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Co-benefits of global HFC phase-down under the Kigali Amendment

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IIASA - Air Quality and Greenhouse Gases

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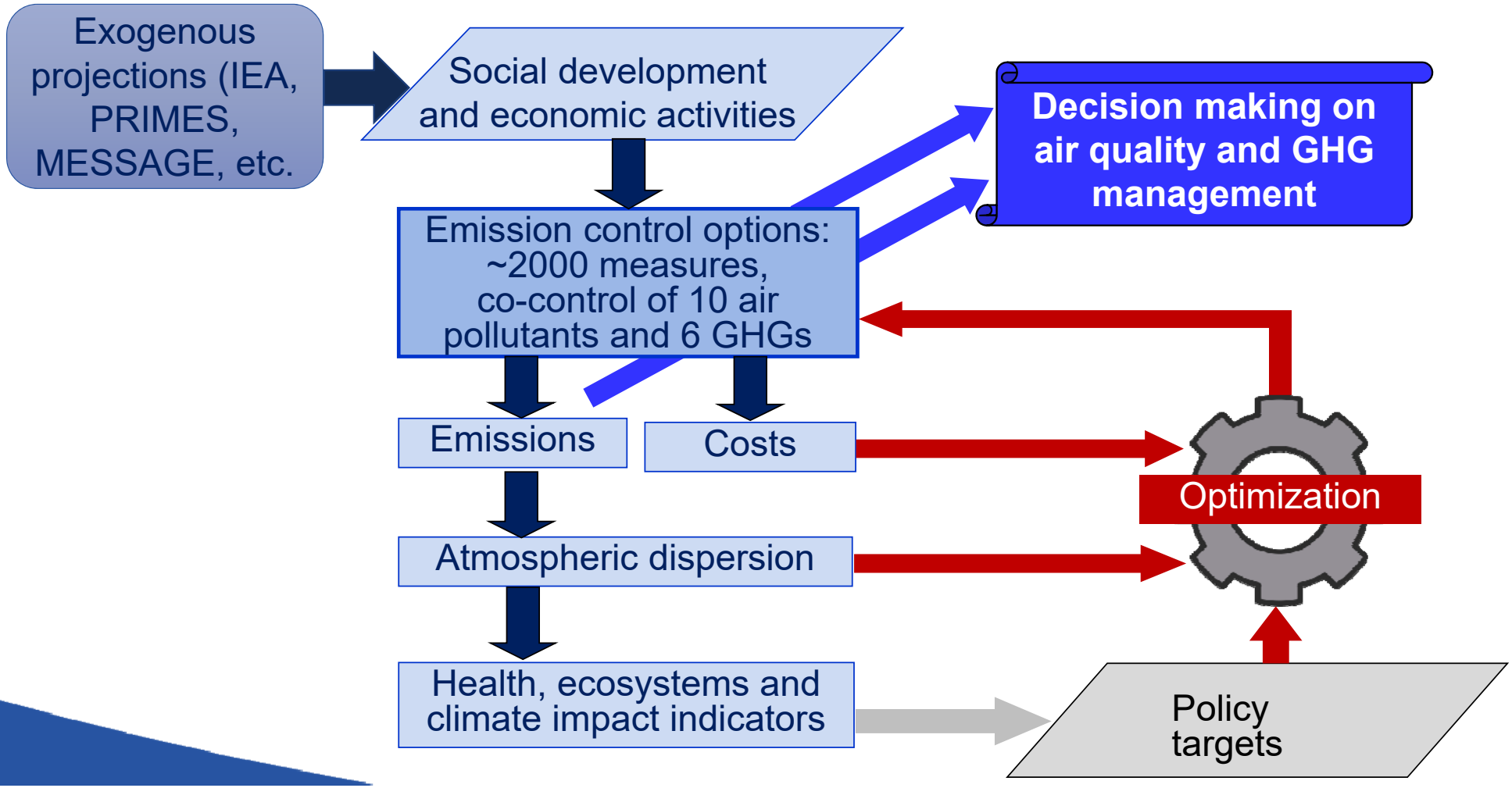
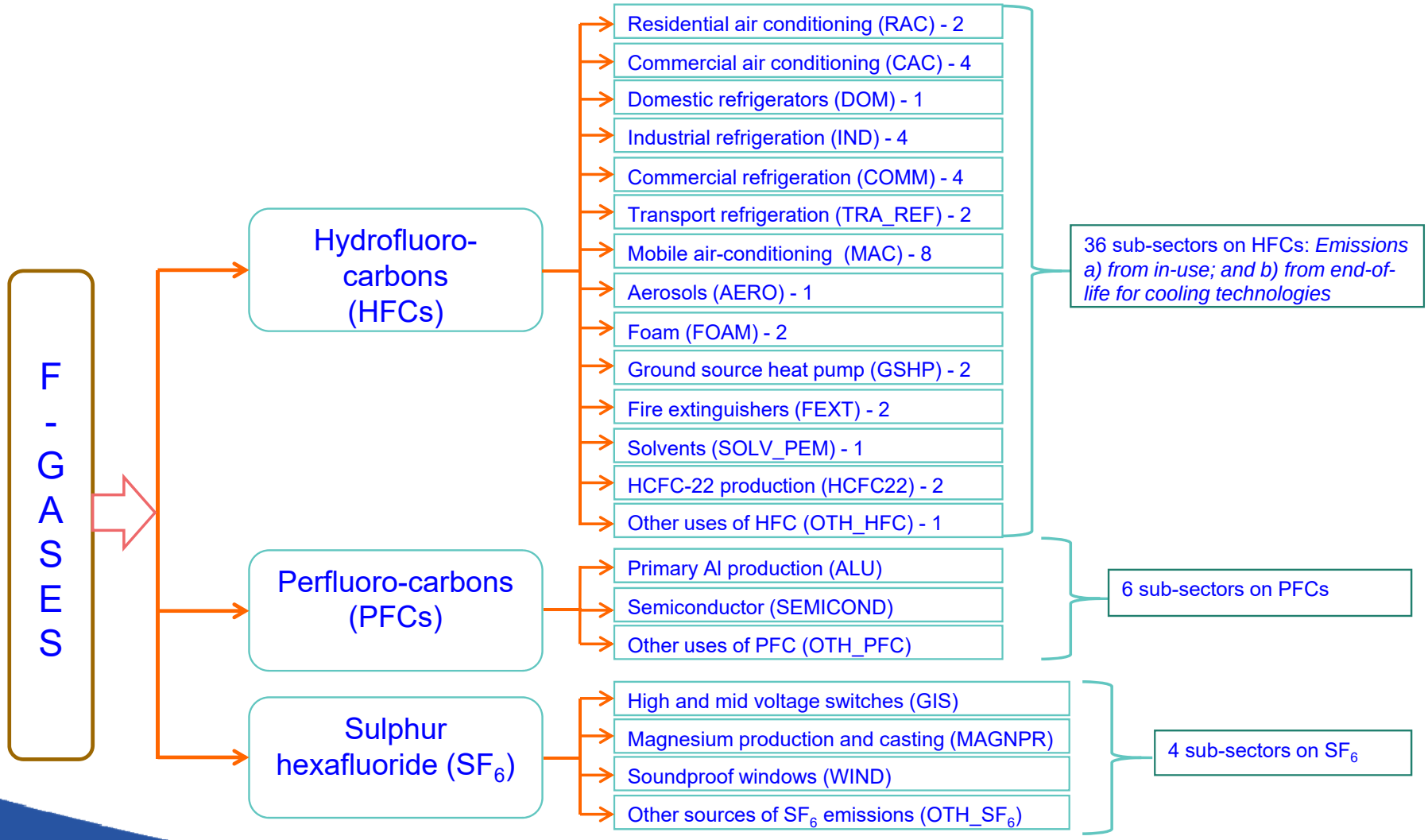
Greenhouse gas - **A**ir Pollution **IN**teractions and **S**ynergies (GAINS) Model



GAINS: Activities and Sectors



Purohit et al. (2017) Atmos. Chem. Phys., 17: 2795–2816

Drivers and data sources

Drivers

- Air conditioning
  - Stationary (GDP, population, household size, cooling degree days, commercial floor space etc.)
  - Mobile (Number of vehicles, penetration rate, etc.)
- Refrigeration
  - Domestic refrigerators (GDP, population, household size, urbanization and electrification rate)
  - Commercial refrigeration (Growth in commercial value added)
  - Industrial refrigeration (Growth in industrial value added)
  - Transport refrigeration (Growth in GDP)
- HCFC-22 production (Growth in industrial value added)
- Aerosols (Growth in population)
- Other (Fire-extinguishers, Foam, Solvents, heat pumps, etc.) - (Growth in GDP)

Data sources

- GDP and population: IEA, IIASA/SSP Database
- Cooling degree days: IEA
- Commercial floor space: IIASA/GAINS
- Household size, Urbanization, Electrification : IEA, UN-Habitat, World Bank
- Historical data on HFC consumption: UNFCCC, UNEP/CCAC, UNDP and other secondary sources
- HCFC-22 production (UNEP Ozone Secretariat)
- Energy efficiency (technical/economic): LBNL
- Leakage rates/emission factors: IIASA/GAINS
- GWPs: IPCC AR2, AR4 and AR5
- Lifimetime, refrigerant charge etc.: IIASA/GAINS

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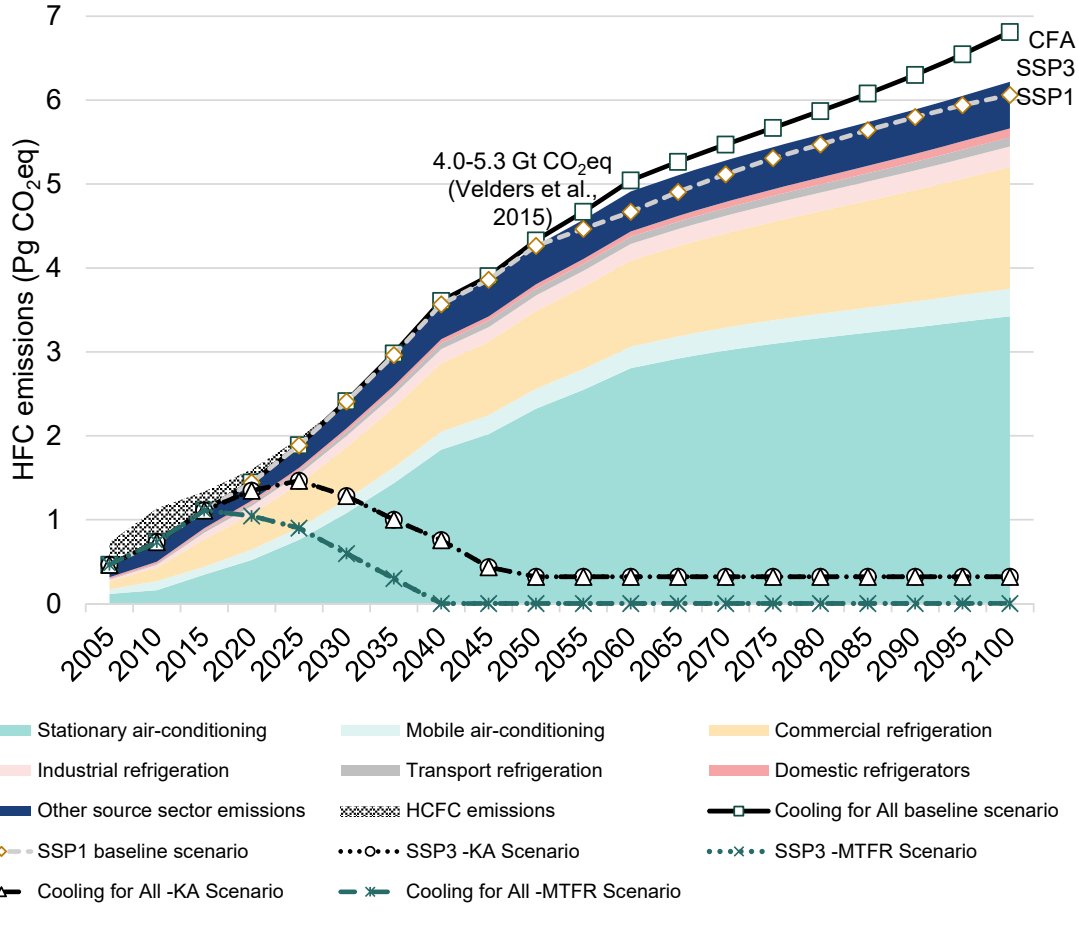
Overview of the HFC/co-benefits emission scenarios

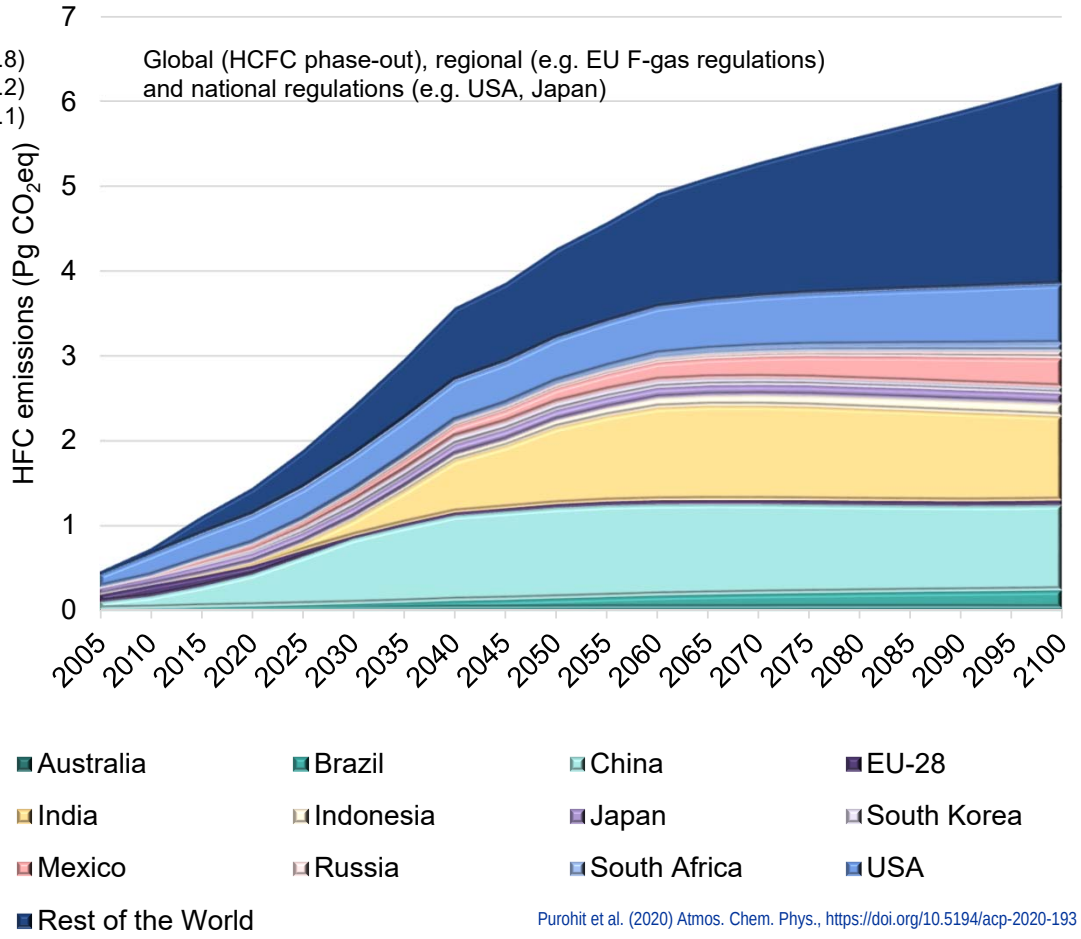
	Baseline	Alternative emission reduction scenarios													
		a) Kigali Amendment (KA)	b) KA with High Energy Efficiency (KA-EE)						c) (MTFR)	d) MTFR with High Energy Efficiency (MTFR-EE)					
			Technical EE potential			Economic EE potential				Technical EE potential			Economic EE potential		
			CPS+	NPS	SDS	CPS	NPS	SDS		CPS	NPS	SDS	CPS	NPS	SDS
Baseline –SSP1	✓														
Baseline –SSP3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cooling for All*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*The Cooling for All initiative focuses on how we provide sustainable access to cooling within a clean energy transition, and in turn, support faster progress to achieve the goals of the Kigali Amendment.

+CPS: Current policies scenarios; NPS: New policies scenario; and SPS: Sustainable development scenario

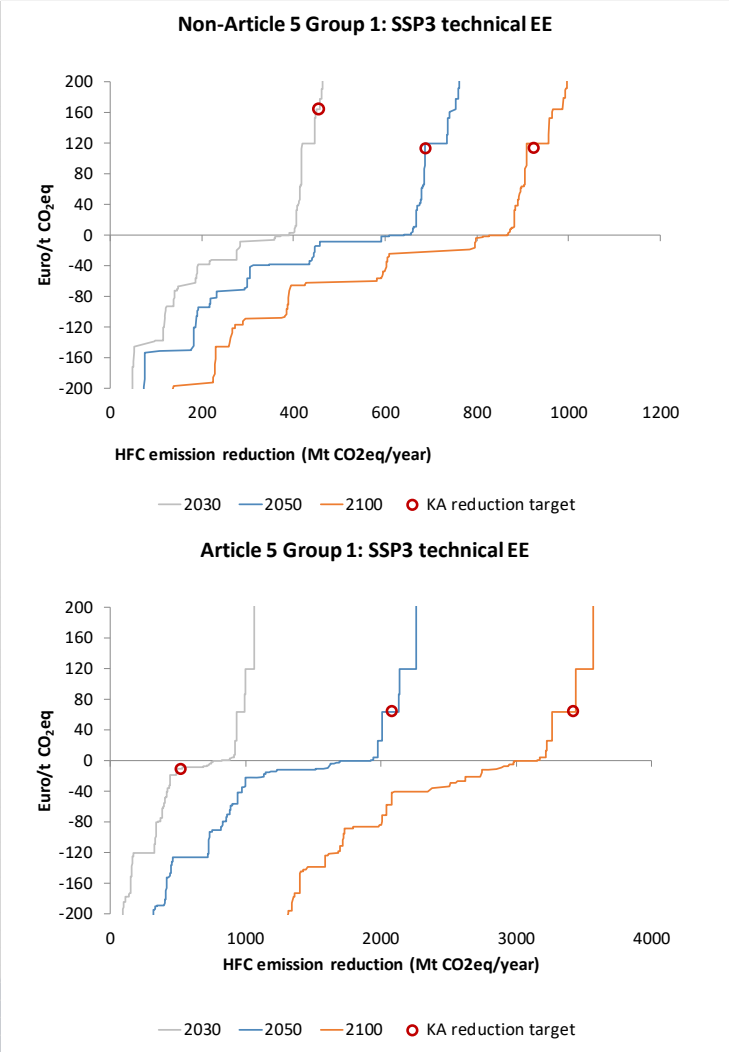
Pre-Kigali baseline annual emissions of HFCs are expected to increase from about 0.5 to 4.3 Gt CO_2eq between 2005 and 2050, reaching between 6.1 and 6.8 Gt CO_2eq in 2100, depending on whether or not all households in hot climatic conditions install residential air conditioning. Cumulative HFC emissions over the period 2018 to 2100 are estimated at 363 and 378 Gt CO_2eq in respective baseline scenarios.

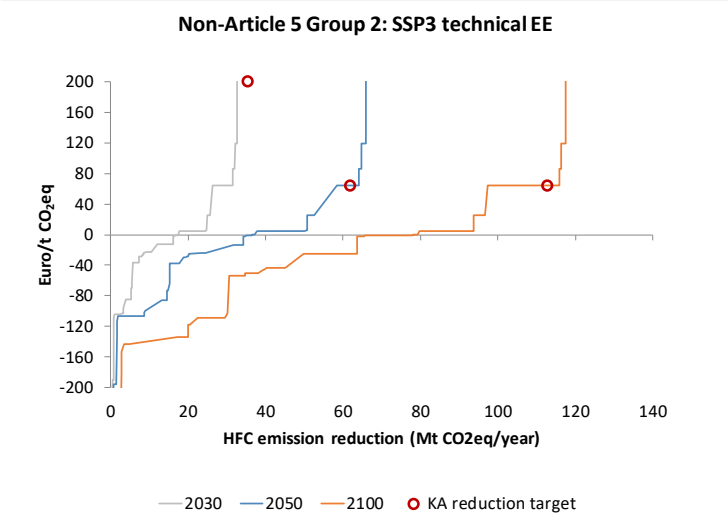


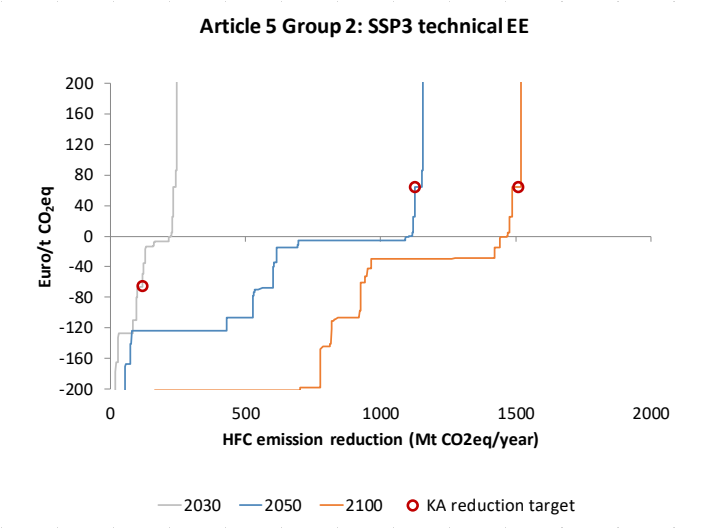


Purohit et al. (2020) Atmos. Chem. Phys., https://doi.org/10.5194/acp-2020-193

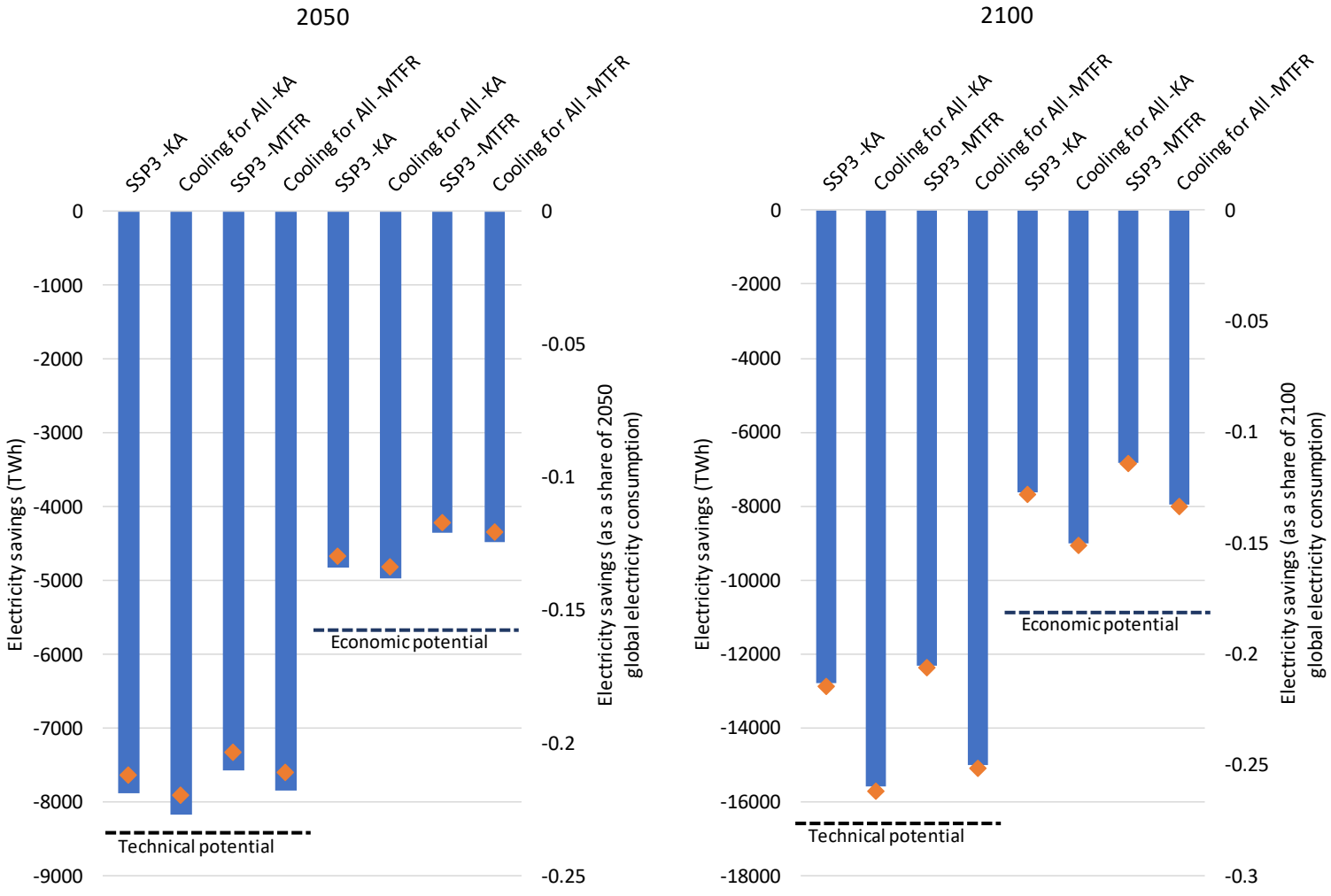
Marginal abatement cost curves (MACCs)







If technical energy efficiency improvements are fully implemented, the resulting electricity savings could exceed 20% of future global electricity consumption, while the corresponding figure for economic energy efficiency improvements would be about 15%.



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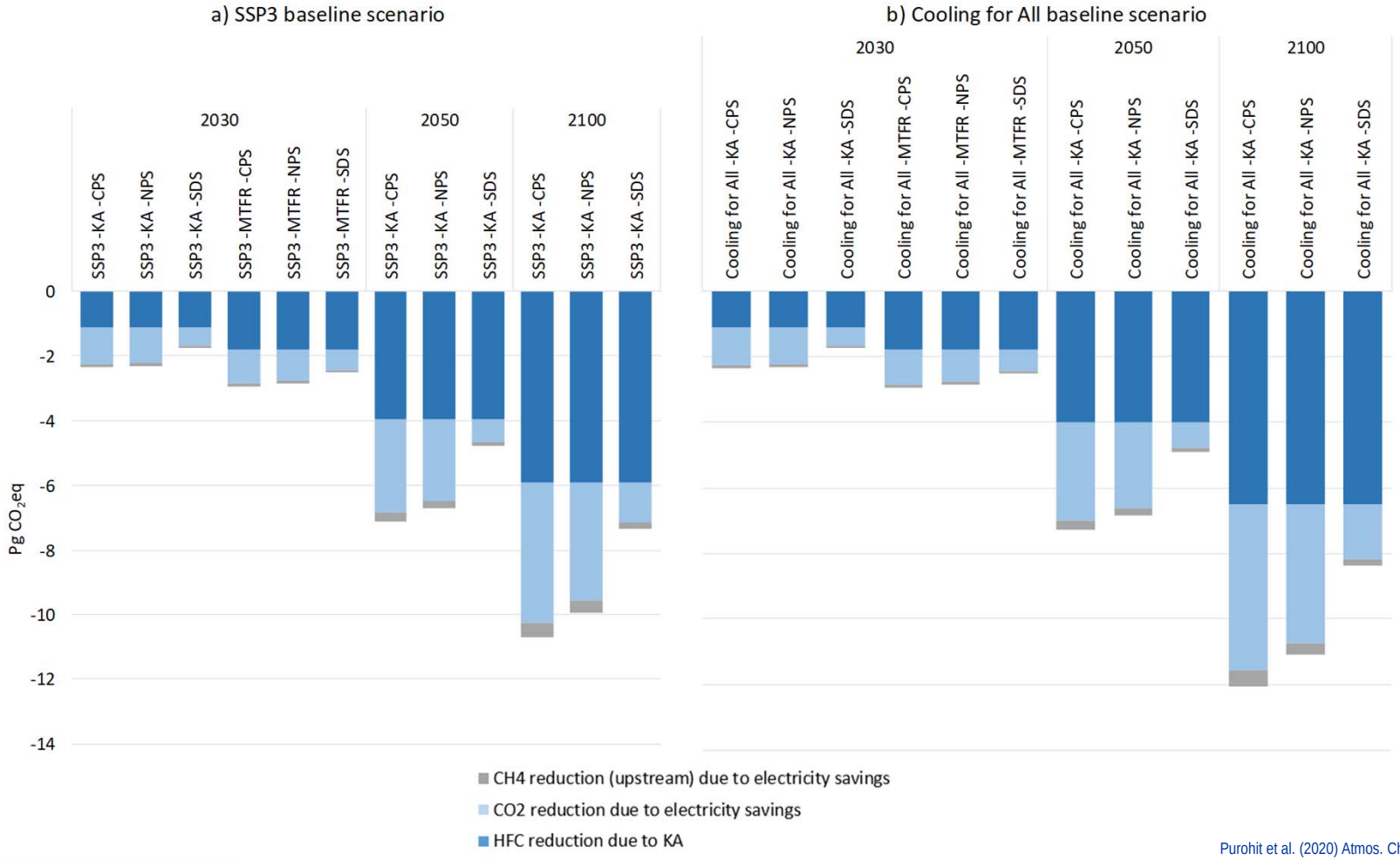
The combined effect of KA and energy efficiency improvement of the stationary cooling technologies and future changes in the electricity generation fuel mix would prevent between 411 and 631 Gt CO_2eq. of GHG emissions between 2018 and 2100, thereby making a significant contribution towards keeping the global temperature rise below 2°C.



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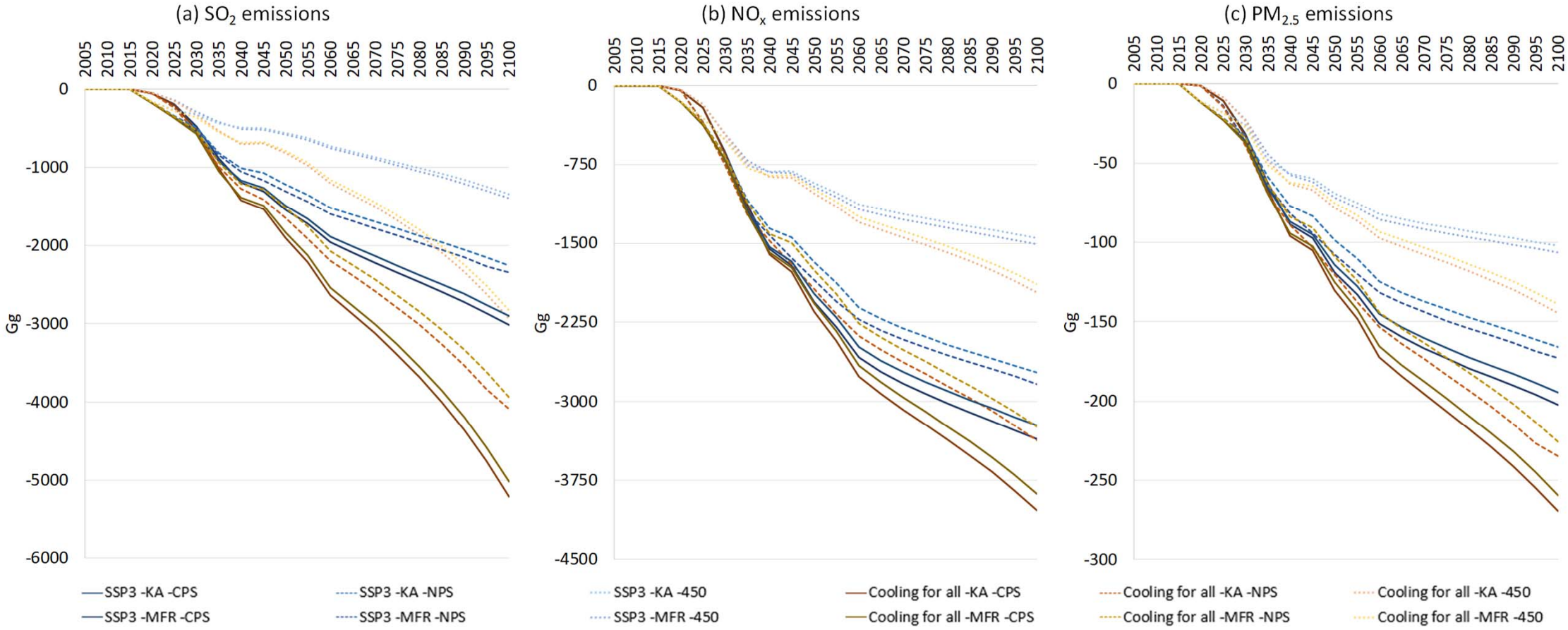
Reduced electricity consumption also means lower air pollution emissions in the power sector, estimated at about 5-10% for SO_2, 8-16% for NO_x and 4-9% for $PM_{2.5}$ emissions compared with a pre-Kigali baseline.



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