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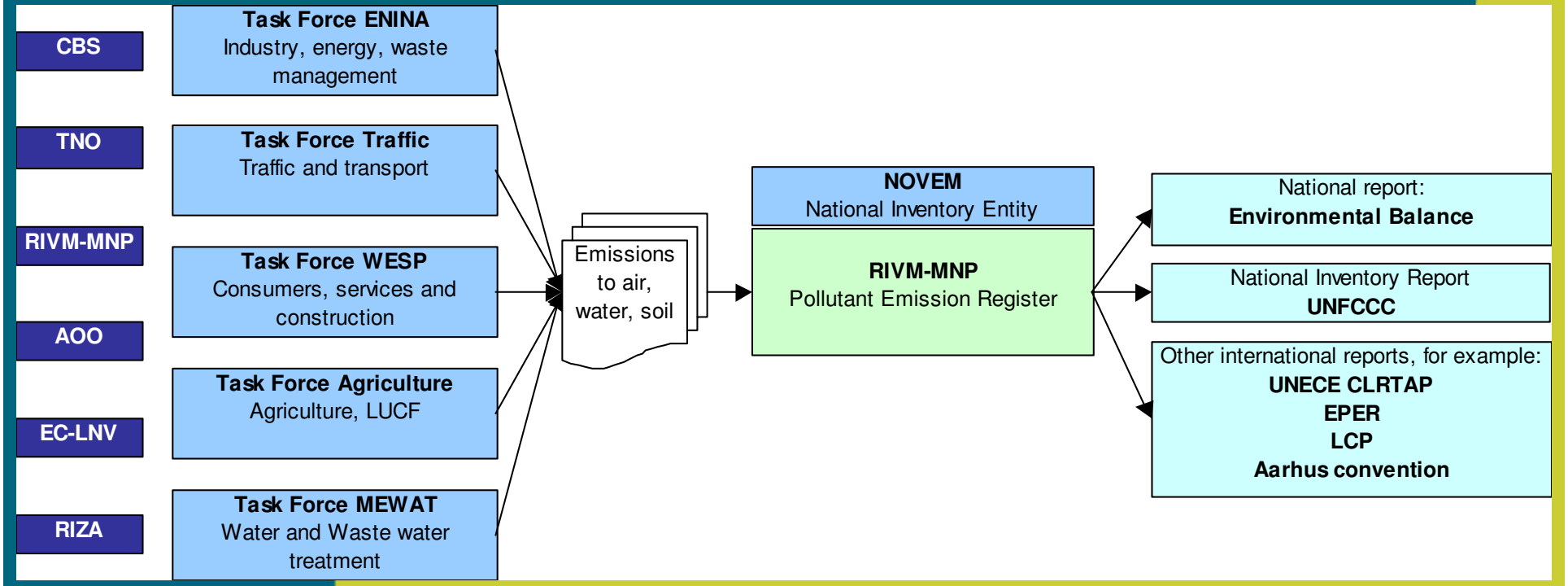
Validation, Verification and Uncertainty Assessment for Improving the Netherlands' PER

Structure of the presentation

- The Netherlands' Pollutant Emission Register
  - organisation, general principles
  - monitoring industrial emissions
- Uncertainty assessments
  - greenhouse gases
  - acidifying substances
- Verification
- Conclusions

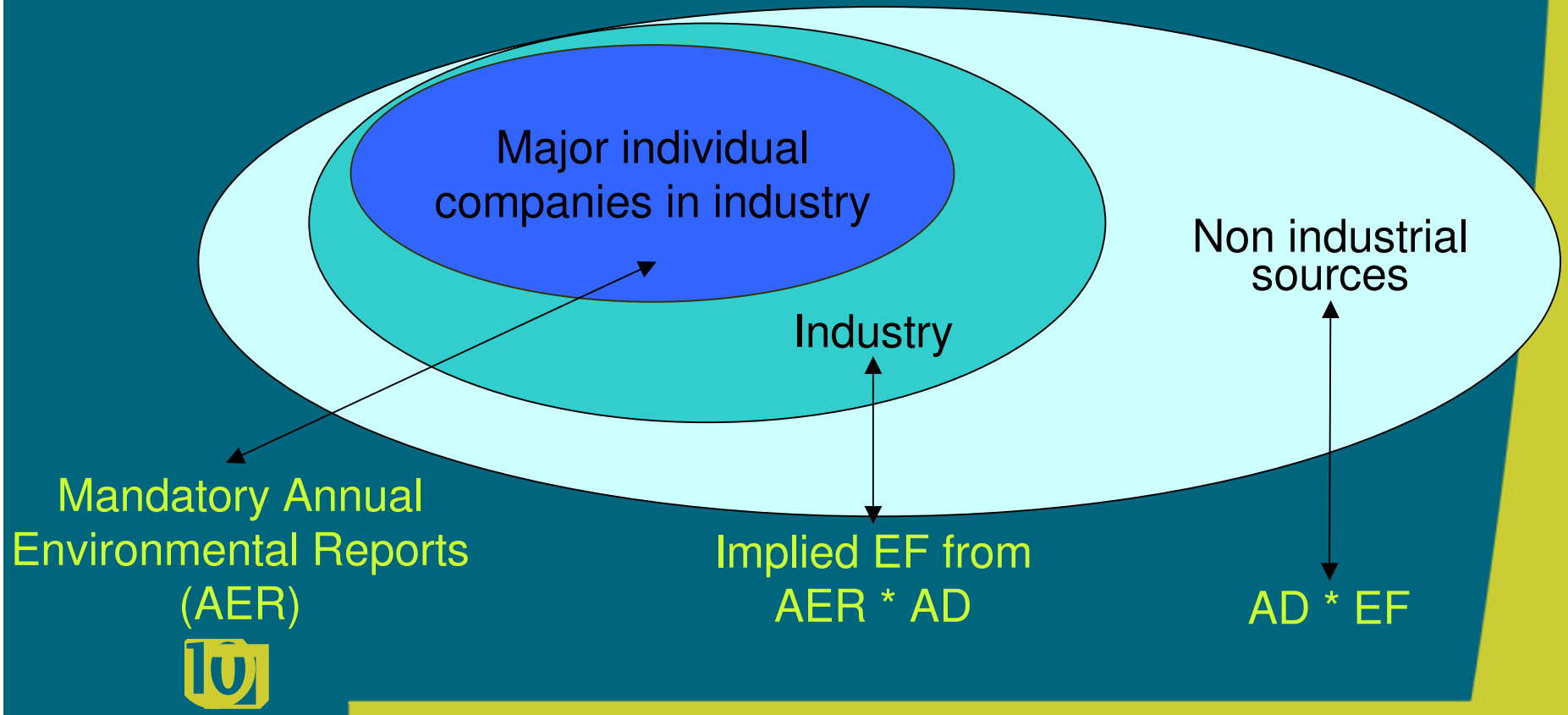
Netherlands PER: organisation

- Ministries of VROM and V&W: financial means, priorities, new or improved methodologies, reporting obligations
- RIVM-MNP: co-ordination of the annual compilation of the PER
- 5 Task forces: data collection, calculation and validation
- Participating institutes: CBS, RIZA, TNO, AOO, EC-LNV and others.



Netherlands PER: general principles

- PER contains emissions to air, water and soil for about 170 substances
- 75% of the industrial emissions are directly reported by companies



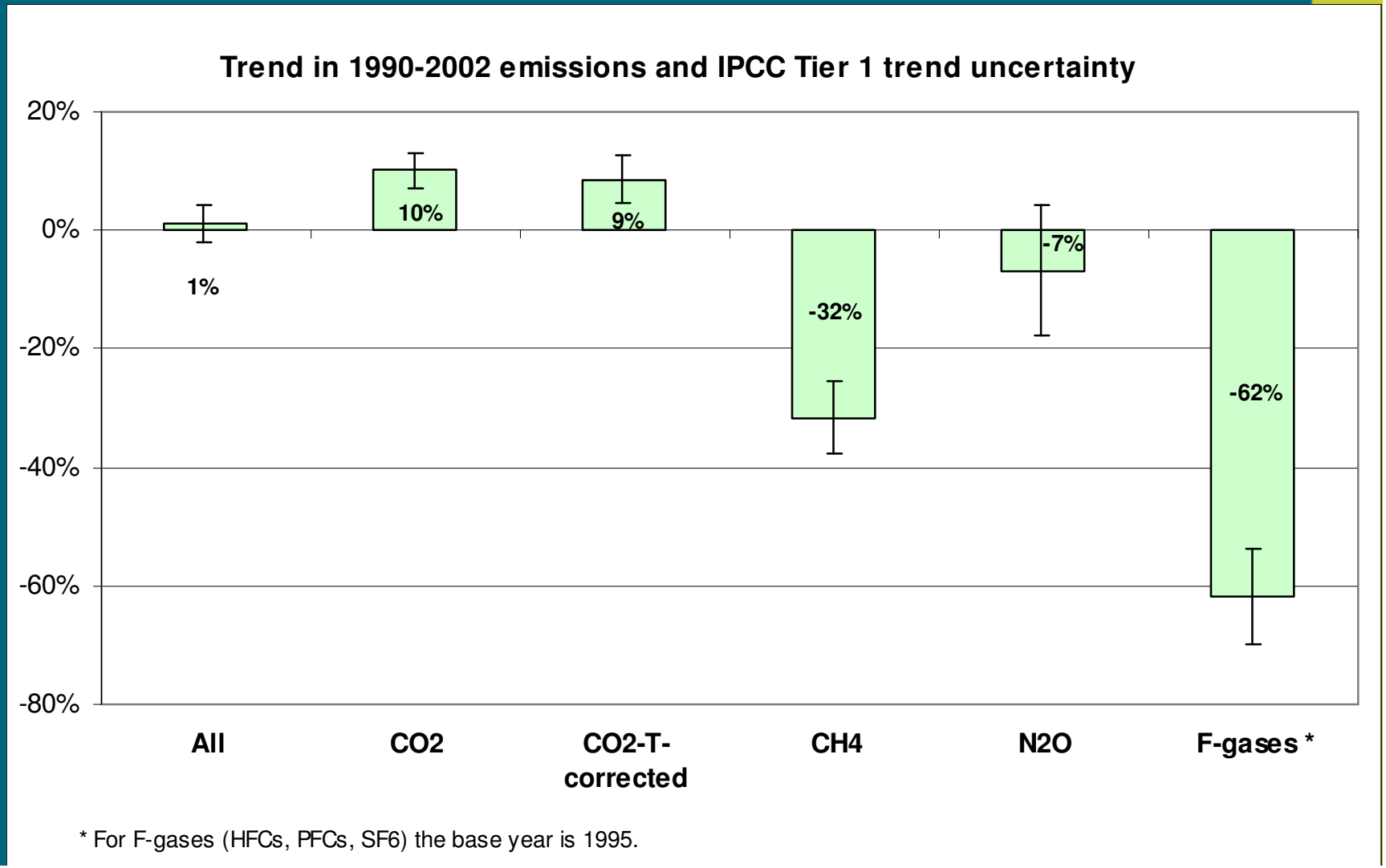
Netherlands PER: monitoring industrial emissions

- Annual environmental reports
  - More accurate because plant-specific data is used, BUT:
  - Transparency of reporting: e.g. incomplete reporting of fuel use
  - Consistency with the non-reporting part of a sector
- Transparency is still insufficient
  - Statistics Netherlands showed that a sectoral top down calculation of fossil fuel related emissions provides more reliable, consistent and transparent emissions data
  - Comparison of company reports with the sectoral top-down estimates for verification of both estimates.
  - Electronic reporting since 2004 results in higher data quality

Uncertainties in greenhouse gas emissions

- NIR IPCC Tier 1 approach for annual emissions and emission trend
- Uncertainty values used from:
  - a national workshop held in 1999; default uncertainty estimates from the IPCC GPG and expert judgement of RIVM emission experts.
- Uncertainty values are comparable with the IPCC defaults.
- Most uncertainty estimates are based on expert judgement and therefore show a high degree of subjectivity.
- Useful for identifying most important uncertain sources
- A Tier 2 assessment resulted in similar magnitudes of overall uncertainty estimates. See next presentation by Harry Vreuls, SenterNovem

Uncertainties in greenhouse gas emissions: trend uncert.



* For F-gases (HFCs, PFCs, SF6) the base year is 1995.

Uncertainties in emissions of acidifying substances

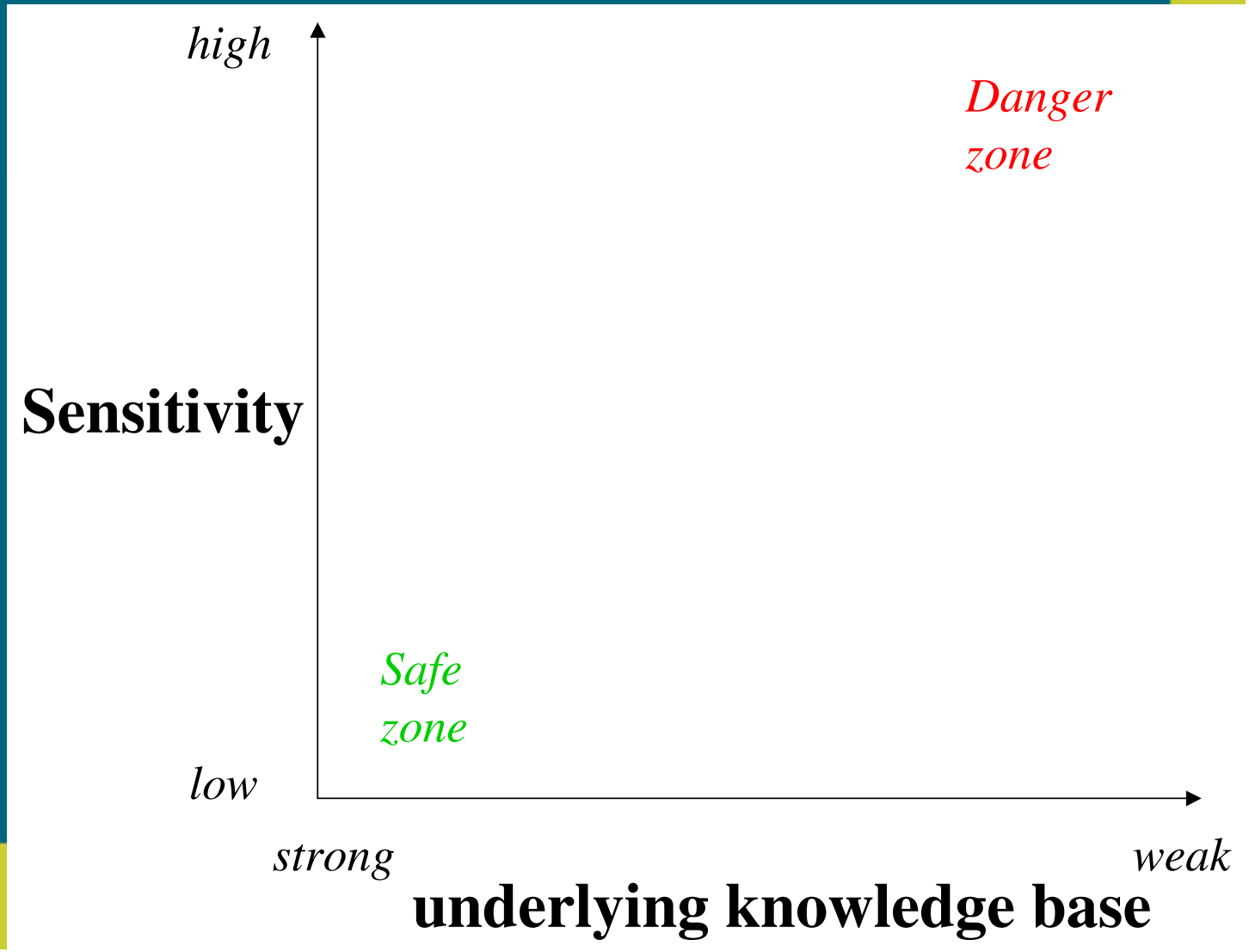
- Recent Tier 2 uncertainty assessment by TNO
- Expert elicitation
  - Identifying sources of uncertainty and bias
  - Elicitation of Probability Density Functions (PDF)
  - Score for underlying knowledge base
  - Correlations
- Defaults from UN-ECE Emission Inventory Guidebook for non-key sources
- Monte Carlo analysis
- Results in so called NUSAP diagrams

Uncertainties in emissions of acidifying substances

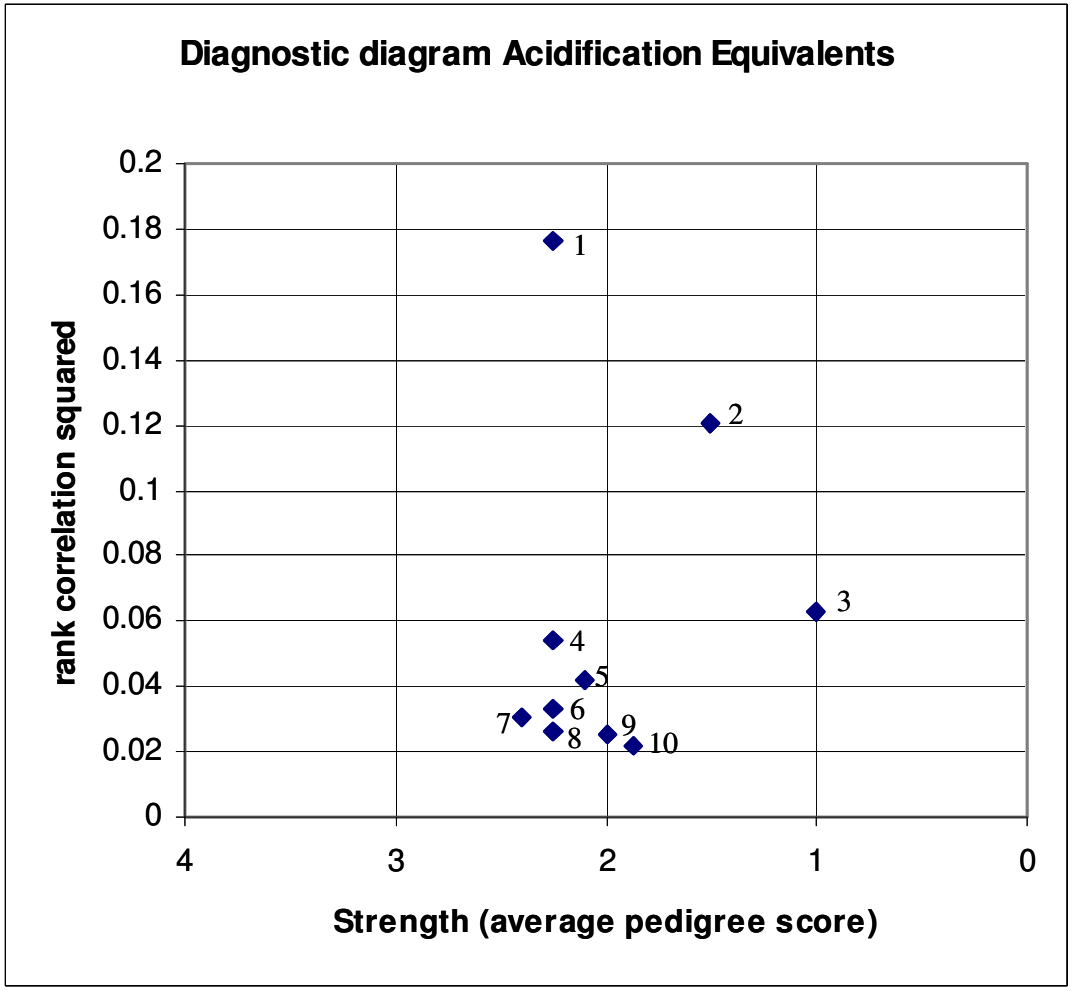
- NUSAP analysis: introducing pedigree criteria data quality

Code	Proxy	Empirical	Method	Validation
4	Exact measure	Large sample direct mmts	Best available practice	Compared with indep. mmts of same variable
3	Good fit for measure	Small sample direct mmts	Reliable method commonly accepted	Compared with indep. mmts of closely related variable
2	Well correlated	Modeled/derived data	Acceptable method limited consensus on reliability	Compared with mmts not independent
1	Weak correlation	Educated guesses / rule of thumb	Preliminary methods unknown reliability	Weak / indirect validation
0	Not clearly related	Crude speculation	No discernible rigour	No validation

Uncertainties in emissions of acidifying substances



Uncertainties in emissions of acidifying substances

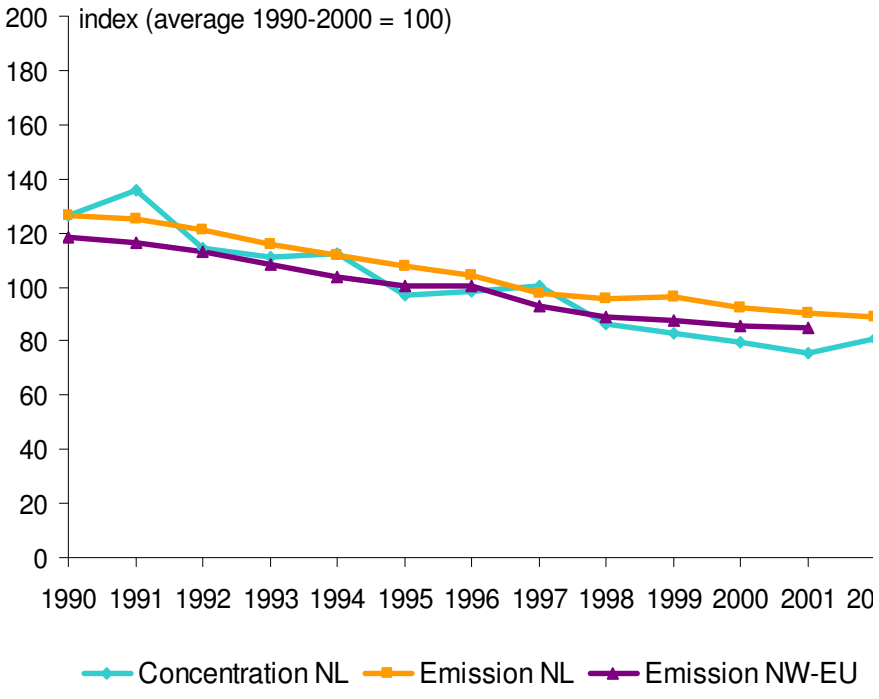


Rank	Label
1	NH3 dairy cows, application of manure
2	NOx mobile sources agriculture
3	NOx agricultural soils
4	NH3 meat pigs, application of manure
5	NOx highway: gasoline personal cars
6	NH3 dairy cows, animal housings and storage
7	NOx highway: truck trailers
8	NH3 breeding stock pigs, application of manure
9	NH3 calves, yearlings, application of manure
10	NH3 application of synthetic fertilizer

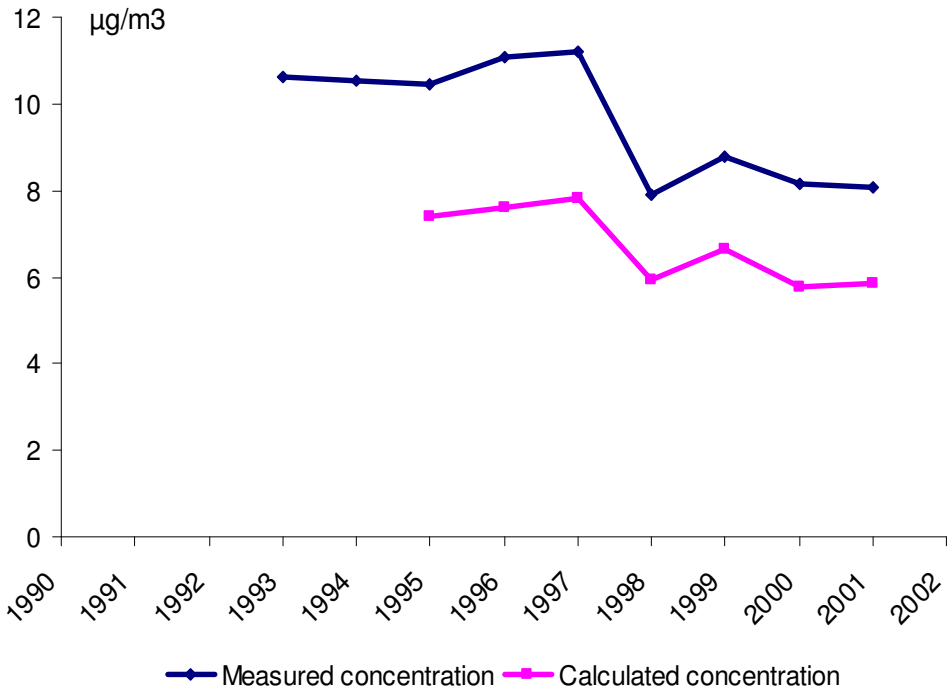
Verification

- Air quality measurements from the Air quality monitoring network allows independent validation of emission trends
- Nitrogen oxide emissions and concentrations decreasing at same rate
- Trends in calc. and meas. concentration of ammonia are similar
- Absolute difference in level of about 30%. This may be explained by a possible underestimation of emissions and an overestimation of the dry deposition

Nitrogen Oxide (NOx)



Annual average NH3 concentration



Conclusions (1)

- Verification
  - Comparison with other datasets is useful, in particular when incompleteness or systematic errors are suspected.
  - Caution should be taken with respect to the precision of the conclusions drawn on the other datasets.
- Monitoring of industrial emissions
  - Use of plant-specific data is preferred. Conditions:
    - transparent reporting;
    - consistency with the non-reporting part of a sector.

Conclusions (2)

- Uncertainty assessments
  - Provide quantitative judgement of the inventory quality.
  - Helpful for prioritizing improvement plans
  - A Tier 1 uncertainty assessment may be sufficient for these purposes, since experience with more detailed Tier 2 assessments resulted in similar magnitudes of overall uncertainty estimates.
  - Focusing on the order of magnitude of the individual uncertainty estimates provides a reasonable first assessment of the uncertainty of key source categories.
  - NUSAP analysis is a useful tool to direct improvement actions to those areas where investment are most efficient.

End of presentation

- More information:
  - www.NUSAP.net

    uncertainty management, expert elicitation, sensitivity analysis, risk communication
  - www.greenhousegases.nl

    Information on greenhouse gas emissions and monitoring in The Netherlands
  - www.emissieregistratie.nl

    Datawarehouse Emission Inventory
  - www.environmentaldata.nl

    Environmental Data Compendium
  - www.rivm.nl

    RIVM Environment and Nature: publications and press releases

Uncertainties in greenhouse gas emissions: annual uncert.

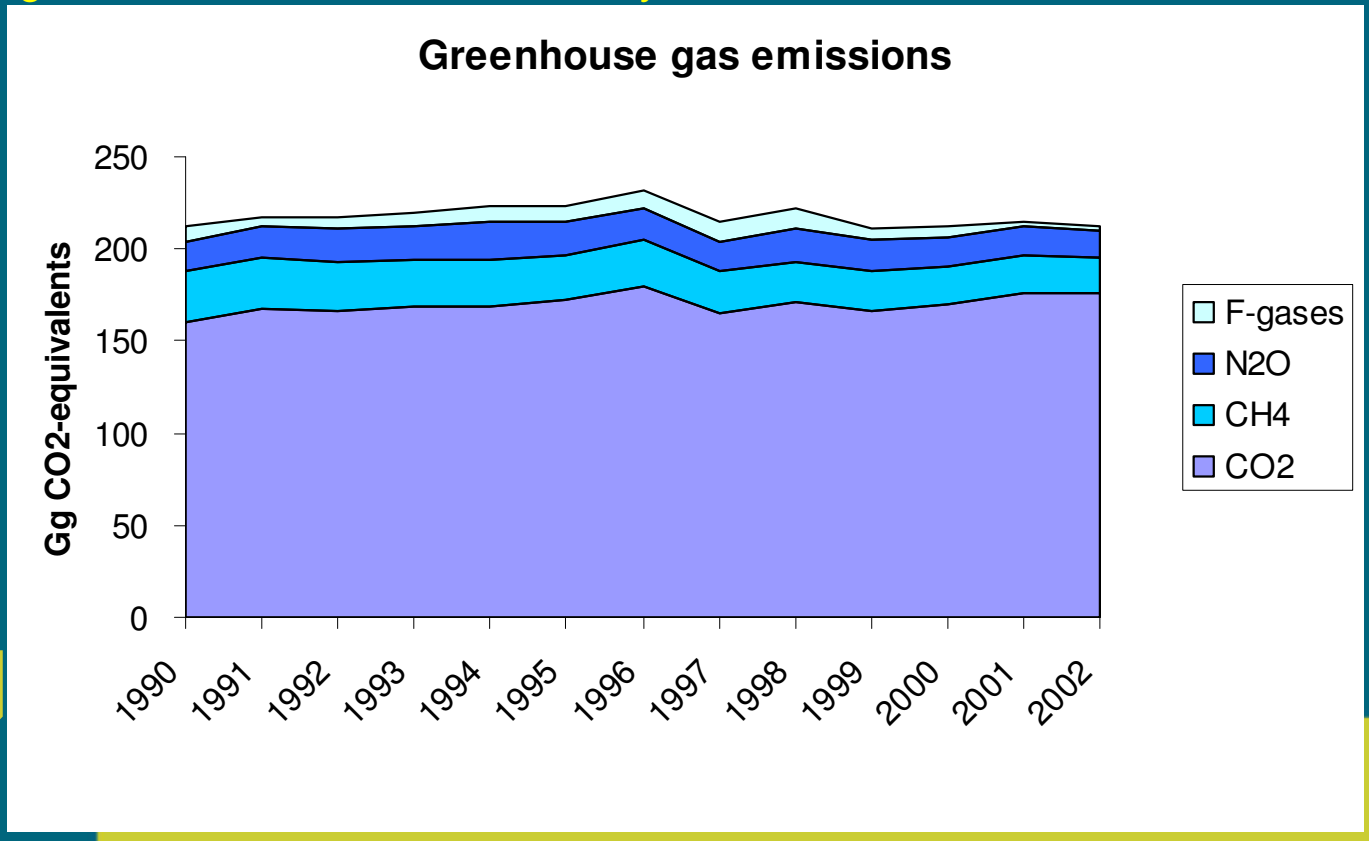
Greenhouse gas	Tier-1 uncertainty (calculated)	Tier-1 uncertainty (estimated)
Carbon dioxide	± 2%	± 3%
Methane	± 17%	± 25%
Nitrous oxide	± 34%	± 50%
F-gases	± 21%	± 50%
Total CO_2-equivalents	± 4%	± 5%

Top 10 sources contributing the most to total annual uncertainty in 2002

	IPCC Source category	% of total national emissions
4D	Direct N2O from agricultural soils	1.5%
4D	Indirect N2O: nitrogen used in agriculture	1.4%
2X	N2O from nitric acid production	1.3%
6A	CH4 from solid waste disposal sites	1.1%
7X	N2O from polluted surface water	1.1%
1A	CO2 from stationary combustion: energy industries	1.1%
1A	CO2 from feedstock oil	1.0%
4A	CH4 from enteric fermentation: cattle	0.6%
1A	CO2 from mobile combustion: other	0.6%
1A	CO2 from stationary combustion: other sectors	0.6%

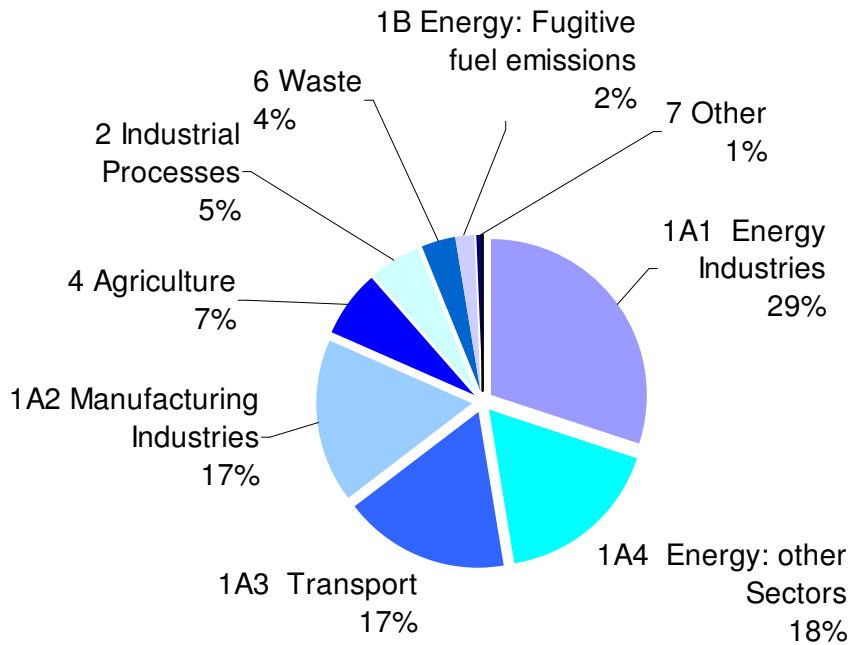
Greenhouse gas emissions in The Netherlands

- 1990-2002 calculated trend
  - CO_2 +10%; traffic and energy sector.
  - CH_4 -32%; waste sector, agriculture and energy.
  - N_2O -7%; industry.
  - F-gases -66% since 1995; industry.



Greenhouse gas emissions by sector

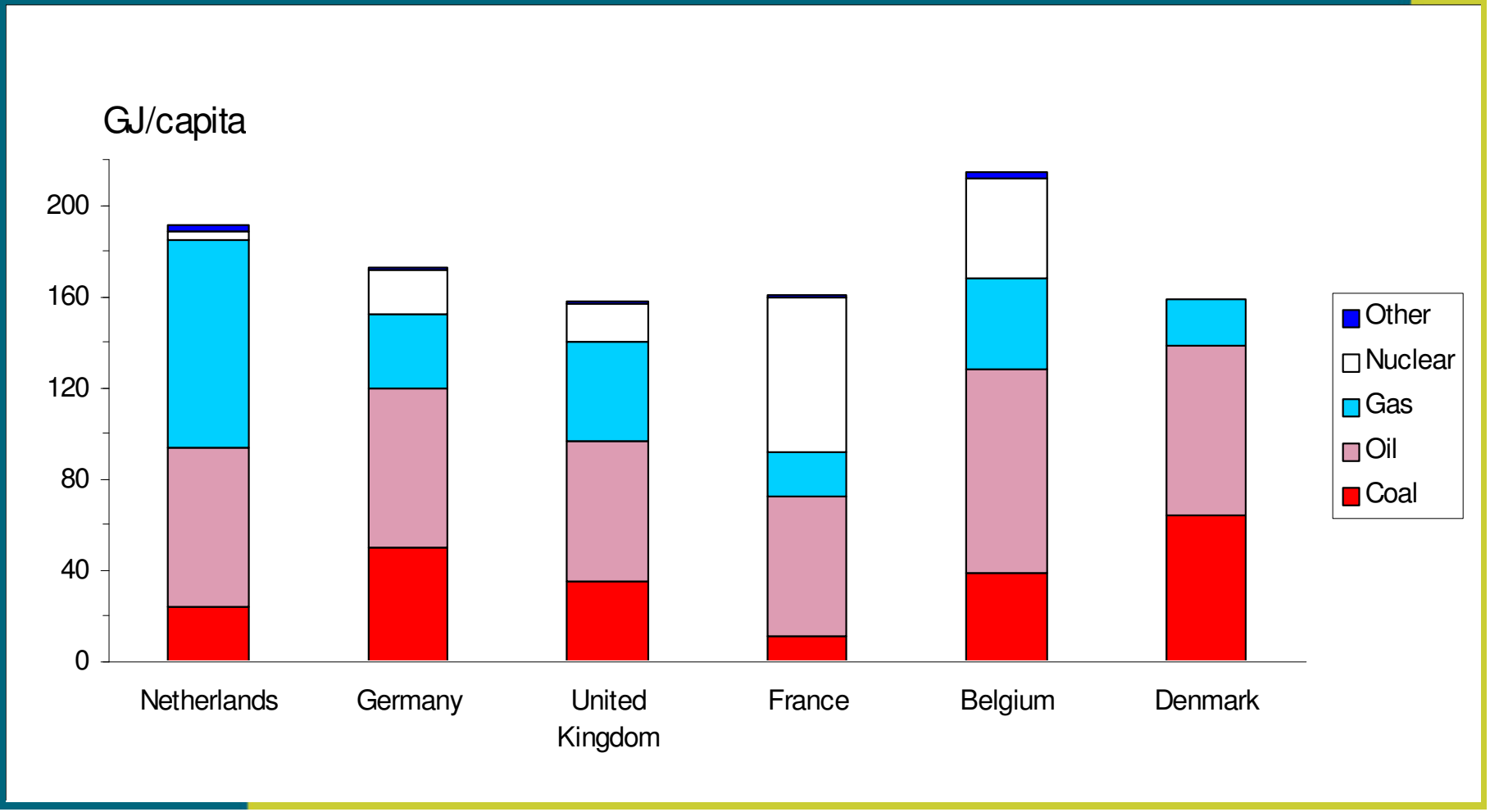
- Emissions from fuel combustion (1A): increase from 75% in 1990 to 80% in 2002
- Other emissions: 20% (industrial processes, agriculture and waste)



Reserve sheet 1: fuel mix

Fuel mix

- much gas, oil for transport and non-energy use, coal only for steel and power



National circumstances (1990 – 2002)

Population and households

- Population, number of households
  15 → 16 million, 6 → 7 million

Agriculture

- Manure production -18%

Transport

- energy use +30%

Energy intensive industry

- Large petrochemical industry
- 6 refineries
- Steel and aluminum production
- energy use as fuel -17%
- conversion to other products: +20%

Fuel mix

- much gas, oil for transport,
  coal only for steel and power