

NON-CO₂ GHG in GAINS



POTENTIALS AND COSTS FOR MITIGATION OF NON-CO₂ GREENHOUSE GASES IN ANNEX 1 COUNTRIES

L. Höglund-Isaksson, IIASA

W. Winiwarter, IIASA

A. Tohka, Finnish Environment Institute

CH₄

N₂O

HFCs, PFCs, SF₆

Non-CO₂ GHG: Methodology



- Follows IPCC guidelines (1997, 2006) as closely as permitted by model structure boundaries and available information
- Principal data sources:

Activity data: FAO, IEA, IPCC, UNFCCC, EUROSTAT and more...

Emission factors: IPCC, UNFCCC, and many subject-specific sources

Current control, technical mitigation potentials, costs:
USEPA, UNFCCC, IEA, EEA, IPPC, Methane to markets, Statistics Canada, Australian Bureau of Statistics, Statistical Handbook of Japan, AEAT and many more subject-specific sources

CH₄ sources and mitigation options in GAINS: Annex-I 2020: 1860 Mt CO₂eq. (-41% red. potential)



Sector	Fraction of CH ₄ emissions	Fraction of CH ₄ mitigation potential	Mitigation options
Livestock	30%	7%	Farm-scale and community scale AD, Feed changes
Agricultural waste burning	1%	0.4%	Ban
Coal mining	11%	13%	Extended gas recovery with flaring
Oil and gas extrac. & process	12%	22%	Extended gas recovery with flaring
Gas transmission & distr	22%	41%	Reduced leakage at compressor stations, More frequent control of networks, Replacement of iron-cast networks
Solid waste	14%	11%	Diversion from landfills through recycling, AD, composting, incineration, Landfill gas recovery
Wastewater	5%	5%	Utilization of biogas from anaerobic wastewater treatment
Rice cultivation	1%	1%	Intermittent aeration of continuously flooded fields, Alternative rice hybrids, Sulfate containing amendments
Transport	1%	0%	no CH ₄ specific mitigation options
	100%	100%	

N₂O sources and mitigation options in GAINS

Annex-I 2020: 1198 Mt CO₂eq. (-34% red. potential)



Sector	Fraction of N ₂ O emissions	Fraction of N ₂ O mitigation potential	Mitigation options
Combustion	9%	18%	Combustion modification (for FBC) CO ₂ -specific options (side-effects)
Transport	6%	2%	No N ₂ O specific option
Adipic acid production	1%	0.2%	Catalytic reduction
Nitric acid production	6%	14%	Catalytic reduction
Nitrous oxide use (anaesthetics)	1%	4%	Reduced application, replacement
Manure management	7%	0%	No N ₂ O specific option
Soils	54%	54%	Reduction in fertilizer application, Application optimization, Agro-Chemistry (nitrification inhibitors), Precision farming
Histosols	2%	5%	Ban agricultural use
Wastewater	2%	2%	Optimizing operating parameters towards N ₂ O abatement
Other N ₂ O	11%	0%	Not applicable
	100%	100%	

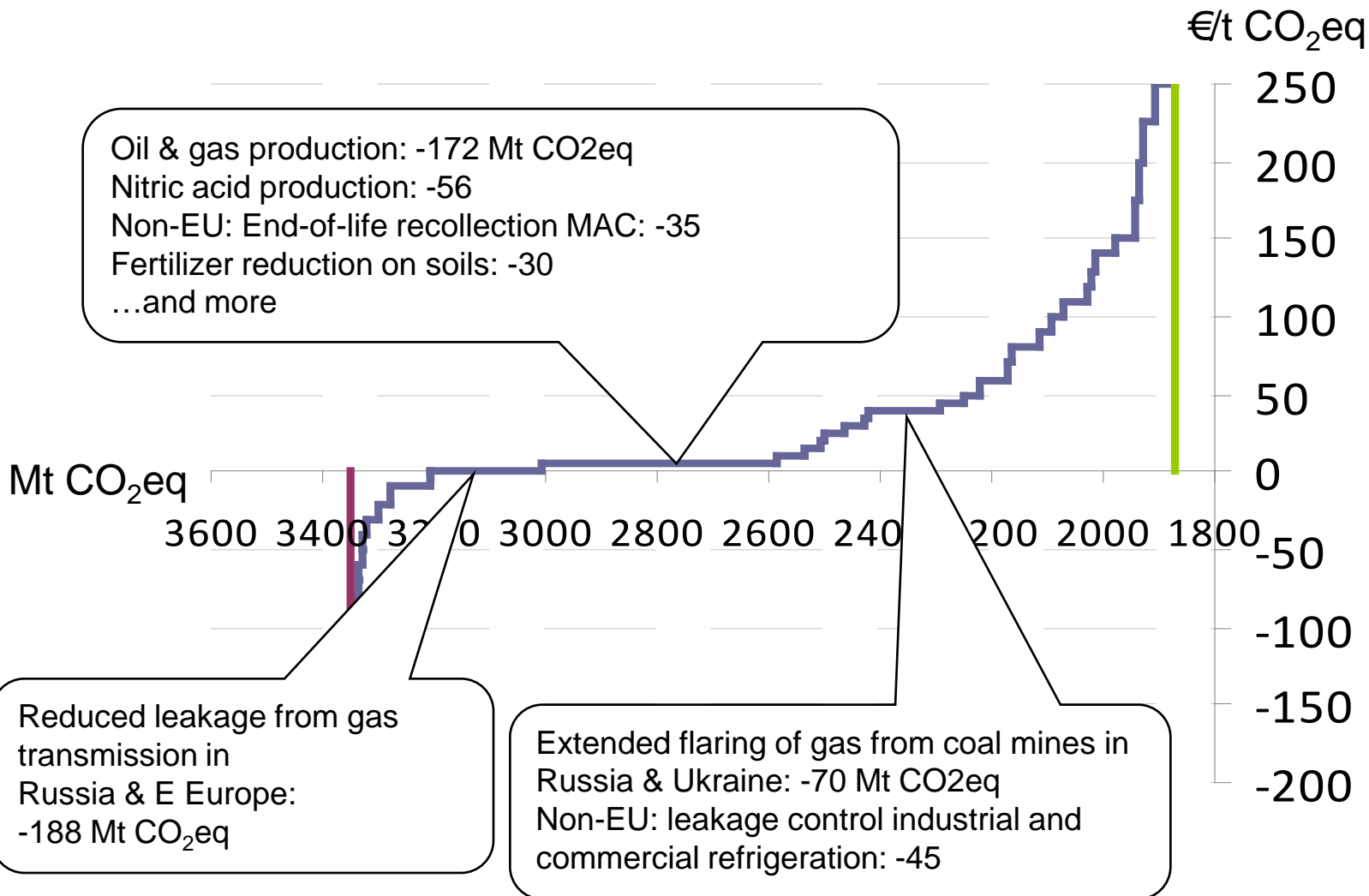
F-gas sources and mitigation options in GAINS

Annex-I 2020: 474 Mt CO₂eq. (-80% red. potential)



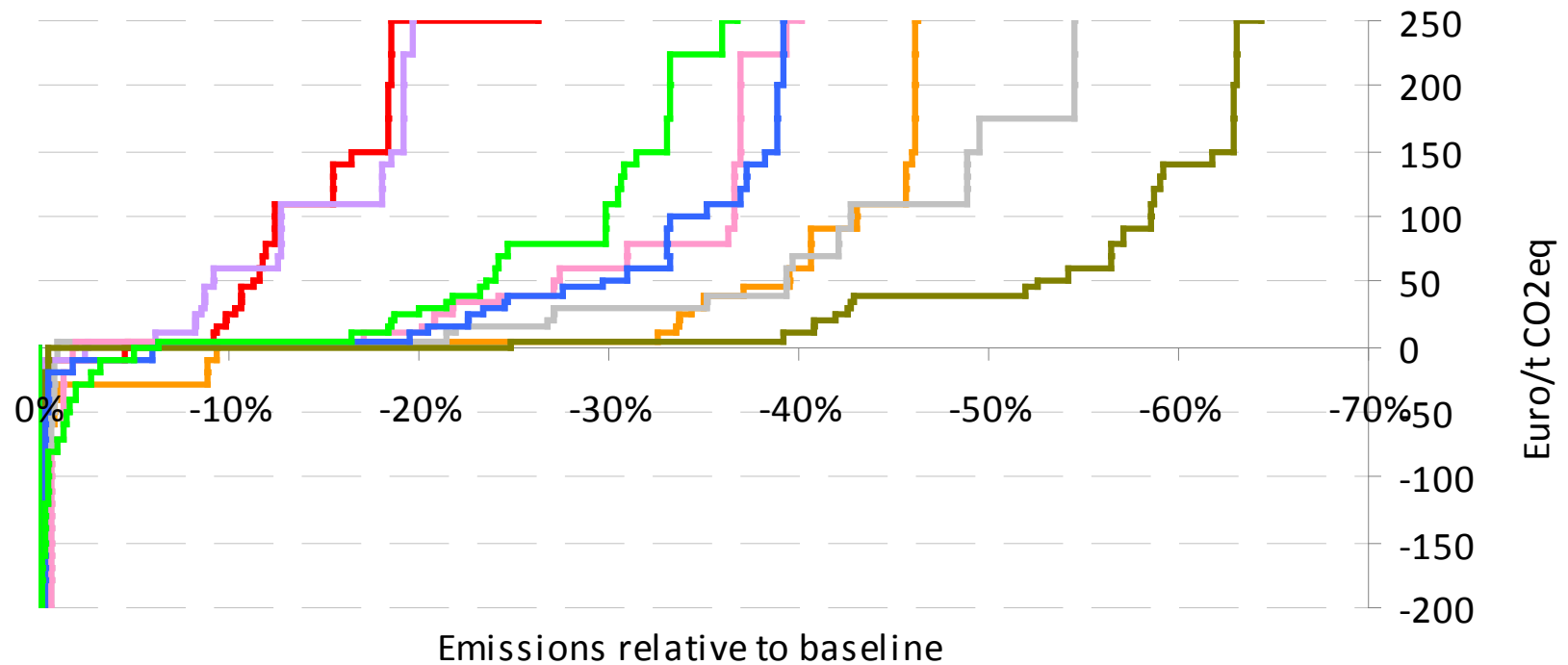
Sector	Fraction of F-gas emissions	Fraction of F-gas mitigation potential	Mitigation options
HCFC22 production	3%	2%	Post combustion of HFC-23
Refrigeration and stationary AC	54%	55%	Good practice: leakage control and end-of-life recollection, Process modifications incl alternative refrigerants
Mobile air conditioning	21%	25%	Good practice: leakage control and end-of-life recollection, Alternative refrigerant: pressurized CO ₂
Aerosols	3%	0.1%	Alternative propellant
Foams	1%	1%	Alternative blowing agent
Aluminium production	8%	8%	Retrofitting existing technologies or conversion to modern technology
Semiconductor industry	2%	3%	Alternative solvent: NF ₃
High & mid voltage switches	4%	4%	Good practice: leakage control and end-of-life recollection and recycling
Magnesium production	2%	2%	Alternative protection gas: SO ₂
Other F-gas use	3%	1%	Ban of use
	100%	100%	

Non-CO₂ cost curve for Annex-I 2020 (4% interest rate)



Non-CO₂ GHG cost curves by region

Reduction from region baseline 2020



- Australia
- New_Zealand
- United_States_of_America
- Canada
- Norway
- EU27
- Japan
- Russian_Federation

CH₄ from solid waste



- IPCC: First-Order-Decay model (up to 50 years decay)
- not possible to implement fully in GAINS structure
- In GAINS, **emissions are approximated by relating them to waste amounts generated 10 years back for fast-decaying waste (food) and 20 years back for slow-decaying waste (paper, wood).**
- Mitigation potential in 2020 limited to fast-decaying waste as emissions from slow-decaying waste stem primarily from waste that has already been landfilled. Full mitigation potential only from 2030 onwards.

Projecting future waste amounts



Estimation of waste generation elasticities using panel data methods (FE and RE)
Based on data reported for European countries in 1985-2004 (EUROSTAT, 2005)

For Municipal solid waste/capita/year:

Explanatory variables: GDP/capita and urbanization rate

$E_1 = 0.48$ (i.e. as GDP/capita increases by 10%, MSW/capita increases by 4.8%)

$E_2 = -0.17$ (i.e. as urbanization increases by 10%, MSW/capita decreases by 1.7%)

For industrial solid waste by sector/year:

Explanatory variable: Sector VA at factor costs (no physical measure available)

Food industry: $E = 0.81$ (as VA increases by 10%, waste amount increases by 8.1%)

Paper industry: $E = 1.03$

Textile/leather: $E = 0.74$

Wood/wood products: $E = 0.33$

Similar estimates were obtained for industrial wastewater.

N₂O from soil



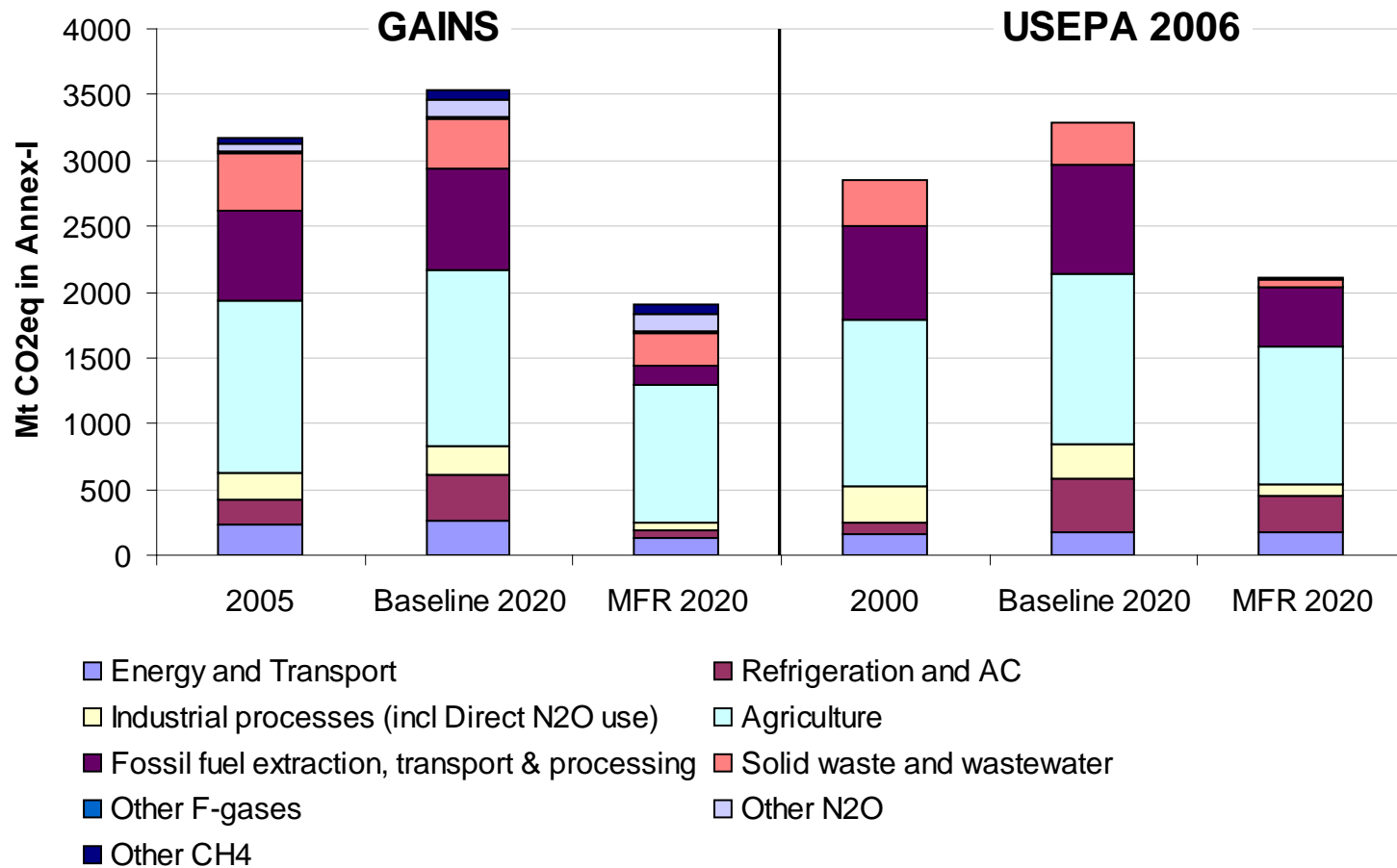
- N₂O from soil dominates N₂O emissions (and uncertainties)
- GAINS applies N₂O emission factors (direct&indirect),
→ good agreement to country emissions
- Abatement measures *represent* categories
 - Fertilizer reduction: “good housekeeping” – avoiding fertilizer losses
 - Fertilizer timing: matching N-additions to the crop’s need to avoid unnecessary N surplus in soils
 - Nitrification inhibitors: agrochemicals to optimize nitrogen uptake and further reduce N need
 - Precision farming: characterizes the highest N-use efficiencies
- Challenge: application of manure may compromise on N-use efficiency, but is needed to tighten N-cycles

Uncertainties



- **Uncertainty in driving factors for activities:**
Non-energy related activities (agriculture, waste, f-gas activities) have different uncertainty than energy-related activities.
- **Uncertainty in emission factors:**
Most important source of uncertainty
Large uncertainty with N₂O from soils
Comparison with ef:s reported to UNFCCC
- **Uncertainty in abatement:**
Large uncertainty remains in costs
Availability/adoption of technologies by 2020

Non-CO₂ emissions in Annex-I GAINS vs USEPA (2006)



Conclusions non-CO₂ GHG in GAINS



- **Large low-cost potential to reduce non-CO₂ GHG**
Annex-I 2020: -43% from baseline or 1500 Mt CO₂eq
Half of reduction potential at < 5 Euro/t CO₂eq.
90% of reduction potential at < 100 Euro/t CO₂eq.
- **Largest reduction potentials in 2020 found in sectors:**
fossil fuel prod. and transmission (38% of total potential), refrigeration and AC (20%), N₂O from soils (15%), and waste and wastewater (8%).
- **Sector importance in reduction potentials vary between regions:**
Australia: Coal mining (but costly)
Russia: Fossil fuel prod & transmission
EU-27: N₂O from soils
USA: Refrigeration and AC, fossil fuel production and transmission
Japan: Refrigeration and AC
- **Important uncertainties remain for emission factors and technology adoption/availability in 2020**