AN ENVIRONMENTAL INPUT-OUTPUT MODEL FOR IRELAND

Joe O'Doherty[a] *and Richard S.J. Tol*[a,b,c*]

[a] *Economic and Social Research Institute, Dublin, Ireland*

[b] *Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands*

[c] *Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA, USA*

* *Corresponding author: ESRI, Whitaker Square, Sir John Rogerson's Quay, Dublin 2, Ireland, richard.tol@esri.ie*

January 3, 2007

Abstract

This paper is presented in two parts. The first part demonstrates an environmental input-output model for Ireland for the year 2000. Selected emissions are given a monetary value on the basis of benefit-transfer. This modelling procedure reveals that certain sectors pollute more than others – even when normalised by the sectoral value added. Mining, agriculture, metal production and construction stand out as the dirtiest industries. On average, however, each sector adds more value than it does environmental damage. The second part uses the results of this input-output model – as well as historical data – to forecast emissions, waste and water use out to 2020. The growth in emissions of fluorinated gases and carbon monoxide and the growth of hazardous industrial waste exceed economic growth. Other emissions grow more slowly than the economy. Emissions of acid rain gases (SO_2, NOx and NH_3) will decrease, even if the economy grows rapidly.

1. Introduction

With rapid economic growth comes rapidly growing pressure on the environment, while concern about pollution and resource use waxes too. Ireland is no exception. Although it has leapt forward to become one of the richest countries on the planet, its environmental care is more typical of a middle-income country. As improving the quality of life depends less on increasing economic wealth, the people of Ireland will reprioritise and seek a new balance between the economy and the environment.

Efforts elsewhere to develop a balance between economic and environmental objectives have required complex modelling of national, regional, or even world economies and their interaction with the environment (see Duchin and Lange, 1994; Dellink *et al.*, 1999). In an Irish context, the imperatives implied by the Kyoto Protocol and the Water Framework Directive[1] will require the construction of similar

[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

models so as to develop a thorough understanding of environment-economy linkages and the effect of policy.

Like environmental care, research in environmental economics is underdeveloped in Ireland. This paper makes a modest step forward by introducing a preliminary environmental input-output model (EIO). EIOs are a suitable tool for estimating the short-term response of emissions and resource use to changes in consumption and production, be it induced by economic growth or by changes in (environmental) policy. Like input-output models, EIOs are static and linear. The data needed for constructing an EIO are a subset of the data needed for a more dynamic environment-economy model for the medium term. An EIO is therefore a useful first step – and, with proper caveats, can yield policy insights too.

According to its founder, Wassily Leontief,

> 'input-output analysis describes and explains the level of input of each sector of a given national economy in terms of its relationships to the corresponding levels of activities in all the other sectors' (1970, 262).

Essentially, this involves a matrix representation of the economy in order to predict the effect of changes in one industry on others, while at the same time modelling the effect of this interaction on consumers, the government and foreign suppliers.
The first effort to model the effect of these interactions on the environment was undertaken by Leontief himself, when in 1970 he sought to account for pollution and a new industry aggregation – the anti-pollution industry – within a hypothesised two-sector, two-good economy.

However, Van den Bergh and Hofkes (1999, p. 1114) note that 'the most important recent study [in environmental input-output modelling] is by Duchin and Lange (1994)'. Their ambitious model involves a detailed input-output model of the world economy, covering the dynamics of trade in sixteen regions and fifty sectors. This study sought to test the Brundtland Commission's statement that growth and sustainable development could go hand in hand, and concluded that this is not the case.[2]

A common issue in relation to input-output models is that these models 'are structurally fixed in the sense that sectoral classification and disaggregation, and assumed technologies, cannot change endogenously' (van den Bergh and Hofkes, 1999, p. 1115).

One effort to overcome these problems is the Regional and Welsh Appraisal of Resource Productivity and Development (REWARD) project in the UK (see Ravetz, et al., 2003). The project distinguishes different regions of the UK and thus further subdivides the standard input-output modelling framework to create a Regional Economy-Environment Input-Output (REEIO) model. Environmental input-output modelling is furthest developed in the USA. The EIOLCA model (www.eiolca.net; Henderson *et al.*, 2006) has almost 500 economic sectors and a long list of resources and emissions. Such data are unfortunately not available for Ireland.

[2] Dellink *et al.* (1999) extend a computable general equilibrium model to environment-economy relationships in the Netherlands up to 2030. Their principal conclusion – 'that economic growth can be reconciled with a reduction in environmental pressure…[if] there is improved environmental efficiency combined with a significant restructuring of the economy' (ibid, 153), counters that of Duchin and Lange.

The model presented in this paper is an input-output model comprising 19 sectors, 13 pollutants, five classifications of waste, and water use. It is constructed such that it models the production side of the Irish economy. Household demand is included, but household pollution is not, although its contribution is substantial (see Barrett et al., 2005, 83). Household *demand* is, of course, included. The model as presented here is able to address the following questions: Which sectors of the economy produce the largest quantities of pollutants? Which sectors add the most value – considering the environmental damage they cause? How is the situation likely to change in the future?

There is a large body of research on the relationship between economic and social activity and key environmental media in Ireland,[3] though until now these analyses have employed medium-term econometric models, rather than input-output models as we do here.

The paper is presented as follows. Section 2 reviews the structure of environmental input-output models. Section 3 discusses the data and the basic results. Section 4 presents environmental efficiencies and compares them to damage cost estimates from existing research. Section 5 presents forecasts of emissions and intensities out to 2020. Section 6 concludes.

2. Input-output and environmental input-output models

Goods and services are produced either for consumption or for use in further production. That is,

$$
\begin{aligned}
X_1 &= X_{1,1} + X_{1,2} + \ldots + X_{1,n} + Y_1 \\
X_2 &= X_{2,1} + X_{2,2} + \ldots + X_{2,n} + Y_2 \\
&\ldots \\
X_n &= X_{n,1} + X_{n,2} + \ldots + X_{n,n} + Y_n
\end{aligned} \tag{1}
$$

where X_i is the production of good *i*, and $X_{i,j}$ is the use of good *i* in the production of good *j*; Y_i is the consumption of good *i*, which, for convenience, includes exports and build-up of inventories. Equation (1) can be rewritten as

$$
\begin{aligned}
X_1 &= a_{1,1}X_1 + a_{1,2}X_2 + \ldots + a_{1,n}X_n + Y_1 \\
X_2 &= a_{2,1}X_1 + a_{2,2}X_2 + \ldots + a_{2,n}X_n + Y_2 \\
&\ldots \\
X_n &= a_{n,1}X_1 + a_{n,2}X_2 + \ldots + a_{n,n}X_n + Y_n
\end{aligned} \tag{2}
$$

where

[3] The relationship between greenhouse gas emissions and the economy has been modelled by Conniffe *et al.* (1997), Bergin *et al.* (2002) and Fitz Gerald (2004). Teagasc has modelled the impact of agriculture on greenhouse gas emissions (Behan and McQuinn, 2002). Work on the impact of economic activity on the generation of solid waste is described by Barrett and Lawlor (1995). The state of research on the link between economic activity on water use and emissions to water is described by Scott (see Scott *et al.*, 2001 and Scott, 2004). Finally, a range of different types of research on transport has been carried out for Ireland (See, Department of Public Enterprise, 2000), and a simplified model of the transport sector is already incorporated into the ESRI's HERMES model of the Irish economy.

(3) $$a_{i,j} := \frac{X_{i,j}}{X_j}$$

In matrix notation,

(2') $$\begin{bmatrix} X_1 \\ X_2 \\ \dots \\ X_n \end{bmatrix} = \begin{bmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,n} \\ a_{2,1} & a_{2,2} & \dots & a_{2,n} \\ \dots & \dots & \dots & \dots \\ a_{n,1} & a_{n,2} & \dots & a_{n,n} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \dots \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \dots \\ Y_n \end{bmatrix}$$

or

(2") $$X = AX + Y \Leftrightarrow (I - A)X = Y \Leftrightarrow X = (I - A)^{-1} Y = LY$$

Equation (2) specifies how production *X* would respond to a change in demand *Y*, including all intermediate production. *L* is commonly referred to as the Leontief inverse.

Emissions *M* of substance *l* equal

(4) $$M_l = b_{l,1} X_1 + b_{l,2} X_2 + \dots b_{l,n} X_n \forall l$$

where $b_{l,i}$ are the emission coefficients, that is, emission per unit of production. In matrix notation,

(5) $$M = BX = BLY$$

Equation (5) relates emissions to production (via *B*) and to final consumption (via *BL*).

3. Data

CSO (2006a) has the input-output tables for Ireland for 2000 for 48 sectors according to NACE.[4] CSO (2006b) has the environmental accounts for Ireland for 1997-2004 for 19 sectors, which are aggregates of NACE sectors. Data are limited to the main greenhouse and acidifying gases. EPA (2005a) has data on carbon monoxide, volatile organic compounds, hydrofluorocarbons ('HFCs'; 13, of which 8 have zero emissions) and fluorinated gases ('F-gases'; 8, of which 4 have zero emissions). We aggregated the HFCs and F-gases based on their 100-year global warming potential (Ramaswamy *et al.*, 2001). Scott (1999) presents data for solid waste and eutrophication, for the same 19 sectors, for 1994. According to Toner *et al.* (2005), eutrophication has hardly changed between 1994 and 2000, so we used Scott's 1994 data for 2000. EPA (2005b) has sectoral data on waste for 2004. We interpolated between 1994 and 2004 to get "data" for 2000. Camp Dresser and McKee (2004) report abstractive water use per sector, for 2001 for selected industrial sectors and for an unknown year for agriculture. We assume that these data hold for 2000.

We aggregated the 48 sector input-output table to the 19 sector input-output table, computed the Leontief inverse (*L*), the emission coefficients of production (*B*), and the emission coefficients of consumption (*BL*) for carbon dioxide (CO_2), nitrous oxide

[4] NACE is a statistical classification of economic activities. NACE is an acronym for 'Nomenclature générale des activités économiques dans les communautés européennes' (General Industrial Classification of Economic Activities within the European Communities).

(N_2O), methane (CH_4), sulphur dioxide (SO_2), CFCs and F-gases (CFC+F), carbon monoxide (CO), volatile organic compounds excluding methane (VOC), nitrogen oxides (NO_x), ammonia (NH_3), agricultural waste, industrial waste (hazardous or not, recycled or not), organic matter (BOD), nitrogen (N), phosphorus (P), and water (H_2O).

Table 1 shows the 2000 emissions, waste and water use per sector, and the sector's economic output. Table 2 shows the emission coefficients of production. Table 3 shows the emission coefficients of consumption. These tables contain no qualitative surprises, at least to those who have studied environmental pollution, but the numbers are interesting nevertheless. Table 1 shows that whereas economic activity is concentrated in services, pollution is mostly from agriculture, industry and transport. Table 2 confirms this, with low emission coefficients for services, but higher ones for the other sectors.

Table 3 is perhaps most surprising. It shows that, for every euro of agricultural produce bought directly from the farmer, 20 grams of ammonia is emitted. For every euro of processed food bought, only 7 grams of ammonia is emitted. The difference is explained by the difference in price per gram of food. For every euro of food bought from the farmer, 308 grams of carbon dioxide is emitted, which compares to 404 grams of carbon dioxide per euro of processed food. Although the price per gram of processed food is much higher, processing, packaging, and transport also emit considerable amounts of carbon dioxide (but hardly any ammonia). The largest difference in consumption and production coefficients is in methane emissions from wood and wood products: 6.29 grams are emitted per euro of wood and wood products consumed, versus 40 millionths of a gram per euro of chemicals produced, a factor of 1.5 million difference. This difference is so large because there is hardly any methane emission from production itself, while wood and wood products use substantial amounts of agricultural products as inputs.[5]

4. Efficiencies and damages

Table 4 shows the sectoral environmental efficiencies, that is, valued added per emission. A comparison of sectoral efficiencies reveals which sectors contribute most to pollution and resource use relative to the size of the sector. It also reveals which sectors are best targeted for emission reduction – particularly if structural policy is used for environmental ends[6]. Indeed, if a sector adds less value per tonne of pollution than the damage done by that tonne, then it would, to a first approximation, be better to close that sector.[7]

The average value added is €6,000/tCO_2, with a minimum of €520/tCO_2 in non-metallic production. This compares favourably with the price of a carbon dioxide

[5] Note the aggregation problem; the methane of course comes from animal husbandry, while the wood comes from timber. A further disaggregation is unfortunately impossible with publicly available data, but will be a priority in future research.

[6] It should be noted that a sector which ostensibly pollutes very little may have marginal cases of high polluting units, and vice versa.

[7] This reasoning is from an Irish perspective. Presumably, Irish consumers would still buy these products, which would be imported. The environmental effects of production would then burden other countries.

permit, which is €9.45/tCO_2,[8] not too far from the \$50/tC reasonable upper limit of the marginal damage cost suggested by the meta-analysis of Tol (2005). Non-metallic production adds over 500 times the value that it destroys through carbon dioxide emissions. Similar, or better comparisons hold for the other greenhouse gas emissions – methane (CH_4) is about 20 times as potent as carbon dioxide (CO_2) as a greenhouse gas, while laughing gas (N_2O) is about 300 times as potent (Ramaswamy *et al.*, 2001). For instance, the production of electrical goods adds value of €24,000/$tCO_{2;\,eq}$, which should be compared to the same €9.45/tCO_2 in abatement and damage costs. The cost-benefit comparison is also favourable for acidification. Irish farmers add value (incl. subsidies) of €44 for every cubic metre of water used. This compares rather well with the €0.31/m^3 that it costs, on average, to produce drinking water in Ireland (Camp Dresser and McKee, 2004).[9] Non-recycled, non-hazardous waste costs on average €0.14/kg to dispose of, but yields at least €0.58/kg. Other waste categories are hard to value in the aggregate. Eutrophication is difficult to value too, and few attempts have been reported. The Baltic Sea is probably the best studied. Turner *et al.* (1999) report damages as high as €3.66/kg of nitrogen and €96.24/kg of phosphorous. Eutrophication is less of a problem in and around Ireland than in the Baltic, however. Pretty et al. (2000, 2003) report total damages of £16 million for nitrates, and £55 million for phosphates. If we assume that eutrophication is similar in Great Britain and the UK (Aertebjerg and Carstensen, 2003; EEA, 2005; Trent, 2003) and that total damage proportional to GDP, then impacts amount to €0.01/kgN and €0.59/kgP. The cost-benefit ratio for nitrate is rather positive (around 145,000 for the economy as a whole, and 5,000 for agriculture) but less so for phosphate (42,000 for the whole economy, 2,500 for agriculture). Note that the cost-benefit ratio is also positive for the much higher damage estimates of Turner *et al.* (1999).

Not unexpectedly, agriculture regularly stands out as the least environmentally efficient sector. Multiplying all emissions with their damage cost estimates and adding the results, the total environmental damage done amounts to €0.3 billion, while total value added is €6.9 billion. That is, for every €1.00 earned and subsidised in agriculture, €0.04 is lost in environmental damage. Methane emissions are the largest contribution (53%), followed by nitrous oxide (33%) and ammonia (6%) emissions. Actually, mining is the least environmentally efficient sector, losing 27 cents for every euro earned, 97% of which is due to waste.[10] Metal production comes third (after agriculture), losing 4 cents in every euro, 93% of which is due to waste. For the economy as a whole, 1 cent is lost on every euro earned. Of this, 58% is due to waste, and 38% due to greenhouse gas emissions. The total environmental damage of production is about €1.6 billion; 25% is due to the mining industry, 22% due to construction, and 16% due to agriculture. Mining and agriculture are also among the least environmentally efficient industries. Construction ranks 4th, but is five times bigger than metal production.

Although the damage estimates are crude, they do allow us to identify the largest environmental problems (waste, climate change) and the dirtiest sectors (mining, agriculture and metal production if measured in terms of average efficiency; mining,

[8] On Nov 8, 2006 according to www.pointcarbon.com; on Jan 2, 2007, the price had fallen to €6.55/tCO_2.
[9] This number is the ratio of the total water demand and the annual expenditure on public water supply.
[10] Again, there may be an aggregation problem. Mining waste is unlike waste from other sectors; the bulk of the waste is earth and stone.

agriculture and construction if measured in terms of total pollution). This helps to target environmental pollution.

5. Forecasts

5.1. Constant emission coefficients

Tables A1 and A2 show scenarios of possible changes in the Irish economy out to 2020. Table A1 corresponds to the High Growth scenario of Barrett *et al.* (2005), whereas Table A2 is based on their Low Growth alternative.[11] These results were derived from the HERMES model of the Irish economy. Note that the HERMES model has six service sectors while the model here has only two; and that HERMES has three industrial sectors where this model has sixteen.

The scenario in Table A1 assumes continued rapid economic growth, whereas Table A2 presents a slower growth path. In both models, growth is fastest in industry and transport. Agriculture is projected to grow only slowly, while construction grows first but then declines. These scenarios are used only for illustration.

Table 5 shows what would happen to emissions, waste, and water use if the economy were to grow as in Table A1. Table 6 shows the equivalent for the low growth alternative (see Table A2). In both tables it is assumed that there would be no policy, technological or behavioural changes with regard to the environment; that is, emission coefficients stay constant at their 2000 levels. This, of course, is an unrealistic assumption. See below for a limited sensitivity analysis.

Under both scenarios, all indicators go up, some more slowly than economic growth (e.g., agricultural waste, ammonia, nitrogen, methane) and some faster (e.g., HFCs, carbon monoxide, hazardous industrial waste). Nitrogen oxides are projected to rise at a rate marginally above that for economic growth in the high growth scenario, but at a rate less than economic growth in the low growth alternative. Again, this is strictly illustrative. Policy, technology, and behaviour will change between now and 2020.

5.2. Falling emission coefficients

Emission coefficients are unlikely to stay constant. CSO (2006b) has emission data for selected greenhouse and acidifying gases, while sectoral economic activity can be downloaded from http://www.cso.ie. For these pollutants, emission coefficients have fallen consistently between 1994 and 2004. The year-on-year changes in emission intensities in the period 1994-2004 were used to construct both the arithmetic and geometric mean of changes in this period for each sector and pollutant.[12] These were then used to extrapolate out to 2020 using the predicted growth rates of each sector shown in Tables A1 and A2. For comparison, a third trend is also shown wherein intensities were assumed not to change over the period, and thus emissions change

[11] The high growth scenario is presented as 'one in which the US economy does not adjust and continues to experience robust growth, although remaining on an unsustainable growth path' (Barrett *et al.*, 2005, 28). The low growth scenario is one in which 'the US current account deficit declines gradually to a long-run sustainable level' (ibid).
[12] The geometric mean better reflects the exponential nature of growth but is, for short time series, subject to uncertainties introduced by interannual variability.

only with changes in industry production (as above). The projected changes in emissions are shown in Figure 1 (see also Tables A3 to A8).

For carbon dioxide, there is a downward trend in emissions for most sectors, though the largest contributors (non-metallic mineral production, transport and services) will increase their emissions, ensuring an overall increase in carbon dioxide emissions. For nitrous oxide, there is a downward trend in emissions for most sectors, but the only contributor of note (agriculture) will increase its N_2O emissions. For methane, the largest contributors are agriculture and the services sector, which dwarf all other sectors. Agricultural emissions are set to continue rising out to 2020[13], with emissions in services set to remain largely constant. The overall trend is for increased methane emissions, however. For sulphur dioxide, all sectors show a reduction in emissions out to 2020. The largest of these contributors – the services sector (excluding transport) – will reduce its emissions by around 50% compared to 2004 levels. For oxides of nitrogen, there is a downward trend in emissions for the largest contributors (agriculture, transport and services) that will lead to an overall decline in emissions of NO_x. However, there will be large percentage increases for some industries that currently emit relatively low levels of NO_x (mining, non-metallic mineral production and textiles and clothing). For ammonia, emissions from agriculture are set to rise slowly out to 2020, though this is from a relatively high base. Conversely, the transport sector will see ammonia emissions rise by between 550% (assuming a low growth rate, and calculated using a geometric mean) and 700% (assuming a high growth rate, and calculated using an arithmetic mean), but from a much lower level compared to agriculture.

For all of the pollutants discussed here, the high-growth scenario would result in higher levels of emissions than in the low growth alternative, and predicted emissions are higher when an arithmetic mean is used to calculate future trends. This can be seen in Figure 1.

It is also clear that the projections based on constant emission coefficients overestimate future emissions. This is particularly striking for emissions of sulphur and oxides of nitrogen, where technological progress changes the sign of the change, but it can also be seen for the other pollutants.

6. Conclusions

An environmental input-output model was constructed for Ireland for the year 2000. The model results confirm that certain sectors pollute more than others – even when normalised by the sectoral value added. Mining, agriculture, metal production and construction stand out as the dirtiest industries. On average, however, each sector adds more value than it does environmental damage. The dirtiest industry, mining, does 27 cents worth of damage for every euro of value added. For the Irish economy as a whole, only 1 cent is lost in damage for every euro earned. Waste and greenhouse gas emissions are the largest environmental problems. The environmental impact of consumption is very different from the impact of production because of the intermediary deliverables. We find differences up to a factor of 1.5 million, in case production is clean but intermediates are dirty. Even without technological progress,

[13] The HERMES model predicts that agricultural emissions will continue to rise out to 2020. However, this model does not incorporate any future changes to the Common Agricultural Policy of the EU, which could impose regulations that reduce emissions from agriculture.

behavioural changes, and policy interventions, most environmental problems will increase more slowly than the rate of economic growth, with the exception of fluorinated gases, carbon monoxide, and hazardous industrial waste. For the subset of pollutants for which data are available, emission intensity falls. For sulphur, emission intensities fall sufficiently fast to more than offset economic growth. When a forecast is constructed of emissions out to 2020, certain trends become apparent. Emissions of greenhouse gases (CO_2, N_2O and CH_4) will increase, while emissions of acid rain gases (SO_2, NOx and NH_3) will decrease.

These results should be treated with caution. The results for waste and eutrophication are particularly weak. Partly, this is a matter of data – the analysis here is restricted to data in the public domain. Furthermore, waste and eutrophication are not national, but regional phenomena. The same holds true for water. A regional analysis would require either regionalising the national results, or using a regional input-output model for crucial sectors (e.g., agriculture). Either route would be constrained by data availability. Further improvement of the sectoral disaggregation would be needed too – as demonstrated by the methane emissions attributed to the wood products sector. A finer categorisation of "waste" would be welcome too. Emission coefficients are here assumed to be static, but in fact respond to structural changes within the economic sectors, technological changes, prices, and environmental policies. Finally, input-output analysis focuses on the production side of the domestic economy. Household pollution and resource use is not included. This particularly affects carbon dioxide, waste and water. Similarly, the environmental impacts of the production of imported goods are excluded.

It is evident that much remains to be done in developing a thorough model of environment-economy relationships in Ireland. The results presented here may prove to be a useful first step.

Acknowledgements

John FitzGerald, Sean Lyons and Sue Scott had valuable comments on earlier versions of this paper. Adele Bergin, Yvonne McCarthy and Sue Scott pointed us to crucial data. The Environmental Protection Agency provided financial support.

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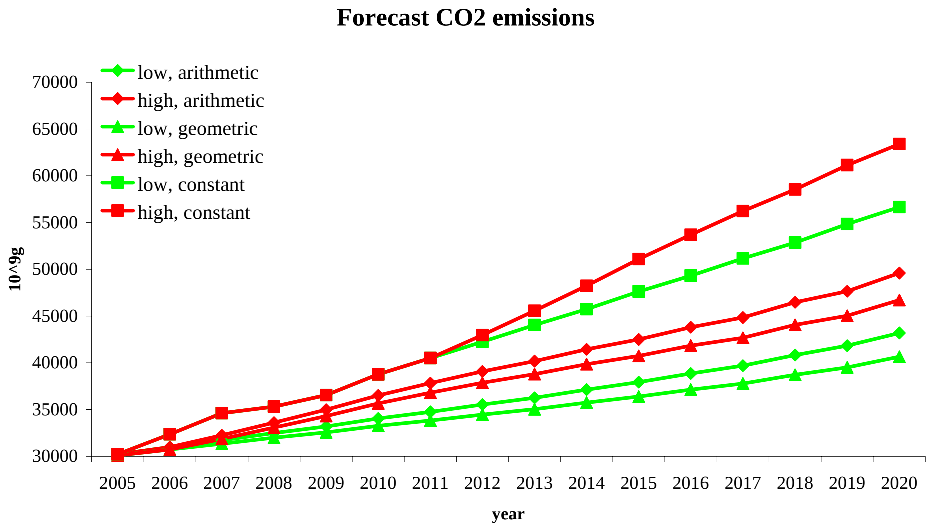
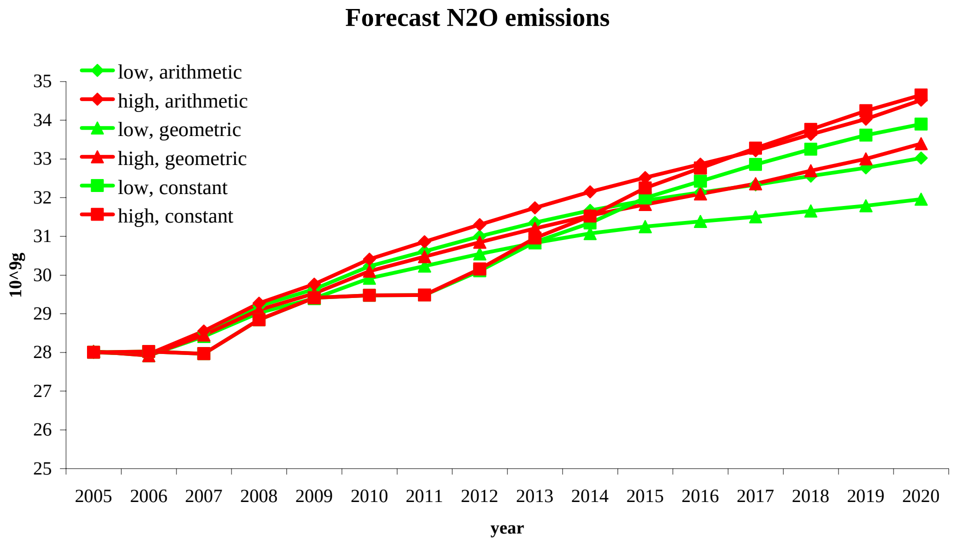
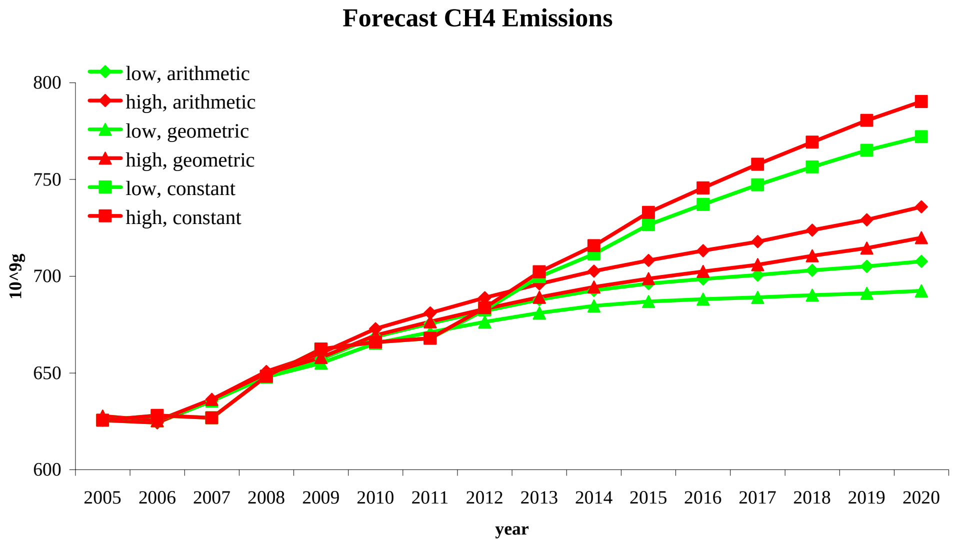
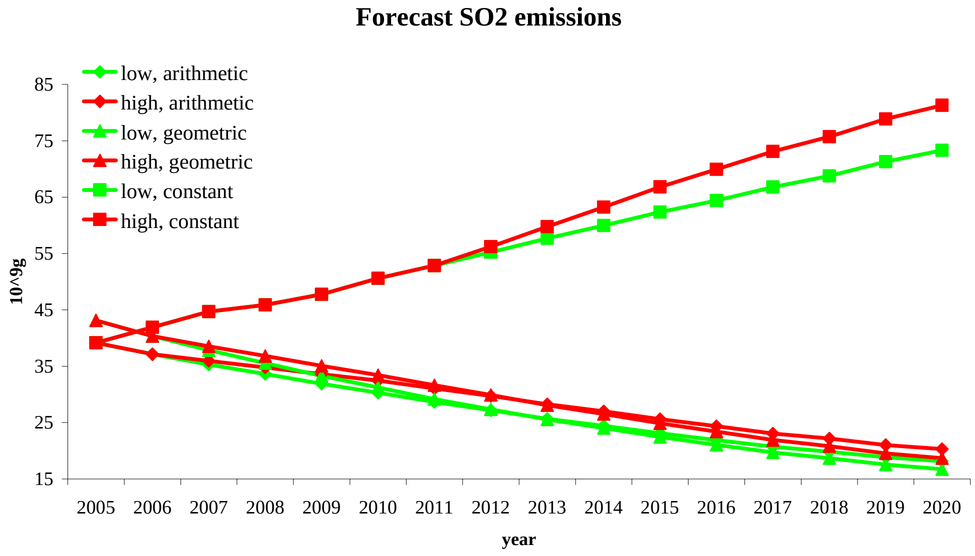
Figure 1. Forecast changes in emissions








Forecast SO2 emissions
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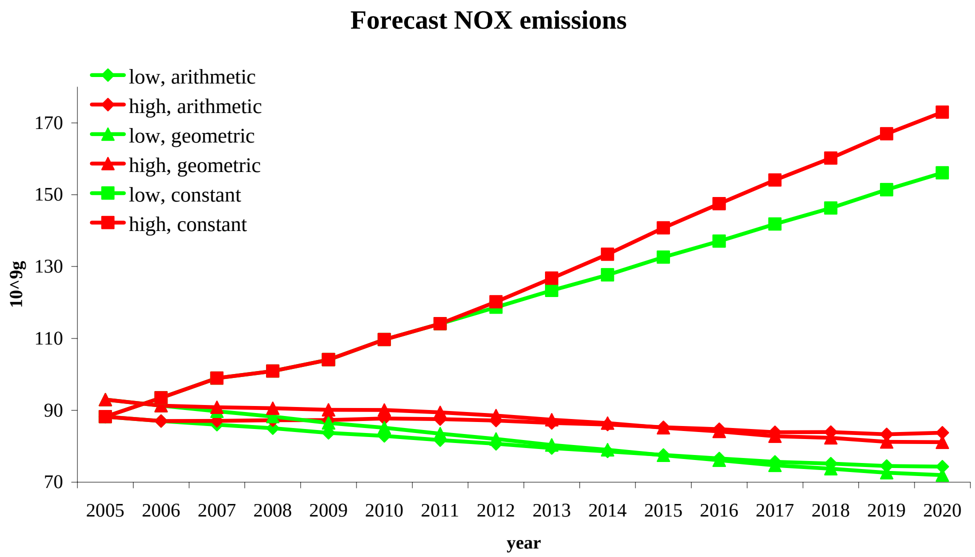
high, arithmetic
low, geometric
high, geometric
low, constant
high, constant
10^9g
85
75
65
55
45
35
25
15
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
year


Forecast NOX emissions
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high, arithmetic
low, geometric
high, geometric
low, constant
high, constant
10^9g
170
150
130
110
90
70
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
year

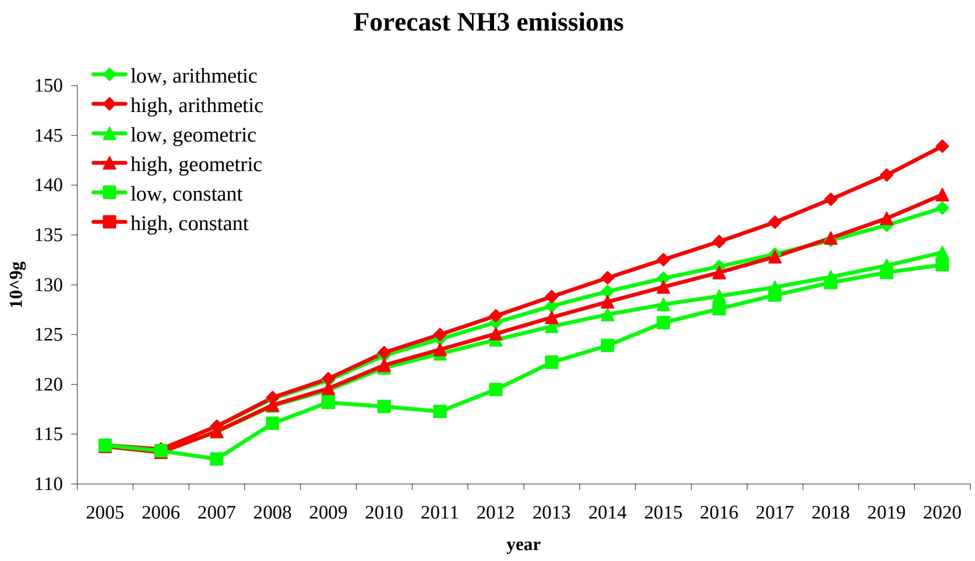
Forecast NH3 emissions
low, arithmetic
high, arithmetic
low, geometric
high, geometric
low, constant
high, constant
10^9g
150
145
140
135
130
125
120
115
110
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
year

Table 1. Emissions, waste and consumptive water use, per economic sector and supply at basic prices, Ireland, 2000.

		Climate change						Acidification			Waste					Eutrophication			Water	Economy
	NACE	**CO2**	**N2O**	**CH4**	**HFC+F**	**CO**	**NMVOC**	**SO2**	**Nox**	**NH3**	**AW**	**HIWNR**	**HIWR**	**NHIWNR**	**NHIWR**	**BOD**	**N**	**P**	**H2O**	**Supply**
		10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^9 g	10^6 l	10^6 €
Agriculture, forestry, fishing	1-5	1230.3	26.7	554.0	0.0	0.0	0.0	3.2	15.1	120.7	56516.2	0.0	0.0	0.0	0.0	10.0	148.5	4.7	159405	6945
Coal, peat, petroleum, metal ores, quarrying	10-14	1005.8	0.1	0.1	0.0	0.0	0.0	3.5	2.4	0.0	0.0	1.0	0.0	2573.9	96.8	0.0	0.0	0.0	0	1481
Food, beverage, tobacco	15-16	2579.6	0.2	0.5	0.0	0.1	0.0	8.7	6.2	0.0	0.0	0.1	0.8	251.3	1698.0	17.3	1.8	1.8	23721	13696
Textiles Clothing Leather & Footwear	17-19	243.1	0.0	0.1	0.0	0.0	0.0	0.9	0.7	0.0	0.0	0.6	0.4	24.6	18.5	0.2	0.0	0.0	0	3219
Wood & wood products	20	269.7	0.0	0.0	0.0	0.0	0.0	1.4	0.7	0.0	0.0	0.0	1.1	3.1	167.7	0.0	0.0	0.0	0	956
Pulp, paper & print production	21-22	251.1	0.0	0.0	0.0	8.9	0.2	1.3	0.6	0.0	0.0	2.4	2.9	63.3	76.3	0.0	0.0	0.0	30930	7732
Chemical production	24	2563.0	2.7	0.8	48.6	0.1	0.0	5.8	3.9	0.0	0.0	72.8	101.7	37.4	52.3	3.7	1.5	0.1	9082	22285
Rubber & plastic production	25	356.9	0.0	0.0	0.0	0.0	0.0	1.8	0.9	0.0	0.0	0.4	0.5	3.8	4.5	0.0	0.0	0.0	0	2069
Non-metallic mineral production	26	3122.1	0.1	0.5	0.0	0.0	0.0	2.6	3.2	0.0	0.0	11.0	1.4	67.6	8.7	0.0	0.0	0.0	0	1633
Metal prod. excl. machinery & transport equip.	27-28	760.9	0.0	0.0	0.0	1.2	0.0	4.2	1.9	0.0	0.0	17.4	0.3	732.4	14.1	0.0	0.0	0.0	3520	3331
Agriculture & industrial machinery	29	190.5	0.0	0.0	14.0	0.1	0.0	0.8	0.5	0.0	0.0	0.2	0.2	7.3	7.1	0.0	0.0	0.0	1275	4716
Office and data process machines	30	165.7	0.0	0.0	0.0	0.2	0.0	0.7	0.4	0.0	0.0	1.0	1.0	6.0	5.9	0.0	0.0	0.0	2256	20861
Electrical goods	31-33	716.0	0.1	0.0	615.0	0.2	0.0	3.6	1.7	0.0	0.0	8.3	11.9	15.1	21.5	0.0	0.0	0.0	1577	14589
Transport equipment	34-35	99.1	0.0	0.0	0.0	0.1	0.0	0.5	0.2	0.0	0.0	1.1	2.3	3.7	7.7	0.0	0.0	0.0	1160	4775
Other manufacturing	23,36-37	398.2	0.0	0.1	0.7	0.0	0.0	0.9	0.8	0.0	0.0	0.9	0.3	24.3	8.6	0.0	0.0	0.0	0	2506
Fuel, power, water	40,41	1396.0	0.2	2.5	0.0	4.1	0.2	7.1	3.4	0.0	0.0	0.6	1.0	69.1	118.9	0.0	0.0	0.0	0	2365
Construction	45	44.9	0.0	0.0	0.0	0.2	0.0	0.2	0.1	0.0	0.0	3.0	6.6	2304.8	5062.7	0.0	0.0	0.0	0	15517
Services, excl. transport	50-55,64-95	7733.5	0.9	73.0	0.0	2.9	0.6	27.2	13.3	0.0	0.0	0.0	0.0	0.0	0.0	3.6	8.5	1.8	0	70629
Transport	60-63	11062.4	1.2	2.6	0.0	178.2	25.1	3.5	60.9	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	8805
Total		**34188.8**	**32.2**	**634.2**	**678.2**	**196.4**	**26.5**	**78.2**	**117.0**	**122.4**	**56516.2**	**120.9**	**132.4**	**6187.8**	**7369.1**	**34.8**	**160.3**	**8.4**	**232926**	**208109**

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus.

Table 2. Emission coefficients of production, Ireland, 2000.

		Climate change						Acidification			Waste					Eutrophication			Water
	NACE	CO2	N2O	CH4	HFC+F	CO	VOC	SO2	NOx	NH3	AW	HIWNR	HIWR	NHIWNR	NHIWR	BOD	N	P	H2O
		g/€	g/€	G/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	l/€
Agriculture, forestry, fishing	1-5	177.16	3.84	79.77	0.00	0.00	0.00	0.46	2.17	17.37	8.14	0.00	0.00	0.00	21.38	1.44	21.38	0.68	22.95
Coal, peat, petroleum, metal ores, quarrying	10-14	678.91	0.05	0.03	0.00	0.00	0.00	2.39	1.63	0.00	0.00	0.00	0.00	1.74	0.00	0.00	0.00	0.00	0.00
Food, beverage, tobacco	15-16	188.34	0.01	0.04	0.00	0.01	0.00	0.64	0.45	0.00	0.00	0.00	0.00	0.02	0.13	1.27	0.13	0.13	1.73
Textiles Clothing Leather & Footwear	17-19	75.54	0.01	0.02	0.00	0.01	0.00	0.29	0.21	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00
Wood & wood products	20	282.24	0.03	0.00	0.00	0.01	0.00	1.44	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulp, paper & print production	21-22	32.47	0.00	0.00	0.00	1.15	0.03	0.16	0.08	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	4.00
Chemical production	24	115.01	0.12	0.04	2.18	0.01	0.00	0.26	0.18	0.00	0.00	0.00	0.00	0.00	0.07	0.16	0.07	0.00	0.41
Rubber & plastic production	25	172.51	0.02	0.00	0.00	0.01	0.00	0.87	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-metallic mineral production	26	1911.59	0.03	0.31	0.00	0.01	0.00	1.60	1.98	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Metal prod. excl. machinery & transport equip.	27-28	228.46	0.01	0.01	0.00	0.37	0.00	1.28	0.56	0.00	0.00	0.01	0.00	0.22	0.00	0.00	0.00	0.00	1.06
Agriculture & industrial machinery	29	40.40	0.00	0.01	2.96	0.01	0.00	0.17	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Office and data process machines	30	7.94	0.00	0.00	0.00	0.01	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Electrical goods	31-33	49.08	0.01	0.00	42.16	0.01	0.00	0.25	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Transport equipment	34-35	20.75	0.00	0.00	0.00	0.01	0.00	0.11	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Other manufacturing	23,36-37	158.91	0.01	0.05	0.27	0.01	0.00	0.37	0.33	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Fuel, power, water	40,41	590.35	0.07	1.06	0.00	1.73	0.10	3.02	1.44	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Construction	45	2.90	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
Services, excl. transport	50-55,64-95	109.49	0.01	1.03	0.00	0.04	0.01	0.39	0.19	0.00	0.00	0.00	0.00	0.00	0.12	0.05	0.12	0.03	0.00
Transport	60-63	1256.36	0.14	0.29	0.00	20.24	2.85	0.39	6.92	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus.

Table 3. Emission coefficients of consumption, Ireland, 2000.

		Climate change						Acidification			Waste					Eutrophication			Water
	NACE	**CO2**	**N2O**	**CH4**	**HFC+F**	**CO**	**VOC**	**SO2**	**NOx**	**NH3**	**AW**	**HIWNR**	**HIWR**	**NHIWNR**	**NHIWR**	**BOD**	**N**	**P**	**H2O**
		g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	g/€	l/€
Agriculture, forestry, fishing	1-5	308.09	4.49	93.02	0.36	0.40	0.05	0.81	2.81	20.23	9.47	0.00	0.00	0.02	24.93	1.91	24.93	0.82	27.10
Coal, peat, petroleum, metal ores, quarrying	10-14	849.56	0.07	0.27	0.64	1.28	0.18	2.70	2.23	0.03	0.01	0.00	0.00	1.81	0.03	0.01	0.03	0.00	0.09
Food, beverage, tobacco	15-16	404.08	1.60	33.06	0.31	1.01	0.14	1.15	1.83	7.12	3.33	0.00	0.00	0.04	8.94	1.99	8.94	0.43	11.42
Textiles Clothing Leather & Footwear	17-19	128.81	0.12	2.31	0.07	0.31	0.04	0.43	0.44	0.49	0.23	0.00	0.00	0.01	0.61	0.14	0.61	0.02	0.70
Wood & wood products	20	461.62	0.35	6.29	0.21	0.65	0.09	2.09	1.35	1.34	0.62	0.00	0.00	0.02	1.66	0.14	1.66	0.06	1.87
Pulp, paper & print production	21-22	258.78	0.04	0.57	0.52	4.03	0.38	0.51	1.04	0.05	0.01	0.00	0.00	0.02	0.08	0.03	0.08	0.01	5.66
Chemical production	24	262.42	0.17	0.86	2.83	1.18	0.16	0.55	0.71	0.10	0.04	0.00	0.01	0.02	0.23	0.22	0.23	0.02	0.67
Rubber & plastic production	25	304.92	0.06	0.62	0.52	0.90	0.12	1.17	0.86	0.09	0.04	0.00	0.00	0.02	0.13	0.04	0.13	0.01	0.27
Non-metallic mineral production	26	2147.18	0.05	0.60	0.97	1.40	0.19	1.97	2.68	0.03	0.01	0.01	0.00	0.11	0.04	0.01	0.04	0.00	0.13
Metal prod. excl. machinery & transport equip.	27-28	355.13	0.03	0.25	0.71	1.13	0.10	1.65	0.98	0.02	0.01	0.01	0.00	0.29	0.03	0.01	0.03	0.00	1.25
Agriculture & industrial machinery	29	74.80	0.01	0.11	4.89	0.16	0.02	0.29	0.21	0.01	0.00	0.00	0.00	0.01	0.02	0.00	0.02	0.00	0.35
Office and data process machines	30	73.73	0.01	0.25	5.83	0.29	0.04	0.23	0.20	0.01	0.00	0.00	0.00	0.01	0.03	0.01	0.03	0.01	0.25
Electrical goods	31-33	125.81	0.02	0.24	48.94	0.46	0.06	0.47	0.36	0.01	0.00	0.00	0.00	0.02	0.03	0.01	0.03	0.00	0.24
Transport equipment	34-35	49.99	0.01	0.07	0.57	0.21	0.03	0.18	0.15	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.29
Other manufacturing	23,36-37	355.89	0.04	0.51	1.12	0.87	0.12	0.94	0.94	0.07	0.03	0.00	0.00	0.24	0.10	0.02	0.10	0.01	0.22
Fuel, power, water	40,41	858.96	0.10	1.68	3.00	3.01	0.27	3.79	2.27	0.05	0.02	0.00	0.00	0.28	0.09	0.02	0.09	0.01	0.20
Construction	45	307.79	0.03	0.58	1.28	0.96	0.13	0.57	0.69	0.07	0.03	0.00	0.00	0.29	0.10	0.02	0.10	0.01	0.21
Services, excl. transport	50-55,64-95	208.98	0.03	1.47	0.47	1.01	0.14	0.55	0.59	0.06	0.02	0.00	0.00	0.02	0.20	0.07	0.20	0.03	0.13
Transport	60-63	1787.30	0.20	0.70	0.40	27.90	3.93	0.76	9.64	0.29	0.01	0.00	0.00	0.03	0.04	0.01	0.04	0.01	0.11

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus.

Table 4. Environmental efficiencies per sector, Ireland, 2000.

		Climate change						Acidification			Waste					Eutrophication			Water
	NACE	**CO2**	**N2O**	**CH4**	**HFC+F**	**CO**	**NMVOC**	**SO2**	**NOx**	**NH3**	**AW**	**HIWNR**	**HIWR**	**NHIWNR**	**NHIWR**	**BOD**	**N**	**P**	**H2O**
		€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/kg	€/m3
Agriculture, forestry, fishing	1-5	6	*2.6 02*	*1.25 01*	-	-	-	2.17 03	4.61 02	*5.76 01*	*0.12*	-	-	-	-	*6.94 02*	*4.68 01*	*1.47 03*	*44*
Coal, peat, petroleum, metal ores, quarrying	10-14	1	1.9 04	2.94 04	-	-	-	4.18 02	6.14 02	2.12 06	-	1.52 03	4.05 04	*1*	15	-	-	-	-
Food, beverage, tobacco	15-16	5	8.4 04	2.51 04	-	1.27 05	4.79 05	1.57 03	2.20 03	-	-	1.23 05	1.82 04	55	8	7.90 02	7.50 03	7.61 03	577
Textiles Clothing Leather & Footwear	17-19	13	1.6 05	5.63 04	-	8.91 04	4.59 05	3.43 03	4.71 03	-	-	5.65 03	7.51 03	131	174	1.79 04	-	-	-
Wood & wood products	20	4	3.1 04	2.52 08	-	8.91 04	4.59 05	6.95 02	1.45 03	-	-	4.65 04	8.61 02	308	*6*	-	-	-	-
Pulp, paper & print production	21-22	31	2.7 05	1.34 09	-	8.66 02	3.28 04	6.12 03	1.27 04	-	-	3.24 03	2.69 03	122	101	-	-	-	250
Chemical production	24	9	8.1 03	2.76 04	459	1.80 05	7.43 05	3.84 03	5.71 03	-	-	3.06 02	*2.19 02*	595	426	6.11 03	1.53 04	3.18 05	2454
Rubber & plastic production	25	6	5.2 04	8.56 08	-	8.91 04	4.59 05	1.14 03	2.39 03	-	-	4.90 03	4.15 03	539	457	-	-	-	-
Non-metallic mineral production	26	*1*	3.1 04	3.23 03	-	8.91 04	4.59 05	6.25 02	5.04 02	-	-	*1.48 02*	1.15 03	24	187	-	-	-	-
Metal prod. excl. machinery & transport equip.	27-28	4	6.9 04	1.52 05	-	2.73 03	6.49 05	7.84 02	1.78 03	-	-	1.91 02	9.90 03	5	236	-	-	-	946
Agriculture & industrial machinery	29	25	2.6 05	1.60 05	338	8.91 04	4.59 05	5.81 03	9.23 03	-	-	2.42 04	2.48 04	646	663	-	-	-	3699
Office and data process machines	30	126	1.3 06	1.37 10	-	8.91 04	4.59 05	2.89 04	5.64 04	-	-	2.10 04	2.16 04	3462	3558	-	-	-	9249
Electrical goods	31-33	20	1.8 05	3.07 09	*24*	8.91 04	4.59 05	4.04 03	8.41 03	-	-	1.75 03	1.23 03	964	678	-	-	-	9249
Transport equipment	34-35	48	4.5 05	3.19 09	-	8.91 04	4.59 05	9.44 03	1.99 04	-	-	4.47 03	2.12 03	1305	620	-	-	-	4117
Other manufacturing	23,36-37	6	1.2 05	1.95 04	3725	8.05 04	2.65 05	2.70 03	3.05 03	-	-	2.67 03	7.55 03	103	291	-	-	-	-
Fuel, power, water	40,41	2	1.4 04	9.42 02	-	5.80 02	9.64 03	*3.31 02*	6.93 02	-	-	4.03 03	2.34 03	34	20	-	-	-	-
Construction	45	345	2.9 06	-	-	8.91 04	4.59 05	6.76 04	1.41 05	-	-	5.15 03	2.34 03	7	3	-	-	-	-
Services, excl. transport	50-55,64-95	9	8.3 04	9.67 02	-	2.41 04	1.12 05	2.59 03	5.30 03	-	-	-	-	-	-	1.96 04	8.31 03	3.92 04	-
Transport	60-63	1	7.3 03	3.40 03	-	*4.94 01*	*3.50 02*	2.53 03	*1.45 02*	4.96 03	-	-	-	-	-	-	-	-	-
Total		**6**	**6456**	**328**	**307**	**1060**	**7865**	**2663**	**1779**	**1700**	**4**	**1721**	**1572**	**34**	**28**	**5985**	**1298**	**24790**	**893**
Minimum		*0.52*	*260*	*13*	*24*	*49*	*350*	*331*	*145*	*58*	*0.12*	*148*	*219*	*0.58*	*3.1*	*694*	*47*	*1470*	*44*
Damage cost		<0.01	<3.10	<0.24	<0.01	0.004	0.18	0.15	0.20	0.12				0.14		-	0.01	0.59	0.31

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus. Damage costs: CO2: global damage less than $50/tC (Tol, 2005); N2O, CH4: CO2 times global warming potential (296, 23); HFC+F: CO2; CO, NOx: average of Romilly (1999) and Spitley et al. (2005); VOC: Spitzley et al. (2005); SO2: Romilly (1999); NH3: Pretty *et al.* (2000); N, P: Gren et al. (1997); NHIWNR: Forfas (2006); H2O: Camp Dresser and McKee (2004).

Table 5. Emissions, waste, and consumptive water use, Ireland, 2000-2020 – high growth scenario

		absolute					index				
		2000	**2005**	**2010**	**2015**	**2020**	**2000**	**2005**	**2010**	**2015**	**2020**
CO_2	10^9 g	34188.8	43837.4	58094.4	72014.9	88180.3	100.0	128.2	169.9	210.6	257.9
N_2O	10^9 g	32.2	34.7	39.1	43.0	46.7	100.0	107.5	121.3	133.3	144.9
CH_4	10^9 g	634.2	675.6	744.2	803.0	858.0	100.0	106.5	117.3	126.6	135.3
HFC+F	10^9 g	678.2	881.1	1238.3	1548.5	1855.6	100.0	129.9	182.6	228.3	273.6
CO	10^9 g	196.4	249.0	323.4	409.5	522.4	100.0	126.8	164.7	208.5	266.1
VOC	10^9 g	26.5	33.5	43.4	55.0	70.2	100.0	126.6	163.9	207.7	265.4
SO_2	10^9 g	78.2	101.1	134.8	165.2	199.1	100.0	129.4	172.5	211.4	254.8
NO_x	10^9 g	117.0	146.0	188.5	233.1	287.6	100.0	124.8	161.2	199.3	245.9
NH_3	10^9 g	122.4	126.5	135.6	143.0	148.9	100.0	103.3	110.8	116.8	121.6
AW	10^9 g	56516.2	58190.8	62161.7	65245.5	67546.0	100.0	103.0	110.0	115.4	119.5
HIWNR	10^9 g	120.9	157.1	220.0	273.2	325.2	100.0	129.9	182.0	225.9	269.0
HIWR	10^9 g	132.4	172.1	240.2	296.1	350.0	100.0	130.0	181.4	223.6	264.3
NHIWNR	10^9 g	6187.8	8048.3	10781.5	12013.3	12654.2	100.0	130.1	174.2	194.1	204.5
NHIWR	10^9 g	7369.1	9593.2	12324.0	12188.4	10772.4	100.0	130.2	167.2	165.4	146.2
BOD	10^9 g	34.8	42.5	55.7	67.2	78.6	100.0	122.3	160.2	193.2	226.0
N	10^9 g	160.3	168.3	183.6	196.2	207.0	100.0	105.0	114.5	122.4	129.1
P	10^9 g	8.4	9.7	11.6	13.4	15.1	100.0	115.0	138.5	159.3	180.0
H_2O	10^6 l	232926	259646	309565	351888	391665	100.0	111.5	132.9	151.1	168.1
GDP at factor cost	10^6 €	208109	269253	359027	432742	506527	100.0	129.4	172.5	207.9	243.4

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus.

Table 6. Emissions, waste, and consumptive water use, Ireland, 2000-2020 – low growth scenario

		absolute					index				
		2000	**2005**	**2010**	**2015**	**2020**	**2000**	**2005**	**2010**	**2015**	**2020**
CO_2	10^9 g	34188.8	43837.4	53949.7	64224.7	77053.5	100.0	128.2	157.8	187.9	225.4
N_2O	10^9 g	32.2	34.7	38.3	41.3	43.9	100.0	107.5	118.7	128.0	136.1
CH_4	10^9 g	634.2	675.6	737.6	784.2	817.6	100.0	106.5	116.3	123.6	128.9
HFC+F	10^9 g	678.2	881.1	1104.0	1336.9	1621.2	100.0	129.9	162.8	197.1	239.0
CO	10^9 g	196.4	249.0	304.6	365.9	444.5	100.0	126.8	155.1	186.3	226.4
VOC	10^9 g	26.5	33.5	40.9	49.1	59.6	100.0	126.6	154.6	185.7	225.4
SO_2	10^9 g	78.2	101.1	125.1	148.0	176.9	100.0	129.4	160.0	189.4	226.3
NO_x	10^9 g	117.0	146.0	177.1	209.5	249.9	100.0	124.8	151.4	179.1	213.7
NH_3	10^9 g	122.4	126.5	135.4	141.5	143.9	100.0	103.3	110.6	115.6	117.6
AW	10^9 g	56516.2	58190.8	62137.9	64725.3	65539.4	100.0	103.0	109.9	114.5	116.0
HIWNR	10^9 g	120.9	157.1	196.9	237.2	286.0	100.0	129.9	162.9	196.2	236.5
HIWR	10^9 g	132.4	172.1	215.8	258.5	309.7	100.0	130.0	162.9	195.2	233.9
NHIWNR	10^9 g	6187.8	8048.3	10117.4	11297.9	12385.8	100.0	130.1	163.5	182.6	200.2
NHIWR	10^9 g	7369.1	9593.2	12090.9	12549.3	12327.6	100.0	130.2	164.1	170.3	167.3
BOD	10^9 g	34.8	42.5	51.2	59.9	70.0	100.0	122.3	147.3	172.2	201.3
N	10^9 g	160.3	168.3	182.2	192.3	198.4	100.0	105.0	113.7	120.0	123.8
P	10^9 g	8.4	9.7	11.1	12.4	13.8	100.0	115.0	132.4	148.2	164.9
H_2O	10^6 l	232926.0	259646.2	294942.3	327484.2	360596.6	100.0	111.5	126.6	140.6	154.8
GDP at factor cost	10^6 €	208109	269253	332754	389475	455692	100.0	129.4	159.9	187.1	219.0

Climate: CO2 = carbon dioxide; N2O = nitrous oxide; CH4 = methane; HFC+F = hydrofluorocarbons and fluorinated gases; CO = carbon monoxide; VOC = volatile organic compounds, excl. methane; Acidification; SO2 = sulphur dioxide; NOx = nitrogen oxides (NO and NO_2); NH3 = ammonia; Waste: AW = agricultural waste; HIWNR = hazardous industrial waste, not recycled; HIWR = hazardous industrial waste, recycled; NHIWNR = non-hazardous industrial waste, not recycled; NHIWR = non-hazardous industrial waste, recycled; Eutrophication: BOD = organic matter (biological oxygen demand): N = nitrogen; P = phosphorus.

Table A1. Output per sector according to the high growth scenario of Barrett *et al.* (2005).

	NACE	Output (10^6 €)					Index				
		2000	**2005**	**2010**	**2015**	**2020**	**2000**	**2005**	**2010**	**2015**	**2020**
Agriculture, forestry, fishing	1-5	6945	7151	7638	8017	8300	100.0	103.0	110.0	115.4	119.5
Coal, peat, petroleum, metal ores, quarrying	10-14	1481	1925	2705	3382	4053	100.0	129.9	182.6	228.3	273.6
Food, beverage, tobacco	15-16	13696	17794	25007	31271	37472	100.0	129.9	182.6	228.3	273.6
Textiles Clothing Leather & Footwear	17-19	3219	4182	5877	7349	8806	100.0	129.9	182.6	228.3	273.6
Wood & wood products	20	956	1242	1745	2182	2615	100.0	129.9	182.6	228.3	273.6
Pulp, paper & print production	21-22	7732	10046	14118	17654	21155	100.0	129.9	182.6	228.3	273.6
Chemical production	24	22285	28952	40688	50880	60970	100.0	129.9	182.6	228.3	273.6
Rubber & plastic production	25	2069	2687	3777	4723	5660	100.0	129.9	182.6	228.3	273.6
Non-metallic mineral production	26	1633	2122	2982	3729	4468	100.0	129.9	182.6	228.3	273.6
Metal prod. excl. machinery & transport equip.	27-28	3331	4327	6081	7605	9113	100.0	129.9	182.6	228.3	273.6
Agriculture & industrial machinery	29	4716	6127	8611	10768	12904	100.0	129.9	182.6	228.3	273.6
Office and data process machines	30	20861	27102	38089	47630	57075	100.0	129.9	182.6	228.3	273.6
Electrical goods	31-33	14589	18954	26636	33309	39914	100.0	129.9	182.6	228.3	273.6
Transport equipment	34-35	4775	6204	8719	10903	13065	100.0	129.9	182.6	228.3	273.6
Other manufacturing	23,36-37	2506	3256	4575	5721	6856	100.0	129.9	182.6	228.3	273.6
Fuel, power, water	40,41	2365	3130	4068	4811	6339	100.0	132.4	172.0	203.5	268.1
Construction	45	15517	20209	24904	21307	13696	100.0	130.2	160.5	137.3	88.3
Services, excl. transport	50-55,64-95	70629	92712	118422	143222	170636	100.0	131.3	167.7	202.8	241.6
Transport	60-63	8805	11131	14386	18279	23432	100.0	126.4	163.4	207.6	266.1
GDP at factor cost		208109	269253	359027	432742	506527	100.0	129.4	172.5	207.9	243.4

Table A2. Output per sector according to the low growth scenario of Barrett *et al.* (2005).

	NACE	**Output (10^6 €)**					**Index**				
		2000	**2005**	**2010**	**2015**	**2020**	**2000**	**2005**	**2010**	**2015**	**2020**
Agriculture, forestry, fishing	1-5	6945	7151	7636	7953	8054	100.0	103.0	109.9	114.5	116.0
Coal, peat, petroleum, metal ores, quarrying	10-14	1481	1925	2412	2920	3541	100.0	129.9	162.8	197.1	239.0
Food, beverage, tobacco	15-16	13696	17794	22295	26998	32739	100.0	129.9	162.8	197.1	239.0
Textiles Clothing Leather & Footwear	17-19	3219	4182	5240	6345	7694	100.0	129.9	162.8	197.1	239.0
Wood & wood products	20	956	1242	1556	1884	2284	100.0	129.9	162.8	197.1	239.0
Pulp, paper & print production	21-22	7732	10046	12587	15242	18483	100.0	129.9	162.8	197.1	239.0
Chemical production	24	22285	28952	36276	43928	53269	100.0	129.9	162.8	197.1	239.0
Rubber & plastic production	25	2069	2687	3367	4078	4945	100.0	129.9	162.8	197.1	239.0
Non-metallic mineral production	26	1633	2122	2659	3219	3904	100.0	129.9	162.8	197.1	239.0
Metal prod. excl. machinery & transport equip.	27-28	3331	4327	5422	6565	7961	100.0	129.9	162.8	197.1	239.0
Agriculture & industrial machinery	29	4716	6127	7677	9297	11274	100.0	129.9	162.8	197.1	239.0
Office and data process machines	30	20861	27102	33959	41121	49865	100.0	129.9	162.8	197.1	239.0
Electrical goods	31-33	14589	18954	23748	28757	34872	100.0	129.9	162.8	197.1	239.0
Transport equipment	34-35	4775	6204	7774	9413	11415	100.0	129.9	162.8	197.1	239.0
Other manufacturing	23,36-37	2506	3256	4079	4939	5990	100.0	129.9	162.8	197.1	239.0
Fuel, power, water	40,41	2365	3130	4058	4723	5946	100.0	132.4	171.6	199.7	251.4
Construction	45	15517	20209	25518	24518	20840	100.0	130.2	164.5	158.0	134.3
Services, excl. transport	50-55,64-95	70629	92712	112917	131249	152783	100.0	131.3	159.9	185.8	216.3
Transport	60-63	8805	11131	13575	16324	19834	100.0	126.4	154.2	185.4	225.3
GDP at factor cost		208109	269253	332754	389475	455692	100.0	129.4	159.9	187.1	219.0

Table A3. Extrapolated emissions by industry – carbon dioxide (million grams of CO_2)

	Low growth – Arithmetic Mean				High growth – Arithmetic Mean				Low growth – Geometric Mean				High growth – Geometric Mean			
	2005	2010	2015	2020	2005	2010	2015	2020	2005	2010	2015	2020	2005	2010	2015	2020
AGRICULTURE, FORESTRY, FISHING	901.0	894.3	866.0	815.1	901.00	894.69	872.92	840.04	885.09	803.65	711.81	612.88	885.09	803.96	717.54	631.64
FUEL,POWER,WATER	976.0	955.1	839.1	797.4	975.97	957.31	854.77	850.11	970.31	922.32	787.07	726.48	970.31	924.44	801.74	774.49
Coal, peat, petroleum, metal ores, quarrying	972.2	1395.9	1937.0	2691.6	972.21	1565.67	2243.54	3080.74	961.46	1305.85	1714.07	2253.09	961.46	1464.66	1985.35	2578.84
Food, beverage, tobacco	1202.0	1033.3	858.5	714.3	1202.01	1159.00	994.39	817.55	1194.14	993.39	798.65	643.00	1194.14	1114.20	925.05	735.96
Textiles Clothing Leather & Footwear	420.2	640.7	944.2	1393.3	420.19	718.63	1093.60	1594.77	418.31	623.70	898.74	1296.88	418.31	699.56	1040.98	1484.38
Wood & wood products	132.1	96.8	68.5	48.6	132.06	108.54	79.39	55.64	131.05	92.41	62.98	42.98	131.05	103.65	72.95	49.20
Pulp, paper & print production	106.3	72.4	47.7	31.5	106.26	81.22	55.24	36.00	105.43	69.09	43.75	27.75	105.43	77.49	50.68	31.76
Chemical production	563.7	222.7	85.1	32.5	563.70	249.83	98.52	37.23	557.20	207.78	74.88	27.02	557.20	233.05	86.73	30.93
Rubber & plastic production	249.0	234.6	213.5	194.7	249.00	263.08	247.33	222.82	248.11	229.57	205.28	183.82	248.11	257.49	237.77	210.40
Non-metallic mineral production	3677.1	4821.6	6110.1	7753.8	3677.14	5407.98	7077.08	8874.82	3647.38	4592.07	5587.45	6808.18	3647.38	5150.55	6471.76	7792.50
Metal prod. excl. machinery & transport equip.	775.0	839.4	878.6	921.0	774.97	941.45	1017.67	1054.14	771.23	815.33	833.02	852.30	771.23	914.48	964.86	975.52
Agriculture & industrial machinery	136.3	130.7	121.1	112.3	136.27	146.54	140.22	128.58	135.42	125.88	113.08	101.73	135.42	141.19	130.98	116.44
Office and data process machines	116.5	98.9	81.1	66.6	116.53	110.90	93.92	76.21	109.28	67.26	40.01	23.84	109.28	75.45	46.35	27.28
Electrical goods	436.1	417.6	386.5	358.2	436.07	468.41	447.69	410.04	424.66	356.20	288.75	234.41	424.66	399.52	334.45	268.30
Transport equipment	68.1	58.3	48.3	40.0	68.11	65.41	55.89	45.76	67.80	56.72	45.86	37.13	67.80	63.61	53.11	42.49
Other manufacturing	416.9	528.3	646.9	793.2	416.94	592.52	749.25	907.90	407.39	459.67	501.26	547.38	407.39	515.57	580.59	626.52
Construction	16.6	11.0	5.6	2.5	16.60	10.76	4.84	1.64	16.20	9.51	4.25	1.68	16.20	9.28	3.69	1.10
TRANSPORT*	11123.2	12688.3	14271.9	16220.1	11123.16	13446.46	15981.24	19162.79	11116.46	12642.55	14177.64	16064.60	11116.46	13397.96	15875.72	18979.02
SERVICES excl Transport	7931.5	8896.1	9522.4	10208.1	7931.53	9329.71	10391.11	11400.87	7929.18	8880.26	9491.45	10159.82	7929.18	9313.15	10357.31	11346.96

Table A4. Extrapolated emissions by industry – nitrous oxide (million grams of N_2O)

	Low growth – Arithmetic Mean				High growth – Arithmetic Mean				Low growth – Geometric Mean				High growth – Geometric Mean			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
AGRICULTURE, FORESTRY, FISHING	25.50	27.40	28.73	29.28	25.499	27.414	28.959	30.173	25.466	27.094	28.119	28.369	25.466	27.105	28.345	29.238
FUEL,POWER,WATER	0.10	0.09	0.07	0.06	0.097	0.086	0.069	0.061	0.105	0.093	0.074	0.063	0.105	0.093	0.075	0.067
Coal, peat, petroleum, metal ores, quarrying	0.06	0.08	0.10	0.12	0.064	0.091	0.116	0.142	0.064	0.077	0.090	0.105	0.064	0.086	0.104	0.120
Food, beverage, tobacco	0.06	0.05	0.04	0.03	0.063	0.055	0.042	0.031	0.070	0.054	0.041	0.031	0.070	0.061	0.047	0.035
Textiles Clothing Leather & Footwear	0.03	0.04	0.05	0.07	0.026	0.041	0.057	0.076	0.026	0.035	0.046	0.061	0.026	0.039	0.053	0.069
Wood & wood products	0.01	0.01	0.01	0.00	0.012	0.009	0.006	0.004	0.013	0.009	0.006	0.004	0.013	0.010	0.007	0.005
Pulp, paper & print production	0.01	0.01	0.00	0.00	0.010	0.007	0.005	0.003	0.011	0.007	0.005	0.003	0.011	0.008	0.005	0.003
Chemical production	0.04	0.01	0.00	0.00	0.038	0.009	0.002	0.000	0.054	0.007	0.001	0.000	0.054	0.007	0.001	0.000
Rubber & plastic production	0.02	0.02	0.02	0.01	0.024	0.023	0.020	0.017	0.026	0.023	0.019	0.017	0.026	0.025	0.022	0.019
Non-metallic mineral production	0.03	0.02	0.02	0.01	0.029	0.026	0.021	0.016	0.031	0.025	0.020	0.016	0.031	0.028	0.023	0.018
Metal prod. excl. machinery & transport equip.	0.03	0.02	0.02	0.01	0.027	0.023	0.018	0.013	0.029	0.023	0.018	0.014	0.029	0.026	0.021	0.016
Agriculture & industrial machinery	0.01	0.01	0.01	0.01	0.013	0.014	0.013	0.012	0.013	0.013	0.012	0.011	0.013	0.014	0.014	0.013
Office and data process machines	0.01	0.01	0.01	0.01	0.012	0.012	0.010	0.008	0.013	0.008	0.004	0.003	0.013	0.009	0.005	0.003
Electrical goods	0.04	0.04	0.03	0.03	0.040	0.040	0.036	0.030	0.043	0.034	0.026	0.020	0.043	0.038	0.030	0.023
Transport equipment	0.01	0.01	0.00	0.00	0.007	0.006	0.005	0.003	0.007	0.006	0.004	0.003	0.007	0.006	0.005	0.004
Other manufacturing	0.01	0.01	0.01	0.01	0.013	0.013	0.012	0.010	0.014	0.012	0.010	0.009	0.014	0.014	0.012	0.010
Construction	0.03	0.03	0.03	0.03	0.029	0.034	0.028	0.017	0.029	0.034	0.030	0.024	0.029	0.033	0.026	0.015
TRANSPORT*	1.23	1.58	2.01	2.58	1.229	1.678	2.253	3.052	1.215	1.532	1.904	2.391	1.215	1.623	2.132	2.825
SERVICES excl Transport	0.77	0.79	0.77	0.76	0.773	0.831	0.845	0.848	0.800	0.831	0.824	0.818	0.800	0.871	0.899	0.914

Table A5. Extrapolated emissions by industry – methane (million grams of CH_4)

	Low growth – Arithmetic Mean				**High growth – Arithmetic Mean**				**Low growth – Geometric Mean**				**High growth – Geometric Mean**			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
AGRICULTURE, FORESTRY, FISHING	548.2399	590.2359	619.8629	632.8148	548.2399	590.4619	624.845	652.1901	547.3436	585.8106	611.6027	620.7154	547.3437	586.0349	616.5184	639.7202
FUEL,POWER,WATER	2.01675	1.933632	1.664387	1.549564	2.01675	1.938076	1.695411	1.651973	2.142178	1.981782	1.645944	1.478593	2.142178	1.986337	1.676623	1.576312
Coal, peat, petroleum, metal ores, quarrying	0.027368	0.033873	0.040518	0.048535	0.027368	0.037993	0.046931	0.055552	0.027435	0.027804	0.027232	0.02671	0.027435	0.031185	0.031542	0.030572
Food, beverage, tobacco	0.230186	0.151536	0.096412	0.061427	0.230186	0.169966	0.111671	0.070308	0.261806	0.168854	0.10525	0.065697	0.261806	0.18939	0.121907	0.075195
Textiles Clothing Leather & Footwear	0.118838	0.202277	0.332749	0.548148	0.118838	0.226878	0.385411	0.627399	0.111775	0.180133	0.280557	0.437582	0.111775	0.202041	0.324959	0.500847
Pulp, paper & print production	0.001292	0.000597	0.000266	0.000119	0.001292	0.000669	0.000308	0.000136	0.001578	0.000635	0.000247	9.61E-05	0.001578	0.000712	0.000286	0.00011
Chemical production	0.036202	0.007026	0.001318	0.000248	0.036202	0.007881	0.001527	0.000283	0.052568	0.007701	0.00109	0.000155	0.052568	0.008637	0.001263	0.000177
Non-metallic mineral production	0.777247	1.183438	1.741444	2.566168	0.777247	1.327367	2.017055	2.93718	0.747532	0.907688	1.065176	1.251749	0.747532	1.018081	1.233756	1.432724
Metal prod. Excl. machinery & transport equip.	0.014216	0.007723	0.004055	0.002132	0.014216	0.008663	0.004697	0.002441	0.016802	0.008458	0.004115	0.002005	0.016802	0.009486	0.004766	0.002294
Other manufacturing	0.10514	0.109435	0.110084	0.110892	0.10514	0.122745	0.127506	0.126925	0.109114	0.088426	0.069257	0.054319	0.109114	0.099181	0.080218	0.062173
TRANSPORT*	1.799281	1.587331	1.38082	1.213678	1.799281	1.682177	1.546204	1.433862	1.919653	1.688599	1.464643	1.283611	1.919653	1.789496	1.640066	1.516482
SERVICES excl Transport	72.268	73.30422	70.9614	68.7957	72.268	76.87762	77.43482	76.83424	74.96083	74.51801	70.69658	67.17095	74.96083	78.15058	77.14585	75.01964

Data for the following sectors have extrapolated values of zero out to 2020: Wood & wood products, Rubber & plastic production, Agriculture & industrial machinery, Office and data process machines, Electrical goods, Transport equipment and Construction.

Table A6. Extrapolated emissions by industry – sulphur dioxide (million grams of SO_2)

	Low growth – Arithmetic Mean				**High growth – Arithmetic Mean**				**Low growth – Geometric Mean**				**High growth – Geometric Mean**			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
AGRICULTURE, FORESTRY, FISHING	1.78	1.30	0.92	0.64	1.78	1.30	0.93	0.66	1.93	1.36	0.93	0.62	1.93	1.36	0.94	0.64
FUEL,POWER,WATER	2.57	1.67	0.98	0.62	2.57	1.68	0.99	0.66	2.95	1.80	0.98	0.58	2.95	1.80	1.00	0.62
Coal, peat, petroleum, metal ores, quarrying	1.81	1.80	1.73	1.66	1.81	2.02	2.00	1.90	1.89	1.63	1.36	1.13	1.89	1.83	1.57	1.30
Food, beverage, tobacco	2.35	1.48	0.91	0.55	2.35	1.66	1.05	0.63	2.69	1.56	0.88	0.49	2.69	1.75	1.02	0.56
Textiles Clothing Leather & Footwear	0.84	0.83	0.79	0.76	0.84	0.93	0.92	0.87	0.88	0.84	0.77	0.71	0.88	0.94	0.89	0.82
Wood & wood products	0.37	0.21	0.11	0.06	0.37	0.23	0.13	0.07	0.44	0.23	0.11	0.06	0.44	0.25	0.13	0.06
Pulp, paper & print production	0.29	0.15	0.07	0.04	0.29	0.16	0.08	0.04	0.35	0.16	0.07	0.03	0.35	0.18	0.08	0.03
Chemical production	1.40	0.57	0.22	0.09	1.40	0.64	0.26	0.10	1.75	0.69	0.26	0.10	1.75	0.77	0.30	0.11
Rubber & plastic production	0.65	0.42	0.27	0.17	0.65	0.47	0.31	0.19	0.74	0.45	0.26	0.16	0.74	0.51	0.31	0.18
Non-metallic mineral production	1.09	0.73	0.48	0.31	1.09	0.82	0.55	0.35	1.23	0.78	0.47	0.29	1.23	0.87	0.55	0.33
Metal prod. excl. machinery & transport equip.	3.77	3.76	3.62	3.50	3.77	4.22	4.20	4.00	3.94	3.76	3.47	3.21	3.94	4.22	4.02	3.67
Agriculture & industrial machinery	0.38	0.28	0.20	0.15	0.38	0.32	0.24	0.17	0.42	0.29	0.19	0.13	0.42	0.33	0.22	0.15
Office and data process machines	0.32	0.20	0.12	0.07	0.32	0.22	0.14	0.08	0.36	0.15	0.06	0.03	0.36	0.17	0.07	0.03
Electrical goods	1.11	0.71	0.44	0.28	1.11	0.80	0.51	0.31	1.27	0.69	0.36	0.19	1.27	0.78	0.42	0.22
Transport equipment	0.18	0.11	0.06	0.03	0.18	0.12	0.07	0.04	0.21	0.12	0.06	0.03	0.21	0.13	0.07	0.04
Other manufacturing	0.54	0.42	0.31	0.23	0.54	0.47	0.36	0.27	0.59	0.42	0.29	0.19	0.59	0.47	0.33	0.22
Construction	0.75	0.66	0.45	0.27	0.75	0.65	0.39	0.17	0.81	0.65	0.40	0.22	0.81	0.64	0.35	0.14
TRANSPORT*	1.88	1.16	0.70	0.43	1.88	1.23	0.79	0.51	2.16	1.05	0.50	0.24	2.16	1.11	0.56	0.29
SERVICES excl Transport	17.07	13.84	10.71	8.30	17.07	14.52	11.69	9.27	18.52	14.62	11.02	8.32	18.52	15.33	12.02	9.29

Table A7. Extrapolated emissions by industry – nitrogen oxides (million grams of NO_x)

	Low growth – Arithmetic Mean				**High growth – Arithmetic Mean**				**Low growth – Geometric Mean**				**High growth – Geometric Mean**			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
AGRICULTURE, FORESTRY, FISHING	13.47	14.49	15.22	15.53	13.47	14.50	15.34	16.01	13.44	14.33	14.90	15.06	13.44	14.34	15.02	15.53
FUEL,POWER,WATER	2.00	1.61	1.16	0.91	2.00	1.61	1.18	0.97	2.20	1.71	1.19	0.90	2.20	1.71	1.21	0.96
Coal, peat, petroleum, metal ores, quarrying	2.15	2.81	3.55	4.49	2.15	3.15	4.11	5.14	2.14	2.68	3.25	3.96	2.14	3.01	3.77	4.53
Food, beverage, tobacco	2.67	2.08	1.56	1.18	2.67	2.33	1.81	1.35	2.94	2.23	1.63	1.20	2.94	2.50	1.89	1.37
Textiles Clothing Leather & Footwear	1.12	1.52	1.99	2.61	1.12	1.70	2.30	2.98	1.10	1.46	1.88	2.42	1.10	1.64	2.18	2.76
Wood & wood products	0.27	0.17	0.10	0.06	0.27	0.19	0.11	0.07	0.31	0.18	0.10	0.06	0.31	0.21	0.12	0.07
Pulp, paper & print production	0.22	0.13	0.08	0.04	0.22	0.15	0.09	0.05	0.26	0.15	0.08	0.04	0.26	0.16	0.09	0.05
Chemical production	1.22	0.57	0.25	0.11	1.22	0.63	0.29	0.13	1.48	0.66	0.28	0.12	1.48	0.74	0.33	0.14
Rubber & plastic production	0.51	0.39	0.29	0.22	0.51	0.44	0.34	0.25	0.56	0.42	0.31	0.23	0.56	0.47	0.36	0.26
Non-metallic mineral production	4.06	5.13	6.27	7.68	4.06	5.76	7.27	8.79	4.05	4.52	4.87	5.26	4.05	5.07	5.64	6.02
Metal prod. excl. machinery & transport equip.	1.86	1.85	1.77	1.71	1.86	2.07	2.05	1.95	1.94	1.89	1.78	1.68	1.94	2.12	2.07	1.92
Agriculture & industrial machinery	0.28	0.22	0.17	0.13	0.28	0.25	0.20	0.15	0.31	0.23	0.17	0.13	0.31	0.26	0.20	0.14
Office and data process machines	0.24	0.19	0.14	0.11	0.24	0.21	0.16	0.12	0.27	0.14	0.07	0.04	0.27	0.16	0.08	0.04
Electrical goods	0.88	0.70	0.54	0.42	0.88	0.79	0.63	0.48	0.96	0.66	0.44	0.30	0.96	0.75	0.52	0.34
Transport equipment	0.14	0.10	0.07	0.05	0.14	0.11	0.08	0.05	0.16	0.11	0.07	0.05	0.16	0.12	0.08	0.06
Other manufacturing	0.80	0.87	0.91	0.95	0.80	0.97	1.05	1.09	0.82	0.82	0.79	0.76	0.82	0.92	0.91	0.87
Construction	0.58	0.62	0.50	0.36	0.58	0.61	0.44	0.24	0.60	0.62	0.49	0.34	0.60	0.61	0.42	0.22
TRANSPORT*	43.04	36.76	30.96	26.35	43.04	38.96	34.67	31.13	46.22	39.17	32.74	27.64	46.22	41.51	36.66	32.66
SERVICES excl Transport	12.71	12.65	12.02	11.44	12.71	13.27	13.12	12.78	13.23	13.13	12.45	11.81	13.23	13.77	13.58	13.19

Table A8. Extrapolated emissions by industry – ammonia (million grams of NH_3)

	Low growth – Arithmetic Mean				**High growth – Arithmetic Mean**				**Low growth – Geometric Mean**				**High growth – Geometric Mean**			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
AGRICULTURE, FORESTRY, FISHING	111.643	118.8261	123.3693	124.5126	111.643	118.8716	124.3608	128.3249	111.7161	117.9827	121.5447	121.7207	111.7161	118.0279	122.5216	125.4475
TRANSPORT*	2.234635	4.063522	7.286179	13.2006	2.234635	4.306324	8.158858	15.59544	2.063027	3.68163	6.478532	11.51887	2.063027	3.901613	7.254478	13.60861

Data for the following sectors have extrapolated values of zero out to 2020: Fuel, power and water, Coal, peat, petroleum, metal ores, quarrying, Food, beverage, tobacco, Textiles Clothing Leather & Footwear, Wood & wood products, Pulp, paper & print production, Chemical production, Rubber & plastic production, Non-metallic mineral production, Metal prod. excl. machinery & transport equipment, Agriculture & industrial machinery, Office and data process machines, Electrical goods, Transport equipment, Other manufacturing, Construction, and Services (excluding Transport)