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## **The GAINS model**

**State of play**

# GAINS

## GHG-Air pollution **I**nteractions and **S**ynergies model



- **Extension of RAINS integrated assessment model for air pollution to GHGs**
- **CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFC, PFC, SF<sub>6</sub> in addition to SO<sub>2</sub>, NO<sub>x</sub>, VOC, NH<sub>3</sub>, PM**
- **Currently implemented for 43 countries in Europe (funded by the Netherlands), GAINS-Asia (China and India) implementation started last month (funded by DG-Research)**



**For all anthropogenic sources of GHG emissions in a country:**

- **Identification of available mitigation options**
  - Including structural changes (fuel switch) and add-on measures
- **Country-specific application potentials**
  - Baseline activity rates: exogenous (national of PRIMES) projections
  - Substitution potential and costs derived from alternative PRIMES scenarios
- **Quantification of societal resource costs**
  - Excluding transfers (profits, taxes, etc.)
- **Data sources:**
  - GHG emission inventories consistent with UNFCCC
  - GHG technology cost data from reviewed literature
  - Activity projections: provided by national governments and EU Commission

# Main mitigation options for CO<sub>2</sub>

162 options considered in GAINS



- **Power plants**
  - Fuels shift to natural gas and renewables
  - Co-generation CHP
  - IGCC, carbon capture and storage
- **Transport**
  - More efficient vehicles (hybrid cars)
  - Alternative fuels (ethanol, gas, biodiesel, hydrogen)
- **Industry**
  - End-use savings (including CHP)
  - Fuel shifts
- **Domestic**
  - Insulation
  - Solar, biomass
  - Fuel shift to natural gas
  - Savings for appliances and lighting

# Main mitigation options for CH<sub>4</sub>

28 options considered in GAINS



- **Gas sector**
  - Reduced leakages during gas transmission and distribution
  - Flaring instead of venting
- **Waste management**
  - Recycling/composting of biodegradable waste instead of landfill
  - Methane recovery from landfills
- **Enteric fermentation**
  - Dietary changes for cattle coupled with livestock reductions
- **Manure management**
  - Anaerobic digestion plants and stable adaptation
- **Coal mines**
  - Upgraded gas recovery in coal mines
- **Rice paddies**
  - Modified rice strains
- **Structural changes in agriculture (livestock changes) modeled analog to energy changes**

# Main mitigation options for N<sub>2</sub>O

18 options considered in GAINS



- **Arable land and grassland**
  - Reduced fertilizer application
  - Optimal timing of fertilizer application
  - Nitrification inhibitors
  - Precision farming
  - Less use of histosols (peat soils)
- **Industry**
  - Emission controls in adipic acid and nitric acid industry
- **Combustion**
  - Modified fluidized bed combustion
- **Health care**
  - Reduced N<sub>2</sub>O use
- **Waste treatment**
  - Optimized waste water treatment

# Main mitigation options for F-gases

22 options considered in GAINS



- **Refrigeration** (domestic, commercial, transport and industrial)
  - Recollection, alternative refrigerants and good practice
- **Mobile and stationary air conditioning**
  - Alternative refrigerants, process modifications, good practice
- **HCFC22 production**
  - Incineration
- **Primary aluminum production**
  - Conversion to other processes
- **Semiconductor industry**
  - Limited PFC use through alternative processes
- **Other sectors**
  - SO<sub>2</sub> cover for magnesium production
  - Good practice for gas insulated switchgears
  - Alternative propellants for foams and aerosols
  - End of life recollection of SF<sub>6</sub>

## GAINS approach for modeling “NTM”



- Potentials and costs for structural measures derived from difference between alternative PRIMES scenarios (currently 0, 20, 90 €/t CO<sub>2</sub>), for CAPRI under development
- GAINS maintains balance on energy/agricultural services.
- Option to include demand elasticities, based on external assessments (Auto/Oil, TREMOVE, CAPRI, PRIMES, etc.)
- Not included in GAINS:
  - Behavioral changes
  - Local traffic regulations (incl. speed limits)
  - Spatial shifts in agricultural production
- “Controlled activity levels” are used as decision variables instead of cost curves to capture simultaneous effects on CO<sub>2</sub>, PM, SO<sub>2</sub>, CH<sub>4</sub>, NH<sub>3</sub>, N<sub>2</sub>O, VOC, etc.



## Next steps



- **GAINS optimization method under completion**
- **Will be used for NEC analyses (early 2006)**
  - **Base cases: traditional RAINS approach**
  - **Sensitivity cases: with/without GHGs and NTMs**
- **Structural changes in agricultural sector will take longer.**