

Motivation

- The production and consumption of ozone-depleting fluorinated gases (F-gases) are covered under the Montreal Protocol (MP), which regulates the release of ozone depleting substances (ODSs) such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).
- Release of other F-gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) is regulated under the Kyoto Protocol (KP).
- Emissions of a large number of F-gases covered by the KP (mainly HFCs) have increased significantly in recent years and are projected to rise further in response to the phase-out of ODSs under the MP.
- We estimate global F-gas emissions, technical mitigation potentials and costs for 2005-2050. Thirty-two source sectors for F-gases are identified and region-specific estimates for 162 world regions are produced using the GAINS model framework.

Methodology

Table 1. GAINS F-gas emission sources, activity data and drivers

Emission source	Historical activity data/variables	Projection driver
A. HFC emissions		
Aerosols	HFC consumption for MDI's from UNFCCC CRF tables, UNEP reports	GDP growth
Commercial air conditioning	GDP and population, household size, cooling degree days, commercial floor space	GDP and population projections
Commercial refrigeration	HFC consumption per unit value added in the service sector	Growth in commercial value added
Domestic refrigerators	GDP and population, household size, urbanization and electrification rate,	GDP and population projections
HCFC-22 production*	HCFC production for emissive and feedstock use	Growth in industrial value added
Other*	HFC consumption for solvents and fire extinguishers	GDP growth
Industrial refrigeration	HFC consumption per unit value added in the industrial sector	Growth in industrial value added
Mobile air conditioning	Number of vehicles (cars, buses, light and heavy duty trucks) with air conditioning	Number of vehicles
Foams	HFC consumption in the foam sector	GDP growth
Residential air conditioning	GDP and population, household size, cooling degree days	GDP and population projections
Refrigerated transport	HFC consumption in refrigerated transport sector	GDP growth
B. PFC emissions		
Primary Al production	Primary Al production	Energy consumption in non-ferrous metals
Semiconductor industry	PFC emissions in semiconductor industry	Growth in industrial value added
C. SF₆ emissions		
High and mid voltage switches	Electricity consumption	Electricity projections
Magnesium production and casting	Magnesium production	Energy consumption in non-ferrous metals
Other SF ₆ emissions	Other SF ₆ emissions	GDP growth
Windows	SF ₆ emissions from soundproof windows	GDP growth

Results & Discussions

- Initial results from the GAINS model suggest that in the baseline scenario (Fig 1), i.e., without further adoption of legislative or voluntary control than currently in place, global emissions of F-gases will grow by a factor of three between 2005 and 2050 (0.71 GtCO₂eq. in 2005 to 3.6 GtCO₂eq. in 2050).
- In particular, a sharp increase in emissions from air-conditioning and refrigeration in developing countries contributes to increased emissions (Fig 2).
- Existing mitigation technologies could reduce emissions by up to 94%. Mitigation costs are relatively low, with almost 82% of the mitigation potential attainable at less than 50 €/t CO₂eq (Fig 3-4).

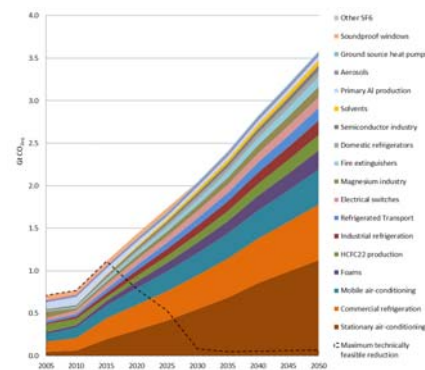


Fig 1. Sectoral development of baseline F-gas emissions

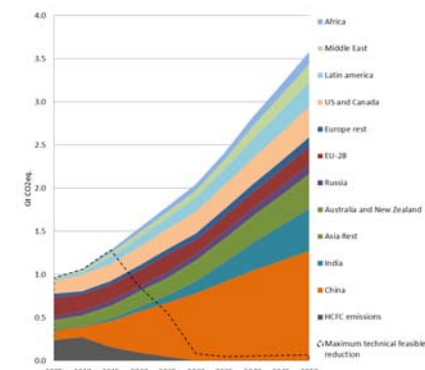


Fig 2. Baseline HCFC and F-gas emissions by major world regions

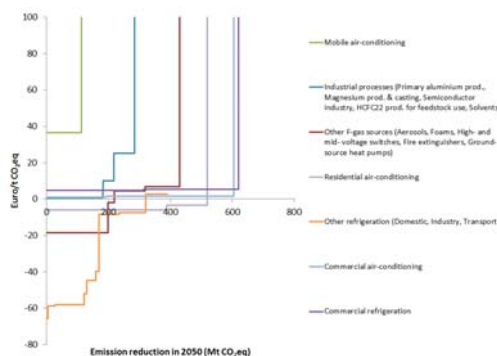


Fig 3. Marginal mitigation cost curve for maximum technical reduction of F-gas emissions in 2050 by sector

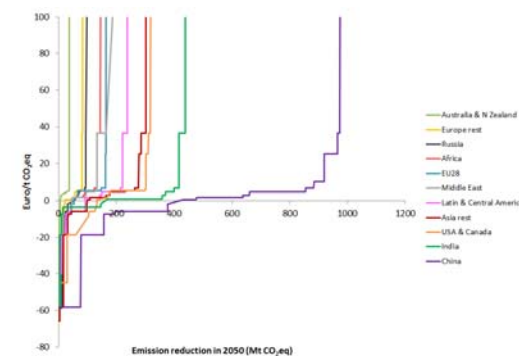


Fig 4. Marginal mitigation cost curve for maximum technical reduction of F-gas emissions in 2050 by major world regions