EURO	7,000	9,000	14,000	22,000

GHG emission, M ton CO_2 eq.	4,000	4,600	5,800	7,200
80% reduction, S-shape	0	92	50	20
Actual emissions	4,000	3,700	2,000	800
(2) - (4)	0	900	3,800	6,400
Assumed compliance costs EURO/ton		10	50	100
Compliance cost (5) x (6) bn EURO		9	180	640
GDP increase since 2000		2,000	7,000	15,000
% of increase		0.45	2.7	4.3

Solution strategies

Cluster A - the monetary value of carbon dioxide. It was argued that:

- Emissions trading is a suitable instrument for big emitters such as industry.
- Different instruments (taxes, emissions trading and project based instruments like Joint Implementation) can work together in a strategy to achieve carbon pricing.
- Taxes will be suitable for the domestic level and the transport sector.
- Project-based instruments like Joint Implementation should also be used.

Cluster B - public and political acceptance.
It was concluded that different instruments (taxes, emissions trading and project-based instruments) can work together in a strategy to achieve carbon pricing. With respect to carbon dioxide taxes it was suggested that transparent environmental funds be used to recycle the revenues to areas such as technological development, support to renewables, and labour market improvements. This is likely to increase public acceptance for the tax.

The key steps in the carbon pricing strategy could be the following:
Step 1: Soft start with emissions trading (for big industry). Consultations with stakeholders and the general public.
Step 2: Extended use of emissions trading for big industry. Imposition of carbon tax for transport sector and other domestic sectors. Project-based instruments.
Step 3. Consultation with stakeholders and the general public about further increases of the price of carbon dioxide.
Step 4. Further increases of the price of carbon.

Backcasting exercise on green electricity schemes/environmental labelling
The underlying assumption of this backcasting exercise was that there will be a 80 per cent market penetration of green labelling products in 2050.

Tomas Kaberger mentioned two success stories with respect to green labelling: the non-chlorine paper and phosphate free washing powder. On both issues, environmental labelling made an impact. In the end the prices for consumers went down. There are three different approaches:

Flat cost minimum in production - new standard. Example: washing powder. A switch occurred at the production companies, because some consumers wanted an alternative product for the same costs.
Process development - non-chlorine paper bleaching. Here, studies proved that consumers were willing to, for a little while, pay more, until R&D was ready to make the new product as cheap as the previous product.
Customer performance. In this case consumer have "bought" environmental performance.

An example of indirect labelling is the high speed train in the Netherlands (HSL), which has to use 10 per cent of its total energy use from green energy.

Obstacles for implementation
The first problem the group identified was the following: how to explain to a fair share of the consumers how the electricity market works? This is a problem because consumers will get confused, especially when companies provide different kinds of electricity.
Other problems are:
- The real willingness of the consumers to pay extra.
- The degree of political support (not only support by green parties; there should be a political consensus).
- EMAS (Environmental Management and Auditing Schemes) and ISO 14000.
- Consumers – product – producers.
- Definition of what is green.
- Perspective/potential to realise results.
- Package with efficiency (and green electricity).
- Real competition (different energy suppliers. In the Netherlands there has been a monopoly up to now). Consumers should have the possibility to choose.
- Niche creation (construction of market opportunities for green electricity).

The most challenging problem(s)
After a voting round with stickers, the following two problems were considered to be the most challenging ones: (1) political support and (2) the potential to realise good results/credible prospects of success.

Solution strategies
To cope with the first problem (political support), the group identified the following solution strategies:
- Credible research and presentation on the desirability of green electricity and the potential of green electricity schemes.
- Support from other actors, such as labour unions, industry and environmental and citizen groups (political support means support for the idea that consumers can make a difference).
- It is important that local opinion leaders are involved and actively support green electricity.
- Exemplary behaviour by public bodies in using green electricity.

To cope with the second problem, the group proposed the following solution strategies:
- Suppliers should be credible sources of information.
- Compulsory green electricity quotas for suppliers of energy.
- Auditing of suppliers.
- Excursions to production plants.
- Customers clubs.
- Green investment funds.

The last three activities are aimed at getting the consumers closer to the energy companies.

Plenary session
In the ensuing plenary session short presentations of the results from the two backcasting sessions were made.

Following the presentation on the carbon pricing, one participant pointed out that the strategy for carbon pricing should have a long-term dimension. It is especially important that industry is convinced that carbon pricing is something that will be independent from political changes. Stability and long-term coherence are desirable conditions for successful outcomes.

Following the presentation on green electricity schemes/environmental labelling, one participant asked how green electricity can become a success on the consumer market. One participant argued that the success of green electricity is hinging on prices. It may not be likely that people are willing to pay more just for the common good. Biological food products are easier to sell because there is an immediate link to health.

2.1.5 Discussion about framework for the strategic vision

Arthur Mol gave a short explanation of the further plans for the COOL Europe project. After this meeting, the project team will write a first draft strategic vision. The participants will have a chance to give feedback to this version. A second draft will be prepared on the basis of the feedback. This draft will serve as an input for COOL Europe workshop 4, 8 December in Brussels. This meeting will lead to further revisions of the strategic vision. The final version is expected to be available by the end of March 2001.

The strategic vision is supposed to be a policy relevant document for actors inside and outside the sector. Among other things it will include EU specific options. The transport group will follow the same procedure.

There was a short discussion about the 80 per cent target: is the assumption that the energy group and the transport group together achieve 80 per cent reduction? Or is it assumed that each group reduces the emissions with 80 per cent? How are the targets divided? The conclusion was drawn that it is not possible to separate the energy use in the two sectors, because the energy group supplies the transport sector with energy. So probably it will be 80 per cent for each sector. However, some sort of co-ordination with the transport group is needed.

What are the most promising long-term options for the sector? The group felt confident to answer this question sufficiently. However, it was pointed out that further information on biomass may be needed. An exact quantification of the role of biomass is not yet possible/available. There is some scepticism in the group about the biomass option. There is a strong belief in wind and solar.

Lastly, the group agreed that there is a need to explain in the strategic vision why nuclear energy and fusion have been excluded. If this is not done it is not likely that anybody will take the report seriously. The implementation of nuclear fusion will take another 100 years, so this will not be a big issue in the next 50 years.

Day 2, 19 September

2.1.6 Backcasting session 3: the dynamics of the transition

The backcasting exercise about the dynamics of transition included the following participants: Ruth Thomas, Jorgen Henningsen, Tom Kram, René Kemp, Jean-Paul Boch, Leen Hordijk, Judit Szonyi, Joyeeta Gupta, Simon Minett, Magnus Andersson (notes), Marleen van de Kerkhof (notes) and Tomas Kåberger (chair).

The key question addressed in this session was the following one: how in quantitative terms would one imagine the transition from the current situation to a situation in 2050 in which the 80 per cent reduction target has been realised? According to the participants there are different possibilities to visualise this: a linear curve, an exponential curve or a S-curve.

Possible reduction pathways (%)

	2010	**2020**	**2030**	**2040**	**2050**
Linear curve	92	74	56	38	20
Exponential curve	92	63.5	43.5	29.5	20
S-curve	92	74	50	29.5	20

The linear curve is very demanding towards the end: from 38 per cent in 2040 to 20 per cent in 2050 is almost a 50 per cent reduction in the last decade on top of an already demanding programme till 2040. The exponential curve corresponds to 31 per cent reduction per decade after decade. This is very demanding between 2010 and 2020 where a lot of old stock still exists. New technologies need relatively long lead times.

The S-curve (taking 2020 and 2040 numbers from the linear curve and the exponential curve respectively and 2030 as average) may be a more realistic way to imagine the transition to a new regime. Other curves between the linear and the exponential curves can be envisaged. It was also argued that a combination of the S-curve and the exponential curve would have a lot of merit. In this curve, the first (steep) part implies cost-effective, no-regret policies. The first part can be reached with current policies. After that, other policies are required to reach drastic reductions.

A combination of the S-curve and the exponential curve would have a lot of merit. In this curve, the first (steep) part implies cost-effective, no-regret policies. The first part (the first ten years) can be reached with current policies. The costs of this will be relatively low. After that, other policies are required to reach drastic reductions.

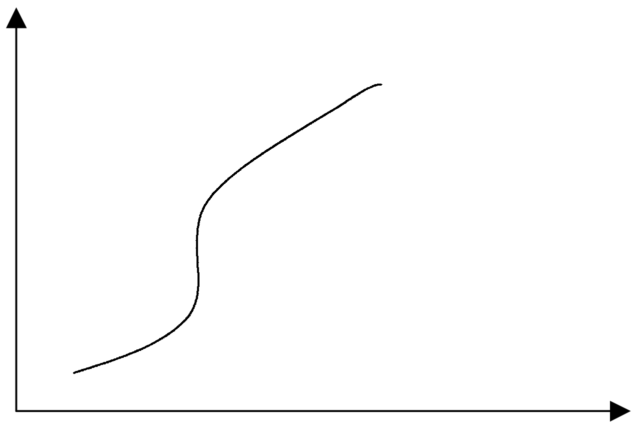
Another graph was presented by one of the participants, which consists of three curves for CHP (Combined Heat and Electricity Production), energy efficiency and RET (Renewable Energy Technology). According to this approach RET will start to be economically feasible around 2020 and will then grow.

It was noted that substantial energy efficiency improvements are assumed in the curves that Kornelis Blok presented in Ecofys' input paper on the two pathways. The group considered the potential for energy efficiency to be quite big. However, without policy this potential will not be realised.

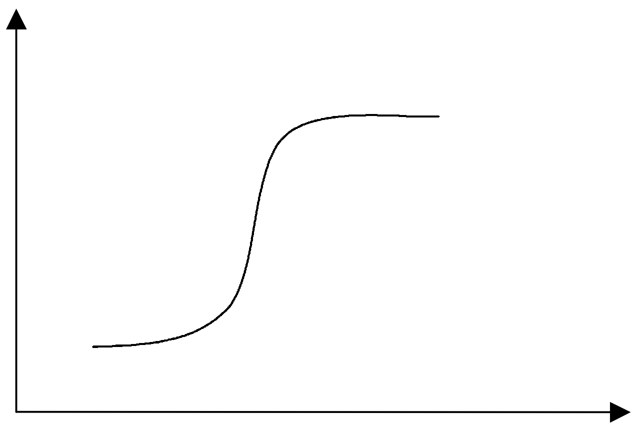
The following conclusions were drawn regarding key options:

1. *Efficiency improvements*. Efficiency improvements have an immediate potential and can be achieved at low costs.

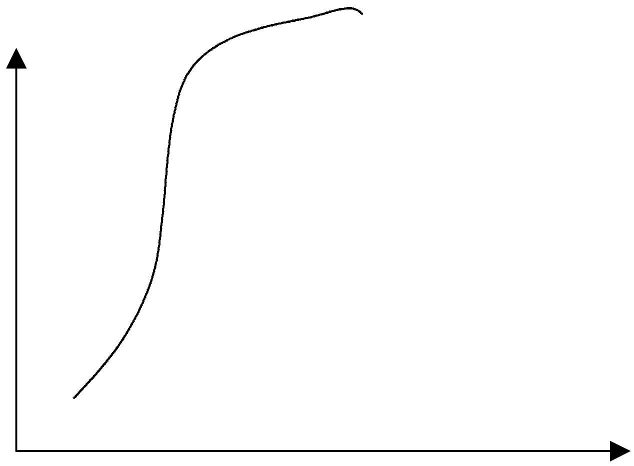
2. *CHP gas*. CHP will be an important option for the short term, but it will also play a role on the longer term. The group thinks that the this option will develop in the following way in the next fifty years (see figure below).



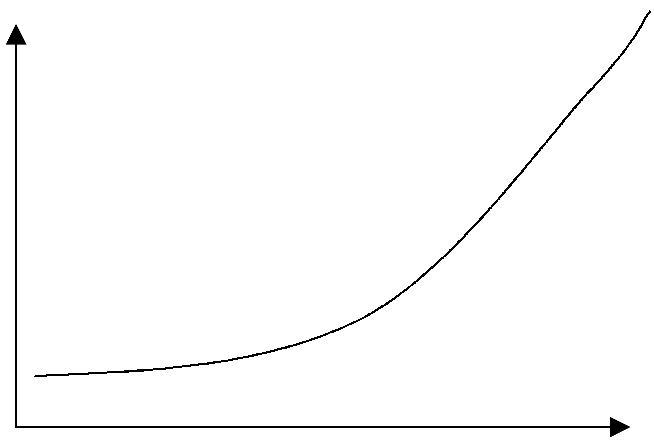
3. *Bio-energy*. The group thinks that the this option will developing in the following way in the next fifty years (see figure below).



4. *Wind energy*. The group thinks that wind energy has a tremendous potential. It has more potential than Ecofys assumes in its input paper on pathways. Nevertheless, the group sees two problems connected with wind power: the costs and the public acceptance (choice for location). Europe has a lot of places available where wind power can be located. (However, the Netherlands is too crowded to implement this option on a large scale.) Problems of public acceptance may emerge. But in countries such as Spain and Germany this is not a problem anymore. Off-shore wind energy will be developed sooner than on-shore wind energy. The expectation is that this development will come early, in the next twenty – thirty years. After that it will stabilise, followed by another growth (see the figure below).



5. *Solar PV*. In order for solar PV to become important in the future large schemes for this options are needed right now. Solar PV will not become very important until 2030. But it is exactly then it will be needed because the assumption has been made in the energy group that no single nuclear power station will be in operation in Europe by 2030. Solar PV power can be pushed by putting in the building codes (see the figure below.)



6. *Overcapacity*. Overcapacity of electricity has been identified as an obstacle for sustainable energy transitions in Europe since it leads to low electricity prices. But overcapacity is also an opportunity in the sense that it makes it possible to shut down some of the oldest plants. After ten years or so, new, modern plants could be built.

A key issue for the short term is to design a strategy to deal with stranded assets. High unemployment rate was identified as a barrier for a reconstruction of the energy economy in Central and Eastern Europe.

2.1.7 Final session about the strategic vision

The group discussed the five bullet-points in the first section of the document entitled Framework for a strategic vision.

The first bullet-point concerns the most promising long-term options for the sector. The group expressed confidence to have sufficient information on this.

The second bullet-point concerns the key boundary conditions on which the options depend. Here the participants mentioned measures such as carbon prices, support and investment to bring the new technologies down the learning curve, and decisive environmental legislation.

The third bullet-point concerns actions needed on the short term to make the options work. The group decided that this has not only to do with how to phase in new options, but also with how to phase out undesirable options, such as coal. There are some good examples of bad behaviour, namely coal subsidies and a prolonged life time of old plants. It was suggested to organise, within in the framework of the COOL Europe project, an ongoing electronic discussion about these topics between the participants.

The fourth bullet-point (how to promote partnerships between the stakeholders on the European scale) was considered to have a strong link with the second bullet-point (key boundary conditions). Relevant questions here are: how do new technologies emerge? Which stakeholders are involved? Are there changes in the positions of the stakeholders? Who are the winners and who are the losers?

The group defined an issue of dissent: should the energy supply system be centralised or de-centralised? The group stated that this point of dissent should be written down in the strategic vision, including the consequences of both systems. Whichever system is chosen it should meet two criteria: it should be completely transparent and there should be real competition.

It was noted that an issue that the group has not yet touched upon is the question what will happen outside the EU. This has clear implications for the developments inside the EU.

The issue of modernisation of industry was briefly addressed. It is important that industry will be helped to make the right decisions. The government can and should play active roles concerning dissemination of information and financial support for the development of new technologies.

The final strategic vision document will be written by the project team with contributions of the participants. All the interesting discussion/input papers will be included in an annex to the document. The participants emphasised that the report should be clear about what the rules of the game in COOL Europe process have been and why the 80 per cent target was chosen.

New question to science derived from workshop 3

What is the most effective way to develop the solar PV option – research and development *or* market introduction?

2.2 Report from the Transport group

Participants

G. Bennett, Syzygy, the Netherlands (Chair)
E. van den Bosch Wageningen University, the Netherlands
L. Hordijk, Wageningen University, the Netherlands
F. Goodwin, European Federation for Transport and Environment, Belgium
A. Kassenberg, Institute for Sustainable Development, Poland
R. Kemp, MERIT, Maastricht University, the Netherlands
M Kok, National Research Programme on Climate Change , the Netherlands
A. Pastowski, Wuppertal Institute, Germany
H. Somerville, British Airways, UK
J. Szony, Wageningen University, the Netherlands
B. Tegethoff, Coalition of German Consumer Unions, Germany
R. Torode, International Union for Public Transport, Belgium
J. Trouve, Schenker BTL, Sweden
W. Tuinstra,Wageningen University, the Netherlands (Notes)

Day 1

2.2.1 Presentation of one pathway for the transport sector by Graham Bennett, Syzygy, the Netherlands

Graham Bennett introduced the path analysis document which was prepared as an input paper for the workshop[6]. He explained that the purpose of the path analysis is to establish important elements, measures and actions in the path from the Future Image back to the present, paying special attention to timing and interdependencies. Furthermore it should assist in identifying key issues for the strategic vision including strategic choices, obstacles, opportunities, pre- and boundary conditions, relevant responses and uncertainties. He explained furthermore that the document under discussion was based on the adjusted Future Image which resulted from earlier workshops and had an indicative character, thus being a basis for further analysis.
Issues for discussion would include comments on the overall approach, specific measures and actions, timing of actions and the identification of Key Issues.

In the discussion that followed several questions were asked and remarks were made about the path-analysis:

Timing

On the one hand the group noted that there is a huge amount of measures which are proposed to start on the short time. On the other hand there were questions if certain actions couldn't start earlier. Some actions depend on others before they can start and some options become feasible earlier than others do.
To be able to give some structure to the many different measures, one of the participants suggested to weigh the different measures and relate them to the different goals, as not all policy measures can be implemented at the same time. It would be good to indicate preferences and to try to find out what is easier to do and what is really difficult. What are the main problems? Who will be the main opponents?

Questions for clarification:

- What is the time span for short, medium and long term?
- Do the options under elements relate to the desired options or to all available options?
- What is the regional scope of the measures?

[6] The full text of the Path Analysis for the transport group can be found in annex III.

- What are the interdependencies between the goals?

Remarks with regards to specific measures

- The path analysis focuses a lot on policy measures. More emphasis should be on other actors. For example the demand from customers should be changed. This has more impact on actions from business.
- The individual carbon budget is too optimistically timed.
- Lifestyle changes are not happening automatically and experiments in local communities are needed.
- Instead of forming new institutions (European Bank for Sustainable Development), we should better reform current institutions.

Suggestions for adding/changing

- Add public participation in decision making to the measures
- Add the implementation of transport in environmental management systems (e.g. ISO 14000)
- Add to "Investments" , investments to promote public transport
- Replace underground transport by new transport modes in general
- Move investments from "awareness" to "structures"
- Address different kinds of public transport
- Avoid redundancy in the measures

2.2.2 Presentation by Adriaan Slob, TNO, on the possibilities of Information and Communication technology to reduce CO_2 emissions

In response of requests in earlier workshops, Adriaan Slob of TNO, the Netherlands, was asked to present a paper on the possibilities of Information and Communication Technology to reduce CO_2 emissions[7].

Adriaan Slob started with introducing the possible contributions of ICT to sustainability.
This included:

- Dematerialization
- Decoupling of time and place
- More efficient organisation
- Tailor made information
- Smarter, intelligent appliances

At the same time rebound effects have to be counted with:

- Dematerialization vs. higher demand
- Optimisation of global logistics vs. extending local logistics
- Teleworking, teleshopping vs. growth of traffic for recreative purposes
- Smart homes vs. "stupid" inhabitants
- Less energy per unit vs. higher demand for units

In the case of transport and mobility, ICT can help optimising infrastructure use, optimising logistic chains, offer opportunities for teleworking, teleshopping, intelligent vehicles and monitoring cargoes. Adriaan Slob concluded that "technology can do everything" but people not. ICT can in principle, contribute to the COOL-targets, however the uncertainties are very

[7] The full text of the paper can be found in annex IX

high; especially the rebound-effect can lower the potentials. Furthermore, an important remaining question is who should take the initiative to introduce several application and organise the needed infrastructure.

In the discussion the following topics were addressed:

- The suggestion was made that it is interesting to compare ICT options with the non-ICT situation (by means of LCA for instance) and to get an idea of the rebound-effects. Slob mentioned the fact that nobody talks about the paperless office anymore and that it seems that e-mail will cost as much energy as an ordinary letter. It was also asked if there exist any environmental technologies without a rebound-effect at all.
- It was noted that we should take into account the dominant trajectories in transport if we want to change transport. The car seems to incorporate the possibilities of ICT much better than the train. The car is both a mobile office and a place of recreation. Public transport should use ICT much better: providing transit information (inter modal transport), reservation systems, door to door information, vehicle control etc.
- The suggestion was also made that for Eastern Europe ICT possibilities should be much better included in education.
- Will the new economy, through its impact on the sectoral structure, have an effect on transport? Slob answered that the new economy will be faster and more optimised. But he does not expect any shifts in its sectoral structure and therefore no effect on transport. At the same time ICT should be seen as a problematic sector as well. For example 10 per cent of the energy use in the USA is from internet uses. This could counterbalance transport gains. A major issue related to ICT and transport is how people and enterprises will locate in the future. There is no research available yet, lot of uncertainties exist around this question.

2.2.3 Back-casting exercises ICT

Following the discussion, two backcasting exercises were performed. Both concentrated on the use of ICT: one focussing on ICT in personal transport, the other on ICT in transport of goods. The groups started with identifying how a transport system facilitated by ICT would look like in 2050.

I *ICT-backcasting personal transport*

Goals

- large amount tele-commuting, tele-shopping
- tele-cottages
- personal “travel-mates”
- 25 per cent information workers
  (so far on the basis of the future image)
- personal travelmates to individually plan and use public transport (for each person available)
- interactive tracking systems
- effective car-share
- transport navigation systems (free air)
- ticketing
- transport systems without drivers

- increased capacity of current infrastructure and transport systems
- sophisticated road-pricing systems
- reduced recreational travel

It was noted that ICT in some cases enables effective means (road-pricing) and in some cases a way to reduce emissions (tele working).
Furthermore it was difficult to identify quantitative goals for ICT in a strategic vision.

The following barriers were identified for realising the above goals:
- lack of societal contacts with teleworking etc.
- car-comfort
- vested interests
- increased prosperity – higher demands
- desire for individual freedom
- companies like their people at the office
- political commitment
- technological developments are going so fast
- efficiency improvement lower the costs and causes an increase in demand
- individual aspirations

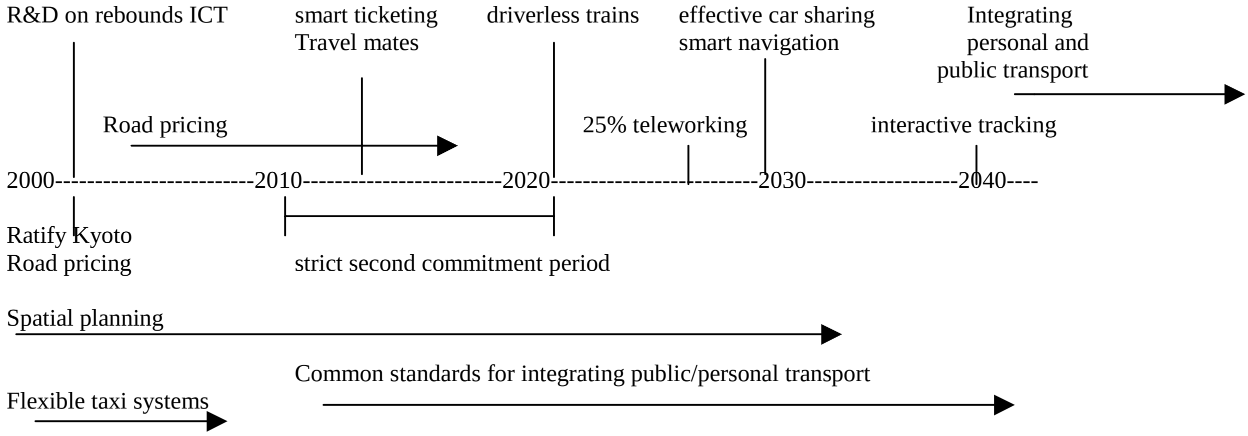
The following opportunities were identified:
- car comfort
- integration of individual and public transport
- cast savings
- for transport sector few extra investments in ICT are needed
- car inefficiencies
- lower information costs
- improved efficiency on air-traffic
- tele working is (already) cost-saving
- network-organisations as a new way of organising

Questions were raised about the possibilities of ICT to increase safety of public transport. The discussion on opportunities and barriers often drifted away from the ICT-options and went into a general discussion on, for instance, public transport. This also happened during the last part of the exercise as the report will show.

As most challenging problems were mentioned (but no real discussion of the most challenging problems and ways how to deal with them was possible):
- realise most effective economic instruments to give transport a price
- perception of individual freedom
- rebound effects

Due to lack of time, the 2000-2050 timeline was filled in quite rapidly, but some policy-strategies were identified:
- R&D on the rebound effects
- "getting the prices right"
- spatial planning
- development of common standards to integrate personal and public transport
- strict climate policies in the second commitment period and ratification Kyoto Protocol

Furthermore regional development and European integration were mentioned as important pre-conditions.



II *ICT-backcasting transport of goods*

The development and introduction of ICT technology offers (in theory) a number of potential opportunities for changes in transport of goods. In the backcasting exercise a number of potentials of ICT in this respect were identified. ICT could, for example, result in improvement of logistics, enabling efficiency levels to go up. Nowadays it occurs quite regularly that trucks drive around only half loaded. By 'information communication technology', the communication and information supply could improve, and drivers could have instant access to a database showing demands for transport.

Below follows the full list of <u>opportunities</u> mentioned by the group :

- Increased load factors (85%)
- Logistics improvement
- Lower demand of transport through
  - Dematerialization
  - Teleshopping (tele food retailing, organisation of distribution centres, pick-ups)
  - Localised production
- Improved use of ICT in rail transport
- Truck fleet connected to GPS system
- New inter modal quick connection systems for long distance transport
- On-line spot-market for road transport
- On-line information on environmental impact of transport of products
- Labelling and tracking system of re-usable goods
- Systems to tax automatically
- Systems to follow up emissions immediately

It was recognised that ICT could also have a negative impact on local shops and local production.
Furthermore tele-shopping could increase transport needs. The issue of rebound effects was discussed extensively.

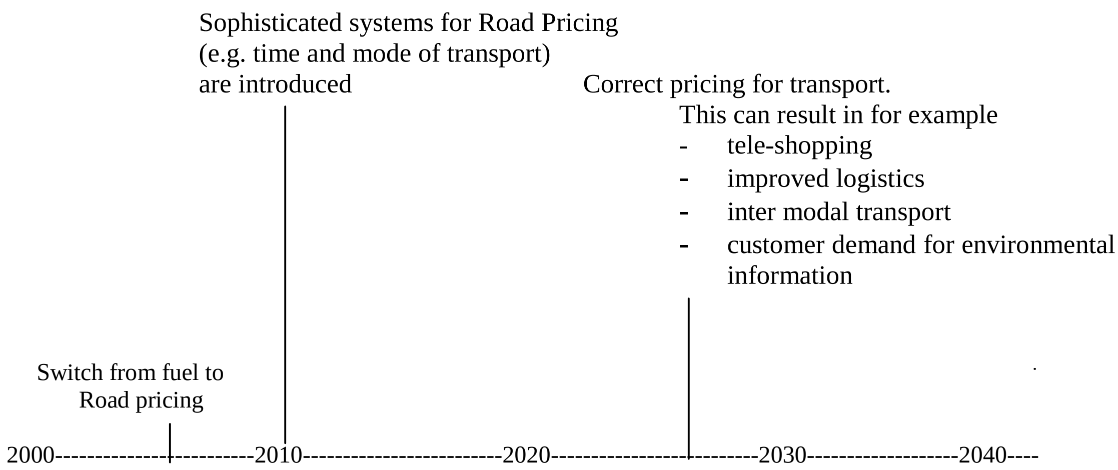
Other <u>obstacles</u> that were identified were:

- Transport is to cheap.
- High walls between and within different transport modes. (Between for example train – car, within for example train - train)
- Decision making frameworks.

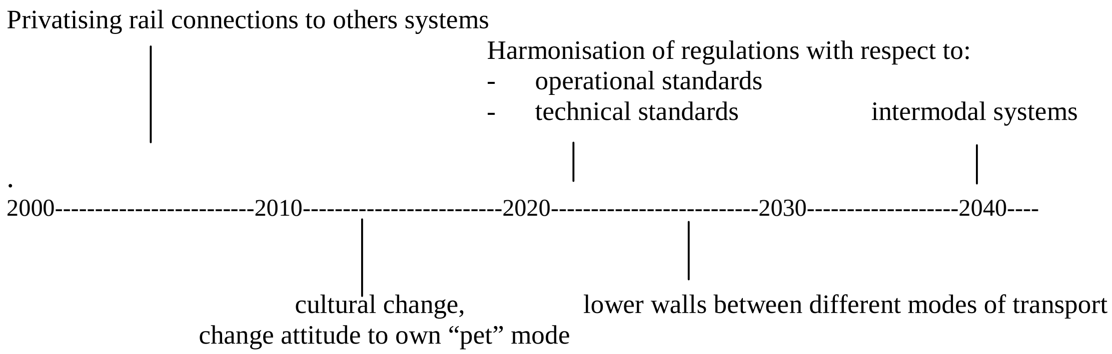
- Lack of information on environmental impacts.

As most challenging problems to discuss in more detail the group identified:
- Transport is too cheap
- High walls between and within different transport modes. (Between is for example train – car, within is for example train - train)

For both problems a timeline was constructed. The first timeline deals mostly with using ICT techniques to come to a correct pricing of transport. It was agreed that a long time is needed to increase prices and that it is very difficult to come ever to internalised external costs as it is difficult to agree what should be included. Road pricing was however seen as sophisticated compared to other ways of taxing or pricing. The costs of transport can be made depended on the time of travel, the mode of transport, etc. By doing so the environmental harmful ways of transportation can be made more expensive and thus less attractive.



The second timeline focused at the ways to break down the “walls” between different modes of transportation. By means as privatisation of railway systems and connections between rail and other systems, and harmonisation of regulations standards these walls should be broken down.
The relation with ICT of some of the suggestions made were limited. Furthermore, in this second part of the pathanalysis the timing of the measures were not made clear.



The main conclusion of the opinions of the participants in the group on transport of goods, was that the expectations on reductions due to ICT should not be too high. Except from improvements in logistics no real chances for improvement through ICT were identified by the group. In many other cases rebound effects will counterbalance possible environmental improvements

2.2.4 Presentation Globalisation and Future Transport

Xander Olsthoorn of the Vrije Universiteit Amsterdam, presented results from the project Globalisation, International Transport and Global Environment (GITAGE), a project which is financed by the Dutch National Research Programme on Global Air Pollution and Climate change (NRP). In this project the Department of Spatial Economics and the Institute for Environmental Studies, Vrije Universiteit Amsterdam, Netherlands Bureau for Economic Policy Analysis (CPB) and the TRAIL Research School, Technical University Delft collaborate.

The relation between globalisation, international transport and the global environment involves a large number of processes and interactions. The future developments of globalisation, transportation and the consequences for the environment are uncertain.
The objectives of the GITAGE project are to map driving forces of globalisation, assess world-wide changes in international transport, explore relations between international trade/mobility, international transport and emissions and to assess climate change effects of trans-border transport on the basis of expert scenarios for transport.
The project makes use of four scenarios for global economic development (scenarios from the CPB Worldscan model). With the help of a review, which relates the role of technological innovations to the development stages of a transport system, four scenarios for transport are derived on the basis of which scenarios for the future of CO_2 emissions are projected.
The transport scenarios include fove modes of transport: aviation, road transport, rail transport and inland and sea navigation. In time the scenarios range from 1995 to 2020, they project tonne-km and passenger-km and they relate GDP in a region to transport.
One of the conclusions of the project is that the divergence in economic developments in CEE countries and EU has limited impact on EU transport (emissions). Another conclusion is that modal shifts have modest impacts and that road transport is most important, in particular passenger transport. As leverages energy efficiency and logistic factors (occupancy rates) play a role.

2.2.5 Presentation and discussion on a calculation tool for environmental impacts of transport

Johan Trouve from BTL presented a tool to calculate environmental impact of road transport[8].
Customers are interested in this kind of tool because they wan to know how much emissions are connected to a certain product, including emissions caused by transport of the product.
With the calculation tool it is possible to see what impact a certain transport arrangement has on the environment. The tool calculates the environmental impact and environmental cost of a particular transport movement by means of an environmental calculation. This examines the conditions applicable to a specific arrangement and the different parts of the chain - collection, handling, reloading, long-distance transport and delivery. This allows for choosing the optimal transport solution from an environmental point of view and a carrier that satisfies environmental demands of the customer (and the customers customer). The environmental calculation also prepares client companies for the increasingly stringent environmental policy currently being adopted in the transport industry.
The tool includes production data, data on transport modes, load factors, energy use and fuel. Also it gives an environmental factor of each train/truck as well as emission factors, and social economic costs.

[8] The full text of this presentation can be found in annex X

In the discussion that followed the remark was made that the calculation only is connected to emissions and not to other impacts of transport. Also space and time are not included.
Furthermore the question arised how social economic costs can be calculated based on emissions. In the case of the presented tool use was made of existing Swedish figures, which were put together by main Swedish companies.
Finally it was noted that not all companies think that environmental marketing is so important, so is this tool interesting for them? In seems to be more important in Scandinavia than in other European countries. It seems to be logical that this will become more and more important: the impact of transport is 20 times as high than the impact of the production of goods itself. Calculation tools are an opportunity for the environmental conscious client.

2.2.6 Presentation and discussion on the aviation sector

Based on input papers of two of the participants Hugh Somerville from British Airways and Andreas Pastowski from the Wuppertal Institute, possibilities for emission reduction on the long term in the aviation sector were discussed. The project team had asked them to focus on certain specific policy options. In the discussion below the following options are highlighted: standard setting by policy; mechanisms to reward long-term thinking as well as possibilities for a long term communication plan to raise awareness. Below, both arguments from the input papers and arguments put forward in the discussion itself are integrated.

Policy setting standards

With regard to standard setting by policy for reducing aviation's climate impact in the form of regulatory instruments Hugh Somerville indicated that British Airways will not accept policy regulation on the demand side. Best chances, according to British Airways can be found in market solutions: emissions trading is the best way forward, and offers the best environmental and economic options. He pointed at the fact that one third of the world freight volume is transported by air, and that this volume will only grow in the future. He furthermore argued that as long as the effects of NO_x and water vapour are not known, it is difficult to address long-term options. Until then attention should focus on carbon dioxide - any reductions in which also lead to reductions in water vapour. Within aviation there has been much discussion about possible mechanisms to limit the input from the industry to climate change. British Airways is currently participating in Working Group 5 of the International Civil Aviation Organisation on "Market based options" - for the control of greenhouse gas emissions. While there is no agreement there has been some movement towards a common position, which could be described as a cap and trade system, at least for carbon dioxide. Before this can be successful however, there is a need for an open trading system between different sectors and across different countries, at least at the Annex B level. Another major issue is the identification of an institutional framework for administration of such a scheme.

In response to this Andreas Pastowski presented a table (see table 1 below) which lists a couple of measures he considered to be important and which suggests appropriate political levels for action and co-operation. The measures listed in the table are not necessarily complete. Two "x" (xx) means that the respective political level would be the first-best solution for theoretical or practical reasons. One "x" (x) indicates that some sort of co-operation is needed with the respective level, that it is the second-best solution or that it may serve in order to get started with achieving the first-best solution.

Table 1 Standard setting for reducing aviation’s climate impact

Sort of standard setting	Political Levels			
	Local	National	European	Global
Preferential slot allocation	x	x		
Emission performance standards	x	x	x	xx
Fuel quality standards				xx
Technical design standards			x	xx
Air traffic control and management		x	xx	
Airport capacity planning		x	xx	
Strategic environmental assessment		xx	x	
Mandatory environmental reporting			x	xx

Table 1 indicates that the European level, with the exception of preferential slot allocation that is more of a local and regional matter, and fuel standards, which need to be unified globally, is very important when it comes to regulatory instruments.

Mechanism to reward Long-term Thinking

In Andreas Pastowski’s view, mechanisms for long-term thinking mainly refer to economic instruments. These instruments change the economic set-up in the aviation industry by establishing incentives for reducing GHG emissions. These incentives may directly result in changes in operation and demand. This will reward those actors in the sector who have been keen on integrating long-term environmental concerns like climate change in their strategies. Furthermore, following such strategies in the future will be rewarded, too. Table 2 provides a list of several such instruments and their preferred political level of implementation or co-operation.

Table 2 Instruments for long-term thinking in aviation supply and demand

Sort of instrument	Political Levels			
	Local	National	European	Global
Kerosene tax			x	xx
Emission tax		x	x	xx
Landing fee	x	x		
Emission crediting and banking			x	xx
Depreciation of dedicated costs		xx	x	
Financing of dedicated R&D		x	xx	

As with the regulatory instruments, economic instruments for rewarding long-term thinking require substantial action and co-operation at the European level. Landing fees are an exception owing to the local character of this instrument.

British Airways paper has provided a paper to the UK government on voluntary agreements to limit emissions of carbon dioxide. In the UK any stretching agreement would have to be offset against Air Passenger Duty - a tax levied on airlines as a surrogate for a kerosene tax which raises close to £1billion per year. The question is if this could be used to encourage airlines to invest in better equipment and to try and develop better procedures (unlike ground transport fuel efficiency is already close to optimum). One significant difficulty in this area is that a major opportunity to improve fuel efficiency lies in the inefficiency of the Air traffic Control and Air Traffic Movement systems which are outside the airlines' control.

Long term communication plan to raise awareness

Many companies have adopted environmental reporting as a long-term approach to communication. Hugh Somerville said that British Airways has been reporting annually for 10 years and has over that period reviewed and extended the range of issues covered. British Airways see this as its Agenda 21 and reviews it, within the limited resources, with groups of stakeholders.

However, communication of this sort is not sufficient. Hugh Somerville believes that it is important to have high profile champions - whether they be public figures such as premiers or heads of corporations. There is little chance of the issue being taken seriously by "the man in the street" until there is genuine commitment from the top.

He believes this is a major obstacle but one that must be crossed and probably will be in the next few years. Another obstacle is the lack of understanding of the terms "environment" and "sustainability". The latter is probably more easy to communicate particularly when the social issues are placed in context. Environment means very different things to different people and one of the roles of the top-level champions should be to communicate key issues.

In this case mobilisation can be ongoing - pulling in champions as the opportunity arises - however they should all sing to the same "song sheet" or at least to similar ones and this means that the messages have to be identified. While people should not be talked down to either as the public or as employees, it is necessary to have a simple, robust position which can be repeated from time to time. This need for consistency in approach applies to local, national and international positions although obviously selective or specific national and local issues would have to be taken into account.

Adreas Pastowski repsonded that the particular climate impact of aviation is, so far, not well known to the general public. At the same time, growth in demand is substantially fuelled by leisure activities with increasing numbers of trips and average distances flown. This demonstrates that there is some potential for influencing demand in the direction of less steep growth. The frequency and average distance of trips by aircraft may be influenced through awareness raising campaigns that provide information on the climate impact related to certain trips as well as on options for reducing it.

In the general discussion that followed it was agreed that airports should become nodes for intermodal connection. With regard to preferences for measures there was agreement that 80 per cent reduction in the air sector as such would not be possible. A combination of emissions trading and emissions charge would be a way of stimulating efficiency improvement.

2.2.7 Discussion on Key issues

In the final discussion round of day 1 Graham Bennett asked the participants to try to focus on the long term again. He reminded the group that the Future Visions of a reduction of 80 per cent GHG by 2050 was chosen to provoke new and creative thinking. What would be key issues to consider?

It was agreed that an *open political process* would be needed based on arguments, evidence, and public interest. It should be less based on lobby interest which makes the political process often not transparent. New ways of implementing measures would be needed. This would imply different decision making systems with more open decisions and communication with society as a whole.

The question was asked how or whether to define *system boundaries*: in the future new, unknown issues and transport needs can emerge. How integrated can our view on transport be? It is clear that all sectors have a responsibility together.

Public awareness and behavioural change was seen as a key issue for change. The biggest impact will come from customers. The customers will have to press for change and therefor they will have to be well informed. However the customers cannot do this on their own. There is a need for extra policy, such as the building of infrastructure and the management of change. It is clear that several groups have a role to play, not only policy makers. Together a long term perspective has to be developed on what we really want, to help to initiate change processes.

With regard to introducing *new technology* we have to be aware of rebound effects. For example the expectation of ICT for CO_2 reduction shouldn't be too high. With new technologies always the needs of people and the way how they use it, as well as possible side effects have to be taken into account.

Day 2

2.2.8 Discussion on Awareness and Lifestyles

One session of the transport group focused on awareness and lifestyles. Based on a paper of one of the participants[9] a discussion was held to try to identify important issues as part of a long term strategy concerning lifestyles.

Lifestyle changes will be crucial in the process of changes in mobility and resulting reductions in CO_2 emissions. New technologies alone will not bring CO_2 reductions about if they are not used optimally and lead to rebound effects. New technologies might even not be developed if there is no incentive from public pressure to get this clean technology in the market. Business will best and most creatively react on customer pressure. Lifestyle changes are not happening automatically and are difficult to influence. For life style changes really to be effective, a certain critical mass is needed. Consumers have to be economical with their means and must continuously seek for compromises between values that are important to them. The way people satisfy their needs is closely related to the opportunities and constraints of their culture.

Important for stimulating lifestyle changes is an increased public awareness. Increased awareness on (1) the nature and consequences of the problem, (2) opportunities for alternative behaviour and (3) the impact of alternative behaviour. However increased awareness alone is not enough. There is the paradox that consumers often know the social issues and want mobility constrained, but they do not wish to be constrained themselves. Alternatives to daily routines should be available, easily accessible and attractive.

Pathways to alternatives to change

- A long term perspective is needed: what do we really want, what can we do to initiate change processes? Which long term trends exist, which ones we can make use of.
- A policy is needed which sets a clear target, develops a pathway and implements infrastructure and support.
- For policies to be effective, it is important to identify what the drivers for certain life styles are. Policies should connect to those drivers. For example currently there is much commuter travel because two members of one family work in different cities. Are there ways to stimulate teleworking here, or are there other drivers to connect to?
- Different people have a role to play: partnerships should be built, business should set targets as well and should play a role in showing and offering customers alternatives. The use of the transport system should be facilitated. There should be a lot of emphasis on services.
- It is important to do experiments. The best possibilities for experiments are at the local level. Local debates can be initiated and local partnerships can be built. On a European level local initiatives and experiences should be exchanged.

A pathway to increased public awareness

- Information and Communication Technology (ICT) should be widely used to facilitate easy access to information on alternatives, to improve logistics and to reduce needs for travel and transport
- Highlight best practices. Show also best practices in other countries: habits differ from country to country. Why can cycling to school in some countries be possible and in others not?
- Increase trust by also increasing awareness of politicians. Policy should be consistent, reliable and realistic.

[9] The full text of this input paper can be found in Annex X.

- Start information campaigns for the general public and implemented in curricula at schools and universities, acknowledging the various reasons to act “green” or to change behaviour in general (ethical reasons, health, time, economy, cultural norms, image of car and public transport, status of walking and cycling, pleasure-seeking, achieving)

2.2.9 Towards a strategic vision for transport

In the final session the discussion was devoted to important aspects for the final strategic vision for the transport group. The chair asked *for suggestions how to maximise out impacts* of the strategic vision; to identify the *added value* of such a strategic vision and/or the preceeding process in which it was constructed; what would be the *essential parts* of the strategic vision; and which *possible surprises* would be important to keep in mind when trying to say anything on such a long term.

With regard to *maximising out impacts* of the strategic vision, tailoring the vision to specific stakeholders was discussed

The vision should be tailored to specific stakeholders because it has to be relevant to different groups in the transport sector, companies as well as grass root movements. For each group it would be important to know what opportunities there are for them for decreasing 80 per cent, what the main problems are, and what different groups can solve together. Companies should be challenged to look at the environment: Why should they be interested? How can they benefit from it in their relation with their customers? Thinking in strategic ways is here important as well as pointing out forerunners, competitiveness and experiments. All big companies with an intelligent business plan should involve strategic visions on the environment.
A vision should be quite specific, it should suggest understandable steps to achieve the targets. It should deliver good examples and show best practices to people who work on alternatives. They need information to work together. It was noted that best practices are not always recognised as best practices, as there is no visible problem if all is running well. Furthermore, it was noted that NGO’s and companies are quite heterogeneous groups in itself, some will find this particular exercise interesting, others not.

Where do we see the <u>added value</u> of the strategic vision?

- It was a great experience to do the exercise on trying to reduce 80 per cent: You have to ask yourself really how it can be done. This experience should be shared in the strategic vision.
- It helps to identify what needs to be done on the short term by looking from a long term perspective
- The concept of the long term is very useful because it removes barriers, and can be translated to steps which have to be taken
- It clarifies which steps would be in the right direction and which ones would be in the wrong direction

<u>Essential parts of the strategic vision</u>

Structure:

- Stepping stones are needed (50 years time horizon should not hinder action now)
- Include timeline for 1950-2000 to show tremendous change
- Include pictures, for example “photos” of 2050
- Show additional benefits of reducing CO2

Content:

- Show that a range of alternative fuels and solutions in Europe in the future will be likely.
- It is very important not to stick in into the technical issues, and to ask first how to avoid traffic and transport needs. How can knowledge be provided in order to help to need less transport, help to use less energy? Companies could earn money with knowledge. It is important to pay attention to life styles (e.g. how long will we work in the future? Will we hire people to do certain things in the household? Will labour cost be lower?)
- Show local solutions for individual areas and relate them to other problem areas
- Pay explicit attention for differences in eastern and western Europe and show ways for eastern Europe to leap-frog
- Include institutions
- Pay attention to “glocalisation”
- Show that different coalitions of partners are needed for different solutions

<u>Surprises:</u>

Possible institutional changes:

- How will insurance companies react on disasters?
- How and in what way will we work together in Europe and in what kind of coalitions?
- Will banks change their investment policies if it is more common practice to provide future vision looking 50 years ahead possibly indicating high business risks?
- How will international financial organisations look like?
- What about demographic changes?

Technical developments

- When will there be a fuel cell break-through?
- How will hydrogen infrastructure develop?
- What will be the role of rebound effects of ICT or other new technologies? It is difficult to see what will be the role of new technologies, because it will depend on how people use it.

ANNEXES

I	Participants' list
II	Letter to participants
III	Path Analysis for the energy group
IV	Path Analysis for the transport Group
V	Framework for strategic vision documents for COOL Europe
VI	Back casting instructions
VII	Input paper J. Gupta: EU's Climate Leadership
VIII	Input paper G. Bennett: European Institutions
IX	Input paper M. van Lieshout and A. Slob: ICT and climate change
X	Participants papers

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Annex II : Letter to participants

Dear participant,

On behalf of the COOL Europe project team at Wageningen University I would like to welcome you to the third COOL Europe workshop to be held at Hotel and Congress Centre "De Reehorst" (tel: +31-318-641188) in Ede (situated between Utrecht and Arnhem in the Netherlands) on 18-19 September. We hope we will enter into a fruitful and inspiring meeting!

This workshop has three major aims. The first aim is to finalize the discussions on possible pathways (implementation trajectories) for the energy and transport sectors. This process is called path analysis. The second aim is to discuss actions to be taken on the short-term. Special attention will here be paid to the role of the EU. Thirdly, the first steps towards the elaboration of strategic visions for the sectors will be taken.

To prepare yourself for the workshop it is important to read the input material which you receive with this letter. It is especially important that you read material that is pertinent to the sector group to which you belong.

With this letter you receive:

- A short background paper on the forms of reference of the strategic visions (for both sector groups).
- Path analysis for the transport sector (for the transport group).
- Two pathways on energy: A. Biomass society and B. Diversification and technical breakthroughs (for the energy group).
- Report from COOL Europe workshop 2, 6-7 April 2000

Furthermore, please find enclosed the programme for the workshop, a list of participants, and practical information.

The input papers written by the participants will be sent out to all of you electronically one week before the workshop. These papers will also be distributed at the workshop. Also a paper on the role of institutions will be distributed.

Finally, you are all welcome to bring material (booklets, information sheets etc) presenting your own organization/company/institute together with information on other things that you think is of vital interest for the participants in the COOL Europe process. This material will be made available at a special table at the workshop facility.

If something is unclear to you, do not hesitate to contact me or Ms. Willemijn Tuinstra (tel: +31-317-48 33 40).

Looking forward to seeing you at our next workshop.

Yours Sincerely,
Magnus Andersson

Project manager
COOL Europe

Annex III: Path analysis for the transport sector

COOL

Climate OptiOns for the Long term

Path analysis for the transport sector

Input paper for the transport group

COOL Europe workshop 3, 18-19 September 2000

1. Introduction: Scope and Purpose of the Document

This document has been prepared as a discussion paper on path analysis for the transport group at the third COOL Europe workshop. A similar document has been prepared on the energy group.

Path analysis is a step in the backcasting process of the COOL-Europe project. In the first workshop (Brussels, November 1999) discussion focused on "Images of the Future": ideas on how the transport sector in Europe might look like in 2050 if CO_2 emissions from the sector were reduced by 80% compared to 1990. In the second workshop (Brussels, April 2000) discussions on the future image continued and a preliminary discussion took place on the identification of the strategic choices and boundary conditions which could shape the "path" from 2050 back to the present. The goal of the third workshop is to identify the key issues in the path and to discuss these in more detail. This will provide important input for the Strategic Vision on the development of the transport sector in Europe (which will be discussed at the fourth and final COOL Europe workshop in December).

This paper takes the elements included in the future image and the outcome of the preliminary discussions on path analysis and presents these as part of a path over the period 2000–2050. Additional elements have been drawn from a recent and interesting OECD study.[10] The path presented in this paper is indicative. The precise timing of the actions is therefore not the prime concern of the exercise. Its purpose is rather to facilitate discussion and the identification by the group of the most important key issues which need to be taken into account in developing a strategy for substantial reductions in CO_2 emissions from the transport sector over the next 50 years—the actions, choices, obstacles, opportunities, preconditions, boundary conditions and uncertainties.

2. Constructing the Path Analysis

The starting point for the path analysis is the Future Image that was presented to the second COOL-Europe workshop. The Future Image was structured around four key means of reducing CO_2 emissions from the transport sector (see also Table 1):

1. Improved efficiency
2. Fuel substitution
3. Changes in structures and patterns
4. Changes in awareness, values and lifestyles.

A range of measures was then developed for each of these four means to produce the proposed Future Image that was discussed during the second workshop. These discussions generated several new elements for inclusion in the image. In addition, a recent OECD-EST study has generated a wide range of options for the transport sector. Three of these, which are new to the COOL discussions and are of special relevance, have been taken into account in this paper (see Table 2).[11]

The Path Analysis brings together all these elements in a structure which presents an indicative path for each of the four means of reducing CO_2 emissions. A time path for implementing each of the relevant facilitating measures is shown and the relevant issues are

[10] What Is Environmentally Sustainable Transport?

[11] The participants made various comments on the Future Image as presented in the second workshop. These included: clarification of estimates and assumptions, the appropriate degree of radical change and the emphasis on technological options. Since the final phase of the COOL project is intended to focus on the strategic framework for emission reductions and on key issues, the Future Image will not be further revised. The comments made by the participants will be taken into account in the further work on the path analysis, the choice of key issues and the development of the strategic framework.

listed under obstacles, opportunities, pre- and boundary conditions and uncertainties. The following points should be taken into account when considering this proposed path analysis:

- The time period given for each measure indicates the estimated period required to develop and implement the respective measure. In most cases the measure will continue in effect after this period.
- Many actions intended to improve efficiency can be taken in the short term. They are relatively easy to develop and implement and do not involve many uncertainties. The appropriate actors can also be readily identified.
- Fuel substitution involves more difficult choices, greater uncertainties and more complex coalitions of actors. It is of greater significance in the medium term. However, it also offers more scope radical change.
- Changes in structures and patterns require a long period to take effect and involve substantial uncertainties. The changes are also dependent to a large extent on appropriate actions by a wide range of actors in other sectors.
- Changes in awareness, values and lifestyles are most difficult to influence since they are dependent on a wide range of factors and complex interactions within society. However, such changes have a huge potential to shape processes that determine the development of the transport sector and CO_2 emissions.
- Some actions or measures (such as individual carbon budgets) can only be taken following the implementation of other actions or measures (such as further improvements in ICT and related technologies.
- Both the discussions in the COOL project and various other studies show that a reduction of CO_2 emissions of the order of 80% by 2050 can only be met through rapid technological development, significant changes in attitudes and behaviour, structural socio-economic change and institutional and policy-making reforms. Many of the measures and actions that are necessary to stimulate and facilitate these changes will have to be taken in the short term.

Table 1. Overview of the main elements of the transport image (Dreborg, 2000)

ELEMENTS	IMPORTANCE TO FULFILLING IMAGE	FACILITATING MEASURES & FACTORS	POTENTIAL OBSTACLES
1. Improved efficiency			
▪ Reduced driving resistance	• Very important	• CO_2 taxes and "feebates" that promote energy efficiency	• Lobby groups for the car, lighter cars less safe
▪ Improved drive train	• Very important	• –	• –
▪ Modal shift	• Some importance	• Road pricing, dedicated bus lanes, improved public transport, park-and-ride schemes, efficient inter-modal terminals	• Lobby-groups for the car, "predict-and-provide"-type of planning for infrastructure
2. Fuel substitution			
▪ Bio-fuels and H_2	• Very important	• Test and pilot projects, environmental zones	• Land needed for food production, oil companies
▪ CO_2 storage	• Important	• CO_2 taxes	• Public opinion and transporters
▪ Solar and H_2	• Some importance 2050, but potentially very important	• Test and pilot projects, environmental zones	• High commercial risk to investors
▪ Wind and hydropower	• Not so important	• –	• Environmental drawbacks
3. Structures & patterns			
▪ Structure of industry (=> freight transport)	• Important	• Tax base reform: from labour to use of natural resources	• Resource-intensive industry
▪ Decentralised concentration (=> passenger transport)	• Important	• Urban planning, commuter trains, local centres for tele-commuters	• Preference for dispersed housing and car driving
4. Awareness, lifestyles & values			
• Green consciousness and support for policy measures	• Very important as a precondition for the other improvements	• Curricula for civic values and environment at schools and universities, information campaigns	• Materialistic values

Table 2. Important additional elements

Suggestions from the second COOL workshop
• New decision making frameworks • Globalisation • ICT • Links to other sectors and other problems Investment policies • Political factors
New options from the OECD-EST study
• Reduce tax on low-emission vehicles • Abolish aviation tax exemptions • "Full-cost" land taxation

INDICATIVE PATH ANALYSIS (1)

ELEMENT	DEVELOPMENT AND IMPLEMENTATION OF FACILITATING MEASURES 2000-2050		
	Short Term	**Medium Term**	**Long Term**
1. Improved efficiency • reduced driving resistance • improved vehicle drive train • modal shift • new transport systems	**Research & development**		
	Intermodal systems		
	Improved infrastructure		
	Dedicated bus lanes		
	Intermodal terminals		
	New public transport systems		
	Improved management systems		
	Intermodal transport		
	co-ordination between different networks & regions		
	Park-&-ride schemes		
	Policy measures		
	Promote research & development		
	Carbon tax		
	Feebates		
	Emissions trading		
	Reduce tax on low-emission vehicles		
	Abolish aviation tax exemptions		
	Road pricing		
	Abolish perverse subsidies		
	Technology-forcing performance/emission standards		
	Promote public transport		
	Promote intermodal systems		
	Promote innovation		
	Promote application of innovations		
	Policy integration		

INDICATIVE PATH ANALYSIS (2)

ELEMENT	DEVELOPMENT AND IMPLEMENTATION OF FACILITATING MEASURES 2000-2050		
	Short Term	**Medium Term**	**Long Term**
2. Fuel substitution • biofuels & H_2 • CO_2 storage • solar & H_2 • wind & hydropower	**Research & development**		
	Pilot & demonstration projects		
	Policy measures		
	Promote research & development		
	Carbon tax		
	Abolish perverse subsidies		
	Technology-forcing performance standards		
	Promote market introduction of fuel cells		
	Promote innovation by market forces		
	Promote technological leapfrogging		
	Promote application of innovations		
	Promote learning/experimentation programmes		
	Designate environmental zones		
	Ban conventional cars from central urban areas		
	Policy integration		

INDICATIVE PATH ANALYSIS (3)

ELEMENT	DEVELOPMENT AND IMPLEMENTATION OF FACILITATING MEASURES 2000-2050		
	Short Term	**Medium Term**	**Long Term**
3. Structures & patterns • spatial structure economy • decentralised concentration	**Research & development**		
	Underground transport		
	Pilot & demonstration projects		
	Improved management systems		
	Improved logistics through ICT		
	Local teleworking centres		
	Park-&-ride schemes		
	Cooperation between different regions		
	Partnerships between green stakeholders		
	Policy measures		
	Promote R&D underground transport		
	Promote technological leapfrogging		
	Promote innovation by market forces		
	Promote application of innovations		
	Fix criteria for green investments		
	Road pricing		
	Internalise external costs		
	Shift tax from labour to natural resources		
	"Full-cost" land taxation		
	Promote investments in infrastructure & distribution systems		
	Promote learning/experimentation programmes		
	Policy integration		

INDICATIVE PATH ANALYSIS (4)

ELEMENT	**DEVELOPMENT AND IMPLEMENTATION OF FACILITATING MEASURES 2000-2050**		
	Short Term	**Medium Term**	**Long Term**
4. Awareness, values & Lifestyles • green consciousness • environmental education	**Education/awareness**		
	Environmental education curricula		
	Public awareness campaign		
	Improved management systems		
	Individual carbon budgets		
	Investment mechanisms		
	European Bank for Sustainable Development		
	Green equity funds		
	Clean Development Mechanism		
	Policy measures		
	Strict application of precautionary principle		
	Agenda 21+21		

Annex IV: Path analysis for the energy sector.

COOL Europe

Pathways

1. Pathway based on biomass-intensive image
2. Pathway based solar hydrogen image

Discussion paper to be used as an input
for the energy group, COOL Europe workshop 3

prepared by

Dr. G.J.M. Phylipsen
Prof.Dr. K. Blok

Ecofys bv

1. Pathway based on biomass-intensive image

1.1 Quantification of energy demand and supply developments

In this section we will first quantify the developments that are required in the energy demand and supply patterns to arrive at the desired image. We will discuss required growth rates for the various energy sources, the required development of electricity supply costs, the issue of security of supply and the required rates of energy savings on the demand side.

Required growth rates in supply

Table 1.1 shows that to reach the desired image, the growth rates for all sources except hydropower need to be high. For biomass and natural gas the electricity production needs to grow with almost 4% each year, for 60 years in a row. Solar thermal and wind energy have to experience an annual growth rate of 8-10%, while PV (solar electricity) even has to grow with 17% per year over this 60-year period. Note that with such high growth rates the rate with which production capacity for e.g. PV modules can be constructed can be a limiting factor. Figures 1.1 and 1.2 show the absolute and relative growth in production for the various energy sources. They show that a high absolute growth occurs in wind and, especially, gas-based electricity production, but by far the largest relative growth occurs in solar electricity.

Table 1.1. Required growth rates for various energy sources to deliver the amount of energy reflected in the energy image[12]

Energy source	Final energy EJ		growth factor	required annual averaged growth rate
	1990	2050		
Wind energy	0.014	2.5	173	9.9%
Hydropower	1.1	1.8	1.6	0.9%
Photovoltaics	0.0001	0.6	5556	17.0%
Biomass	1.6	12.0	7.5	3.8%[1]
Geothermal	0.03	0.03	1	0%
Solar thermal	0.017	0.6	55	7.5%
Natural gas	1.2	9.4	8	3.9%

Notes: The biomass used in 1990 was almost entirely used for electricity and heat, not for transport fuels. The majority of the biomass energy consumption in 2050 is foreseen to be used for transport purposes. The growth rate for biofuels will therefore be larger than shown here.

[12] Note that the image has been changed following the comments of the participants at the second COOL Europe workshop, 6-7 April 2000. Nuclear energy has been omitted from the image. The resulting electricity gap was filled by increasing the amount of wind and solar electricity.

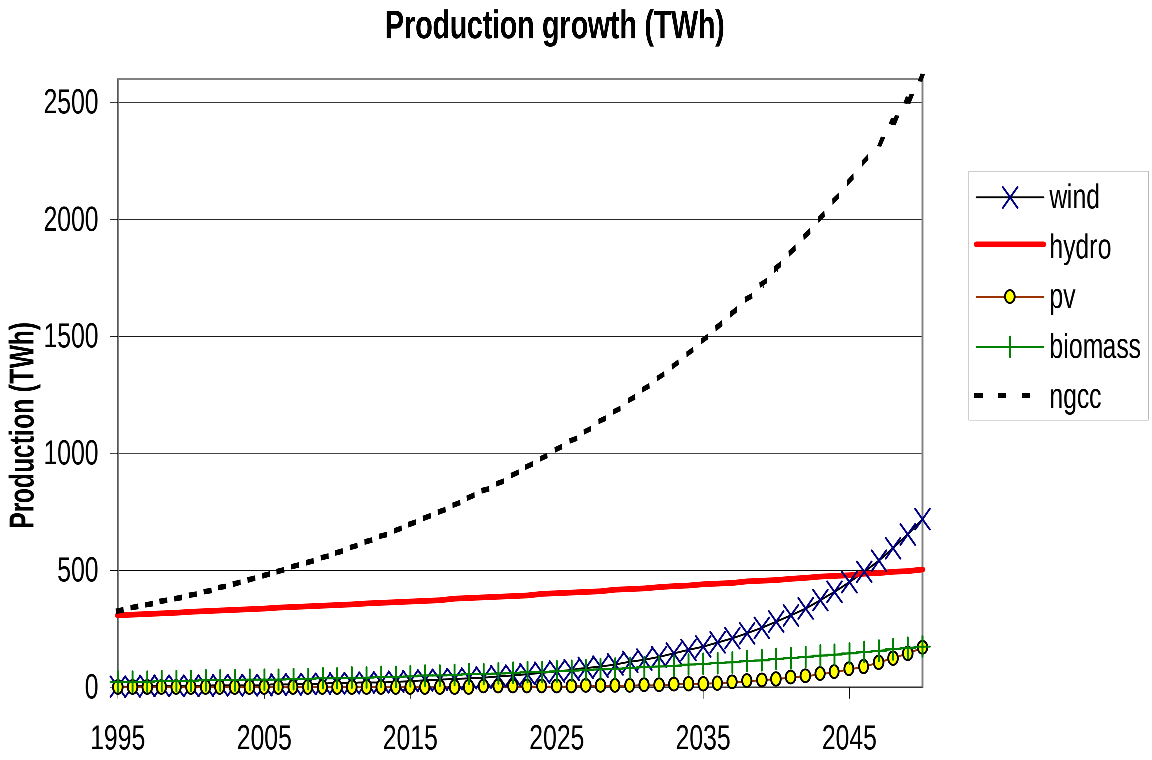

Figure 1.1. Production growth of electricity by source required to meet the contribution of the various energy sources foreseen in the energy image (based on an annual average growth rate). NGCC refers to natural gas combined cycle.

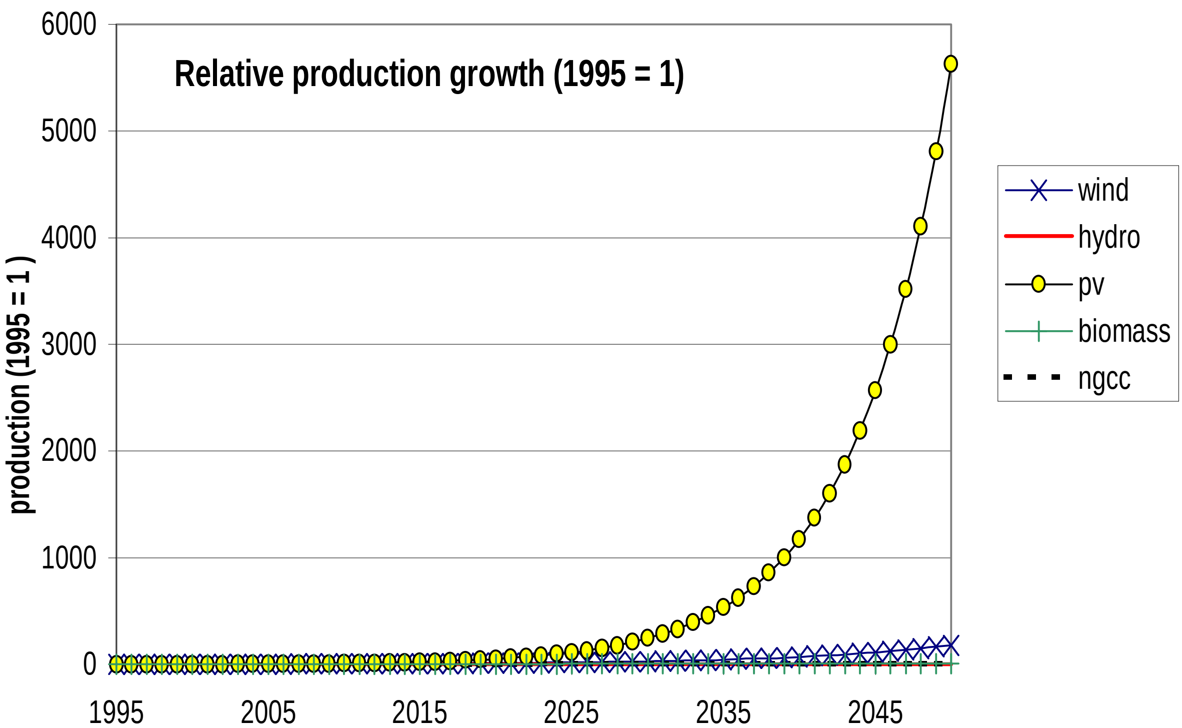

Figure 1.2. Relative electricity production growth by source required to meet the contribution of each source, foreseen in the energy image.

Energy production costs

Table 1.2 shows the current costs of producing electricity and transport fuels [Neij, 1999, Faaij et al., 2000]. Also shown are the progress ratios for various energy supply options, reflecting the reduction in production costs achieved with each doubling of production [IEA, 1998]. For example, a progress ratio of 85% means that a doubling of production capacity leads to a decrease in production costs of 15%.

Table 1.2. Current energy costs and progress ratios for electricity production

Energy source	progress rates [IEA, 1999]	Current costs range		unit	Remarks [source for cost data]
Electricity					
Wind	81%	6,6		1995 $ct/kwh	[Neij]
PV modules	82%	32	40	1995 $ct/kwh	[Neij]
Biomass	70%	8	14	1995 $ct/kwh	[Faaij et al., 2000]
Hydro		7,8		1995 ct/kwh	[Neij]
NGCC	90%	2,8	7,3	1995 ct/kwh	[Neij] fuel price 2.2-5-5 US$/GJ high figure includes CO2 capture
Coal	95%	4,6	7,7	1995 ct/kwh	[Neij], fuel price 1.2-2-5 US$/GJ high figure includes CO2 capture
Nuclear		4	7,7	1995 ct/kwh	[Neij], including waste disposal and decomissioning
Transport fuel					
Biomass transport fuel		14	43	US$/GJ	[Faaij et al., 2000] at the car low figure refers to H_2/alcohol-based systems. High figure refers to biodiesel
Gasoline		8		US$/GJ	Faaij et al., 2000] at the car excluding taxes

Figure 1.3 shows the development of electricity production costs with each doubling of production capacity for various electricity supply options according to the progress ratios shown in Table 1.2. Figure 1.4 shows the cost development over time based on the average annual growth rates shown in Table 1.1. The figures show that if production capacity grows at the same rate (in terms of number of doublings) for all sources PV electricity will remain the most expensive all the way through 2050. The market share of PV can therefore not be enlarged on the basis of production costs. However, the energy image assumes PV electricity production to grow by 17% per year, on average, while other sources ‘only’ experience 1-9% per year in production. From this it is obvious that PV can only play the role foreseen in the energy image if PV is forced into the market (e.g. through regulation or heavy subsidies) or in case major breakthroughs in costs are achieved (i.e. even larger than already required to follow the learning curve).

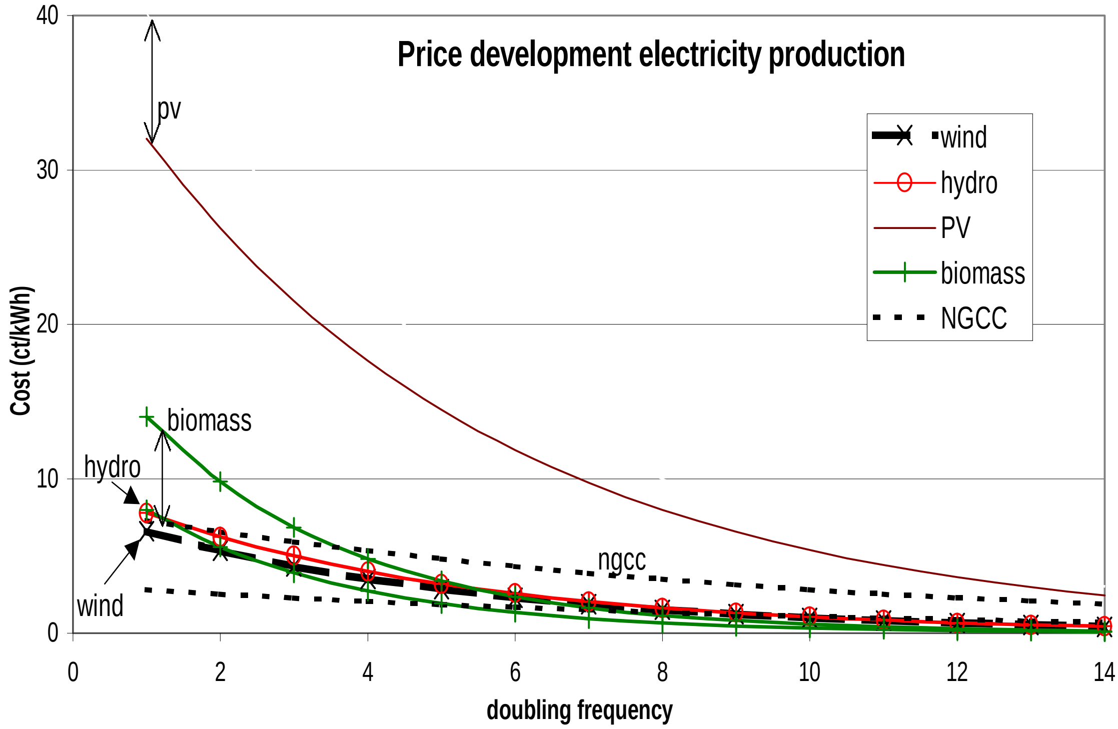

Figure 1.3. Cost development for electricity production by renewable energy source with each doubling of production capacity (according to the progress ratio's shown in Table 1.2. For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed.

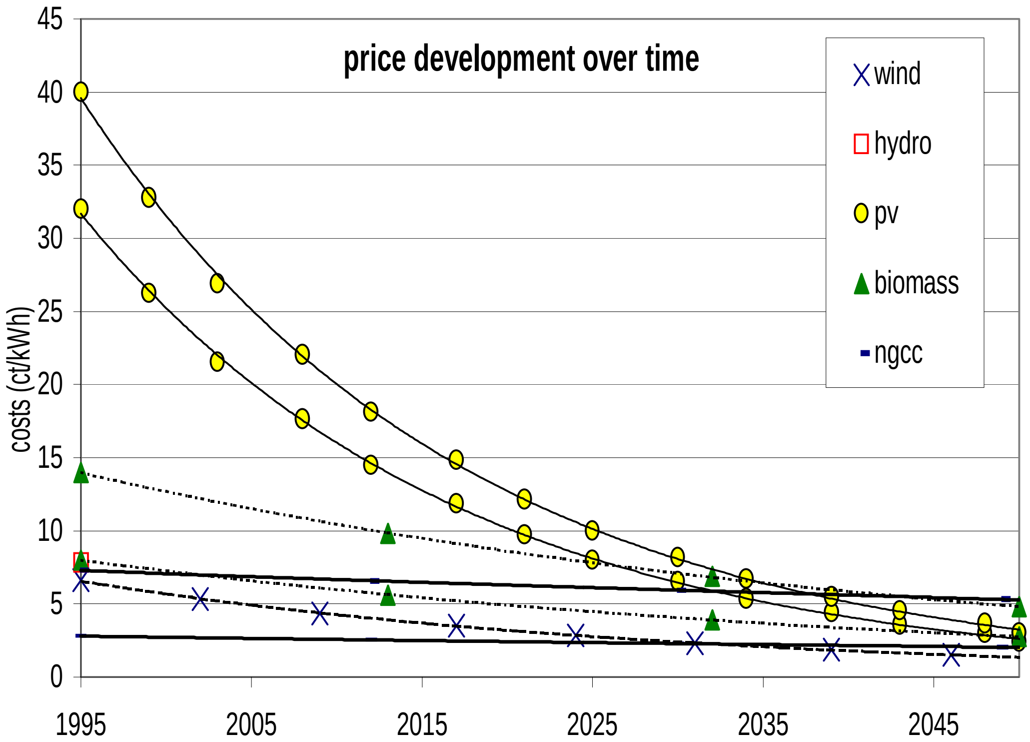

Figure 1.4. The development of electricity costs by source over time ($ct/kWh). For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed.

Table 1.3 shows the long term production costs for biofuels for transport for various options [Faaij et al., 2000]. Together with the cost estimates for electricity production from Figure 1.4 and the total consumption of fuel and electricity by source, total energy supply costs in 2050 for the biomass-intensive image can be calculated. These are shown in Figure 1.5. Figure 1.6 shows the relative contribution of each source to the total costs.

Table 1.3 Long term costs for transport fuels from biomass [Faaij et al., 2000]

Source	Costs (US$/GJ delivered at the car)
Compressed hydrogen	9
Liquid hydrogen	11
Methanol	10
Ethanol from wood	6
Ethanol from sugar	24
Biodiesel	23-28

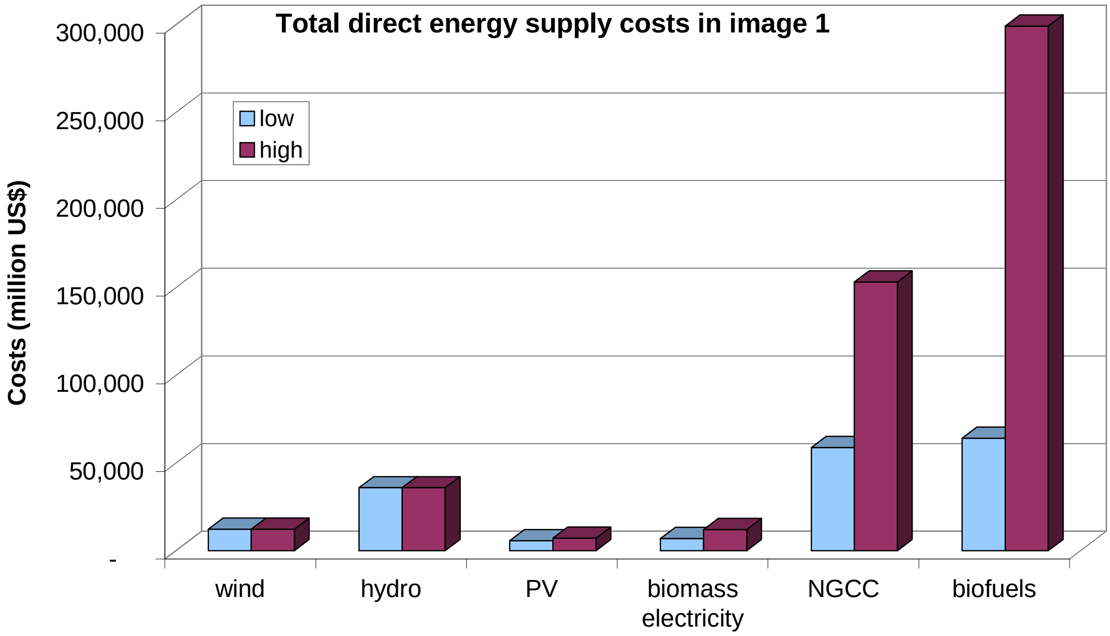

Figure 1.5. Total costs of energy supply in 2050 in the biomass-intensive image. For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed. For biofuels, the low estimate refers to ethanol from wood, the high estimate refers to biodiesel. Note that no indirect costs or benefits are included (e.g. employment effects, etc).

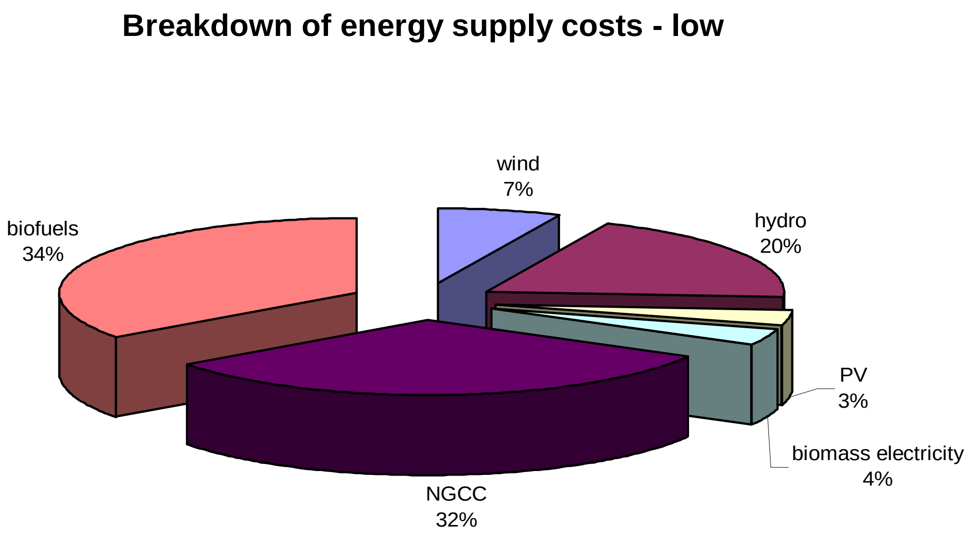

Figure 1.6. Breakdown of energy supply costs (low estimates) by energy source in 2050 in the biomass-intensive path.

Security of supply

When using substantial amounts of intermittent energy sources, security of supply deserves attention. Especially solar and wind energy sources can show great variability depending on weather conditions, the time of day (for solar) and the season. But also hydropower and biomass are, on a seasonal basis, depending on weather conditions. Table 1.4 shows the share of intermittent source in electricity generation in the energy image. It shows that intermittent sources in 2050 contribute for almost 50% to electricity generation, which the highly fluctuating PV and wind sources combined contribute 29%. PV can typically show a variation of 0-50% of the load curve. Wind can even vary between 0-100% of the load curve, posing a larger problem. As a consequence, security of supply cannot be guaranteed without either a substantial over-capacity or a storage system. In addition, all the available electricity production capacity needs to be able to come on/off line quickly.

Table 1.4. Share of intermittent sources in electricity generation in the biomass-intensive energy image in 2050

Source	Share (%)
Hourly fluctuation	
PV	6%
Wind	23%
Seasonal fluctuation	
Hydro	17%
Biomass	3%
Total	49%

Demand-side developments

Besides changes in the supply side, also energy demand patterns need to be changed to achieve the energy image in 2050. Table 1.5 shows the development of energy demand leading up to the energy image. The developments of the consumption of different types of energy carriers in each sector are based on expected technical, economic as well as social developments (autonomous or policy-driven).

Table 1.5. Rate of change in final energy consumption between 1990 and 2050 by carrier and by sector and total final energy consumption. A negative change indicates a reduction in energy consumption. Note that the change rates listed here are the result of combined changes in activity level (e.g. more transport), structure (e.g. different products in industry) and energy efficiency.

Carrier	Sector	Category	Rate of change (%/yr)	Final energy consumption in 2050 (EJ)
Heat	industry	Low temperature	-0.5%	0.2
		High temperature	-0.5%	1.5
		Steam	-0.5%	2.0
	Residential	Low temperature	-1.5%	3.0
	Tertiary + agriculture	Low temperature	-1.5%	1.1
	Total			**7.9**
Electricity	Industry		0.8%	4.7
	Residential		0.8%	3.0
	Tertiary + agriculture		1.0%	2.9
	Total			**10.7**
Fuels	Industry		0.0%	2.7
	Residential		-1.0%	0.2
	Tertiary + agriculture		-1.0%	0.2
	Transport		0.4%	9.3
	Total			**12.4**
Total				**30.9**

Compared to 'business as usual' developments, the developments shown in Table 1.5 are ambitious. This becomes clear if the energy image developments are compared to those included in various short-term scenarios, as shown in Table 1.6.

Table 1.6. Demand-side developments in short-term reference scenarios [Capros, 1999]. Shown are average annual changes over the period 1995-2020.

Carrier	Sector	Rate of change (%/yr)
Steam	Industry	1.2%
	Residential	1.4%
	Tertiary and agriculture	3.3%
Electricity	Industry	1.1%
	Residential	1.6%
	Tertiary and agriculture	2.8%
Fuel	Industry	0.1%
	Residential	0.3%
	Tertiary and agriculture	0.1%
	Transport	1.0%

Note that the fuel listed in this Table is also partly used to supply heat. No distinction on the basis of energy service (heat, electricity, fuel for other purposes than heat as done in Table 1.5) could be made.

For electricity, growth rates foreseen in the image are lower than in most short-term scenarios. This requires a substantial increase in the efficiency of domestic and office appliances, industrial motors and drives and lighting systems. In addition, also new buildings have to be designed in such a way that they make optimal use of daylight and passive solar energy. Also the implementation of heat/cold storage systems could lead to lower growth rates e.g. for air conditioning. Behavioural changes such as switching appliance off stand-by or fully loading (dish) washers and will be important. Behaviour, however, will play a bigger role in purchasing equipment and the choice for insulation, etc.

The decrease in low-temperature heat consumption foreseen in the image will have to be met through increased insulation in buildings (including walls, roofs and windows) and a better use of passive solar energy. An increased efficiency of heat generation (high-efficiency boilers, heat pumps and district heating) will lead to a lower fuel demand for heat production. The reduction in high-temperature heat and steam demand in industry can be achieved through an increased integration of processes, a shift to different processes (e.g. using membranes for separation instead of distillation) and products (e.g. less energy-intensive industry and more knowledge-intensive industries and services). An already occurring example is the emergence of internet publishing as an alternative to 'regular' printing, using paper.
A shift to electricity could also contribute to the decrease in heat (e.g. by using electric compressors instead of steam-driven compressors).

For transport, the growth in fuel demand in the image is much lower than is assumed in short-term scenarios. A large part of this difference can be achieved by the introduction of hydrogen or methanol-fuelled vehicles. Such vehicles have a fuel intensity that is typically three times (for hydrogen) that of gasoline cars. In addition, behavioural changes, such as tele-working, car pooling, increased use of public transport and the use of bikes for short-distance travel can play an important role.

1.2 Bottlenecks

Costs

As shown in the previous section, currently costs of renewable energy production are usually higher that that of conventional sources. Figure 1.4 has shown that the cost of wind and biomass electricity may become competitive on the relatively short term, perhaps even within 2-3 doublings of production capacity. This means that an increase in consumer preferences for green energy and energy tax exemptions for renewable energy may go a long way in reaching the required capacity increase and price reduction. For PV, however, cost differences are so large that much stronger incentives will be needed if it is to play the role foreseen in the image.
Biofuels are currently not competitive, when production costs are compared to those of gasoline. However, taxes can increase the gasoline price paid by the consumer by a factor of 2-3 in a number of Member States. Exempting biofuels (partly) from those taxes would make them competitive on a relatively short term (not taking into account the infrastructural side of the problem).
In addition to PV and, to a lesser extent, biofuel production processes, other technologies that need further development are for example heat pumps, underground

storage systems for heat/cold, hydrogen storage systems (both for vehicles and for electricity production).

Security of Electricity Supply

The large share of intermittent renewables foreseen in the energy image will result in a decreased security of supply. To absorb the variation in supply from hour to hour (for wind and solar), day and night (mostly solar) and season to season (all sources) a safeguard needs to be built in the system. This could be done either through the availability of back-up capacity or by means of storage capacity. In case back-up capacity is used, a distinction can be made between peak capacity (for short-term fluctuations) and medium or base-load capacity (for seasonal variations). In case storage systems are used, one can choose for (a combination of) pumped storage (hydro), hydrogen (from the electrolysis of water) or batteries.

Biomass supply and required land area

The current energy image heavily depends on biomass. Besides biomass wastes, energy crops are expected to require 17% of total land area in Europe (for comparison: cropland currently covers 140 Mha, or 30% of total crop land, with forests and woodlands covering another 33%). About 80% of the land demand for energy crops can be met using excess croplands, starting with currently set-aside land. This would require an adjustment of agricultural policies. Currently, EU agricultural policy provides a subsidy to farmers that set aside land in order to decrease over-capacity in food production. Farmers loose this subsidy if the set-aside land is used for energy crops. This, in combination with currently low potential prices for the energy crops, forms a barrier for farmers to (partly) switch from food crops to energy crops. The remainder of the required land (almost 20% of 17%, i.e. 3% of total land area in Europe) needs to be found elsewhere, e.g. through energy plantation forests. This may lead to competition for land, e.g. with more extensive ('biological') farming, recreation, etc. A solution might be the combination of different activities, e.g. energy plantation forests and recreation, in the same area.
On the other hand, biomass-fuelled plants will have difficulties starting up if the supply of fuels is not sufficiently large and stable. Insecurity in the supply of biomass will lead to lower plant utilisation or higher fuel prices. Closing a deal with surrounding farmers for guaranteed supply/demand of biomass at fixed prices may benefit both parties involved.

Infrastructure

New infrastructure will need to be developed for the distribution of biofuels and for a potential storage system. Currently no biofuelled cars can be introduced, because no infrastructure is in place to supply the vehicles with biofuels. On the other hand, no biofuel infrastructure will be developed, because there is no demand for biofuels yet. This seemingly vicious circle needs to be broken in order to achieve a substantially biofuel-driven vehicle fleet. One option is to start with blending biofuels with gasoline, as is also being done in Brazil. This can be done in regular engines. This means infrastructure can be built up, and all cars can use biofuels when available. Once sufficient infrastructure is developed dedicated cars can be introduced.

One additional problem regarding infrastructure are the competing options for biofuels (see Table 1.3) and other alternative fuels. Building up infrastructure for different types of alternative fuels will be too expensive. This means a choice for a specific type of alternative fuel has to be made, without knowing up front which type will develop into the best and cheapest option. In this respect, hydrogen has an advantage, since it can be made from e.g. fossil fuels (in the transition phase for example), from biomass or from electricity (fossil or renewable). Considering biomass-derived hydrogen, a distinction could be made between on-board production of hydrogen, in which the vehicle is fuelled with biofuels and an on-board reformer transforms the biofuel into hydrogen, and direct fuelling with hydrogen at the pump. The former option has the flexibility to start with mixing biofuels with regular gasoline in the transition phase and to switch to on-board reforming vehicles when sufficient infrastructure is in place. The latter option has the flexibility of using possible routes for hydrogen production, but it does not offer a solution for the transition phase (although DaimlerBenz has experimented, before the merger with Chrysler, with dual fuel hydrogen/gasoline cars).

Current stakeholders

Current stakeholders that might be threatened by the developments foreseen in the energy image and the path leading up to it are large-scale electricity producers, electricity distributors, and oil companies. Other stakeholders that need to play an important role are farmers, car manufacturers, architects and building contractors.
In achieving the situation sketched in the energy image it is important to involve the potential opponents in the solution to the problem. Part of the players is already doing this, e.g. oil refineries diversifying into solar technologies such as Shell and BP, or car manufacturers investing in hybrid or fuel cell technologies (Toyota, DaimlerChrysler, Ford). Large-scale electricity producers and distributors could be involved in the development of the required new capacity (wind parks, CHP plants) but they could also refocus on the delivery of ‘energy services’ instead of mere electricity. This could include advising on managing back-up capacity and/or storage systems, demand-side management, offer integrated concepts for heating/cooling systems, etc.

1.3 Possible intermediate steps

Supply-side

- Stimulate consumer preference for green electricity with publicity campaigns.
- Energy/CO_2 tax with tax exemption for renewable energy.
- Large scale R&D programme for PV.
- Mandatory requirement of installing PV in newly built houses, commercial buildings, sound barriers, etc..
- (Partial) exemption from gasoline taxes for biofuels.
- R&D on the most efficient, cost-effective storage system.
- Allow set-aside subsidies to continue for land used for energy crops.
- Close guaranteed supply contracts between farmers and biomass-fuelled plants .
- Investigate possibilities for combination of land uses.
- Start experiments with biofuels (limited distribution e.g. gas stations from one big oil company along major highways).
- (Partial) exemption from gasoline tax for biofuels.

- Subsidise gas stations/oil companies to provide biofuel outlets (could be done by using part of the gasoline tax).
- Subsidise the development of biofuel (or hydrogen) dedicated cars.

Demand-side

- Strict energy performance standards for new buildings.
- Mandatory energy performance certificate for existing houses upon sale. This could be coupled with subsidies for retrofit and in a later stage (e.g. 2020) be replaced with minimum performance standard.
- Minimum efficiency standards for all appliances, updated every five years, in which the lowest efficiency classes are eliminated.
- Provide tax incentives for public transport users, car poolers (e.g. through tax rules for lease/company cars) and bike-riders.
- Provide tax incentive for tele-working.
- Improve public transport systems (capacity, frequency, reliability, coverage) and bicycle infrastructure (bike paths, guarded bicycle sheds, service stations)
- Limit parking possibilities in city centres and with companies (coupled with providing parking space at train/bus stations).

NB:

The current image is based on the assumption that a 80% emissions reduction is reached in 2050. Probably the most important bottleneck in achieving the energy image foreseen for 2050 is convincing all stakeholders (including consumers and politicians) that climate change is sufficiently urgent to warrant the ambitious changes described in this path.

2. Pathway based on solar hydrogen image

2.1 Quantification of energy demand and supply developments

The participants of the second workshop feared the original energy image (presented under 1) would pose too high demands on the available space in Europe because of the high biomass demand for energy purposes. Large-scale PV plants were suggested as a less land-intensive route for energy production. Therefore, a second, alternative image and path have been developed, which is less biomass-intensive. We have assumed that the amount of land area used for energy crops in this alternative image is limited to 75% of the excess farmland (about 50 Mha, compared to 80 Mha in the biomass-intensive iage). This leaves room for other land uses, such as recreation, extensive farming, etc. Since the majority of the biomass in image 1 was used to produce transport fuel, the PV-generated electricity in image 2 will be used to produce hydrogen, that can also be used as a transport fuel. The image is therefore referred to as the solar hydrogen image. The efficiency of solar hydrogen production is assumed to be 85% (current efficiencies in small-scale plants are 70-75%) [Johansson et al., 1993]. This results in an energy mix in 2050 as shown in Figure 2.1.

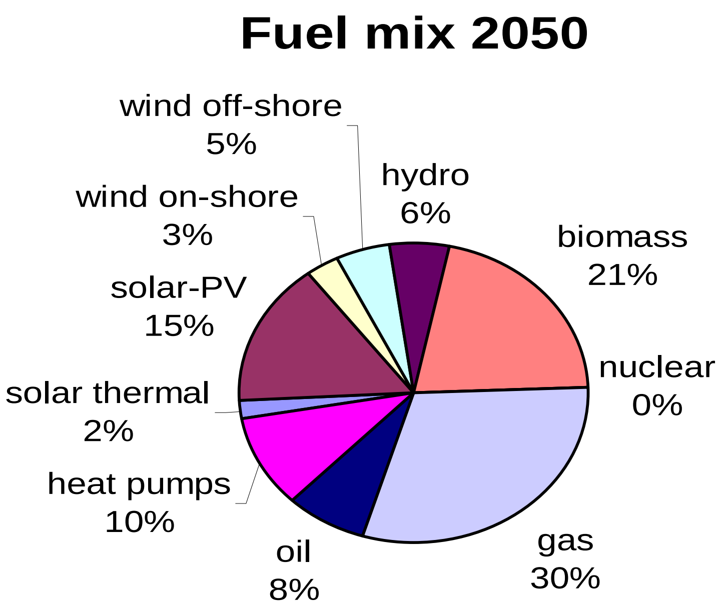

Figure 2.1. Energy mix in 2050 in the second, solar hydrogen image.

Required growth rates in supply

Table 2.1 shows that to reach the desired image, the growth rates for all sources except hydropower need to be high. For biomass and natural gas the electricity production needs to grow with almost 3-4% each year, for 60 years in a row. Solar thermal and wind energy have to experience an annual growth rate of 8-10%, while PV (solar electricity) even has to grow with almost 22% per year over this 60-year period. biofuels. It must be clear that with such high growth rates the rate with which production capacity for e.g. PV modules can be constructed can be a limiting factor. Figures 2.2 and 2.3 show the absolute and relative growth in production for the various energy sources. They show that a high absolute growth occurs in wind and, especially, gas-based electricity production, but by far the largest relative growth occurs in solar electricity.

Table 2.1. Required growth rates for various energy sources to deliver the amount of energy reflected in the energy image[13]

Energy source	Final energy EJ		Growth factor	required annual averaged growth rate
	1990	2050		
Wind energy	0.014	2.5	173	9.9%
Hydropower	1.1	1.8	1.6	0.9%
Photovoltaics	0.0001	4.8	51307	21.8%
Biomass	1.6	6.5	4.6	2.8%[1]
Geothermal	0.03	0.03	1	0%
Solar thermal	0.017	0.6	55	7.5%
Natural gas	1.2	9.4	8	3.9%

Notes: The biomass used in 1990 was almost entirely used for electricity and heat, not for transport fuels. The majority of the biomass energy consumption in 2050 is foreseen to be used for transport purposes. The growth rate for biofuels will therefore be much larger than shown here.

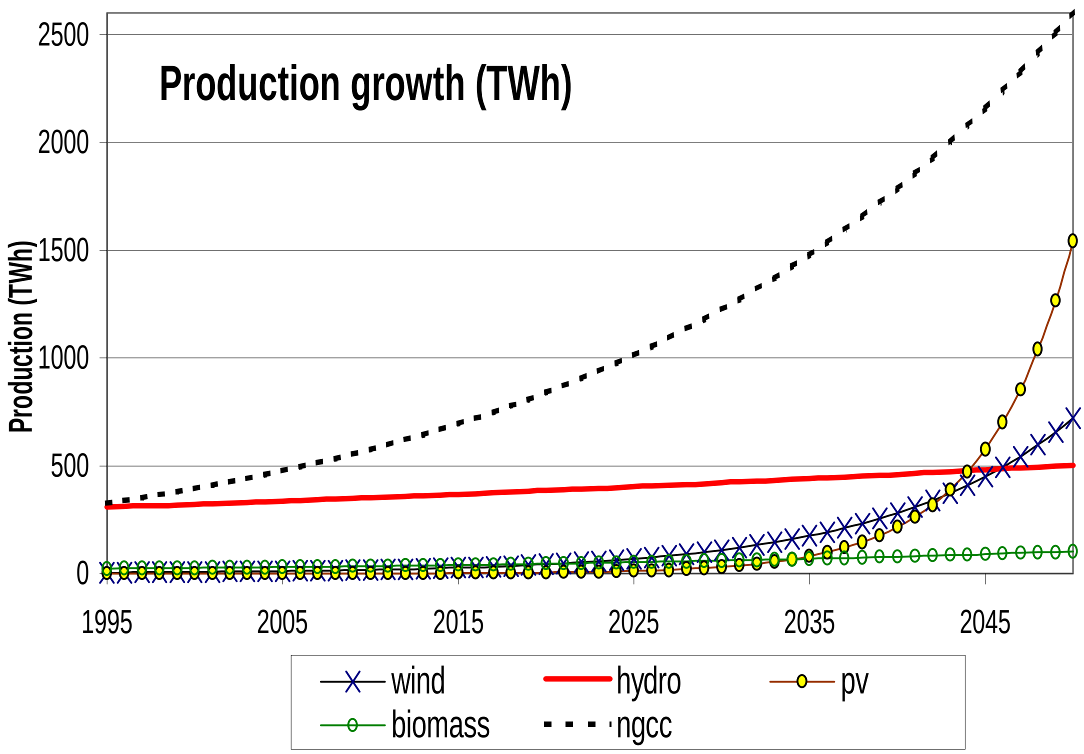

Figure 2.2. Production growth of electricity by source required to meet the contribution of the various energy sources foreseen in the energy image (based on an annual average growth rate).

[13] Note that the image has been changed following the comments of the participants at the second COOL Europe workshop, 6-7 April 2000. Nuclear energy has been omitted from the image. The resulting electricity gap was filled by increasing the amount of wind and solar electricity.

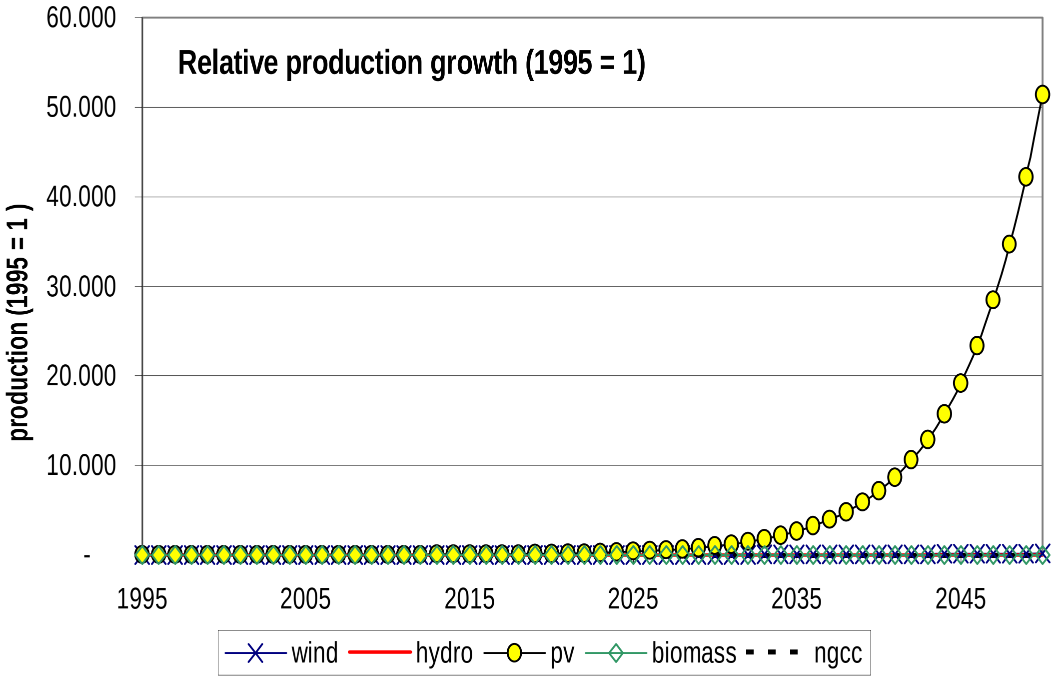

Figure 2.3. Relative production growth by source required to meet the contribution of each source, foreseen in the energy image.

Energy production costs

In the second image the same data on the current costs of producing electricity and transport fuels and progress ratios are used as in the first image [Neij, 1999, Faaij et al., 2000; IEA, 1998].

Figure 2.4 shows the development of electricity production costs with each doubling of production capacity for various electricity supply options according to the progress ratios. Figure 2.5 shows the cost development over time based on the average annual growth rates shown in Table 2.1. The figure shows that if production capacity grows at the same rate (in terms of number of doublings) for all sources PV electricity will remain the most expensive all the way through 2050. The market share of PV can therefore not be enlarged on the basis of production costs. However, the energy image assumes PV electricity production to grow by 22% per year, on average, while other sources ‘only’ experience 1-10% per year in production. From this it is obvious that PV can only play the role foreseen in the energy image if PV is forced into the market (e.g. through regulation or heavy subsidies) or in case major breakthroughs in costs are achieved.

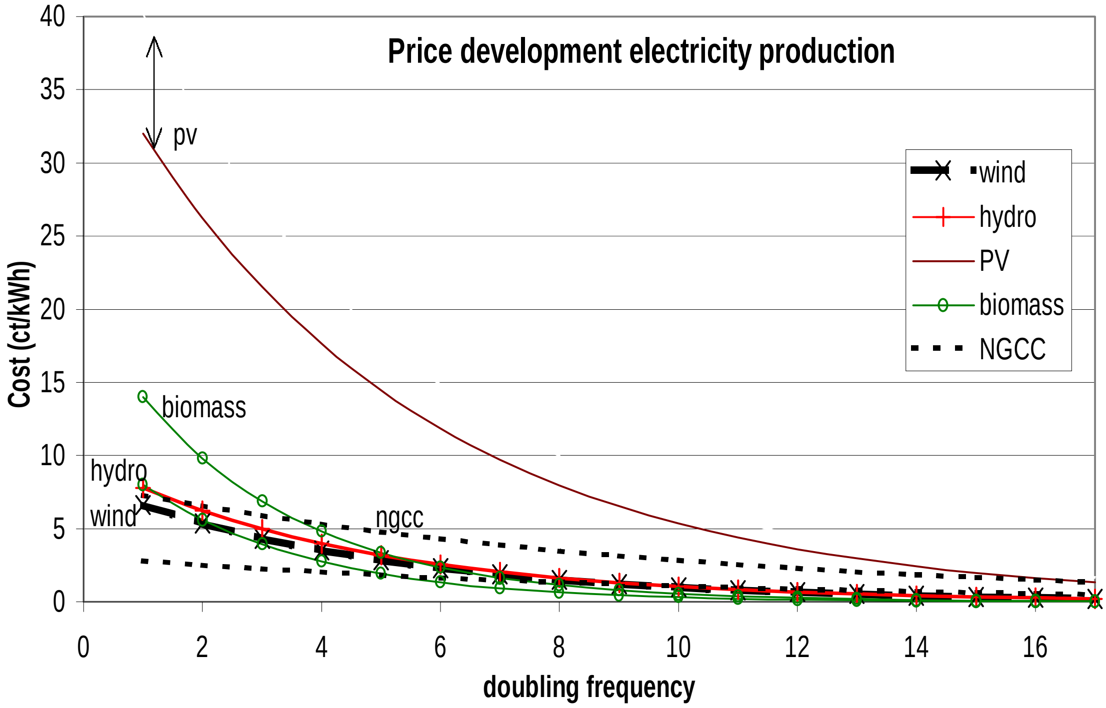

Figure 2.4. Cost development for electricity production by renewable energy source with each doubling of production capacity (according to the progress ratio's shown in Table 2.2. For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed.

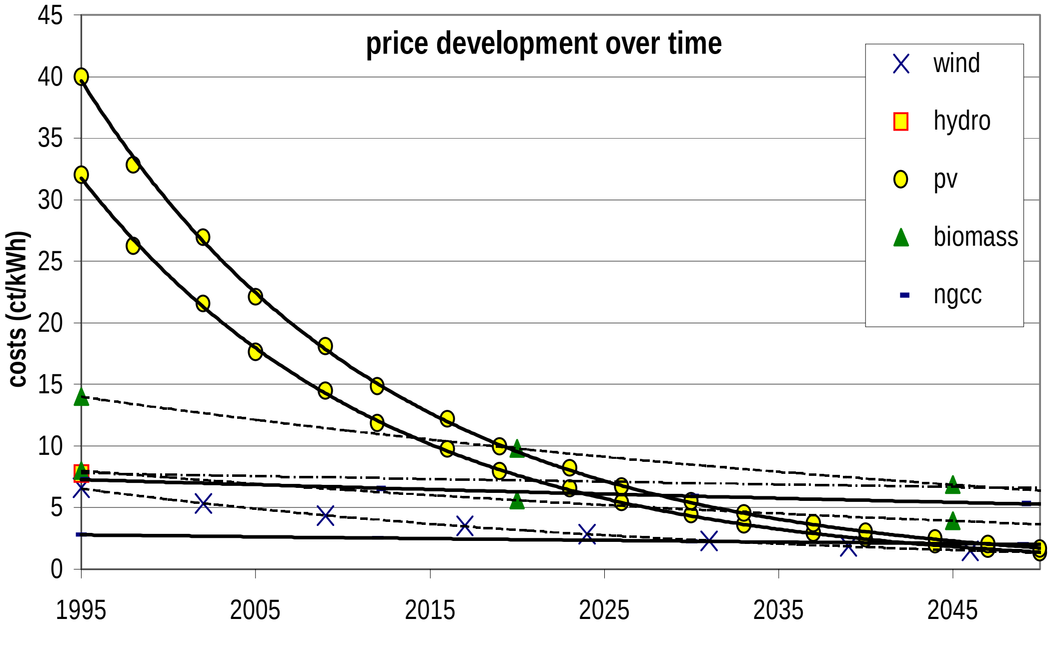

Figure 2.5. The development of electricity costs by source over time ($ct/kWh). For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed.

In image 2, the same long term costs for biofuels for transport are used as in image 1 [Faaij et al., 2000]. For solar hydrogen a cost range of 25-30 US$/GJ delivered at the car is used. Note that these costs are based on production on sites in Europe. In case the hydrogen is produced in the African desserts, prices will increase with an additional 10-15US$/GJ [Johansson et al., 1993]. Together with the cost estimates for electricity production from Figure 2.5 and the total consumption of fuel and electricity by source, total energy supply costs in 2050 for the solar hydrogen image can be calculated. These are shown in Figure 2.6. Figure 2.7 shows the relative contribution of each source to the total costs.

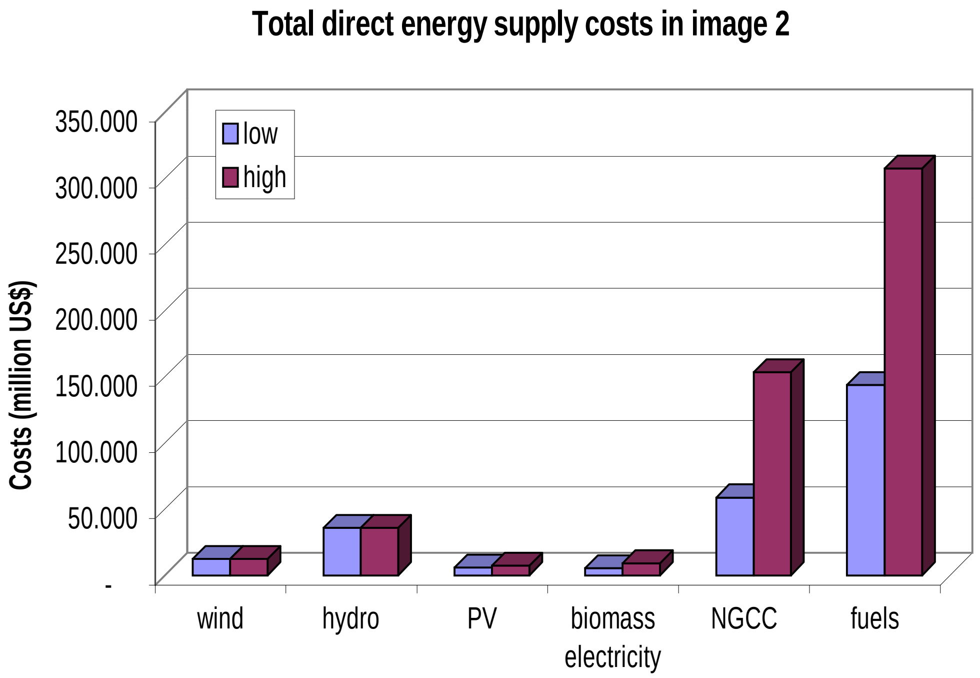

Figure 2.6. Total costs of energy supply in 2050 in the solar hydrogen image. For the gas-fired plants (NGCC) the high estimate reflects a plant with CO_2 removal and storage, while the lower figure does not include the removal and storage option. In the current image no CO_2 removal and storage is assumed. For biofuels, the low estimate refers to ethanol from wood, the high estimate refers to biodiesel. Note that the costs for solar hydrogen are included in ‘fuels’, not in ‘PV’. From the fuel costs, about 60-70% is for solar hydrogen.

Breakdown of energy supply costs - low

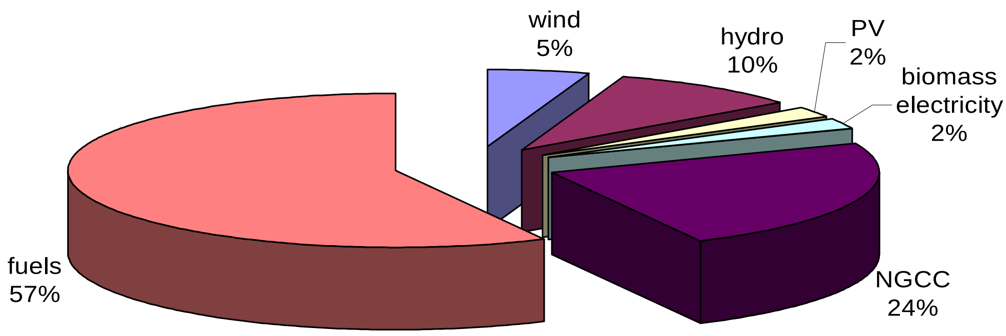

Figure 2.7. Breakdown of energy supply costs (low estimates) by energy source in 2050 in the solar hydrogen image.

Security of supply

When using substantial amounts of intermittent energy sources, security of supply deserves might be threatened. Especially solar and wind energy sources can show great variability depending on whether conditions, the time of day (for solar) and the season. But also hydropower and biomass are, on a seasonal basis, depending on weather conditions. The share of intermittent source in electricity generation in the solar hydrogen image are the same as in the biomass-intensive image (almost 50% of electricity generation in 2050 is covered by intermittent sources, of which 3/5th is from highly fluctuating PV and wind sources). As a consequence, security of supply cannot be guaranteed without either a substantial over-capacity or a storage system. In addition, the solar hydrogen image is also depending on highly fluctuating solar energy sources for 1/3rd of its fuel demand. This means a substantial amount of fuel must be kept in storage to secure the supply of transport fuels e.g. during winter.

The demand-side developments in the solar hydrogen image are comparable to those in the biomass-intensive image, described in Section 1.

2.2 Bottlenecks and intermediate steps

The bottlenecks and required intermediate steps towards image 2 will be to a large extent be similar to the ones described in section 1.2 and 1.3. Here we will discuss the most important differences.

- The amount of land required in the solar hydrogen image is smaller than the biomass-intensive image. Since the land demand is limited to 75% to expected excess croplands, there will also be room left for other activities with a demand for land. Land demand is therefore not expected to be a problem in the solar hydrogen image. Biomass will, however, still contribute a substantial part to the energy supply in 2050. Therefore, the intermediate steps discussed in section 1 will still be needed.

- The introduction of PV has to be much larger in the solar hydrogen image than in the biomass-intensive image. Therefore, technological breakthroughs, substantial cost reductions and strong policy actions have to be attained to an even larger extent than in the biomass-intensive image.
- Security of supply is a bigger issue in the solar hydrogen image, since the contribution of intermittent sources is larger than in the biomass-intensive image. However, large part of the PV capacity will be used for fuel production, which is, in a way, a storage system. A sufficiently large amount of fuel would need to be kept in storage to be able to act as a buffer for transport purposes alone (to make sure fuel demand can be met at times with less sunshine). To flatten out fluctuations in electricity supply (e.g. from wind), additional storage capacity and quickly adjustable capacity (coming on/off lone quickly) will still be needed.
- With regard to transport fuel infrastructure, the same vicious circle (low demand -> so no infrastructure is developed -> so no demand can develop) needs to be broken as with the biomass-intensive image. Hydrogen vehicles would create the flexibility of using different possible routes for hydrogen production (produced from renewable electricity, biomass or fossil fuels). It does not, however, offer a solution for the transition phase in which the switch from conventional to alternative fuels take place (such as with biofuels, that can be mixed with gasoline).

Figure 2.8 shows a comparison of the total direct energy supply cost between the two images, showing the big difference in costs, realted to solar hydrogen production.

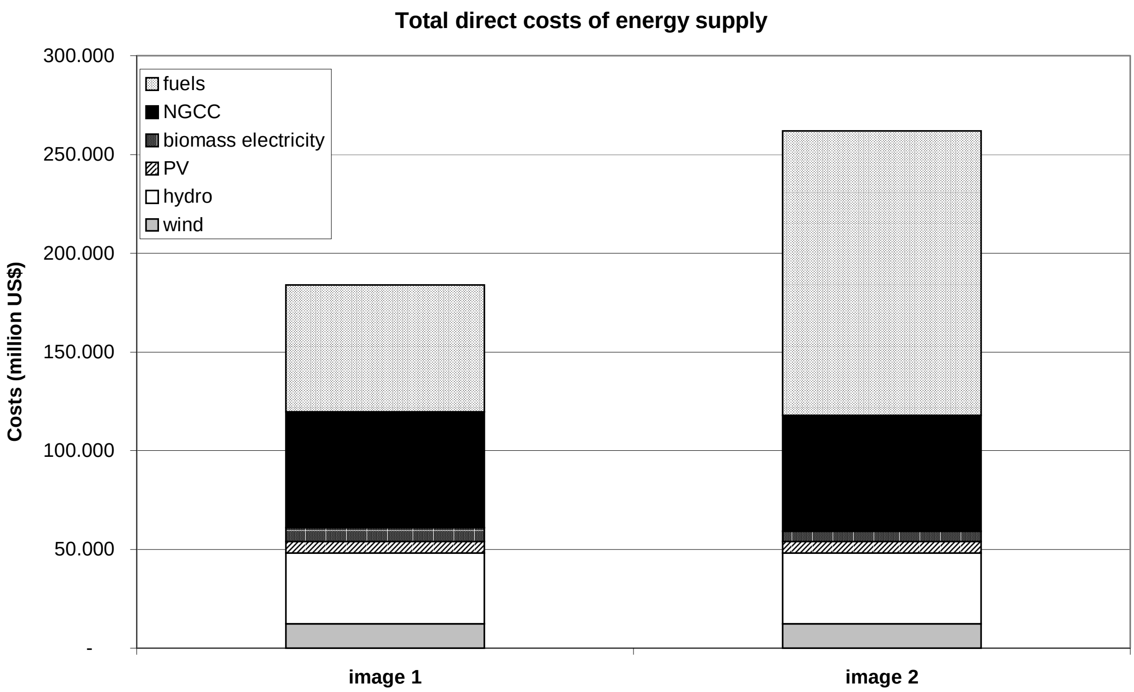

Figure 2.8. Comparing total direct energy supply costs between 1. the biomass-intensive image and 2. the solar hydrogen image (low estimate). Note that solar hydrogen costs are included under ‘fuels’, not with ‘PV’.

References

Capros, 1999, *European Union Energy Outlook to 2020*, The Shared Analysis Project, European Commission, Brussels.

Faaij, A., C. Hamelinck and M. Tijmensen, 2000, 'Long term perspectives for the production of fuels from biomass: integrated assessment and RD&D priorities – preliminary results', proc. Of *the First World Conference and Exhibition on Biomass for Energy and Industry*, Sevilla, 5-9 June 2000.

IEA, 1998, *Energy Technology Price Trends and Learnin*g, Commission on Energy Research and Technology, Paris.

Johansson, T.B., H. Kelly, A.K.N. Reddy, R.H. Williams, 1993, *Renewable Energy; Sources for fuels and electricity*, Earthscan Publications Ltd, London.

Neij, L., 1999, *Dynamics of Energy Systems; Methods of analysing technology change*, PhD thesis, Lund University, Department of Environmental and Energy Systems Studies, Lund.

Annex V: Framework for strategic vision documents for COOL Europe

This note deals with the end product of the COOL Europe process, the strategic visions. The culmination point of the discussions of the energy and the transport groups in the European COOL Dialogue will have the shape of "strategic vision" documents. This note gives the two sector groups some tentative guidelines for the design of their strategic visions.

1. The function of the strategic vision

A strategic vision is an inspiring narrative about feasible choices. What would we like to see happening? What are we able to realise? What are the steps to be taken to achieve this? In the European COOL Dialogue we suppose that the emission for greenhouse gasses in Europe in 50 years is reduced by 80%. The question arises: which steps should and could be taken in the coming fifty years in order to realise this goal?

A strategic vision for the long term includes concrete decisions on the short term. As the focus of the project is Europe, the vision should reflect in particular on ideas about the kind of European settings in which different actions could take place.

The central questions are:

- What are the most promising long-term options for the sectors?
- What are the key boundary conditions on which these options depend, paying especially attention to the European setting?
- What actions are needed on the short term to make these option works?
- How can we best promote partnerships among the stakeholders on the European scale in order to implement these options?
- How can we best send out the message to the relevant actors that the objectives and options are desirable and feasible?

The European COOL Dialogue is meant as a common creative process and not as a planning process. By identifying what is needed on the short term in order to realise the long-term options, we develop a better insight in the feasibility of the desirable options.

A strategic vision can be used in several ways: as an example how long-term ideas could be concretised; as inspiration to start further long-term thinking; in decisions about the contents of a R&D programme; as a stimulus to start co-operation and partnerships with others; as public relation instrument; as starting point for discussion with authorities; as reference point for investment decisions etc. The transport and energy groups themselves have to decide on what the ambition level of their strategic vision is and what would be relevant addressees.

It is important to stress that the European COOL Dialogue does not aim at consensus, but that the quality of the argumentation underlying the possible choices counts. This implies that the vision document should state clearly on which issues there is consensus and on which issues there is not consensus about preferred options. In both cases, the underlying argumentation of preferred options should be described extensively.

It should be kept in mind that the strategic vision cannot be expected to be complete or comprehensive. Only a limited set of aspects can be elaborated. Choices are made based on the preferences of the groups and the elaboration is based on the limited time and resources of information available in the groups.

The size of the document will possibly be 15 to 20 pages, excluding annexes (which may consist of, for example, scientific input papers or other material that played a role in the assessment process).

2. Proposed structure

The two groups define the content, size and the ambition level of the vision document. Below follows a proposal for the structure which the sector groups can use as a guiding framework and which they can also amend.

Summary
The summary contains the conclusions and recommendations of the sector group, emphasising the key issues:

- interesting long-term options which are expected to have a high potential
- possible implementation trajectories
- key actors/institutions and key decisions/actions/investments on the short term

Chapter 1: Images of the Future.
This chapter reflects the first step in the back-casting approach in which an idea about the sector in the future is developed in the form of images of the future. The images of the future form the reference points for the development and assessment of the options.

Chapter 2: Options
In this chapter an overview is given of the options which have been discussed extensively, including the arguments why the expected potential of that option is high or low. All kind of options can be mentioned: technological options, institutional changes/options, public and private policy options, awareness raising campaigns etc. When assessing the potential of the options it is recommended that the following factors are taken into account: technical, financial and social feasibility and expected reduction potential of greenhouse gas emissions. The technical aspects of the options should not dominate; it is the aspects related to implementation that should get most attention.

Special attention should be given to the European dimensions of specific options (e.g. requirements of co-operation between several countries within Europe/EU and/or political (and economic) support by the EU).

The earlier formulated future images could function as a reference point when exploring the options.

Chapter 3: Implementation trajectories (path analysis)
Chapter three includes a description and analysis of implementation trajectories of interesting options which are expected to contribute significantly to the realisation of 80% reduction of greenhouse gas emissions by 2050.

This chapter is the result of discussions in the third step of the dialogue exploring what is needed to realise the options, areas where further research is needed, what kind of uncertainties exist, which obstacles for implementation are to be expected and how can those obstacles be dealt with.
Possible elements, according to which the different options could be described, are:

- key choices,
- key actions and actors,
- boundary conditions,
- obstacles and opportunities to be expected
- uncertainties,
- examples of possible surprises

If relevant, attention could be paid to the relation between options selected by the group. Where and when do a mutual dependency or mutual reinforcements between options occur? There should be also attention for consequences of the options for other sectors and for actions in other sectors.

Chapter 4: Back to the beginning of the 21st century

The last chapter deals with the short-term implications of the implementation trajectory: about the concrete here-and-now. Questions to be addressed are for example:

- Which opportunities does the sector see for itself, given the developed implementation trajectories?
- Which recommendations are there for other private actors or sectors?
- Which recommendations are there for the national governments?
- Which specific recommendations are there for the European Commission and the Council of Ministers?
- Which specific recommendations are there for institutional reform and the enlargement process in the EU?
- Which recommendations are there for scientific research?
- Which role is foreseen for (individual) citizens?
- Which implications do the implementation trajectories have for capacity building in Europe (capacity with regard to competence, resources and legal matters)?
- Which implications do the implementation trajectories have for the national, European and global agendas?
- What kind of innovations suggested by the COOL Europe process could be useful for the further development of the international climate policy regime?

3. Practical issues

A first draft for the strategic vision document will be made by members of the COOL Europe project team, based on the discussions and outcomes of the first three workshops. This draft will be discussed and amended in the fourth workshop according to the ideas of the sector groups.

Annex VI: Backcasting instructions for COOL Europe workshop 3

Preparations.
Divide the sector groups into two subgroups (or three) (3-5 persons in each group)
Attach two long papers (with a time line 2000-2050) horizontally to the wall.
Ask one person in each subgroup to be a facilitator (the facilitator should also give his views).

<u>The eight steps in the backcasting exercises are the following:</u>

- **Step 1**. Put the option (a concrete and desirable goal) at the end of the time line (2050).
- **Step 2**. Continue with a short brainstorm (15 minutes) based on the following question: Assuming that this option has been realised in 2050, which problems (obstacles etc) have been resolved in the previous fifty years? Put all the answers on a flip-over without discussion (questions for more information are allowed). Add a short brainstorm on chances and opportunities. Put also these ideas on a separate flip-over paper.
- **Step 3**. After the brainstorm ask: 'what do you think is the two most challenging problems? (this means: important to solve *and* more or less open for concrete human influence.)
- **Step 4**. Discuss (5 minutes or so) the two 'most challenging problems' to be selected
- **Step 5.** Take the most challenging problems one by one and ask: what is needed to solve this problem? Brainstorm about possible action to be taken. Elaborate on the most promising possibilities (for example, a ten year R&D programme, institutional reforms etc) and transfer them into concrete steps on the time line. Indicate what can be realised at which moment, key intermediate step, who are the most important actors, etc. The participants are free to ask questions, make proposals, and suggest links. These questions and proposals can also be written down on a flip-over paper.
- **Step 6.** Prepare the final version of the time line (15 minutes). Use a new time line paper if this is considered to be necessary to convey a clear message.
- **Step 7**. The result is a time line filled with concrete steps to solve some challenging problems leading to the realisation of the desired option.
- **Step 8**. Presentation of the time line for the whole sector group (5 minutes).
- **Step 9**. Reflection and discussion in the sector group. Are there any aspects that have been neglected? What issues should be followed up? Formulation of questions to science.

ANNEX VII: The EU's Climate Leadership: Reconciling Ambition and Reality

Draft of august 2000. Permission to print kindly granted by Kluwer Academic Publishers.
Full reference to the final paper:
Gupta, J. and L. Ringius (2001). "The EU's Climate Leadership: Reconciling Ambition and Reality." In: International Environmental Agreements: Politics, Law and Economics, Vol. 1, No. 2, April, pp. 281-299.

By Joyeeta Gupta and Lasse Ringius[14]

Key words: European Union, climate change, directional leadership, instrumental leadership, structural leadership.

Abstract: This article argues that while the EU aspires to and is capable of structural, directional and instrumental leadership in the climate change regime, it has thus far not fully utilised this potential. This is partly because of the implementation difficulties which make any external instrumental leadership less credible. It is also because the internal negotiation process is so complicated that the EU has not taken the time to evaluate the possible impacts of its positions on other countries. Nevertheless, the EU is pushing the process forward. The article recommends that if the EU wishes to maintain its leadership role, it needs to adopt a combination of the three types of leadership and a short, medium and long-term strategy.

Abbreviations: CDM: Clean Development Mechanism, CEIT: Countries with Economies in Transition, EU: European Union, FCCC: Framework Convention on Climate Change, JI: Joint Implementation, KP: Kyoto Protocol.

Introduction

The ratification deadlock: need for leadership

The Kyoto Protocol (KP) to the United Nations Framework Convention on Climate Change (FCCC), adopted in 1997 is a major achievement of global environmental diplomacy. It sets binding targets for developed countries and countries with economies in transition (CEITs) and contains three new climate policy instruments, namely Joint Implementation (JI), the Clean Development Mechanism (CDM), and emissions trading (commonly termed the flexibility mechanisms). Although it developed rapidly in the early stages, the climate change regime is now at a critical stage because just 22 developing countries have ratified the KP. U.S. ratification appears to be dependant on 'meaningful participation' by developing countries (Clinton 1997). Initially it appeared that the EU and Japan would only ratify when and if the U.S. did so. This is insufficient for the KP to enter into force and implementation of domestic measures and the flexibility mechanisms has consequently been delayed. The climate regime will possibly lose momentum if the KP does not enter into force soon. There is clear need for leadership to break the negotiation and ratification impasse. It is against this background that we examine the potential for the European Union (EU)[15] to play a leadership role in the climate regime by assessing multidisciplinary published analyses (Ringius 1999a, b, Ott and Oberthür 1999, Gupta and Grubb (eds.) 2000, Haigh 2000, etc.). We also draw

[14] The first author is a senior researcher at the Institute For Environmental Studies, Vrije Universiteit Amsterdam; while Ringius is Senior Researcher at the UNEP Collaborating Centre on Energy and Environment, Risoe National Laboratory, in Copenhagen.
[15] Although it is the European Community that is empowered to sign and ratify international agreements, we follow the common usage in this field and talk about the EU.

extensively from 63 interviews with negotiators and observers from EU and non-EU countries (Gupta and van der Grijp 1999).

At this stage of the negotiations, the key issue is that of distribution. The perceived magnitude of the costs (and benefits) of climate control and their international distribution cause widespread concern (especially in the US), and it largely explains the current deadlock among OECD countries. The perceived disappointment in the leadership role of the developed countries to some extent explains the deadlock in the negotiations between developed and developing countries. Hence, we examine a set of inter-linked issues: international burden sharing, policies and measures, the flexibility mechanisms, increasing international participation in mitigation projects (especially the inclusion of developing countries) and issues in relation to adaptation.

Theoretical perspectives

The literature reveals many terms to describe different types of leadership (Young 1991, Underdal 1994 and Malnes 1995). These terms, all subtly different, include structural, coercive, 'carrots and sticks approaches', entrepreneurial, instrumental, problem-solving, intellectual, unilateral and directional leadership. For this article, we build on leadership definitions explored in a project on EU leadership in the climate regime (Grubb and Gupta 2000: 23). We define a *structural leader* as one who acts on behalf of a state and leads the bargaining process by constructive use of the power that stems from the state's material resources and sometimes takes the shape of "carrots" and "sticks". A *directional leader* demonstrates through domestic implementation that the goal is achievable and attempts to shape how negotiators perceive the issues under consideration and think about solutions to these issues. For example, this type of leadership can be shown when the EU sets an example for others to follow and demonstrates its willingness and ability to deal with the climate problem, and thereby increase its symbolic power and legitimacy.[16] An *instrumental leader* uses negotiating skills to construct mutually beneficial solutions using issue-linkages, coalition building and moves away from distributive towards integrative bargaining.

Structural leadership is not merely a question of economic and political power, but the way the power is used to craft incentives for others to participate in the process. Directional leadership is not merely being 'ahead of the crowd', but influencing behaviour through changing the incentives of other actors, demonstrating the feasibility, effectiveness or efficiency of a particular measure, and thus changing the perceptions and beliefs of others, or by demonstrating that a particular course of action may be normatively compelling and thus 'raise the moral standard' that others will be judged against.[17] Finally, instrumental leadership is not just mastering negotiating skills, but using these skills to pursue issue-linkages, issue-based coalitions and integrative bargaining.

Before examining the EU's capacity for directional leadership, we briefly discuss the EU's capacity for structural leadership. The EU by virtue of its membership (at present fifteen countries, but likely to grow considerably), combined population (370 million) and its combined GDP (5690 billion ECUs; European Community 1998: 18) has considerable structural power. It is a unique and globally important actor. Its major potential strength is that it combines growing political will and implementation potential (see Section 2) with a common negotiating position for fifteen industrialised countries (see Section 3). It can potentially rely on the fifteen foreign affairs (and often environmental) departments of member states to use their long-standing diplomatic relations with most countries in the world. It has a high-risk profile, at least in relation to climate change. Although the EU

[16] On this type of leadership, see Ringius (2000).

[17] For example, in an open economy unilateral emission control measures by one country would tend to reduce the indirect abatement costs faced by competing economies. We are indebted to Prof. A. Underdal for his insights in relation to this paragraph.

provides financial support to non-EU countries on energy policy via the programme - SYNERGY, and on related policy areas via THERMIE, ALTENER, INCO, LIFE, TACIS and PHARE, on forestry via the Lomé Convention, it has not developed incentives purely based on its structural power but rather linked to its aspiration as directional and instrumental leader.

The EU and DIRECTIONAL LEADERSHIP

Potential to reduce emissions

Unlike the JUSSCANNZ[18] and the Umbrella groups,[19] the EU has generally been optimistic about the domestic opportunities for reducing greenhouse gas (GHG) emissions. In 1997, the European Commission (1997) predicted that new policies and measures could reduce total CO_2 emissions by about 800 million tonnes by the year 2010, equalling a 15 percent reduction compared to the 1990 level. This reduction could, if made cost-effectively, be achieved at a cost of 0.2–0.4 percent of GDP in 2010. The largest potential for emission reduction was in passenger cars in the transport sector and through cogeneration and renewables in power generation. In the absence of new policies, however, total emissions were predicted to increase by 8 percent over the 1990 level by 2010. In the Second Communication from the European Community (1998: 9), it is stated that it is likely that the EUs CO^2 emissions will have stabilised in 2000 with respect to 1990 levels, but that it cannot be excluded that the emissions may rise up to 5% above 1990 levels.

But this optimistic scenario does not indicate that the EU has indeed transformed its production and consumption patterns through sustained policy development and implementation. A recent European Environment Agency study (Berdowski *et al.* 1999) shows that the EU as a group has managed to nearly stabilise emissions in the 1990-1996 period primarily because Germany and Britain have offset increases in emissions from the remaining thirteen countries. Moreover, circumstances and policies largely unrelated to climate policies have contributed to significant GHG reductions within the EU. German reductions have to a significant degree been the result of economic restructuring in the former East Germany. British reductions have mainly been an unintended outcome of privatisation in its energy sector (cf. European Community 1998). Having said that, one must acknowledge that most member states have adopted a number of measures to deal with the problem of climate change, but the high economic growth has led to emission increases that have offset planned reductions.

The Union has competence on trade, tax and foreign policy and competence to harmonise laws on environmental, energy, and transport.[20] It has used its competence to liberalise electricity markets, to adopt the Integrated Pollution Prevention Control Directive,[21] revise the Large Combustion Power Plant Directive, to adopt the Directives on Packaging and Packaging Waste and landfills, and reform the Common Agricultural Policy, all of which will have impacts on the EUs GHG emissions. Since 1990, the EU has explored four major policy instruments to reduce emissions, namely carbon/energy taxes, policies to encourage demand side management and the use of renewable energy, and the common monitoring mechanism (Ringius 1999b, Wettestad 2000, Dahl 2000).

Although the carbon/energy tax has been on the EU agenda for a long time, progress has been slow. The reasons are manifold. Some countries argue that fiscal issues should be decided at

[18] This is a loose coalition of Japan, the US, Switzerland, Canada, Norway, and New Zealand.
[19] This coalition consists of some JUSSCANNZ members and Ukraine and Russia.
[20] This is specially seen as necessary to encourage some countries like Belgium and Italy to take on measures.
[21] This Directive includes Energy efficiency as a criterion for the determination of best available technology (European Commission 1998: 9).

national level. Others believe that these taxes will have a negative impact on the competitiveness of industry. Further, the consensus requirement for fiscal environmental measures and the need for lenient treatment of the Cohesion countries (i.e. Greece, Ireland, Portugal, and Spain) severely impedes progress. There is a proposal for a minimum energy tax on the table and several countries have individually adopted some taxes, most notably Germany with a far-reaching progressive energy tax. The opposition to these taxes seems to have weakened at EU level but a tendency to "nationalise" fiscal issues is apparent.[22]

In 1987 the Commission developed the SAVE (Specific Action for Vigorous Energy Efficiency) programme to promote energy efficiency measures. Unfortunately, the resources and regulatory content were weakened by the time the programme was adopted, and it had little impact on energy efficiency (Wagner 1997, Collier 1996, Wettestad 2000). However, it did achieve legal and administrative actions improving the performance standards of buildings and equipment and greater efficiency in power generation and supply, and support for 250 pilot actions (European Community 1998: 38). The follow-up programme (SAVE–II) with a budget of 66 million Euros aims to stimulate energy efficiency, encourage energy conservation investments by private and public consumers and industry, and improvement of the energy intensity of final consumption (European Commission Press Release 1999b). Directives on energy efficiency requirements for household refrigerators and freezers (96/57/EC), on energy labelling of household washing machines (96/57/EC) and on energy labelling of combined washer-dryers (96/60/EC) have also been adopted.

The EU has also developed the ALTENER programme (1993-1997) to promote renewable energy. Although ambitiously conceived, it was weakened in content and budget by the time it was adopted and there is no assessment available of the impacts of the programme in terms of avoided emissions (Wettestad 2000; Collier 1996, European Commission 1998). The evaluation of the programme led to the adoption of ALTENER II (1998-2002) and it is expected that the use of renewables could lead to a 16% reduction of CO^2 emissions in 2020/1990. The Parliament-Council Conciliation Committee has agreed to spend 77 million Euros on ALTENER (European Commission Press Release 1999b).[23]

The monitoring mechanism for GHGs, a key EU programme with significant potential, has been affected by poor implementation. Member state reports have been delayed and their quality has varied, and no reports were prepared in 1997 and 1998 (Coffey, Wilkinson and Haigh 1998; European Commission 1998). Haigh (1999) speculates that the lack of commitment to form, suggests lack of commitment to substance by the member states.

The Commission has initiated a strategy to improve the fuel efficiency of passenger cars (which contribute 12% of EU CO^2 emissions) to reduce CO^2 emissions from new cars to 120g/km by 2005 and at latest by 2010 (European Commission 1998) through voluntary agreements with industry, fiscal incentives and CO^2 emissions labelling (European Commission Press Release 2000). The recent agreement with the Automobile Manufacturers Association is encouraging though researchers are wary of being too positive about the outcome (Wettestad 2000: 40). The Parliament Council Conciliation Committee has agreed on 9 March 2000 to establish a monitoring scheme for CO^2 emissions from new passenger cars which would have to be confirmed by an absolute majority of votes in the Parliament and a qualified majority in the Council.

Such a monitoring scheme would strengthen the impact of voluntary environmental agreements with the car industry. About 310 such voluntary agreements have been made in Europe. However, experience with voluntary environmental agreements is mixed at the national level and there are examples of targets set below business-as-usual levels because of

[22] See Schlegelemilch (1998) for a detailed analysis of the energy tax issue.

[23] At the same time, the effectiveness of the these measures is undermined by the subsidies in the EU on coal and energy. The average annual direct subsidies to energy producers in Western Europe is 19.9 billion US dollars (Ruigrok and Oosterhuis, 1997).

the strategic behaviour of industry and few environmental agreements actually include a monitoring clause (Carraro and Léveque1999:3; Liefferink and Mol 1997).

Another opportunity is policies facilitating the integration of environmental issues into other policy areas. Although on the agenda for more than a decade, the Commission has only recently committed itself to a number of measures including: a new integration unit reporting directly to the Directorate General (DG) for the Environment, an integration correspondent in each of the DGs, environmental appraisal of proposals with environmental effects, an annual appraisal of environmental performance, and an environmental code of conduct. The 1997 Amsterdam treaty emphasises sustainable development and environmental integration, and the Cardiff process initiated in June 1998 has led to the development of strategies for the integration of the environment into policy areas such as energy, transport, and agriculture (European Commission 1999; European Commission Press Release 1999). Although the Commission's strategies are general and lack specific targets and satisfactory indicators for measuring policy integration (e.g. see House of Lords 1999), sectoral integration and mainstreaming of the environment could have a significant impact on the EU's ability to address the climate problem. While a general prescription for common policies and measures fails given the internal structural diversity, there are thus reasons to believe that in specific issue areas, common and coordinated policies may lead to benefits for the EU as a whole and individually; however, there is limited unequivocal research in this area.

The EU has had most success in tackling the complex and controversial internal burden sharing issue. Since 1990, the EU has had a common target. However, allocation of targets among the member states proved difficult. The breakthrough came with the development of the so-called Triptique Approach by Dutch experts (Blok et al. 1997) and decision-makers. This bottom-up approach to differentiation calculated national obligations by adding individual allowances for three economic sectors (domestic, heavy industry and electricity generation) and by taking economic growth, population changes, and climate-adjusted energy use into account. The sectoral allowances themselves were not regarded as sectoral targets.[24] This approach created a useful framework for the EU's internal negotiations prior to Kyoto and facilitated agreement on a differentiation of national targets and an overall target for the OECD (Ringius 1999a).

The EU also has considerable support from environmental groups, industry, the research community and municipalities. European non-governmental organisations, including the Climate Network Europe and the World Wide Fund for Nature have been actively lobbying. 800 European local authorities are members of the Climate Alliance which aims "to halve CO_2 emissions by the year 2010, and then to reduce them even further step by step" (Klima-Bundnis/Alianza Del lima e. V. 1999: 3). European industry is also responding with concrete proposals (e.g. Shell and British Petroleum are developing renewable energy services, the European Chemical Industry has a Voluntary Energy Efficiency Programme (CEFIC 1997), and the European Business Council for a Sustainable Energy Future promotes a renewable portfolio obligation for all energy service companies (E5, February 1998)). The building sector consumes a substantial part of the energy in Europe and significant emissions reductions could be achieved if the EU develops innovative ways to encourage creation of

[24] A per capita approach was used to calculate emission allowances in the domestic sector. The Triptique Approach assumed that the emissions from the domestic sector would converge at the same level in the member states in year 2030, and that emission allowances per capita were identical in all EU member states in 2030. Energy efficiency improvement targets were established for the heavy industry. Because of large differences in the EU electricity sector, a tailor-made approach was followed to calculation of emissions allowances in this sector. Significantly, it was assumed that the poorer member countries should carry lesser burdens and, rather than choosing a single indicator at the level of individual members, the approach combined several energy indicators at the sectoral level. In this way it shifted attention away from comparing contributions and fairness among members to comparing sectoral contributions and fairness across sectors in the EU.

coalitions of actors such as ICI's Euroce (European Alliance of Companies for Energy Efficiency in Buildings) and interested local authorities (EC workshop, 1998). Under SAVE-II, there is a new initiative to encourage local and regional energy management agencies undertake such projects (European Community 1998: 39). Given industry's extended time-horizons, they are likely to be the most suitable bodies to provide and support long-term leadership (Graedel and Allenby 1995: xvii; Fussler and James 1995: 16). But since they are also affected by "industrial inertia" (cf. Byé 1997, Fussler and James 1995: 9), healthy scepticism would not be out of place.

Implications

Thus, the EUs GHG emissions are around 1990 levels and it is pursuing a range of common and coordinated policies and measures and internal burden sharing arrangements. However, the reduction in the growth of the emissions cannot be substantially attributed to EU policies and thus does not have the demonstrative effect required to influence others. Nor does it promote confidence regarding sustained emission reductions in the future. Neither, does the EU have much experience with flexibility mechanisms and emission trading. Part of the EU's shortcomings in relation to policy design may be attributed to lack of uncontroversial research. For example, Hourcade et al. (2000) point out that experts argue about the results of bottom-up and top-down models, the existence of double dividends from ecotaxes, the impact on the competitiveness of industry, the usefulness of a uniform tax, etc. and these scholarly debates produce conflicting advice for policy-makers. Instead it is to the credit of the EU that it is trying to grapple with such complex and uncertain issues.

This brings us to a discussion of the EUs institutional structure. Europe's advantages over other groups of countries is that it has a supranational regulatory framework that gives opportunity for implementing measures in the member states. However, the voting procedures in the Council are time consuming and delay action. The unanimity rule has led to decisions that reflect the lowest common denominator and lack of harmonisation of environmental directives (unlike the directives dealing with the technical obstacles and the internal market) (Johnson and Corcelle, 1997: 4). The Environment Commission seems to be understaffed and there are conflicts between Directorate Generals (Jachtenfuchs and Huber, 1993), between Councils, between countries, and between ministries in member states. Since mid-1999, the powers of the EU Parliament have, however, increased.

As a supranational organisation, the EU is potentially able to facilitate a decision-making process that commits fifteen countries. The EU is still in a learning process and if it fine-tunes its administrative and political machinery, if it implements its policies, it will be able to exert strong directional leadership. As mentioned, it seems that the EU's emissions will be close to 1990 levels by 2000– obviously this would reduce the challenge of reaching the Kyoto target. Furthermore, the EU influences the prospective members of the EU and encourages them to introduce energy taxes, to adopt demand side management, and to explore potentials for renewable energy.[25] Nigel Haigh's (1999) historical analysis concludes that the EU has become a major influence in national environmental policy, and has started to integrate environmental concerns in other policy areas. Both of these goals were considered unrealistic twenty years ago. The further evolution of the EU as an institution can thus be expected from an examination of its past history.

However, pessimists would argue that the EU's modest achievements reflect the existence of deep-rooted differences among countries, that these differences will be further exacerbated by the new members. In such a case, the EU would be ill-suited to take on the leadership role.

[25] Michaelowa and Betz (2000) argue in favor of using the surplus emissions in Eastern European countries after their accession to the EU. This would not be an indication of leadership, however, but would alleviate some of the pressure for domestic implementation.

EU and Instrumental leadership

EU and its negotiating strategy

As mentioned earlier, instrumental leaders facilitate international cooperation by using their diplomatic skills. This section evaluates the EUs record in the climate negotiations. The EU has been active since 1990 when the European Council adopted a stabilisation target for CO^2 emissions by the year 2000 with 1990 as a base year. This boosted the work of the Intergovernmental Negotiating Committee on Climate Change and facilitated the adoption of similar positions by other developed countries and CEITs. However, the EU was not successful in convincing the US, one of two OECD countries without a domestic target at that time, to agree to a legally binding determinate text on targets in the FCCC.

Subsequently, the EU focused on internal policies and burden sharing. At COP – 1, the EU is credited as having persuaded the G-77 to support its position (Yamin 2000: 50) to establish a negotiating process for legally binding commitments for developed countries. To its credit, the possible lack of international support did not deter the EU from stating that it would conditionally accept a –15% target for the three main GHGs by 2010 in relation to 1990 levels based on the internal burden sharing agreement. The EU claimed that there should be a common target for all developed countries, although it had itself differentiated internally. Despite initial hostility, pressure built up and led to legally binding quantified commitments in the Protocol (Article 3).

The EU position on policies and measures was that the international community should adopt annexes on mandatory common policies, policies that should be given high priority and policies that could be included depending on the national circumstances of countries. It developed this position partly as a fall-back position, if the US continued to oppose targets. Other theories about the EU's reasoning include the need for the smaller EU countries to solve internal disagreements or the wish of Commission to expand its competence through international agreement on policies and measures (Yamin 2000: 52-53; Dahl 2000). The EU was fairly isolated on this issue and was not able to articulate and defend why its approach would be more reasonable, cost-effective and fair to all countries. The final text in the Kyoto Protocol does not reflect the EUs extensive position, but does list policies that countries could focus on (Article 2).

The EU had a clear position on Joint Implementation (JI), the highly debated mechanism in the climate change regime. Sympathetic to G-77 arguments, the EU argued in favour of JI to be limited to countries with quantified commitments and subject to the principles of supplementarity and additionality (see discussion in other articles, this issue). The EU was not supportive of emission trading in the pre-Kyoto phase. However, in the process of the negotiations, although the EU succeeded in limiting JI to the developed countries, no concrete agreements were made on supplementarity and additionality. Further, an article was introduced which opens up the possibility of emission trading. Finally, the Brazilian proposal for a Clean Development Fund, the position of other JUSSCANNZ countries on the need to include developing countries in JI, and the position of some developing countries supporting JI, led to the birth of the Clean Development Mechanism (CDM), i.e. JI aimed at sustainable development.

The Commission's strategy for COP-4 was to focus on principles for the flexibility mechanisms and enhancing the participation of key developing countries (European Commission 1998b). The wisdom of half-heartedly supporting the US position on voluntary commitments from key developing countries is questionable. At the end of the day, this alienates both parties. At COP-5, the EU announced that it would create the conditions necessary for the Protocol to enter into force by 2002.

EU and its influence on other countries

This history indicates that the EU has played a proactive role in the negotiations. In line with negotiation theory which argues that the outcome of negotiations between two strong parties with quantitative objectives/bids tends to be the midpoint of the two objectives, the final Kyoto target for the EU was –8%, and for the US –7%, though the latter's negotiating position was for a stabilisation target. This victory does not go unnoticed, since interviews reveal that the EU is seen as leader in the "number game" in 1990, 1992 and 1997, hence as "fore-runners" and "trailblazers". In quite the same way, the EU was able to limit JI to Annex – I countries and to ensure an article on policies and measures in the Protocol.

However, the influence is not uncontroversial. Non-EU interviewees argue that first, the EUs position on several issues is hypocritical since the EU did not stick to its –15% target (even though this is standard negotiating practice at least in bilateral situations), since the EUs opposition to the high emission allowances to Russia and Ukraine which enable emission trading in so-called 'hot air' is unjustified since the EU itself has benefited from wind-fall gains that have brought its own emissions down; since the EU opposed differentiation for other developed countries, despite internal differentiation and since the EUs insistence on supplementarity is not seen as consistent with its own burden sharing position. Second, interviewees argue that in terms of the ability to make coalitions, the EU was neither proactively engaging in discussions with, or seeking support from the accession countries, developing countries, or JUSSCANNZ. Third, the EU does not often have a clear fall-back position, and is either taken by surprise or is seen to be taken by surprise when new agenda items emerge. This is partly because of the complex nature of the EU that it can seldom manoeuvre in public without a clear-cut internal mandate (Yamin 2000).[26] Finally, analysis of the negotiation shows that the EU influences the agenda more than it does the outcome (Gupta and van der Grijp 2000; see in particular, Gore 1997 and the U.S. State Department Press Release 1998). "The EU has wanted but not been able to perform as a leader" concludes Sjöstedt's analysis (1998: 250). In effect, the EU is seen as a 'leader by default' and even Gore gracefully acknowledged at COP-3: "You have shown leadership here and for that we are grateful".

We believe that there is evidence that the EU raised the moral standard against which others were judged. This may have also been the reason for the resentment expressed by many non-EU developed country interviewees. However, the number game may have been won at some cost since the inclusion of three additional GHGs and sinks in the Kyoto Protocol may weaken the overall goal in relation to the three key GHGs. At the same time, the EU has not demonstrated that emission-reductions can be achieved cost-effectively and measures taken within the EU do not of themselves reduce the cost of taking measures elsewhere.

The EU's inability to operate as one actor with a mandate and room to negotiate gives the US an advantage in international negotiation. However, EU policy is more member-country driven and thus has greater legitimacy and compliance pull in the member states. Nevertheless, interviews reveal that the EU is unable to make full use of its strength because of lack of clarity about the competence of the EU vis-à-vis the sovereignty of member states. Further, aggregating the positions of fifteen countries is difficult and the EU is not perceived to have a well-developed position. On occasion the fifteen states tend to send out different messages. Hence, the EU focussed more on internal coherence ('bunker room mentality') than on international lobbying. At the same time, the EU has to deal with the tendency of the US (and other countries) to negotiate with individual member countries.

By virtue of its fifteen member states and their long-standing contacts with countries in all world regions, the EU has considerable potential for harnessing the diversity of contacts to develop coalitions with other countries. That other countries have primarily used this diversity

[26] However, this is not to say that the EU does not have a confidential fall back position; merely that the EU is unable to respond flexibly to positions and statements of others.

to divide the EU reflects that the EU still has to learn to use this diversity, at least in relation to the climate change issue.

EU and its potential for future leadership

Leadership options for the EU

The EU still has leadership aspirations as the 6th Environmental Action Programme should 'aim at maintaining EU leadership in international fora' (European Environment Council 2000a: 8). The foregoing analysis shows that the EU has abilities in relation to all three leadership types. Under these circumstances what can the EU do to lead the process out of the doldrums? Ott and Oberthur (1999) argue the EU should ratify the KP in coalition with Russia, Eastern European CEITs, and Japan; strengthen the implementation of climate policies of the member states and coordinate such measures between the leader countries; and involve the developing countries by helping them to adapt to climate change and engage in a dialogue on the fair allocation of emission rights. Grubb et al. (2000) similarly argue that the EU should ratify the KP and seek to involve key developed and developing countries. They recommend that the EU needs to listen to criticism about its strategy and to learn from it. They believe that the EU should confidently try and implement the Kyoto Protocol since there is internal technical and political feasibility, and since there are a range of multiple benefits in other EU sectors. Further, the EU needs to put considerable thought into how the climate regime needs to be developed further to prevent its collapse and to try and harness all its diplomatic skills to bring other countries, including the US on board. We believe that in order for the EU to show effective and credible leadership, it needs to develop a long, medium and short-term strategy focused on elements of structural, directional and instrumental leadership. In terms of structural leadership, we believe that the EU needs to develop confidence in its own position in the long-term, coordinate strategies in other issue areas and other cooperative regimes in the medium-term and in the short-term influence the G-7 and G-77 through summit meetings. The EU states have discussed climate change at the G-7 meeting and at the Africa-Europe Summit (2000) where there was agreement for support of national climate policy focal points and policies and CDM projects and technology transfer. These are indications of the climate change agenda being integrated into the political agendas of cooperation between regions and countries, an important trend for further development.

Potential for directional leadership

Since credibility is a key corner-stone of any leadership strategy, the EU needs to develop a long-term vision of how it is to develop and implement a climate policy. Achieving the Kyoto Protocol calls for an estimated emission reduction of around 550 to 600 Mtonnes of CO^2 equivalent (European Commission 1998b: 8). The EU's hesitant leadership stems from concerns about the resulting loss of competitiveness in international markets as a consequence of unilaterally adopted climate policies. This threat may not be real since the economy of the EU as a whole is unlikely to be negatively affected by the adoption of no-regrets measures; and some sectors will be winners, while others losers. Further, policies that promote industrial transformation based on the principles of de-materialisation, de-carbonisation, and eco-efficiency are likely to neutralise this threat. Weizsäcker *et al.* (1997) emphasise the need for a factor four philosophy (i.e. increasing wealth but decreasing environmental damages by reducing material and energy intensity by a factor of four) as a first step towards a long-term factor ten philosophy which would, among other things, create room for growth of the emissions in developing countries. Climate change must, thus, be placed in the context of industrial change and may even lead to the improvement of the quality and quantity of employment in Europe and reduced oil and gas imports and consequently reduces the risk of resource-related conflicts in other parts of the world (Jung and Loske 2000). Every change creates opportunities for new actors. This can be promoted through a new macro-economic structure, internalisation of costs and incentives for consumers (Vellinga et al 1998).

In the medium-term, the EU needs to continue with the Cardiff Process to enhance the opportunities for sectoral integration of environmental issues. The European Council (2000b) calls for a comprehensive review of the integration process at the next meeting of June 2001. However, integration is not easy. As Haigh (2000: 110) points out: 'It is easy to point to several environmental directives which were only adopted because other ministries did not know what was going on.' The process of integration will bring to the fore a range of environment – economy debates that the Environment Commission needs to be well-prepared for.

In the short-term, the EU needs to enhance the implementation of existing and new programmes. In this context, the Commission's recent Green Paper on GHG emissions trading experimentation within the Community by 2005 and the Environment Council's (2000b) decision to welcome a recent proposal of the Commission to develop a European Climate Change Programme are welcome initiatives.

Potential for instrumental leadership

It is necessary but not sufficient for the EU to focus only internally. In order to send a strong signal to the private sector and to accelerate the use of the flexibility mechanisms, the KP must enter into force soon. This necessitates ratification by at least 55 countries, including the Annex 1 countries (i.e. developed countries and CEITs) responsible for at least 55 per cent of the total CO^2 emissions by Annex 1 countries in 1990. This means that at least two of the three major emitters (the US, the EU and Russia) must ratify the KP. An influential school in international politics would argue that the blocking power of the US is a reason for doubting that the EU alone can move a sufficiently large number of countries to ratify the KP. From this perspective, it is questionable whether the EU itself would ratify the Protocol unless the US also does so. Analysts who apply game theoretical models to study the potential for EU leadership similarly argue that the EU cannot lead alone (Carraro 2000). This implies that it is neither sufficient nor wise to try to isolate the US.

A better strategy would be to explore the potential for developing a ratification coalition while understanding key US concerns. The EU may need to consider exploring the potential of a "55% coalition" of G-7 to G-77 countries.[27] In the meantime, the European Environment Council (2000b) has adopted a Community Strategy on Climate Change which reiterates its position to promote entry into force of the Kyoto Protocol by 2002 at the latest and to that effect makes recommendations to member states to start taking action in order to ratify. At the recent Japan-EU Summit (2000), it was agreed that Japan and the EU will contribute 'to ensure the entry into force of the Kyoto Protocol by no later than 2002'. We are appreciative of the lobbying work undertaken by EU member countries to persuade the non EU G-7 countries, namely Japan, US and Russia that it is vital that for the Kyoto Protocol to enter into force by 2002. The European Council (2000b) has also asked member states to take steps towards ratification and the Commission to prepare a proposal on ratification by 2001. The EU appears to be well on its way to secure the 55% coalition, but it needs to consolidate the results achieved.

The critical issue remains the participation of the U.S. What is preventing the US from moving forward at present? It could also be relevant to consider whether opportunities exist to increase the US's willingness to pay for climate protection. Among the potential strategies are building transnational coalitions between EU and US decision-makers, awareness raising in the US, research collaboration between the EU and the US, and neutralising blocking

[27] There have been precedents set in the "30% coalition" which led to the first Sulphur Protocol to the Long Range Transboundary Movement of Air Pollutants, and the 'stabilisation coalition' which led to the adoption of the weakly worded stabilisation aspiration in the UNFCCC.

coalitions in the U.S. domestic arena. We believe that by ratifying the KP, the EU might strengthen pro-Kyoto forces in the US and accelerate ratification of the KP by the US. Irrespective of who is elected as president in the November 2000 elections, it will be vital to find support among the Republicans on the climate issue. Such support may be forthcoming, if there is a critical mass of support from key industry and civil society. 2,000 economists, including eight Nobel laureates, have signed a statement saying that the United States could reduce GHGs in a way that wouldn't restrict economic growth or sacrifice jobs, and there are reports that the impact on the United States would lower the US gross domestic product by only 0.15 per cent by 2010 (cited in Stone 1997). The National Climate Action Network and the National Religious Partnership for the Environment are just some of the bodies that support action on climate change and some civil actors have even started initiated a process to implement Kyoto without ratification. Furthermore, initiatives taken by EU-based energy industry may influence American oil companies. The EU may achieve much by encouraging the EU industry to discuss these issue with their counterparts, by encouraging EU-based scientists, economists and social scientists to discuss these issues with their American counterparts, and by encouraging EU Parliamentarians to discuss with US legislators. Science may be a driving force in US domestic policy as the bulk of the world's climate scientists live in the US and the knowledge base on this issue is most developed in the US. Thus, although the current political climate in the US is unfavourable, ratification in the medium term may be possible

In order to bring in the non-EU members of the OECD and develop issue-based coalitions with them the EU should explore possibilities for support for its position[28] and engage in a constructive dialogue on sinks, financial mechanisms, and the involvement of developing countries. For example, Japan, Norway, and Switzerland do not quite share the US position on developing countries. Another example, Norway has adopted a carbon tax and some others presently consider introducing a tax. A third issue is the EU position on hot air. While concerns to maintain the credibility of the regime are important, the complete collapse of the economies in Russia and Ukraine to levels lower than many developing countries, implies that it is vital to keep these countries interested in climate policy in their re-structuring process. Allowing hot air may be a small price to pay for keeping these countries committed to the process[29] while allowing for a coalition with the Umbrella group. In taking this position, we recognise that we are not entirely supported in the literature. The issue of supplementarity is not just economic, but political. While supplementarity increases the cost of implementation and monitoring, it demonstrates good-will towards developing countries that climate sacrifices are not being exported to other countries. We believe that if supplementarity is implemented via an adaptation tax levied on all flexibility mechanisms, i.e. on all measures undertaken in foreign countries, this would raise the cost of taking measures abroad and ensure that a higher proportion of reductions take place domestically. The added advantage of such an approach is that it would be in line with the G-77 view on synchronising the mechanisms and in raising additional resources for adaptation.

In the medium-term, the focus needs to be on developing a strategy on how to involve the accession countries in terms of adopting emission reduction targets and participating in the flexibility mechanisms.

[28] The Council (2000b) supports supplementarity, guidelines for the flexibility mechanisms, the adoption of a strong compliance mechanism including a Compliance Fund, a Compliance Action Plan, loss of access to the Kyoto mechanisms as a consequence of non-compliance, and the development of a positive list of safe, environmentally sound, eligible projects based on renewable energy sources, energy efficiency improvements and demand side management in energy and transport to be supported through the flexibility mechanisms. Finally, the EU reiterates that the inclusion of sinks should not undermine the effectiveness of the international agreements.

[29] This point has been repeatedly made by representatives of these countries, including by … at the EFIEA conference in April 2000.

While there can be no doubt that developing countries need to be brought on board, the way to do this is to move away from 'distributive' or 'win-lose' bargaining and move towards integrative or win-win bargaining. Cooperation with the developing countries is an area in which the EU might act as a bridge between the non-EU developed countries and the developing countries, since the EU and its member states have strong historical ties with developing countries and since the EU negotiating position is often close to theirs. The EU could first, emphasise that the policy to encourage the hard core of the G77 countries is essentially a long-term policy and will be undertaken in the context of sustainable development. It should reiterate that the first steps will come from the developed countries through ratification, demonstrable progress by 2005 and legally binding commitments for the second budget period. Second, the EU should try and understand the basic fear of the G-77 that strategies in relation to 'graduation' 'key developing countries' etc. are perceived as divide-and-rule strategies. This implies the need for the EU to enter into discussions with the G-77 leadership on what the future steps should be. This could in the short-term be reflected in joint statements of the EU and G-77 on issues where they agree, thus demonstrating that the EU can make flexible issue based coalitions. Third, instead of focusing on only targets and differentiation, it should try to develop a package approach[30]which allows for integrative bargaining. The EU itself appears to be partly convinced of this idea. The package needs to include technology transfer per sé, cooperation via the clean development mechanism, the compliance fund, adaptation tax on all flexibility mechanisms traded for a quantitative target on supplementarity, a guarantee that ODA will not be diverted for climate change projects but that ODA and climate change measures will be mutually supportive and not counter-productive. Constructive bilateral EU-US discussions on the CDM would be a good starting point. In terms of differentiation itself, the EU can lead by building on experiences gained in the internal negotiations on the EU "bubble".[31] But it should be stressed that it took the EU member states more than five years to work out a differentiated burden sharing arrangement, and although the Triptique approach created an useful framework and starting points for negotiations, it cannot be assumed that future differentiation can be dealt with successfully by simply following this or any other technical approach (Ringius 1999a).[32] However, the EU could support attempts to develop frameworks for differentiation at the global level, both from a scientific perspective and through informal discussions with experts. In this way the EU could stimulate trust building among countries and perhaps even stimulate global cooperation. Such principles could be an elaboration of the polluter pays and the ability to pay principles. The elaboration of these principles may not only include legal precedents, but also ideas emerging from the tryptique approach. It is evident that the expectations of developing countries have been raised significantly by the prospect of future financial mechanisms (i.e. the CDM) channelling resources and investments from industrialised to developing countries. But most would agree that an important element in involving developing countries better is cooperation that explores and demonstrates the ways in which climate concerns could be integrated into existing policies without changing overall national priorities or negatively affecting the welfare and the economic and social development in developing countries.

[30] See, for example, Gupta 1999 on a proposal for a package approach to involve developing countries.

[31] A recent study by the analysts who developed the Triptique approach concludes that this approach could be extended from a regional to a global context (Groenenberg et al. 2000). The study estimates that the targets for the former Soviet Union Eastern Europe are in the range of –25% to –45% and in the –15% to – 30% range for countries in Central and Eastern Europe. The reduction targets of industrialized countries range from –25% to +15%, while developing countries would increase emissions by 40% to 425%. The targets depend both on the calculation methods used as well as the availability of necessary data.

[32] EU scholars currently are developing alternative differentiation frameworks and approaches.

Conclusion

We conclude, thus, that the EU can take on a leadership role in forging issue-based coalitions at international level and in promoting implementation domestically. We believe that the EU could develop a strategy that focuses on some structural, directional and instrumental elements and that the strategy should have a short, medium and long-term focus as summed up in the table below.

Table 1. Elements of a leadership strategy

Leadership	Long-term	Medium-term	Short-term
Structural	Develop confidence in own leadership skills	Coordinate strategies in other issue areas and other cooperative regimes	Influence G-7 and G-77 through summit meetings
Directional	Industrial transformation	Improve credibility; Reach for sectoral integration; provide demonstrable progress	Strengthen implementation of SAVE, ALTENER, the Monitoring Mechanism, Voluntary Agreements, Experience with emission trading
Instrumental	Relationship with developing countries	Relationship with Accession Countries and second period targets	The 55% coalition for ratification

From the range of options defined, we highlight three recommendations: First, the EU should develop a vision of the long-term development of the global climate change regime. The key concern of most countries is the impact of climate policy on development. The EU vision should focus on identifying ways to demonstrate that the perceived negative impact on economic development and well-being could be minimised through industrial transformation policies. The key ingredients of such a vision should be promotion of a new macro-incentive structure, including taxing resources and pollutants rather than labour, internalising environmental costs in pricing policy, adoption of an industrial ecology agenda, including product and process lifecycle management, and creation of incentives for consumers to change their consumption patterns on the basis of conscious consumer choice (cf. Weiszächer et al 1997; Vellinga et al. 1998; Grubb et al 2000). This has the potential to demonstrate that climate policies are feasible in the long-term as well as to reduce the costs of taking measures in other parts of the world.

Second, the EU needs to improve the credibility of its internal policy and implement measures in member countries, through traditional channels and through support for local organisations and NGOs especially in the building sector. Critique that the EU is making use of no-regrets policies and not developing specific climate policies can be countered by arguing that climate policy per sé is unlikely to be successful; one needs to talk in terms of energy, transport and/ or agricultural policy (O’Riordan and Jaeger 1996).

Third, the EU should focus on a 55% coalition with like-minded countries and create the conditions for early ratification. In addition the EU should try and motivate domestic actors to engage into discussions with actors in the US, Japan and the CEITs to develop a fallback negotiating strategy. The EU needs to correct inconsistency and disingenuity between its internal policy and its international policy and should develop a modus operandi to optimise the combination of a common negotiation position and the diplomatic channels of its fifteen member states to ensure that its total influence is united, flexible, effective, and wide in its outreach. Implementation of the instrumental policy, however, should not be undertaken at EU level but should instead be delegated to the member states. For example, the UK could further develop its relations with Anglophone countries, whereas France could keep contact with the Francophone countries. Germany, UK, France, the Nordic countries and the Netherlands could be most appropriate for developing coalitions with the CEITs. The UK and Germany could be the relevant channels for discussing issues with the US, and France and Germany may be relevant for discussing the issues with the rest of the OECD countries. The EU and its members could use their structural power to develop capacity building programme in developing countries financed through ODA and continue to discuss industrial transformation in addition to climate change at multilateral and bilateral summits.

Undoubtedly, the EU has been quite successful, and the Kyoto targets would not have been as ambitious as they are without the EU. The follow-up, however, depends on effective implementation: a different game altogether. Only few EU member states will meet the stabilisation target for year 2000. A few might achieve their targets through lucky circumstances, but none will achieve their targets through wise strategy and implemented policy. The EU leadership strategy is therefore running out of credit. A good leadership strategy for the EU must seek to maintain credibility both in terms of rhetoric and in terms of taking early action.

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References

Aaheim, H.A. and C. Bretteville (2000), 'Emission Reductions in EU Countries' in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 221- 238.

Africa-Europe Summit (2000), *Cairo Plan of Action*. Cairo: OAU and EU, 3-4 April 2000.

Berdowski, J., M. Gager, B. Raberger, M. Ritter, and A. Visschedijk (1999), *Overview of National Programmes to Reduce Greenhouse Gas Emission,* Copenhagen: European Environment Agency, Topic Report No. 8/1999.

Blok K., Phylipsen G.J.M., and Bode J. W. (1997), *The Triptique Approach: Burden Differentiation of* CO_2 *Emission Reduction among European Union Member States*. Utrecht: Department of Science, Technology and Society, Utrecht University.

Bye P. (1997), 'Productive inertia and technical change', in P. Bye, J.J. Chanaron and A. Richards (eds.) *Industrial History and Technological Development in Europe*, Research papers of the European Science and Technology Forum, March 21-22. London: The Newcomen Society and the Science Museum.

Carraro, C. (2000), 'The Economics of Coalition Formation', in J. Gupta and M. Grubb, eds., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 135-156.

Carraro, C. and F. Léveque (1999), 'Introduction: The Rationale and Potential of Voluntary Approaches' in C. Carraro and F. Léveque, ed., *Voluntary Approaches in Environmental Policy*. Dordrecht: Kluwer Academic Publishers, 1-16.

CEFIC (1997), *Voluntary Energy Efficiency Programme 2005*. The European Chemical Industry.

Clinton, W.J. (1997). Remarks by the President on Global Climate Change at the National Geographic Society on October 22, 1997; also available at http://www.whitehouse.gov/ Initiatives/Climate/19971022-6127.html

Coffey, C., D. Wilkinson, and N. Haigh, N. (1998), *Background Paper to Workshop on the Effectiveness of EC Environmental Legislation*, London, September 25-26.

Collier, U. (1996), 'The European Union's Climate Change Policy: Limiting Emissions or Limiting Powers? *Journal of European Public Policy*, 3(1)122-138.

Dahl, A. (2000), 'Competence and Subsidiarity', in J. Gupta and M. Grubb, eds., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 109-134.

E5 (1998), 'E5: Policy priorities for 1998', European Business Council for a Sustainable Energy Future.

EU Workshop (1998), 'European Climate Change Policies: Stakeholder Perspectives'. 27 February, Brussels, organised by EC DG XII.

European Commission (1997), *Climate Change – The EU Approach for Kyoto*. Commission Communication to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. Brussels: European Commission, 4-8.

European Commission (1998a), *Second Communication from the European Community Under The UN Framework Convention on Climate Change*. Brussels: Commission of the European Communities, (SEC(98) 1770).

European Commission (1998b), *Climate Change- Towards an EU Post-Kyoto Strategy, Communication from the Commission to the Council and the European Parliament*. Brussels: Commission of the European Communities (COM (98) 353).

European Commission (1999), *From Cardiff to Helsinki and Beyond: Report to the European Council on Integrating Environmental Concerns and Sustainable Development into Community Policies.* Brussels: Commission of the European Communities, 24 November.

European Commission Press Release (1999a*), Parliament-Council Conciliation Committee Agreement on SAVE and ALTENER*, 13849/99 (Presse 404). Brussels: Commission of the European Communities.

European Commission Press Release (1999b), *Report to the European Council on the Strategy for Integrating Environmental Aspects and Sustainable Development into Energy Policy*. Brussels: Commission of the European Communities, 3 December 1999.

European Commission Press Release (2000), *Parliament-Council Conciliation Committee Agreement on CO_2 Emissions Monitoring Scheme from New Passenger Cars*, 6596/00 (Presse 62), Brussels. Commission of the European Communities.

European Council (2000a), *Presidency Conclusions of Santa Maria Da Feira European Council*, 19-20 June, Santa Maria da Feira: European Council Press Release 200/00.

European Environment Council (2000a), *Council Conclusion on the Community Strategy on Climate Change*. June 2000, Brussels: Commission of the European Communities.

European Environment Council (2000b), *Council Conclusion on the Evaluation of the 5th Environmental Action Programme*. March 2000, Brussels: Commission of the European Communities

Fussler, C. and P. James (1996*), Driving Eco-Innovation: A Breakthrough Discipline for Innovation and Sustainability*. London: Pitman.

Gore, Al (1997), *Briefing on Kyoto Warming Pact*, 11 December 1997 (document with authors).

Graedel, T.E. and B.R. Allenby (1995), *Industrial Ecology.* New Jersey: Prentice Hall.

Groenenberg, H., D. Phylipsen, and K. Blok, (2000), *Differentiating the Burden World Wide: Global Burden Differentiation of GHG Emissions Reductions Based on the Triptych Approach:*

A Preliminary Assessment. Utrecht: Department of Science, Technology and Society, Utrecht University.

Grubb et al. (2000), ‘Policy Makers Summary’, in J. Gupta and M. Grubb, eds., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers.

Grubb, M. and C. Vrolijk (2000), ‘Target Differentiation and the ‘European Bubble’’ in J. Gupta and M. Grubb, eds., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 333-340.

Grubb, M. and J. Gupta (2000), ‘Implementing European Leadership’, in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 287-312.

Grubb, M. and J. Gupta (2000), ‘Leadership: Theory and Methodology’, in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe*? Dordrecht: Kluwer Academic Publishers, 15-24.

Grubb, M. and J.C. Hourcade (2000), ‘Implementing EU Commitments Under Kyoto’, in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 239-260.

Gupta, J. (1999 b), ‘North-South Aspects of the Climate Change Issue: Towards a Constructive Negotiating Package for Developing Countries’. *Review of European Community and International Environmental Law,* 8(2) 198-208.

Gupta, J. and N. v.d. Grijp (1999), ‘Leadership in the Climate Change Regime: The European Union in the Looking Glass’. *International Journal of Sustainable Development,* 2(2) 303-322.

Gupta, J. and N. v.d. Grijp (2000), ‘Strengths, Weaknesses, Opportunities and Threats of the EU’, in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 263-274.

Haigh, N. (1989), ‘New Tools for European Air Pollution Control’. *International Environmental Affairs*, 1(1) 26-37.

Haigh, N. (1991), ‘The European Community and International Environmental Policy’. *International Environmental Affairs*, 3(3) 163-180.

Haigh, N. (1992), *Manual of Environmental Policy: The EC and Britain*, London: Cartermill Publishing/IEEP, Part 14, Climate Change (1997 update).

Haigh, N. (1994), ‘The Development of EC Climate Policy from its Origins to EC Ratification of the FCCC’, in *Study of the Possible options for the Further Development of Commitments within the Framework Convention on Climate Change*. London: IEEP.

Haigh, N. (1996), ‘Climate Change Policies and Politics in the European Community’, in Tim O’Riordan and Jill Jäger, eds., *Politics of Climate Change: A European Perspective,* Global Environmental Change Programme. London and New York: Routledge, 155-186.

Haigh, N. (1999), ‘European Union Environmental Policy at 25: Retrospect and Prospect’. *Environment and Planning C: Government and Policy,* 17, 109-112.

Hourcade, J-C, P. Courtois and T. Lepesant (2000), ‘Socio-economics of Policy Formation and Choices’, in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 109-134.

House of Lords (1999), *Environmental Audit Committee 1 Report: EU Policy and the Environment: An Agenda for the Helsinki Summit. Report and Proceedings of the Committee, together with Minutes of Evidence and Appendices.* London: The Stationery Office.

Jachtenfuchs, M and Michael Huber (1993), ‘Institutional Learning in the EC: the Response to the Greenhouse Effect’, in J. D. Liefferink, P. D. Lowe and A.P.J. Mol, (eds.), *European Integration and Environmental Policy,* London: Belhaven Press, 36-58.

Jachtenfuchs, Markus (1996): *International Policy-making as a Learning Process? The European Union and the Greenhouse Effect*. Aldershot: Avebury

Japan-EU Summit (2000), *Joint Conclusions*. EU Press Release 10577/00, Brussels: Commission of the European Communities.

Johnson, S. and G. Corcelle (1995), *The European Policy of the European Communities*, Second Edition. International Environmental Law & Policy Series. London, The Hague, Boston: Kluwer Law International.

Jung, W. and R. Loske (2000), 'Issue-linkages to the Sustainability Agenda', in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 157 - 172.

Klima-Bündnis Allianza Del Clima e.V. (1999), *Local Authority Contributions to Climate Protection: Status Report 1999 of the Climate Alliance of European Cities*, Frankfurt: Climate Alliance.

Kyoto Protocol to the United Nations FCCC, December 1997, FCCC/CP/1997/L.7/Add.1

Levy, Marc A. (1993), 'European Acid Rain: The Power of Tote-Board Diplomacy' in P. Haas, ed., *Institutions for the Earth. Sources of Effective International Environmental Protection*. Cambridge, Mass.: MIT Press, 75-132.

Lieferink, D. and A. Mol (1997), 'Voluntary Agreements as a Form of Deregulation', in U. Collier, ed., *Deregulation in the European Union: Environmental Perspectives*. London: Routledge.

Malnes R (1995), 'Leader' and 'Entrepreneur' in International Negotiations: A Conceptual Analysis'. *European Journal of International Relations*, 1(1): 87-112.

Michaelowa, A. and Betz, R. (2000), Implications of EU Enlargement on the EU Greenhouse Gas 'Bubble' and Internal Bubble Sharing. *International Environmental Agreements: Politics, Law and Economics*, 1(1).

O'Riordan, T. and J. Jaeger (1996), 'Beyond Climate Change Science and Politics', in O'Riordan, T. and J. Jaeger, eds., *Politics of Climate Change, A European Perspective*, London: Routledge, 346-360.

Oberthür, Sebastian and Hermann E. Ott (1999), *The Kyoto Protocol. International Climate Policy for the 21st Century*. Berlin, Heidelberg et al: Springer Verlag, 359.

Ott, H. (1998), 'Global Climate'. *Yearbook of International Environmental Law*, 9, 183-189.

Ott, H. and S. Oberthür (1999), *Breaking the Impasse: Forging An EU Leadership Initiative on Climate Change.* Berlin: Heinrich Böll Foundation.

Ringius, L. (1999a), 'Differentiation, Leaders, and Fairness: Negotiating Climate Commitments in the European Community'. *International Negotiation* 4(2), 133-166.

Ringius, L. (1999b), *The European Community and Climate Protection: What's Behind the 'Empty Rhetoric'?* Oslo: CICERO Report 1999: 8.

Ringius, L. (2000), *Radioactive Waste Disposal at Sea: Public Ideas, Transnational Policy Entrepreneurs, and Environmental Regimes.* Cambridge, Massachusetts: The MIT Press, forthcoming.

Sands, P. (1995), *Principles of International Environmental Law, Vol. I, Frameworks,Standards and Implementation*. Manchester: Manchester University Press.

Schlegelmilch, K. (1998), *Energy Taxation in the EU and Some Member States: Looking for Opportunities Ahead.* Wuppertal: Wuppertal Institute for Climate, Environment and Energy.

Sjostedt, G. (1998), *The EU Negotiates Climate Change: External Performance and Internal Structural Change*. Nordic Journal of International Studies, 33(3), 227-256.

Stone, P.H. (1997), 'The Heat's On'. *The National Journal* 29(30), July 26, 1505.

Underdal A. (1994), 'Leadership Theory: Rediscovering the Arts of Management', in *International Multilateral Negotiating: Approaches to the Management of Complexity*. San Francisco: IIASA / Jossey-Bass, 178-197.

US State Department (1998). *US State Department Fact Sheet*. Washington: US State Department, January 15, 1998.

Vellinga, P., J. Gupta and F. Berkhout (1998), 'Towards Industrial Transformation', in P. Vellinga, F. Berkhout and J. Gupta, eds., *Managing a Material World: Reflections on Industrial Ecology*. Environment and Policy Series, Dordrecht: Kluwer Academic Publishers, 321-344.

Wagner, J.P. (1997), 'The Climate Change Policy of the European Union', in G. Fermann, ed., *International Politics of Climate Change*. Oslo: Scandinavian University Press, 297-340.

Weizsäcker, Ernst von, Amory B. Lovins and L. Hunter Lovins (1997), *Factor Four. Doubling Wealth - Halving Resource Use.* London: Earthscan.

Wettestad, J. (2000), 'The Complicated Development of EU Climate Policy', in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe*? Dordrecht: Kluwer Academic Publishers, 25-46.

Yamin, F. (2000), 'The Role of the EU in Climate Negotiations', in J. Gupta and M. Grubb, ed., *Climate Change and European Leadership: A Sustainable Role for Europe?* Dordrecht: Kluwer Academic Publishers, 47-65.

Young O.R. (1991), 'Political Leadership and Regime Formation: on the Development of Institutions in International Society', *International Organisation*, 45, 3.

Annex VIII: Long-term institutional change and climate control measures in europe

Graham Bennet, SYZYGY

Introduction: Institutional Change in a Changing Institutional Context

It is a curious fact that most current debates on the feasibility of securing institutional change in Europe fail to appreciate that the past fifty years have seen two separate and unprecedented institutional revolutions on the continent. The process that started with the establishment of the European Coal and Steel Community in 1952 and progressed through the European Economic Community and the European Community to today's European Union has transformed the economic and political architecture of western European. Then, nearly four decades later, the events of 1989 triggered a complete reordering of the political, economic and social institutions of twenty states in a region extending from the Baltic Sea to the Bering Strait. Institutional change of such character, scale, magnitude and impact is unique. Moreover, both revolutions are far from spent – witness the current processes of EU and NATO enlargement, the forthcoming EU Intergovernmental Conference on institutional reform and the huge transition challenges still facing the countries of central and Eastern Europe. The capacity for institutional change in Europe cannot therefore be questioned, nor the existence of powerful cultural, political, economic, social and technological forces that are driving further change. Unlike the US, where climate policy will develop within a remarkably stable institutional environment, the long-term prospects for climate control actions in Europe are certain to be profoundly influenced by the course of institutional change.

An analysis of institutional change in Europe shows that time and again it is powerful driving forces that determine the course and timing of key shifts rather than the formal competences of the institutions themselves. In other words, given a political or socio-economic critical mass, certain developments take place whether or not formal institutional competences or requirements exist; conversely, in the absence or decay of this critical mass, other developments will not take place, even where these may be formally required. The past 50 years have produced examples enough: the original Treaty of Rome laid down the primary task of the European Economic Community as the establishment of a common market, a task that was only seriously taken up some 30 years later when economic recession stimulated the member states to embark on the "1992" project; in the period up to 1987, broad social and political consensus on the need to mitigate increasingly conspicuous environmental problems led to the EU adopting some 200 legal measures concerning the environment, despite the fact that the original Treaty of Rome provided no explicit legal basis for the Community to regard the environment as a legitimate object of Community action; the more recent "velvet revolutions" in the CEE countries were driven by broad social dissatisfaction with the prevailing political regimes and institutions which, although apparently strongly embedded in the legal, economic and social fabric of all the countries in the region, had failed to generate sufficient credibility to be able to resist the upswelling of popular pressure for fundamental change.

The key issue is therefore how the driving forces behind the continuing institutional revolution in Europe will shape the boundary conditions that largely determine the future course and substance of climate control actions. Consequently, this paper is predicated on the conviction that any assessment of the longer-term institutional context for climate control actions in Europe should focus on the forces that drive institutional change rather than on institution-specific analyses: over a period of several decades, the most important institutional changes are the consequence of responses to external needs and pressures rather than to short-term internal dynamics. Reforming voting procedures in the EU Council of Ministers will not significantly influence the course of European climate policy; a crisis concerning the legitimacy of EU governance that leads to a paradigm shift in the democratic accountability of EU institutions will.

Demythologising European Mythology

Before discussing these driving forces, it is worth pausing to reflect on a number of commonly held but largely erroneous perceptions on the character, operation and consequences of certain key European institutional processes. A first misconception is that the complex institutional architecture of the EU operates to obstruct any attempt to develop and adopt effective measures to resolve a "global-commons" problem such as climate change. It is true that the predominantly intergovernmental character of EU decision-making has difficulty in transcending the national interests of the member states; but it is also true that the emergence of an EU institutional culture and the wealth of Community procedures and competences that have evolved over several decades – and which apply to most aspects of environmental policy-making – enable the EU to function on the international stage with a far greater degree of unity, confidence and purpose than other intergovernmental organisations. The agreement to phase out the production of CFCs through the 1987 Montreal Protocol is a prominent example of how the EU can successfully shape global environmental action. Although in this case the original pressure for international action came from the US government, it was concerted action by the EU in support of production limits as the most effective instrument for reducing CFC emissions that persuaded first US environmental organisations, then US industry and government, of the merits of such an approach in preference to the initial proposal by the US government for controls on CFC use.

It is also widely assumed that Community policies and legislation are invariably uniform with respect to the policy objectives and the formal obligations that are imposed on the member states. Thus, EU environmental directives lay down common protection levels, environmental standards and implementing instruments that apply without exception to all member states. Bound by this straitjacket of uniformity, the more ambitious member states and the policy-making institutions of the EU are constantly forced to accept Community measures that represent the "lowest common denominator" of the fifteen national policies of the member states. But in fact, an analysis of the *acquis communautaire* – and especially EU environmental law – shows there to be not only a remarkable degree of explicit or implicit differentiation in the level of obligations imposed on the member states but also considerable scope for each member state to adapt implementing measures to its own circumstances and requirements. See, for example, the various EU water pollution directives, the Habitats Directive and the EU position on implementing the Kyoto Protocol. This degree of flexibility, in combination with the persuasive pressures that negotiating processes always impose on small minorities, ensures that policy outcomes which represent the lowest common denominator are the exception rather than the rule in the EU.

A tendency in most analyses of policy-making in the Community arena is to focus solely on the role of the most prominent EU institutions: the Council, the Parliament, the Commission, the Court. However, the institutional environment that shapes the way in which the myriad of actors in this arena behave is far more complex and subtle. In reality these actors are influenced by an enormous number of overlapping institutional footprints: at the international level alone, actors in the EU operate within frameworks developed through, amongst others, the Council of Europe, the CIS, the Benelux, the OECD, the NATO, the UN, the WTO and a range of specific multilateral agreements, in addition to the multitude of co-operative arrangements and interests in the economic sectors – aviation, energy, chemicals, agriculture, banking et al. Europe is an arena characterised by an enormous variety of interlinked institutional constituencies in which the EU, although politically the most prominent and integrated, is increasingly interacting with and becoming dependent on the actions of an interwoven lattice of institutions.

From a western European perspective, it is all too easy to confuse the widespread desire in the CEE countries to enjoy the economic fruits of EU membership with a wish to discard eastern for western culture: citizens in central and eastern Europe are western Europeans in all but name. The perspective from the east is far removed from such simple notions. To be sure, the candidate member states are well aware that they are being offered a binary choice: EU membership or not? A negotiated settlement on the future blueprint of the Union is not on offer, at most an agreement on where derogations from the *acquis* will apply and for how long. But there exists throughout the region a strong cultural preference for strong political institutions as a means to secure social stability and welfare. And in the long term, with the prospect that within a generation CEE countries will comprise about half the total number of EU member states, this cultural factor could prove to be of enormous import for the future institutional development of an enlarged EU.

A final misconception which in the context of long-term institutional change in Europe merits correction concerns the effect of EU policies. Much has been written on the so-called "implementation deficit" of EU legislation, and particularly environmental directives which in the recent history of the Union have comprised about 40 per cent of all infringement proceedings against the member states. Implementation shortcomings have indeed been a serious problem with EU environmental policy: even after more than 20 years, the majority of member states have still failed to ensure compliance with the Birds Directive, to give just one example. Yet recent years have seen a major improvement in the implementation record of EU environmental directives. Serious enforcement efforts by the European Commission, judgements by the Court of Justice and the provision introduced by the Treaty of Maastricht whereby financial sanctions can be imposed on member states which fail to comply with a ruling of the Court have progressively had their effect. The present-day reality is that compliance with EU legislation is in general relatively good. More significantly, EU legislation is a far more effective policy instrument than other kinds of international agreement, where regimes with the capability to impose effective legal enforcement and, if necessary, persuasive sanctions are generally in their infancy. Moreover – again a point that is poorly appreciated – EU environmental measures are monitored far more rigorously than the provisions of multilateral environmental agreements, with a wide range of Community procedures and agencies ensuring that progress in implementing environmental measures and their effect on the environment is relatively well monitored and reported.

The Driving Forces

Which driving forces might determine the course of institutional change in Europe, especially with respect to climate change actions? Four forces may prove to be particularly influential during the coming decades: globalisation, EU enlargement, scientific research on climate change and public values and perceptions. Globalisation – the process through which the markets for products, services and investments and the operational sphere of companies become increasingly international in character – is shifting the balance of power and influence from government to market interests. Specifically, the capability of transnational companies and investors to take actions that have an impact on the environment is outpacing the capacity of governmental institutions to manage the processes that cause those impacts. An "institutional deficit" is evolving as national governments become increasingly constrained in their opportunities to impose environmental controls on companies – legally in the EU as more and more competences and environmental policy measures become responsibilities of the Union rather than the member states themselves, and economically as companies become increasingly capable of shifting production operations away from countries where operating costs are relatively high and expansion opportunities are limited, both of which are adversely affected by strict environmental controls – and these developments are not being matched by a compensatory strengthening of international government institutions.

However, at the same time companies are becoming increasingly aware of the need to strengthen their relationships with their consumers. Internationally renowned brand names can be worth billions of dollars: the potential economic damage to transnational companies from behaviour that is widely perceived to be socially or environmentally irresponsible is enormous – witness the Brent Spar example – particularly given the fact that the investment required to attract a new customer is on average four to five times that required to keep an existing consumer.

The second key driving force on institutional change in Europe is EU enlargement. A Union with, shortly, 21 member states, in the medium term with perhaps 26 and in the longer term with possibly 35 will impose substantially different needs and pressures on the structure and working of EU institutions. These changing needs and pressures are already the subject of serious attention and analysis – as demonstrated by the forthcoming EU Intergovernmental Conference on institutional reform in Nice. The enlargement will inevitably have three important consequences for EU institutions: it will increase even further the already substantial degree of diversity within the EU – cultural traditions and perceptions, political regimes, socio-economic profiles, institutional structures and processes, environmental conditions – with a concomitant decline in Community cohesion; the greater number of actors will complicate even further Community decision-making procedures and the allocation of competences; and the Union will face even greater challenges in ensuring that EU measures are appropriately, consistently and promptly implemented across a greater number and a more diverse family of member states.

A third driving force of enormous potential impact is improved scientific understanding of the greenhouse effect – "potential" because it remains to be seen what results further scientific research on climate change will produce. However, it is almost certain that improved atmospheric models will further clarify the relation between emissions of the so-called greenhouse gases and climate change. It is also distinctly possible that these models will confirm the current hypotheses on climate change and enable the construction of more detailed and confident prognoses of global and regional climate changes. These scientific advances may be supplemented by evidence that demonstrates a causal link between specific natural disaster incidents and climate change. The probable result would be the formation of a vocal and active constituency comprising the existing and potential victims of climate change and popular opinion that accepts the reality and seriousness of the threat. The "30% Club" and its role in promoting acid emission control measures is in this respect an interesting precedent.

The final driving force that is likely to have a profound impact on European institutions is public pressure that follows from changing values and perceptions. The values of European societies are evolving rapidly in response to economic and communication developments: traditional forms of social organisation – families, communities, religious groupings, trade unions – are being superseded by common-interest networks which are more specialised, more extensive, more informal, more flexible, more transitory and more consumer-oriented in character. The falling away of the traditional structures through which groups have secured representation and promoted their interests in societal and political processes are being replaced by an evolution in civil society in which network interests are being organised and promoted through more direct, focused and flexible means, such as television and the Internet. With a greater proportion and volume of goods and services being provided through competitive markets, citizens are also becoming increasingly aware of their power as consumers. This can be linked with a growing demand for more responsive democratic institutions which do not necessarily follow the ground rules of traditional government organisations, not least at the European level. In the longer term, these developments will ensure that the way in which societal values impact on those public and private decision-making processes that shape actions which have consequences for environmental quality will operate very differently to current mechanisms.

Institutional Impacts

The impact of these driving forces on institutions in Europe will be profound. The precise impacts, however, be predicted with any degree of accuracy in the medium-to-long term: one of the most important lessons of recent European history is how events that are unexpected and to a large extent unpredictable can transform apparently highly resilient political and socio-economic institutions. (Note that this is not to say that such "surprises" cannot to a certain degree be anticipated.) As a consequence, any perspective on institutional change that measures its time horizon in decades cannot pretend to foresee the details of institutional structures, competences and procedures. But although details can take on decisive importance in particular cases, it is the broad topography of the future institutional landscape of Europe and the main opportunities and obstacles that this implies for climate control actions that is important for the COOL process.

As a powerful and, by definition, global driving force, globalisation will have far-reaching impacts at all institutional levels, across virtually all institutional sectors and on the relation between government and business. It will drive the process of harmonising the economic policies and legislation of the main trading blocs – the EU, NAFTA and parallel developments in South America, Asia and Africa – and thereby reduce the scope for autonomous EU policy on many environmental issues. But this development is also likely to feed the countervailing needs for, first, more explicit and more elaborate international rules on the scope for local, national or regional differentiation with respect to trade regulations and instruments where this is necessary in the interests of environmental protection and, second, more effective international enforcement regimes. The current proposal to establish a World Environment Organisation is a reflection of such a perceived need. To be sure, business will be reluctant to accept a significant degree of regulatory differentiation, but in a parallel development companies themselves will appreciate the advantages of launching initiatives that demonstrate a high level of social and environmental responsibility, thereby strengthening consumer trust in particular brand names and, in the words of an IBM executive, securing a "societal residents permit".

For Europe itself, the greatest institutional impacts during the next two decades will in all probability follow from the EU enlargement process. The greater diversity, institutional complexity and implementation challenges that are the inevitable consequences of enlargement will drive EU policy-making away from the traditional practice of negotiating highly specific and detailed regulations and directives; instead a far greater emphasis will be placed on framework measures that lay down basic rules and targets for a particular policy object but which allow the member states a greater degree of discretion in how the objectives are achieved and which instruments are applied for that purpose. This in turn infers a shift towards longer-term policy-making and a need to develop policy frameworks, mechanisms and instruments that can prove to be effective in formulating and securing long-term goals and objectives. In other words, it will be the achievement of clearly defined and enforceable ends – to an increasing extent in the medium-to-long term – that will become the principal focus of EU policy-making rather than the precise means by which these ends are to be achieved. For environmental policy, this implies a shift to the formulation of locally or regionally appropriate environmental and ecological quality and performance targets rather than detailed emission or technological standards. Where feasible, groups of member states may establish particular forms of flexible co-operation, for example with regard to the use of certain economic instruments. As in the case of globalisation, an important consequence of EU enlargement will be a greater acceptance of and the establishment of more explicit rules concerning differentiated measures that are locally or regionally appropriate.

The impact of scientific research on institutional change is subject to greater uncertainties, in the main because it cannot be predicted how further research will alter our understanding of the greenhouse effect and the role of atmospheric emissions in the process. However, it is probable, if further research were to confirm the more pessimistic viewpoints – and it would be almost certain if a number of conspicuous natural disasters were to be attributed to climate change – that the impact on public and political perceptions will be sufficient to drive changes to those institutions and mechanisms that are associated with the development of climate policies and control measures. That implies a strengthening of international mechanisms for dealing with global-commons problems or the creation of a dedicated and substantive global climate regime. Consumer pressure will also be such as to force business to demonstrate its environmental responsibility through initiatives that reduce the climate impact of branded products through innovations to design and manufacture.

Perhaps the most interesting and potentially the most volatile driving force for institutional change in Europe is public perception. The unprecedented rate at which individual values, social organisation and demographic patterns are changing suggests that the longer-term impacts on institutions could be profound. Some of the greatest impacts could result from the increasing need by individuals, groups and organisations – and, through continuing developments in information and communications technology, their expanding capability – to exert direct and multi-focused pressure on public and private institutions on matters of concern. The way in which two aspects of this process will operate are of special interest and importance. First, an area of potential tension is how these developments will interact with the cultural preference in the central and eastern European countries for strong political institutions, particularly if and when these countries make up a substantial proportion of the number of EU member states. It should not be forgotten that the long road to EU institutional integration and reform will carry two-way traffic: impulses for institutional change will come from the new as well as the old member states. Second, it is instructive in considering the potential for EU institutional change to bear in mind the institutional revolution that is taking place in the countries of central and eastern Europe and the forces that triggered this revolution: the EU as a political entity, and certainly its institutions as a means of formulating and implementing socially relevant measures, have never captured and enthused the public imagination for any prolonged period of time. Indeed, today they fail to command widespread popular respect and support. This makes the institutional constructs of the EU particularly vulnerable to a capricious event that could catalyse public opinion in the same way that the relaxation of border controls in Hungary and the fall of the Berlin Wall inspired popular imagination in 1989. The potential consequences of a crisis in the democratic accountability of EU governance could be enormous and certainly unpredictable.

A final observation can be made on the significance of these institutional impacts for the future of climate control actions. Most of the projected consequences offer new and interesting opportunities for securing mitigating measures: policy harmonisation between the major trading blocs will require new global institutional mechanisms – possibly including an enforcement regime – which could be exploited for environmental purposes, particularly if new rules are agreed defining the scope for differentiation in the interests of environmental protection; companies will better appreciate the advantages of taking voluntary environmental initiatives; EU policy-making will feature a more prominent long-term dimension, will focus more on the definition of enforceable environmental targets and will offer greater scope for flexibility by the member states in the choice of measures appropriate to achieve those targets; credible scientific evidence confirming greenhouse processes, if forthcoming, would lead to greatly increased pressure on government and business to take effective action and develop appropriate institutional arrangements; and changing public perceptions on democratic accountability and the legitimacy of EU institutions could force radical changes in European governance.

To be sure, these are foreseeable opportunities that are likely to be created by the institutional impact of driving forces that show evidence of persisting into the medium term at the very least: in that sense they represent a surprise-free scenario. But Europe's future will not be surprise-free. for the continent has for centuries proven to be a remarkably complex and dynamic entity. In this respect at least the future holds no surprises, for the process of radical institutional change across the continent will certainly continue well into the 21^{st} century; indeed, it is difficult from the perspective of 2000 to foresee a time when this process will stabilise or to predict the form into which Europe's institutional architecture will eventually evolve. That this process receives so little popular attention can only be accounted for by two factors: that Europeans have become accustomed to institutional change and, particularly in the EU, that citizens are not actively involved in shaping the process, which remains essentially an intergovernmental matter. But, as noted above, it would be naive to assume that both of these conditions will persist indefinitely. When either or both cease to apply, the institutional outcome will be unpredictable and possibly, as so often in the past, chaotic. COOL would therefore do well to emphasise the importance of developing response strategies as a means of exploiting events that may not be predictable but can at least be anticipated.

Annex IX: ICT and climate change

Essay written as a contribution to the COOL dialogue

Date: 1 September 2000

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Introduction

What do technological developments in the area of information and communication technology have to do with climate change? At first glance, nothing. But on closer consideration the connection is easily made. The rapid pace of technological developments in the field of ICT may lead to major changes in the economy. The Netherlands Bureau for Economic Policy Analysis (CPB) (CPB, 2000) suggests that ICT has the character of a "breakthrough technology", similar to the invention of the steam engine and electricity. Such breakthrough technologies can substantially change the structure and shape of the economy. ICT could have a major impact on how we work, live, shop, spend our leisure time, move around, etc. ICT applications make it possible to perform certain actions faster, in a smarter way and at any time and anywhere. For example, it is easy to order a book from the US via the Internet. Such changes will be felt at the micro-level (the behaviour of consumers, producers), but also at macro-level (the economy, globalisation)

These changes can in turn prompt changes in energy consumption. This is the link to climate change, since the emission of CO_2 which is directly related to energy consumption has a significant impact on the climate.

This essay, which looks at the relationship between developments in ICT and climate is therefore mainly concerned with the possible effect of the introduction of ICT (via changes in the economy and society) on energy consumption.

This essay has been written for the Climate Options for the Long Term (COOL) project. The aim of the COOL project, which is part of the National Research Programme on Global Air Pollution and Climate Change, is to create a dialogue between scientists, policymakers and the various sectors of society who are facing the stiff challenge of reducing energy consumption. In this dialogue, the various groups are considering how to achieve a reduction of 80% in CO_2 emissions in the various sectors by the year 2050. This 80% reduction is needed not only to cope with climate change but at the same time to facilitate a fair distribution of emission reductions between different countries so that Third World countries can still allow CO_2 emissions to grow.

The dialogue has raised the question of what social and economic changes could be prompted by the rapid pace of developments in ICT and what they might signify for energy consumption and the resulting CO_2 emissions.

In this essay we want to:

- present an overview of the developments in ICT,
- provide an insight into the changes that could occur as a result of these developments, as well as the background to these changes,
- highlight the uncertainties,
- further define the relationship with the climate problem (read: energy consumption),
- indicate what policy options there are.

The developments outlined above can be looked at in a number of totally different ways. We have opted for an approach in which we consider the changes that technology causes in a technological system in a social context. The role of the government, the market, companies and consumers are assessed in a balanced way. So we consider not only the technology itself (in other words, we do not regard the development of technology as autonomous), but review developments at system level, in which different related technologies, infrastructure, and last but not least various societal actors play an important role. The use of technology by the various actors, how it is applied, will have an effect on energy consumption.

The questions
The central question asked in this essay is:

What are the consequences of the rapid pace of developments in the field of information and communication technology for climate change, in this case translated into the effects for energy consumption on different scales (global, national and sector-specific)?

This problem is broken down into the following questions:
1. What developments are taking place in the area of information and communication technology and which are relevant for climate change? What trends, dynamics and processes can be identified?
2. What positive and negative consequences could ICT developments have for the climate? These aspects will be considerd in both general (international, national) and sector-specific terms.
3. Under what conditions can the positive consequences arise (behaviour, infrastructure, policy, etc.); What are the maximum effects you can then expect?
4. What major questions and points for discussion can be identified to feed the debate at the COOL meetings?

In this essay we will start by defining what we mean by technology in the social context (section 3). In the following sections we will then address each of the above questions in turn. In section 4 we look at the technological developments surrounding ICT and their social implications. In section 5 we look at the relationship between these developments and climate change. In section 6 we discuss the possible effects and the conditions under which these effects could occur. Finally, in section 7 we will present the main conclusions, discussion points and questions for the COOL project.

Technology in a social context
In the introduction we mentioned that we are looking at the entire technological system in the social context. For this we want to use a simple but transparent model (Slob, 1999). This model (see figure 1) has three central elements:
- **Arrangements**: all institutional, organisational or commercial arrangements that are needed to direct technological development and the behaviour of individuals and companies in a particular direction. These include, for instance, environmental laws and regulations, but also tax measures or public information, the institutions to implement them, etc. In this context, services can be seen as a commercial arrangement whereby technology is used more efficiently and at the same time behaviour is influenced. Services may therefore have a worthwhile environmental benefit.
- **Behaviour**: this refers to the behaviour of companies and individuals. The behaviour in the technological system will have a major impact on the resulting environmental effects. Both quantitative and qualitative aspects are relevant in this regard. The quantitative aspects (volume) of production and consumption are closely related to the quantity (amount) of the environmental aspects, while the qualitative aspects (quality of products and services) are largely responsible for the nature of the environmental aspects.
- **Technology**: the artefacts that are developed and used to meet the needs of consumers and producers. In this context, improved and innovative technologies that cause far less pollution are interesting. These technologies are also referred to with the “factor-metaphor” which describes the extent to which the technology is improved (e.g. by factor of 4, a factor of 20).

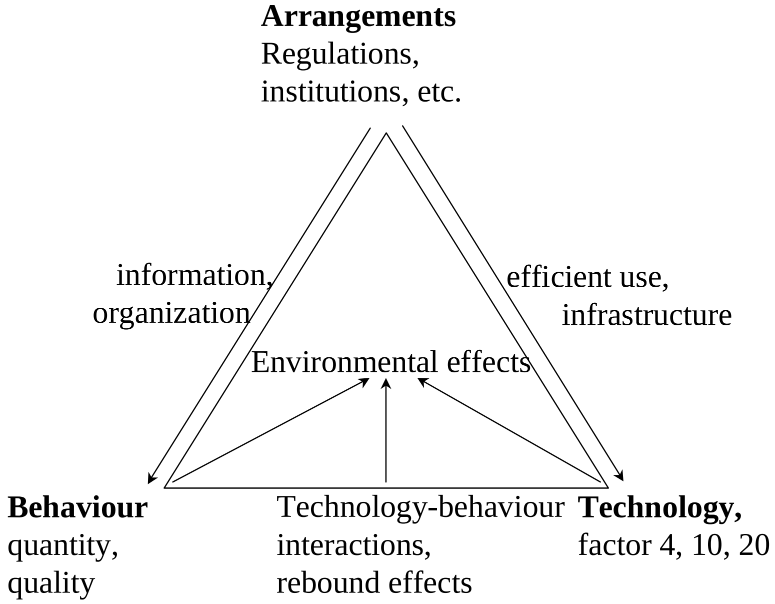

Figure 1: Technology in social context

These three elements are not independent but interact along the sides of the triangle:

- **Organisation and information** as the link between arrangements and behaviour. Information and organisation can be seen as a weak form of guiding behaviour. Environmental information and eco teams are examples of this. On the other hand, information and organisation can be used to provide feedback to arrangements (monitoring): have the envisaged effects of policy or regulation been achieved? Should targets be revised?
- **Infrastructure** as a physical form of an arrangement, particularly with a view to directing the application of technology. We also include the R&D infrastructure which directs the development of technology in this. Infrastructure offers an important (technological) context for the application of technology and can therefore direct the efficient use of technology and the environmental benefits arising from it to a large extent. Infrastructure is essential if we are to profit from new technological possibilities. After all, new technological possibilities sometimes require an entirely new infrastructure. At the same time, the old infrastructure can sometimes slow the process enormously. There may be interests associated with the old infrastructure (especially those of the owner of the infrastructure) which can form a significant barrier to the optimal use or introduction of new infrastructures. The discussion in the 1980s concerning the delivery of electricity from windmills in the Netherlands to the national grid is an example of this. This only changed when the Electricity Act was amended (an arrangement).
- **Technology-behaviour interactions** determine the way in which the user ultimately deals with the technology. There is a lot of evidence from the past showing the existence of a rebound effect: the phenomenon that the potential environmental benefits resulting from technological improvements are not secured because behaviour also changes (see Slob et. al., 1996). The technology is used differently than was intended or new applications are thought up so that the environmental effects arising from the volume of use cancel out the environmental consequences of more efficient use. Examples of this are the introduction of the long-life light bulb, which led to new applications (outdoor lighting etc.) rather than the desired substitution of ordinary light bulbs in the living room.

The behaviour of the user has to be carefully considered in estimating the environmental aspects resulting from the introduction of new technology.

The behaviour of users and the technology used (artefacts) are jointly responsible for the resulting effects on the environment. The arrangements influence environmental effects via the technology used and the manner in which it is used (the behaviour). New technology incites new behaviour: new, previously unexplored applications (behaviour options) are found for new technologies. Changes in behaviour can in turn call for new arrangements. Infrastructures can also induce certain behaviour, while at the same time old infrastructures can prolong certain forms of behaviour. The introduction of new technology leads to change at each corner of the triangle. So when considering new technology, one also has to examine the other aspects from the triangle: behaviour, arrangements, organisation, information, infrastructure and the technology-behaviour interactions

Trends in ICT applications

Trends

The pace of innovation in information and communication technologies is high. New generations of products succeed one another in quick succession. For instance, the current expectation is that a mobile telephone will be followed after nine months by the next generation of mobile telephone, which is smaller, uses less energy and provides more services. Many owners of a PC with a 486 processor, which three years ago was still ‘top of the bill’, now keep them stored in their attic. The basis for these rapid developments is expressed in Moore's Law (Cohen et al., 2000). The law, which dates from the early 1980s, predicts that the capacity of chips will double every eighteen months while the price remains the same. This law could still apply for many more years (the estimate is until 2020) and forms an important driving force behind numerous ICT trends (miniaturisation, etc.).

There is not enough space in this paper for an in-depth and systematic survey of the developments in the technological basis of ICT. Nor is it crucial for our purpose, since we assume that it is not so much the technology itself as the organisation of the technology in specific social arrangements and in specific user contexts that counts. Nevertheless, to get a feel for the background to the current developments, we will briefly present a number of interesting trends, which together give an impression of the ‘push’ side of this wave of technological innovation (see Bozetti, 1999; Bozetti, 2000). We identify five interesting trends:

1. Continuous *miniaturisation* of individual components (chips, digital cameras (the size of a sugar cube), mobile telephones, monitors).
2. *Digitisation* of text, image, voice, data making it possible to develop applications that can handle all sorts of data; this enables, for instance, telephony via the Internet (Voice over IP) and vice versa, Internet via the telephone (WAP: Wireless Application Protocol).
3. *Convergence* of formerly separate networks; telecommunication networks, computer networks and TV networks converging into a single infrastructure carrying text, images, voice and data. Two remarks need to be made here. First, the formerly ‘vertical’ structure (vertical segmentation: separate telephone, TV and computer networks) is being replaced by a layered structure (horizontal segmentation: infrastructure – network services–applications), which has major repercussions for the organisation of market players. Secondly, a single infrastructure that carries everything does not mean that the entire infrastructure is completely transparent; many individual networks are being created.
4. *Integration* of architectures, standards and protocols; the Internet protocol currently seems to be dictating the direction of network developments, from internal business applications to public networks.

5. Added *intelligence* to networks and applications. In a dialogue with the user, Smartbots develop an impression of what the user wants, and provide the link between 'front office' and 'back office'.

It is impossible to forecast whether these trends will still manifest themselves in the same way in fifty years' time. At the moment, the technological horizon for most companies extends not much further than two years at most. What we can say with certainty is that for the time being the technical potential of ICT will only increase. The fact that the computer is everywhere nowadays, from refrigerators to high-tech business systems, is known as 'ubiquitous computing' (ICT everywhere, under any circumstances and at any time). Nevertheless, it is going too far to assert that the availability of ICT automatically leads to its application. Against the potential of ICT as an *enabling technology* there is the problem of its integration and acceptance in society. As emerged in the introduction, we assume that ICT and the social context within which it has to function go hand in hand. Each influences the other and they cannot be seen separately from each other. There are plenty of examples of promising technologies that failed to take off or whose use fell far short of expectations. While we can regard the rapid introduction of the mobile telephone as a success story, the other side of the coin is represented by the failed introduction of the electronic purse (chipknip and chipper), the failure of digital money to get off the ground and the failure of steadily more advanced office accessories to increase productivity by as much as anticipated (CPB, 2000). So the success stories have to be treated with a certain reservation.

The new economy

ICT seems to be turning old economic laws on their head. There is currently a transition taking place from a product economy, in which supply and demand focus on finding a market equilibrium for scarce goods, to a service economy, where the same service can be repeatedly sold at marginal additional cost. Illustrative of the current economic order is the fact that mobile telephones are given away or sold for a very low price with a subscription. The profit is no longer to be found in the added value of the physical production but in the services provided along with the telephone (the use of the telephone, the SMS options, its use abroad, connection to the Internet). The new economy is further characterised by the emergence of new giants in the telecommunication, media and amusement markets. Enormous sums are being paid in the mega-mergers between formerly independent companies (media giant Time Warner merges its activities with Internet behemoth America Online, and amusement colossus Endemol goes into partnership with Spain's telecommunication company Telefonica). Even the proceeds from the auction of the third generation of mobile telephone frequencies (UMTS) are – with the exception of the Netherlands – enormous: the sale of licences raised 80 billion guilders in the United Kingdom, and as much as 120 billion guilders in Germany. The sale has boosted economic growth in Germany by a few tenths of a percentage-point this year and the German government will close the financial year with a budget surplus rather than a deficit (De Volkskrant, 30 August 2000). One final factor that we want to point out is the imbalance between the 'virtual' value of Internet companies in particular and their actual earnings. The share value of large new e-services, like the famous electronic bookstore Amazon.com, the browser Netscape and many other familiar and less familiar initiatives, is far higher than the sales of those companies would justify. In fact, there are signs that this is about to change. The collapse in the share price of WorldOnline in the Netherlands, but also the fact that financiers are starting to pull out of loss-making e-commerce activities on the Internet, point to a possible turning point.

The growing economic importance of the ICT sector also emerges from a recently published study by the CPB (CPB, 2000). The ICT sector makes a relatively large contribution to economic growth. And for the first time the increase in labour productivity in the ICT sector is also higher than average. The CPB study breaks the ICT sector down into producers of ICT products and ICT service providers. The latter category encompasses services relating to ICT products (system management, software maintenance, installation of software) and telecommunication facilities. In relation to the environment, it is interesting to note that, according to some, for the first time economic growth and environmental burden have been decoupled. A study in the US shows that the economic growth in the last two years has not led to a proportionate increase in the environmental burden (Romm, 1999). This is partly attributed to the new economy, in which services cause less environmental harm than the traditional economy with its material production. However, the arguments presented in support of the correlation shown in the study are not particularly strong.

ICT and sustainability

ICT can contribute to reducing environmental effects in different ways via different mechanisms (see for example Ducatel et al, 1999).

First, it can do so through the technology itself. The trend towards miniaturisation and digitisation can contribute to *dematerialisation* of the economy. After all, miniaturisation means that in computers and similar products fewer materials are needed to perform the same function. Digitisation means that products are available digitally rather than materially, such as sending an e-mail instead of a letter.

Second, there can be a *decoupling of time and place*. Thanks to the increased possibilities of communication, actions can be carried out from anywhere. This means that various activities can be performed from the home: shopping, learning, working, etc. The potential effect of this for the environment will be substantial if there is *substitution* of movements. We will look at this in more detail in the following section.

Third, ICT can lead to *more efficient organisation* which is facilitated by the faster exchange of information in companies and in chains. Various activities can be performed more efficiently.

Fourth, it is increasingly possible to provide consumers with *tailor-made information* for purchasing decisions and about the use of appliances. Moreover, it may be possible to buy environmentally-friendly products via the Internet. Through its “catch all effect” ICT solves the problem of a diffuse market in which the buyers are initially few and far between.

Fifth, miniaturisation means that ICT can be built into a growing number of appliances, so that more and more *smarter, intelligent appliances* will come on to the market. This will make it possible for appliances to provide instructions for use (feedback technology) or programme themselves for optimal use. In other words, it will be possible to delegate user's behaviour in an intelligent manner to appliances.

But the relationship between ICT and sustainability is double-edged: substitution (of raw materials, transport movements) and optimisation lead on the one hand to a reduction in the use of raw materials, but on the other hand these gains are totally nullified by the explosive growth in the use of ICT. The few thousand mainframes of twenty-five years ago bear no relation to the many tens to hundreds of millions of computers worldwide with a shelf-life of little more than three years. The rise of e-mail has up to now led to scarcely any reduction in the flow of paper. The arrival of Internet companies in Amsterdam has led to extra demand for electricity. However, there are also more positive reports (Forsebäck, 2000). The Japanese Telecommunication Council forecasts a reduction of 3.81 MTon of CO_2 by 2008 (or approximately 7% of Japan's CO_2 emissions) if teleworking, intelligent transport systems, paper reduction through the use of Local Area Networks, household management systems, electronic publishing and e-learning are exploited in a realistic fashion. The question ultimately is whether the balance of savings and new and additional activities is still positive. The uncertainties in this respect are considerable.

ICT and climate change

The home and the built-up environment

The home environment will become more important in the society of the future. Besides being a place to live, many activities in the house lend themselves to digitisation and development of virtual services, ranging from television viewing and telephoning to electronic banking, telelearning, teleshopping and teleworking.[33] The home is an ideal place for decoupling processes formerly linked in time and space. A person can bank electronically at any time of the day and no longer needs to visit the bank.[34] The energy saving from teleactivities arises from the fact that the suppliers (for example banks) need fewer people, fewer offices, fewer activities (in fact the work shifts to the consumer), that less transport and distribution of physical goods is needed (video-on-line means a reduction of transport between the video store and the central warehouses) and the saving of paper (thanks to electronic communication). These savings are empirically demonstrable but are probably not significant in terms of the total energy consumption of a household.[35]

A second aspect is the degree to which ICT regulates overall energy consumption, starting with the provision of information prior to the planned purchase to the installation of equipment or software in the information architecture in the home and optimisation of the use in combination with the intelligence built in to appliances. Even energy management itself has energy saving potential. But the direct contribution of ICT to the savings will be modest, and because more appliances will be purchased with a higher replacement rate, may even be nil or negative. If the new style of living also involves the need for more rooms (for example because of teleworking, but also in connection with higher demands on home comfort) this will have a negative effect on the amount of energy needed. It should also be pointed out that although appliances may become more energy-efficient the energy balance will shift more towards production, distribution and disposal of the appliances.

A final aspect that we want to mention in connection with homes is the way in which they are an element of spatial planning. If ICT contributes to reducing the importance of distance as a factor in the choice of where one lives, a possible consequence of this is that distances travelled (to work, to the shopping centre, to leisure centres, to school) will increase. If this is attributed to a household it generates additional energy consumption. On the other hand, it is conceivable that carefully considered locations for new housing in relation to each other and to business parks, shopping centres, schools, etc. could lead to energy saving. It is also possible that advantages of scale could arise in the intelligent linking of intelligent energy infrastructures between home and working environments (combined heat and power generation plants in districts, district heating complexes, options for supplying heat back to the national grid, etc.). Up to now, there has been little or no research into such possibilities and effects of spatial planning. Generally speaking, it is disappointing to have to observe that ICT developments are very seldom assessed for their spatial planning implications, and vice versa. ICT has scarcely been mentioned in the debate that has preceded the (forthcoming) Dutch Fifth Policy Document on Spatial Planning. In a project like Gigaport, the aim of which is to produce the successor to the existing Internet infrastructure and applications that can use it, considerations of sustainability play scarcely any role.[36]

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33 We return to teleworking in the section on transport.

34 As Forsebäck argued in a recent study: we need banking, but we don't need banks (Forsebäck, 2000).

35 In a case study of the replacement of individual answering machines with a single central *on-line* answering service, Telia produced energy savings of a more than a factor 200. Although measured over a million households it is a substantial effect, the benefits per household remain small.

36 Interview with Ms. J. Tammenoms-Bakker, April 2000

Transport and mobility

The use of ICT can promote sustainability in the traffic and transport sector in a number of ways:

1. by optimising the use of the infrastructure (including promotion of the ‘modal split’);
2. by optimising the logistics chain;
3. by reducing the pressure on mobility through alternatives (teleworking, teleshopping, telelearning);
4. with intelligent vehicles and monitoring of cargoes.

The optimisation of the infrastructure does not automatically lead to a reduction of CO_2 emissions. More efficient use of the infrastructure could help to spread traffic through the day, so that if the traffic flow increases there will be greater emissions of CO_2. Promoting the modal split is a way of stimulating the most efficient form of transport from an energy perspective (especially transport by water compared with transport by road). However, ICT mainly further reinforces the competitive advantage of the door-to-door approach of road transport, in part because the use of ICT increases the opportunities for customised service.

Optimising the logistics chain fits in with the *Just in Time* approach. Greater control of the entire transport and distribution process means that smaller inventories need to be held and consequently smaller storage systems. With the use of a comprehensive logistics system, the utilisation of capacity of goods transport can be increased: fewer empty runs and optimisation of the length of trips. But in a recent study Transport en Logistiek Nederland (TLN) pointed to the likely increase in the number of trips with (small) vans if e-commerce really takes off (TLN, 2000). In the next five years TLN expects an increase of 38% in the number of trips for freight transport. Of this 38% increase, 21% will be ‘autonomous’ growth and 17% due to developments in e-commerce (8% growth in the Business to Consumer sector, 9% in the Business to Business sector). A scenario study by the ministries of Transport, Public Works and Water Management, Economic Affairs and Housing, Spatial Planning and the Environment concluded that with the conscious use of ICT tools CO_2 emissions could decline sharply but would probably still remain above the target of 168 billion kilos (Nederland digitaal, 2000).

Teleworking leads to substitution of commuter traffic. The savings could rise to 40% of the number of trips per week (ICT & Sustainability, 2000; Forsebäck, 2000, p. 34). The increased use due to the car becoming available generally seems to be less than the savings (Puylaert et al, 1999). In other words, the sum of the effect of a car being freed up for secondary purposes (social and recreational traffic), other work-related movements or instigation of new commuter traffic is less than the savings achieved. In combination with the assumption that the house is a more energy-efficient place to work than the office (ICT & Sustainability, 2000), large-scale introduction of teleworking could make a positive contribution to reducing CO_2 emissions. Besides teleworking, teleshopping can also save trips. Up to now the expectations for teleshopping have scarcely been converted into quantifiable data. Following the TLN study, a certain degree of scepticism is therefore justified about the direction these developments will take.

Industry

There is some literature on the effects of ICT at macro level, but we found no literature for specific sectors of industry. What follows, therefore, is based mainly on our own forecasts of those effects. ICT could have two major influences on industry. On the one hand, optimisation in companies and collaboration in chains so that energy and materials can be used more efficiently. On the other hand, ICT could reinforce the existing trend of the growing importance of services in the economy, because services can be provided via e-commerce and tailored to the individual customer. Transport activities relating to industry are not considered here. They were discussed in the previous section.

The greater accessibility of information and the speed with which information is exchanged will make it easier for companies to share information worldwide about the environment and to monitor flows of raw materials and waste substances. This information is essential for chain management, where the various steps in the production process, from raw material to product to waste, can be linked in such a way as to keep pollution to a minimum. In this respect, ICT acts as a facilitator for collaboration between suppliers and customers and hence can help to optimise the entire chain. This aspect will have a positive effect particularly for the substances emitted to the environment and not so much for energy consumption. To grasp these benefits an organisational structure setting out the protocols for information exchange (method of exchanging information, infrastructure, assurance of reliability, confidentiality, etc.) is needed.

Various industrial production processes can be made more intelligent and can be better monitored with ICT applications. This could generate savings of raw materials and energy, although for the time being we do not estimate this effect as being very great. Production processes in companies are already largely optimised. ICT could make a minor contribution to this.

Finally, ICT can help to increase the transparency of the market for raw materials, waste and residual products. For instance, industrial ecological complexes could be formed at local level, in which the waste from one company becomes the raw material for another, or in which companies swap heat and electricity with each other. But ICT can contribute little to the creation of these complexes: it is not so much the “market” that is the problem but rather the need for collaboration between companies, which poses a number of dilemmas, such as the creation of mutual dependency, the division of costs and benefits and the risks for business operations. The introduction of ICT is expected to have at best a modest impact on energy consumption.

The trend towards the increasing importance of services in the economy has been apparent for years. For the COOL project, an important question is therefore how the industrial sector will develop in relation to the service sector. Will we have a fully service economy in 2050 or will there still be substantial industrial activity?

From the ICT perspective, what we can say is that ICT can make a significant contribution to the creation, sale and delivery of services. The literature (Bilderbeek et al., 1998, Miles, et al., 1999) shows that ICT plays an important role in service innovation. Many new services are born from ICT applications. Take for instance the “booming business” of e-commerce. It is therefore likely that ICT will reinforce the trend towards the service economy.

What does this mean for the likely environmental effects? Generally speaking, environmental scientists take a very positive attitude towards services, based on the idea that the material component in services is smaller than in products. However, in another study we showed that this relationship is not so straightforward (Nijhuis et al., 2000). After all, services often also need products (for example, computers when we are talking about e-commerce), and since people have to do the work there is often a significant transport component involved in getting the service providers to the client.

Another aspect that emerged in this study was that the “rebound effect” of services can be considerable. Simple access to the purchase of services can easily lead to far more services being bought than would be necessary purely on the basis of substitution. The volume of demand hence increases, as do the related environmental aspects, so savings can be cancelled out.

We therefore do not simply assume that an increasingly service-oriented economy will automatically lead to reductions of emissions or energy saving.

Agriculture and food

We will look here only at ICT applications in the production phase and not in the processing or consumption phase. In the previous section we considered the consequences for industry and there is no reason to believe the mechanisms described above should work differently for the food industry. At the same time, we considered the consumption phase in the section on "home".

Precision agriculture is a promising application of ICT for the cultivation of crops in agriculture. Precision agriculture is a form of farming where growers respond to the natural variability of the soil with the help of different technologies. By sowing, tackling weeds and diseases, applying nitrogen and harvesting according to the requirements of a specific location, it is possible to improve the quality of the harvest, increase yields and curb harmful effects for the environment.

Satellites are an important element of precision agriculture, as with the aid of GPS (Global Positioning Systems) objects, in this case harvesters and sowing machines, can be followed and steered. The yield from a plot is measured using a harvesting machine fitted with a yield meter and a GPS. The result is a yield map, which shows the yields for each location in the plot of land. The differences in yields are explained, for instance by differences in soil composition, ground water level etc. The data acquired in this way are processed and converted into charts for manure spreading, spraying and sowing. With the aid of sensor technology, muck spreaders, sprays for pesticides and sowing machines can adapt the doses to the exact needs of a particular point in the plot. All the calculations are entered in a single central computer, which helps the farmer to determine the optimal time and route for harvesting. Precision agriculture increases productivity, improves the quality of the crops and the efficiency and effectiveness of the use of resources such as seed, manure and pesticides (Nijhuis, 1999, Nijhuis et al., 2000). Precision agriculture therefore contributes mainly to the efficient use of raw materials and can also help with the more efficient use of energy. We do not feel the effect on energy consumption will be particularly large.

Processes in horticulture and livestock sector are already heavily mechanised. ICT applications could make these processes even smarter and further optimise them. We do not estimate the effect on energy consumption as particularly great.

The effect of ICT on climate change

In this section we will try to translate the applications of ICT technology described in the previous section into the consequences for energy consumption in the various sectors. But we wish to stress that the estimates are very tentative. We found no basis for them in the literature, nor is this the time or place for a more in-depth analysis. However, a quantitative estimate does provide an insight into the mutual relationships and further elaborates on the qualitative estimate. Table 1 lists the various applications in the different sectors and explains how these applications contribute to reducing pollution and energy consumption, with references to the different mechanisms mentioned in section 4.3 (dematerialisation, decoupling of time and place, efficient organisation, information provision, intelligent appliances).

	Mechanism[37]	**Technically feasible energy saving**[38]	**Likely energy saving**

[37] The different mechanisms are: dematerialisation (1), decoupling of time and place (2), more efficient organisation (3), tailored information (4), intelligent appliances (5).

Home			
• Energy in the home	3, 4, 5	10%	5%
• Electrical appliances	4, 5	5%	0
• On-line services	2	5%	0
• Spatial Planning	2, 3, 4	?0?	0
Transport			
• Infrastructure/ modal split	2, 3	20%	- x%
• Logistics	2, 3, 4, 5	15%	5-10%
• Intelligent vehicles	1, 5	20%	15%
• Teleworking, teleshopping, etc.	2, 3	40%	20-25%
Industry			
• Chain management	3, 4	5-10%	0
• Smart processes	5	10%	0
• Services	1, 3	?0?	- x %
Agriculture			
• Precision agriculture	1,3,5	10%	0

Table 1: The contribution to energy conservation by the various ICT applications.

The table makes a distinction between the technically feasible energy savings and the most likely energy savings. Under the technically feasible savings we indicate the maximum effect that ICT could have if other aspects are ignored, such as behaviour, organisation, infrastructure, etc. In the column "likely energy saving", we indicate what effect is likely if ICT is used in a traditional manner, in other words without a complete "redesign".

We estimate that the energy savings actually achieved are likely to be less than what is technically feasible. This relates to the model that we outlined in section 3. In our view, when new technology is introduced attention should be given to all aspects mentioned there: the behaviour of societal actors, new arrangements, infrastructure, organisation and information, and the technology-behaviour interactions. Many of the technical possibilities are not properly exploited because of:

- rebound effects: for example, with teleworking the car is not used for work but for extra private trips; a more efficient organisation means that there is time left over for extra production, etc. We therefore expect that the extra 'room' created will be swallowed up by new activities, which leads to extra energy consumption.
- too little attention to accompanying organisation and infrastructure.
- failure to provide information to the user.
- divided interests and power positions of actors, so that no one takes the lead in directing the use of ICT technology. Neither the government nor companies feel compelled to create new arrangements or institutions.

This table shows that our estimates of the potential savings through optimal use of technology are generally modest and nowhere near the desired 80%. The savings in transport (traffic and transport) produce the highest returns from a technological perspective. But the interaction between the various aspects is highly complex: optimising logistics chains, for example, could have a negative effect on the modal split, and to a certain extent also on the use of the

[38] The quoted percentages are for savings that could be realised in the relevant domain. Savings of 10% for energy in the home means that through the optimal use of technology the total energy consumption of a household can generate savings of up to 10%. For the interpretation of the percentages, therefore, it is a question of the potential savings in the given situation. For an overall impression, the mutual proportions of energy consumption in the home, transport, industry and agriculture have to be included in the calculations. We don't do that here.

infrastructure (more capacity available, hence less need to shift to a different form of transport). Because of the interdependencies between the various actions the savings cannot simply be added up. From the (we repeat: tentative) table, it follows that the potential savings in homes, industry and agriculture remain around ten percent, and for traffic around 30%. The expected savings (from incorporating ICT in current activities, in other words without substantial reversal of trends) in the case of homes, industry and agriculture are slightly positive or possibly even negative. The savings will be highest in transport.

What policy options do we feel should be adopted?
First of all, we want to stress the importance of collaboration between the government, companies and civic groups, in which they start a dialogue about what measures have to be taken, and by whom, to supervise the ICT applications in order to gain the maximum benefit from energy-saving effects. The COOL dialogue is itself in fact a good example of this.

Within this context, agreements can be made with respect to:
- the monitoring of the use of ICT in society, which would have an important function in identifying the following aspects;
- influencing technology-behaviour interactions; preventing rebound effects;
- ensuring that the infrastructure is adequate;
- providing information to users and ensuring there are adequate organisational models for information-exchange and feedback;
- developing intelligent appliances;
- desired rules and regulations.

Major conclusions and points for discussion

- Technologically, a lot if not everything is possible, especially in view of the rapid developments with respect to information and communication technology. A far more important question is how we can and want to take advantage of the new possibilities. As we have tried to indicate in this essay, the social context of the technology has a major, if not decisive, influence on its ultimate use, and hence on the resulting energy consumption. Can we and do we want to influence this social context by means of various arrangements and policy options? What additional policy will we use to do this?
- The use of ICT can contribute to the 80% reduction targeted by COOL, but will never in itself be enough.
- Our analysis shows that transport and traffic can make a particularly significant contribution to the reduction of CO_2. Other sectors can also achieve additional energy conservation, but to a lesser extent. If we want to “reap” these benefits, consideration will have to be given to new institutional arrangements, new organisational and information structures, infrastructure, and to understanding and influencing the behaviour of the users of technology.
- In our essay we have placed a major question mark against the energy-saving effects of the growing service-orientation of the economy. It is impossible to say in advance whether a service will lead to additional energy conservation since services could lead to extra demand as well as extra transport movements. However, services can play a role in saving energy. It is therefore essential to find out more about the relationship between the growth of services and energy consumption and to use the findings to provide more direction for the development of services.
- There are enormous uncertainties surrounding the effects of the rapid developments in ICT. The future interaction between the technology and the user (the rebound effect) is particularly difficult to predict. It is precisely this interaction that will account for the ultimate effect on energy consumption. Additional or different use of the technology

could turn a potential benefit for energy consumption into a disadvantage. Intelligent appliances can be used to direct user behaviour. But there is still little known about technology-behaviour interactions. We therefore call for the creation of a research programme "Technology and Behaviour" to increase our understanding of this phenomenon and conduct practical experiments.

- Who feels compelled to take the initiative to implement the various conceivable and possible arrangements: the government, the private sector? In this essay we have given some (global) indications of arrangements that could be made. Something will have to be done if we want to avoid a social dilemma, in which everyone sits and waits for everyone else.
  In this context, we call for collaboration in which the public and private sectors jointly study policy options, conduct research, assign responsibilities for actions and carry them out, all with a greater emphasis on shared responsibility and interactive policy-making.

Literature

Bilderbeek, R, P. den Hertog, G. Marklund and I. Miles (1998): *Services in Innovation: Knowledge Intensive Business Services (KIBS) as co-producers of innovation"*, SI4S synthesis paper, stage 3, STEP Group.

Bozetti, M. (2000). The technological evolution of ICT and standards. In: EITO 2000. pp. 118-217.

Bozetti, M. (1999). The technological evolution of ICT and standards. In: EITO 2000. pp. 80-161.

Cohen, S., J, Bradford DeLong, J. Zysman (2000). *Tools for thought: What is new and important about the Economy?* BRIE Working Paper 138, Berkeley University, USA.

CPB (2000). *ICT en de Nederlandse economie – Een historisch en internationaal perspectief.* Werkdocument 125. Centraal Planbureau, Den Haag, 2000.

Ducatel, K., Burgelman, J-C, Howelss, J. Bohlin, E., Ottisch, M. (1999). *Information and Communication technologies and the Information Society Panel Report*. Futures Report Series 03. Sevilla: IPTS.

Forsebäck, L. (2000). *Case Studies of the Information Society and Sustainable Development.* IST-programma, mei 2000.

ICT and sustainability (2000). *Making work more environment-friendly and creating a better society.* http://www.sectec.co.uik/wired/bp14.htm [21 augustus 2000].

Martens, M.J. e. a. (1999). *The mobility impact of the electronic highway - A technology forecast and assessment using a scenario approach.* Report 99/NV/074, Delft: TNO-INRO.

Miles, I., R. Coombs and S. Metcalfe (1999): *"Services and innovation"*, Background paper for the 6 countries Programme workshop: Manchester, 22/23 april 1999.

Nederland Digitaal (2000). *Nederland Digitaal – Drie toekomstbeelden voor Nederland in 2030; eindrapportage*. Den Haag: V&W/VROM/EZ.

Nijhuis, E.W.T., G. Scholl, A.F.L. Slob (2000): *Innovation of eco-efficient producer services*; report stage 1: conceptual paper; EU-project "Creating Eco-efficient Producer services"; IÖW, TNO-STB, Delft.

Nijhuis, E.W.J.T., (1999), *Precisielandbouw en TNO*, TNO Strategie, Technologie en Beleid, Delft, STB 99-13

Nijhuis, E.W.J.T., A.B. Smit, S.M. Janssens, *Precisielandbouw biedt akkerbouwer toekomst*, Landbouwmechanisatie, pp. 44-45, januari 2000

Puylaert, H. e.a. (1999). *Wonen en werken: uit en thuis met ICT – Een verkenning naar de invloed van ICT op (de relatie tussen) wonen en werken,* Rapport P99-007, Delft: TNO-INRO.

Remote Sensing Nieuwsbrief, *Themanummer Precisielandbouw*, nummer 86, juni 1999

Romm, J. e.a. (1999). *The Internet Economy and Global Warming*, GEFT/SECS, December 1999. (www.cool-compagnies.org).

Slob, A.F.L. , M. J. Bouman, M. de Haan, K. Blok, K. Vringer (1996), *Consumption and the Environment: Analysis of trends*, TNO-STB, University of Utrecht, CBS, Ministry of Housing, Spatial Planning and Environment, the Hague, 1996

Slob, A.F.L. (1999): *"Close encounters: Business opportunities in a sustainable society are no science fiction"*, paper for the International Business Forum 'Sustainable Consumption and Production, 13 – 15 October 1999, Berlin, TNO Institute of Strategy, Technology and Policy, Delft.

TLN (2000). *Nieuwe wijn in oude zakken - Pleidooi van Transport en Logistiek Nederland voor meer ruimte voor het vrachtverkeer om de groei van de nieuwe economie op te vangen*. Zoetermeer: Transport en Logistiek Nederland.

Annex X : Participants papers

Analytical framework for sustainable energy transitions
Ewaryst Hille, Polish Foundation for Energy Efficiency

The biomass potential in Poland
Ewaryst Hille, Polish Foundation for Energy Efficiency

Why and how to make the "new economy" a "sustainable economy"?
Dr Paul E. Metz e[5] *- European Business Council for a Sustainable Energy Future*

Bioenergy Potentials In The Hungarian Agriculture
Diana Ürge-Vorsatz Central European University Budapest, Hungary

Long Term European Communication Plan to raise awareness around sustainable transport.
Roger Torode, London transport

How to calculate the environmental impact of a transport in Europe
-an example from Schenker-BTL available on internet.
Johan Trouvé, Head Environmental Affairs, Schenker Land Transport, Europe

Comments on participants papers
Martin Patel, Ecofys.

Analytical framework for sustainable energy transitions

Ewaryst Hille
Polish Foundation for Energy Efficiency

Input paper for COOL Europe workshop 3

1. "Transition of the energy" is a relatively rapid process with high dynamic resulting in no credibility of statistical data and a breakdown of formerly observed trends. A sustainable energy transition have to embrace not only energy supply systems but also (and mainly) a wide range of demand-side issues and environmental aspects of both – energy supply and demand.

2. The analytical framework should encompass the situation *before* the transition (the current state off the energy sector and existing trends) and *after* the transition (goals and expected trend changes based on sustainable development criteria). Those frames would be drafted as the following one:
   - defined energy and energy related retail and bulk products for "today" (like, e.g., energy as itself, system security services and products on the wholesale market) and for "tomorrow" (like, e.g., retail energy services, wholesale market energy services, energy as itself, energy to service converting appliances, non energy–cost sharing services, e.g. media-related products),
   - demand prediction for the above defined products as a function of growth, education level, information access, technological progress, globalisation and so forth,
   - prediction of the capacity of supply for defined products,
   - related semi-products demand and supply,
   - necessary new market creation for the new products and dynamic of its development from directly regulated to liberalised,
   - expected kinds of regulations and changes over the time,
   - actor categories for specific markets, public level responsibility for specific issues,
   - ownership structure for "today" and for "tomorrow",
   - energy economy environment (like macroeconomic growth dynamic, capital market circumstances - scope, alternatives, interest, risk issues...), legal (transparency, stability...), societal (labour market, income level, polarisation...), environmental issues (like absolute pollution level, dynamic of changes on the local, regional and global level).

3. The historically shaped energy economy is based on a few, strongly technically integrated supply sub-systems (electricity, gas and central heat) as well on a few technically decentralised systems (liquid fuels, hard coal and lignite extraction). Usually energy systems are plenty of expensive assets, constructed on the basis of directly public or publicly secured investment resources. The inter-relation of the energy systems with macroeconomic, short-term political problems, society and environment costs are very strong and its current shape is a function of the development stage and historical economical doctrines (e.g. central planning system in Poland). Transitions of the whole economic system impose the necessity of an energy economy transition as well. This ongoing process could be shaped by historically developed goals and criteria and multiply then some existing (and obsolete) patterns from well-developed capitalistic countries or according to alternatives defined on the base of sustainable development goals and criteria. To achieve sustainability of the energy transition, transition processes have to be co-ordinated and integrated with other big transition processes. An investigation of the synergy effects and cost sharing opportunities is one of the most important issues for analysing.

4. The following phenomena seem to be important for analyses of a energy transition towards sustainability:
- globalisation of the economy (easy access to technology, capital, information – global optimisation of resources)
- macro-regional integration of infrastructure, like, e.g., energy networks,
- “horizontal” integration of different energy infrastructural activities and with other non-energy businesses,
- decentralisation of supply facilities and energy markets (dispersion of assets and authority, capacity limitation – miniaturisation, hierarchical system of reliability improvement, local markets development, short investment cycles, growing saving demand vs. increase supply competition, local resources activation e.g. renewable),
- individualisation (single person households, dispersion, individually shaped services, transportation costs),
- informatization (influence on TPA, DSM, accounting cycles, pricing and financing rules, transparent costs allocation, monopoly regulation),
- growing welfare and income level
  - less policy-related decisions (high energy security and reliability, no problem with basic social good supply, short investment cycles, capital market with normal commercial risk),
  - higher education level of the society in average, consumption structure and preferences changes, importance of the quality of products and risk control,
  - ongoing liberalisation of new market products,
  - gradual internalisation of environmental costs and growing value of that.

5. When the range of changes, expected economic and social costs are extremely high, the sustainable energy transition has to be a long lasting and gradual process. This is why young the generation’s priorities and long-term consumption patterns are important for the analyses. These issues are strongly related to the education system, information access and available patterns of consumption based on technology, absolute level of income (welfare) and its dynamic.

6. The possible appearance of social problems should be analysed as barriers against transition. It could be the follow ones:
- labour market inertia when low education level,
- lack of houses limiting mobility of the society,
- accumulation of many sector transitions effects politically difficult
- demand structure adequate to income level and education, tradition and customs (society quite close to the bottom of the pyramid of goods),
- technological shock for elderly people,
- structural demographically changes,
- polarisation of society,
- economic emigration of elites,
- high cost of social reforms (retirement system, insurance system, health protection system),
- regional concentration of chosen reforms (like the coal industry reforms in Upper Silesia in Poland).

7. The process of the sustainable transition should be stronger and stronger related to long term criteria and less and less to the historical criteria represented by the structure of assets and related political power (among other trade unions). Growing share of the currently public issues (some of them artificially) should be systematically privatised. To assume available dynamic of such kind processes one should analyse:
- opportunities to eliminate stranded assets and compensate social problems of that,
- dynamic and mechanisms to improve decision-making processes and availability of elimination of the local and special interest domination against society values,

- possible diversification of risk and cost by internalisation, privatisation and liberalisation,
- the readiness of the society to increase its personal responsibility for a new kind of decisions.

8. The dynamic range of issues adequate to be solved by competitive market mechanisms is a core issue for sustainable transition process. This should be a basis for analysis of alternative regulation mechanisms.

9. There are a number of analyses out of the energy sector which should be done for energy transition evaluation. It is for example:
- telecommunication techniques and law,
- capital market development procedures and economy capitalisation,
- ecological issues like absolute state of environment, dynamic of changes, society perception of that,
- societal understanding and acceptation of transition processes,
- interrelations with other sectoral strategies like transportation, agriculture, and industry.

10. When public authorities are responsible for the creation and implementation of macro and micro economic mechanisms an important issue is to analyse the division of that responsibility among different public level institutions such as: national government, international governmental bodies (conventional), regional and local authorities as well as dynamic of ongoing changes of that structure.

11. For the sustainability of the transition, subsidiary public authorities is important. Thus analyses of the style of regulation is also important. One could analyse the following issues:
- ways of creation of microeconomic rules,
- quality of the technical infrastructure for market decision,
- policy of standardisation,
- existing policy for better information access,
- policy of competitiveness stimulation, monitoring and control,
- existing mechanisms for structural and policy risk compensation.

12. When energy transition processes are long lasting, analysis of forecasting risk management would be of great importance. This means a necessity to analyse:
- existing uncertainties and related kinds of risk,
- methods of risk limitation,
- methods of compensation of the negative risk consequences,
- alternative risk allocation concepts among different actors,
- available incentives for risk taking by commercial actors,
- methods of covering the same risk categories by public institutions.

13. For science the most important matter for analysis are the best methods to support current decision making process within mathematical models, data and information under uncertainties of the transition process. The typical procedure is a qualitative and quantitative investigation loop: Stories ==> Scenarios ==> Models ==> Scenarios ==> Stories.

14. One of the most important problems is the geographical range of sustainability. Currently, when the world is still divided, existing inter-regional conflicts of interest creates different perspectives of sustainable development. It is very difficult for common understanding of values and costs for (for example) societies with 25 k$/c and 1 k$/c income level. From the global sustainable development point of view, high risk exists of creation of obsolete structures and consumption patterns in developing countries. When the purchase power is low those countries could be saturated with inefficient appliances

and energy intensive structures could be established (e.g. motorways system against railways) – the “end of pipe” approach is dominating behind decisions. For sustainable energy transition the idea of Trans European Network creation before environmental cost internalisation is also very dangerous. TEN is a vehicle to increase competitiveness of existing, mineral fuels based or nuclear fuel based power stations (without investment cost) against dispersed local renewable sources (with investment costs) and energy saving.

The generic reason of such situation is the necessity of economic and social process continuity. Natural preferences for local and short-term effects are also a big reason. It is why analysis of the society understanding of the regional interrelation as well as acceptance of next generations rights is of great importance for sustainable energy transition.

The biomass potential in Poland

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Polish Foundation for Energy Efficiency

Input paper for COOL Europe workshop 3

To assess the biomass potential in Poland two alternative, strategic approaches have been used:

A. Passive approach
B. Active approach

The passive approach assumes that biomass potential is being a function of time and microeconomic phenomena. This means that a majority of the processes are dominated or even determined by the existing, only slowly changing, market situation and its actors. Under these assumptions biomass is a risky endeavour and its economic potential is strongly limited by historical circumstances like existing assets, lobbies, and interests division. New actors, with investment and market entrance costs, have to struggle with a number of existing matured actors without such costs.

The active approach assumes that the biomass potential in Poland is effected by a macroeconomic strategy of a sustainable development of the society and its economy. It means that macroeconomic and political risks for the biomass market development is compensated by public institutions on the basis of the demand for expected public values. Valuation is done on the basis of the defined public values witch in the moment due to number of reasons is no yet "privatised" goods to the market regulations. It could be, for example, the following categories: (1) transformation of the rural sector of the economy and creation of plenty of new labour demand, (2) improvement of the energy security of the economy, and (3) local, countrywide and global environmental effects.

It is expected that those different approaches create different allocation of risk and interest and result in synergetic effects (or not) at the microeconomic level. The main assumed synergetic effect is the decision to use less or more of the available land for biomass production against other rural and non-rural activities.

The following resources have been qualified as potential primary energy biomass resources:

1. Solid biomass:
- forest, garden and city wood and wooden waste,
- wood and paper industry waste,
- food industry waste,
- straw and other agricultural waste,
- special energy plants:
- one season plants e.g.: crops, hemp, rape, cane,
- trees and the like e.g.: poplar, willow, aspen,
- many seasons plants grass and the like e.g.: Miscanthus spp., Arundo spp. Spartina spp.
- communal – city waste;

2. Gaseous biomass:
- waste treatment biogas,

- sewerage treatment station biogas;

3. Liquid or semi-liquid biomass:
- sedimentation rest of the sewerage treatment station,
- animals droppings.

The number of the above-mentioned resources is currently recognised as a difficult residue and its energy potential is not taken in to account. Eligible part of these resources which are used for energy supply are used only to cover the producer's own demand which benefit then producer's and consumer's surplus together. When biomass is not standard market commodity yet it effect that:

- there is no market for biomass itself and no market price for it,
- there is limited information about the biomass potential in Poland for a majority of the biomass categories, and
- for the biomass potential assessment it is necessary to analyse biomass resources and technical circumstances for its utilisation for the final services together.

The appraisal of the economical biomass potential is extremely difficult because of:
- the market for the facilities of biomass utilisation is on the very preliminary stage of development,
- there are plenty of energy efficiency improvement opportunities and the market for related services will develop itself, and
- traditional energy systems possess eligible over capacity from long distance; conventional sources and energy market liberalisation is ongoing.

The all above-mentioned circumstances are strong microeconomic barriers for the market entrance of biomass in the near future. From the another side there are strong macroeconomic and social arguments for a reduction of hose barriers and a promotion of biomass at the strategic level.

Due to above-mentioned reasons, the below presented biomass potential in Poland can only be a qualitative estimation. According to the European Center for Renewable Energy (EC BREC) [Warsaw 2000] the technical potential of the primary biomass in Poland is:

a.	straw and other agricultural waste	533 PJ/a
b.	forest and garden wood and waste	481 PJ/a
c.	communal – city waste	130 PJ/a
d.	animals droppings	38 PJ/a
e.	special energy plants	44 PJ/a
	Total	1226 PJ/a

According to J. Hauff, the total biomass potential for Poland is 810 PJ/a [World Bank, Warsaw 1996]. Both of these estimations are based on a passive approach.

Below I present my estimation of the primary biomass potential for Poland, based on active approach

1. Solid biomass:

■ forest, garden and city wood and wooden waste	500 PJ/a
■ wood and paper industry waste	40 PJ/a
■ food industry waste	15 PJ/a
■ straw and other agricultural waste	553 PJ/a

■ special energy plants	1000-1400 PJ/a
■ communal – city waste	130 PJ/a

2. Gaseous biomass:

■ waste treatment biogas	10 PJ/a
■ sewerage treatment station biogas	55 PJ/a

3. Liquid or semi-liquid biomass:

■ sedimentation rest of the sewerage treatment station	100 PJ/a
■ animals droppings	38 PJ/a

Grand total: 2441-2841 PJ/a

According to the Polish government, the energy demand for 2020 year will oscillate around 5,000 PJ/a (the presented range is c. 4700-5100 PJ/a). It means that actively shaped biomass potential if used, for example, for 30% in the year 2020, is able supply over 15% of the estimated demand.

Additional comments:

Land use structure changes are inevitable. It is due to the necessity to increase of the agriculture productivity of food 2-3 times during coming years. Simultaneously there is an over supply of food for the European market. It means that the eligible part of the land has to be free from conventional, commercial food production. This available land only to some extent will be used for reforestation, extensive "ecological" (unconventional) food production and so-called civilisation demands (trends for decentralisation and dispersion of living) etc.

When biomass technology-related markets will be developed to same stage and related prices will be much lower then today's number of additional and commercially available opportunities appear for biomass e.g. related to specific land areas not used today.

Why and how to make the "new economy" a "sustainable economy"?

Dr Paul E. Metz
e^5 - European Business Council for a Sustainable Energy Future

Input paper for COOL Europe workshop 3

The political agenda of today is not dominated by sustainability concerns and tricks or strategies for those who strive at reversing this are urgently needed.

In the COOL exercise our focus is even narrower: climate stabilisation. In the broad governmental perception this is seen as a very difficult and costly battle. The public and parliaments in many countries are less afraid of taking actions.

This is caused by the 'natural conservatism' of those in power – mainstream politics and business – who failed to read the book 'Natural Capitalism', open their minds to its relevance for any future, 'new' economy and apply it.

Relevant backcasting lessons were given by Arnold Toynbee in "The rise and fall of civilisations", concluding that the two main causes of decline are 'extreme concentration of material wealth' and 'lack of adaptation to new conditions'. Both criteria seem to be related and fulfilled in our present civilisation to a large extent.

Trying to look back now 100 years, we see that few scientific and technological developments could be predicted. And what was predicted correctly by Arrhenius on the climate impact of CO2-emissions and by Jules Verne on 'unlimited travel' was not believed. Just like now the various attractive predictions about a very prosperous and fully sustainable global society relying for 100% on the efficient use of renewable energy and the recycling of non-renewable materials.

For the COOL process it is therefore most relevant to analyse the political conditions that have given in the past, that are giving now and that will give in the near and more distant future the incentives to certain developments and disincentives to others – both can be wanted or not.
"Progress is not just a chance – it is a choice !" Who said this before Bill Clinton ?
Innovation cannot be ordered, but is neither autonomous: its direction can be chosen and society is manmade. Therefore, backcasting is extremely useful.

Free markets have never existed, they are a utopia

"It's the economy, stupid !" can only be said by ignorant or calculating politicians. Business lobbyists know that the reverse is true: the 'playing-field' of all business conditions, including the consumer decisions is created by politicians. Free labour markets have mainly resulted in slavery and other abuses, free capital markets brought inflation and financial criminality. We have learned that these markets can only be as free as possible when they are protected by a strong framework of regulations and independent supervision.

Now we are in Europe trying to 'modernise' energy, transport and environmental policies and practices by substituting state control and public management by 'liberalisation'. It is clear that a simple '**de**-regulation' cannot be sufficient to make the markets work to achieve the goals of improved efficiency and fairness. For the desired, not just 'level' but **high**-level-playing-field a few choices have been proposed and should get highest priority: **re**-regulation with market-improving policy measures.

1. Structural subsidies distort markets.

It is well-known that the European energy- and climate-related markets are distorted by a broad package of direct and indirect subsidies that do the opposite of what economic theory prescribes: they **ex**ternalise part of the costs of energy at the expense of other options for the taxpayers. In the USA during the past 50 years 20 times more subsidies have been given to nuclear energy than to all renewable technologies – in absolute numbers and per unit energy produced.

With Euratom and the Coal and Steel Treaty the EU probably is not doing better. Structural subsidies, which always include tax incentives and exemptions, for aviation and shipping are a world-wide phenomenon, but national and EU-actions are not completely impossible.

Subsidies are only justified temporarily for promising technologies. That stage is now over for nuclear and most fossil energy technologies. The level-playing-field approach would allow the same amount of these accumulated subsidies to be available for all renewables and efficient use technologies from now on. According to the polluter-pays-principle the budget for these subsidies should be raised from the users of – nuclear and fossil – energy, not from the taxpayers.

2. Free emissions distort markets.

Greenhouse gas emissions are historically unpriced. Ecological taxation has been introduced in several member states of the EU and will spread further for national climate and other policy reasons. The Kyoto Mechanisms are in an early design stage and promise to add a series of international exchange components in up to 8 years, which are fully complementary to the national policy instruments.

Bioenergy Potentials In The Hungarian Agriculture

Diana Ürge-Vorsatz
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Input paper to COOL Europe workshop 3

Hungary used to be considered as an agricultural economy during the Soviet era; the country has traditionally supplied the majority of the Soviet Union with a wide spectrum of agricultural products, including canned fruits and vegetables, vegetable juices, etc. Given Hungary's geographic, climatic and mineral resources, agriculture clearly has a high potential in contributing to the Hungarian economy. In 1997, agriculture has contributed app. 10% to the Hungarian GDP (KSH 1999). The future of this economic orientation, however, is controversial in the light of EU accession and the problems of EU agriculture. Thus, there is an increasing pressure towards the utilisation of agricultural lands for renewable biomass energy production to replace fossil fuels, and other utilisation of biomass energy sources from agriculture. However, as in many other OECD countries, this mainly remains still on the rhetorical level, or at best at the planning stage. There is currently a frequently attacked biodiesel programme supported by the Ministry of Agriculture and Regional Planning.

The International Energy Agency (1995) estimates that the exploitation of agricultural and forestry by products and waste material and production of specialised plants and tree crops on surplus farmland could be capable of providing more than 1.1 Mtoe of energy annually, comparing to the app. 25 Mtoe TPES in 1999 (IEA 1999). However, the report also admits that information is very limited in this area. The most comprehensive study on biomass energy potentials from agriculture was carried out by the Hungarian Academy of Sciences in the early 1980s, as a response to the oil crises (which had limited direct impact on Soviet-system economies due exclusively Soviet imports, and the "Bucharest formula" for calculating fuel prices). While Hungary's economy has changed since 1985, experts consider the figures in this study (Lang 1985) still largely valid ballpark figures for estimating biomass potentials.

Lang et al. (1985) estimated that Hungary's primary (plant) biomass production in agriculture and forestry was app. 53.4 million tons. More recent studies (Kocsis 1995) found that this figure has not changed significantly: app. 55 – 58 Mt, out of which 26 – 28 Mt are by-products. The same study estimated that app. 3.5 Mt of this can be used for energy production. Unfortunately I have not seen the assumptions, but this figure to me seems as a very conservative estimate. Since the Lang study is the most detailed and thoroughly researched, now we go back to the detailed findings in that report.

When the biomass is translated into energy figures, 369.3 PJ are by-products out of the 941 PJ agricultural plant biomass production. This is constituted as follows:

	PJ
Corn residues	188.7
Straw	136.5
Other	44.1
Total	*369.3*

Out of the 369 PJ, app. 13 PJ was used for energy production in the 1980s, and app. 284 PJ remained as stalk residues after subtracting other uses. Since total agricultural production has decreased since the 1980s, I estimate that this amount is app. 20 – 30% smaller today.

In animal husbandry, there was app. 5,650 Mt of byproducts in the early 1980s, with 92 PJ energy equivalent of manure. Unfortunately the Hungarian livestock numbers have close to halved since 1980 (KSH 2000), thus this figure can now be estimated to be around 46 PJ. 59% of manure originates from cows, and 20% from pigs.

In summary, Hungary has a significant potential for producing biomass energy in agriculture. The potential is largest in the burning of crop residues (corn and cereals, but also fruit tree and vine cuttings), and in the production of biogas from animal manure. As Hungary is waiting to access to the EU, it may also be desirable to convert some agricultural land into biomass plantations.

References:

International Energy Agency (1995). Energy Policies of Hungary, 1995. IEA/OECD.

International Energy Agency (1999). Energy Policies of Hungary, 1999 review. IEA/OECD.

Istvan Lang et al. (1985). The potential for biomass utilisation (in Hungarian). Mezogazdasagi Konyvkiado, Budapest

Ferenc Sagi (cited 2000) Újratermelõdõ természetes anyagok az Európai Unióban. Mezõgazdaságunk útja az Európai Unióba, 5. Fuzet. http://re.omgk.hu/MGUT5/mgut5tj.html#2_5

KOCSIS, K.: Az energia környezetbarát termelése és felhasználása az agrárgazdaságban. "Agro-21" Füzetek, 1995, 6.sz.

Kozponti Statisztikai Hivatal (KSH), various years. (Central Statistical Office): Statistical Yearbook of Hungary. Kozponti Statisztikai Hivatal.

Long Term European Communication Plan to raise awareness around sustainable transport.

Roger Torode

This note is expected to bring creative and new ideas to stimulate discussion. It is rather better at setting out the problem than in suggesting solutions, but it will hopefully be a good stimulus to brain-storming in the 3rd workshop.

The Problem with transport

- CO_2 is the principal greenhouse gas emitted from the transport sector.
- Transport is one of the major contributors of CO_2 emissions. It is the fastest growing source, and it has almost unlimited potential for future growth.
- About 50% of transport CO_2 emissions are estimated to be due to private cars, and about 35% to road freight. If the emissions from the manufacture of vehicles, and the construction of roads and other infrastructure are included, the true figure is even higher.
- Globally, fuel consumed for transport increased by 50% between 1973 and 1990, and it is forecast to increase by up to 130% by the year 2025. Of that growth, almost all is accounted for by the increase in private car use.
- N_2O is also a growing problem from road transport, as catalytic converters emit higher proportions of N_20 in NOx than older cars without catalytic converters.

Transport is not, at present, sustainable

- Traffic-related air pollution.
- Child health.
- Road accidents.
- Noise pollution.
- Social exclusion.
- Lack of exercise.
- Break up of communities.
- Congestion.
- Consumption of space in cities.
- Disruption to public transport and pedestrians.
- Visual intrusion and degradation.
- Bio-diversity loss and habitat fragmentation from infrastructure construction
- Damage to buildings and the fabric of historic cities.
- Urban sprawl and the dispersal of development.
- Pressure to spend increasing financial resources on roads and parking, and
- Effects on employment.

The problem is getting worse

Populations are expanding, people are travelling more, and an increasing proportion of journeys are being made by car – even very short journeys. In the European Union, the daily distance travelled per person doubled between 1975 and 1995. Now, 80% of all personal journeys in the European Union are by car and 50% of all car trips are less than 5 km. A further doubling of traffic is expected in the next twenty years. Car registrations across the world are growing more than twice as fast as the population.

This increase in traffic reflects:

- Economic growth
- Increasing populations
- Improving standard of living
- Decreasing "real" costs of car ownership and usage
- Increasing travelling by everybody
- Increasing propensity to use private cars, not walking, cycling or public transport.
- Increasing expectations – quality, quantity, standard of service.
- Increasing concern for personal safety and privacy ("personal space") leading people to use cars, not public transport.
- Increasing standards/sophistication of cars – 4 wheel drive, people movers, air conditioning and other interior electronic equipment, gas guzzlers.

For public transport:
- Rising passenger expectations for good quality service at all times of day.
- It is increasingly difficult to recruit enough staff to work unsociable hours etc.
- Increasing pressure on finances from public funds, and through competition.

The increasing emissions from the transport sector are counteracting achievements in emissions elsewhere (eg in industry).

Actions needed
- Carrot and stick – persuasion and direction.
- Not anti-car, but promoting intelligent use of the car.
- Public understanding of the issues and of the changes that are needed.
- Political willingness to take action, even if unpopular in the short term.

Government action needed
Forcing – the "stick":
- Road pricing, congestion charging, fair allocation of external costs - ensuring that the full costs of users' transport choices are reflected in the charges to them for different modes, with charges and taxes linked to the costs of use rather than the costs of ownership of the vehicle, in order to encourage an appropriate choice for each journey.
- Differentiated circulation and purchase taxes to ensure the correct incentives / disincentives are in place when people purchase vehicles
- Government decision-making which takes full account of greenhouse gas emissions and other impacts on the environment, including noise and accidents, and effects on the economy such as land costs and access to employment.

Persuading: the "carrot"
- Investing, or encouraging investment, in high quality, energy-efficient public transport, and
- Land use planning to reduce overall travel demand, whilst encouraging walking, cycling and public transport, and reducing the need to travel by car.
- Traffic management and parking policies to encourage public transport use and provide road conditions in which people can walk and cycle safely and public transport can operate efficiently.
- Agreeing funding measures to assist developing countries in public transport improvements.

The benefits of these policies would accrue to the whole community, even those who remain in their cars and find their journeys easier to make, and so will help public opinion to accept a reduction in car use.

Communication Plan/Tackling the public mindset

What actions are needed now to achieve a long term change in public opinion?

Need to promote:

- Public understanding of the problem;
- Greater awareness of the effects on individuals and of the effects caused by individual behaviour;
- Greater awareness on the relationship between the personal costs of transport (petrol and car taxes etc.), the economic costs of transport (e.g. road construction and maintenance, police patrols, lighting etc.) and the societal costs of transport (air pollution, accidents, court time, sedentary lifestyles etc.).
- More selective use of private cars etc;
- Acceptance/support for the alternatives – walking, cycling, public transport, traffic constraint;
- Motivation and enthusiasm for health generating walking, cycling etc.
- Knowledge of best practice – experience of more sustainable cities and environments;
- Debate on applying these lessons locally;
- Political consensus - continuous support rather than Stop-Go.

Arguments for:

- The environment;
- Quality of life in cities;
- Community health;
- Equity.

Institutions and the role of government, at European, national and local levels.

- Correct fiscal framework
- Clear messages and policies;
- Enabling legislation at higher levels of government;
- Targets, benchmarking and financial support for local governments;
- Determined and clear action at local level specific to the local situation.

Timing:

- Plan of what must happen now, later, in the future.
- Thorough research into best practice, public perception and attitudes.
- Enabling legislation.
- Creation of targets, strategies etc.

Problems:

- This is seen as politically difficult. Elected politicians unwilling to sacrifice themselves on this issue.
- Adversarial politics (eg UK Parliament) – good ideas are opposed if there are votes to be gained.
- The need is to influence millions of people making millions of individual travel decisions.
- The public do not like to be lectured, or to be told what to do!
- Paradox that consumers are also motorists – they (generally, not always) know the social issues and want use of cars constrained, but then they do not wish to be constrained themselves.

How to calculate the environmental impact of a transport in Europe

-an example from Schenker-BTL available on internet.

Johan Trouvé
Head Environmental Affairs
Schenker Land Transport, Europe

Quantification of the environmental impact

When we produce a transport arrangement for a customer it is simple to see what impact this arrangement has on the environment. We calculate the environmental impact and environmental cost of a particular transport movement by means of an environmental calculation. This examines the conditions applicable to a specific arrangement and the different parts of the chain - collection, handling, reloading, long-distance transport and delivery. This allows you to choose the optimal transport solution from an environmental point of view and a carrier that satisfies your environmental demands and those of your customers.

The basic idea is that as a customer you can see both the environmental impact of your choice of transport and the socio-environmental cost. The environmental calculation also prepares client companies for the increasingly stringent environmental policy currently being adopted in the transport industry.

Emission On line

- A taste of Schenker-BTL's sophisticated tools and metods aimed at environmentally optimized logistics solutions.

Emission On line is based entirely on representative average values from SCHENKER-BTL data, therefore the results of this emission calculation are approximate.
Emission On line is easily handled and used by everyone. For a more exact analysis of your company´s transport system, consult miljo@btl.btl.se. The environmental staff at miljo@btl.btl.se has access to more sophisticated data (based on the ten-figure Customer ID designation) and can therefore compile a more detailed Emission Report applicable to your company´s real consignment data. Schenker-BTL has worked for several years on the environmental adaptation of its transport services, both through technical solutions and better logistics. The latest version of Emission Report is now at hand. With it's help it is possible to compile a more detailed emission report applicable to your company´s real consignment data.

Typical transport in SCHENKER-BTL´s network

In cases where road transportation is described in our database, we use this information to calculate the transport assignment and emissions. Sometimes distances seem long. This may be partly due to more extensive groupage and co-ordination, which increases distances but achieves higher loading degree and frequency.
A consignment distance consists of one road distance and possibly one or more stages by ferry or rail. A distance within Sweden can however consist of up to three road transport stages, as small places in Sweden are linked to terminals in the SCHENKER-BTL network. Compared to Europe, Sweden has many more destinations registered.

Transport stage distances

In the emission calculation distances within Sweden are taken from Swedish National Road Administration´s distance tables. For Europe distances are calculated by the software RouteLogix. Most consignments are collected by a distribution vehicle that transports them to a terminal, from where goods are taken to a second terminal. They are reloaded onto a distribution vehicle, which delivers the consignment to its final destination. A consignment distance therefore consists of distances from up to three road transport stages and possibly one or more stages by ferry or rail.

On the Internet, there are web sites showing distances between town and cities in Europe and within European countries, Shell Denmark, for example, has the following web site: Truck/car in Europe

Country-to-country relations
Country-to-country relations are based on the fastest route between two countries. Therefore, it is not certain that a particular route will be used for a specific transport assignment, as hazardous goods, heavy loads, etc. requires special handling. Road transport is used between many countries, but for the UK, Scandinavia and the Baltic States, ferries are a common transport mode. Between certain countries there are several possible ferry connections. In these cases, we have tried to take into account (using knowledge from traffic managers in the SCHENKER-BTL network) the proportional use of respective ferry routes. We use an external route planning system, RouteLogix, to calculate distances. It may occur that we factor in a ferry route that is not available in reality but would be correct if you took an average of several transport consignments. If a ferry crossing is required between two countries, the choice of ferry line can depend on how urgent the delivery. Between certain countries railways are generally used and we have factored this for these cases. For the Baltic States and Scandinavia when ferries are used, some road transport distances may be misleading as RouteLogix selects the fastest route which usually implies the shortest ferry route. This could mean more road transport than actually occurs in practice. Today, railways are used between Italy and Sweden as well as for crossing the English Channel. Railway transport distances have been obtained from the railway operators of the respective lines.

Countries
The emission calculation now encompasses 44 European countries. This register is updated as required. The countries covered are: Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Georgia, Gibraltar, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonian, Monaco, Moldavia, the Netherlands, Norway, Poland, Portugal, Rumania, Russia, San Marino, Slovenia, Slovakia, Spain, Sweden, Switzerland, Turkey, the UK, Ukraine, White Russia and Yugoslavia and Montenegro.

Towns and cities
The destinations included are those currently used in the SCHENKER-BTL network. As changes occur this register will be updated. There are 450 European towns and cities, including some terminals, in the register at present (14/9/99). For Sweden, there are another 450 primary towns and places included for traffic within the country.

Choice of vehicle
In terms of vehicle selection, we have presumed that a Euro 0 vehicle is the average cargo carrier within, and to and from, Eastern European countries. Euro 1 is presumed to be the average cargo carrier within and between the Western European countries (excluding Greece). These presumptions are based on knowledge from our operative units.
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Total loaded weight
Total weight for the ordinary **long-distance** truck and trailer unit in our European fleet is estimated at 40 tonnes, except for Sweden and Finland where 60-tonne vehicles are most common. In the calculation, we use representative values for the total load of 20.4 tonnes (40-tonne vehicle) and 28.8/28 tonnes (60-tonne vehicle).

Total weight for the ordinary **distribution** truck in our European operations is estimated at 40 tonnes, except for Switzerland, Sweden and Finland where 24-tonne trucks are used. The calculated average load is 20.4 tonnes (40-tonne vehicle), 12 tonnes (Switzerland), 10.1 tonnes (Sweden) and 9.8 tonnes (Finland) respectively.

Today, the average loading degree in Swedish domestic operations is 72%. Corresponding figure for the rest of Europe is 78%. The values are based on information from SCHENKER-BTL´s operative units.

Fuel
In calculations it is presumed that EC1 (Environmental Class 1) diesel is used in and between Sweden and Finland. Otherwise, it is assumed that EC3 diesel is used. These presumptions are based on information from SCHENKER-BTL´s operative units. The difference between EC1 fuel and EC3 is that the sulphur level is much lower and that NOx-emissions fall slightly when EC1 is used. However, fuel consumption might rise slightly using EC1.

Truck emissions
The various emission values are based on NTM's data (9/3/99). Truck transportation emissions and energy consumption are expressed in gram/vehicle-kilometre. For other types of transport, emissions and energy consumption are expressed as gram/tonne-kilometre. LCI (Life Cycle Inventory) values are used throughout. LCI values also take into consideration energy consumption in the actual production of the fuel or energy used by the respective type of transportation. Emissions vary depending on vehicle weight category, Euroclass and the fuel used. EC3 diesel releases approximately 5% more NOx and 50 times more SO2 than EC1 diesel. Emissions are also affected by driving style, the vehicle's service status, weather conditions, etc and these variables cannot be included in the calculation.
{PRIVATE "TYPE=PICT;ALT=Link - Facts about Emission On line"**}{**PRIVATE "TYPE=PICT;ALT=Link - Facts about Emission Report"**}{**PRIVATE "TYPE=PICT;ALT=Link - Read more about different types of emissions"**}{**PRIVATE "TYPE=PICT;ALT=Link - Glossary"**}**

Railway emissions
Railway emissions on international routes are currently being revised by SJ (Swedish State Railways) and are therefore likely to change. The values used today are based on the assumption that 50% of trains are diesel-powered and 50% electric-powered. This mix applies to SJ before their changeover to 'green' electricity. SJ emission levels are taken from NTM (9/3/99). In Sweden, SJ now only uses "green" electricity, which has resulted in a substantial reduction of emissions. Green or eco-labelled electricity is obtained from water, wind and bio-fuel.

Ship emissions
Ships' emissions show wide variations between individual vessels. Variables include dead weight tonnage, speed and installed engine power. Emissions are also affected by the highly variable quality of bunker fuel. We have once again used NTM's figures (9.3.99), which will probably improve in future.

Aircraft emissions
Aircraft transports are currently not included in the emission calculation

Emission Report

The more extensive calculation, or Emission Report, includes all the goods consignments dispatched for a customer during a specified period. This is based largely on the vehicles used, the loads and the loading degrees. It could, for example, take the form of an annual account of the company's transport-related emissions.

This Emission Report, which gives a more exact description of the company's transport arrangements, is prepared by Schenker-BTL environmental staff and other employees who can handle the Emission Report tool

To present figures of the environmental load of a particular consignment in the form of emissions in kg of carbon dioxide (CO_2), nitric oxide (NO_x), hydrocarbons (HC), sulphur dioxide (SO_2) and particulate matter (PM), we have used information from our own and other databases. External databases include the Network for Transport and the Environment's sector values based on a life cycle emissions inventory depending on vehicle type and the economic evaluation by SIKA (the State Institute for Transport and Communications Analysis) of the harmful effects of emissions in accordance with Swedish conditions.

Also used are the National Road Administration's distances between Swedish locations and distance tables taken from the RouteLogix program covering the most rapid route between European locations.

The quantified emissions cause environmental problems on a local, regional and global level, e.g. acidification, over-fertilisation, health problems and the greenhouse effect. The socio-economic cost of the emissions is presented together with the volume of emissions

The new emission calculation is part of the Schenker-BTL Green Logistics concept. The next step will be to launch a more advanced analytical tool, Emission Analysis, where different logistics arrangements can be tested and compared with each other with the aim of minimising emissions.

The Emission Report covers:
44 countries
4 215 locations of which
3 800 are Swedish
400 000 distances
Calculation speed:
50 consignments/second or
3 000 consignments/minute

Comments on participants papers

Martin Patel, Ecofys

Comments on Diana Ürge-Vorsatz's paper titled "Bioenergy potentials in the Hungarian Argiculture"

The paper gives a very interesting short assessment of bioenergy potentials in Hungary by comparing the data from various sources. It becomes clear that plant bioenergy currently accounts for about 1%[39] of the country's TPES. The respective figures on the potential contribution in the future are

- ca. 4%[40] according to the IEA for plant biomass and
- roughly 6%[41] for plant biomass according to Kocsis (1995).

According to Ürge-Vorsatz, biomass availability amounts to

- about 35%[42] for plant biomass and to
- about 44%[43] for plant biomass plus manure.

It is clear that the latter figures do not account for economic, technical and possibly also environmental constraints and hence, it is not amazing that these figures are clearly higher than those given by the IEA and Kocsis. However, the gap between the two is indeed quite high (factor of 6 to 11). This could possibly be taken as a starting point for an in-depth techno-economic analyis. Among many other aspects, such an analysis would have to take into account the fertilising effect of leaving biomass residues on agricultural land and the possible impacts if this practice is given up. Biodiversity would be another important issue to considered. The integration of low-cost bioenergy technologies (e.g. co-firing of straw in coal-fired plants) in existing energy supply structures might also be an interesting question.

Two interesting conclusions can be drawn without further analysis:

- The current share of biomass energy in Hungary (1%) is lower than that of all 15 EU Member States (3% in 1997, see European Commission's White Book on the Promotion of Renewable Materials).
- It is very likely that there is sufficient scope in Hungary to reach the EU's goal of 6% bioenergy by 2010.

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[39] Bioenergy from plants: 13 PJ * ~75% = 10 PJ. Total country: 25 Mtoe = ca. 1050 PJ; 10 PJ/1050 PJ = ca. 1%

[40] 1.1 Mtoe / 25 Mtoe = 4.4%

[41] Kocsis estimates the amount of biomass that can be used for energy production at 3.5 Mt; this is roughly equivalent to 3.5Mt * 941PJ / 53.4Mt = 62 PJ. 62 PJ is equivalent to 62PJ/1050PJ = ca. 6%.

[42] 369 PJ/1050 PJ = 35%

[43] (369 PJ + 92 PJ) / 1050 PJ = 44%

Comments on Paul Metz's paper titled "Why and how to make the 'new economy' a 'sustainable economy'?"

This paper points out the need for brave and clear decisions at the policy level. According to Metz, governments consider climate stabilisation to be "a very difficult and costly battle" while "the public and parliaments in many countries are less afraid of taking actions". However, **the general acceptance of policy measures can be doubted** if – just to take an example from the last few days - one considers the public feelings about petrol and diesel prices throughout Europe: Governments are making compromises with hauliers in The Netherlands and in France and existing eco-tax schemes are being heavily attacked by the German opposition which, among other concessions, will most likely make the German government introduce clear tax rebates for commuters. Many other events from the recent past could be quoted. This means that, compared to the economy which has become a unified global actor, **policy is not rarely disintegrated**. And unfortunately, this is particularly true for environmental policy and climate policy.

Maybe this is a preliminary phonomenon and policy might in fact be able to revive its primacy[44]. However, it seems that a lot of work still needs to be done to convince individuals at all levels. Public discussion must finally lead to a broad consensus about the necessity to change the boundary conditions, with the ultimate goal of a sustainable economy. **Backcasting** – as proposed by Paul Metz – can definitely provide this discussion with valuable inputs. Convincing strategies need to be developed and marketed. Innovative companies will have to intensify their search for and the implementation of win-win options and to contribute to a deepened consciousness about these possibilities. And all stakeholders will have to understand the urgence of the issue. On this basis, **determined action** will have to be taken both with regard to renewable energy and energy efficiency improvement.

E^5 plays a extraordinarily important role in this ongoing, complicated process.

[44] Compare M. Müller in DIE ZEIT, 7.9.2000, p.20

Comments on Ewaryst Hille's paper titled "The biomass potential in Poland"

This interesting paper gives estimates about the quantities of biomass use in a hesitant, risk-adverse environment ("**passive approach**") as opposed to a pro-active policy ("**active approach**"). According to Ewaryst Hille, biomass penetration differs by a factor of 3 to 4 in the two approaches (810 PJ/a according to the World Bank versus 2400-2800 PJ). This is less than the results by Diana Ürge-Vorsatz for Hungary. However, both authors share the conclusion that **biomass use could be increased considerably** if the required decisions were made at the policy level.

The two authors agree well with regard to the importance of biomass use in the proactive case: While the figures given by Diana Ürge-Vorsatz are equivalent to a maximum share of 44%, it is about 50% according to Ewaryst Hille[45]. However, regarding the **lower estimates** (Ewaryst Hille calls this the passive approach) the **figures given by the two authors differ decisively**: While, according to Diana Ürge-Vorsatz, the share is in the range of 4% to 6%, Ewaryst Hille's data indicate that a respectable share of 16% to 24% is feasible.[46]

It might be worthwhile to study whether the estimates made by the two authors for Poland and Hungary are comparable with regard to the technical and economic assumptions made.

PS.: I do not understand the percentages given on page 3 of Ewaryst Hille's paper; I hope that I did not misinterpret him when determining the figures given above.

[45] Total potential in the active approch: 2400-2800 PJ. Total country's energy use: 5000 PJ

[46] 800 PJ / 5000 PJ = 16%; 1200 PJ / 5000 PJ = 24%;

Comments on Ewaryst Hille's paper titled "Analytical framework for sustainable energy transitions"

In this paper, Ewaryst Hille provides a large **number of aspects** to be considered when analysing the transition to sustainable energy systems. Among them are the credibility of statistical data, the expected development of demand in the future, global develoments, social developments, forecasting and aspects of global sustainability and global equity.

Possibly one could add a few aspects which seem relevant for Poland in the light of EU accession, e.g. the constraints and external pressure with regard to subsidy practices and the liberalisation of the power sector.

It it might also be a topic for further study to develop a **structured method** taking into account the interactions between the various aspects mentioned. In many cases it will probably be possible to **use existing tools and methods** for operationalisation. Examples are life-cycle assessment tools for environmental evaluations, techno-economic models including linear programming in order to determine the cost-effective saving potentials at the sectoral or macroeconomic level and economic input/output analyses, e.g. to determine the employment effects.

Comments on Roger Torode's paper titled "Long-term European communication plan to raise awareness around sustainable transport"

This paper provides a good overview of the problems related to transportation systems and the required action to make them more sustainable.

The paper starts with a list of the general problems related to transport. All data indicate that **transportation will continue to increase in future** and so will energy use, the related GHG emissions, other environmental and health impacts and the various external effects. This is in line with the expectations expressed by many other experts. Regarding **car use, the problem of high fuel consumption** due to the continued trend towards particularly heavy and powerful cars is also mentioned (e.g. SUV, Sport Utility Vehicles) which, by the way, is indeed a paradox given the limited usefulness of this type of cars in urban areas and the generally increased understanding about the environmental problems.

Regarding public transport, an emerging problem could be added: Municipal public **transportation systems belonging to the local utilities** have so far often benefited from the **profits made in the power sector**; however, given the fact that many of the municipal power plants are not profitable since deregulation of the electricity sector, municipal public transportation units might have to cut down their services (this is observed e.g. in Germany).

In his paper, Roger Torode also gives a list of **"hard" measures** (the "stick"). One measure which could be added here is the abolition of the motor vehicle tax in favour of increased taxes on petrol/diesel. Regarding the **"soft" measures** (the "carrot") the following options could also be discussed:

- Voluntary agreements of car manufacturers to reduce specific energy use and CO_2 emissions
- Attractive combined transport offers, e.g. the "treintaxi" or a combination of rail use for long distances and local car rental services.
- Start-up support for companies offering car-sharing
- Increased attractiveness of public transport (esp. rail) for certain target groups, e.g. for business people (by providing meeting facilities and comprehensive availablility of communication systems).

To summarise, the list of aspects provided by Roger Torode represents an excellent starting point for discussion. His final conclusions are considered to be very valid. His point that transportation policy can be a highly sensitive policy area is proven by the current developments in many European countries (concessions made to hauliers and private car owners).

Comments on Johan Trouvé's paper titled "How to calculate the environmental impact of a transport in Europe"

In his paper, Johan Trouvé presents Schenker-BTL's impressive activity of making a calculation tool available on the internet; this calculation tool can be used to estimate the environmental effects of transportation services. The tool has a large geographical coverage (44 countries) and it distinguishes between two different types of trucks and fuels. Five types of atmospheric emissions are distinguished. The sources and simplifying assumptions (share of ferry transport) are clearly described.

It can be assumed that the inventory assessment and the impact assessment stage of this tool comply with the ISO Standards (ISO 14 041 and ISO 14042). However, the model developers have gone one step further by also including socio-economic costs. So far, no generally acknowledged or standardised methodology exists for this type of calculation which raises the question how the figures are determined.

This tool can be expected to have various positive effects. For example, it undoubtedly contributes to an increased awareness for both the company's clients and its own employees. For companies publishing environmental reports and making use of Schenker-BTL's services, it offers an elegant way to report also the environmental impact related to commissioned transport activities. It might also act as an incentive for competing companies to introduce such a tool and to integrate it in their decision process. The planned extension of the tool to include also analyses of different logistics arrangements offers the opportunity to implement environmental optimisation in day-to-day business.

To conclude: Considering the sustained growth of the transportation sector (compare paper by Roger Torode), activities of this type are of particular importance.

Comments on Hugh Somerville's paper titled "Aviation", taking into account also Andreas Pastowski's comments

This very interesting paper combines a number of technical, economic and policy issues and provides an excellent basis for an exciting discussion. The paper sets out with the statement that "there has been some movement towards" emission trading for CO_2. Given this fact and considering that there seems to be a tendency to opt for emission trading also in other sectors, I will try to translate Somerville's explanations on the experience made with regard to aircraft noise to emission trading. Another reason why I decided to concentrate on emission trading is the fact that the results achieved with voluntary agreements have not generally been positive. Finally, emission trading is a market-based instrument which enjoys higher acceptance than regulations. So, what does the lesson about aircraft noise teach us with regard to emission trading?

- Hugh Somerville states that the process of setting standards for noise has taken more than 20 years. This is understandable since such a process is largely consensus-oriented and those partners who have difficulties to comply will try to slow down the process. However, a period of 20 years is too much in the context of climate policy since achievements must be made by the 2008-2012 time frame. In contrast to standard setting, this should in fact also be possible if emission trading is introduced in the aviation industry since this instrument allows for flexibility, i.e. those who can reduce their emissions at low cost will do so while the others will purchase emission permits. This means that the experience made with standard setting concerning aircraft noise does not encourage the use of standards for GHG mitigation in the aviation industry, while emission trading might be an effective instrument.
- As stated by Hugh Somerville the new round of noise standards should be based on technology that is deliverable – not on future designs. This Best-Available-Technology (BAT) Approach is inevitable in the context of standard setting. However, again, emission trading offers larger flexibility, due to the principle possibility of purchasing emission rights (it is also evident that any industry will try to link their commitments to the potentials it considers to be viable within its own processes/activities, but this does not impair the argument just given. It seems also worthwhile mentioning that ambitious emission reduction targets could promote innovations, such as hydrogen-fuelled aircrafts or larger carriers having smaller per capita fuel consumption values).
- Hugh Somerville points out that the value of the existing fleets must be protected which is more than justified given the high investment costs. This is also in line with emission trading since the continued operation of old aircrafts is possible (more emission permits might be required compared to a new aircraft but there is no principle problem).
- Retrofitting and unsimultaneous compliance with a certain standard (these are Hugh Summerfiel's next two points) do not pose any principle problem for emission trading either.
- Finally, banking of credits (originating from activities taken in the past) could be dealt with by the initial allocation of emission permits.

To summarise, the experience made with aircraft noise do not seem to speak against a trading scheme for CO_2. Also the fact that there are unfavourable boundary conditions which cannot be easily changed by the aviation industry itself ("inefficiency of air traffic control and air traffiv movement"), does not have any effect on this finding.

Environmental reporting has an important function with regard to public awareness for environmental issues and corporate identity. It should not be abolished with the argument that there are more effective ways to reach the public and I actually suppose that Hugh Somerville also considers the two approaches to be complementary (if not, this might be an issue for discussion). Public awareness for environmental issues can also be enhanced by internet presentations and tools, as demonstrated by Johan Trouvé for hauliers.

Finally, I would like to state that – according to my knowledge – the energy intensity of aviation is generally above that of trains for short (to medium) transportation distances. The longer the distance is the smaller the difference becomes; however, the comparison is obviously irrelevant for long distances since rail does not represent a real alternative in this case.

Comments on Andreas Pastowski's review of Hugh Somerville's paper

I read also this paper with much interest. I will be more brief because, to a large extent, my comments on Hugh Somerville's paper cover also Andreas Pastowski's review (Pastowski doubts the usefulness of the experience made in aircraft noise as a starting point for discussions about climate change policy while I tried to prove that the experience with noise does not contradict a trading scheme for CO_2).

In the chapters "Setting standards for reducing GHG emissions" and "Rewarding long-term thinking" Andreas Pastowski comes to the final conclusion that the European level is particularly important. I can follow the line of reasoning but I am not sure what this conclusion can be used for (Moreover, given the fact that both aviation and global warming represent international/supranational issues, this conclusion is not really amazing.).