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European Emission Inventories

Development, validation, future goals and needs

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Air pollution policy processes in Europe

1979: UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) signed

1983: European Monitoring and Evaluation Programme (EMEP) established

1985-2001: A number of Protocols signed under the CLRTAP; SO_2 (1985, 1994), NO_x (1987), NMVOC (1991), HM (2001)

1997: EU Acidification Strategy

1999: Protocol to Abate Acidification, Eutrophication and Ground-level Ozone of CLRTAP *(Gothenburg Protocol – ratified 17 May 2005)*

2001: EU National Emission Ceilings Directive (*SO_2, NO_x, NH_3, NMVOC)*

2005: EU Clean Air For Europe (CAFE) strategy proposed *(includes for the first time targets for Particulate Matter emissions)*

2006: Review of the EU NEC Directive and Gothenburg Protocol

Brief history of recent European emission inventories… (1)

- **Until recently only highly aggregated national emission data were available to the international community, exceptions were:**
  - **MAP** inventory for 1985 (covered EU-12)
  - **PENTAGONALE** inventory for 1989 (six Central European countries); emission factors, activity data and LPS
  - **CORINAIR** 1990, 1994 (28 countries); also emission factors, activity data, LPS
- **At the end of 80's the development of the *Emission Inventory Guidebook* was initiated; continues until today**

Brief history of recent European emission inventories… (2)

- **Signature of the *Gothenburg Protocol* and *NEC Directive* was followed by "louder" demands for improved transparency and validation of emission inventories,**
- **Following the example of the UNFCCC (CRF reporting) CLRTAP asked its Task Forces to establish new reporting guidelines where activity data and emissions would be reported simultaneously in a format broadly compatible with UNFCCC/CRF but maintaining specific needs of the CLRTAP…and so the NFR was born.**

Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook

- An important document that leads to improvement of transparency and comparability of emission estimates,
- First edition published in 1994, current 3rd edition available from the EEA web site
- The Guidebook provides a default set of emission characteristics for air pollutants,
- Different level of coverage for pollutants, e.g., not complete for particulate matter,
- It is important to secure resources for continuous update,

Validation

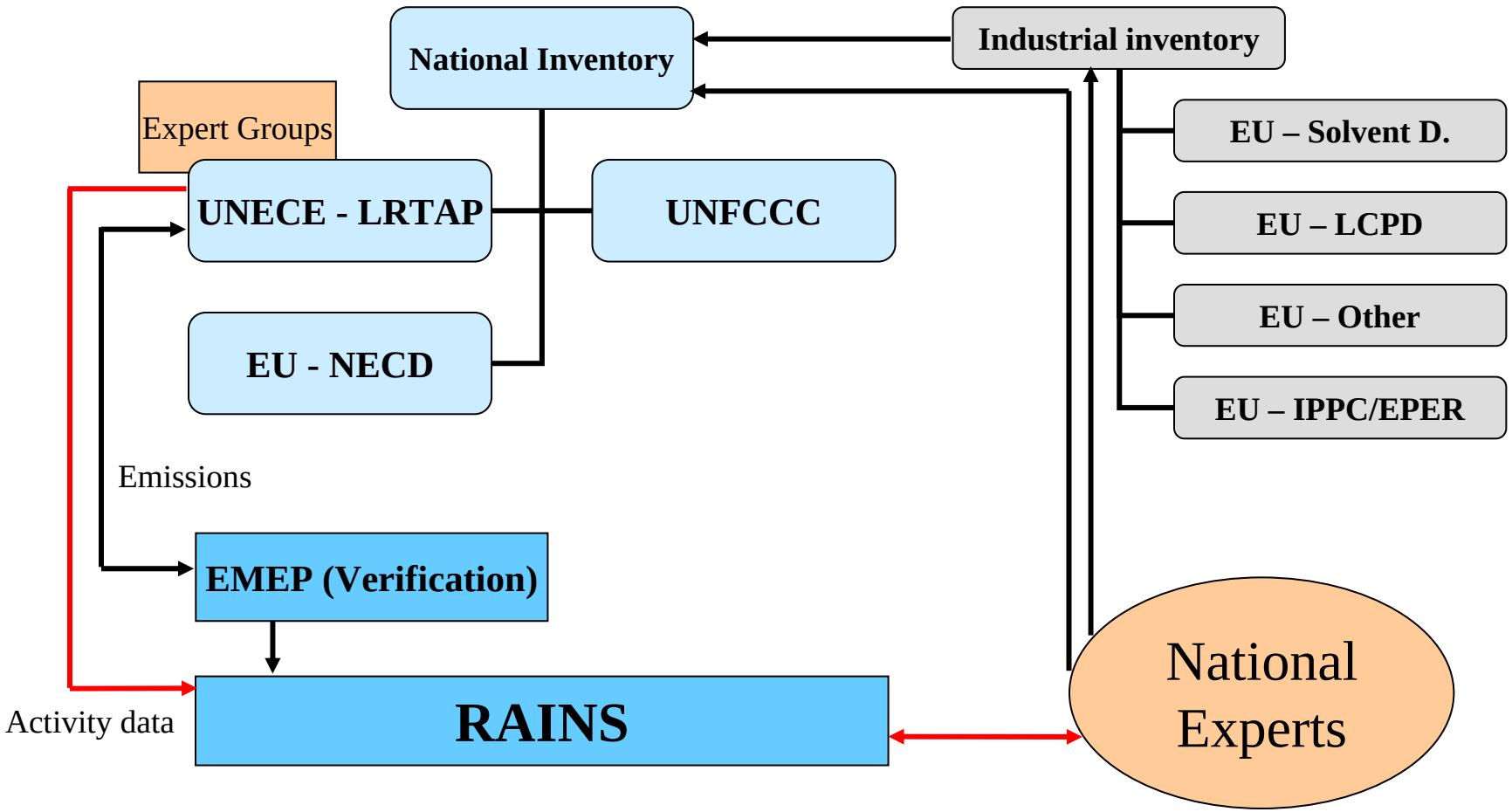
EMEP performs validation checks upon receiving data and does further consistency verification

- Q&A with Member States during the annual submission process
- Principal consistency checks performed annually assuring comparability of data
- A more detailed review performed every five years involving modelling team from CIAM

Within CAFE and NEC review process RAINS model used to reproduce national submissions to CLRTAP and NEC Directive

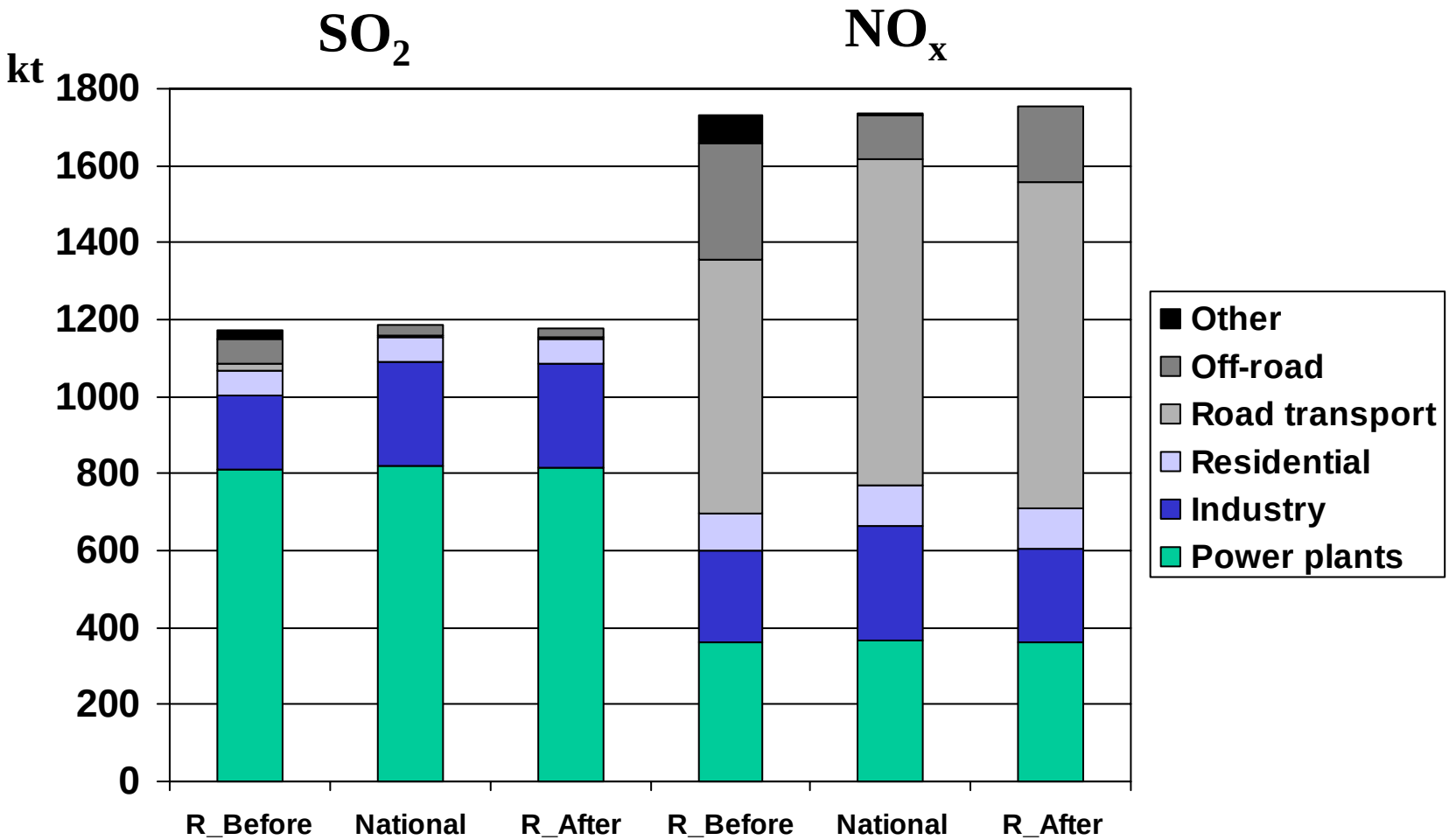
- Questionnaires to Member States on behalf of EMEP
- Bilateral consultations
- In most cases good overall fit, some discrepancies in sectoral estimates remain
- RAINS maintains international consistency; discrepancies to national estimates are documented

Data flow


National Inventory
Industrial inventory
Expert Groups
EU – Solvent D.
UNECE - LRTAP
UNFCCC
EU – LCPD
EU – Other
EU - NECD
EU – IPPC/EPER
Emissions
EMEP (Verification)
National Experts
Activity data
RAINS

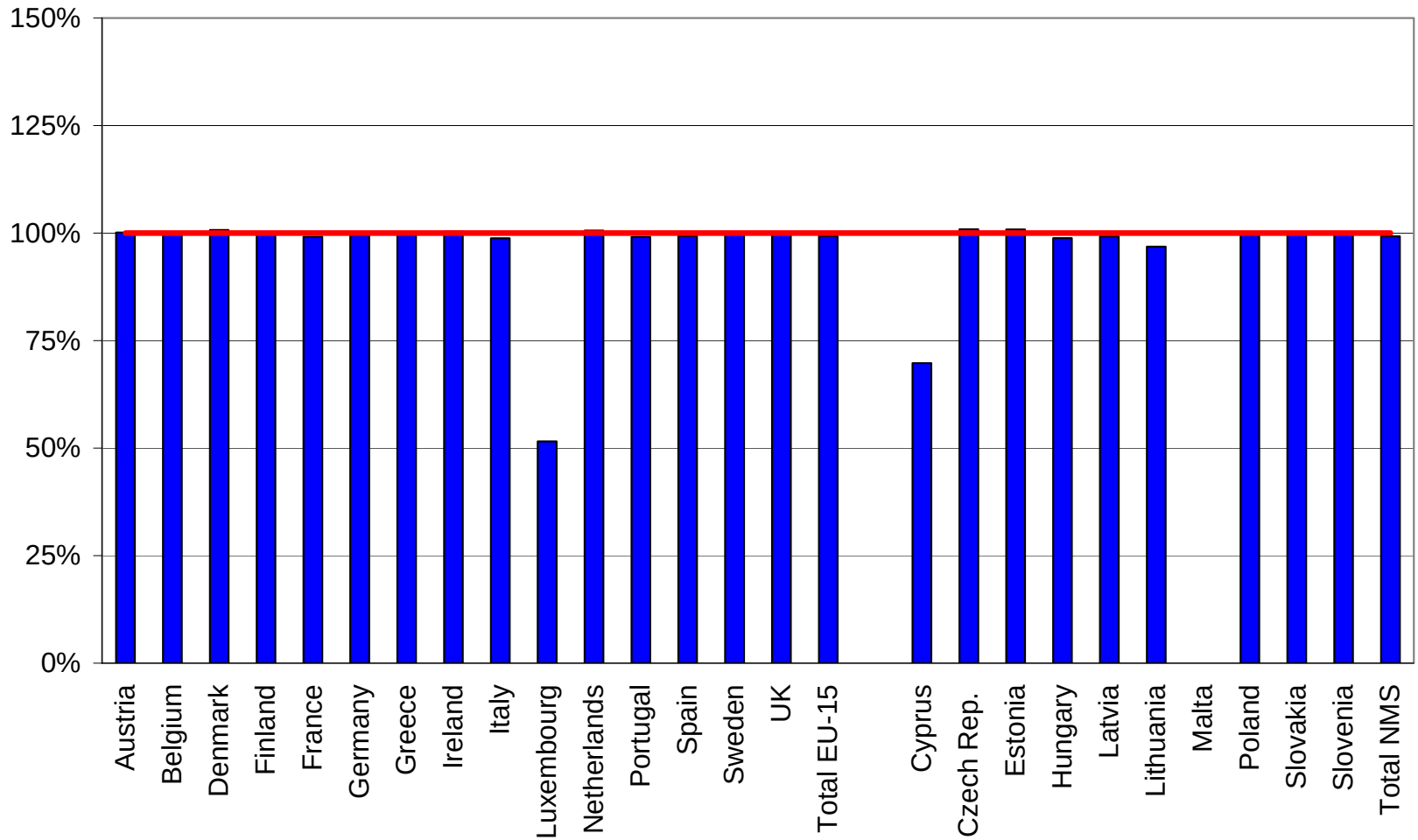
Example for UK

Adjustments of SO_2 and NO_x emissions in RAINS

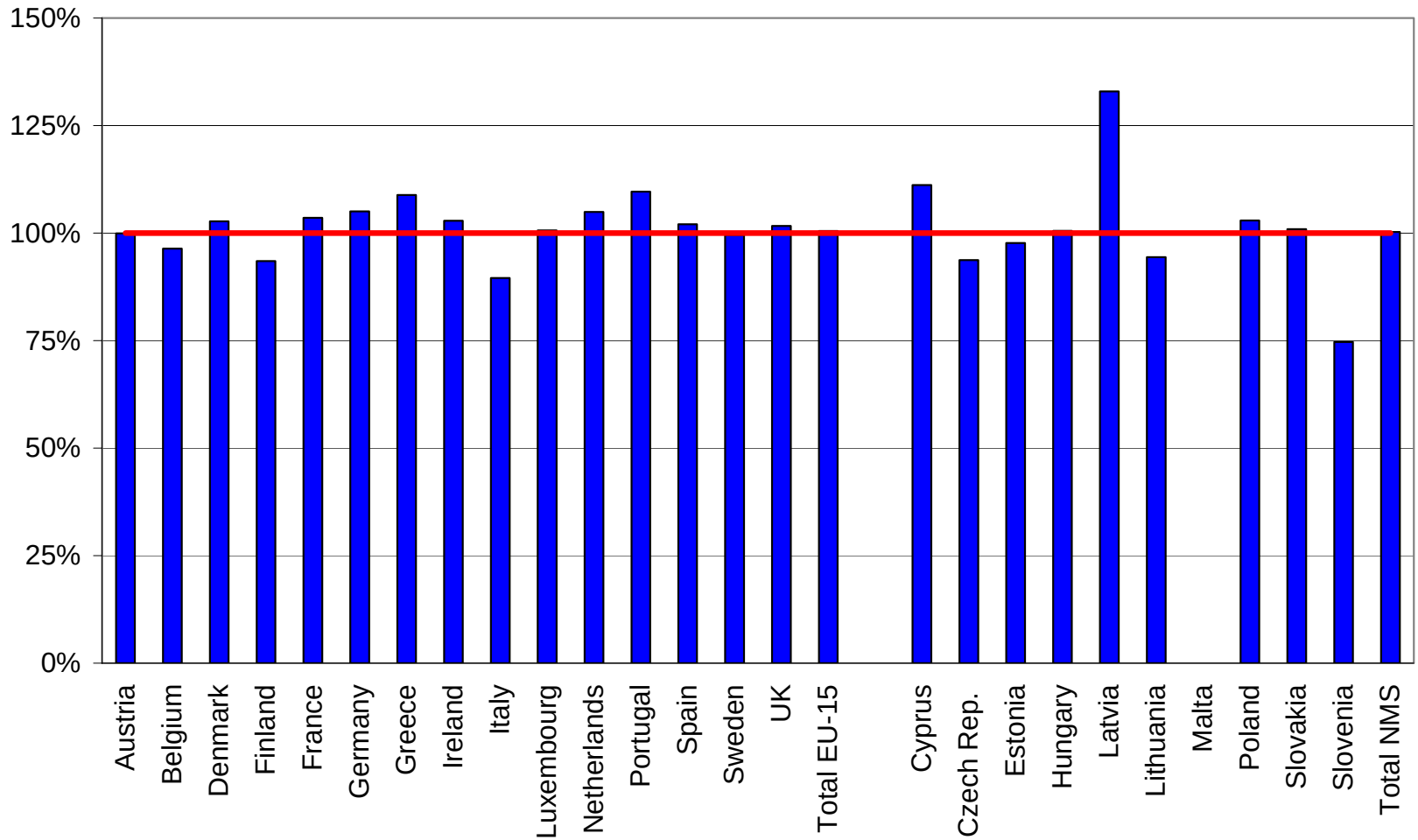


RAINS emission estimates for NO_x

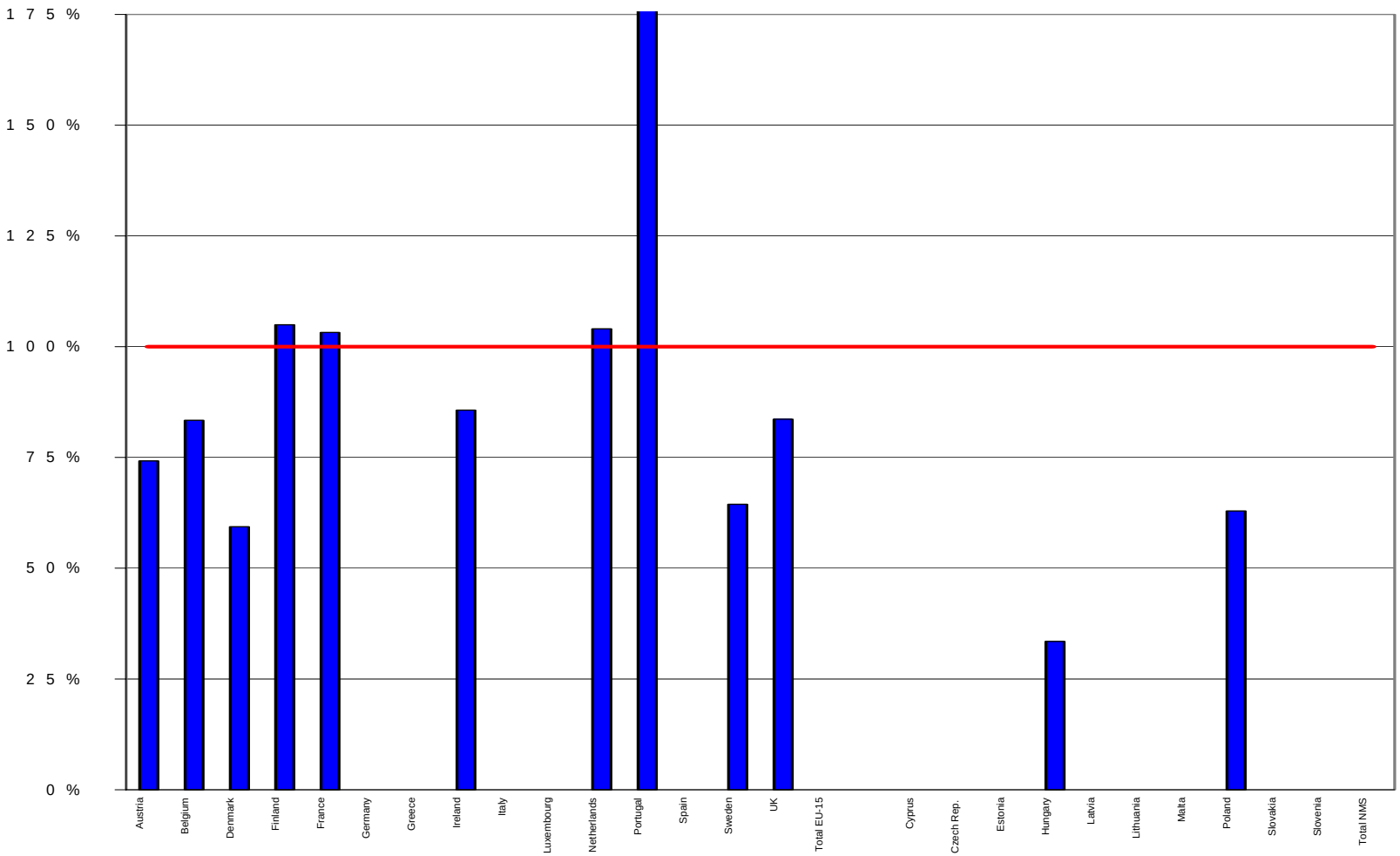
vs. national inventories, 2000



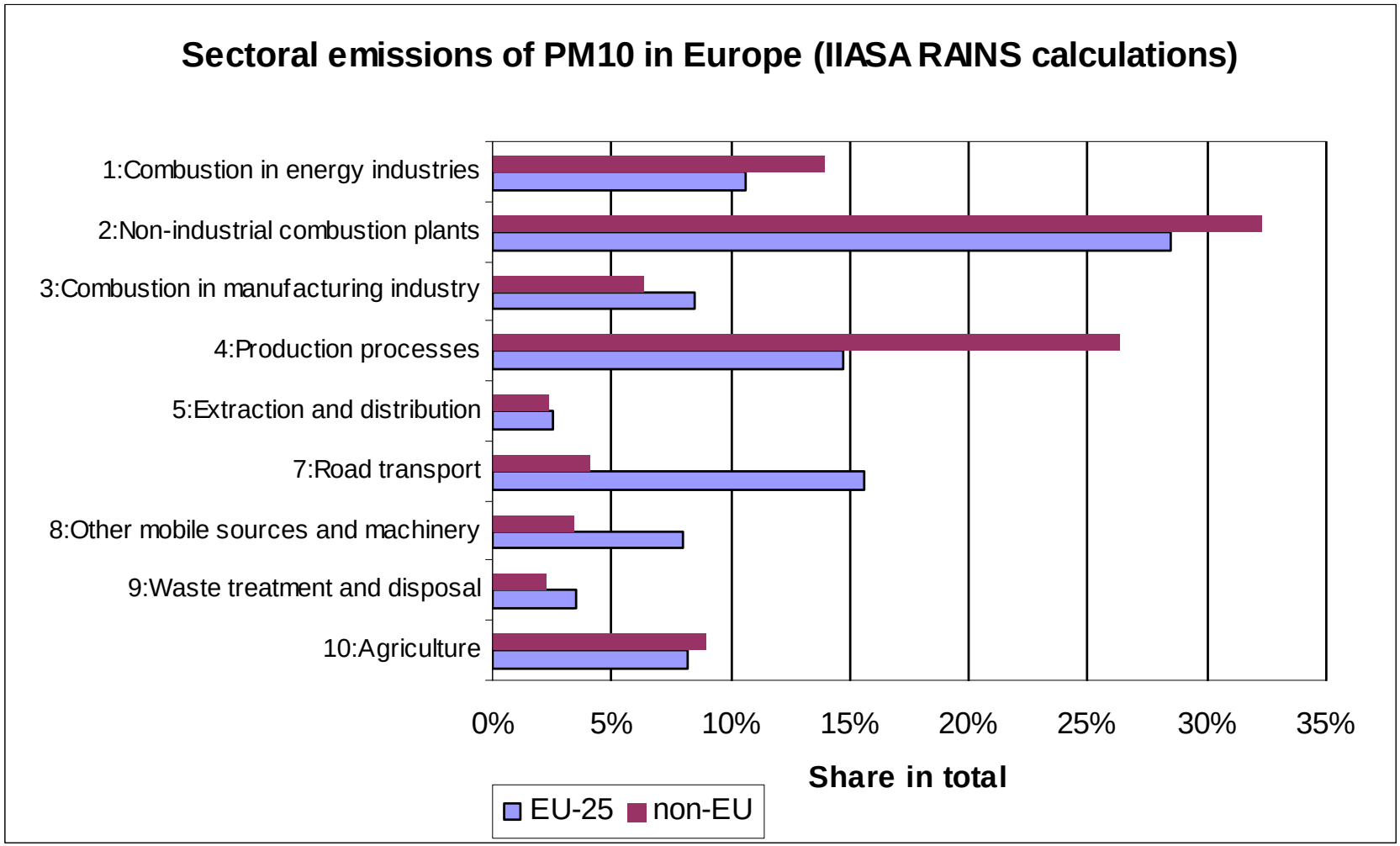
RAINS emission estimates for VOC
vs. national inventories, 2000



RAINS emission estimates for $PM_{2.5}$
vs. national inventories, 2000



PM10 emission sources



Some of the remaining questions on emissions

- Still poor information on size and chemical speciation of PM emissions (crucial for atmospheric modeling and impact assessment),
- Possible underestimation of a number of non- (or poorly)-regulated sources, e.g., small industrial combustion plants, off-road sources, residential combustion,
- Sea shipping and recreational shipping emissions,
- ‘Real life’ reduction efficiencies, e.g., NOx-HDT, PM-DPM, etc.,
- Spatial and temporal distribution is still a problem child for some activities,
- Questions of applicability of western methods (and assessments) to the non-EU25 countries largely remain.
- And more…

Task Force on Emission Inventories and Projections
Emission Inventory Guidebook

- **The Guidebook does not appropriately cover PM methodologies**
- **A number of PM sources are missing in reporting formats and guidebook; several of them, however, relevant only for coarse particles, e.g.,** *animal houses and crop production, construction, sawmills, coal production*
- **Priorities have been identified:**
  - Small-scale and industrial combustion
  - Processes in iron and steel industries
  - Off-road sources
  - Burning of agricultural residues
  - Validation of factors across UNECE area
- **Establishment of a PM Task Group under TFEIP to *i.a.***
  - Review the immediate requirements of modelers, e.g., chemical and size speciation
  - Propose priorities for methodology development

How uncertain are emissions?

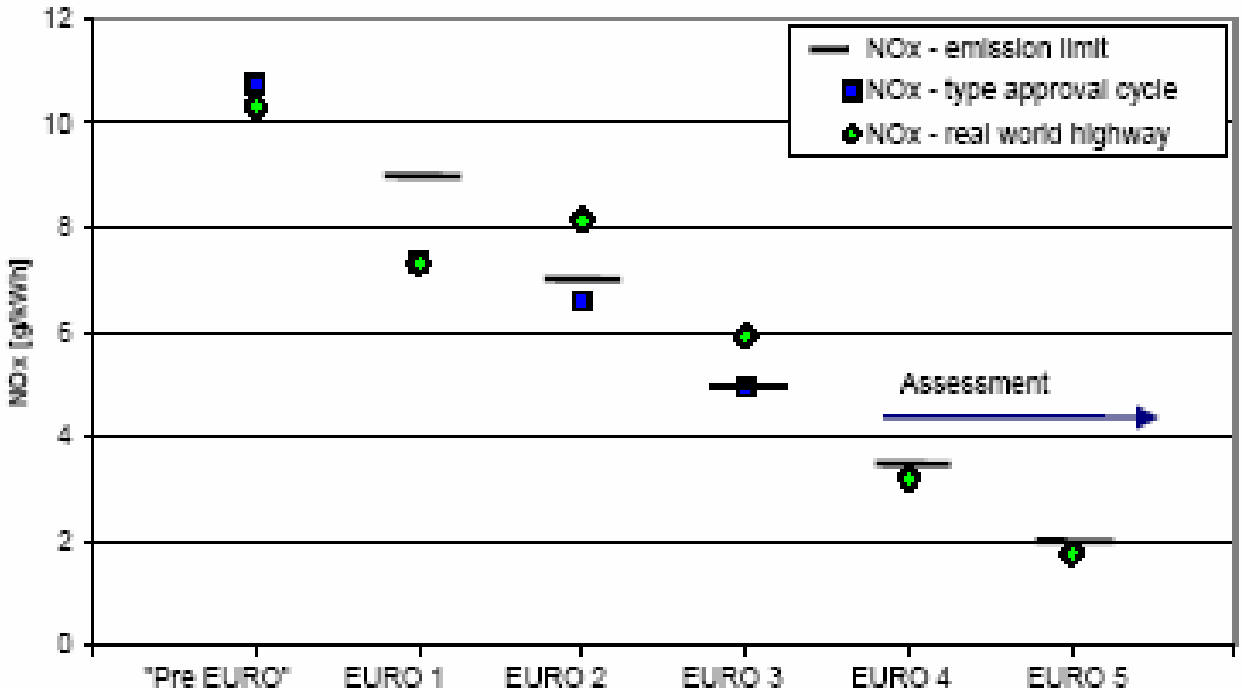
Examples of recent uncertainty estimates of national emissions

95% confidence intervals

	1990		2010			
Pollutant	**IIASA, 2000**	**Rypdal, 2002**	**IIASA, 2000**	**Rypdal, 2002**	**CITEPA, 2002**	**Syri et al, 2000**
SO_2	6-23	4	9-36	5	10	5
NO_x	8-26	12	10-33	12	46	15
NH_3	9-23	21	12-33	21	80	40
NMVOC	9-26	18	12-33	15	30	-

How uncertain are emissions?
EURO II, III for Heavy Duty Vehicles case

Source: Hausberger et al., 2003



- **Problems to meet NEC and Gothenburg Protocol obligations in several countries**
- **The EU insists that if reductions cannot be achieved in transport sector, other sources have to be reduced further**

Sensitivity Analysis
for UK and Swiss Emission Estimates

95 percent confidence intervals in national emissions if only uncertainties of a particular parameter are considered.

United Kingdom

	SO_2		NO_x	
	1990	2010	1990	2010
Activity data	±8 %	±14 %	±5 %	±8 %
Emission factors	±7 %	±6 %	±9 %	±7 %
Removal efficiency	±0 %	±3 %	±0 %	±3 %
All factors considered	±11 %	±15 %	±10 %	±11 %

Switzerland

	SO_2		NO_x	
	1990	2010	1990	2010
Activity data	±7 %	±11 %	±6 %	±9 %
Emission factors	±6 %	±5 %	±11 %	±8 %
Removal efficiency	±3 %	±2 %	±4 %	±5 %
All factors considered	±9 %	±13 %	±13 %	±13 %

Discussion

Where input from the emission inventory community is needed the most

- **Assessment of the uncertainty in input parameters;**
- **Assessment of probability of failure to comply with emission standards;**
- **Verification of country-specific parameters in models, e.g. how representative are model technologies;**
- **How well the assumptions adopted in a model represent legislation?**

What will be the future questions asked to IAM and does it imply need for new type/quality of data?

For example:

- **Health related studies… spatial resolution;**
- **Regional and global pollutants…coordination of efforts to ensure comparability, transparency, etc**
- **…**

Recent developments

- **Stronger focus on effects of aerosols, in particular health effects, over the last years**
- **Health impacts from particulate matter at a center of the strategy developed within the European Clean Air for Europe programme (CAFE);**
- **During the revision of the National Emission Ceiling (NEC) Directive the Commission is carefully looking into how a ceiling would be established for PM2.5 emissions in 2015**
- **Currently main focus is on particle mass by size (PM_{10}, $PM_{2,5}$); Data on chemical speciation (e.g. BC and OC) is considered as useful information, but have been of second priority so far; *used for modeling purposes only***

Further steps to improve PM inventories

- **To a large extent PM inventories can be produced using the same methodologies as other pollutants, but**
  - There are additional sources
  - To achieve acceptable accuracy, more information is needed about combustion technologies; *Data on chemical speciation are often not available from the same studies as the size speciation and emission factors*
- **Need for more measurements**
- **Working to improve methodology guidance over the next years**
  - New resources may become available; *driven by the current policy debate*
  - *EC research initiative* to know more about the chemical speciation may take place in the years to come