

Convention on Long-Range Transboundary Air Pollution -
Expert Group on Ammonia Abatement

**CALCULATING THE UNIT COSTS
OF AMMONIA ABATEMENT
TECHNIQUES
and TEMPLATE**

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Network'

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INTRODUCTION

At the last meeting of the Expert Group at Průhonice, Czech Republic from the 27th to 28th April 2006 it was agreed to establish a network¹ to collate information on abatement costs. This note describes the way costs of each technique should be calculated and set out, using the **template**, in order to get the most value from the process.

The rationale for adopting a common approach is that:

- Only by having a common approach can costs be discussed on an objective basis between countries. Without such a common approach there is no common understanding.
- Information sharing is an important issue. This becomes more difficult in the absence of a common approach.
- Understanding the differences in costs between countries may lead to the development of more cost-effective techniques. Again this is hampered by the lack of a common approach.
- Europe-wide comparisons are currently used in the RAINS model operated by IIASA² and possibly elsewhere. If countries adopt a common costing techniques there will be a greater understanding of the issues raised by these models.

Initially, participating countries are invited to submit costs, on a voluntary basis, for techniques included in the RAINS model. These techniques are listed at Appendix 1. Future developments of this and other models are likely to include other options not listed at Appendix 1. Therefore countries are encouraged to submit cost data on all the techniques they are considering.

METHODOLOGY

This section comprises the following topic areas:

- Overview.
- Type of measure.
- Calculation of 'unit' costs.

OVERVIEW

The method outlined below is the same as that set out in the IPPC Intensive Livestock Bref.

¹ See Appendix 1

² International Institute for Applied Systems Analysis, Laxenburg, Austria.

The calculation of unit cost requires a clear understanding of:

- The proposed technique to be introduced to reduce emissions.
- The whole range of systems of production and management that are found on affected farms in the country concerned.
- The impact that the introduction of the technique will have on particular farm production and management systems in both physical and financial terms as well as in terms of both costs and benefits.

The calculation will result in an annual cost, which may comprise an allowance for capital expenditure amortised over the life of the investment.

CATEGORIES OF TECHNIQUE

Techniques applicable to livestock sector of the agricultural industry may be described by one of the following categories:

- Feed.
- Housing.
- Manure storage.
- Treatment of manure.
- Application of manure to land.
- Off-farm measures.

Note: 'Manure', in this context, may be liquid slurry or solid manure

The technique should be identified under one of the above categories, and according to livestock category affected for example, laying hens or breeding pigs. The categories are subsequently used to identify how 'unit' costs should be calculated.

CALCULATION OF UNIT COSTS

Unit costs are the annual increase in costs that a typical farmer will bear as a result of introducing a technique. Therefore the calculation should show the **additional costs** compared with normal practice, sometimes referred to as the **reference system**.

The general approach to the calculation of unit costs is as follows:

- Define the physical and husbandry changes resulting from implementation of the abatement technique based on a thorough understanding of current farming systems.
- For each technique identify those areas where costs or performance changes will be associated with the introduction of that technique.

- In all cases, only those costs directly associated with the technique should be considered.
- Additional costs associated with any technical enhancements should be ignored.
- As the assessment of costs are at farm level, any grants that are available should be deducted from expenditure.
- Costs should be **net of taxes**.
- Take account of cost savings.
- **Only those costs which are additional to the reference system should be included in the calculation.**

For this purpose, all costs should be expressed in Euros. Where countries use other currencies conversion to € should be made at the exchange rate applicable for 2004. This data can be found in the printed versions of the IMF annual statistics and reports. Monthly data can be found at http://www.imf.org/external/np/fin/rates/param_rms_mth.cfm and may be used if the printed document is not available.

All the material for inclusion in this database should be written in **English**.

THE TEMPLATE

This general template is provided so that all countries can prepare, and submit for collation, costs in a common format. Some guidance on figures is given but countries should use their own data wherever possible. The cost items will vary with technique and livestock type. Separate costings will be needed for each technique, livestock type and scale of operation being considered.

A blank template is given at Appendix 6.

Technique: *Briefly describe the technique.*
Livestock type: *Identify the livestock categories to which the costs refer.*
Reference system: *Briefly describe the reference system.*
Country:

Technical Description

Provide a description of the size or scale of the unit on which the cost are based.

| | Units ¹ | Number of units |
|--|--------------------|-----------------|
|--|--------------------|-----------------|

Note 1: See Appendix 3

Basis of the costs

Identify the cost components, their usage and cost in €/unit of usage used in the calculation of the cost of the technique. All cost should be detailed here to permit readers to fully understand the basis of the calculations.

| Components ² | Units | Number of units |
|-------------------------|-------|-----------------|
|-------------------------|-------|-----------------|

Note 2: see Appendix 4

Calculation of the annual cost

Use this table template to calculate the annual cost of a particular technique on a per unit basis.

| | Unit ¹ | Capital Cost € | Total Cost € per year/unit |
|---|-------------------|----------------|----------------------------|
| Capital Cost <i>Identify the items</i> | | aa.bb | |
| Annual Cost | | | |
| Annual charge ² for capital | €/... | | cc.dd |
| <i>Identify the items²</i> | €/... | | ee.ff |
| <i>Identify the items²</i> | €/... | | gg.hh |
| Total | €/... | | ww.yy |

Note 2: See Appendix 4

A worked example is shown at Appendix 5.

COLLATION

Once the calculations are completed, countries are asked to send the templates to a member of the network, see Appendix 1. The information will be collated and, if appropriate, made available to other countries seeking guidance on cost calculations.

Appendix 1 Members of the network

Though not closed to any willing participants, the network will consist, initially at least, of the following volunteers:

| Name | | Organisation | e-mail address |
|--------|------------------|-------------------|--|
| To be | advised | RIVM, Netherlands | bronno.de.haan@rivm.nl |
| Arne | Grønkjaer Hansen | Denmark | agh@landscentret.dk |
| Zig | Klimont | IIASA, Austria | klimont@iiasa.ac.at |
| Gema | Montalvo | Pig-champ, Spain | gmontalb@tragsa.es |
| Carlos | Piñeiro | Pig-champ, Spain | carlos.pineiro@pigchamp-pro.com |
| Martin | Ryan | Defra, UK | martin.ryan@defra.gsi.gov.uk |

Appendix 2 Techniques considered by RAINS

The following ammonia abatement techniques for agriculture are currently considered in the RAINS model. In the future it is likely that more techniques will be added to the options available

| Technique | Efficiency (where applicable) | |
|--|-------------------------------|-----|
| | High | Low |
| Covered slurry storage | ✓ | ✓ |
| Covered solid manure storage | ✓ | ✓ |
| Low NH ₃ application of slurry | ✓ | ✓ |
| Low NH ₃ application of solid manures | ✓ | ✓ |
| Low N feed systems | | |
| Slurry scraping | | |
| Pig housing | | |
| Poultry housing | | |
| Bio-filtration | | |
| Urea substitution | | |
| Incineration of poultry manure | | |
| Anaerobic digesters | | |

Further information on the generic techniques included in RAINS can be seen at this web site: <http://www.iiasa.ac.at/rains/reports/ir-04-048.pdf>

Appendix 3 Units used for assessing costs

'Units' Used for Assessing Costs

| Category | 'Units' | Details |
|--|--------------------------|---|
| Feed | per head | Per head of livestock |
| Housing | places | Building capacity |
| Manure storage, treatment and land application | m ³ or tonnes | Liquid slurry (including dilution) and solid manure (including bedding) |
| Off farm measures | m ³ or tonnes | When concerned with slurry and manure treatment |

Appendix 4 Typical component costs

The following detailed factors should be considered in relation to each technique:

Feed

Changes to diets can be applied to many classes of livestock to reduce ammonia emissions. The following implications need consideration in each case.

| Capital Costs | Annual Costs to Consider |
|----------------------------|--|
| Additional feeding systems | Annual charge ¹ , repairs ² and power inputs. Changes to carcass value. Relative costs of diets. Changes to livestock performance and feed consumption. Changes in excreta output . Changes in labour requirements. |

Housing

Typically, the following elements should be considered. Local conditions may require other elements to be calculated.

| Capital Costs | Annual Costs to Consider |
|----------------------------|---|
| Changes to housing systems | Annual charge ¹ , repairs ² and power inputs. Changes in house capacity. Changes in labour requirements. Changes in bedding requirements Changes to livestock performance and feed consumption. Changes in excreta storage capacity in the building . Fuel usage ³ . |

Capital costs may refer to either the modification of existing facilities or the **additional** costs of replacement facilities. The choice will depend on building condition and suitability for conversion, normally related to age and remaining economic life. Only the additional costs of providing

those facilities that relate to the facilities pollution abatement capabilities should be included.

Manure Storage

Typically, the following elements should be considered. Local conditions may require other elements to be calculated.

| Capital Costs | Annual Costs to Consider |
|--------------------|---|
| Additional storage | Annual charge ¹ , repairs ² . |
| Permanent covers | Annual charge ¹ , repairs ² . |
| | Cost of temporary covers on an annual basis. |
| | All covers: |
| | Changes in labour requirements. |
| | Reductions in rain water dilution. |
| | Fuel usage ³ . |

Application of manure to land

Typically, the following elements should be considered. Local conditions may require other elements to be calculated.

| Capital Costs | Annual Costs to Consider |
|------------------------|---|
| Low emission spreaders | Annual charge ¹ , repairs ² |
| | Changes in tractor power requirement |
| | Changes in work rates |
| | Changes in labour requirements. |
| | Fuel usage ³ . |
| | Or alternatively use the contractor costs |

Where it is considered normal practice to employ **contractors** to apply slurry or manure either as part of the reference system or as a consequence of adopting a low emission system the appropriate typical contractor costs should be used in place of the calculated typical cost of using the farmers' own equipment.

Notes to the above

Note 1: Capital expenditure on abatement techniques should be converted to an annual charge when calculating the unit cost. Calculate the annual charge using the following standard formula:

$$\text{Annual charge} = C \times \left[\frac{r(1+r)^n}{(1+r)^n - 1} \right]$$

Where:

C = capital investment in €

r = rate of interest expressed as a decimal of 1. For example an interest rate of 4% is entered in the equation as 0.04.

n = term in years

For the purposes of calculating costs for UN ECE, EU and RAINS use a **standard interest rate of 4%**. For national calculations the rate of interest that is applied should reflect that commonly paid by farmers and will vary by country and by investment term.

The term will depend on the type of investment and whether it is a new facility or a conversion.

In the case of new facilities the following economic lives are given as a guide. In particular circumstances it may be necessary to vary these figures.

| Type of investment | Economic life in years |
|--------------------|------------------------|
| Buildings | 20 |
| Fixed equipment | 10 |
| Machinery | 5 |

In the case of conversions it is necessary to annualise the capital cost over the remaining life of the original facility.

In many cases the facility may have a productive life in excess of the economic life, though it is the economic life that must be used in these calculations.

When using this method, an additional allowance for depreciation of the asset should **not** be included in the calculation.

Note 2: Repair costs associated with any investment will vary greatly. The type of investment, original build quality, operating conditions, age in relation to design life and amount of use all play their part in influencing costs.

Local figures should be used where available. If these are unavailable the following percentages of the cost of the investment cost of new equipment may be used to calculate the annual cost of repairs.

| Type of investment | Annual repair costs as a percentage of the new equipment cost |
|-----------------------------|---|
| Buildings | 0.5-2 |
| Fixed Equipment | 1-3 |
| Tractors | 5-8 |
| Manure and slurry spreaders | 3-6 |

Note 3: The following general formulas can be used to calculate fuel costs:

Electricity

$$\text{Fuel cost} = \text{kWh} \times \text{Hours of use} \times \text{Fuel price}$$

Tractor Fuel

$$\text{Fuel cost} = \text{kWh} \times \frac{\text{Fuel consumption}}{\text{per kWh}} \times \text{Hours of use} \times \text{Fuel price}$$

Appendix 5 Example cost calculation

| | |
|-------------------|-----------------------------------|
| Technique: | Littered system in a new building |
| Livestock type: | Finishing pigs |
| Reference system: | Fully slatted accommodation |
| Country: | Spain |

Technical Description

| | Units | Number of units |
|-------------------|--------|-----------------|
| Building capacity | places | 1440 |

Basis of the costs

| Components ² | Units | Number of units |
|---|-----------------------|-----------------|
| Accommodation additional construction costs | € | 0 |
| Dunghill cost | € | 6825 |
| Dunghill life | years | 15 |
| Repairs for dunghill | % investment | 1 |
| Interest rate ¹ | % | 4 |
| Straw needed | kg/pig/week | 2.10 |
| Straw cost | €/kg | 0.06 |
| Occupancy rate | % | 85 |
| Machinery for cleaning and spreading manure | hours/place/year | 0.80 |
| Machinery cost | €/hour | 30 |
| Slurry produced | m ³ /place | 2.50 |
| Slurry application cost | €/ m ³ | 0.70 |

Note 1: For the purposes of calculating costs for UN ECE, EU and RAINS use a **standard interest rate of 4%**. For national calculations use a rate appropriate to local circumstances.

Calculation of the annual cost

| | Unit ¹ | Capital Cost € | Total Cost € per year/place |
|--|-------------------|-------------------|-----------------------------------|
| Capital Cost | | | |
| Dunghill | total € | 6825 | |
| Annual Cost | | | |
| Annual charge for capital ¹ | €/place | | 0.43 |
| Dunghill repairs ² | €/place | | 0.05 |
| Straw ³ | €/place | | 5.57 |
| Tractor costs ⁴ | €/place | | 24.00 |
| Slurry application ⁵ | €/place | | -1.75 |
| Total | €/place | | 28.30 |

Notes:

1. $€6825 \times 0.090$ (15years at 4%) \div 1440 places = €0.43/place.
2. $€6825 \times 1\%$ \div 1440 places = €0.05/place.
3. $2.1\text{kg/place/week} \times 0.85$ (occupancy) \times 52 weeks \times €0.06/kg = €5.57/place.
4. 0.8 hours per place \times €30/hour = €24/place
5. Costs saved in connection with reference system slurry no longer collected and spread – $2.5 \text{ m}^3/\text{year}$ at €0.70/ m^3 = €1.75/place

Appendix 6 Blank template

Technique:

Livestock type:

Reference system:

Country:

Technical Description

| | Units | Number of units |
|--|-------|-----------------|
|--|-------|-----------------|

Basis of the costs

| Components | Units | Number of units |
|------------|-------|-----------------|
|------------|-------|-----------------|

Calculation of the annual cost

| | Unit ¹ | Capital Cost € | Total Cost € per year/... |
|---------------------------|-------------------|-------------------|------------------------------|
| Capital Cost | | | |
| Dunghill | total € | | |
| Annual Cost | | | |
| Annual charge for capital | €/... | | |
| | €/... | | |
| | €/... | | |
| | €/... | | |
| | €/... | | |
| Total | €.... | | |