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Overview of current approaches in GAINS for estimating European wide NH_3 mitigation costs

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Content

- GAINS model, IAM; http://gains.iiasa.ac.at
- Categories of agricultural control measures in GAINS
- Cost methodology
- Sources of data
- Issues

Integrating over different policy areas:

GAINS: A model to harvest synergies by integrating multiple pollutants and their multiple effects

Impacts	Emissions and control measures for air pollutants					and greenhouse gases			
	PM	O_3	NO_x	VOC	NH_3	CO_2	CH_4	N_2O	HFCs PFCs SF_6
Health impacts: from fine particulate matter	√	√	√	(√)	√				
from ground-level ozone			√	√			(√)		
Vegetation damage: Ozone (agricultural crops)			√	√			(√)		
Acidification (forests)		√	√		√				
Eutrophication (biodiversity)			√		√				
Radiative forcing: - from direct greenhouse gases						√	√	√	√
- via aerosols and ozone	(√)	(√)	(√)	(√)	(√)		(√)		

Optimization

- Linear optimization of air pollution control strategies in RAINS/GAINS:

Objective: minimize (Costs)

s.t. $EnvEffect_k < Limit_k$

Minimize costs, such that environmental effects do not exceed pre-defined limits

There are additional technology constraints, e.g.

- maximum application rates
- vintage structure
- etc.

Categories of emission control options in GAINS for agriculture

- Low nitrogen feed
- Low emission housing
- Air purification
- Incineration of poultry manures
- Covered storage
  (low and high efficiency)
- Low ammonia application
  (low and high efficiency)
- Urea substitution

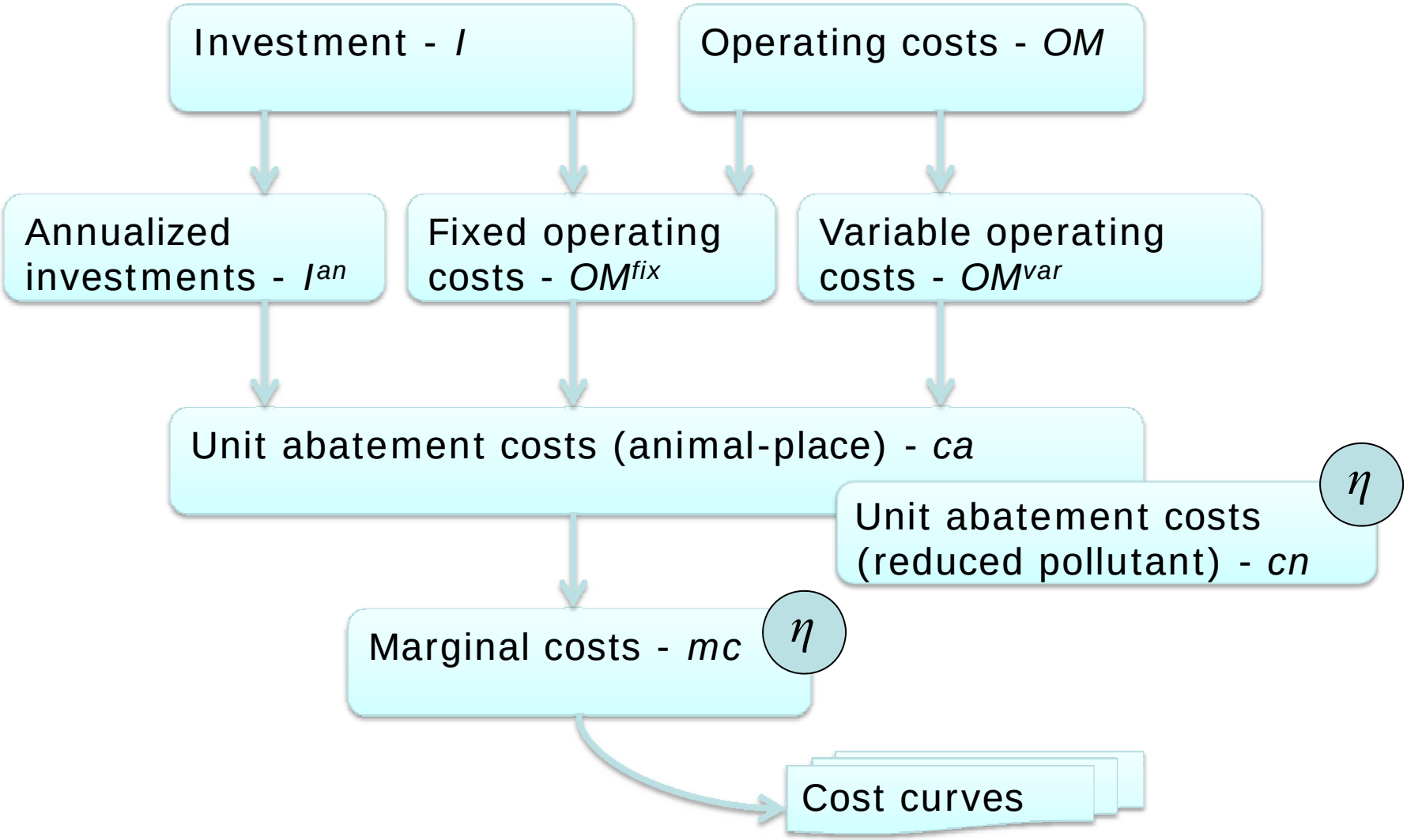
- Combinations of the above options

- + options to control non-CO_2 GHG (CH_4, N_2O)

The expenditures on emissions control are differentiated in GAINS into:

- **Investments**
- **Fixed operating costs**,
  i.e., costs of maintenance, insurance, administrative overhead
- **Variable operating costs**,
  e.g., increase in feed or fertilizer price, additional energy, water and labour use, costs of waste disposal, etc.

Cost methodology in GAINS



Investment cost

$$I_{i,k,l} = ci^{f}_{i,k} + \frac{ci^{v}_{i,k}}{ss_{i,l}}$$

ci^f, ci^v **– investment function coefficients**
ss **– average farm size**
i,k,l **– livestock category, abatement technique, country**

or for storage

$$I_{i,k,l} = \frac{(ci^{f}_{i,k} \cdot st_{i,l} \cdot mp_{i,l})}{ar^{2}_{i,l}} + \frac{ci^{v}_{i,k}}{ss_{i,l} \cdot ar_{i,l}}$$

st **– storage time**
mp **– manure 'production' per year**
ar **– production cycles per year**

Annualized investments

$$I^{an}_{i,k,l} = I_{i,k,l} \cdot \frac{(1+q)^{lt_k} \cdot q}{(1+q)^{lt_k} - 1}$$

i,k,l **– livestock category, abatement technique, country**
lt **– lifetime of abatement technique**
q **– interest rate (4%)**

Operating costs

$$OM^{fix}_{i,k,l} = I_{i,k,l}\ fk_{i,k}$$

$$OM^{\text{var}}_{i,k,l} = \sum_{p} Q_{i,k,p} c_{i,k,p}$$

fk **– percentage of investment costs**
Q **– quantity of *p***
c **– unit price of a given *p***
p **– parameter type (additional energy, labour, waste disposal, etc.**

Costs of low ammonia application options

$$C^{m}_{k,l} = ci^{f}_{k} - ci^{v}_{k} \cdot Q^{mh}_{k,l}$$

Total cost are calculated considering region specific shares of technologies

$$OM^{\text{var}}_{i,l} = \sum_{k} (S^{m}_{i,k,l} \cdot C^{m}_{i,k})$$

C^{m}	– Cost of option *k* per m³
ci^{f}, ci^{v}	– cost coefficients for a specific option *k*
Q^{mh}	– manure application rate for option *k*
i,k,l	– livestock category, abatement technique, country
S^{m}	– share of option *k*

Unit costs

$$ca_{i,k,l} = \frac{(I^{an}{}_{i,k,l} + OM^{fix}{}_{i,k,l})}{sb_{i,l}} + \frac{OM^{var}{}_{i,k,l} \cdot ar_{i,l}}{sb_{i,l}}$$

ca **– unit costs per animal-place**
ar **– production cycles per year**
sb **– capacity utilization factor**
η_k **– removal efficiency of option *k***

Cost efficiency can be evaluated if the annual costs are related to the abated emissions

$$cn_{i,k,l} = \frac{ca_{i,k,l}}{ef_{i,k,l} \cdot \eta_{i,k,l}}$$

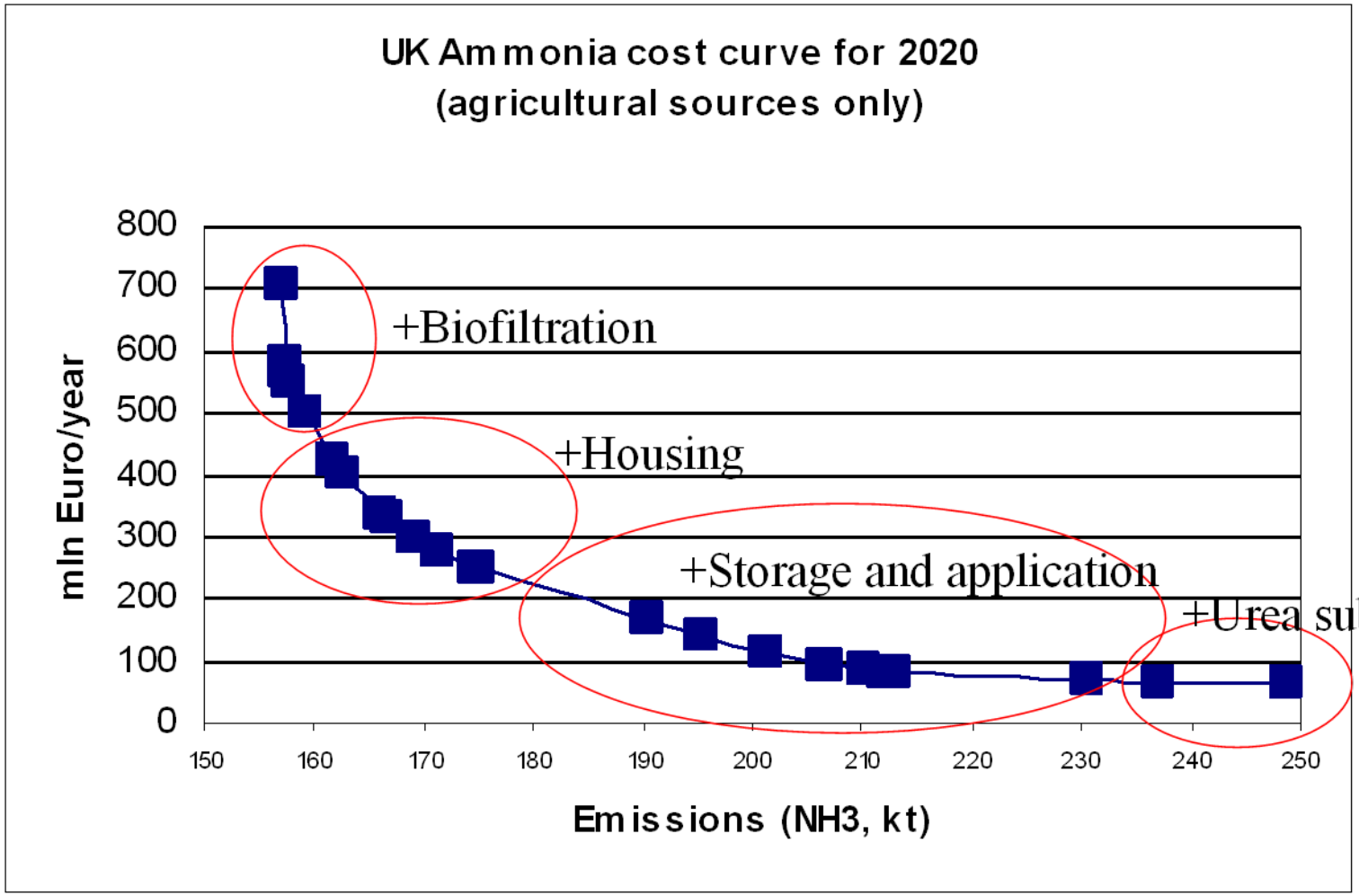
$ef_{i,l}$ **– emission factor for livestock category *i* and country *l***
η_k **– removal efficiency of option *k***

Marginal cost

$$mc_k = \frac{cn_k \eta_k - cn_{k-1} \eta_{k-1}}{\eta_k - \eta_{k-1}}$$

cn_k – unit costs for option *k*
η_k – removal efficiency of option *k*

Example of a cost curve



Costs differ by country

- Agricultural practice
- Implementation of measures
- Farm size
- Climate
- Internal cost structure (labour cost, ...)
- Constraints limiting wide application (*Applicability*)

→ **GAINS needs input reflecting local factors!**

Status of data in GAINS

- Basic data as used for the CAFE process
  (For NH_3 related technology principally based on the 1999 guidance; cost parameterization relies primarily on mid90's to early00' data from the Netherlands, Denmark, UK, Switzerland)
- Some of the regional characteristics updated in 2009/10
- The new TFRN guidance document information not included yet
- The update should take place before the scenarios for the review of the UNECE Gothenburg Protocol will be finalized

Issues

SELECTED with respect to: *Costs, Reduction potential*

- Is the set of measures in GAINS appropriate?
- Better representation of European experience in applying measures (costs, efficiency, limitations)
- Current structure and its evolution, e.g., future size distribution
- Constraints in application (applicability) of specific measures in the future
- Consideration of some pollutant/media interactions

- So far it has been more difficult to develop parameterization for Southern and Eastern Europe