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Introducing Costs of Nitrogen Abatement in the EMEC Model

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Contents

1. Introduction

The Swedish parliament has enacted 16 environmental quality objectives serving as benchmarks for the national environmental policy, which ultimately seeks to solve the major environmental problems within one generation (i.e. before 2020). Reducing nitrogen oxides emission is important in order to fulfil several of the quality objectives, such as "Natural Acidification Only", "Zero Eutrophication", "A Balanced Marine Environment", "Flourishing Coastal Areas and Archipelagos", "Flourishing Lakes and Streams", and "Clean Air". A refunded charge on Nitrogen oxide emissions was introduced in 1992 on combustion plants producing at least 50 GWh per year. The motivation for a refunded charge on the largest plants rather than a pollution tax relates to the rather extensive monitoring costs, which incentive a switching to smaller less emission effective plants in order to escape the charge. In 1996 the limit for which plant to charge was lowered to 25 GWh per year due to decreasing monitoring costs (Höglund Isakssons, 2005). According to Swedish EPA (2003), the specific emissions were decreased by 40 percent since the introduction of the charge.

The Environmental Medium Term Economic Model (EMEC) is an applied general equilibrium model of the Swedish economy developed and maintained by the National Institute of Economic Research for analysis of the interaction between the economy and the environment. The modelling of this interaction includes, for example, the emissions of nitrogen oxides (NO_x) resulting from fuel combustion in the goods production and households' fuel combustion. The opportunity of abating the nitrogen oxides (NO_x) emitted in the hot water supply and in the production of pulp and paper is introduced in the model by the method presented in the following sections. EMEC includes 26 industrial sub sectors, 33 composite commodities and a public sector producing a single commodity.[1] Produced goods and services are exported and used together with imports to create composite commodities for domestic use. Composite commodities are used as inputs by industries and for capital formation. In addition, households consume composite commodities and there are 26 consumer goods. For a full description of EMEC, see Östblom and Berg (2006).

A short theoretical background is given in Section 2. The abatement cost function is presented in Section 3. The data and estimation results are given in Section 4. Section 5 presents the new equations introduced in the model given the opportunity of nitrogen abatement. A summary and suggestions for further work follow in Section 6.

2. Theoretical background

Economic activities sometimes pollute air and water. Firms and households value alternative use of these environmental resources and should thus be compensated by the polluter. No market exists for clear air and fresh water, but the society can internalise the costs of polluting by a corrective duty or tax on the polluting activities. Damage costs are not modelled in EMEC and thus the welfare effect of a Pigouvian

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[1] The sectors in EMEC are: agriculture, fishery, forestry, mining, other industries, mineral products, pulp and paper mills, drug industries, other chemical industries, iron and steel industries, non-iron metal industries, engineering, petroleum refineries, electricity supply, hot water supply, gas distribution, waster and sewage, construction, railroad transports, road goods transports, road passenger transports, sea transports, air transports, other transports, services, and real estate.

tax cannot be analysed. Instead, the cost effectiveness to attain given reductions of polluting emissions is the object of analysis.

The polluting activity will be reduced in scale due to the corrective excise. When abatement processes exist for the polluting activity (e.g. end of pipe processes), the reduction of output also depends on the abatement cost as the polluter will choose abatement as long as the corrective excise exceeds the abatement cost. It is therefore of interest to model abatement processes in an applied general equilibrium model.

Abatement can be introduced in applied equilibrium models in different ways. We could assume a sector producing abatement services by use of labour, capital and material and that the services are demanded by the polluting activities. We could also let the polluting activities produce the services themselves by use of equipment delivered by other sectors. Bergman (1989) uses the first approach by letting abatement services be produced with capital as the exclusive factor of production. Also, Dellink, Gerlagh, and Hofkes (1999) and Dellink (2000) use this approach but in a somewhat different way as they let the composite good, demanded by the polluting activities, be a mix of abatement and pollution. Capros et al (1995) let the abatement services be produced by the polluter to an additional cost for demanded abatement equipment. The production costs for abatement services produced either by an abatement service sector or by the polluter, are often derived from abatement cost curves. Bergman (1989), however, uses the cost of capital in the abatement service sector. The approach adopted for the model EMEC follows that of Capros et al (1995) and was used by Östblom (2002) for modelling sulphur abatement in EMEC.

The unit cost of abatement increases with the quantity abated as the less expensive measures of abatement are applied first. A typical abatement process has stepwise increasing marginal costs due to indivisibility in the measures of abatement. The marginal cost function of abatement is however for mathematical convenience often modelled as a smooth function in applied general equilibrium models.

3. The abatement cost function

The abatement activities are here seen as deliverances of goods and services by industries producing end-of-pipe-technology, which is ready to use as inputs in firms, and not as an investment of new capital equipment. Therefore, the abatement cost is modelled as a cost of materials per unit of emissions abated and is added to the price of energy. The material cost is assumed to be an increasing function of the degree of abatement as the less expensive measures of abatement are applied first. This approach is useful for "end of pipe" technologies reducing nitrogen oxides resulting from fuel combustion.

Producers are assumed to use the production factors labour *L*, capital *C*, energy *E* and materials *M* with corresponding prices *PL*, *PC*, *PE* and *PM* to produce commodities *Q* with prices *PQ*. Total revenue equals total costs in production:

$$PQ \cdot Q = PL \cdot L + PC \cdot C + PE \cdot E + PM \cdot M \ . \qquad (1)$$

A part of materials is required as material input M_a for abatement services and this part is assumed to be related to energy input by a function α such that $M_a = \alpha \cdot E$.

The material input remaining for other purposes will seemingly be $(M - \alpha \cdot E)$. Equation (1) is rewritten as:

$$PQ \cdot Q = PL \cdot L + PC \cdot C + (PE + \alpha \cdot PM) \cdot E + PM(M - \alpha \cdot E) \qquad (2)$$

Abatement services per unit of emissions are assumed to relate to the unit cost of abatement measures $c(a)$ and the degree of abatement $0 \leq a < 1$. Emissions relate to the use of energy by the emission coefficient e and thus abatement services per unit of energy input is: $\alpha = c(a) \cdot a \cdot e$. The unit cost of abatement measures, in base year prices, is in turn assumed to be an increasing function of the number of measures. It increases with the degree of abatement as successively more expansive abatement measures must be used when increasing the degree of abatement and thus: $c'(a) > 0$ and $c''(a) > 0$.

The equation (2) can now be rewritten as:

$$PQ \cdot Q = PL \cdot L + PC \cdot C + (PE + c(a) \cdot a \cdot e \cdot PM)E + PM(M - c(a) \cdot a \cdot e \cdot E) \quad (3)$$

The unit cost of abatement services $c(a) \cdot a \cdot e \cdot PM$ becomes a component in the price of energy to the firm and the material input for production reduces to total materials M less the material input used for abatement services $c(a) \cdot a \cdot e \cdot E$.

We may also have a fixed Pigouvian unit tax or charge t on the various emissions and given the opportunity of an abatement process, the unit cost of emissions CE to the firm will have a cost component for abatement and a cost component for the actual emissions $t \cdot (1 - a) \cdot e$.

$$CE = c(a) \cdot a \cdot e \cdot PM + t \cdot (1 - a) \cdot e \qquad (4)$$

The degree of abatement a will be a decision variable of the firm in order to minimise the unit cost of emissions. Minimising the unit cost of emissions CE with respect to the degree of abatement a, gives the following first order condition $\left(\frac{\partial CE}{\partial a} \right) = 0$ and with the expression for CE in equation (4) we arrive at the following marginal condition, where the marginal cost of abatement services equal the tax rate:

$$PM \cdot (c'(a) \cdot a + c(a)) - t = 0 \qquad (4')$$

The first derivative $c'(a)$ of the abatement cost function (in base year prices) is the resulting marginal abatement cost function when more expensive abatement measures are successively introduced in abating an increasing share of emissions. The firm will choose abatement as long as the cost of abating another unit of pollution falls below the tax or charge paid for emitting another unit of pollution. Plotting the increasing marginal cost of introducing abatement measures result in a stepwise function. When solving large-scale models, we rather deal with smooth functions than stepwise functions and, therefore, we choose to fit the following function, suggested by Capros et al (1995), to the data of marginal abatement costs.

The marginal abatement cost function is specified as:

$$c'(a) = \beta(1-a)^{\gamma}, \quad \beta > 0 \text{ and } \gamma < 0. \tag{5}$$

Integrating the function in (5) gives the corresponding unit abatement cost function:

$$c(a) = \frac{-\beta}{1+\gamma}(1-a)^{\gamma+1} + k, \quad \beta > 0 \text{ and } \gamma < 0. \tag{6}$$

4. The use of GAINS data for constructing abatement cost functions

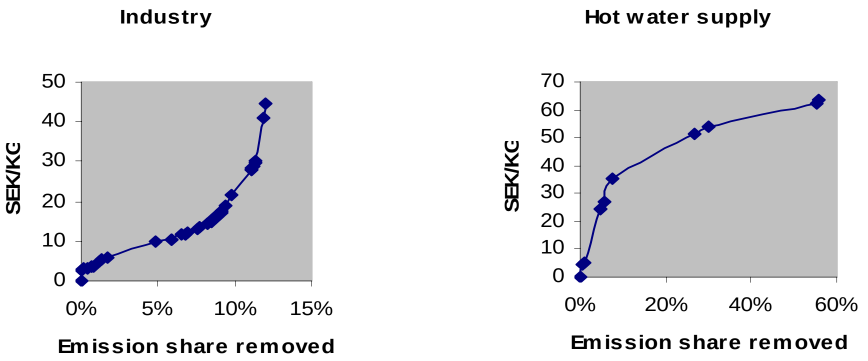
The task is now to determine appropriate parameters to the unit cost function for the abatement measures. The ideal is, of course, to estimate such a function from empirical observations. Data of abatement costs for the Swedish industry are however sparse as concluded by Kristenson (2001) and, we instead use the data for Sweden in the GAINS model and the Clean Air for Europe (CAFE) programme at IIASA (http://gains.iiasa.ac.at/gains/). Data for Sweden is reported by the Swedish EPA, and here we use the data update presented by the member countries during 2006.

The data

All data of the abatement costs for nitrogen oxides (NO_x) are from the GAINS model data base, which is described by Cofala and Syri (1998), and depicts the situation in the year 2020. Starting point is the "Current legislation" and the data rank all emission control options that are still available on top of measures required by the current legislation, according to their cost-effectiveness. The initial emissions and control costs include measures, which are already adopted by the current legislation. Costs are in 2005 SEK.

In the GAINS model a number of sources generating emissions are grouped into seven sectors of economic activities. The emissions generated are classified by fuel and abatement technique. For every emission classified in this way, the quantity of emission abated and the abatement cost are given. For Sweden only the fuel conversion sector and the industrial sector have a sufficient number of observations to estimate abatement cost functions. These observations are for different abatement techniques when combusting fuels (oil and coal) and are presented in Table B1 and Table B2 of Appendix B for hot water supply and the industry sector, respectively. The plotted unit costs of abatement in per cent for the industry sector and hot water supply are shown in Figure 1. Data plotted for the industry sector fit, rather well, the abatement cost function of equation (6), whereas data of the hot water supply sector has a much poorer fit to this function as the curve plotted for hot water supply is not increasing.

Figure 1 Plotted unit costs of NOx- abatement.



Estimation results

The parameters β and γ are estimated from the GAINS model database by using the linear form of the unit cost function given in equation (6). Estimating this equation with OLS for the data of the industry and hot water supply sectors in tables 1 and 2, letting k be the costs at initial emissions, give the parameter estimates in Table 1.

$$\ln(c-k)=\ln\left(\frac{-\beta}{1+\gamma}\right)+(\gamma+1)\ln(1-a) \qquad (6')$$

Table 1 Parameter estimates

Sector	β	γ	K
Industry sector	58.41	-19.75	0
Hot water supply	32.24	-3.12	-10

The unit cost function for industry will then be:
$$c(a)=3.12\cdot(1-a)^{-18.75}$$

and the corresponding marginal abatement cost function is
$$c'(a)=58.41\cdot(1-a)^{-19.75}$$

The unit cost function for the hot water supply will then be:
$$c(a)=15.28\cdot(1-a)^{-2.11}-10$$

and the corresponding marginal abatement cost function is:
$$c'(a)=32.24\cdot(1-a)^{-3.11}$$

Using a wide range of values for the degree of abatement and simulating the unit cost functions and the marginal cost functions give the typical shapes of these functions depicted in the Figures 2 and 3. We note that the degree of abatement approaches a limit at lower levels of abatement for the industry sector than for the hot water supply. The measures of abatement are thus more costly in the industry sector than in the hot water supply sector.

Figure 2 Unit cost functions for industry and hot water supply

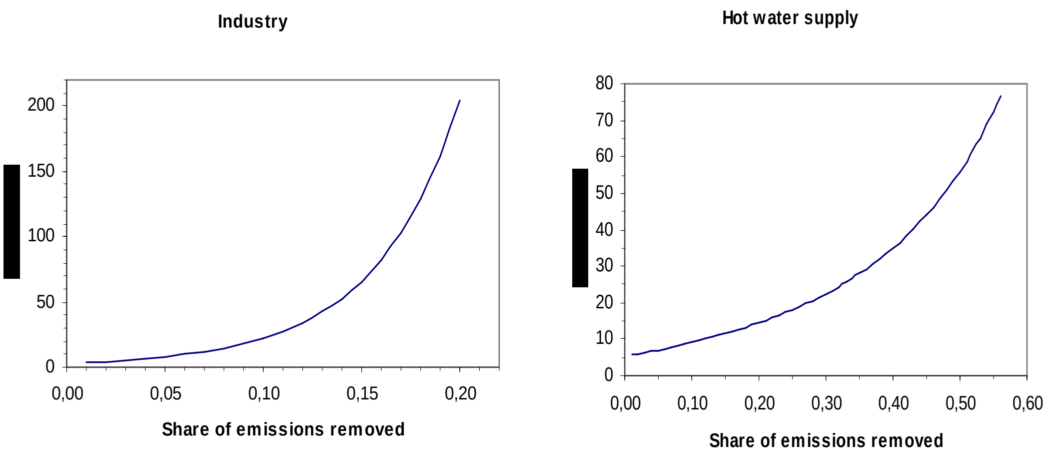
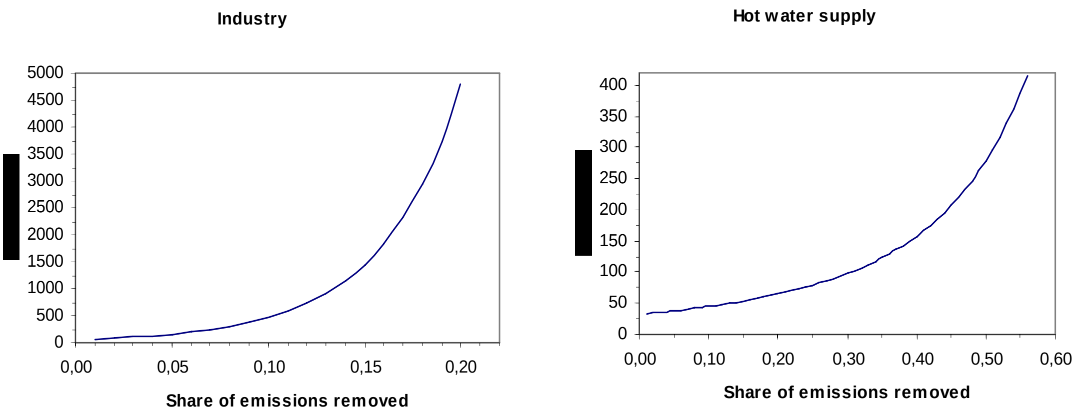


Figure 3 Marginal cost functions for industry and hot water supply



5. The new equations of the model EMEC

The estimated cost function of the hot water supply is used to model costs for abating NO_x in combusting coal and heating oils (commodities 6 and 15 in EMEC) for production of hot water (sector 14 in EMEC) [2]. That of the industry sector is used in the same manner for production of pulp and paper (sector 7 in EMEC). The following total cost functions $TCOST_{ilj}$ (corresponding to $c(a)$ in equation (6)) and marginal cost functions $MCOST_{ilj}$ (corresponding to $c'(a)$ in equation (5)) of abating pollutant *l* when using commodity *i* in sector *j*, are introduced in the model:

$$TCOST_{ilj} = \frac{-\beta_{ilj}}{1+\gamma_{lkj}}\left(1-a_{ilj}\right)^{\gamma+1} + k_{ilj}; \quad l = NOx; \quad i = 6,15; \quad j = 7,14$$

[2] For sector classification and commodity classification see tables B3 and B4, respectively, in Appendix B.

$$MCOST_{ilj} = \beta_{ilj}\left(1 - a_{ilj}\right)^{\gamma}; \qquad l = NOx;\ i = 6{,}15;\ j = 7{,}14$$

The marginal condition (4') is stated in the model EMEC as:

$$PM_j \cdot \left(MCOST_{ilj} \cdot a_{ilj} + TCOST_{ilj}\right) - EMKOEF_{ilj} \cdot ITP_{ilj} = 0 \qquad l = NOx;\ i = 6{,}15;\ j = 7{,}14$$

Where PM_j is the price of materials used in sector *j*, $EMKOEF_{ilj}$ is an emission coefficient for pollutant *l* when using commodity *i* in sector *j* and ITP_{ilj} is tax on commodity *i* for pollutant *l* in sector *j*. The emission coefficient in the equation transforms ITP_{ilj}, which is a tax on the polluting commodity, into a tax on the pollutant, and thus $EMKOEF_{ilj} \cdot ITP_{ilj}$ corresponds to the tax *t* in equation (4').

The cost of abatement measures being a component in the price of energy alters the price equations of the model. The price equations of heating oils and coal, $PDS_{15,i}$ and $PDS_{6,i}$ respectively, must be altered when introducing the opportunity of abatement. The initial price equations are given in appendix A. When taking into account the costs of abatement, the new price equations become:[3]

$$\begin{aligned} PDS_{15,i} = {} & PD_{15} \cdot \left(1 + itp_{15}\right) + itpe_{15,i} + itpNOX_{15,i} \cdot \left(1 - a_{15,l,i}\right) + itpCO2_{15,i} + itpSO2_{15,i} + \ldots \\ & \ldots + PM(i) \cdot TCOST_{15,l,i} \cdot a_{15,l,i} \cdot EMKOEF_{15,l,i} \end{aligned}$$

$$\begin{aligned} PDS_{6,i} = {} & PD_{6} \cdot \left(1 + itp_{6}\right) + itpe_{6,i} + itpNOX_{6,i} \cdot \left(1 - a_{6,l,i}\right) + itpCO2_{6,i} + itpSO2_{6,i} + \ldots \\ & \ldots + PM(i) \cdot TCOST_{6,l,i} \cdot a_{6,l,i} \cdot EMKOEF_{6,l,i} \end{aligned}$$

for $i = 7{,}14$.

Where itp_{15} is the ad valorem net tax on inputs of oil and $itpe_{15,i}$, $itpSO2_{15,i}$, $itpCO2_{15,i}$ and $itpNOX_{15,i}$ are energy tax, sulphur tax, carbon tax and emission charge on nitrogen oxides, respectively, on oil. The energy tax and the environmental taxes are specific to various industries so as to allow for tax exemptions.

By substituting the expression for *TCOST* in these equations and deriving with respect to the degree of abatement gives conditions for the degree of abatement in terms of the parameters $\beta_{ilj}, \gamma_{lkj}$ and k_{ilj}. These conditions could then be programmed in the model as suggested by Capros et al (1995) in order to determine the degree of abatement at various tax rates.

An alternative approach used here, is to program the marginal condition as an inequality and letting *MCOST* be a part of the objective function. Consequently, we minimise *MCOST* with the marginal condition ≥ 0 but maximise consumption expenditures *PKL*. Thus:

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[3] These equations correspond to equations (1) and (2) in appendix A.

$$MAX\left\{\left(\sum_i \sum_j \sum_l MCOST_{ilj}\right)^{-1} + PKL\right\}$$

subject to

$$PM_j \cdot \left(MCOST_{ilj} \cdot a_{ilj} + TCOST_{ilj}\right) - EMKOEF_{ilj} \cdot ITP_{ilj} \geq 0$$

Also, a few more equations of the model must be altered to have a solution allowing for abatement. The sectoral demand of materials is affected as material input is used in the abatement process. The equations for emissions of pollutants will of course also be changed, as a part of the emissions will be abated.

The equations of sectoral demand of materials will change to [4]

$$M_i = bm_i^{sme_i - 1} \cdot \left(\frac{PME_i}{PM_i}\right)^{sme_i} \cdot ME_i + TCOST_{15,l,i} \cdot a_{15,l,i} \cdot EMKOEF_{15,l,i} \cdot IO_{15,i} + \\ + TCOST_{6,l,i} \cdot a_{6,l,i} \cdot EMKOEF_{6,l,i} \cdot IO_{6,i} \quad \text{for} \quad i = 7,14 \quad \text{and} \quad l = NO_x$$

The equations for emissions of pollutants will change to[5]

$$EM_l = \sum_{pr=6,15} \sum_i \left(1 - a_{pr,l,i}\right) \cdot EMKOEF_{pr,l,i} \cdot IO_{pr,i} + \sum_{pr=4,16} \sum_i EMKOEF_{pr,l,i} \cdot IO_{pr,i} + \\ + \sum_i EMKOEFM_{l,i} \cdot M_i, \qquad \text{for} \quad i = 7,14 \quad \text{and} \quad l = NO_x$$

6. Summary and suggestions for further work

EMEC is an applied general equilibrium model of the Swedish economy for analysis of the interaction between the economy and the environment. The opportunity of abating the nitrogen oxides (NO_x) emitted by hot water supply and in the production of pulp and paper was introduced in the model EMEC by the method presented here and the opportunity of abating the sulphur dioxide (SO_2) was introduced in EMEC by Östblom (2002).

Given these abating opportunities, the EMEC model will be better suited for examining the rates of taxes or charges necessary to imposed on sulphur dioxide and nitrogen oxides to reduce NO_x and SO_2 emissions in accordance with Sweden's environmental objectives. For example, the findings, by Östblom (2009), suggest that additional policy instruments would have to decrease the SO_2/GDP and NO_x/GDP ratios by 48 and 72 per cent, respectively for the 2020 carbon emissions target, in order to counteract the obstruction of ancillary benefits following from the redefined carbon emissions target actually discussed by the Swedish Government.

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[4] See equation (3) in Appendix A for the initial equation.

[5] See equation (4) in Appendix A for the initial equation.

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Appendix A

Price equations

PDS_{15} and PDS_6 are equilibrium prices, including taxes, on the goods markets for heating oils and combustion coal, respectively.

$$PDS_{15,i} = PD_{15} \cdot (1 + itp_{15}) + itpe_{15,i} + itpCO2_{15,i} + itpSO2_{15,i} \quad (1)$$
$$PDS_{6,i} = PD_6 \cdot (1 + itp_6) + itpe_{6,i} + itpCO2_{6,i} + itpSO2_{6,i} \quad (2)$$

for $i = 7{,}14.$

where itp_{15} and itp_6 is the ad valorem net tax on of oil and coal, respectively. The parameters $itpe_{15,i}$, $itSO2_{15,i}$, and $itCO2_{15,i}$ are energy tax, sulphur tax, and carbon tax, respectively, on heating oil. The parameters $itpe_{6,i}$, $itSO2_{6,i}$, and $itCO2_{6,i}$ are energy tax, sulphur tax, and carbon tax, respectively, on coal.

Demand for materials

Differentiation of the minimum cost per unit of material-energy composite ME_i, with the price PME_i, gives sectoral demand for materials M_i, with the price PM_i,:

$$M_i = bm_i^{sme_i - 1} \cdot \left(\frac{PME_i}{PM_i} \right)^{sme_i} \cdot ME_i \quad .i = 1,\ldots,18. \quad (3)$$

where sme_i is the substitution elasticity and bm_i is a calibration constant.

Emissions

The model evaluates the emissions of (CO_2), (SO_2) and (NO_x) as a function of the energy use and the material input for industries and the energy use for households. Total emissions of CO_2, SO_2 and NO_x in the use of energy and materials in production are given by:

$$EM_l = \sum_{pr=4,6,15,16} \sum_i \cdot EMKOEFF_{pr,l,i} \cdot IO_{pr,i} + \sum_i EMKOEFFM_{l,i} \cdot M_i, \text{ for } i = 7{,}14 \text{ and } l = NO_x \quad (4)$$

where $EMKOEFF_{pr,l,i}$ are coefficients for emissions *l* in the use of energy carriers *pr* in sector *i,* and $EMKOEFFM_{l,i}$ are coefficients for emissions *l* in the use of materials in sector *i.*

Appendix B

Table B1. Share of reduction and reduction cost for NOx emissions in hot water supply

Fuel[1]	Technique[2]	NOx share removed in per cent	Unit cost in SEK per Kg NOx
OS2	CM	0.33	4.18
MD	CM	0.75	5.45
HC1	CSC	4.75	24.21
HF	SCR	4.83	24.55
HF	SCR	5.58	27.15
OS2	SCR	7.67	35.48
OS2	SCR	26.75	51.41
BC1	CSC	30.17	53.67
GAS	SCR	55.08	62.61
GAS	CSC	55.58	63.60

Note: [1] Heavy fuel oil (HF), Hard coal (HC), Other solid-high sulphur (OS), Medium distillates (MD), Brown coal (BC), Natural gas (GAS). [2] Combustion modofocation (CM), Selective catalytic reduction (SCR), CM+SCR (CSC).

Table B2. Share of reduction and reduction cost for NOx emissions in industry

Fuel[1]	Technique[2]	NOx share removed in per cent	Unit cost in SEK per Kg NOx
HC1	CM	0.05	2.56
HC1	CM	0.06	2.56
HF	CM	0.14	2.95
HF	CM	0.39	3.13
GAS	CM	0.68	3.38
HF	CM	0.72	3.48
HF	CM	0.73	3.51
MD	CM	1.23	4.93
GAS	CM	1.37	5.19
LPG	CM	1.69	5.72
OS2	CM	4.83	10.12
OS2	CM	5.88	10.55
MD	CM	5.91	10.57
OS1	CM	6.57	11.51
OS1	CM	6.79	11.78
HC1	CSN	6.82	11.83
HC1	CSN	6.92	11.96
GAS	CSN	7.50	13.05
HF	CSN	7.67	13.38
HF	CSN	8.16	14.27
HF	CSN	8.22	14.40
HF	CSN	8.41	14.78
HF	CSN	8.49	15.01
HF	CSN	8.52	15.09
GAS	CSN	8.78	15.98
GAS	CSN	8.86	16.28
HF	CSC	8.92	16.52
HF	CSC	9.11	17.26
HC1	CSC	9.15	17.45
HC1	CSC	9.17	17.51
GAS	CSC	9.40	18.86
OS2	CSN	9.82	21.44
OS2	CSN	11.08	27.97
HF	CSC	11.08	28.00
HF	CSC	11.11	28.14
HF	CSC	11.14	28.29
HF	CSC	11.21	28.71
GAS	CSC	11.32	29.79
GAS	CSC	11.34	30.10
OS2	CSC	11.85	41.10
OS2	CSC	12.01	44.52

Note: [1] Heavy fuel oil (HF), Hard coal (HC), Other solid-high sulphur (OS), Medium distillates (MD), Brown coal (BC), Natural gas (GAS), Liquefied petroleum gas (LPG). [2] Combustion modofocation (CM), Selective catalytic reduction (SCR), CM+SCR (CSC), Selective non-catalytic reduction (SNCR), CM+SNCR (CSN).

Table B3 Definition of private production sectors

Production sector in EMEC	NACE Rev.1*	Sector label in the Swedish National Accounts
1. Agriculture	01	Agriculture and hunting
2. Fishery	05	Fishing
3. Forestry	02	Forestry and logging
4. Mining	13	Metal ore mining
	14	Other mining and quarrying
5. Other industries	15,16	Manufacture of food, beverage and tobacco
	17-19	Textile industries
	20	Manufacture of wood and wood products
6. Mineral products	26	Manufacture of non-metallic mineral products
7. Pulp and paper mills	21	Manufacture of pulp, paper and paper products
	22	Printing and publishing
8. Drug industries	244	Manufacture of pharmaceuticals products
	245	Manufacture of soap and detergents
9. Other chemical industries	24 excl 244,245	Manufacture of chemicals and chemical products
	25	Manufacture of rubber and plastic products
10. Iron & steel industries	271-273	Iron steel basic industries
11. Non-iron metal industries	274-275	Non-ferrous metal basic industries
12. Engineering	28	Manufacture of metal products
	29	Manufacture of mechanical machinery
	30,31	Manufacture of electrical machinery and computers
	32	Manufacture of communication equipment
	33	Manufacture of measuring equipment, etc.
	34,35	Manufacture of transport equipment
	36,37	Other manufacturing industries
13. Petroleum refineries	23	Petroleum refining
14. Electricity supply	401	Electricity
15. Hot water supply	403	Steam and hot water supply
16. Gas distribution	402	Gas manufacture and distribution
17. Water and sewage	41	Water supply and sewage disposal
18. Construction	45	Construction
19. Rail road transports	601	Railway road transports
20 Road goods transports	6024	Road goods transports
21. Road passenger transports	6021-6023	Road passenger transports
22. Sea transports	61	Water transports
23. Air transports	62	Air transports
24. Other transports	63	Other transport activities
	64	Communications
25. Services	50-52	Wholesale and retail trade
	55	Restaurants and hotels
	65	Financial institutions
	66	Insurance
	71-74	Business services
	75,80-85,90-95	Other private services
26. Real estate	70	Letting of dwellings and other real estate

Note: *Nomenclature Général des Activités Economiques dans les Communautés Européennes. The statistical classification of economic activities in the European Community amended in March 1993.

Table B4 Definition of commodities

Commodity in EMEC	CPA code*	Commodity label in the Swedish National Accounts
1. Agricultural products	01	Products of agriculture and hunting
2. Fish	05	Fish and fishing products
3. Timber	02	Products of forestry and logging
4. Bio fuels	02 pt	Wastes from logging
5. Metal ores	13	Metal ores
	14	Other mining and quarrying products
6. Coal	10	Coal
7. Products n.e.c.	15,16	Food products, beverages and tobacco products
	17-19	Textiles and textile products
	20	Wood and wood products
8. Mineral products	26	Non-metallic mineral products
9. Pulp and paper	21	Pulp,paper and paper products
	22	Printed matter
10. Pharmacy products	244	Pharmaceuticals and medical chemicals
	245	Soap,detergents and cosmetics
11 Other chemical products	24 excl 244,245	Chemicals and chemical products
	25	Rubber and plastic products
12. Iron and steel	271-273	Basic iron and steel , tubes and wires
13. Other metals	274,275	Basic non-ferrous metals
14. Engineering products	28	Metal products
	29	Mechanical machines
	30,31	Electric machines and computers
	32	Communication equipment
	33	Measuring equipment
	34,35	Transport equipment
	36,37	Other manufactured products
15. Fuels	23200 pt	Heating oils
16. Motor fuels	23200 pt	Motor gasoline,diesel and jet fuels
17. Other petroleum products	23200 pt	Other refined petroleum products
18. Crude petroleum	11	Crude petroleum
19. Electricity	401	Electricity
20. Steam and hot water	403	Steam and hot water
21. Gas	402	Manufactured and distributed gas
22. Fresh water	41	Collected, purified and distributed water
23. Buildings	45	Construction works
24. Rail transports	601	Rail transports
25. Passenger transports	6021 pt,6023	Passenger transports by bus
	6022	Passenger transports by taxi
26. Large truck transports	6024 pt	Goods transports by trucks > 32 tons
27. Medium truck transports	6024 pt	Goods transports by trucks 3.5 - 32 tons
28. Small truck transports	6024 pt	Goods transports by trucks < 3.5 tons
29. Sea transports	61	Sea transports
30. Air transports	620	Air transports
31. Other transports	63	Other transport products
	64	Communication products
32. Services	50-52	Wholesale and retail trade products
	55	Restaurant and hotel services
	65	Financial services
	66	Insurance services
	71-74	Business services
	75,80-85,90-95	Other private services
33. Dwellings	70	Real estate services

Note: * EU Classification of products by Activity (CPA).