

# Input-output modelling of the EU ETS and electricity generating technologies in the UK

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## UK Input-Output table for 2004

An input-output table is a set of accounts showing all inter-industry transactions in an economy during a specific year.

Example: IO table for Scotland in 2004, £million

	Primary and Construction	Manufacturing and Utilities	Distribution, Transport and Services	Sales to Intermediate Demand	Final demand	Total Gross outputs
Primary and Construction	3,513.2	2,306.0	2,380.1	8,199.2	10,708.7	18,907.9
Manufacturing and Utilities	1,125.7	6,830.0	2,390.2	10,345.9	28,653.7	38,999.7
Distribution, Transport and Services	3,127.5	4,505.6	22,061.3	29,694.5	79,847.9	109,542.4
<b>Total intermediate demand</b>	<b>7,766.3</b>	<b>13,641.7</b>	<b>26,831.6</b>	<b>48,239.6</b>	<b>119,210.3</b>	<b>167,449.9</b>
Imports	3,920.5	11,847.1	17,589.6	33,357.2	9,078.9	42,436.1
Taxes net of subsidies	36.4	600.3	3,547.6	4,111.4	7,865.4	11,976.8
Compensation of employees	4,555.0	8,572.0	39,998.0	53,125.0	-	53,125.0
Other value added	2,702.5	4,338.6	21,575.6	28,616.7	-	28,616.7
<b>Total primary inputs</b>	<b>11,141.6</b>	<b>25,358.0</b>	<b>82,710.7</b>	<b>119,210.3</b>	<b>16,944.3</b>	<b>136,154.6</b>
<b>Total gross inputs</b>	<b>18,907.9</b>	<b>38,999.7</b>	<b>109,542.4</b>	<b>167,449.9</b>	<b>136,154.6</b>	<b>303,604.5</b>

It is possible to turn the IO into a model by assuming constant returns to scale, Leontief technology and a passive supply side. Type 1 output multipliers can be calculated to show the effect of an increase in final demand for a sector on total economic output. When households are endogenous to the model these become Type 2 multipliers. This technique can also be extended to incorporate physical amounts e.g. CO<sub>2</sub> emissions.

Leontief inverse with emissions attribution:

$$X = e(I-A)^{-1}Y$$

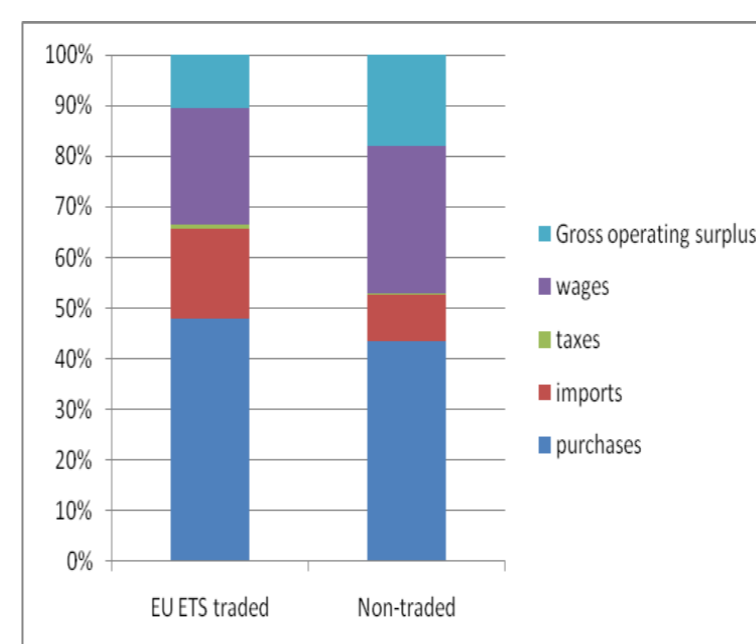
We use an IO table of the UK from 2004 which gives all transactions for 123 economic sectors in that year. GHG and CO<sub>2</sub> emissions were attached to each sector. However, in order to allow modelling of relevant climate change and renewables policy questions it was necessary to make several adjustments to the IO table. In particular we incorporate the EU ETS and also disaggregate the electricity sector.

## EU Emissions Trading Scheme

Using various data and assumptions the UKIO table has been aggregated to 25 economic sectors and adjusted to distinguish between those sectors covered by the EU ETS and those which are not.

We calculated an overall 'Traded' sector Type 1 (Type 2) output multiplier of 1.88 (2.95) and a 'Non-traded' sector Type 1 (Type 2) output multiplier of 1.71 (3.07)

Figure 1: Portion of inputs by type to turnover of traded and non-traded sectors



CO<sub>2</sub>-output multipliers have then been calculated for all sectors and ranked accordingly.

sec No.	Sector	Type 1	Rank (1-25)	Type 2	Rank (1-25)
1	Mining and quarrying	1000	8	1230	9
2	Food and Drink	435	15	918	17
3	Textiles; wearing apparel; leather products	451	14	991	13
4	Wood; Pulp and paper; Printing and publishing	413	17	939	15
5	Coke, refined petroleum products and nuclear fuel	1599	5	1904	5
6	Gases and dyes; Chemicals	1121	6	1541	7
7	Glass and glass products	1070	7	1624	6
8	Ceramic goods	600	12	1217	10
9	Clay, cement, lime and plaster	7715	2	8210	2
10	Articles of concrete, plaster and cement; cutting, shaping and finishing of stone; manufacture of other non-metallic products	845	9	1377	8
11	Iron and Steel; non-ferrous metals	2386	4	2834	4
12	manf of Motor vehicles and other transport	345	19	819	21
13	Production and distribution of electricity	7993	1	8297	1

sec No.	Sector	Type 1	Rank (1-25)	Type 2	Rank (1-25)
14	Agriculture, hunting and related service activities	529	13	908	18
15	Forestry and fishing	795	10	1200	11
16	Other Manufacturing	411	18	932	16
17	Gas and water supply; Construction	420	16	863	20
18	Wholesale retail trade; Repair of vehicles; personal and household goods; Hotels and restaurants	254	21	818	22
19	Air Transport	2976	3	3379	3
20	Other Transport	606	11	1179	12
21	Finance	179	22	652	24
22	Real Estate, renting and business activities	104	25	533	25
23	Public administration and defence; compulsory social security	269	20	943	14
24	Education; Health and social work	164	24	908	19
25	Other community, social and personal service; Private households with employed persons	173	23	712	23

## Electricity sector

The electricity sector in the UKIO table has the largest Type 1 and Type 2 CO<sub>2</sub>-Output multipliers of all sectors. Yet there are various low-carbon technologies available for generation. The heterogeneity of emissions-intensity of generating technologies is important for meeting UK carbon budgets.

The UK 2004 IO table has only one sector (SIC 40.1) for electricity production, distribution, transmission and trade. We therefore attempt to disaggregate the sector into 9 technologies and a supply sector.

Sector	Type 1	Rank (1-29)	Type 2	Rank (1-29)
Supply of electricity	2.29	2	3.12	18
Nuclear	1.52	28	2.07	29
Coal	1.82	15	2.54	27
Gas and Oil	2.37	1	3.31	8
Hydro	1.53	27	2.92	23
Biomass	2.05	7	4.17	1
Onshore Wind	2.22	3	3.61	4
Offshore Wind	2.22	5	3.88	3
Other generation	1.61	25	3.48	5
Solar/Marine	2.22	4	4.01	2

Gas and Oil generation has the largest Type 1 output multiplier and Biomass has the largest Type 2. Nuclear and Hydro have particularly low output multipliers while many renewables have relatively large output effects. The output multipliers of renewables may be overestimated by subsidies received. The considerable difference in CO<sub>2</sub> multipliers is shown below for each technology.

Sector	Type 1	Type 2
Supply of electricity	7995	8339
Nuclear	264	491
Coal	41617	41916
Gas and Oil	17138	17528
Hydro	103	678
Biomass	210	1090
Onshore Wind	294	870
Offshore Wind	246	932
Other generation	120	894
Solar/Marine	246	988
Production and distribution of electricity	7993	8297

## References

- Gay, P. and J. Proops (1993), Carbon-dioxide production by the UK economy: An input-output assessment, *Applied Energy*, 55 pp. 113-130.
- Allan, G., McGregor, P., Swales, J.K. and K. Turner (2007), The Impact of Alternative Electricity Generation Technologies on the Scottish Economy: An Illustrative Input-Output Analysis, *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy* March 1, 2007 221: 243-254.