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Effects of air pollution mitigation strategies on short term climate forcing

Working progress

Workshop on:
Synergies and Trade-offs between Climate and Air Pollution Policies:
Optimizing Opportunities and Preventing Risks

Utrecht, June 18, 2010

Outline

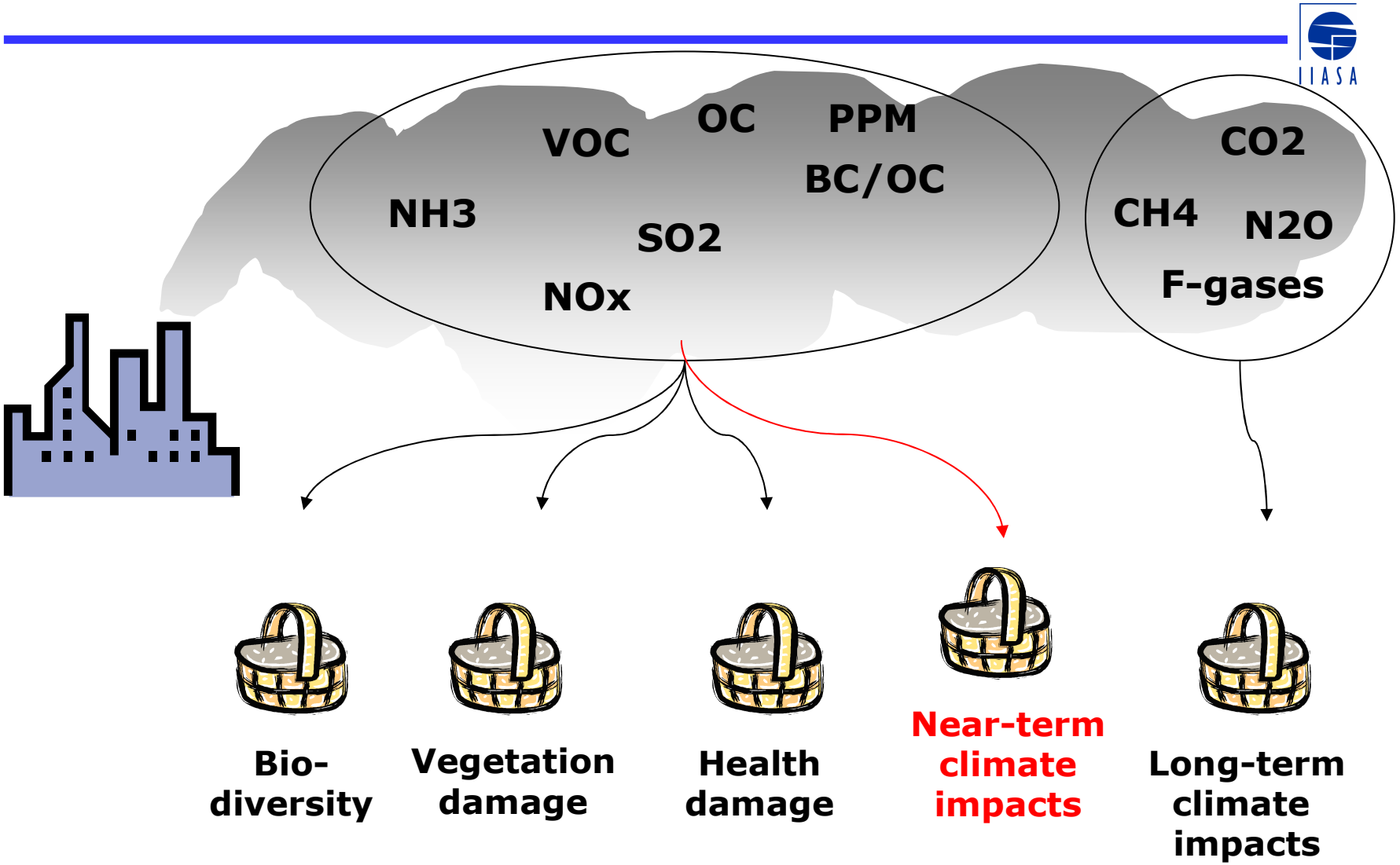
- Black carbon and other SLCF in a multi-pollutant/multi-effect emission control framework

- Two examples of ongoing analysis
  - From Baseline towards RF mitigation
  - From Baseline towards AQ mitigation

- Presented intermediate results draw on the ongoing work under UNEP BC Assessment, UNECE CLRTAP Gothenburg Protocol Revision (Ad-Hoc Black Carbon Expert Group), and Arctic Council TF on SLCF

Work on further development of GAINS supported by Dutch government

A two-baskets approach for climate impacts



Potential approaches for GAINS optimization
for the CLRTAP Gothenburg protocol

Starting from an energy scenario that achieves given (long-term) climate objectives (expressed through GWP):

<u>Option 1:</u>

- Optimize for targets on
  - health and ecosystems (as before),
  - near-term forcing and carbon deposition to the Arctic.

<u>Option 2:</u>

- Optimize for targets on
  - health and ecosystems (as before),
  - with maximum co-benefits on short-term forcing.

Important features

Such an approach would

- as a side effect, increase robustness of health impact strategies (preferential treatment of BC vs other PM2.5 components),

- consider co-controls
  - between short-lived forcers,
  - between short- and long-lived substances.

Approach

Example (GAINS) – *From Baseline scenario towards RF mitigation*

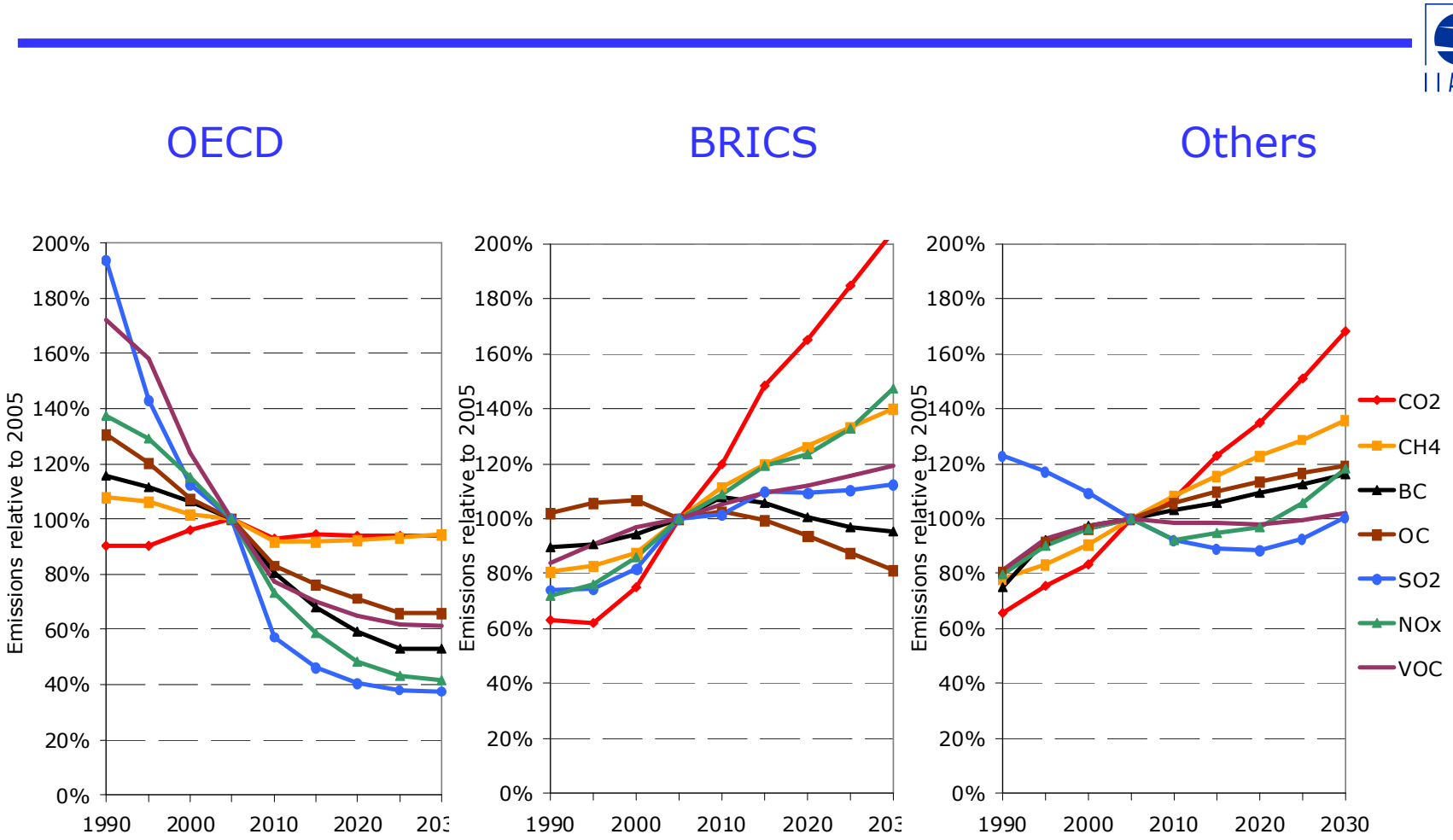
1. Develop emission projections for all substances
2. Determine future RF by sector and gas
3. Rank measures by net RF of their BC/OC reduction
4. Choose a set of efficient measures and estimate their mitigation potential

Data sources

- Activity projections of IEA World Energy Outlook 2009, Reference case, 450 ppm GHG stabilization scenario, PRIMES 2010 for EU-27
- GAINS emission factors and mitigation measures
- Literature data on GWP20 and GWP100
- Analysis performed for 150 world regions, here presented mostly for
  - Global regions (OECD/BRICS/Other countries)
- **Work in progress!**

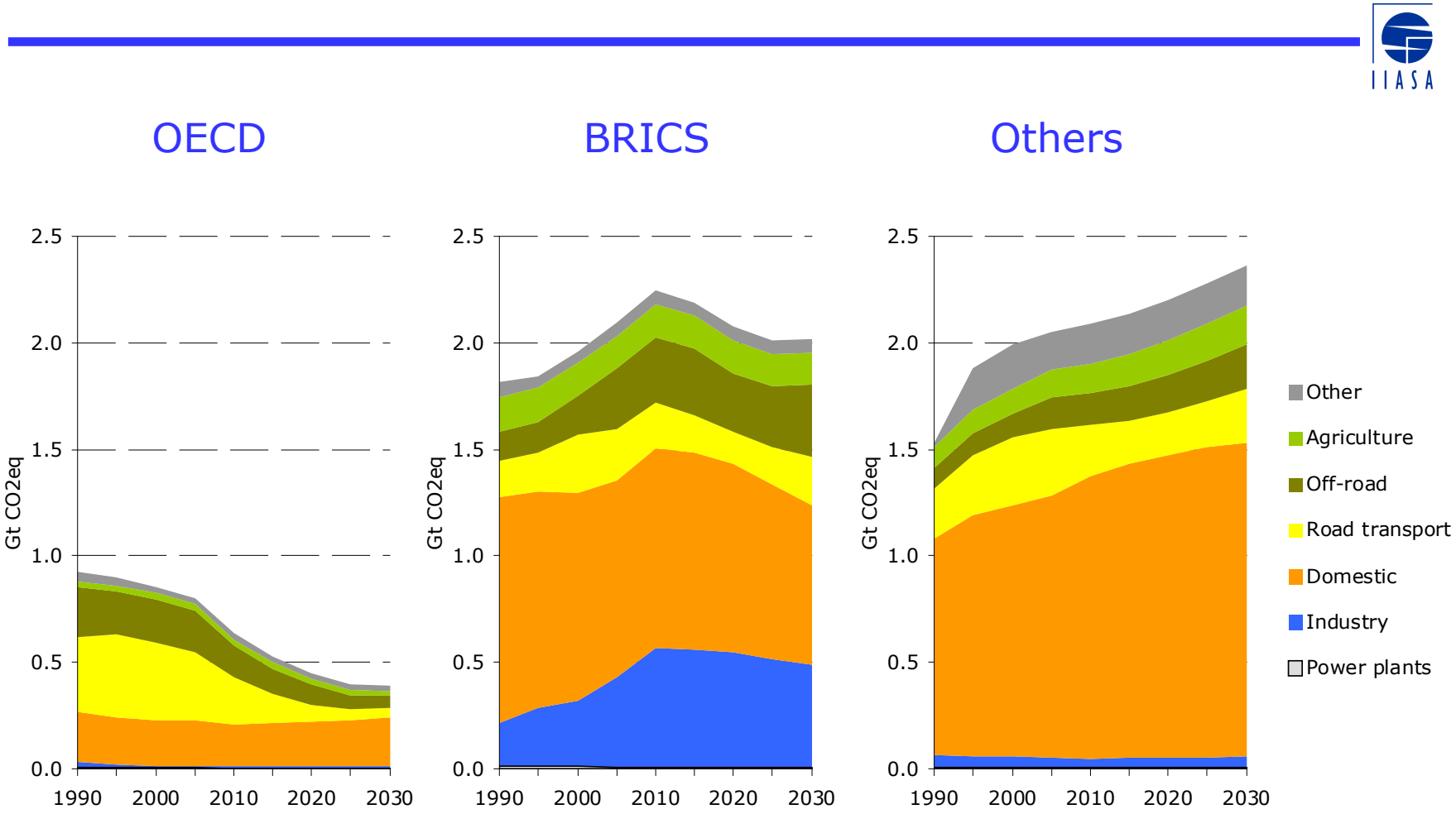
Emission trends 1990-2030

GAINS calculation for IEA World Energy Outlook 2009



Work in progress!

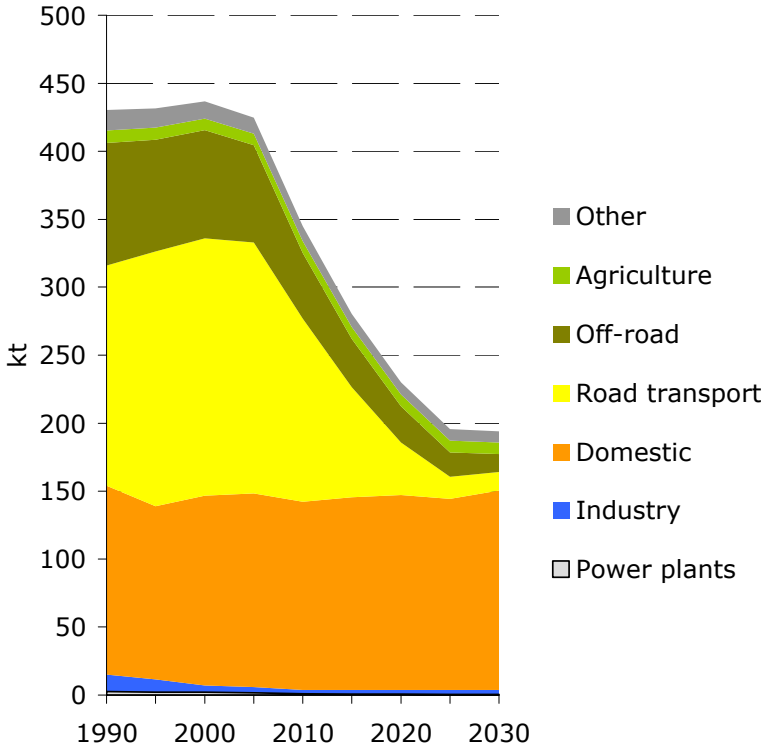
BC inventories 1990-2010 and trends to 2030
GAINS calculation for IEA World Energy Outlook 2009



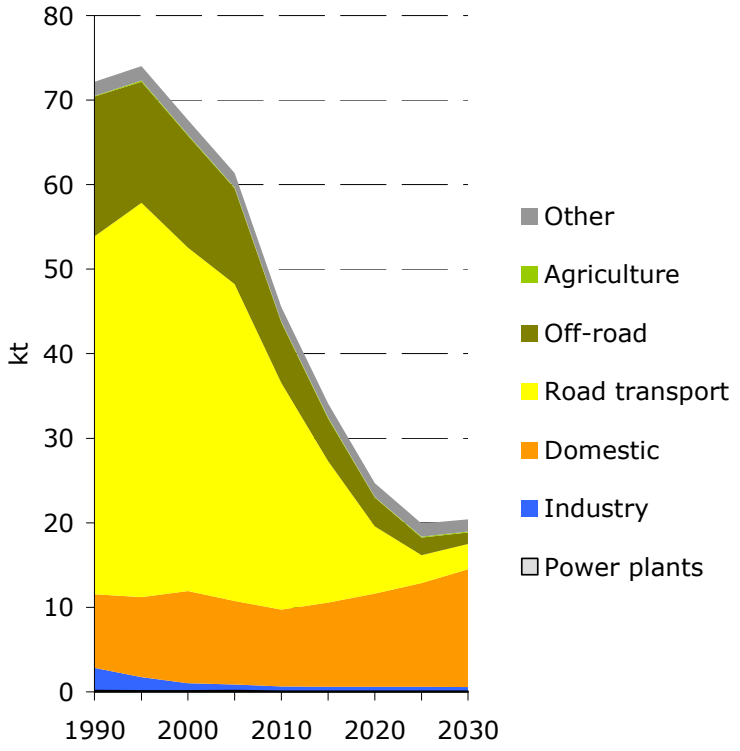
Work in progress!

BC inventories 1990-2010 and trends to 2030
GAINS calculation for IEA World Energy Outlook 2009

EU27



BeNeLux-Germany



Work in progress!

Approach

Example (GAINS) – *From Baseline scenario towards RF mitigation*

Steps:

1. Develop emission projections for all substances
2. Determine future RF by sector and gas/aerosol
3. Rank measures by net RF of their BC/OC reduction
4. Choose a set of efficient measures and estimate their mitigation potential

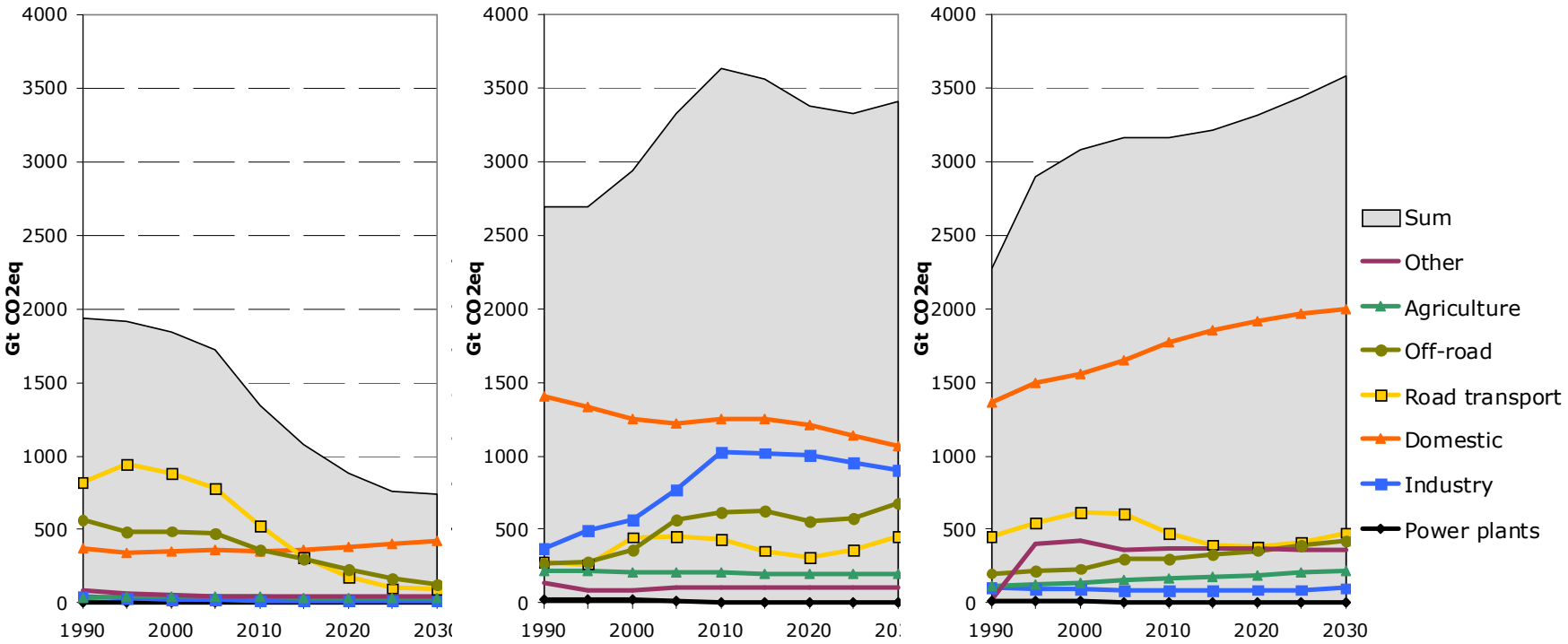
GWPs used for screening of mitigation measures

	20 yrs	100 yrs	Source
CO2	1	1	IPCC, AR4
CH4	72	25	IPCC, AR4
N2O	289	298	IPCC, AR4
SO2	-140	-40	Fuglestvedt et al., 2009
BC	2200 (690-4700)	680 (210-1500)	Bond and Sun, 2006
OC	-240	-69	Schulz et al., 2006
VOC	12	3.4	IPCC, AR4
CO	4.5	1.9	IPCC, AR4

GWP20 from BC+OC by sector

IEA WEO 2009- Reference

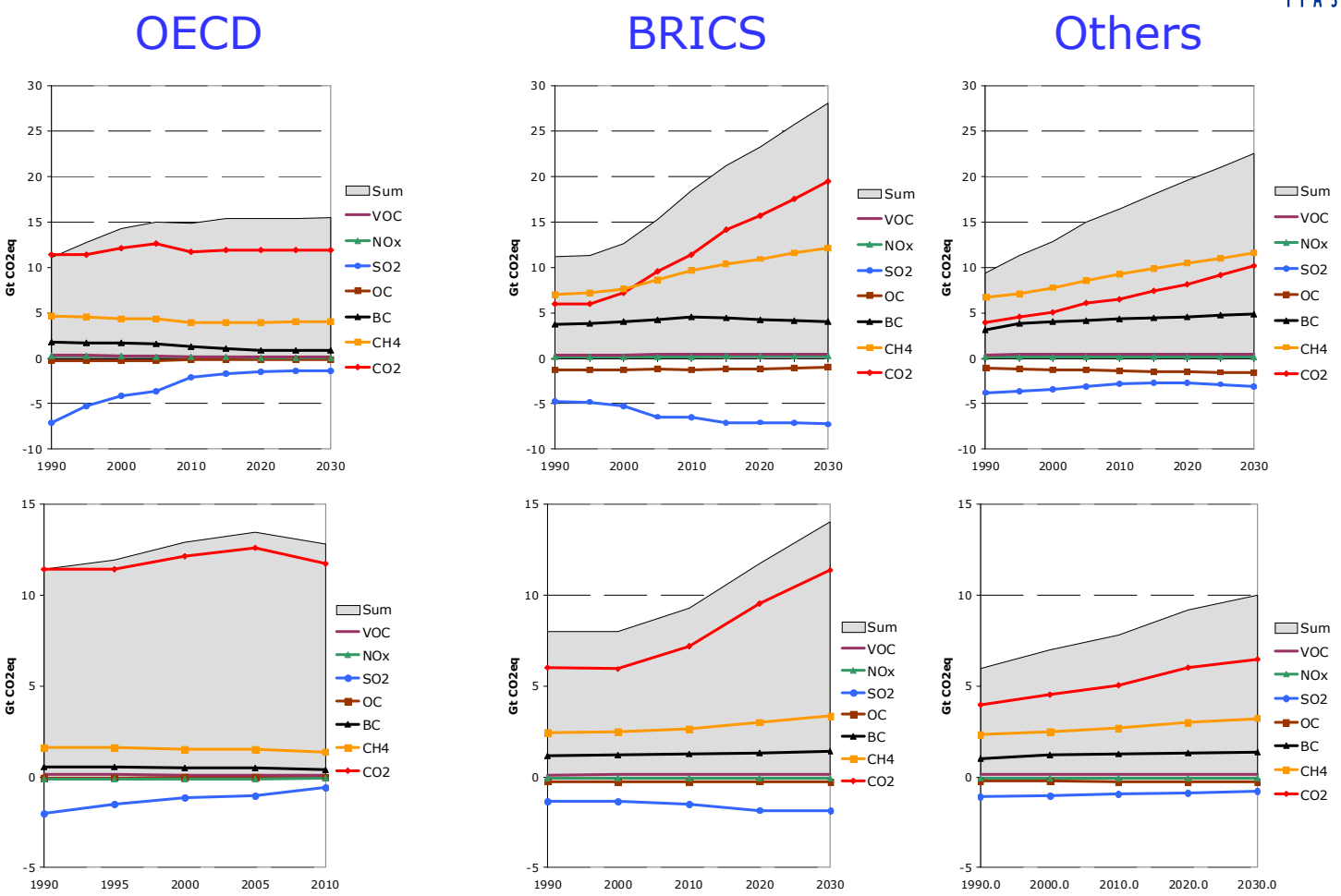
OECD BRICS Others



Work in progress!

CO_2eq emissions by species

1990-2030, IEA WEO2009-Reference



Work in progress!

CO_2eq emissions by species
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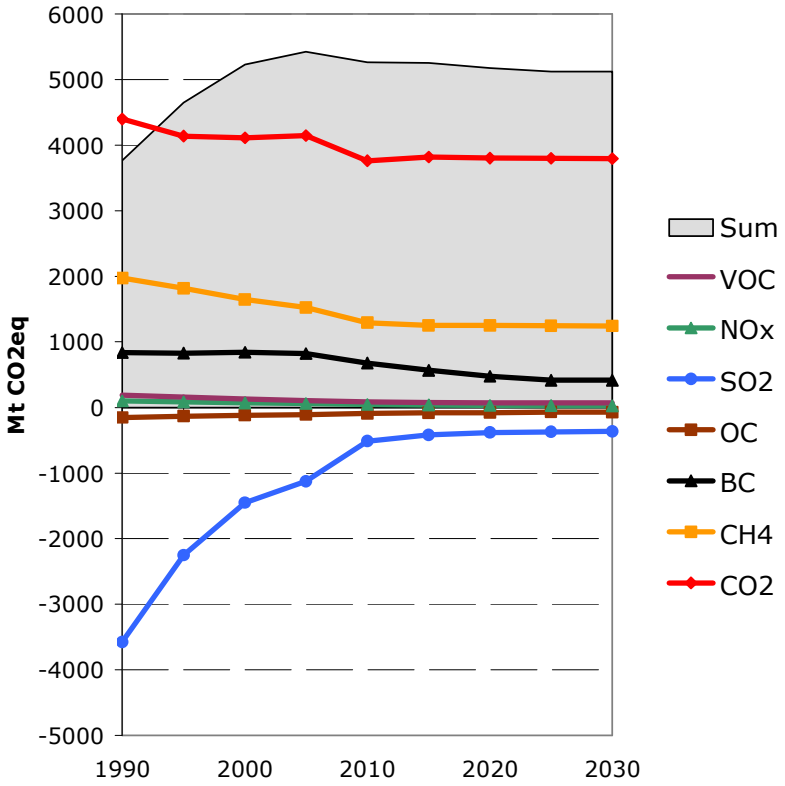
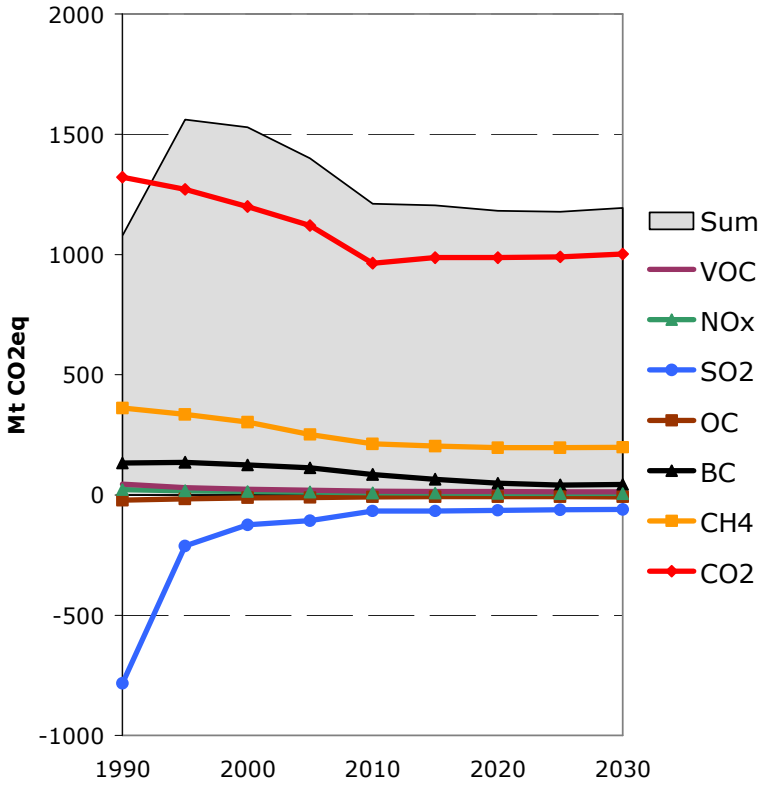
EU-27



BeNeLux-Germany



Work in progress!

Approach

Example (GAINS) – *From Baseline scenario towards RF mitigation*

Steps:

1. Develop emission projections for all substances
2. Determine future RF by sector and gas
3. Rank measures by net RF of their BC/OC reduction
4. Choose a set of efficient measures and estimate their mitigation potential

Emission control measures considered

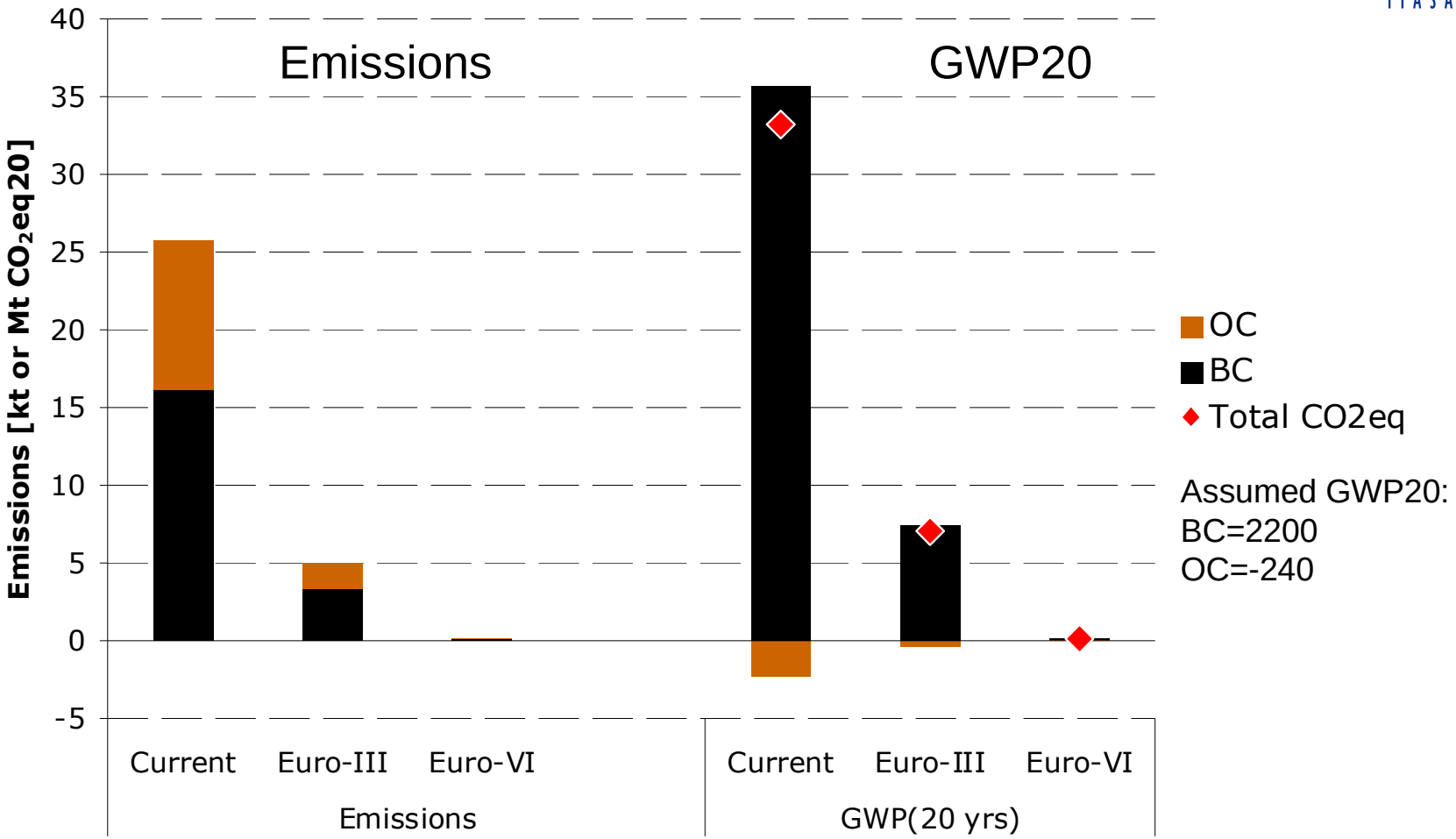
(Measures in italic are only assumed for OECD countries)

Approx. 2300 control measures considered for each country/region, incl.:

- Households:
  - Improved biomass and coal stoves, *switch to pellets, etc.*
  - Replacement of biomass cooking stoves
- Industry and power generation:
  - Cyclones, ESP, fabric filters, etc.
  - Non-recovery coke ovens with end-of-pipe
  - Brick kilns: VSBK technology, *tunnel kilns*
- Road transport:
  - Particle traps (DPF) for heavy and light duty vehicles
  - Elimination of super-emitters
- Off-road:
  - Particle traps (DPF)
  - Elimination of super-emitters
- Open burning:
  - Ban of open burning of agricultural residues
  - Ban of open burning of garbage

Net GWP20 of BC mitigation

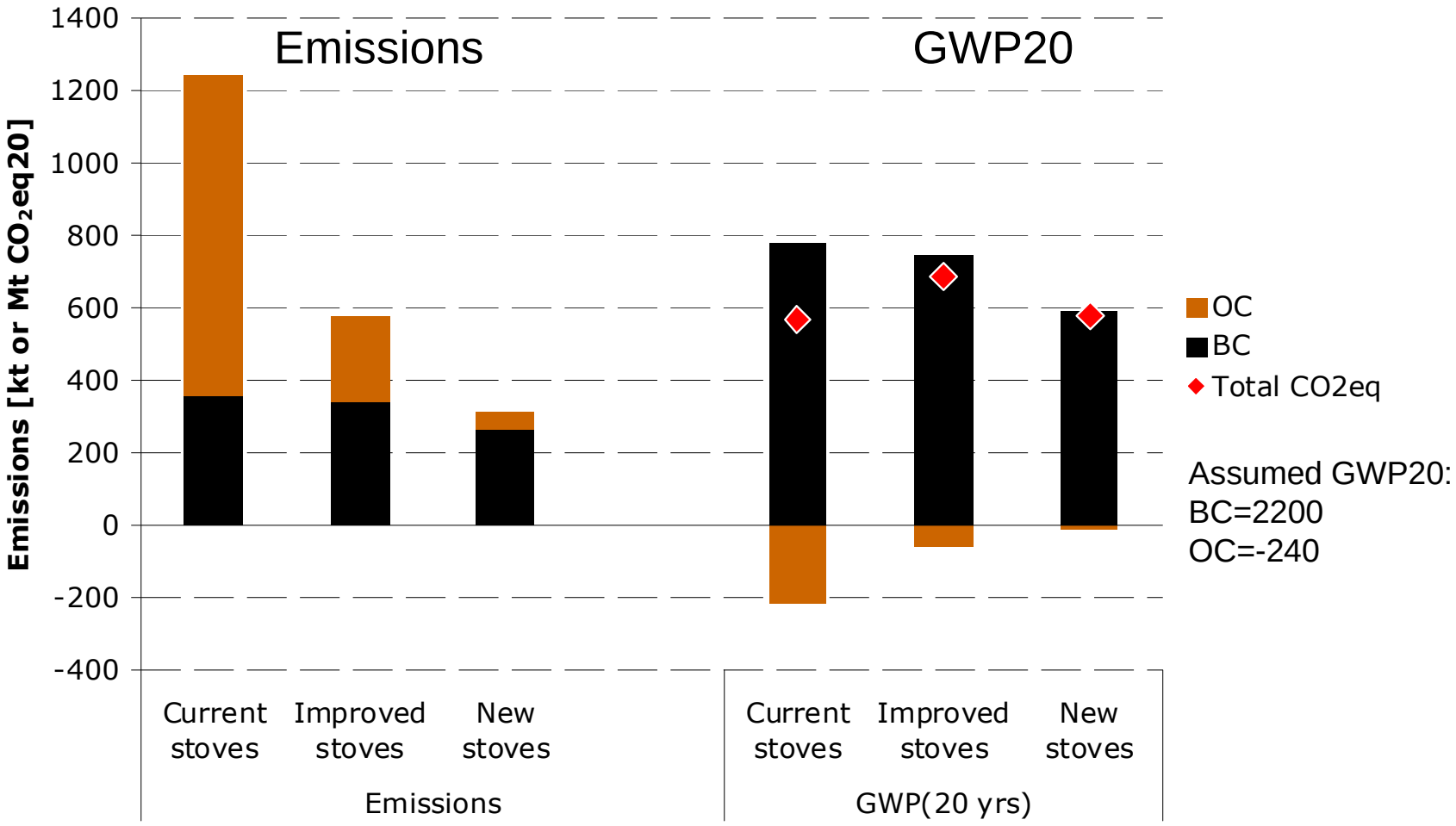
Diesel heavy duty vehicles *(Example for India 2030)*



Work in progress!

Net GWP20 of BC mitigation

Biomass (ag. residue, dung, wood) *(Example - cooking stoves in India 2030)*



Work in progress!

Approach

Example (GAINS) – *From Baseline scenario towards RF mitigation*

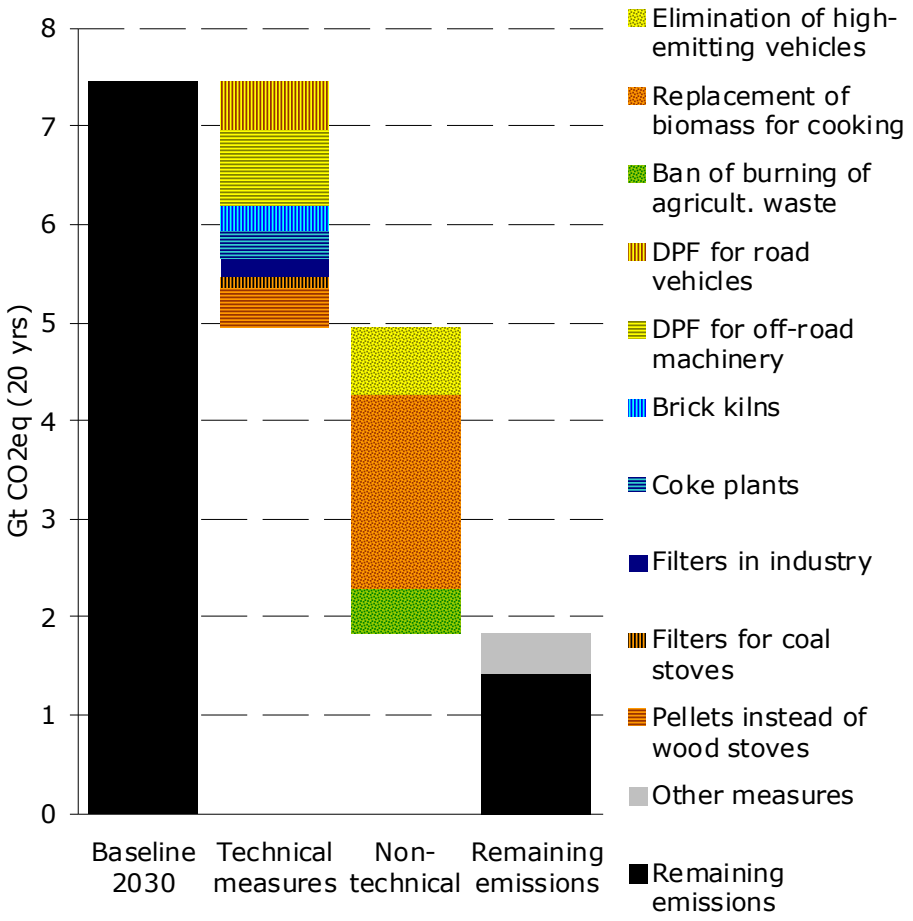
Steps:

1. Develop emission projections for all substances
2. Determine future RF by sector and gas
3. Rank measures by net RF of their BC/OC reduction
4. Choose a set of efficient measures and estimate their mitigation potential

Global mitigation potential for BC+OC in 2030

Net impact on GWP20

for IEA WEO2009-Reference



Assumptions:

- Applicability of technical measures considered, e.g.:
  - No pellets for households in developing countries
  - Limited penetration of tunnel kilns in India
- Full turn-over of capital stock by 2030
- Feasibility of non-technical measures to be determined

Impacts in 2030:

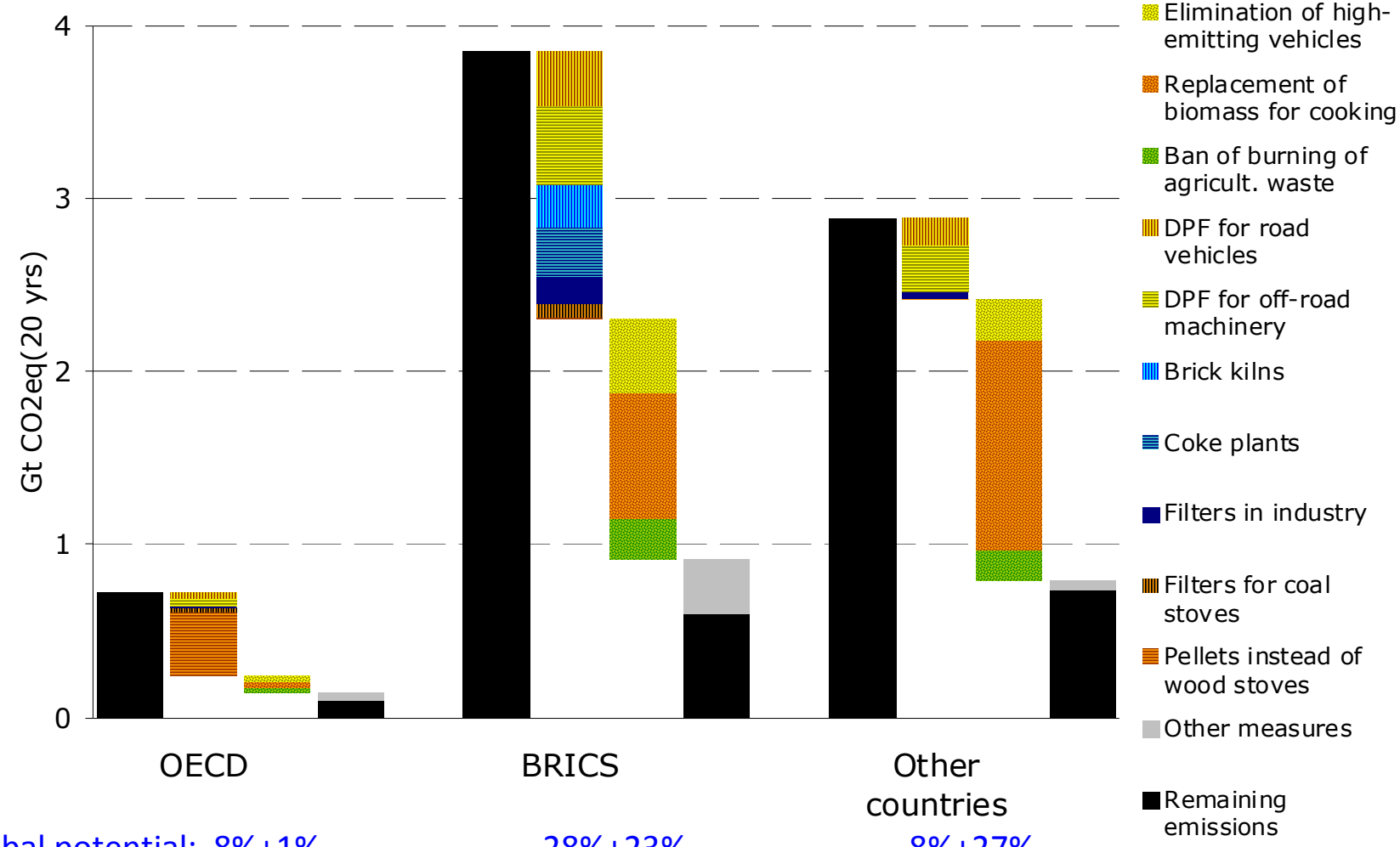
- -35% from technical measures
- -40% from non-technical measures

Work in progress!

Regional mitigation potential for BC+OC in 2030

Net impact on GWP20

for IEA WEO2009- Reference

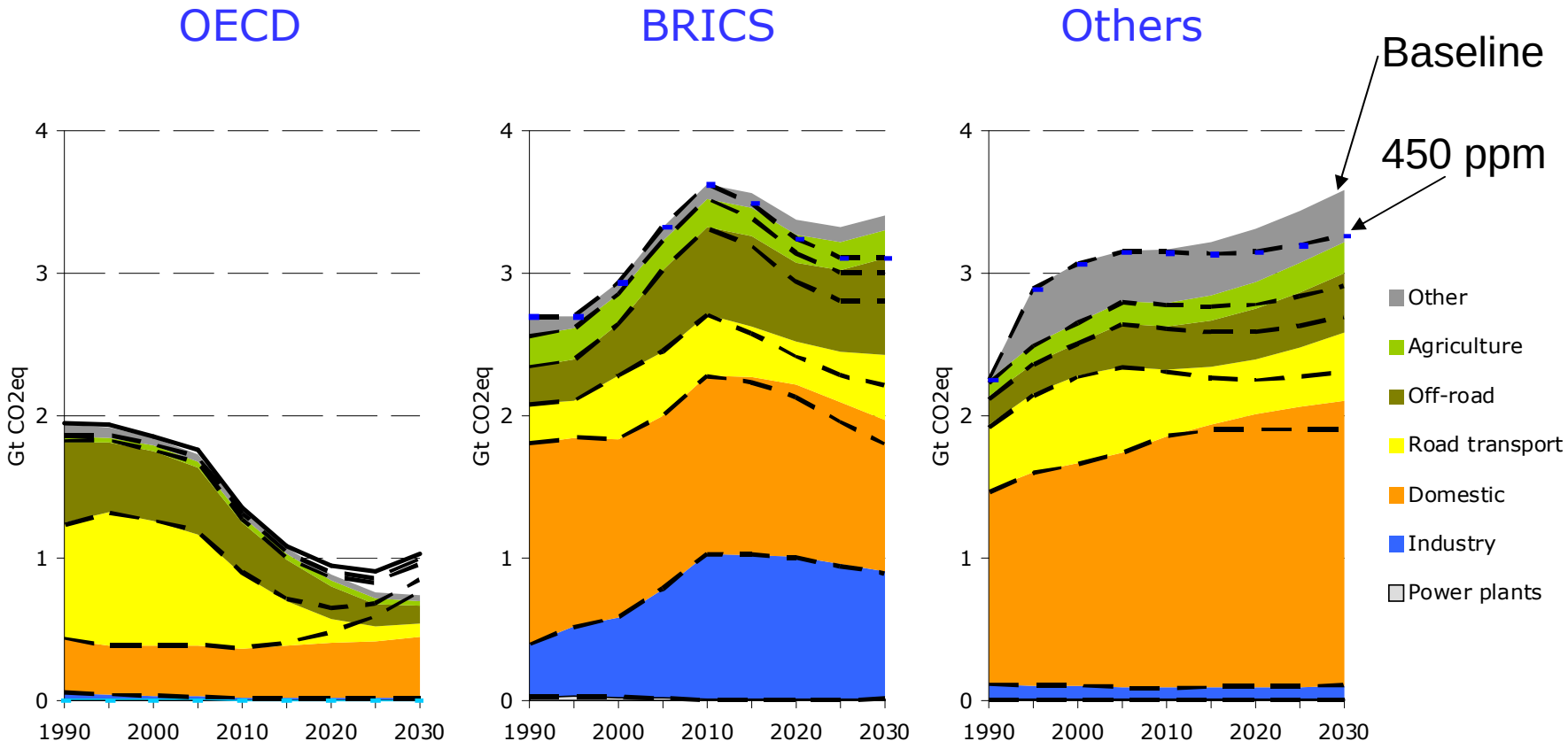


Of global potential: 8%+1% 28%+23% 8%+27%

Work in progress!

BC/OC 'mitigation' from a low-carbon scenario

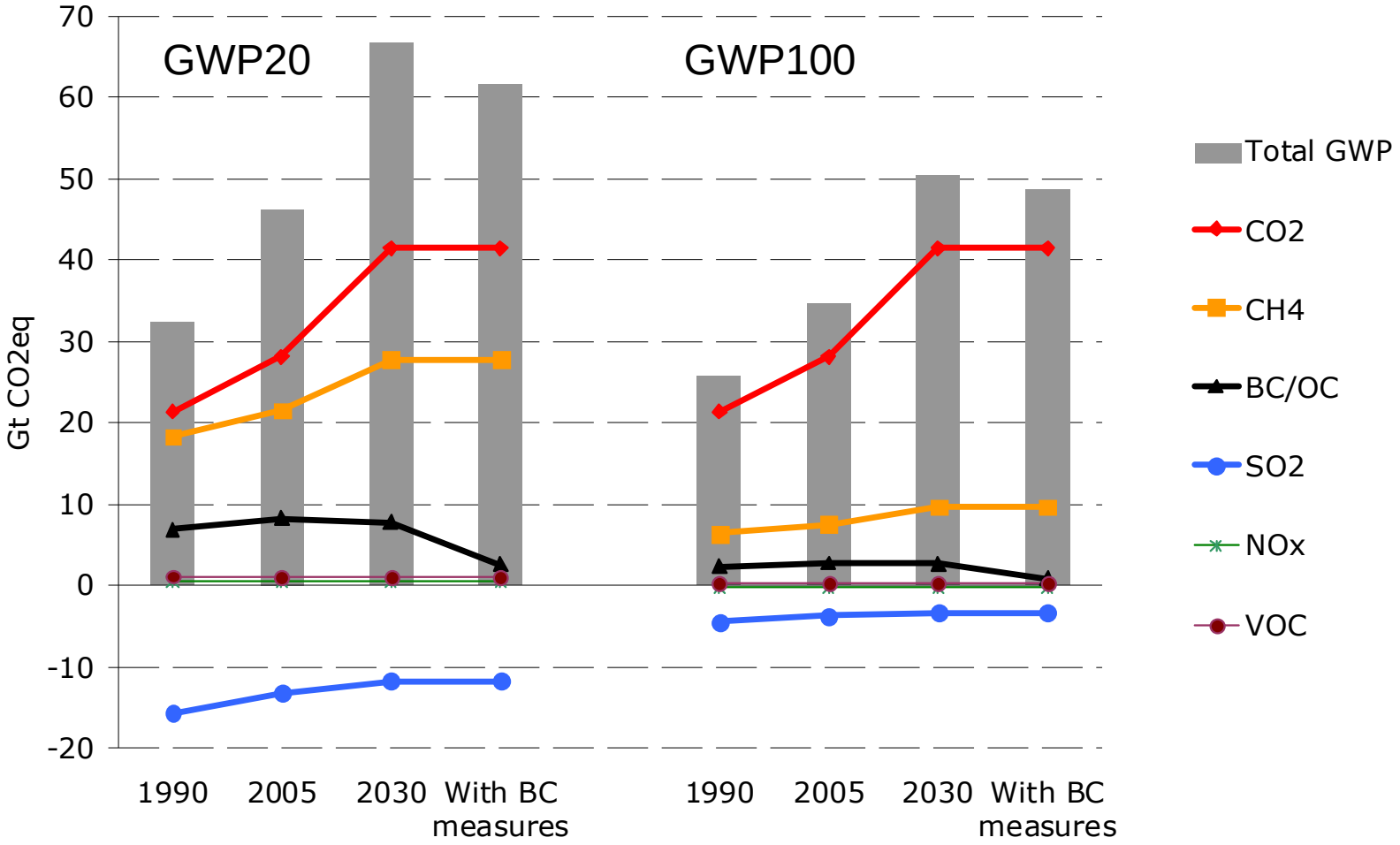
GWP20 IEA WEO2009 REF vs 450 ppm scenario



Work in progress!

Impacts of BC/OC measures on total GWP

Global emissions, IEA baseline



Work in progress!

Approach

Example (GAINS-Europe) – *From Baseline scenario towards AQ mitigation*

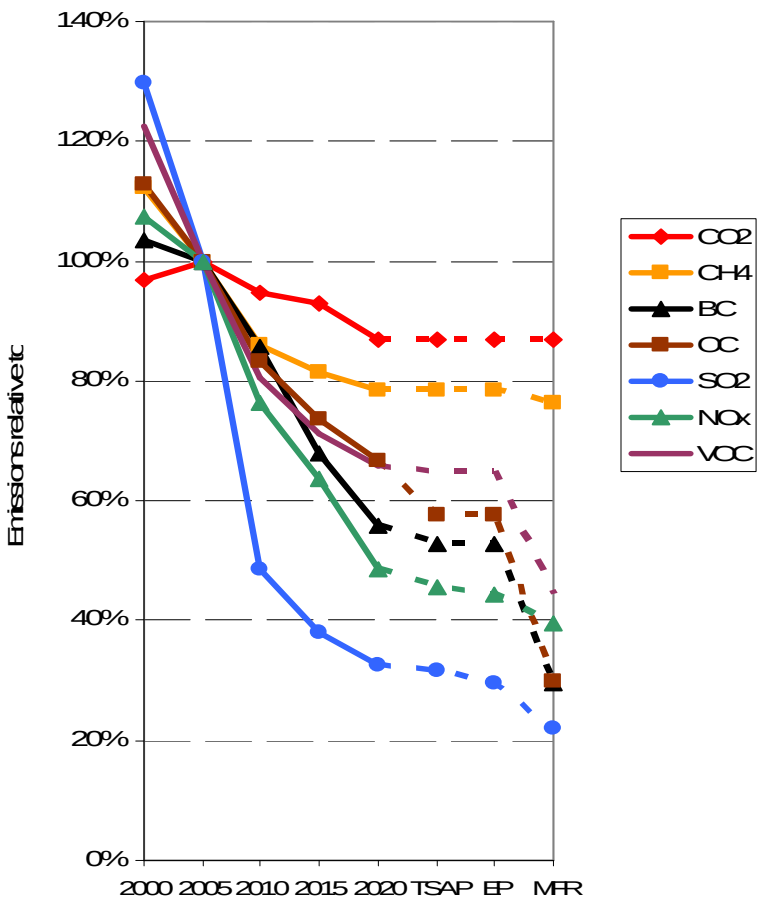
Steps:

NEC Directive

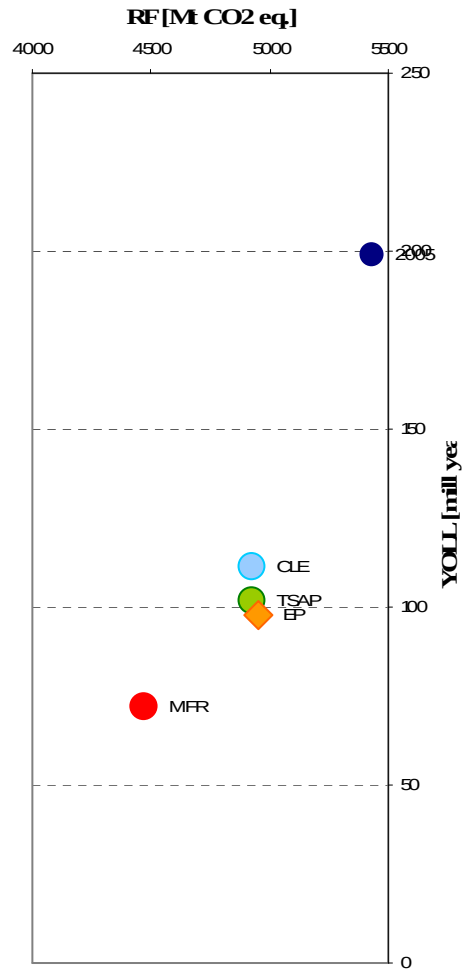
1. Develop emission projections for all substances
2. Optimize reductions of pollutants contributing to the primary and secondary PM to achieve specified AQ target at least cost
3. A set of efficient AQ measures is derived

4. Determine total RF for the achieved AQ target

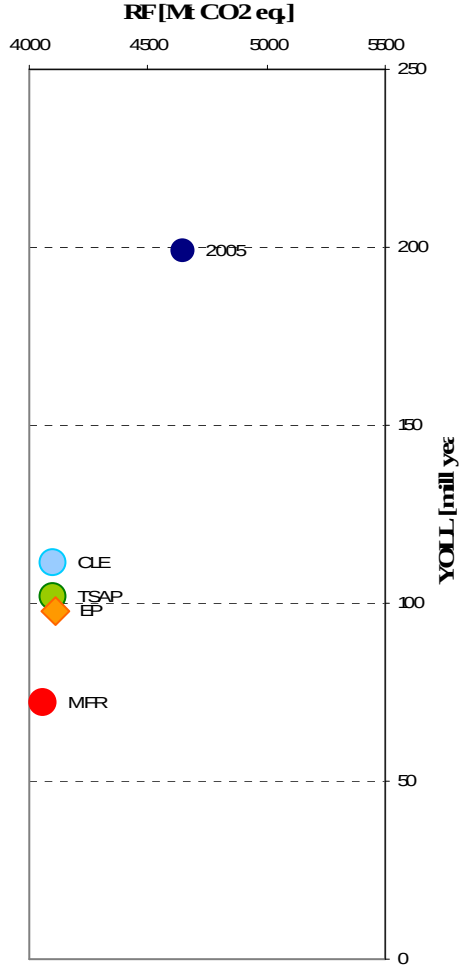
Impact of CLE, AQ, and MFR policies on RF (GWP20)
Example for EU-27



Emission change

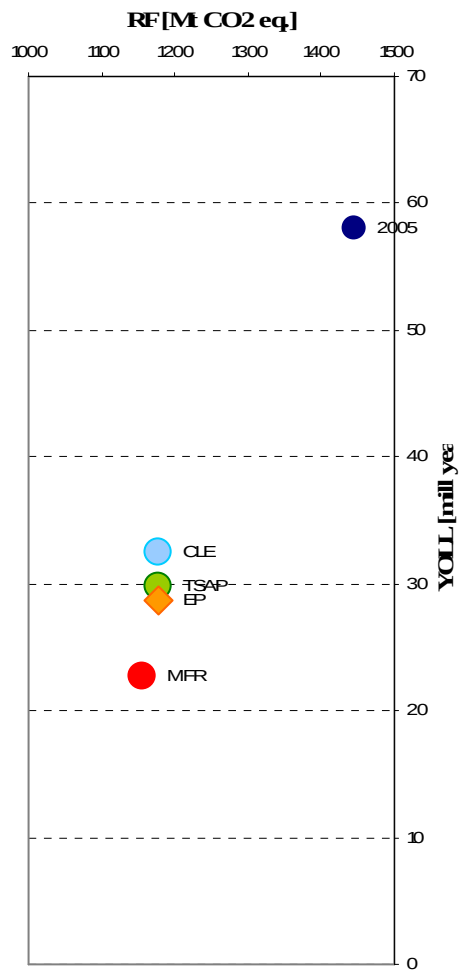


GWP20

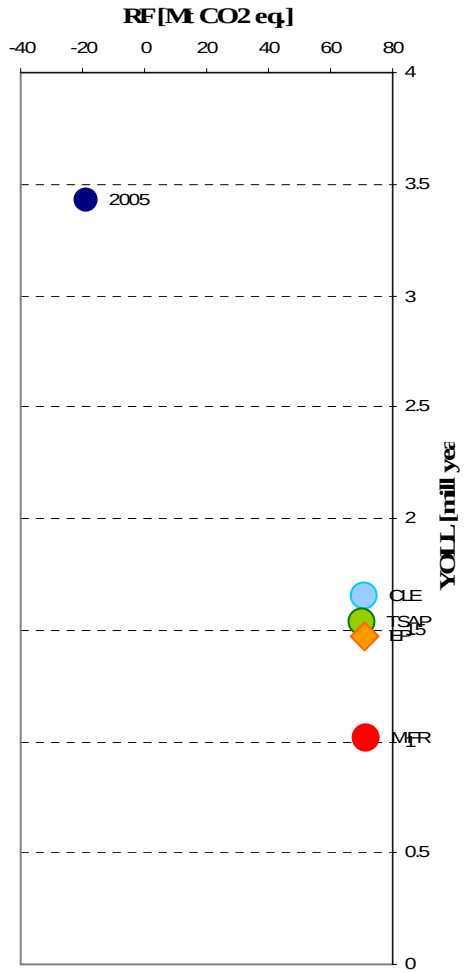


GWP100

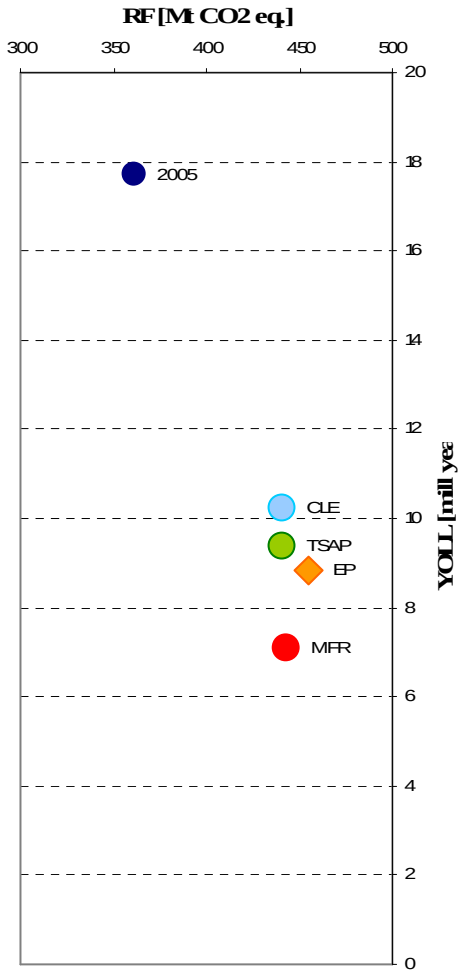
Impact of CLE, AQ, and MFR policies on RF (GWP20)
Examples for Europe



BeNeLux-Germany



Bulgaria



Poland

Some key uncertainties

- Reduction efficiency for BC/OC of improved/new biomass cooking stoves in developing countries
- BC/OC emission factors for brick kilns, coke ovens, flaring are virtually unknown; lab and field efs for stoves widely different
- Some activity data (e.g., use of non-commercial fuels in domestic combustion, open burning of biomass and waste)
- Quantification of super-emitting vehicles (present and future)
- Quantification of radiative forcing of aerosols
- Feasibility of non-technical measures

Open questions and next steps

- Consideration of regional forcing?
- Considering various metrics…
  - GWP..20, 100 years?
  - GTP?
  - Instantaneous forcing?
- Could these BC/OC-emission changes significantly influence near-term climate change?
- Inclusion of methane measures
- Full consideration of co-emitted species for abatement measures including, beyond BC/OC, also CO, NMVOC, CO2, CH4, SO2, NOx
- Quantification of source-impacts relationships (between national emissions and regional forcing)
- Extension of GAINS optimization routine

Conclusions

- Globally, implementation of 10 key measures could lead to a 75% reduction in short-term forcing of BC/OC in 2030.
- However, some of these improvements in RF will be compensated by associated reductions in SO_2 emissions (DPF, brick kilns, etc).
- 50% of this potential emerges in BRICS countries, 33% in other developing countries.
- 30% of the potential depends on reduction efficiency of improved biomass cook stoves for BC. Phase-out of biomass as alternative?
- 45% of the mitigation potential could be achieved through technical measures, 55% require non-technical interventions.
- A health-targeted strategy would not necessarily reduce near-term forcing, but all BC measures also reduce health impacts (although not as efficiently).