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Co-benefit and co-control studies in Norway

Bjarne Sivertsen

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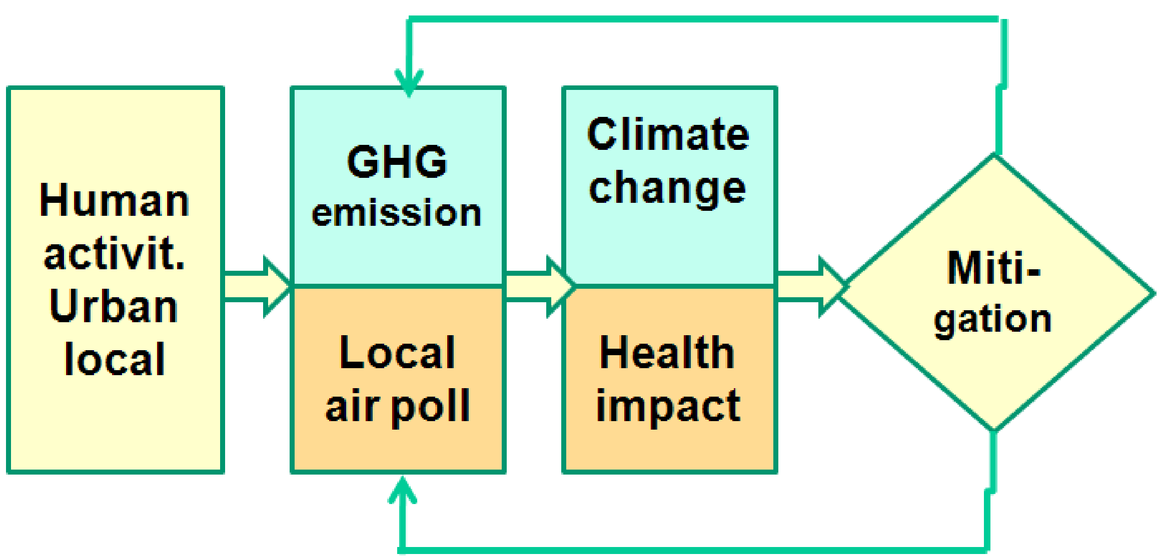

Co-benefit and Co-control studies in Norway

Bjarne Sivertsen, NILU-Norwegian Institute for Air Research

1 Introduction

During recent years focus has shifted from local air pollution and its threat to health and environment, toward global threats due to greenhouse gas (GHG) emissions and their impact on climate. In both developing and industrialized countries, abatement of air pollution and mitigation of climate change have generally been treated separately. There are, however, large benefits in considering the control options together; such approaches would mostly lead to increased health and/or climate benefits and decreased costs.

As global warming has recently taken most of the focus in the political decision processes, local and regional challenges seem to have been set aside. Today's air quality management requires integrated and coordinated measures where urban air quality planning includes also greenhouse gas (GHG) emissions and climate change issues. Several studies evaluating different strategies were recently performed in Norway, looking at different geographic areas in and outside Norway.

NILU has recommended decision makers take a balanced view, as it is possible to reduce both GHG emission and local pollution simultaneously. International experience shows that climate change mitigation can result in a simultaneous reduction in air pollution. IPCC states in its fourth assessment report that "integrating air pollution abatement and climate change mitigation policies offers potentially large cost reductions compared to treating those policies in isolation".

2 Possible co-benefits

The IPCC recommends a co-benefit thinking in the climate change mitigation. To support this argument, a number of technologies and measures in the energy supply, transport, building and industry sector have been identified to also help abate urban air pollution.

Focusing on co-benefit actions is now and will in the future, be an important part of NILU's research both in the local and regional air quality management planning. It is necessary also in the study of climate change, including the study of mitigation steps and their effects.

A stringent global climate policy will lead to considerable improvements in local air quality and consequently improves health. Measures to reduce emissions of greenhouse gases to 50% of 2005 levels, by 2050, can reduce the number of premature deaths from the chronic exposure to air pollution by 20 to 40%. (Bollen et al., 2009).

Climate policy will already generate air quality improvements in the OECD countries in the mid-term; whereas in developing countries these benefits will only in the longer run show to be significant (OECD, 2008).

The integrated long-term cost-benefit approach balances the means to lower simultaneously the adverse impacts of climate change and air pollution and shows significant climate benefits only after 2050. In summary, these simulations and results from the literature review suggest that for countries giving priority to GHG mitigation, the local air pollution co-benefits provide an additional incentive by off-setting a proportion of the GHG mitigation costs. These co-benefits could be larger than currently estimated since most estimates omit the possible co-effects of GHG mitigation on indoor air pollution, which is expected to be large in countries such as India and China (IPCC, 2007).

3 The NILU planning tool

The NILU planning tool AirQUIS has been developed by NILU to handle a number of air pollution tasks and challenges. It is based on a Geographical Information System (GIS). The main objective of a modern environmental surveillance platform like AirQUIS is to enable direct data and information transfer and obtain a remote quality control of the data collection.

The system combines monitoring, data presentation and modelling in one package. It also includes a module for emission inventorying, which enable to connect fuel consumption, energy use and industrial processes with emission rates. The system can estimate classical air pollutants as well as greenhouse gas emissions. The planning tool thus enable the user not only to present and evaluate the present situation, but also to undertake environmental planning for a sustainable future both when local impacts and health effects are concerned and when GHG emissions are to be evaluated. The GIS platform, on which the system is operated, provides easy access to the data and gives a perfect and easily understandable data presentation tool.

4 Norwegian studies and actions

Background for measures employed in Norway is to be found in several commitments. In addition to the need to comply with air quality directives, Norway undertakes to reduce global greenhouse gas emissions by the equivalent of 30% of its own 1990 emissions by 2020, and intends to cut the global emissions equivalent to 100% of its own emissions within 2030. In other countries, most notably in China, authorities are also increasingly looking to measures that simultaneously improve local air quality and reduce GHG emissions.

Measures to achieve these goals include moving from fossil based energy to more use of biofuels. This however may change the environmental challenges. While the GHG emissions will be reduced, emissions of particulate matter, nitrogen oxides and polyaromatic hydrocarbons may increase and give rise to more local air pollution as well as to more harmful pollution composition, and increase exposures of human populations. Combination of criteria pollutant changes and GHG emissions may lead to increasingly harmful effects on our built cultural heritage.

Carbon capture and storage technologies have been in focus for some time, and are subject to scrutiny from the point of view of their wider environmental impacts. Studies of co-benefit of different policies, most notably in the area of air pollution and climate change abatement, have further need for methodological developments. These include development and application of integrated assessment taking into account various geographic scales, improved exposure assessment for human population and establishment of exposure-response relationships, as well as further studies to increase our knowledge on local and regional aerosol formation and its influence on climate forcing and weather patterns.

4.1 Integrated studies

The integrated and co-ordinated projects where urban air quality planning included also greenhouse gas emissions and climate change issues was presented based on a discussion that NILU introduced in a seminar in The World Bank meeting in May 2006.

4.2 Scenarios Oslo

Studies have been performed in Oslo in order to evaluate the exposure to people for alternative scenarios identified in order to reduce the air pollution impacts. Simultaneous estimates of GHG emission reduction potential have been part of these studies. A traffic volume increase from 1990 t0 2005 of 3% in energy per car resulted in a 17% increase in GHG emissions.

4.3 Norwegian Climate Policy and Carbon Capture

The Norwegian Government is committed to develop Carbon Capture and Storage (CCS) technologies, and hopefully contribute to make this technology commercially viable at a global scale.

Carbon Capture and storage programmes are already being undertaken in Western Norway. NILU has been working on the effects of local impacts from possible amine emissions. There may be several local negative effects of reducing compounds impacting global climate.

The consumption of energy used for the CO2 capture has also been a hot issue lately together with the emissions that comes from the production of this energy. It is known that there will be more than 50 different substances that are produced within the process. Some of these will probably be cleaned and taken out as liquid or solid waste, follow the CO_2 stream for deposition and be emitted to air. After emission these products will enter into the photochemical processes and additional components will be formed

NILU emphasizes that an evaluation of the potential impact for health and the environment from a CO_2 capture plant based on amines should be mandatory. An evaluation should at least look into a theoretical exercise for establishing possible effects of the different types and quantities of amine emissions. The need for collecting emission data and knowledge of health and environmental impacts of these emissions should be a requirement in the emission permit to the capture plants.

4.4 From fossil fuel to bio fuels

Moving from fossil based energy to more use of bio fuels may change the environmental challenges. The GHG emissions as CO_2 will be reduced, but emissions of PM, PAH and NOx may increase and give rise to more local air pollution.

Relative to a gas fired power plant with cleaning equipment a bio fuel based power plant at the same capacity will emit more pollutants.

4.5 Climate change and our Cultural Heritage

Traditionally our cultural heritage; monuments and buildings have been impacted by pollutants linked to local sources and compounds such as SO_2 and NOx. Combining these pollutants with greenhouse gases and climate change will accelerate the impacts. It will speed up the deterioration and will require more maintenance.

5 CDM an instrument for limiting GHG emissions

With the Kyoto Protocol becoming legally binding from 16 February 2005, the Clean Development Mechanism (CDM) is becoming a key instrument for limiting greenhouse gas emissions (GHG) and promoting sustainable development.

For both developing and developed countries to benefit from the CDM, it is important to establish increased awareness and understanding of its various aspects. Building capacities in the baseline methodology and assessment of GHG emission reductions/sequestration benefits of CDM projects are keys to the successful development and implementation of the CDM.

The following types of GHG mitigation or sequestration projects and activities can be eligible for CDM**:**

- Renewable energy technologies
- Energy efficiency improvements - supply side and/or demand side
- Fuel switching (e.g., coal to natural gas or coal to sustainable biomass)
- Combined heat and power (CHP)

- Capture and destruction of methane emissions (e.g. from landfill sites, oil, gas and coal mining)
- Emissions reduction from such industrial processes as manufacture of cement
- Capture and destruction of GHGs other than methane (N2O, HFC, PFCs, and SF6)
- Emission reductions in the transport sector
- Emission reductions in the agricultural sector
- Afforestation and reforestation
- Modernization of existing industrial units/equipment using less GH-Gintensive practices/technologies (retrofitting)
- Expansion of existing plants using less GHG intensive-practices/technologies (Brownfield projects)
- New construction using less GHG-intensive practices/technologies (Greenfield projects)

Seven basic stages have been identified in the development of a CDM project.

6 Co-control and co-benefit projects China

NILU proposed a new project for China together with Norwegian institutions and CAI Asia developing a programme for co-control. The project places a strong emphasis on assisting Chinese institutions in building technical capacity and expertise, specifically on the co-control of air quality, energy and climate change. By building capacity for co-control, this project will make it easier for China to reduce local air pollution and contribute to greenhouse gas reductions. This is fully in line with Norwegian priorities for development cooperation, which has made climate change and environmental protection a cornerstone of its development cooperation.

The proposed project is a national level project, with demonstration of co-control policies concentrated on cities in Western China, while a training component will cover the national, provincial and local levels.
The **objectives** of the project are:

- To provide policy guidance and advice on integrated control of air pollution and GHG emissions in the 12th and 13th 5 year periods (FYP).
- To demonstrate the viability of the co-control approach in addressing environmental challenges related to air quality and energy management at the regional and local level.
- To enhance the capacity of MEP and other related institutions, at national, regional and local level to formulate and carry out simultaneous cuts in air pollution and GHG emissions in the 12th and 13th five year periods.

The objectives will be achieved through **three main project components:**

1. National level policy analysis, suggestions and support on co-control
2. Demonstration and pilot cases of integrated AQM and co-control at the urban level, in selected cities in Western China.

3. Capacity building for integrated AQM and co-control at national, regional and local level, with an emphasis on Western China Provinces.

NILU also performed studies in China related to cost effectiveness (Guangzhou) and cost-benefit (three cities in Shanxi province). Comparisons of cost-benefits were performed for various identified control actions in order to reduce SO_2 and TSP exposure and health impacts in the three cities.

These studies have shown that there are actions where the cost of implementing these actions are less than the cost-estimated benefits gain in improved health effects in the population.

7 Areas of further development

NILU have identified further needs for development in order to continue the work related to integrated assessment, co-benefit studies and co-ordination of climate change and local air pollution issues. Some of these issues are:

- Exposure-response on human health
- Local and regional influence of aerosols on climate forcing and weather patterns
- Development and application of combined integrated assessment at various scales
- This requires competence on:
- Emission inventories, air quality and atmospheric science
- Climate and pollution policies
- Integrated assessment modelling, e.g. cost effectiveness / optimisation of abatement measures

The issues presented in this paper are important issues in order to improve the tools for integrated assessments, and this work will continue in Norway as well as at NILU.

8 References

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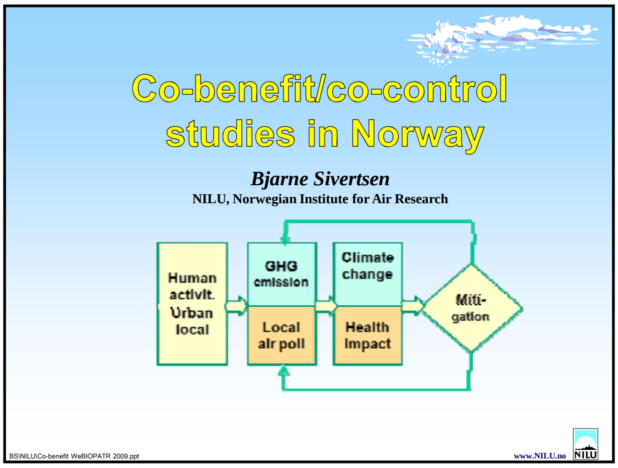
Appendix A

Transparences


Co-benefit/co-control
studies in Norway
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NILU, Norwegian Institute for Air Research
Human activit. Urban local
GHG emission
Climate change
Local air poll
Health impact
Miti-gation
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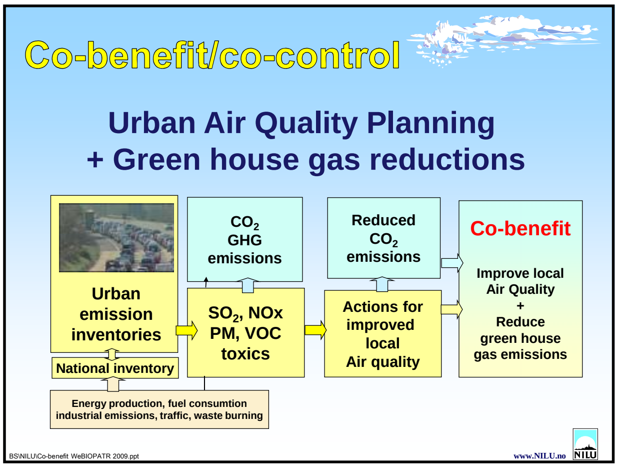
Co-benefit/co-control
Urban Air Quality Planning
+ Green house gas reductions
Urban emission inventories
National inventory
CO_2 GHG emissions
SO_2, NOx PM, VOC toxics
Reduced CO_2 emissions
Actions for improved local Air quality
Co-benefit
Improve local Air Quality
+
Reduce green house gas emissions
Energy production, fuel consumtion industrial emissions, traffic, waste burning
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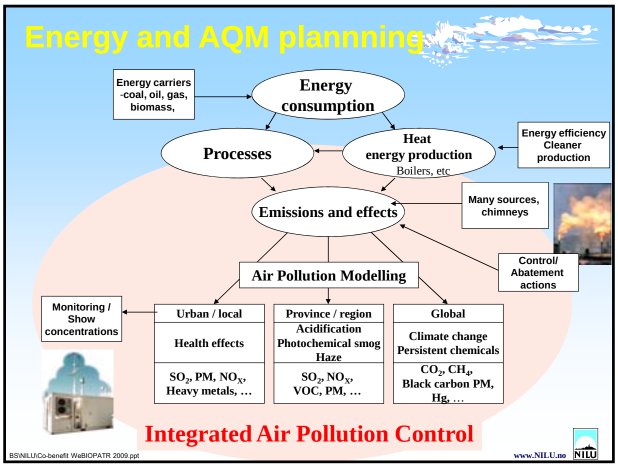
Energy and AQM plannning
Energy carriers -coal, oil, gas, biomass,
Energy consumption
Processes
Heat energy production Boilers, etc
Energy efficiency Cleaner production
Emissions and effects
Many sources, chimneys
Control/ Abatement actions
Air Pollution Modelling
Monitoring / Show concentrations
Urban / local
Health effects
SO_2, PM, NO_X, Heavy metals, …
Province / region
Acidification Photochemical smog Haze
SO_2, NO_X, VOC, PM, …
Global
Climate change Persistent chemicals
CO_2, CH_4, Black carbon PM, Hg, …
Integrated Air Pollution Control
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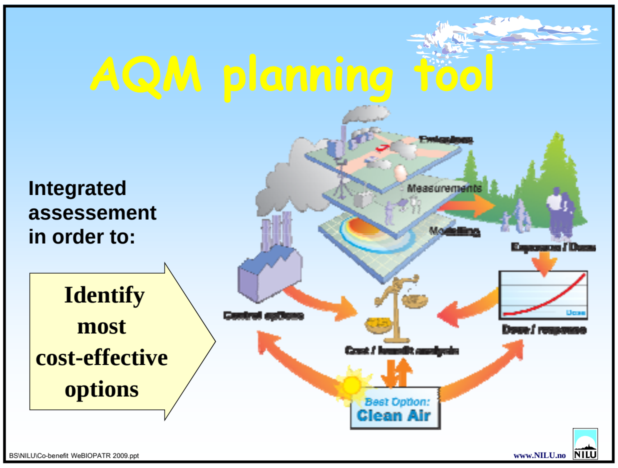
AQM planning tool
Integrated assessement in order to:
Identify most cost-effective options
Emissions
Measurements
Modelling
Exposure / Dose
Control options
Dose / response
Cost / benefit analysis
Best Option:
Clean Air
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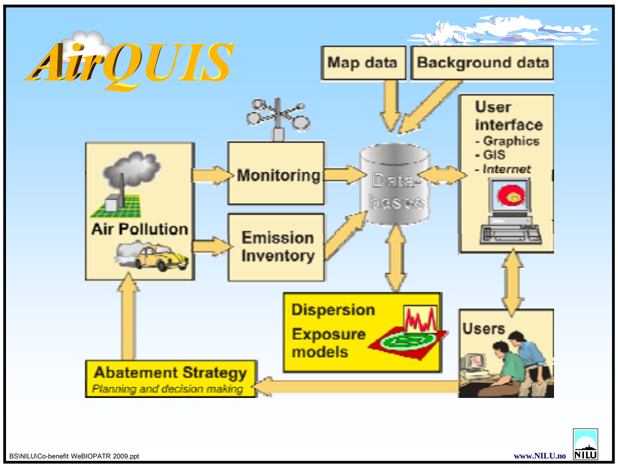
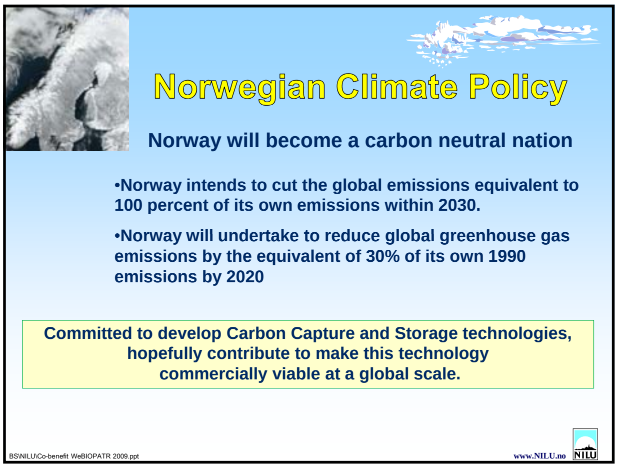

AirQUIS
Map data
Background data
User interface
- Graphics
- GIS
- Internet
Monitoring
Data bases
Air Pollution
Emission Inventory
Dispersion Exposure models
Users
Abatement Strategy
Planning and decision making
BS\NILU\Co-benefit WeBIOPATR 2009.ppt
www.NILU.no
NILU


Norwegian Climate Policy
Norway will become a carbon neutral nation
•Norway intends to cut the global emissions equivalent to 100 percent of its own emissions within 2030.
•Norway will undertake to reduce global greenhouse gas emissions by the equivalent of 30% of its own 1990 emissions by 2020
Committed to develop Carbon Capture and Storage technologies, hopefully contribute to make this technology commercially viable at a global scale.
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The Norwegian Government has Ambitious Goals

Make widespread use of carbon capture and storage a reality

- The Norwegian Government intends to:
  - cooperate with the industry
  - provide public funding
- *"All new gas fired power plants shall be based on technology for CO_2 capture"*

Ministry of Petroleum and Energy www.mpe.dep.no

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GHG emission reductions

Part of the process:

- People's awareness
- Energy Efficiency in industry
- Electricity generation: renewable sources, cleaner coal
- Carbon capture and storage
- Transport sector; public transport
- Damage costs of climate change impacts
- Cost/benefit (costs of no action)

Part of CDM process: Assign Designated National Authority

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Kyoto protocol, 1997

The Clean Development Mechanism

CDM allows emission reduction projects that assist in creating sustainable development in developing countries to generate "certified emission reductions" for use by the investor.

CDM promote sustainable development in developing countries, while allowing developed countries to contribute to the goal of reducing atmospheric concentrations of GHG.

6 **Six main greenhouse gases:** carbon dioxide, methane, nitrous oxide; hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride.

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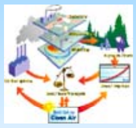
Intervention Strategies



- Identify possible sources
- Implement reduction measures
- Estimate costs
- Estimate impact reductions (model)
- Cost estimate improvements
- List of priority; cost - effective
- Select best possible actions
- Develop Action Plan

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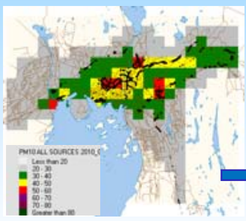
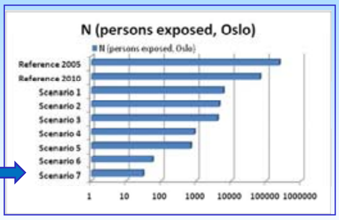
Exposure estimates, Oslo 2010





Projection of the 8th highest daily grid value (National Target) of PM_{10} ($\mu g/m^3$) for 2010. The black dots are illustrating the building points where the 8th highest daily PM_{10} value is above limit value of 50 $\mu g/m^3$.

Reference years and 7 scenarios

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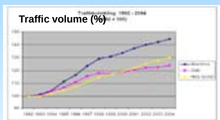
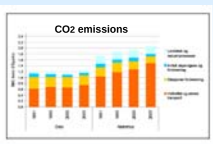
Oslo study: GHG emissions & local AQ



Air Quality improved in spite of traffic volume increase



Traffic volume increase 1990-2005
+ 3% increase in energy per car per km
⇨GHG increase 17 % (1991-2004)

GHG 2005: 1 % lower than 2005

Goal Oslo: Reduce GHG emissions 50% during 1990 - 2030

Ref: CIVITAS: Oslopakke 3-KS-1

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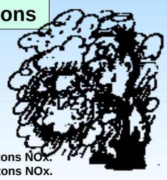
From fossil fuels to Bio fuel

Reduce: CO_2 : and GHG
SO_2 : Sulphur emissions

Increased: PM :
PAH :
NOx :



Bio fuel based power plant Finland emits annually 440 tons NOx.
Gas power plant at Kårstø Norway emits annually 150 tons NOx.
Same size (400 MW), and both are equipped with cleaning device

Norway: Bio fuels instead of fuel oil
reduces electricity consumption only 3-4 %

Carbon Capture and Storage (CCS)

Global benefits, local ???

Several alternative methods

Absorption with amine solution most appropriate technology to take out CO2 from exit gas.

Test Center Mongstad will test the amin capture technology

NILU investigate the local impact of emissions of amines

Amines are in general caustic and corrosive and will therefore have a potential effect on the local environment.

Local impacts of CCS?

The amine group is a large group of chemical substances.

- ✓ **Long time exposure ; some of the amines can be carcinogenic.**
- ✓ **Vegetation impact of emissions – fertilization??**
- ✓ **Soil deposition: accumulation and degradation.**
- ✓ **Surface water: concentrations evaluated for accumulation in organisms**
- ✓ **The mass flux into the sea: investigate potential effects.**
- ✓ **Reactive amines may enter into the photochemistry of the atmosphere**
- ✓ **Odor problems: Amines have in general a strong and unpleasant smell.**

The consumption of energy used for the CO2 capture and the emissions that comes from the production of this energy should be estimated.

Climate Change Threat to our Cultural Heritage

Traditionally local impacts From SO_2 and NOx

Combined pollutants +GHG speeding up deterioration, more maintenance

Warmer and humid climate

Traditional deterioration due to SO_2 and NOx recently accelrated due to climate change

Noah's Ark (2008b) Global climate change impact on built heritage and cultural landscapes. URL: http://noahsark.isac.cnr.it /)

Reduce impacts of climate and air pollution

Ancient buildings were designed for a specific local climate.

Studies to protect buildings undertaken in Norway

UNESCO:
The impacts of Climate Change on World Heritage properties must be assessed through appropriate monitoring and vulnerability assessment processes.

Climate change - research cooperation with China

The **NORKLIMA** programme is announcing a total of NOK 20 million in funding for climate research conducted in cooperation with China.

The treatment of uncertainty and **risk** related to **climate change** in key areas of society, including the understanding of uncertainty in climate scenarios and socio-economic uncertainty

Proposed Norwegian Project on Co-controls in China

NILU with inputs from other Norwegian organizations and CAI-Asia is developing a project to assist China in development and adoption of a co-control program:

COMPONENT A: Policy
1. National policy analysis based upon the economic planning tools of the DRC
2. Development of a policy package for MEP and the State Council
3. Policy guidelines for key sectors and policy concepts

COMPONENT B: City case studies
6. Detailed work plan for the 2 city demonstration studies, and output specification
7. Cities base case situation report
8. City demonstration study reports
9. City demonstration co-control action plans for integrated air quality and GHG control
10. Report on CDM activities

COMPONENT C: Training
11. Assessment of AQM and co-control capabilities in cities in Western China
12. AQM and co-control training for senior officials of provinces and cities in China
13. AQM and co-control for AQM professionals
14. Design of a Comprehensive AQM Training System

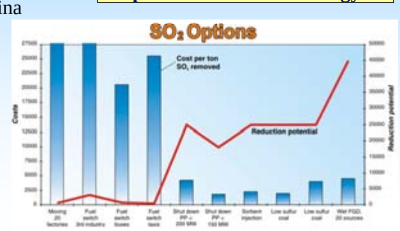
www.cleanairnet.org/caiasia
26 CAI-Asia Center

Ex: Cost-effective actions

Guangzhou, China

- A.Q. Assessment
- Health impacts
- Abatement options
- Cost analyses
- Optimal abatement strategy

Cost effective SO_2 options



费用效益分析 Cost benefit analysis

Shanxi, China

A comparison of cost-benefit of various control options for SO_2 and TSP in Taiyuan

Cost benefit analysis:

A comparison of cost-benefit of various control options for SO_2 and TSP in Taiyuan

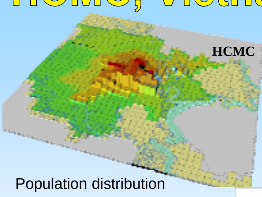
A comparison of cost-benefits of various control options for SO2 in Taiyuan

	Emission Reduction (t)	Concentration reduction (μg/m³)	Cost-benefit ratio	Rank
Natural gas utilization	20400	19.79	-52	2
Desulfuration in power plants	18460	6.47	115	4
Centralized heating	30000	51.89	-424	1
Implementation of productivity policies	9280	5.75	2000	5
Clean coal technology	36600	6.24	-23	3

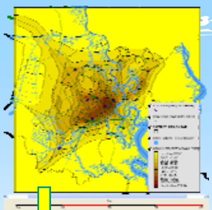
A comparison of cost-benefits of various control options for TSP in Taiyuan

	Emission Reduction (t)	Concentration reduction (μg/m³)	Cost-benefit ratio	Rank
Natural gas utilization	31900	16.7	-0.489	2
Centralized heating	69400	90.29	-1.601	1
Implementation of productivity policies	17000	18.57	3.711	5
Clean coal technology	47100	93.13	-0.008	3
Dust control		50	1.813	4

HCMC, Vietnam

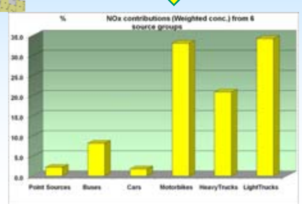


Population distribution

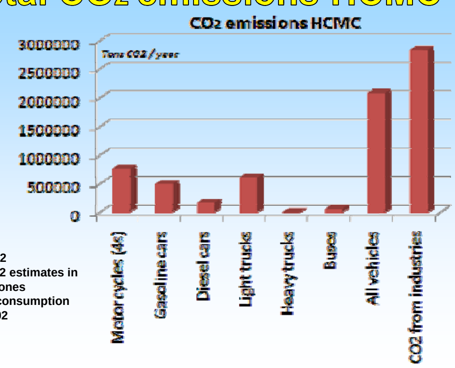


Estimated concentrations

Relative contributions of sources to the exposure in HCMC



Total CO2 emissions HCMC



Industrial CO2
Based on SO2 estimates in 9 industrial zones
and total oil consumption in HCMC 2002

Areas for further development

- Exposure-response on human health
- Local and regional influence of aerosols on climate forcing and weather patterns
- Development and application of combined integrated assessment at various scales
- This requires competence on:
  - Emission inventories, air quality and atmospheric science
  - Climate and pollution policies
  - Integrated assessment modelling, e.g. cost effectiveness / optimisation of abatement measures

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Climate change
and air pollution
speed up damages
and increase costs

Integrated assessments and Co-controls are needed

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