EUROPEAN
pathways

NEWSLETTER FROM »PATHWAYS TO SUSTAINABLE EUROPEAN ENERGY SYSTEMS«

#2/2011

Project status

"There has been a very positive response on the result books from the first phase of the Pathways project and we are already almost out of copies! I am very happy that we are now up and working with Phase 2 of the project."

cont'd on page 2

Prof. Filip Johnsson
Project manager of
the Pathway project

Phase 1 finalized!
Two books report results from phase 1 (2006-2010) of the Pathway project that has evaluated pathways to a sustainable European energy system, with a focus on the stationary energy system and the time period up to the year 2050.

page 3

New report!
"Opportunities for reducing CO_2 in the European industry until 2050"

page 2

New licentiate thesis

page 8

Licentiate seminar:
The oil refining industry in Europe

page 8

Pathways to Sustainable European Energy Systems is a project within THE AGS The Alliance for Global Sustainability

Phase 2 initiated!

After a successful first phase of Pathways, the project continues into a second phase. Pathways phase 2 started January 2011 and will be running for three years. The areas of research in phase 2 are those for which there is a solid base in the methodology developed and for which it is believed that the Pathways research group has scientific excellence.

1. Assessing the European electricity generation market (the Chalmers Energy Infrastructure Databases)
2. Modeling the European electricity generation system and related systems
3. Assessment of CCS infrastructure
4. Assessment of biomass – supply and climate benefit
5. Assessment of biomass – conversion technologies

read more on page 4

Path dependence in the legal system

Institutional path dependence means that decisions made in the past affect future choices. As the core of the formal institutional framework – the legal system – is characterised by a path dependence, implication is that changes are sometimes difficult to make. Since the planning and location of energy installations, such as windmills, typically involves application of legal rules that to various extents are coloured by path dependence, the transformation of the energy system may prove difficult. A more sustainable energy system thus depends e.g. on the design of the institutional framework and whether the law is promoting or counteracting the diffusion of renewable energy technology such as wind power.

cont'd on page 6

An overview of the carbon strategies of ten of Europe's largest energy companies

A study of the 'carbon strategies' of ten of Europe's largest energy companies reveals that the large European energy producers are in the process of implementing strategies that reflect the need for less-carbon-intensive and more sustainable energy production.

cont'd on page 7

Project status – Phase 2 is up and running

There has been a very positive response on the result books from the first phase of the Pathways project and we are already almost out of copies! (but the books can be downloaded from the Pathways homepage). I am very happy that we are now up and working with the second phase of the project. Based on the results presented in the result books of the first phase, the new phase focus on the areas where we believe we have reached excellence and where focuses best provide knowledge for the society and industry. In addition, we have targeted some areas where we need to strengthen our research. We have now the tools to in detail assess the European stationary energy system, with databases and techno-economic models with which we in detail can analyze the energy system with a resolution down to each member state in EU27 (plus Norway). Phase 2 continues the development of these tools, which have gained significant interest in the international community. In the pathway consortium we are proud to have established cooperation with the DG Joint Research Center of the European Commission (DG JRC). Together, we will provide results to be used in the strategic work and decision making in the European Commission. The initial cooperation work focuses on developing a methodology to in detail analyse the ramp-up of a CCS infrastructure – an issue which was identified in the first phase of the project to be of crucial importance for successful commercialization of CCS. The methodology will be integrated into the energy systems modelling with the aim to improve the description of the CCS in these models. The cooperation will also comprise issues on large scale introduction of wind power and associated transmission network issues.

I am looking forward to the Phase 2 activities!

Prof. Filip Johnsson
Project manager of the
Pathway project

Pathways workshop – lining up for the second phase

In early April, many of the researchers that participated in the first phase of the Pathways project met up for a one-day workshop. The themes of workshop were to summarize the successfully completed phase of the project and to discuss co-operation in the future. Filip Johnsson introduced the second phase of the Pathways project and the main research focus areas (see page 4). Current work and research results, as well as planned activities within these focus areas were presented. The discussion was thereafter broadened to brief on on-going projects in the different research groups and possible shared activities within the Pathways research network. The performed research and work within the Pathways project has provided an important platform to use in future research proposals and other collaborations.

New report!

"Opportunities for reducing CO_2 in European industry until 2050
- a synthesis of industry within the Pathway project"

European industry has the potential to contribute substantially to both reduced CO_2 emissions and development towards sustainability. However, to reach low emission levels, all types of measures, including structural change, energy efficiency improvements, fuel substitution and carbon capture and storage are needed. Energy-intensive industries play a key role in this process, and have substantial potential for large step-wise reduction measures. However, implementation of these measures is crucially dependent upon energy market conditions and infrastructure, and therefore on interactions with other parts of the energy system.

Within the Pathway project a number of sub-projects directed towards the industrial sector have been included, in which the development of specific industrial sub-sectors and/or types of measures for reducing CO_2 emissions are studied. These results provide a basis for estimating the potential contributions of technological and structural changes within industry to the development of overall energy systems pathways. In this report, a synthesis for the entire European industry sector is presented that strive to utilize fully the knowledge gained in all these studies, supplemented with data in the literature.

The report can be downloaded at:
www.energy-pathways.org/publ.htm

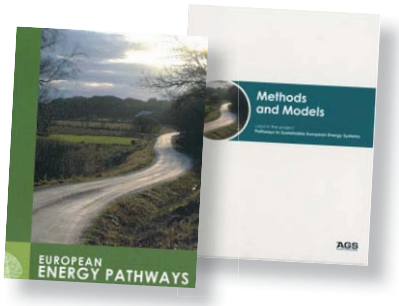
For further information: EVA ANDERSSON and INGRID NYSTRÖM, CIT Industriell Energi AB

Pathways to Sustainable European Energy Systems

- Phase 1 finalized!

Two books report results from phase 1 (2006-2010) of the Pathway project that has evaluated pathways to a sustainable European energy system, with a focus on the stationary energy system and the time period up to the year 2050. The project covers a broad range of topics related to how the European energy system can be transformed to meet targets for emission reductions while maintaining security of supply and preserving social and economic sustainability. The following overall conclusions can be drawn from these efforts:

1. There are several possible pathways towards a sustainable energy system
2. Two pathways are proposed (the Policy and Market Pathway)
3. All technologies and measures are required to follow the pathways
4. Bridging technologies can facilitate early reductions in emissions at lower cost
5. There has to be a cost associated with emitting GHG
6. Electricity and district heating will be increasingly important energy carriers
7. The existing energy infrastructure will strongly influence the pathways
8. Existing and new infrastructures must be developed
9. Pathways for the juridical framework must be in place
10. To follow the pathways requires structural changes across sectors
11. The two pathways offer synergies between sectors
12. Companies are preparing to respond to the requirements of the energy pathways
13. Global fossil fuels resources are too large – this is the challenge!
14. Carbon Capture and Storage is a key technology to meet the fossil fuel challenge
15. Both pathways strengthen the security of supply
16. Energy efficiency must be implemented on both the supply and demand sides
17. Biomass holds promises as a source of fuels for near-term bridging technologies
18. Industry has to consider all options to follow the pathways
19. Implementing pathways requires responsibility at all levels, from global to local
20. An integrated methodology for Pathway analysis has been developed



The reports can be downloaded at: www.energy-pathways.org or be ordered from inger.hessel@chalmers.se

The Policy Pathway

- Focuses on the end-use (of energy) with respect to technologies and measures.
- Gives a well-balanced mix of technologies, involves strong reduction in primary energy use and is therefore favourable with respect to security of supply.
- Requires large investments in the electricity transmission network to accommodate the large fraction of intermittent (wind) power generation.
- Represents a significante decrease in energy use per capita over time, i.e. a substantial cange from the historical trend. This trend alteration would typically require life-style changes.
- Represents a future in which a large number of actors and decision makers at all levels down to private consumers will have to take responsibility for the transformation of the energy system.

The Market Pathway

- Requires large-scale dissemination of all technologies and measures, including extensive CCS with coal as a fuel.
- Is supply-oriented with respect to choices regarding technologies and measures, and will exert less pressure for life-style changes.
- Benefits from existing infrastructure through increased use of electricity generation and district heating, as well as through shifting fuels to produce these energy carriers.
- Represents a significante decrease in energy use per capita over time, i.e. a substantial cange from the historical trend, although not as significant as in the Policy Pathway.
- Represents a future in which most of the responsibility for the transformation of the energy system is in the hands of large energy companies and professional market actors.

Pathways to Sustainable European Energy Systems

- Phase 2 initiated!

After a successful first phase of Pathways, the project continues into a second phase. Pathways phase 2 started January 2011 and will be running for three years. The areas of research in phase 2 are those for which there is a solid base in the methodology developed and for which it is believed that the Pathways research group has scientific excellence.

Areas and key research questions

1. Assessing the European electricity generation market (the Chalmers Energy Infrastructure Databases)

For some eight years the Division of Energy Technology has developed the so called Chalmers Energy Infrastructure Databases. This work will be continued with overall purpose to provide one of the best available descriptions of the European energy systems and global fuel markets in order to assess and provide analyses of the electricity generation system and to be used in modeling (area 2) and CCS assessment (area 3).

2. Modeling the European electricity generation system and related systems

There will be a continued development of the modeling package developed within the Pathway project with the overall aim to provide a well-balanced and powerful modeling toolbox, which can illustrate possible development pathways for the European stationary energy system from now and until year 2050 as well as be used to assess key parts of the electricity system (generation, distribution and demand side management).

"Phase 2 initiated!"

The model package developed (partly) within the Pathway project consists currently of the following models: ELIN (Electricity investment), BALWIND (Wind power integration), WALL (Wind power allocation), EPOD (Electricity production) and DCFlow (Transmission network). The different models can either be used alone or together in an iterative way (see Newsletter #1/2010). Key issues are to model effects of intermittent power generation including demand side management, possibilities for CCS, geographic allocation of wind power and requirements on development of the transmission network.

3. Assessment of CCS infrastructure

It is uttermost important to incorporate a CCS infrastructure analysis in the energy systems modeling in order to assess the prospects of CCS. This is normally not done in energy systems modeling but within the Pathway project we have started such work which has gained international interest and, as an example, cooperation with the European Joint Research Center (EU-JRC) around this issue (as well as for other issues) is currently under discussion.

A methodology to model and assess CO_2 transportation and storage infrastructure will be developed. The methodology will be made so as to enable application of the Chalmers Energy Infrastructure Databases (see area 1) and fit with the energy systems modeling (area 2). An important part of this task is to include detailed description of CO_2 storage sites with respect to location, storage capacity and geological parameters. The overall aim of this area is to provide a clear and thorough analysis of the ramp-up of CCS infrastructure which can be linked to the energy systems modeling developed in Pathways.

4. Assessment of biomass – supply and climate benefit

There are several open questions related to how biomass can be included in the energy conversion infrastructure as well as how much biomass is available both domestically within EU and as from import. It is proposed to continue the assessment of biomass with respect to both supply (such as the cost-supply curves developed in the REFUEL project) as well as with respect to analysing conditions for establishing a biomass supply infrastructure. The research will aim at illustrating development pathways for biomass supply and utilization in the European

power and heating system, including climate benefits.

5. Assessment of biomass – conversion technologies

There are many possibilities for integrating biomass in the energy conversion system such as co-firing in coal plants or using biomass in polygeneration schemes.

The aim of this research area is to continue the technology assessment work which was initiated in the first phase of the Pathway project. An important objective is to develop a methodology which can compare different biomass conversion technologies from technical and economic perspectives as well as identify their niche markets with respect to economy, plants size, required infrastructure and fuel quality requirements.

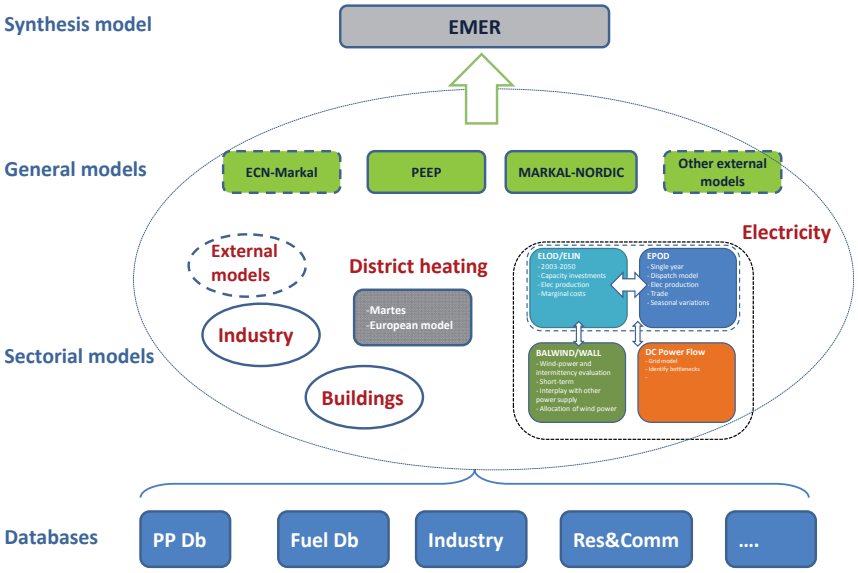


Figure: Structure of databases and models used in the Pathway project. Databases describing the current situation represent input to different models that describe possible future developments for different parts of the energy system. The model results are summed up in a synthesis model to describe different pathways.

Management, organization and reporting

The organization will be as for the first phase of the project with Professor Filip Johnsson as project leader and Bo Rydén (Profu) for additional project management. In addition, there will be a project coordinator assisting the project leaders (Ulrika Claeson Colpier). This organization has proven efficient with Filip Johnsson focussing on the scientific leadership and Bo Rydén on the overall management and coordination between researchers as well as on producing newsletters and arranging workshops and seminars.

Reporting will be through scientific papers, newsletters, reports and with a final book in the end of the period. As for the first phase of the Pathway project, the project participants will present the work in various workshops and lectures, including invited lectures.

One important aim in this second phase is also to cooperate and to coordinate the work with a new project hosted by ELFORSK ("North European Power Perspectives") as well as with the European Joint Research Center (EU-JRC) in Petten.

EU Commissions Joint Research Centre (JRC) visited Chalmers

Representatives from the DG Joint Research Centre (JRC) of the European Commission visited Chalmers on May 18-19 for a workshop which discussed the work within the ongoing Chalmers-JRC collaboration as well as ideas for new joint projects. As part of the ongoing collaboration, Chalmers supports JRC in building up a reliable power plant database. Chalmers and JRC are also collaborating on developing a methodology to integrate a CCS infrastructure analysis in the modeling of the electricity sector in EU. The first results from this cooperation is presented at the 6th Trondheim Conference on CO2 Capture, Transport and Storage (June 14-16).

A conclusion from the workshop was that Chalmers and JRC are interested in expanding the ongoing co-operation both within the existing projects and through addition of new projects, in particular on issues related to the electricity transmission network and large scale integration of intermittent power generation including dispatch modeling.

JRC
EUROPEAN COMMISSION

Path dependence in the legal system: implication for the development of wind power

The research concerning of the role of the legal system in the transformation of the energy system is continued at the University of Luleå. The aim of the next step is to analyse the legal implementation of wind power in Sweden on the basis of presumed path dependence.

Institutional path dependence means that decisions made in the past affect future choices. As the core of the formal institutional framework – the legal system – is characterised by a path dependence, implication is that changes are sometimes difficult to make. Since the planning and location of energy installations, such as windmills, typically involves application of legal rules that to various extents are coloured by path dependence, the transformation of the energy system may prove difficult. A more sustainable energy system thus depends e.g. on the design of the institutional framework and whether the law is promoting or counteracting the diffusion of renewable energy technology such as wind power. The aim of this work has been to analyse the legal implementation of wind power in Sweden on the basis of presumed path dependence. The work illustrates that the path dependence of the legal regimes affecting wind power development in some instances is significant and that policy implementation therefore may be seriously hampered. The purposes for which expropriation of land is possible in Sweden were for example founded in the early 20th century, a time in which very few thought of producing energy by harnessing wind. Although time has changed, the regulation remains and the rules are – if not hampering – at best neutral vis-à-vis wind power development. The resource management provisions under the Environmental Code also show clear signs of institutional path dependence; regardless of repeated criticism from e.g. the Council of Legislation regarding the rules applicability the system persists and continues to confuse both legal scholars and practitioners. The municipal planning monopoly and right of veto is another feature of the Swedish institutional framework that produces self-reinforcing sequences that are hard to breach. And without municipal consent, energy policy, and particularly wind power policy, is very difficult to implement. Although the institutional path dependence suggests a complex and complicated situation, the norms, expectations, traditions, customs etc. that constitute the social structure in which the law is embedded can change, and so can the law. A few recent court cases demonstrate that the law can in fact be applied in favour of wind power development even facing preservation interests. This may be a sign of a necessary change happening.

Path dependence theory

The general idea of path dependency suggests that choices made in the past affects (constrain or expand) the subsequent range of possible or reasonable choices. A decision to take a left instead of a right turn at a crossroads might forever foreclose the possibility to explore what was down the road from the right turn. Not necessarily because the right turn option is no longer there, but because it would be too costly (time, gasoline etc.) to go back. The choice to take a left turn will thus to some extent control also were we go from there.

According to Hathaway (Hathaway 2003) three strands of path dependence theory can be identified: increasing returns path dependence, evolutionary path dependence and sequencing path dependence. Each of these three strands has implications for the course and development of the legal system.

The term self-reinforcing sequence is used by Mahony to describe the type of path dependence where an institutional pattern is produced by increasing returns (utility or benefit) and states that: “With increasing returns, an institutional pattern – once adopted – delivers increasing benefits with its continued adoption, and thus over time it becomes more and more difficult to transform the pattern or select previously available options” (Mahony 2000, p. 508).

Pierson argues that the general notion of path dependence, defined as the casual pathway by which decisions affect future choices, should be limited to “positive feedback”, or self-reinforcement, since it implies that with time the relative benefits – the increasing returns – of maintaining some feature of the system increases.

Hathaway, O.A. (2003). “Path Dependence in the Law: The Course and Pattern of Legal Change in a Common Law System”
Mahony, J. (2000). “Path dependence in historical sociology”
Pierson, P. (2000). “Increasing Returns, Path Dependence, and the Study of Politics”

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An overview of the carbon strategies of ten of Europe's largest energy companies

A study of the 'carbon strategies' of ten of Europe's largest energy companies reveals that the large European energy producers are in the process of implementing strategies that reflect the need for less-carbon-intensive and more sustainable energy production.

In the European Union, about 36% of greenhouse gas emissions are attributable to the generation of electricity and heat. A focus on the actual emitters of greenhouse gases is essential for assessing the real prospects of achieving a transition to more sustainable energy production. In Pathways a study of the 'carbon strategies' of ten of Europe's largest energy companies has been performed (based on their responses to the 2009 Carbon Disclosure Project inquiry).

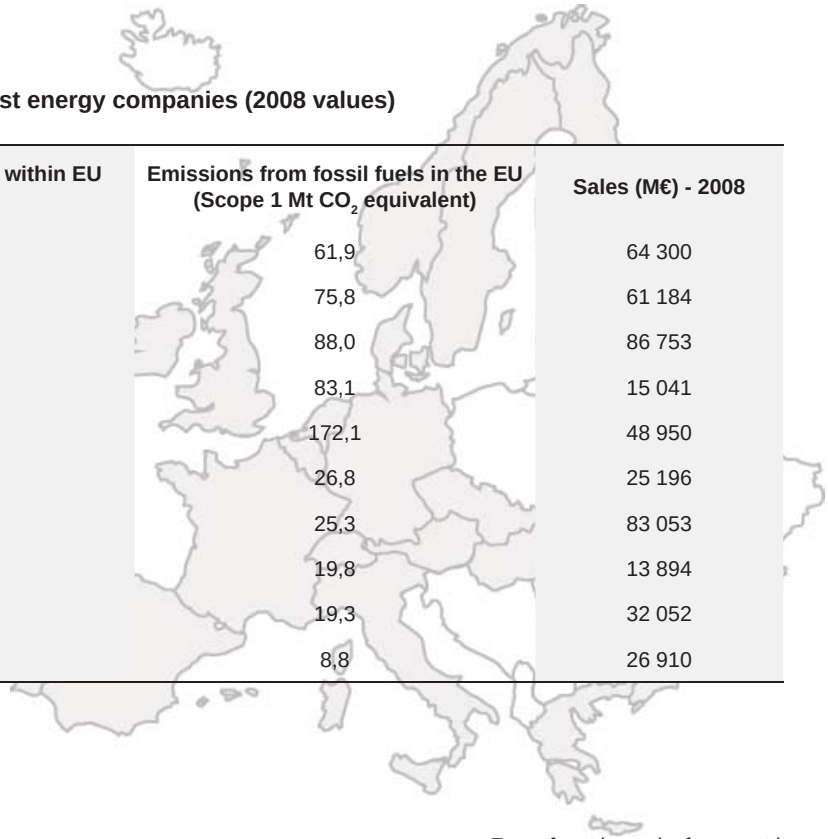
The findings of this study reveal that the large European energy producers are implementing strategies that reflect the need for less-carbon-intensive and more sustainable energy production. However, when the carbon strategies are viewed through the lens of the four different strategic dimensions, emission reductions, product stewardship, clean technology and sustainability vision, the companies seem somewhat biased towards emission reduction efforts. This is perhaps not surprising, given the substantial benefits that companies can reap from reducing emissions. Clean technology investments also play an important role, allowing the companies to renew their production portfolios and meet future needs. Renewable capacity investments represent the largest chunk of the investments, although investments in thermal capacity also are significant. This underlines the importance of new mitigating technologies, such as CCS, for making real progress towards CO_2 abatement.

Overall, the portfolio of measures that constitute the companies' carbon strategies seems geared more towards internal efforts than towards customers and stakeholders. The reason for this may be that the empirical material does not emphasize these external aspects, resulting in a somewhat unbalanced portfolio of mitigation measures. Nevertheless, if these large energy companies are to make a broader contribution to sustainable development, product stewardship and the corporate vision have to be geared towards sustainability. Further research should elucidate the roles that energy companies can play in the transition towards more sustainable energy production and consumption.

Table : Key statistics for ten of Europe's largest energy companies (2008 values)

Corporation	Installed capacity within EU (MW)	Emissions from fossil fuels in the EU (Scope 1 Mt CO_2 equivalent)	Sales (M€) - 2008
Electricité de France (EDF)	107 370	61,9	64 300
ENEL	62 003	75,8	61 184
E.ON	56 489	88,0	86 753
Vattenfall	52 122	83,1	15 041
RWE	41 895	172,1	48 950
Iberdrola	32 946	26,8	25 196
GDF Suez	30 983	25,3	83 053
Energías de Portugal (EDP)	14 969	19,8	13 894
Scottish & Southern Energy	10 571	19,3	32 052
Centrica	3 822	8,8	26 910

Source: Carbon Disclosure Project (2010)



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Licentiate seminar:

The oil refining industry in Europe

Daniella Johansson has now reached the halfway milestone in her PhD studies. On March 23, she presented her findings at the equivalence of a licentiate seminar (a so-called "mittseminarie"). The essence of this seminar is presented below.

Currently, the oil refining industry in EU emits around 155 MT CO_2/year. However, there are several possible options for CO_2 mitigation in this industrial sector: energy efficiency, fuel substitution, carbon capture, utilization of excess heat and use of biomass, see also Figure 1.

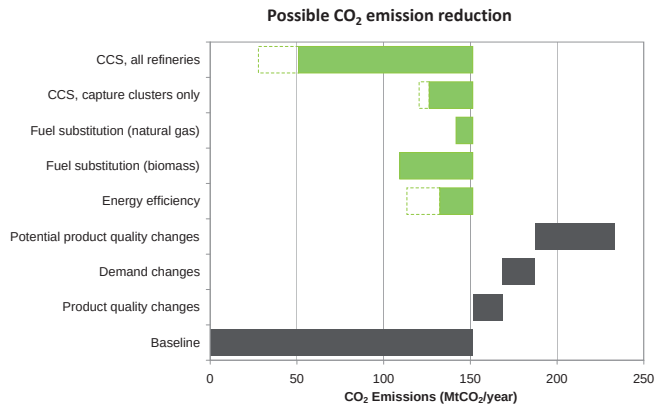

Figure 1. The potential for CO_2 emission reduction from different CO_2 abatement strategies (green bars and dashed line depending on path) and potential increases in CO_2 emissions as an effect of demand and product changes (grey bars).

Hydrogen (H_2) production

Hydrogen production through biomass gasification compared with steam methane reformer can reduce CO_2 emission up to 170 kton/y. However, using biomass for hydrogen production at a refinery reduces CO_2 emissions less than using the same amount of biomass to replace coal, e.g. in coal power plants.

Carbon capture

In the studied refineries it is possible to extract excess heat at high temperatures. This heat can be used in post-combustion processes. Thus, CO_2 capture is an interesting option for the oil refinery sector, at least at high cost levels for emitting CO_2, see Figure 2.

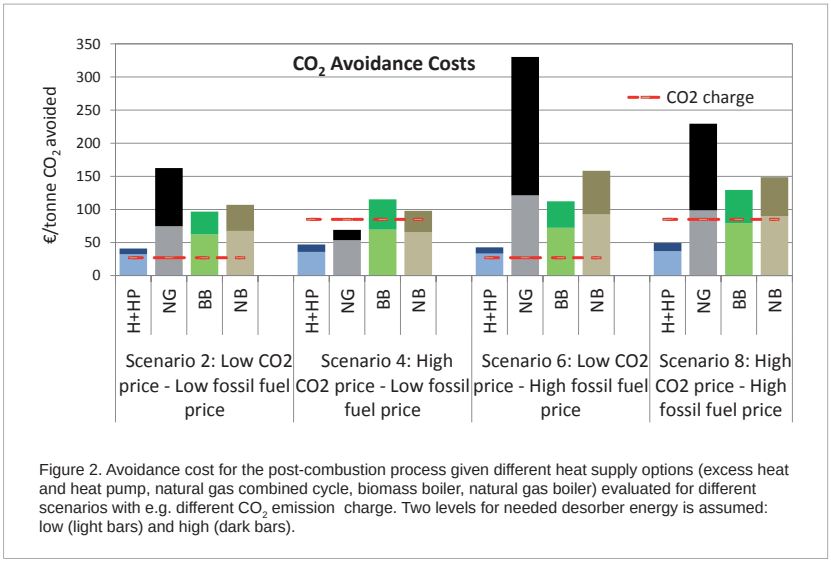

Figure 2. Avoidance cost for the post-combustion process given different heat supply options (excess heat and heat pump, natural gas combined cycle, biomass boiler, natural gas boiler) evaluated for different scenarios with e.g. different CO_2 emission charge. Two levels for needed desorber energy is assumed: low (light bars) and high (dark bars).

For further information:
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New licentiate thesis:

Energy efficiency and carbon dioxide mitigation in building stocks

- development of methodology using the Swedish residential stock

Érika Mata

This thesis investigates the implementation of energy-saving measures (ESM) in existing building stocks from an energy systems perspective. The effects of the measures are assessed in terms of net and delivered energy levels, carbon dioxide (CO_2) emissions, and the costs for implementing the measures. For this assessment, a bottom-up engineering energy balance model was developed that facilitates modelling of an entire building stock, i.e., the Energy, Carbon and Cost Assessment for Building Stocks (ECCABS) model. The model was validated by modelling a residential building in Sweden and an office building in Spain, and by comparing the results from the model developed in this work with measurements and with the results from a detailed heat balance model. The simplified model gives satisfactory results. When the model was applied to 1400 buildings representative of the Swedish residential building stock, the results showed good agreement with the available statistics on energy use in the Swedish residential building stock.

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