**Workshop on Transboundary Air Pollution in North-East Asia, 10-11 November 2011, Incheon, Republic of Korea**

# Two presentations by Janusz Cofala and Zbigniew Klimont (IIASA) on: *GAINS-ASIA for CHINA* and on *GAINS-CITY for Beijing and Jinan*

delivered by:

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Janusz Cofala

# Integrated Assessment of Air Pollution and Greenhouse Gases mitigation in China

Methodology

Results from GAINS China Project

Ongoing work on GAINS CITY – examples for Beijing

GREENHOUSE GAS – AIR POLLUTION INTERACTIONS AND SYNERGIES

# GAINS ASIA

## COST-EFFECTIVE CONTROL OF AIR POLLUTION AND GREENHOUSE GASES IN CHINA

IIASA ERI TSINGHUA UNIVERSITY teri ies Institute for Environment and Sustainability SIXTH FRAMEWORK PROGRAMME

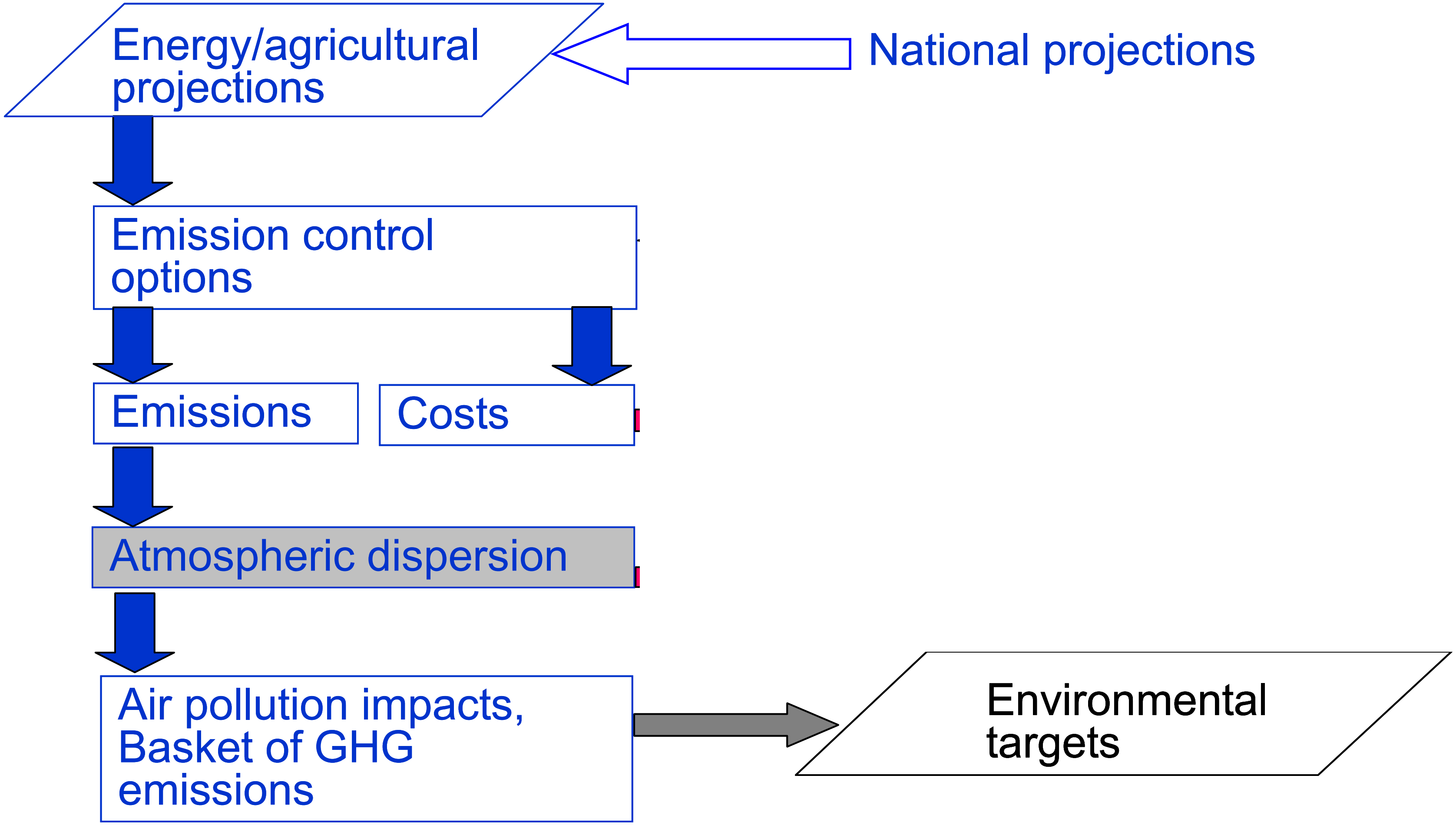
# GAINS: A tool for a systematic assessment of the cost-effectiveness of emission control strategies

- GAINS quantifies sectoral emission control potentials and costs,
  - for exogenous (governmental) activity projections,
  - considering physical and economic interactions between pollutants.
- Search for least-cost mix of mitigation measures to meet air quality and/or GHG targets
- GAINS is implemented for China, India, Pakistan, Europe

# Example questions for GAINS analyses

- How much would it cost to reduce air pollution levels to a given standard in a country?
- For the worst-affect areas only?
- What is the cheapest way to reduce health impacts on the population?
- Which measures should be taken?
- In which economic sectors?
- Which pollutants should be addressed?
- In which regions?
- Which air pollution controls maximize the reduction of greenhouse gases?

# The GAINS model follows pollution from the sources to their impacts

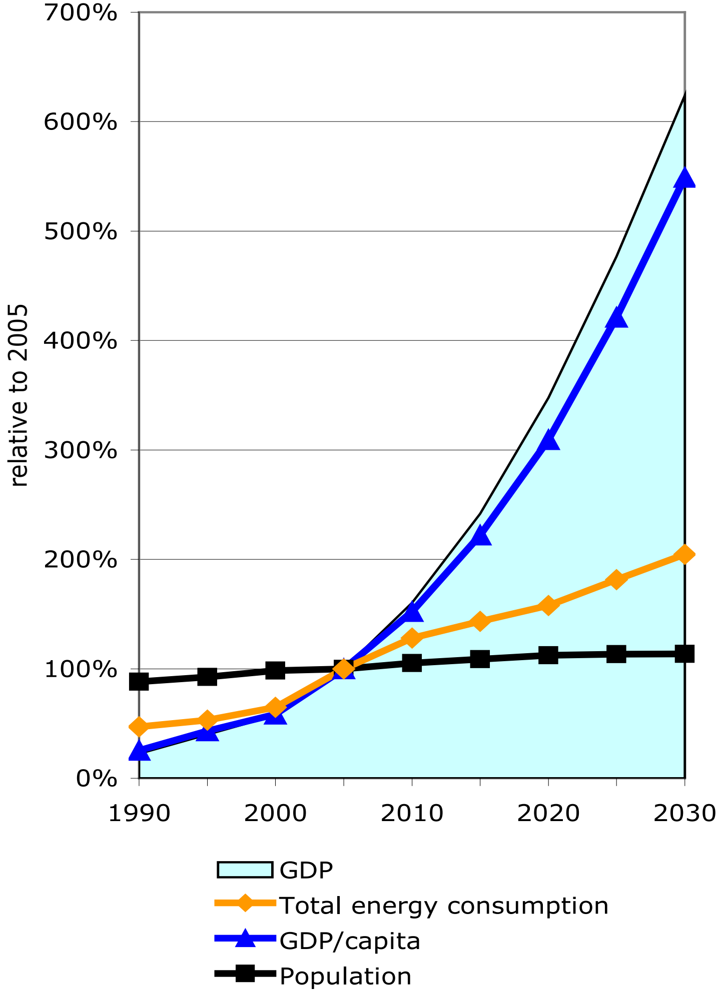


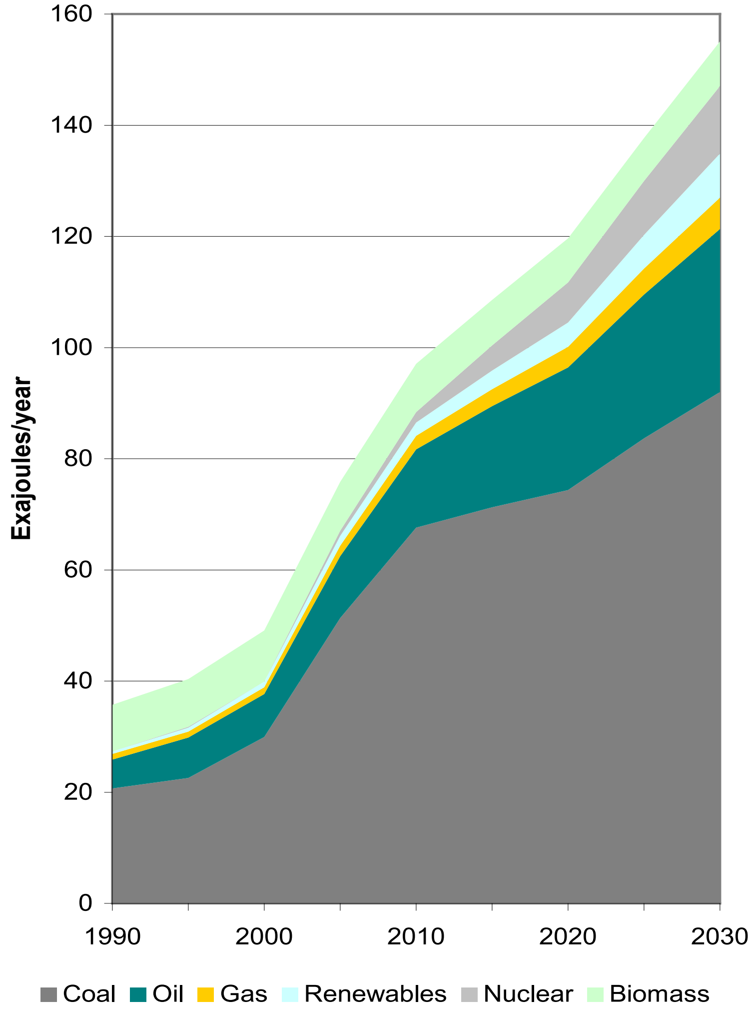
# GAINS: A model to harvest synergies by integrating multiple pollutants and their multiple effects

**Emissions and control measures** — for air pollutants and greenhouse gases

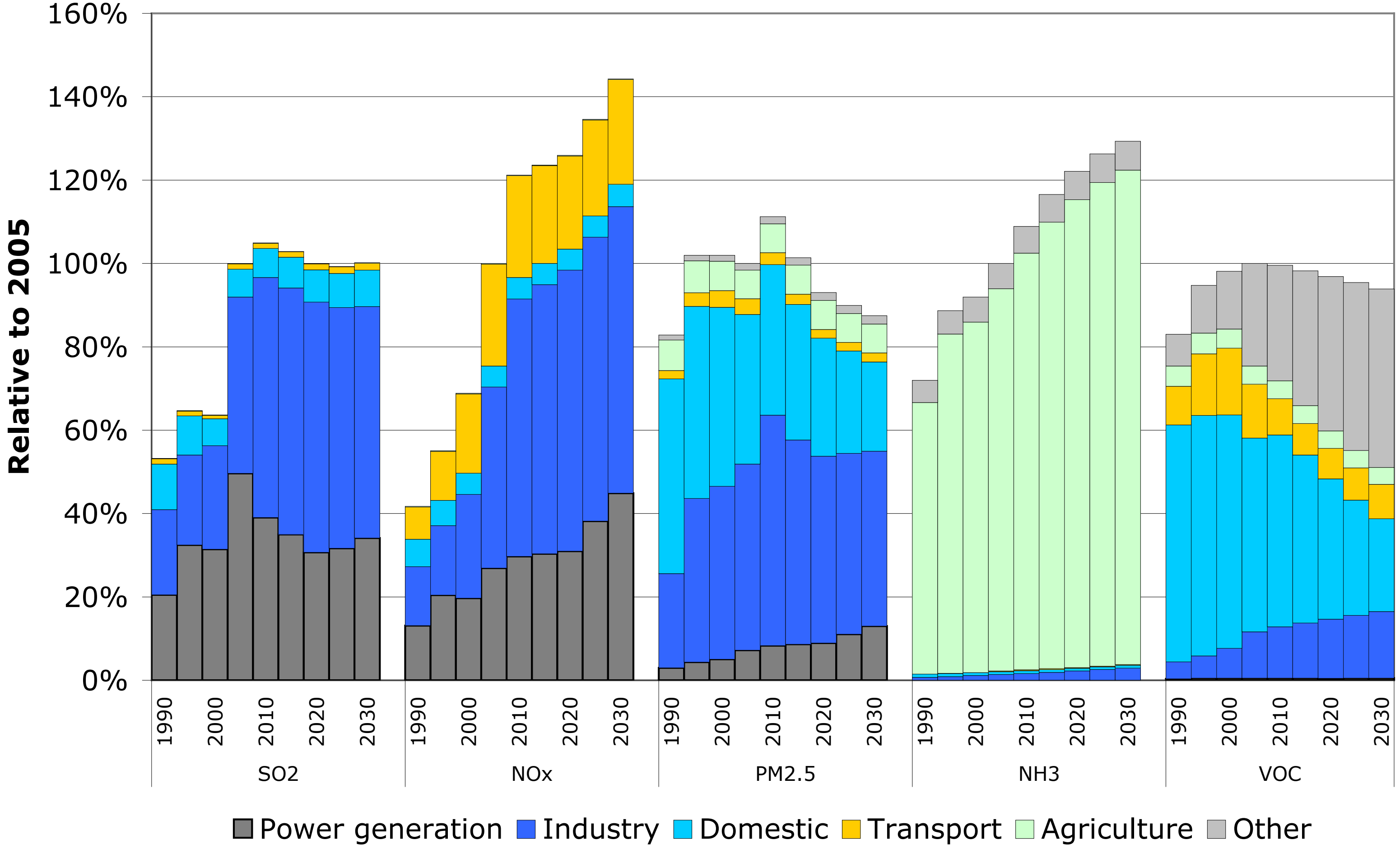
| Impacts | PM BC OC | $SO_2$ | $NO_x$ | VOC | $NH_3$ | $CO_2$ | $CH_4$ | $N_2O$ | HFCs PFCs $SF_6$ |
|---|---|---|---|---|---|---|---|---|---|
| **Health impacts:** from fine particulate matter | √ | √ | √ | (√) | √ | | | | |
| from ground-level ozone | | | √ | √ | | | (√) | | |
| **Vegetation damage:** Ozone (agricultural crops) | | | √ | √ | | | (√) | | |
| Acidification (forests, water) | | √ | √ | | √ | | | | |
| Eutrophication (biodiversity) | | | √ | | √ | | | | |
| **Radiative forcing:** - from direct greenhouse gases | | | | | | √ | √ | √ | √ |
| - via aerosols and ozone | (√) | (√) | (√) | (√) | (√) | | (√) | | |

# Macro assumptions and energy demand – Baseline projection for China

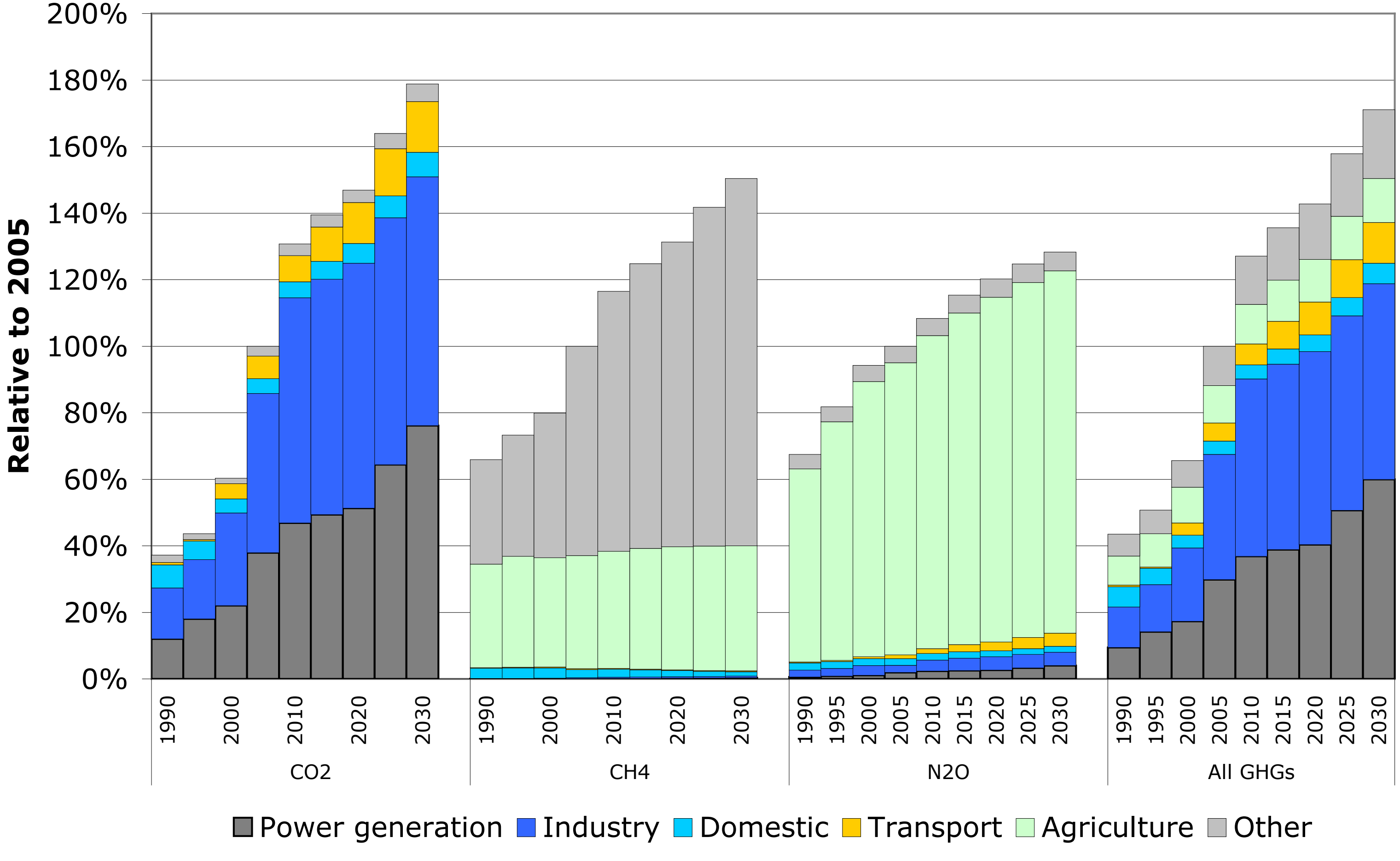


# Air pollutants emissions - Baseline projections
## current legislation (CLE) control measures, 2005=100%

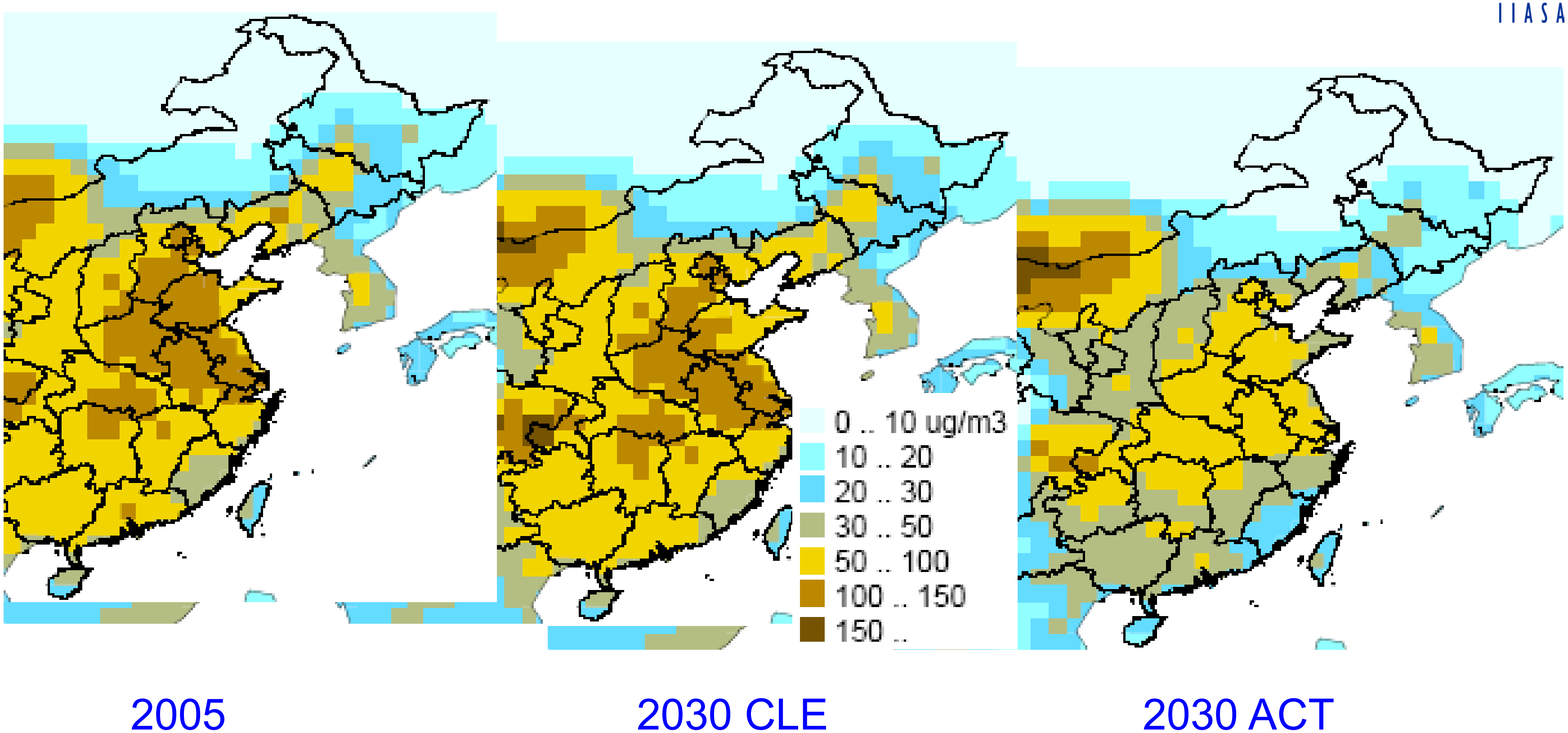


# Greenhouse gases emissions - Baseline projections, 2005=100%



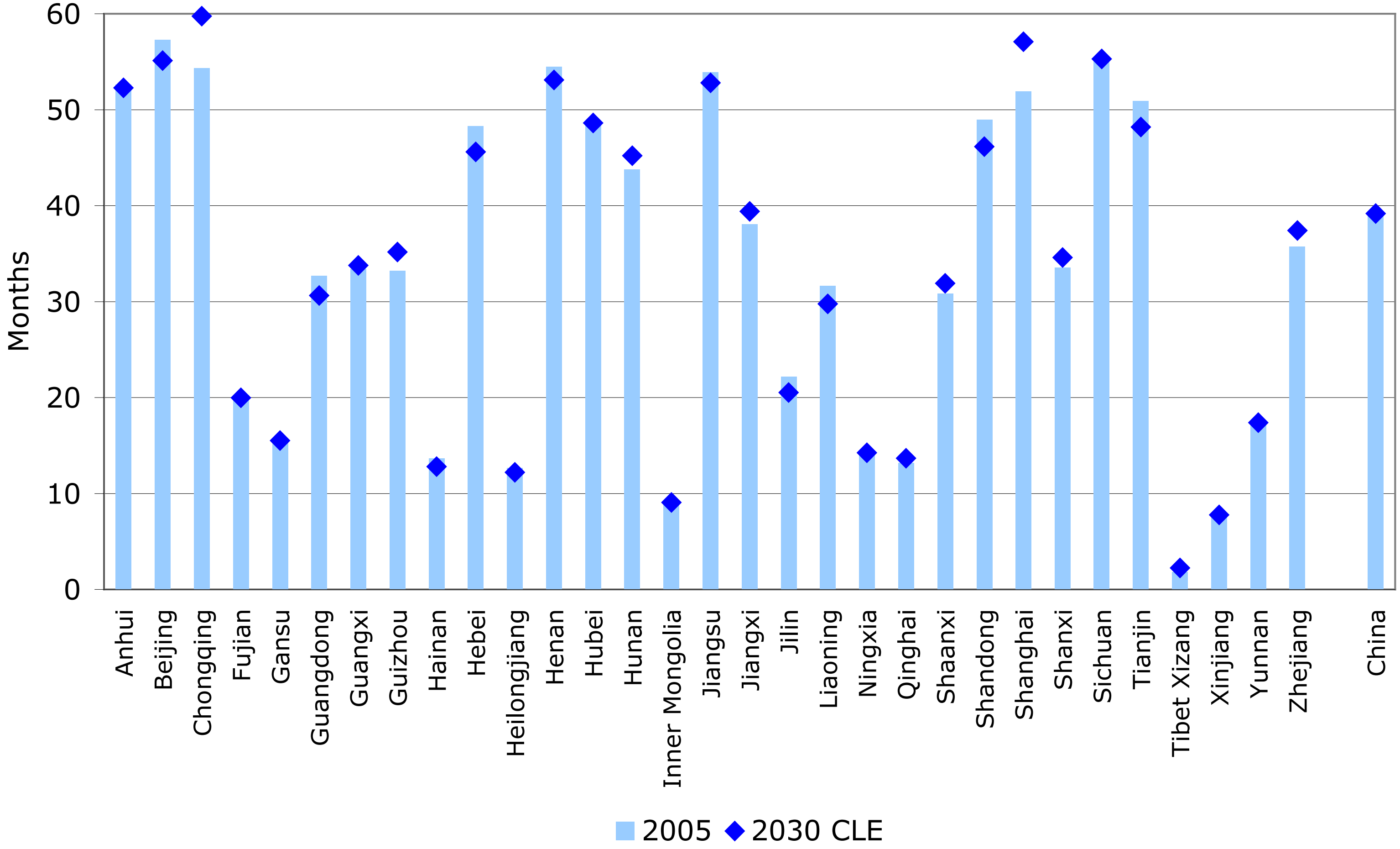
# PM2.5 concentrations

## Annual means, values characteristic for rural background sites, include dust from natural sources




Baseline energy demand, current legislation (CLE) and advanced control technology (ACT) pollution control legislation

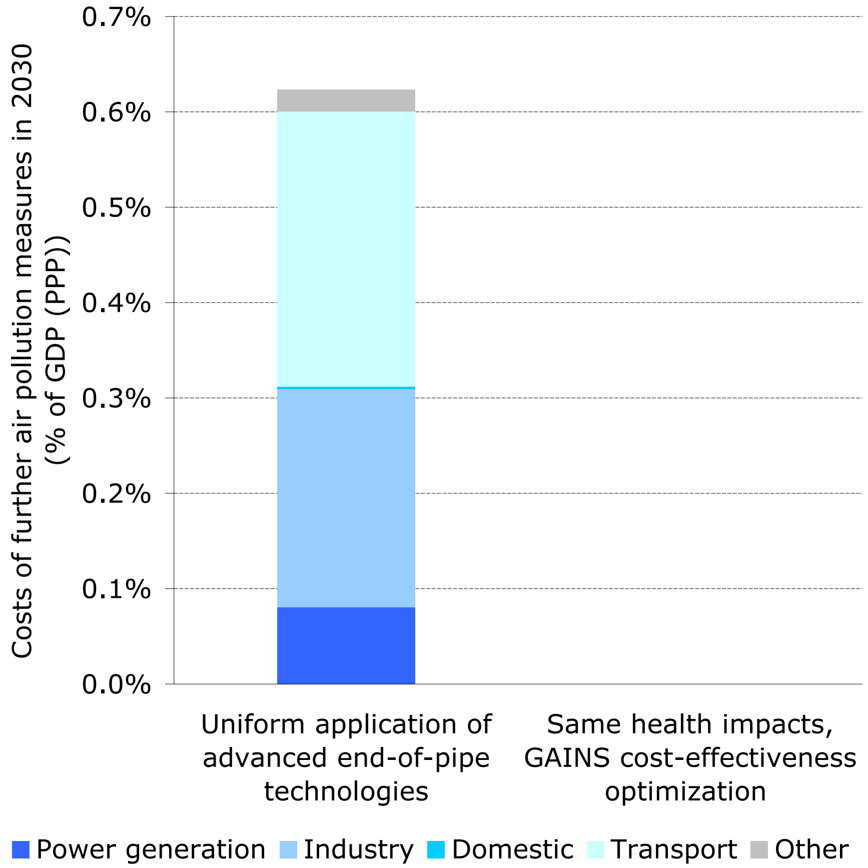
# Loss of statistical life expectancy by province due to outdoor exposure to fine PM



# The GAINS cost-effectiveness approach can reduce costs for improving air quality by up to 80%

- Full application of advanced emission control technologies can reduce health impacts in China by 43% in 2030

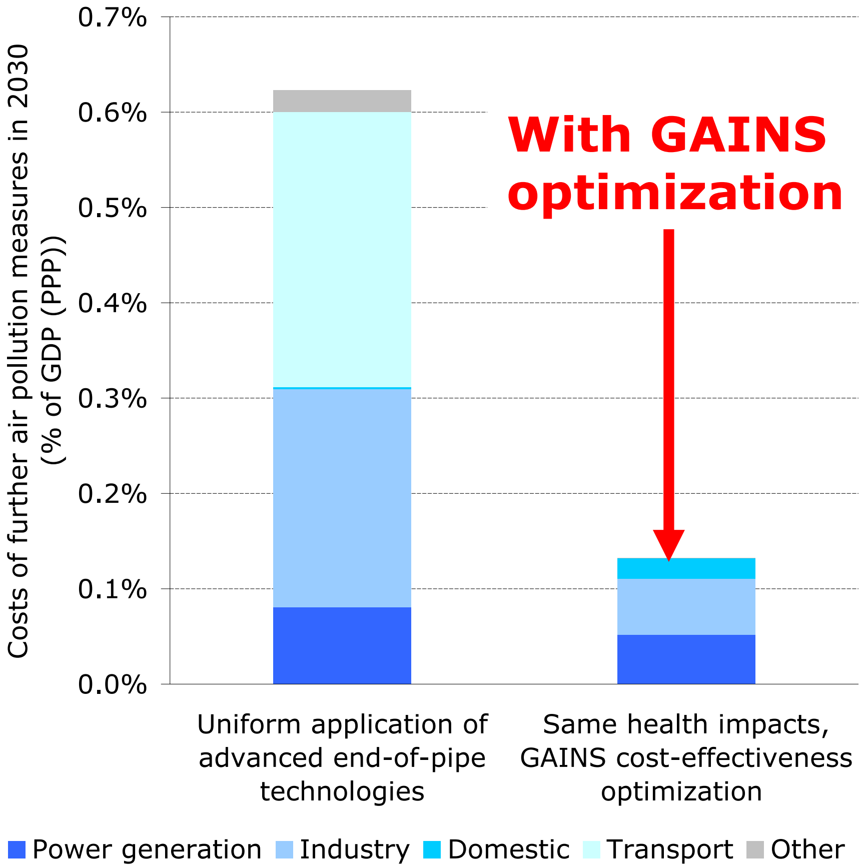
## Emission control costs for reducing PM health impacts in China by 43%



# The GAINS cost-effectiveness approach can reduce costs for improving air quality by up to 80%

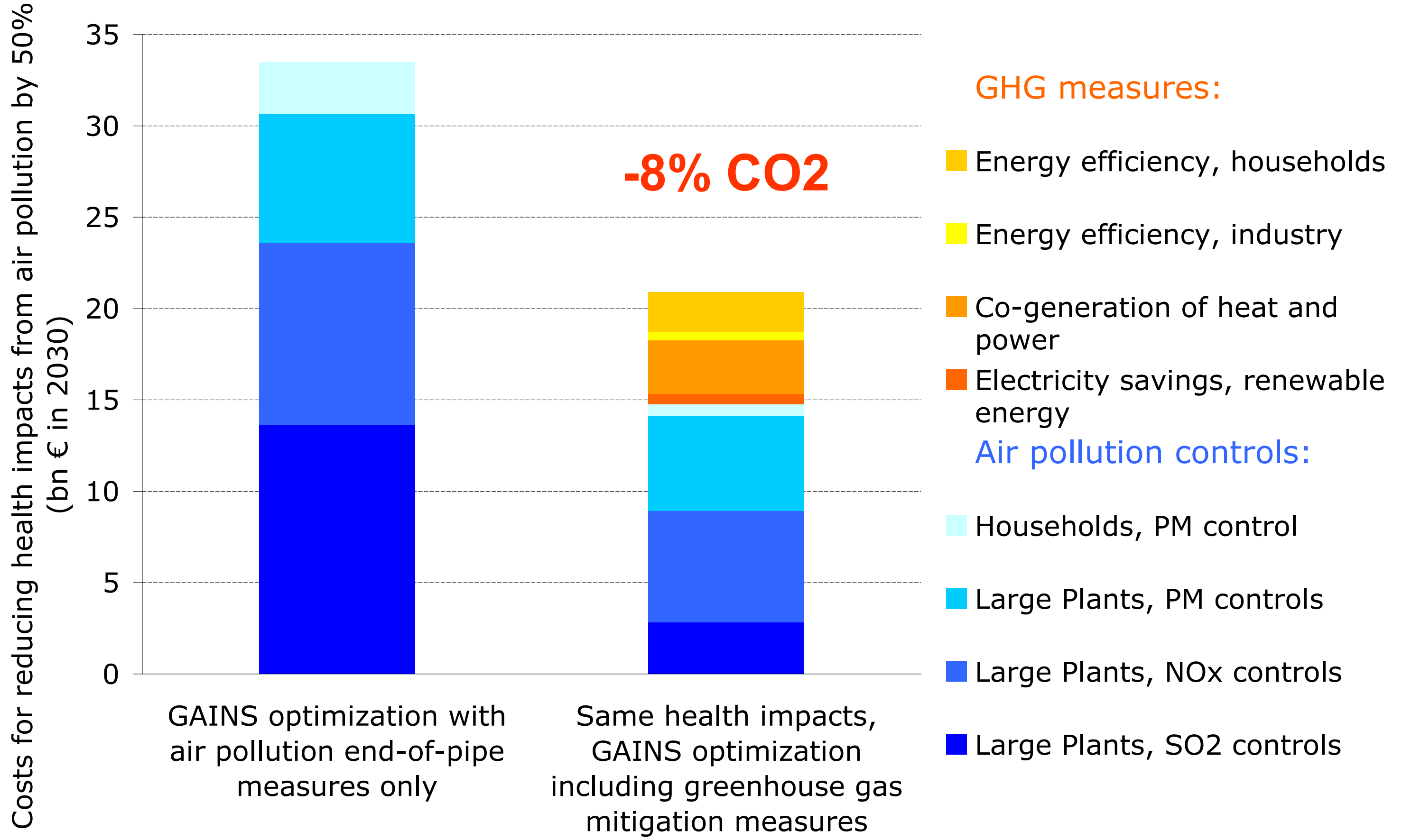
- Full application of advanced emission control technologies can reduce health impacts in China by 43% in 2030
- The GAINS optimization can identify the most cost-effective portfolio of measures – these achieve the same health improvements at 20% of the costs

Emission control costs for reducing PM health impacts in China by 43%



# Well-designed air pollution control strategies can also reduce GHG emissions

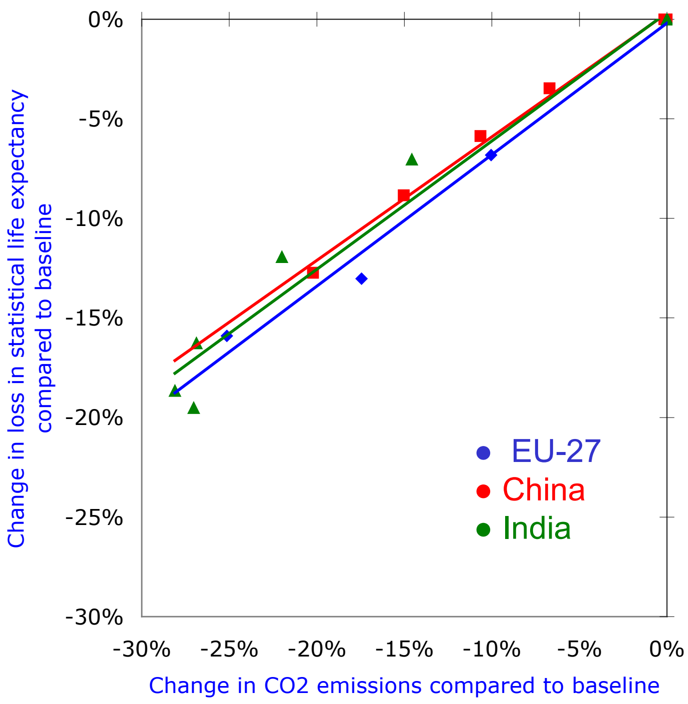
## Emission control costs for reducing PM health impacts in China by 50%



# Low carbon strategies have significant co-benefits - in Europe and in Asia

- Low $CO_2$ strategies result in
  - less $SO_2$, $NO_x$ and PM emissions,
  - lower damage to health and vegetation from reduced air pollution,
  - cost savings for air pollution control equipment, compensating for up to 40% of GHG mitigation costs.

## $CO_2$ emissions vs. health impacts (YOLLs)



# Zbigniew Klimont

## Basic Information on GAINS-City Project

- Project Info
- Project Goals
- Key scenarios for GAINS-City
- Tasks
- Outlook

# Project Info: Development and application of air pollutants and GHG emission model (GAINS-City) for Chinese cities

- Partners
  - Center for Earth System Science, Tsinghua University, Beijing, China
  - IIASA, Laxenbug, Austria
- Funding
  - The Energy Foundation: China Sustainable Energy Program; www.efchina.org
- Project duration
  - November 2010 – November 2011
- Meetings
  - Kick-off: January, 2011, Laxenburg, Austria
  - Final meeting: November 10, 2011, Beijing, China; beyond project partners and funding agency representatives, also local policy makers will attend

# Project goals

- Develop GAINS-*City* model based on GAINS-*Asia* model, to evaluate air pollutant and GHG emissions at megacity level
- Conduct case studies in two Chinese cities, Beijing and Jinan, to evaluate the emissions and air quality under different scenarios

# Key scenarios for GAINS-*City*

- Business as usual
- Air Quality scenario
- Lowe carbon intensity scenario
- Integrated policy, i.e., climate-friendly air quality scenario

# Tasks

1. Basic data collection and model framework design,
2. Development of city emission model based on GAINS model,
3. Update of emission factors based on a comprehensive review of local measurements,
4. Estimation of air pollutants and GHG emissions under different scenarios for Beijing and Jinan,
5. Evaluate the air quality benefit for different scenarios using CMAQ and GAINS-City,
6. Training of students who will lead subsequent analysis in individual cities,
7. Final report summarizing methods, results and future work.

# Outlook

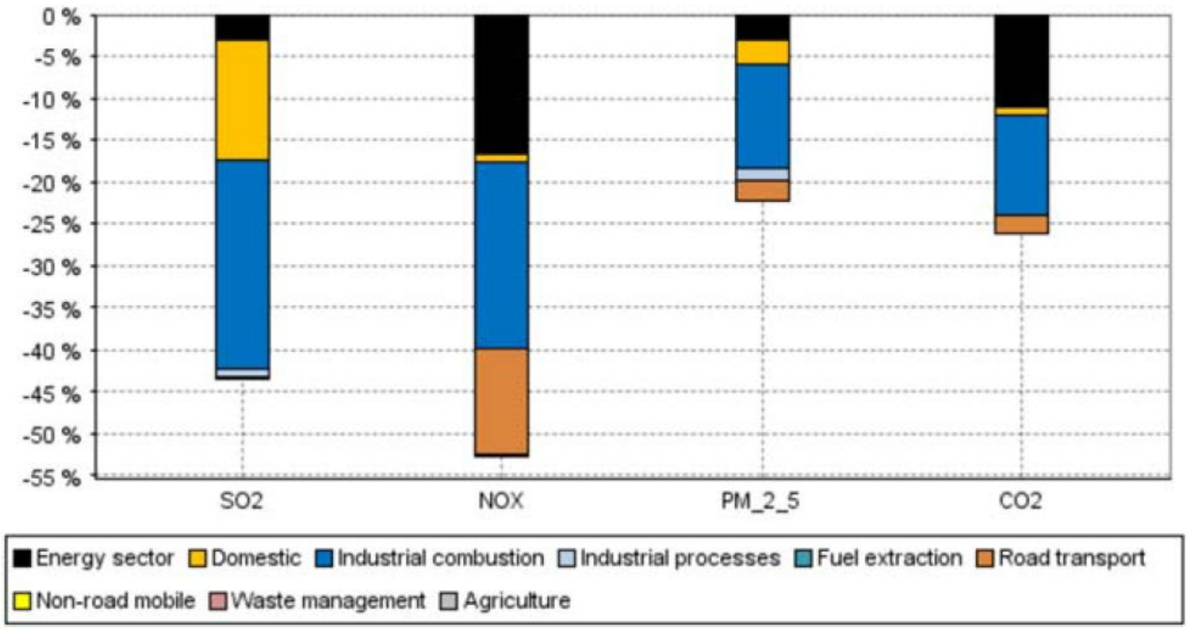
- Provided the first phase is successful, the project might receive further funding for integration and validation of developed toolbox and potential application to other megacities in China
  - Further development will include additional elements in the model, for example: cost calculation, display of concentrations, calculation and visualization of impacts (health from PM and ozone), integration of the policy toolbox
- There is interest expressed already by some Chinese cities as well as other Asian countries, however, no details on potential partners and funding exists or cannot be released

# GAINS City (WORK IN PROGRESS)

- Majority of air pollution originates from megacities
- Tool for analysis of control strategies tailored to the situation of a particular city needed
- Support in creation of control scenarios, like:
  - baseline
  - focus on air quality
  - focus on $CO_2$ reduction
  - integrated approach

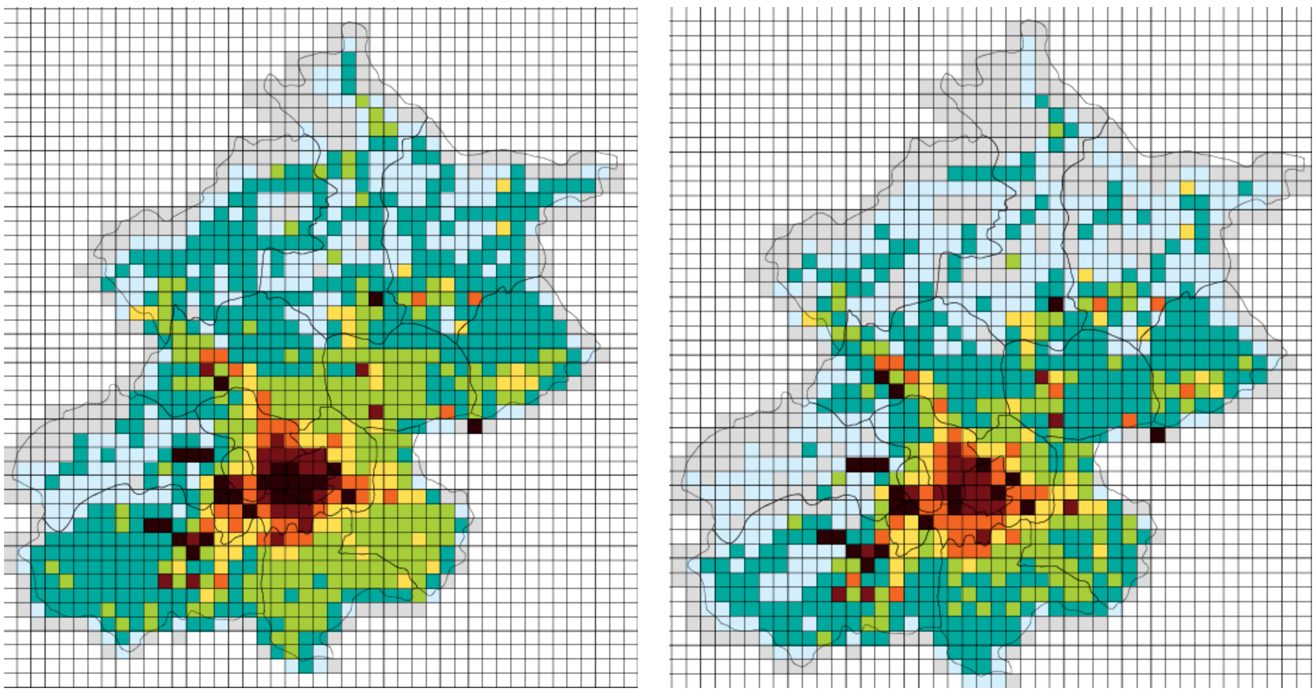
- Currently being applied for Beijing and Jinan

# Emissions reduction in Integrated Policies scenario (air quality and low carbon) relative to Baseline, %



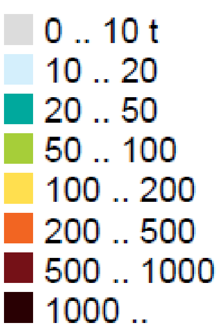

PRELIMINARY RESULTS - Beijing

# Emissions of PM 2.5, tons



2005

2030, Baseline




PRELIMINARY RESULTS - Beijing

# Main messages (GAINS-ASIA and GAINS-CITY)

- Current economic growth will counteract efforts to improve air quality in China unless pollution control laws are significantly upgraded
- Advanced emission control technologies are available to maintain acceptable levels of air quality
- A cost-effective strategy can reduce costs for air pollution control by up to 80% compared to conventional approaches
- A smart mix of measures that includes actions to reduce energy consumption can further cut air pollution control costs, and achieve lower greenhouse gas emissions
- GAINS City will help local authorities in developing city-specific control scenarios.

# The GAINS model is freely accessible on the Internet: http://gains.iiasa.ac.at

- Access to on-line versions
  - China
  - India and Pakistan
  - Europe
- Policy reports, user tutorials, model documentation, etc.
- Implementations for other countries are possible with limited efforts