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# Win-Win and Win-No-Lose Control Measures for Black Carbon and Ozone

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# 'Win-win' air quality measures with co-benefits on climate change

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Radiative forcing from short-lived air pollutants:

- Warming: BC, CO, O<sub>3</sub> precursors (CH<sub>4</sub>, CO)
- Cooling: SO<sub>2</sub>, OC
- Only little net effects: NO<sub>x</sub>, VOC

These substances are often co-emitted,  
and control measures affect several substances at the same time.

**Which air quality measures would also reduce radiative forcing?**

# Approach for UNEP/WMO BC Assessment

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1. Compile literature values on radiative forcing/GWP for each substance
2. For each of 2000 air pollution control measures in GAINS, estimate their impacts on  $\text{CH}_4/\text{BC}/\text{OC}/\text{CO}/\text{SO}_2/\text{VOC}/\text{NO}_x$  emissions and their net effect on radiative forcing
3. Determine their mitigation potential for the baseline emission projection
4. Select the 'top 15+ measures' that reduce most SLCF forcing globally
5. Estimate their temperature impact with GCMs

# Radiative forcing of GHGs and air pollutants

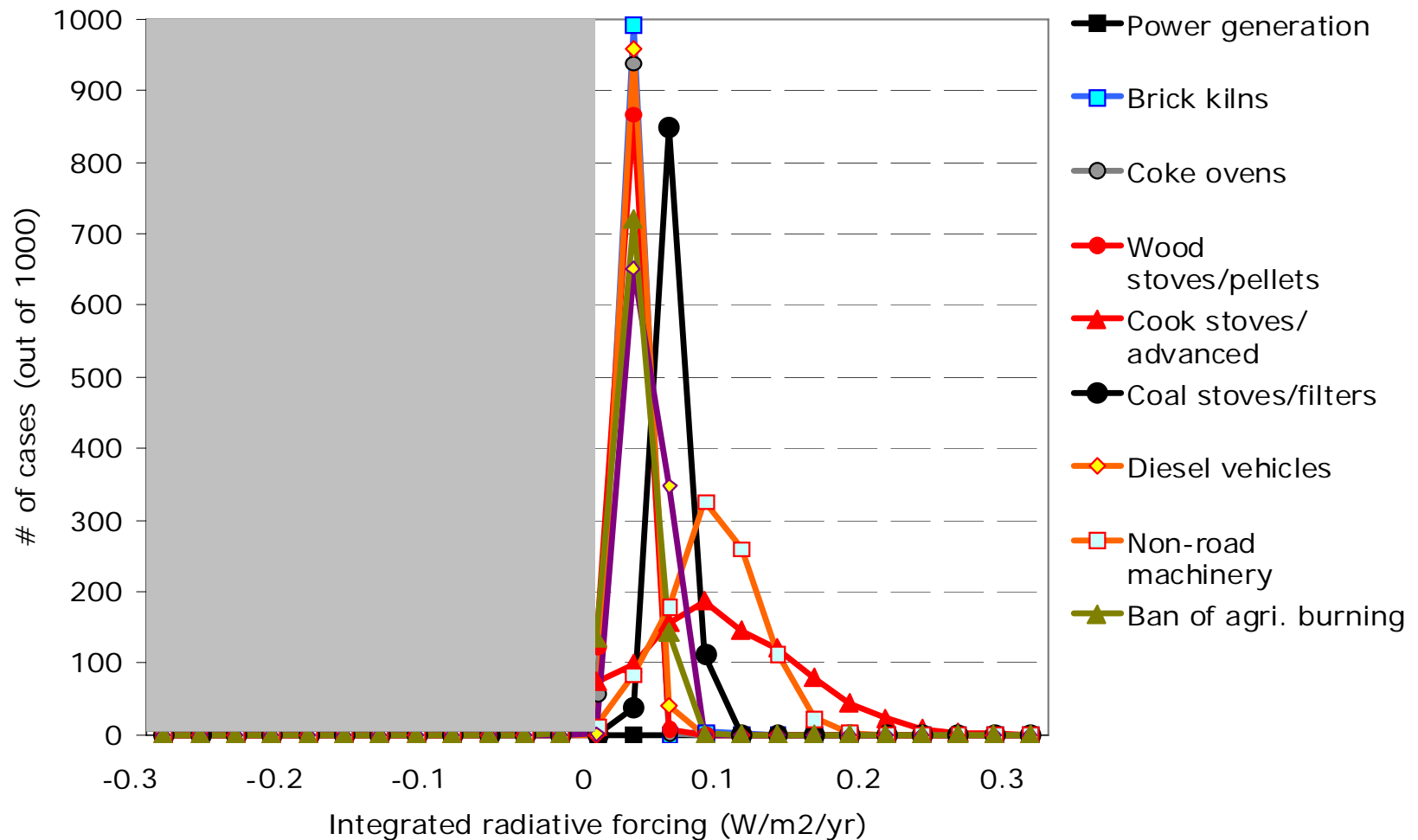
## Literature ranges of GWP100



	<i>Mean value</i>		<i>Range</i>	<i>Reference</i>
CO <sub>2</sub>	1	IPCC, AR4		
CH <sub>4</sub>	25	IPCC, AR4	16 - 34	IPCC AR4
CO	1.9	IPCC, AR4	1 - 3	Range from AR3, cited in AR4
VOC	3.4	IPCC, AR4	2 - 7	IPCC AR4, ref. to Collins et al. 2002
BC	680	Bond & Sun, 2006	210 - 1500	Bond & Sun, 2006
SO <sub>2</sub>	-40	Fuglestvedt et al., 2009	-24 - -56	Schulz et al. 2006, (±40%)
OC	-69	Schulz et al., 2007	-25 - -129	Bond et al. (2011)
NO <sub>x</sub>	~0			

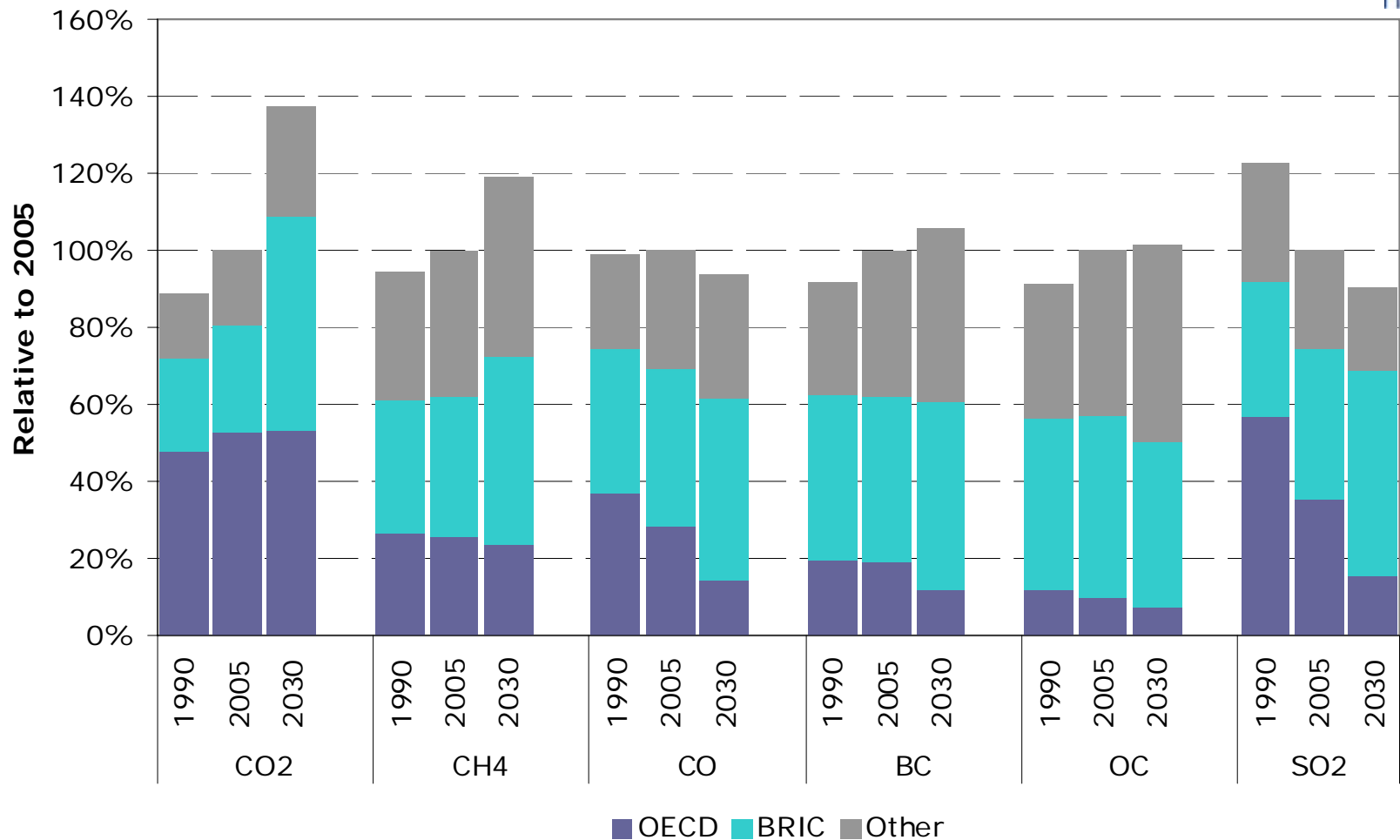
# Net impacts of BC measures on integrated radiative forcing

Monte-Carlo analysis for literature ranges of GWP



# Baseline emission projections

IEA World Energy Outlook 2009



# Three groups of promising measures



## **CH<sub>4</sub> measures**

1. Recovery of coal mine gas
2. Production of crude oil and natural gas
3. Gas leakages at pipelines and distribution nets
4. Waste recycling
5. Wastewater treatment
6. Farm-scale anaerobic digestion
7. Aeration of rice paddies

## **Technical BC measures**

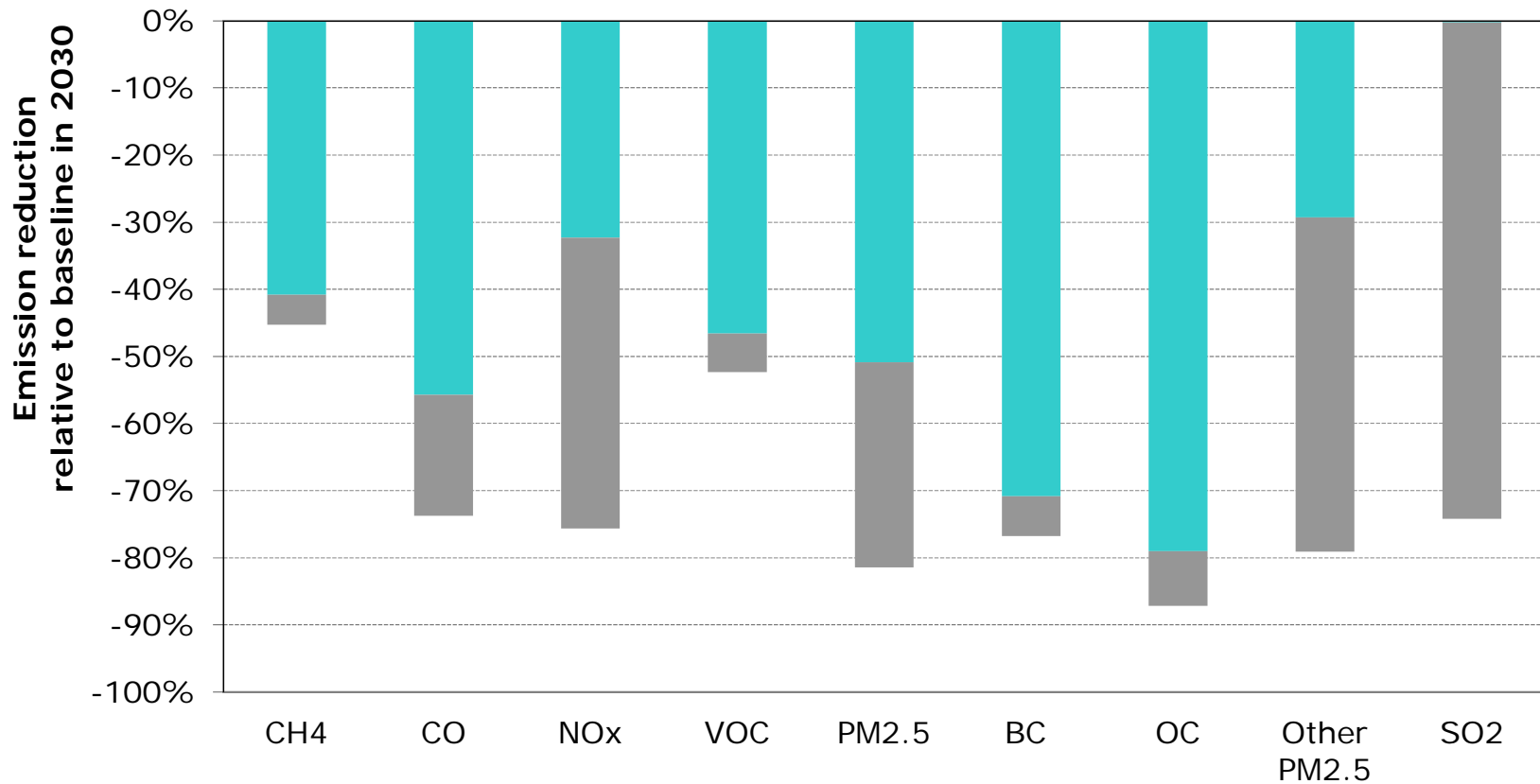
1. Modern coke ovens
2. Modern brick kilns
3. Diesel particle filters
4. Briquettes instead of coal for heating
5. Improved biomass cook stoves
6. Pellets stoves and boilers (in industrialized countries)

## **Non-technical measures**

1. Ban of high-emitting vehicles
2. Ban of open burning of agricultural waste
3. Elimination of biomass cook stoves

# Mitigation potentials in 2030

## World, relative to baseline projection



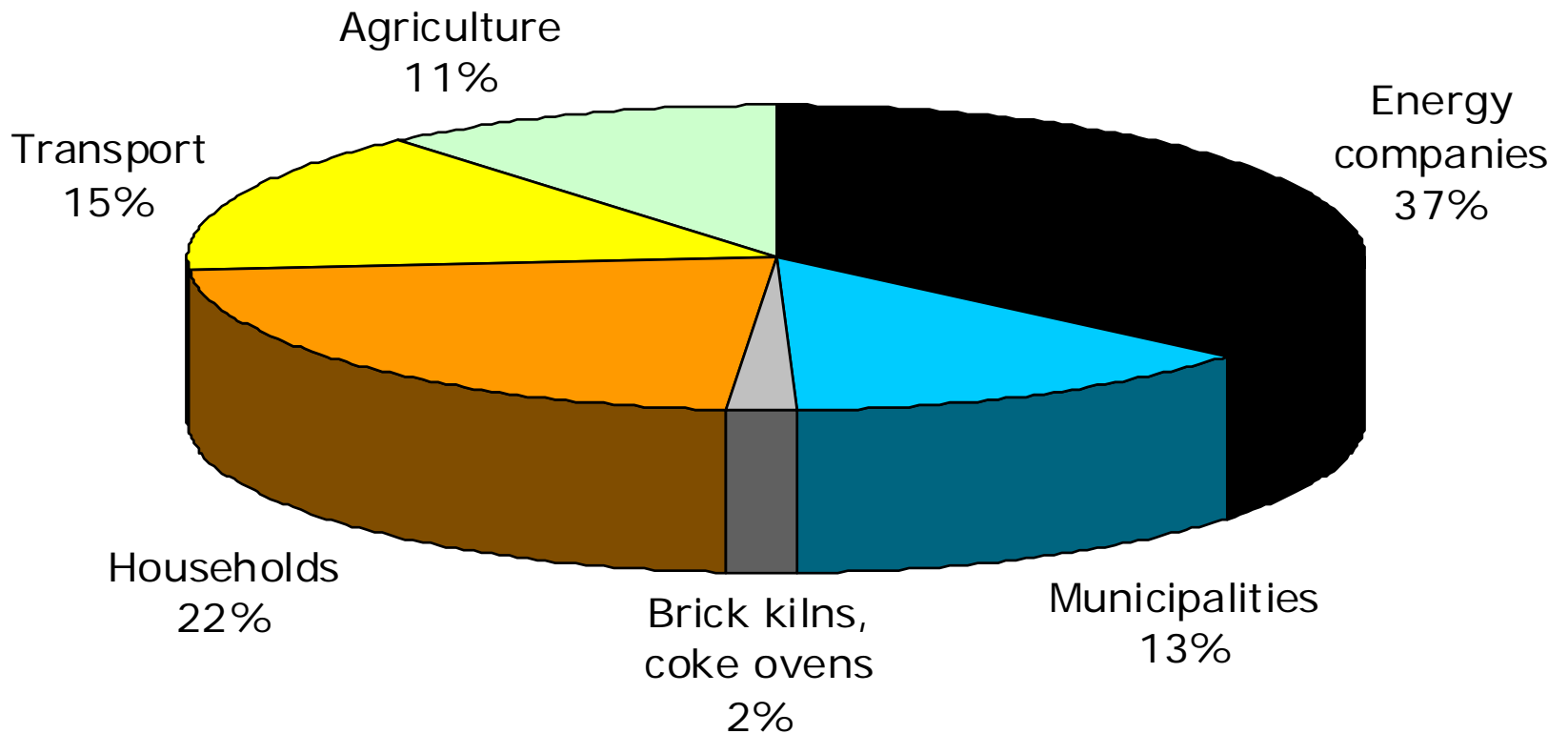
Source: IIASA GAINS  
<http://gains.iiasa.ac.at>

Emission reductions from

■ the chosen 16 measures    ■ all other 2000 measures

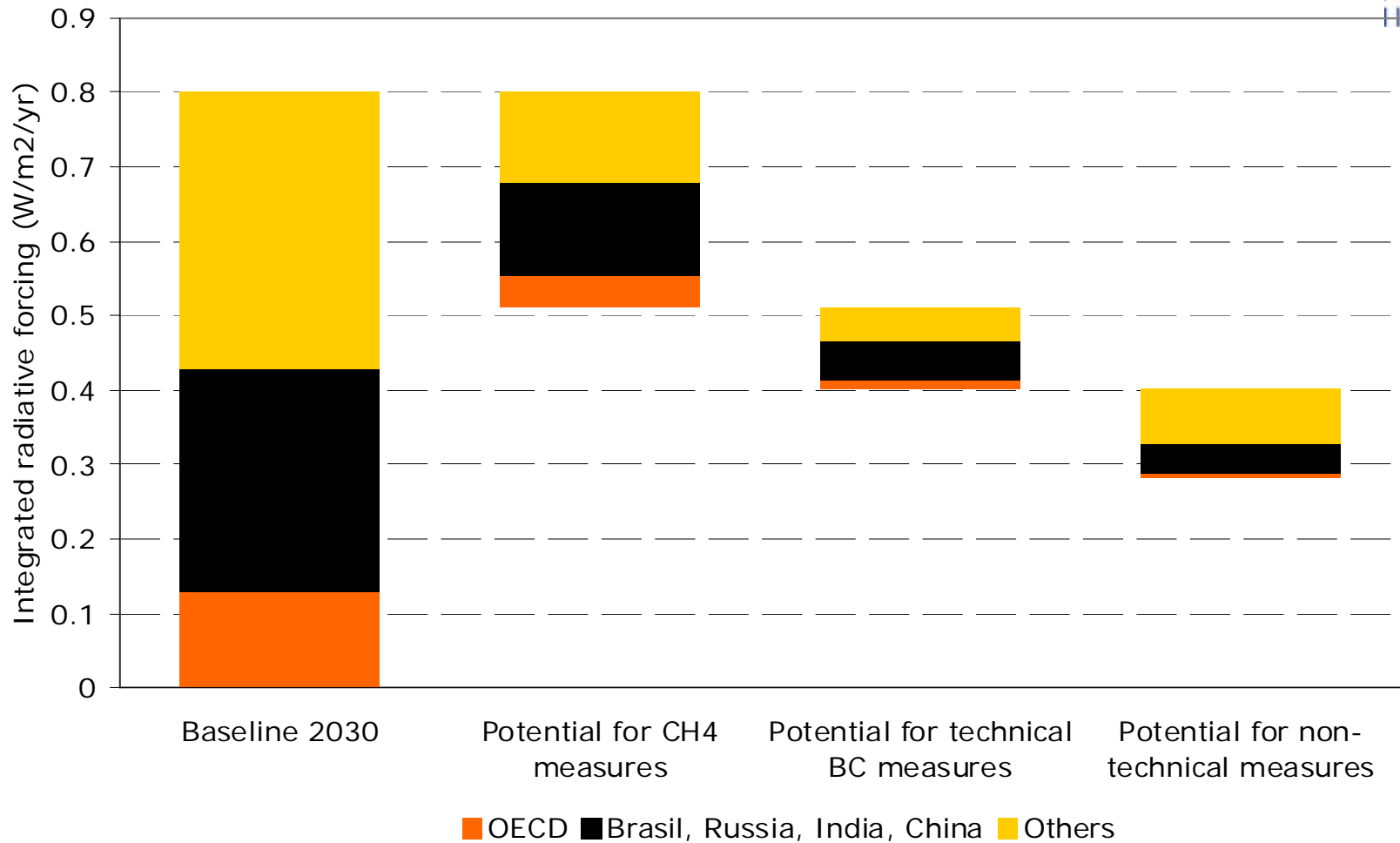
# Mitigation potential for radiative forcing from SLCF, by actors

IEA World Energy Outlook 2030, global



# Mitigation potential for radiative forcing from SLCF, by region

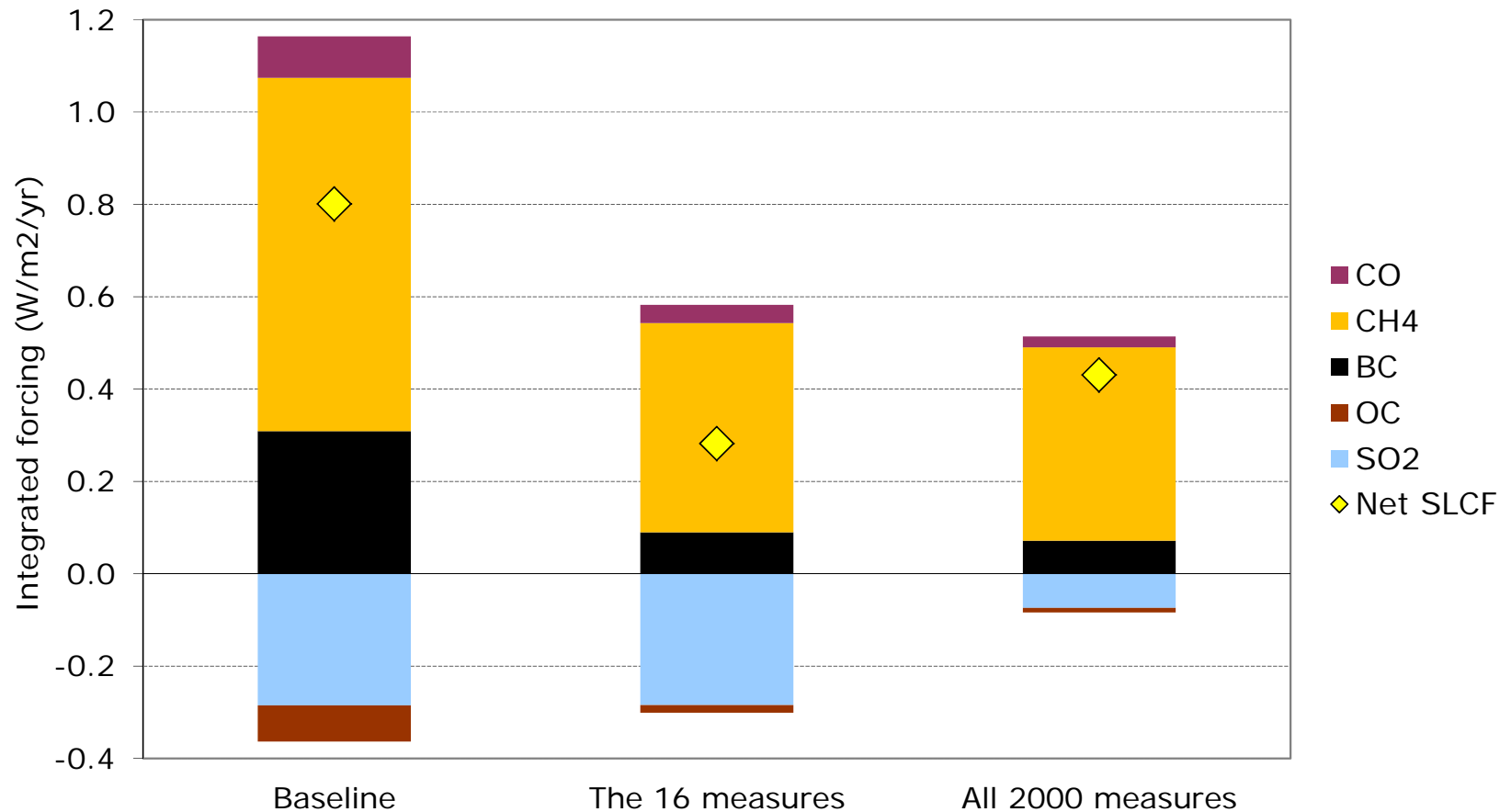
IEA World Energy Outlook 2030, global



For comparison, forcing of CO<sub>2</sub> emissions of 2030 is estimated at 3.6 W/m<sup>2</sup>/yr

# Mitigation potential for radiative forcing from SLCF, by pollutant

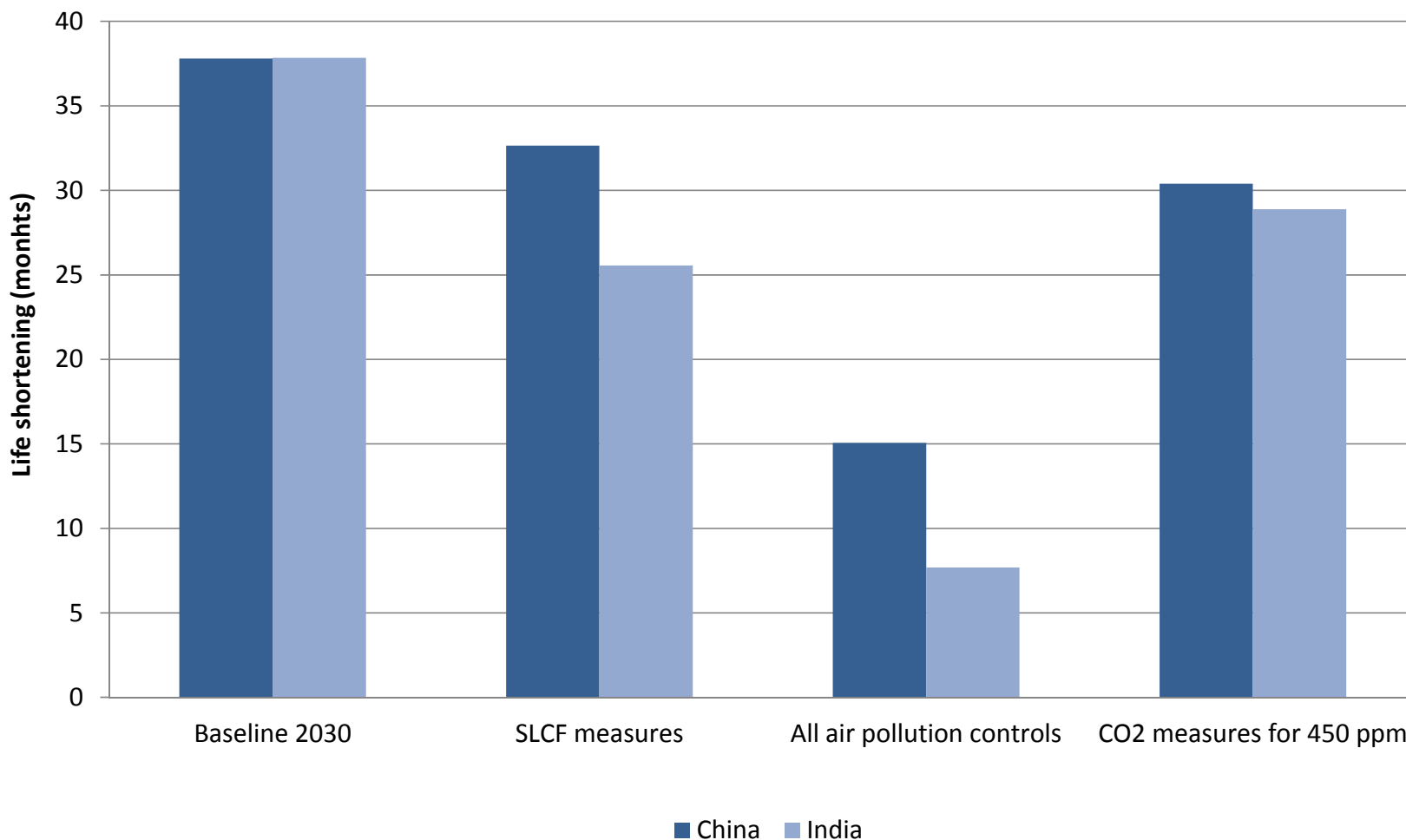
IEA World Energy Outlook 2030, global



For comparison, forcing of CO<sub>2</sub> emissions of 2030 is estimated at 3.6 W/m<sup>2</sup>/yr

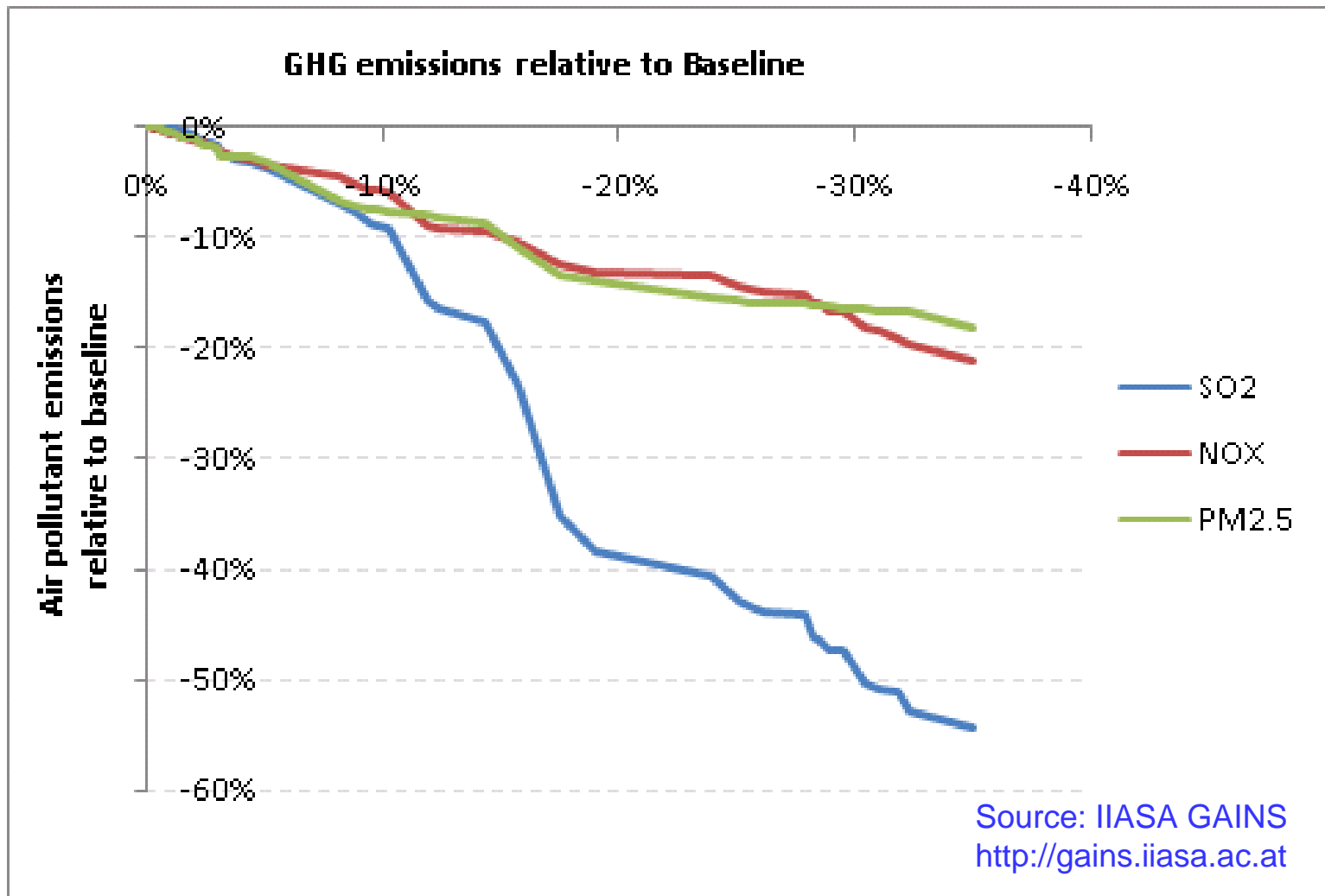
# But: Control of short-lived gases will not resolve all air quality problems!

Loss in statistical life expectancy from PM2.5 (Source: GAINS-Asia)



# Co-control of GHGs and air pollutants

Annex I parties of UNFCCC, 2020



# Conclusions

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- 16 practical measures have been identified that, if globally implemented, could reduce radiative forcing from short-lived substances by about two thirds. These measures exhaust about 90% of the technically available mitigation potential.
- All these measures are already applied in practice; most are low-cost.
- These measures do not only reduce radiative forcing, but also improve local air quality and contribute to other development objectives.
- However, these measures will not resolve all air quality problems. Further air quality improvements must involve SO<sub>2</sub> controls.
- Their negative climate impacts could be diminished if cuts in SO<sub>2</sub> controls are achieved through structural measures that reduce energy consumption and thereby also lower CO<sub>2</sub> emissions.
- This would reinforce CO<sub>2</sub> mitigation strategies, which are indispensable for long-term climate objectives.