

# Swedish legislation impact on acid deposition

- focus on Sweden in 1990 - 2010

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## Aims

- Provide the Swedish EPA with policy instrument evaluation support necessary for the 2015 National In-depth Evaluation of the Swedish Environmental Objectives
- Analyze to which extent specific legislation has reduced acid deposition in Sweden
- Suggest efficient future legislation structures
- To provide quantitative and qualitative evaluation of the historical development of acid deposition in Sweden

## Key Messages

- SO<sub>2</sub> emissions would have dropped in Sweden without the studied legislation, but end in higher levels
- Legislation has reduced the future options available for co-benefits between greenhouse gas and air pollution abatement
- The impact on Swedish deposition from European sources is as big as the total impact of Sweden emission control for the period
- Enhanced focus on process efficiency deserves further analysis when exploring future policy instruments

## Methods

The analysis was based on a decomposition analysis as described in in Rafaj et al. (2012) for Sweden . But qualitative analysis of existing legislation and surrounding factors replaced analysis of changes in energy intensity and energy efficiency.

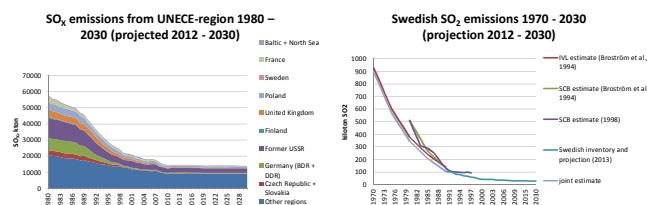
$$\Delta \text{Emission in Rafaj et al., 2012: } \Delta \text{EMIS} = \text{GDP} * \Delta \left( \frac{\text{ENE}}{\text{GDP}} \right) * \Delta \eta * \Delta \left( \frac{\text{EMIS}}{\text{ENE}} \right) * (1 - \text{eff}) * \Delta X$$

$$\Delta \text{Emission in this analysis: } \Delta \text{EMIS} = \text{GDP} * \Delta \left( \frac{\text{ENE}}{\text{GDP}} \right) * \Delta \eta * \Delta \left( \frac{\text{EMIS}}{\text{ENE}} \right) * (1 - \text{eff}) * \Delta X$$

Deposition calculated using the GAINS model (Amann et al., 2011). Focus on SO<sub>2</sub> emissions due to the importance for acidification.

## Data

Activity data and emission factor data from Swedish official emission inventory and projections (Gustafsson et al., 2013). European emission data from Amann et al. (2013.) & CEIP database.

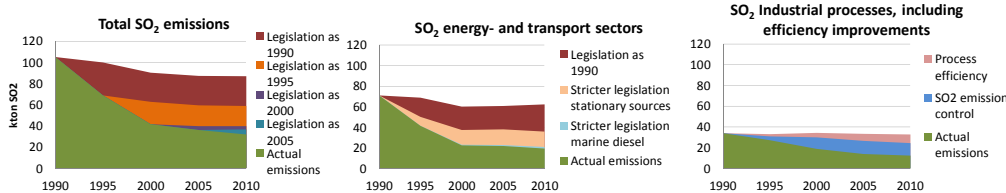


## Selected Results

### Most important legislation

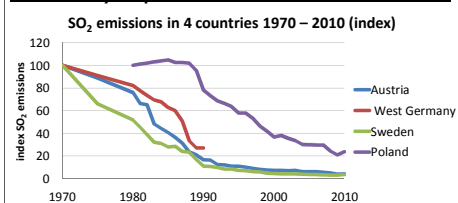
- The Swedish Sulfur laws (1968 - )
- Plant-specific licensing (1969 - )
- Other instruments
  - SO<sub>2</sub> taxes
  - Euro-standards (require low sulfur fuels)
- International agreements are important for a small country like Sweden
  - UNECE CLRTAP
  - EU NEC directives etc.

### Legislation impact on Swedish sulfur emissions 1990 – 2010



Comments: Swedish SO<sub>2</sub> emissions would have declined without further restrictions. This reduction would mainly be caused by improved efficiency in industrial processes, and SO<sub>2</sub> emissions would only have declined 17 kton

### Country-specific emission trends



### Legislation impact on S deposition 2010

Scenario	SO <sub>2</sub> Emissions kton	Sulfur deposition in Sweden mgS/m <sup>2</sup> /ha		
		Average	Min	Max
No control of emissions	157	180	44	1053
S legislation as 1990	87	153	41	655
S legislation as 1995	59	140	39	469
S legislation as 2000	40	132	37	373
Actual emissions	32	128	36	350
S deposition in 2000	42	184	42	575
Sweden 2010 in 2000	32	181	41	570

### Caveats

- Several policy instruments influence the same sources
- What impact has Sweden had on other countries?
- Sweden was an early mover, but no country has acted alone, So a 1990 Sweden in a 2010 Europe would not have happened
- External factors, such as the fall of the Berlin wall influence

## References

- Amann M., et al., 2013, TSAP Report #10
- Amann M., et al., 2011, Cost-effective control of air quality and greenhouse gases in Europe: Modelling and policy applications, Env. Mod. & Softw., 26;
- Rafaj P., et al., 2012, Factors determining recent changes of emissions of air pollutants in Europe - TSAP Report #2
- Gustafsson T., et al., 2013, Greenhouse gas and air pollutant emission projections for Sweden

## Acknowledgement

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