EUROPEAN pathways

NEWSLETTER FROM »PATHWAYS TO SUSTAINABLE EUROPEAN ENERGY SYSTEMS«

#1/2010

Project status

"The expectations on the outcome from the COP 15 meeting in Copenhagen were highly set by many of us. Although the meeting did not deliver any full agreement of binding targets regarding reduction of GHG emissions, it did show that there is a global consensus that the temperature increase should be kept below two degrees ..."

Prof. Filip Johnsson
Project manager of the Pathway project

cont'd on page 2

Pathways to Sustainable European Energy Systems
THE AGS The Alliance for Global Sustainability

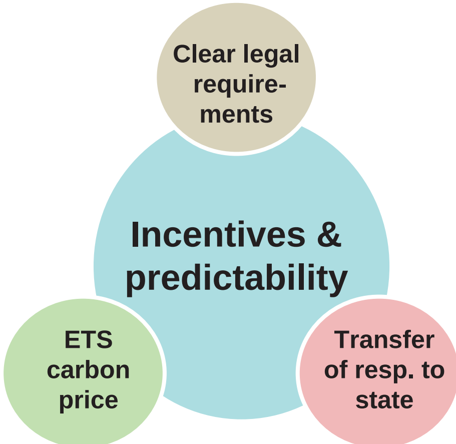
Legal aspects of CCS

CCS is associated with both political and physical risks. Both risks have to be tackled with well-designed legal structures. The legal obstacles of all phases of CCS are to be identified by David Langlet in the Interreg project.

Political/economic risks

Attempts at using Carbon Capture and Storage (CCS) as a climate change mitigation technique raise a number of questions pertaining to law and legal instruments. Briefly put CCS is associated with two distinct kinds of risk. One, which is political/economic in nature, has to do with whether CCS will in fact be deployed – despite the partly untested technology, the cost, the perceived risks etc - on a sufficient

read more on page 7



Legal issues/mechanisms, which need to be considered in relation to CCS.

Mr Gas and little miss Biomass

- a hot Spanish love story

Biomass for energy offers commercially available solutions with good dispatchability as renewable power source. With the "20-20-20" goals of the European Union stating, amongst others, 20% less CO_2 emissions and 20% renewable power to 2020, there is a window of opportunity for development of biomass use for power within the Union and opening of new markets. One such is the south-western regions, e.g. Spain.

cont'd on page 3

Assessment of energy savings strategies for the building stock of EU

Érika Mata has developed a methodology and a bottom up model to asses energy efficiency and CO_2 mitigation strategies for the European building stock. Applying the methodology to the building stock of Sweden results in a technical energy saving potential of 56 TWh/year.

cont'd on page 8

Project status

The expectations on the outcome from the COP 15 meeting in Copenhagen were highly set by many of us. Although the meeting did not deliver any full agreement of binding targets regarding reduction of GHG emissions, it did show that there is a global consensus that the temperature increase should be kept below two degrees and that both developed and developing countries need to contribute to meet this target. COP15 also showed that the climate change issue is raised to the highest level of government. This emphasizes the high importance of the research performed within the Pathways project, as it shows different pathways which meet emission reduction targets for Europe. Thus, our project can show the opportunities as well as the challenges of meeting stringent reduction targets and mitigating climate change, and also indicate the required cost-levels in doing so. These results will then provide policy makers and industry with a good basis for the decisions needed to address climate change.

We are now entering the last year of this stage of the Pathways project. Therefore, the work with synthesizing the results and insights obtained so far will be intensified, hoping we can convey a clear message to decision makers on the many possibilities which are present along pathways to a more sustainable energy system.

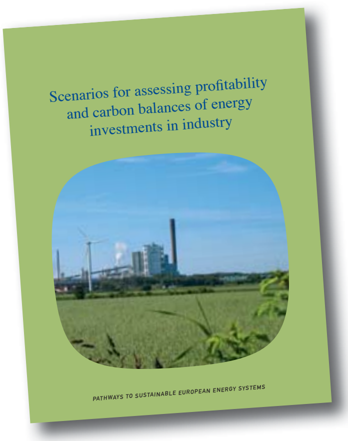
Prof. Filip Johnsson
Project manager of the Pathway project

Internship at the UNECE

During four months this autumn, Eoin Ó Broin undertook an internship at the Committee on Housing and Land Management of the UNECE in Geneva, Switzerland. His working tasks were mainly related to the organisation of two events within the programme on energy efficiency, namely the Climate Neutral City seminar, in Geneva, and the International Forum on Energy Efficiency in Housing, in Vienna. He also participated at different meetings to establish contact networks and prepare and give presentations for the behalf of the Committee. Although back in Sweden, his contact with the UNECE will continue the next couple of months as he will coordinate a UNECE report on the subject of Adaption and Mitigation Strategies for Cities to Climate Change.

Eoin Ó Broin is a PhD student at the division of Energy Technology at Chalmers. He participates in the Pathways project where his research addresses how trends in energy prices, personal affluence and efficiency have influenced energy demand in dwellings in recent decades. These results are used to estimate and discuss future demand.

The United Nations Economic Commission for Europe (UNECE) major aim is to promote pan-European economic integration. It provides analysis, policy advice and assistance to governments. It gives focus to the United Nations global mandates in the economic field, in cooperation with other global players and key stakeholders, notably the business community. The UNECE also sets out norms, standards and conventions to facilitate international cooperation within and outside the region.



The scenario report now in print version!
”Scenarios for assessing profitability and carbon balances of energy investments in industry”

The performance of future or long-term energy investments at industrial sites can be evaluated using consistent scenarios. By using a number of different scenarios that outline possible cornerstones of the future energy market, robust investments can be identified and the climate benefit can be evaluated. To obtain reliable results, it is important that the energy market parameters within a scenario are consistent. Consistent scenarios can be achieved by using a tool in which the energy-market parameters (e.g. energy prices and energy conversion technologies) are related to each other.

For further information: ERIK AXELSSON, Profu

Mr Gas and little miss Biomass
- a hot Spanish love story

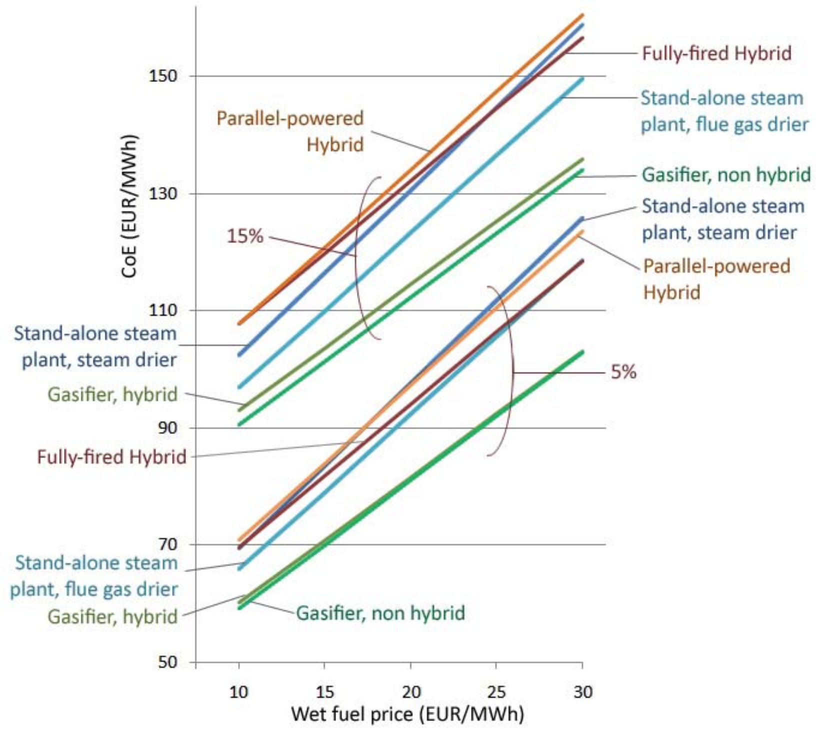
The efficient use of biomass is an important means in attaining a sustainable energy system. Erik Pihl and Stefan Heyne have investigated the possibilities to integrate biomass power generation with the existing power generation system. Their work indicates the potential for biomass power generation if co-located with natural-gas fired CCGT plants.

Efficiently used forest residues can facilitate compliance to 20-20-20-targets

Biomass for energy offers commercially available solutions for dispatchable renewable power generation. With the “20-20-20” goals of the European Union stating, amongst others, 20% less CO_2 emissions and 20% renewable power to 2020, there is a window of opportunity for development of biomass use for power within the Union. In Spain, it is estimated that unused forest residue resources exist, and there is a need for more efficient and cost competitive solutions for power generation from biomass in order to facilitate compliance with current and future climate and energy goals. At present, the Spanish electricity generating system is dominated by natural gas combined cycle plants. An integration of biomass power generation in connection to CCGT plants, in Spain, as well as in many other countries, is therefore of high interest. The study by Pihl and Heyne has explored various options for biomass power generation integrated with existing combined cycle gas turbine (CCGT) power plants. Studied options include hybrid combined cycle and gasification technologies.

Biomass power can compete with conventional power

The study shows that there can be increased efficiency for integration of biomass based power with both the studied CCGT plants, compared to stand-alone steam plants. Using flue gases from the CCGT for biomass fuel drying is seen as a clear, cost effective way to improve efficiencies. A hybrid combined cycle concept where biomass is used in the bottoming cycle can increase efficiencies further; at least with a fully-fired hybrid, but with large increases in investment costs. Yet larger efficiency increases can be found for gasification of biomass, where the syngas is used as supplement for natural gas in the CCGT. The lowest cost of electricity is generally found for gasification concepts and stand-alone steam plants with flue gas drying.



Cost of Electricity (CoE) in EUR/MWh as function of wet fuel cost in EUR/MWhth for selected configurations. Results are shown for interest rates of 5% (lower six lines) and 15% (higher six lines). As reference, current conventional power generation cost in the range of roughly 45-80 EUR/MWh.

Costs will vary greatly with discount rates and fuel costs, see Figure 1. The best hybrid options only give good cost competitiveness, compared with other biomass power alternatives, at low discount rates and high fuel costs, and it is questionable if a hybrid solution will be worth the price in the cases studied for this work. This also applies to the gasification configurations with combustion section as hybrid, compared to that with air-blown combustion.

CCGT plants can supply a biomass thermal conversion unit with large amounts of heat for fuel drying, and efficient disposal of biomass syngas. These advantages lead to improved efficiency and lower cost of electricity for biomass power generation. If fuel costs and discount rates are low, the improvements suggested in this work could mean a move for biomass-based power from barely to fully competitive with fossil-based power, even in a non-CO_2 trading regime.

For further information:
ERIK PIHL and STEFAN HEYNE,
Chalmers University of Technology

Comparing infrastructure planning and regulation

"path dependency" in focus


Comparative research

In a comparative study in the Pathways programme the research at Cefos is used to analyse similarities and differences in cases of market based and policy/government based infrastructure faciltity siting. The concept of path dependency serves as a thematic lens for the observations. At Cefos, University of Gothenburg, Prof. Åsa Boholm and her research group has long research experience of infrastructure facility siting and planning within the energy and the transportation sector.

Politics and market

The mode of political steering vs. market steering has been discussed in the literature on path dependency and it has been noted that the role of increasing returns is markedly different in a market context compared to a political context. Some crucial differences are:

Politics	Market
Many states of equilibrium and possible outcomes	High initial costs (e.g. in investments in new technology)
Accidental occurrences can play a big role	Learning new is resource demanding
Timing and sequencing of events can be essential	Coordination requires effort
Inertia due to institutional rigidity (institutions are designed to resist change)	Change is incremental and adaptive

Comparing infrastructure planning and facility siting

We will look at two cases of planning and building of technical infrastructure that are differently regulated and organized: rail way lines and wind farms respectively. Energy production is de-regulated and private companies (electrical producers and developers specializing in wind farm technology) are responsible for the planning and building of production facilities often with the assistance of consultancy firms with expertise in environmental impact assessment and licensing processes.

Rail way infrastructure on the other hand is state owned and the national government decides on investments in new lines, upgrading or closing down of existing line. The Rail Administration is responsible for the railway system, including provision for rail track, the signal system and the electricity for the trains while the trains are run by companies who hire rail capacity from the Rail Administration.

Key of differences, playing av major role

A preliminary comparison suggests that the differences in regulatory and organizational structure of the facility siting process in these two cases play a major role for the outcome. Railway planning is structured by self-reinforcing co-operation and alliances between key public actors, who assist each other to achieve a common goal (a new railway line). Wind power planning on the other hand, is often to be characterized as a reactive process where a developer or an electricity producer presents an application to a licensing authority that has little incentive to co-operate, but rather to concentrate on legal scrutiny of the project as a potential threat to various public interests, and in relation to environmental regulation or conservation law. In railway planning driven by a state agency exploitation interests encroaching on environmental or conservation values, therefore tend to "win" over conservation interests since the public interest of a new rail way line weights stronger. Wind farm planning however, driven by a private developer or electricity producer, lacks this kind of "inbuilt" public interest (amalgamated by a co-operation of public key actors and licensing authorities) and therefore it is more likely that conservation values will instead "win" over exploitation interests.

PATH DEPENDENCY

Social science research within Pathways uses the concept of "path dependency" as a unifying analytical term to describe the structural and historical continuities that characterize decision processes and organizational arrangements within the energy sector. The concept of path dependency highlights:

- Developments and chains of events having an inbuilt tendency to continue along already established patterns.
- Earlier decisions in a historical sequence exerting decisive influence on what decisions are possible later on.
- Technological systems and artifacts with "lock in-effects" such as the QWERTY key board or rail track gauge.
- "Increasing returns" deriving from following an established path rather than shifting to a new and less familiar one. Shift of path connected with costs in terms of economic resources and loss of skill, and increased uncertainty about outcomes and procedures.
- The role of expectations in decision making and planning: beliefs about a certain technology and its potential, or in certain policy objectives or the effectiveness of particular steering mechanisms contributes to establishing and maintain specific technologies or policies rather than others.

For further information:
ÅSA BOHOLM, CEFOS, Göteborg University

Coordinated electricity-system modelling applied to Northern Europe

The electricity-supply modeling group of Pathways has now taken a further step in the integration of the Pathways electricity system models to achieve a complete model toolbox. With the synergies of the model toolbox, the quality of the results can be ensured, and detailed as well as overview results of strategies for the European electricity system can be produced.

The ELIN model

The ELIN model is mainly used for generating future cost-efficient investment strategies for the electricity-supply system based, among others, on a highly detailed description of present system in the Chalmers PP Database. The figure to the right shows annual electricity production for the entire EU under baseline* scenario assumptions. Important output is also e.g. installed capacity (existing and new investments) for any given year (shown as a dotted "time slice" in the Figure), which is used as input to the EPOD model (below).

The EPOD model

The EPOD model has a more detailed time representation than ELIN and is, therefore, better suited for more detailed analyses of electricity production in a given year. The electricity production is based on the capacity data obtained from the ELIN model (above). The figure to the right depicts an output sample showing the German electricity production in 2025 under baseline scenario assumptions. The resulting production during high-load (and/or low-load) segments (shown as a dotted "time slice" in the Figure) is used as input to the DC Power Flow model (below).

The DC Power Flow model

The DC Power Flow model includes a detailed description of the electricity-transmission grid in the EU. Therefore, this model is an efficient tool to evaluate the grid-related challenges and adjustments that may be necessary for the transformation of the electricity-production system according to the results from the ELIN and EPOD models mentioned above. The DC Power Flow model uses, as inputs, the hourly electricity production estimated by the EPOD model. Thereby, grid bottlenecks may be identified by the DC Power Flow model and necessary grid reinforcements (or alternative production location) may be assessed. The figure to the right shows an output sample for the German transmission grid in a high-load hour and under baseline scenario assumptions in the year 2025. Some potential identified network overloads are marked with red circles.

* 20% CO_2 reduction by 2020 and 80% by 2050

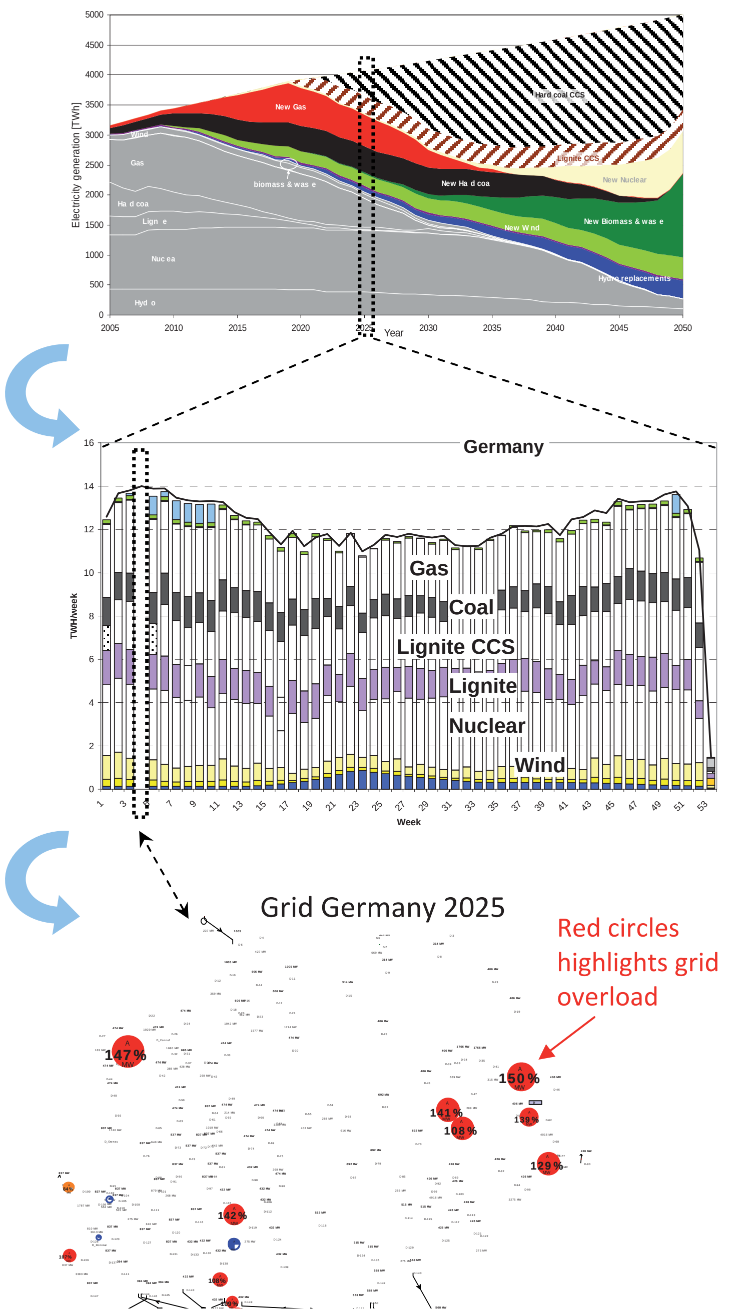


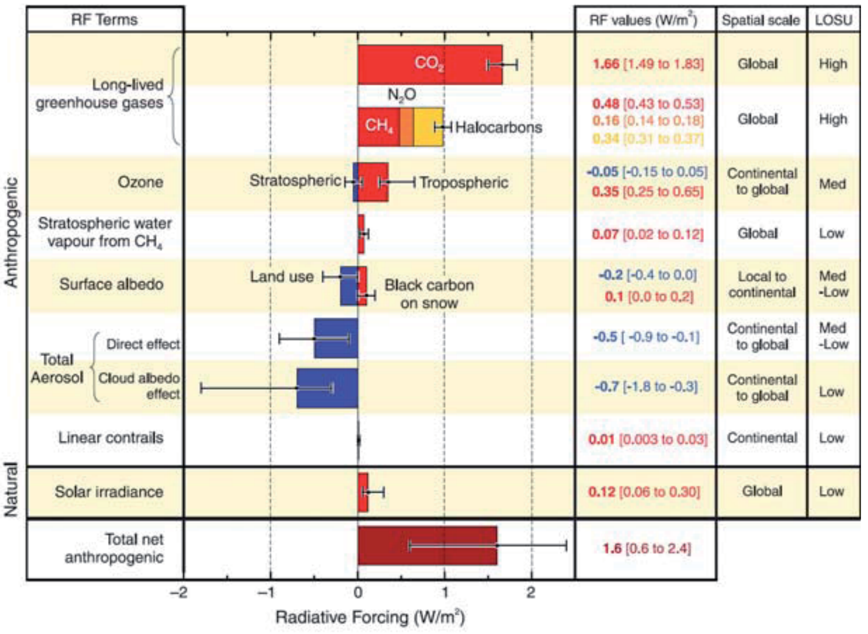
Figure: Principal sketch of the model interaction within the Pathways electricity-system group. Output from ELIN model shows the development of the electricity-supply system in the EU under baseline-scenario assumptions, while the shown output from the EPOD and DC Power Flow models focus on Germany.

For further information:
MIKAEL ODENBERGER, Chalmers University of Technology,
THOMAS UNGER Profu,
TUAN LE ANH, Chalmers University of Technology

The complexity of the climate system

The Earth's climate system is a complex, interconnected system formed by the atmosphere, the oceans and other bodies of water, land surface, snow and ice cover together with all living organisms, and linked by flows of energy and matter.

The carbon and nitrogen cycles are interwoven and influence the amount of CO_2, CH_4 and N_2O in the atmosphere, thus playing a part in climate change. There are however still many open questions on how these cycles interact with each other and what the implications of these interactions might be.



The present level of scientific understanding is high regarding the radiative forcing of CO_2 and the other long-lived greenhouse gases. However, the total effect of particles and aerosols as well as changes in surface albedo and solar irradiance is less well known. The total uncertainty in radiative forcing caused by anthropogenic impact is more than ±50 %. Source: IPCC (2007) : Climate Change - synthesis report.

Greenhouse gases in the atmosphere

Changes in the Earth's climate are influenced mainly by changes in the atmospheric composition of gases and particles, but also by changes in solar radiation and surface albedo. The most important component to influence the atmosphere is CO_2, which stands for 70 % of the global warming potential in the atmosphere. Other gases of great importance are long-lived gases like CH_4 (20 %), N_2O (5 %) and fluor-containing gases like HFC, PFC and SF6 (5 %). All act on a global scale.

Other more short-lived components in the atmosphere are water vapour (obvious climate effect on a daily basis), tropospheric ozone, and particles. The dispersion of these short-lived components is more regional, which also is true for their climate effect.

The uncertainity in radiative forcing is ±50 %

The present level of scientific understanding is high regarding the radiative forcing of CO_2 and the other long-lived greenhouse gases. However, the total effect of particles and aerosols as well as changes in surface albedo and solar irradiance is less well known. The total uncertainty in radiative forcing caused by anthropogenic impact is more than ±50 %.

Sources and sinks

Major sources of non-CO_2 greenhouse gas emissions are energy supply and use, agriculture, industrial processes and waste management. The emissions and the influence by different processes on the emissions to the atmosphere are for some sources and components (emissions of methane and nitrous oxide from forests, peatland etc.) still not known in detail. The magnitude of emission and influence on emissions via land-use changes are consequently connected with considerable uncertainties.

The main sink for N_2O is decomposition by sunlight in the stratosphere which is linked to the depletion of stratospheric ozone.

Emission trends

There is a clear link between the increase of anthropogenic emissions of greenhouse gases and the observed increase of global average temperature.

The estimates of total emissions of CO_2 are significantly better known than the emissions of CH_4 and N_2O.

Abatement measures and mitigation potentials

Mitigation of greenhouse gases must consider not only CO_2 but also the other long-lived greenhouse gases. A so called multi-gas strategy has been found to achieving the same climate goal but at considerably lower costs than a CO_2-only strategy.

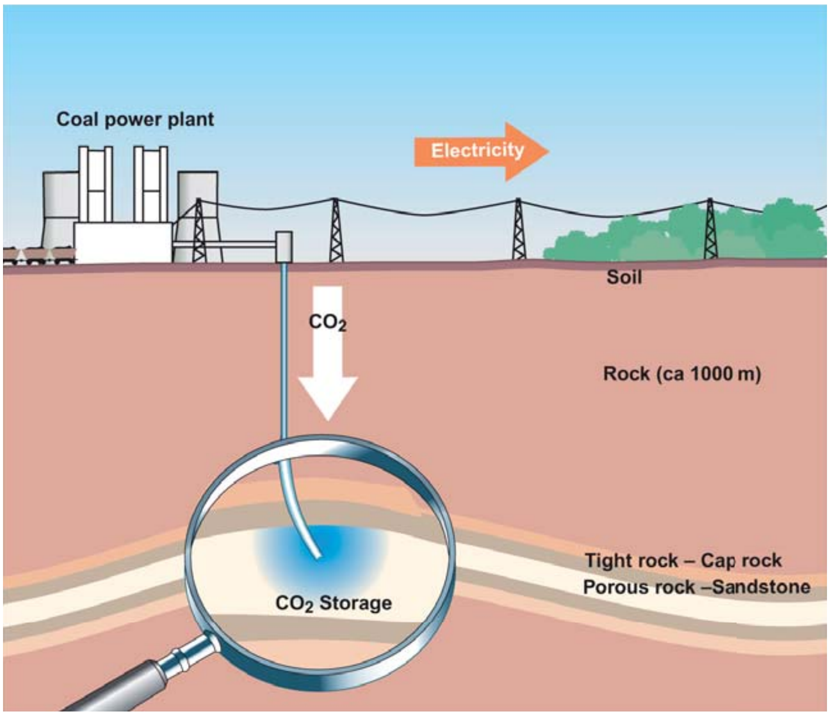
On a global level the energy and agriculture sectors offer the greatest potential for cost-effective mitigation of non-CO_2. There is also a major potential in the waste and industrial processes sectors. Methane mitigation shows the largest potential.

The main sources for this text:
Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007)
Reports on Non CO_2 greenhouse gases. US Environmental Protection Agency (2006)
Scenarios for non-CO_2 greenhouse gases in the EU-27. IIASA (2008)

For further information:
GUN LÖFBLAD and
EBBA LÖFBLAD, Profu, Göteborg

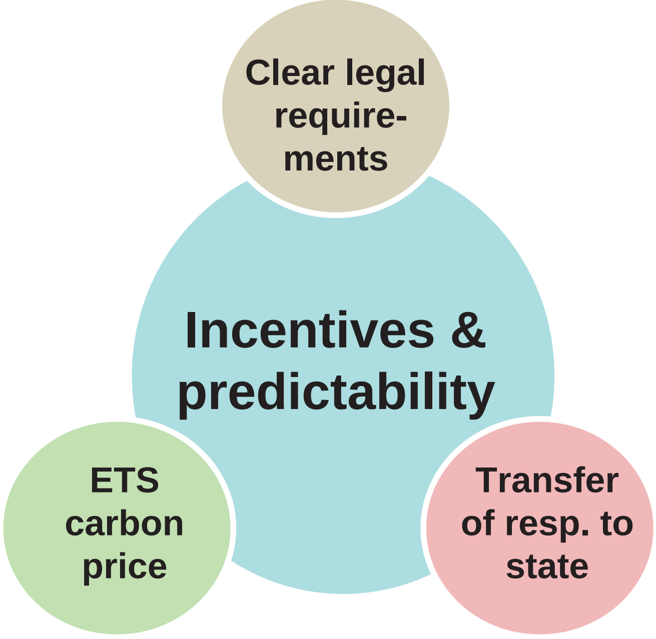
Legal aspects of CCS

CCS is associated with both political and physical risks. Both risks have to be tackled with well-designed legal structures. The legal obstacles of all phases of CCS are to be identified by David Langlet in the Interreg project.



Political/economic risks

Attempts at using Carbon Capture and Storage (CCS) as a climate change mitigation technique raise a number of questions pertaining to law and legal instruments. Briefly put CCS is associated with two distinct kinds of risk. One, which is political/economic in nature, has to do with whether CCS will in fact be deployed – despite the partly untested technology, the cost, the perceived risks etc - on a sufficient scale to make a real climate impact. This may be tackled through facilitation and incentives by means of well-designed legal and economic measures. The EU ETS provides an example of an economic mechanism set up through an elaborate legal structure in order to promote e.g. CCS (to the extent that the technology is cost efficient). Also vital in this respect is regional and international coordination and cooperation in order to share the economic risks and reach a level where economies of scale help cut the cost.



Legal issues/mechanisms, which need to be considered in relation to CCS.

Physical risks

The other category of risk is more tangible, having to do with the potential effects of physical leakage of captured CO_2. This calls for effective safety requirements and guarantees that risks will be minimized and that any damage which still occurs – to the local environment, humans and/or the climate – will be compensated as far as possible. In order to simultaneously achieve facilitation, incentives and safety, legal structures – from the international, to EU, national and local levels – will have to be engaged and coordinated.

Identifying legal obstacles

Ongoing research, i.e. within the Interreg IV project "Managing captured CO_2 within the Skagerrak/Kattegatt-region" (see Pathways Newsletter 4, 2009) aims to identify legal obstacles in all phases of CCS, e.g. pertaining to access to infrastructure, safety restrictions for pipeline transport of pressurized CO_2, and long-term responsibility for storage facilities as well as to propose remedies. The analysis will be based on technical/infrastructure CCS-pathways developed within the project. "Best regulatory practices" in the region from the perspective of enabling CCS deployment with a high level of environmental and health protection are also to be identified. The responsible researcher, David Langlet, has previously analyzed the current state and development options for international law affecting CCS.

For further information:
DAVID LANGLET, Dept. of Law, University of Gothenburg

Assessment of energy saving strategies for the building stock of EU

Érika Mata has developed a methodology and a bottom up model to asses energy efficiency and CO_2 mitigation strategies for the European building stock. Applying the methodology to the building stock of Sweden results in a technical energy saving potential of 56 TWh/year.

Érika Mata's aim of the study is to develop a simplified methodology and model to assess energy efficiency and CO_2 mitigation strategies for building stocks from the owner's perspective. Being a part of the Pathways project, the study focuses on the European building stock.

Bottom up model

The model calculates the energy consumption (with a building physics model) and the costs and CO_2 emissions (according to the data given of cost/intensities of the measures applied and of the fuels). It is a bottom-up engineering model, i.e. the energy consumption of sample houses is calculated, relying on the information of the dwelling characteristics and end-uses themselves, based on power ratings and use of equipment and systems and heat transfer and thermodynamic relationships. Then the results are extrapolated to represent the region or nation. The energy consumption is calculated for the reference year and then the impact of various energy efficiency measures are determined.

Applied on the Swedish building stock

The application of the methodology to the case study revealed that the technical potential energy saving of the Swedish housing is about 56 TWh/yr, which is higher than what previous studies had reported. The single measure with greatest potential is decreasing the indoor air temperature to 20°C. This measure also has a negative cost, see the figure below.

Also upgrading of the ventilation with heat recovery systems has a great potential to a low cost. Other measures with significant impact are increasing the insulation of windows, basement and facades as well as decreasing the use of hot water.

Significant CO_2 reduction

The total CO_2 emissions potential obtained is 3,6 $MtCO_{2e}$/yr, i.e. 60% of the emissions of the building sector. The average abatement costs obtained are 311 €/tCO_{2e}, which is high, due to the characteristics of the Swedish stock and the energy production in Sweden, already low emissive.

For further information:
ÉRIKA MATA, Chalmers Univeristy of Technology

Energy reduction potential and associated cost for different energy saving measures