

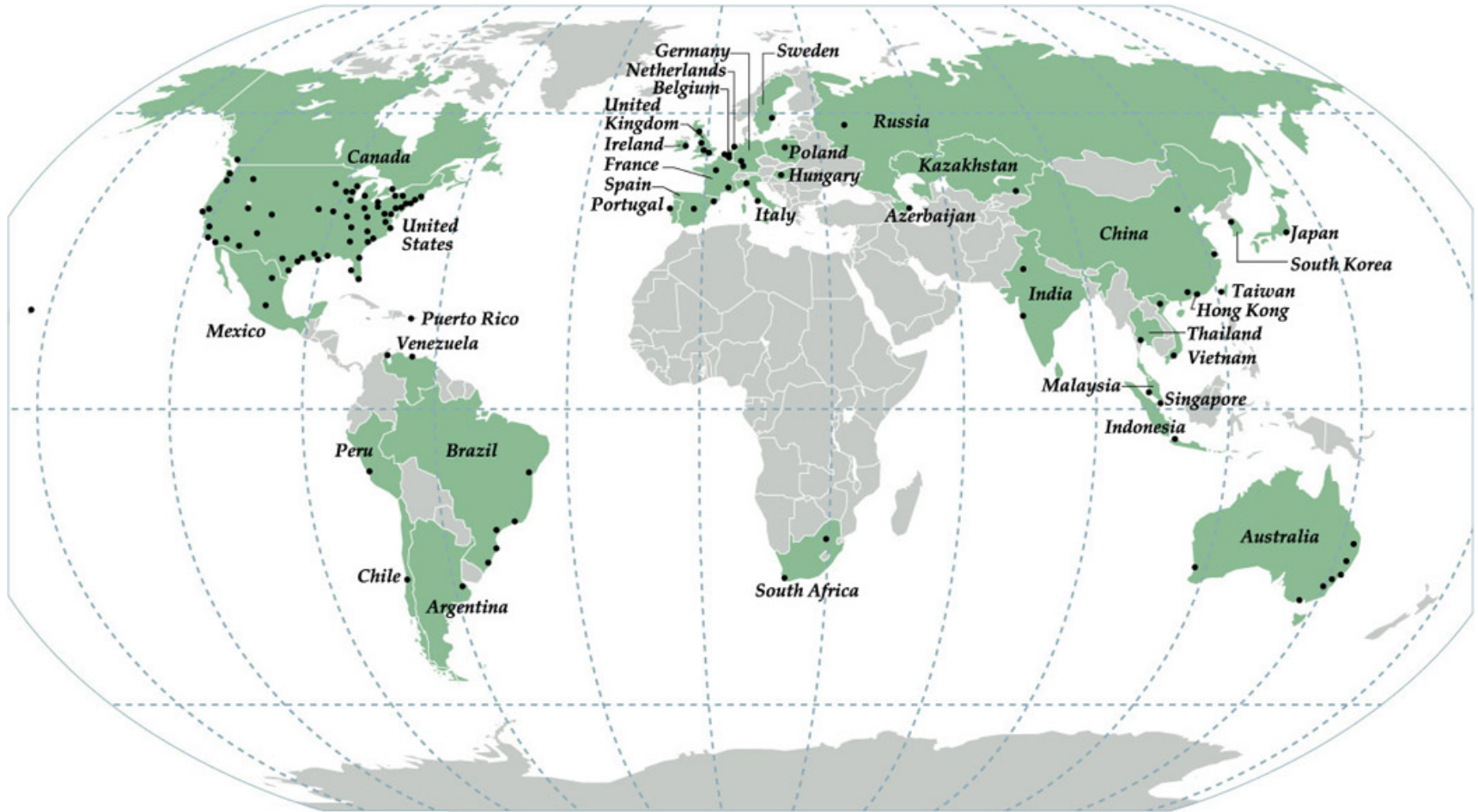
Identification of Key Environmental Loads Using a Life Cycle Approach

Creating and utilising an Input/Output Methodology
Jacob Madsen, ERM Oxford, UK

Who Are We?

- **One of the world's leading providers of environmental consulting services**
- **Over 100 offices in 39 countries**
- **2,500 professional staff**
- **Worked closely with over 55% of the Global Fortune 500 companies in the past 4 years**
- **Completed projects in more than 160 countries**
- **Annual turnover of US\$425.4m (FY05)**
- **Over 30 years of experience**

Global Outlook - Local Implementation



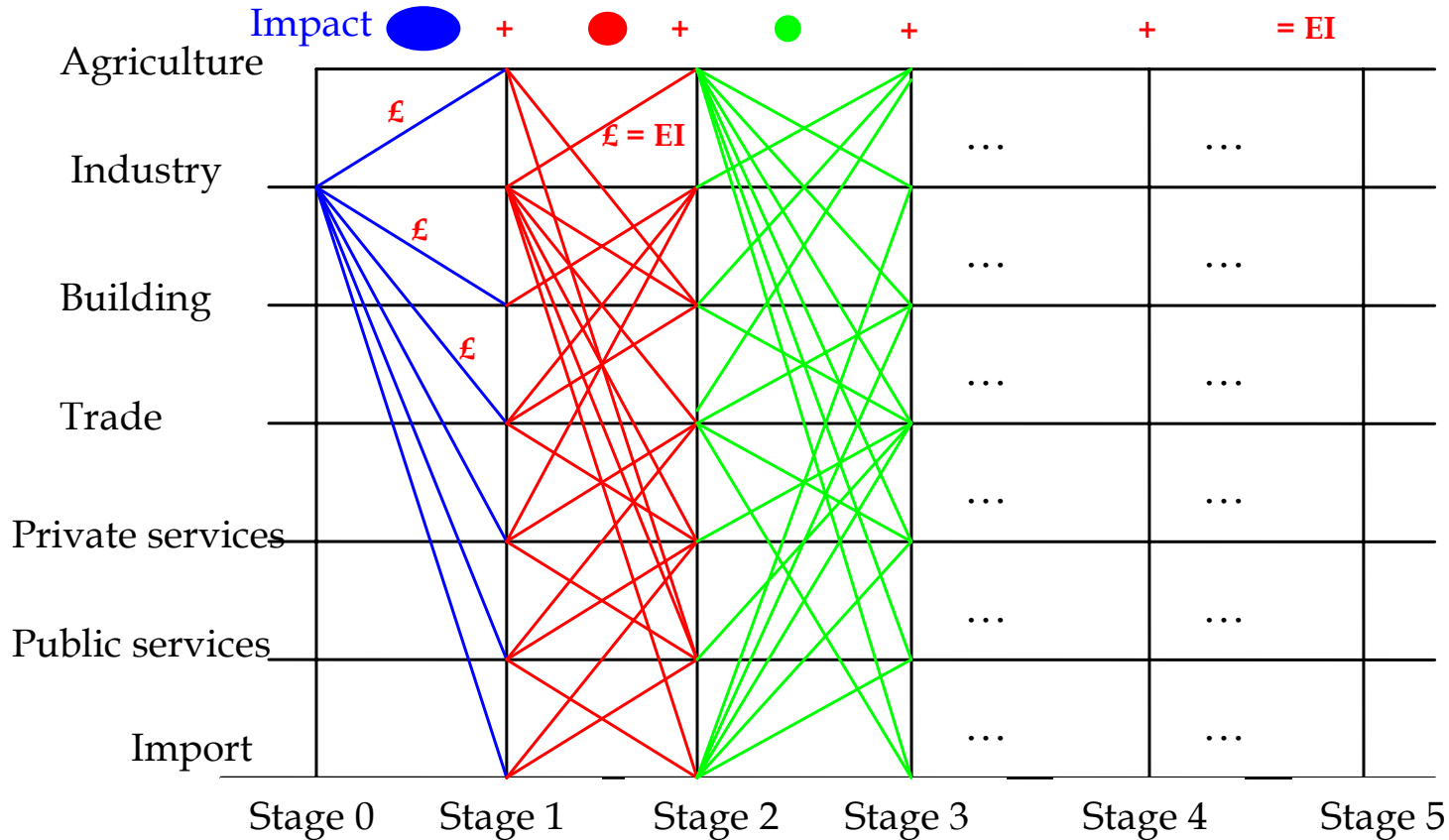
Objectives of Study

- **To review and extend existing I/O models for the UK**
- **To use I/O method to identify the economic sectors that give rise to the greatest overall environmental impacts**
- **To carry out life cycle studies using LCA and I/O data to establish those sectors/activities that have the greatest impact on the environment**

I/O methodology (NAMEEA)

- **$(I-A)^{-1}$ – Leontief inverse (technology matrix)**
- **Specifies for one monetary output of a sector how much input of other sectors is required for producing it.**
- **Specifies how the production of one unit is distributed over all users of the product/service involved**
- **B – Direct environmental interventions per sector**
- **The total direct and indirect environmental interventions per sector (M) is calculated by:**
 $M = B(I-A)^{-1}$

I/O methodology



(Weidema et. al. 2005)

Selection of criteria for review of current NAMEA

- **Include sectors that the EA regulate**
- **Thorough review of existing studies including but not limited to:**
 - EIPRO (Tukker et.al 2006)
 - Prioritisation of Integrated Product Policy (Weidema et al. 2005)
 - Swedish Experience Using Environmental Accounts Data for Integrated Product Policy Issues (Palm et al, 2006)
 - Environmental Load from Private Dutch Consumption (Goedkoop et al, 2002)
 - Relationships between Environmental impact and Added Value along the Supply Chain (Clift and Wright, 2000)
 - Missing Inventory Estimation Tool using Extended I/O analysis (Suh, Huppel, 2002)

Review of existing NAMEEA

- **Technology matrix (A)**

- 78 x 78 sector matrix derived from a 123x123 sector supply use table

- **Environmental matrix (B)**

- Emissions and resource use for each of the 78 sectors

Emission	Emission	Emission	Emission/raw material
CO ₂	PFCs	Pb	Se
NO _x	SF ₆	Cd	Zn
SO _x	CO	Hg	V
CH ₄	PM10	As	Coal use
N ₂ O	NMVOC	Cr	Natural Gas use
NH ₃	Benzene	Cu	Oil use
HFC's	1-3 butadiene	Ni	

Extending the Technology matrix

- **Sectors in 78 x 78 matrix too aggregated**
 - Agriculture
 - Food and Drink
 - Cement, Lime and Plaster
- **Utilise 123 x 123 matrix**
 - Food and Drink into 12 sub sectors
 - Disaggregate Agriculture
 - Arable
 - Dairy and Beef
 - Sheep
 - Energy crops
 - Pig and poultry
 - Disaggregate Cement, Lime and Plaster
 - Cement
 - Lime
 - Plaster
- **Resulting in 129 x 129 technology matrix**

Extending the Environmental Matrix

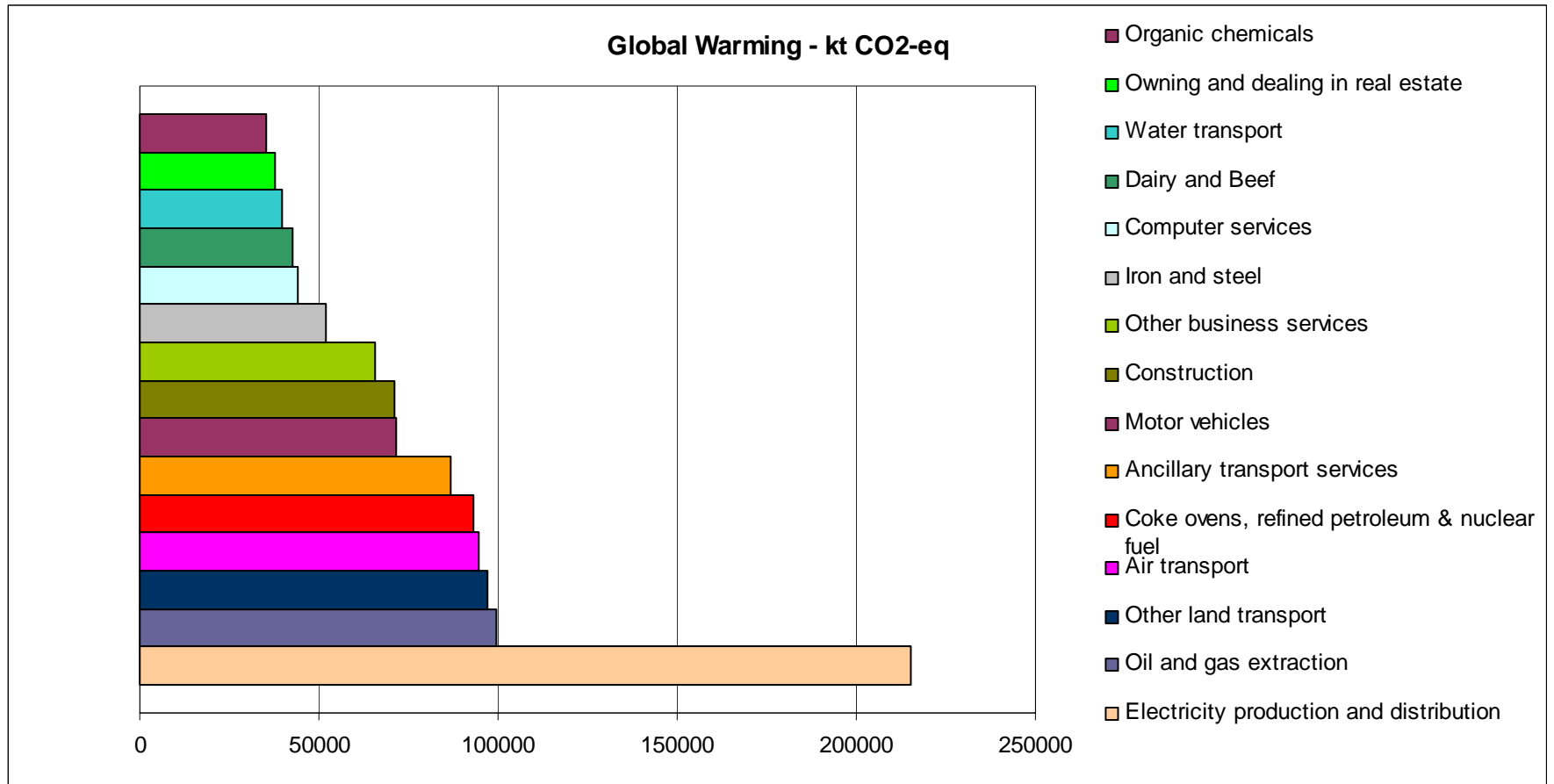
- **Added land use, water use and waste generation**
- **Expand emissions and resource consumptions from 78 sectors to 129 sectors**
 - Ideally using added value per sector
 - Detailed employment figures per SIC code
 - Quality check: Employment figures/Added Value

Interpretation of Results

- **CML Impact Assessment Method**
 - Global Warming
 - Acidification
 - Eutrophication
 - Photochemical Oxidation
 - Human Toxicity
 - Eco-toxicity
 - Abiotic depletion
- **Other indicators**
 - Coal consumption (TJ)
 - Oil consumption (TJ)
 - Natural gas consumption (TJ)
 - Land use (ha)
 - Water use (m³)
 - Waste generation (Kt)

Example of results

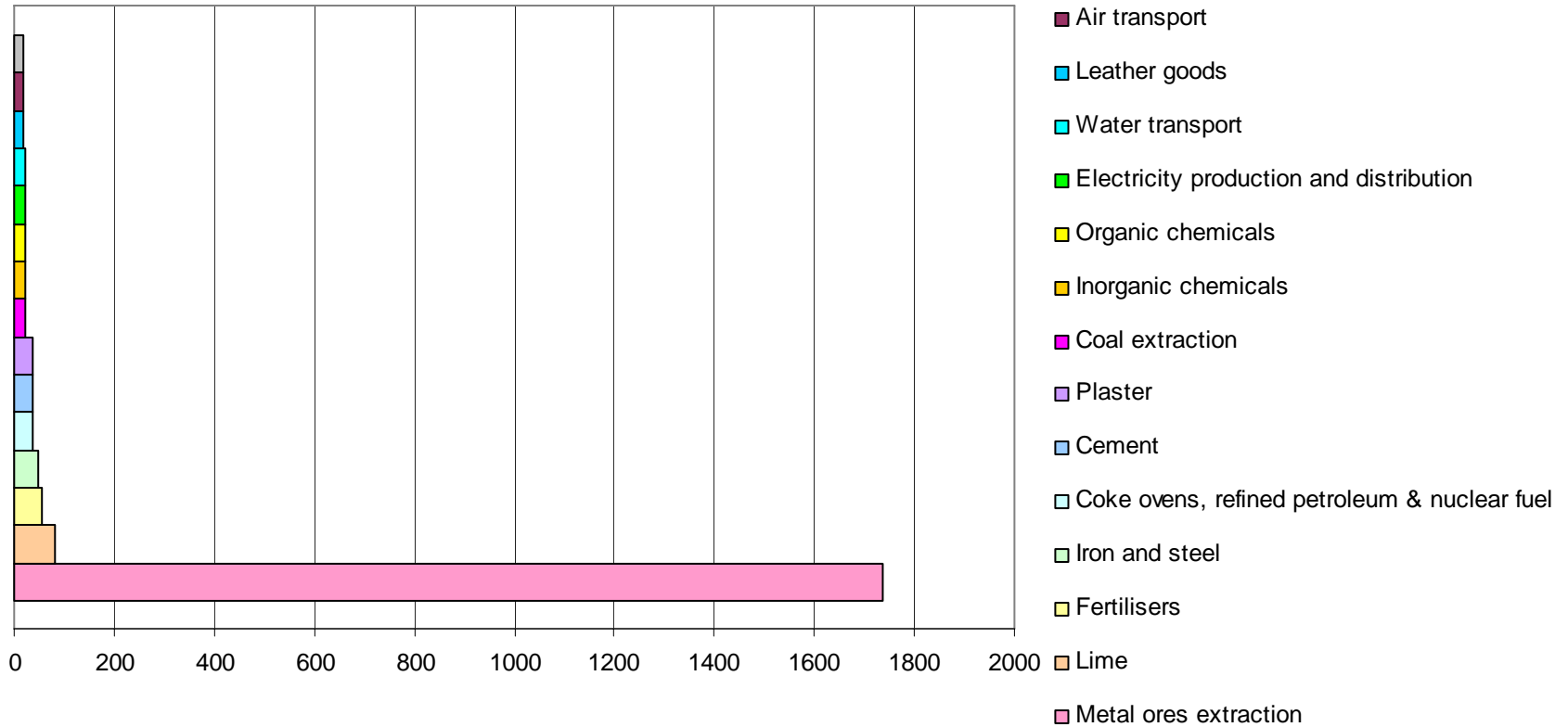
Global warming



Example Results

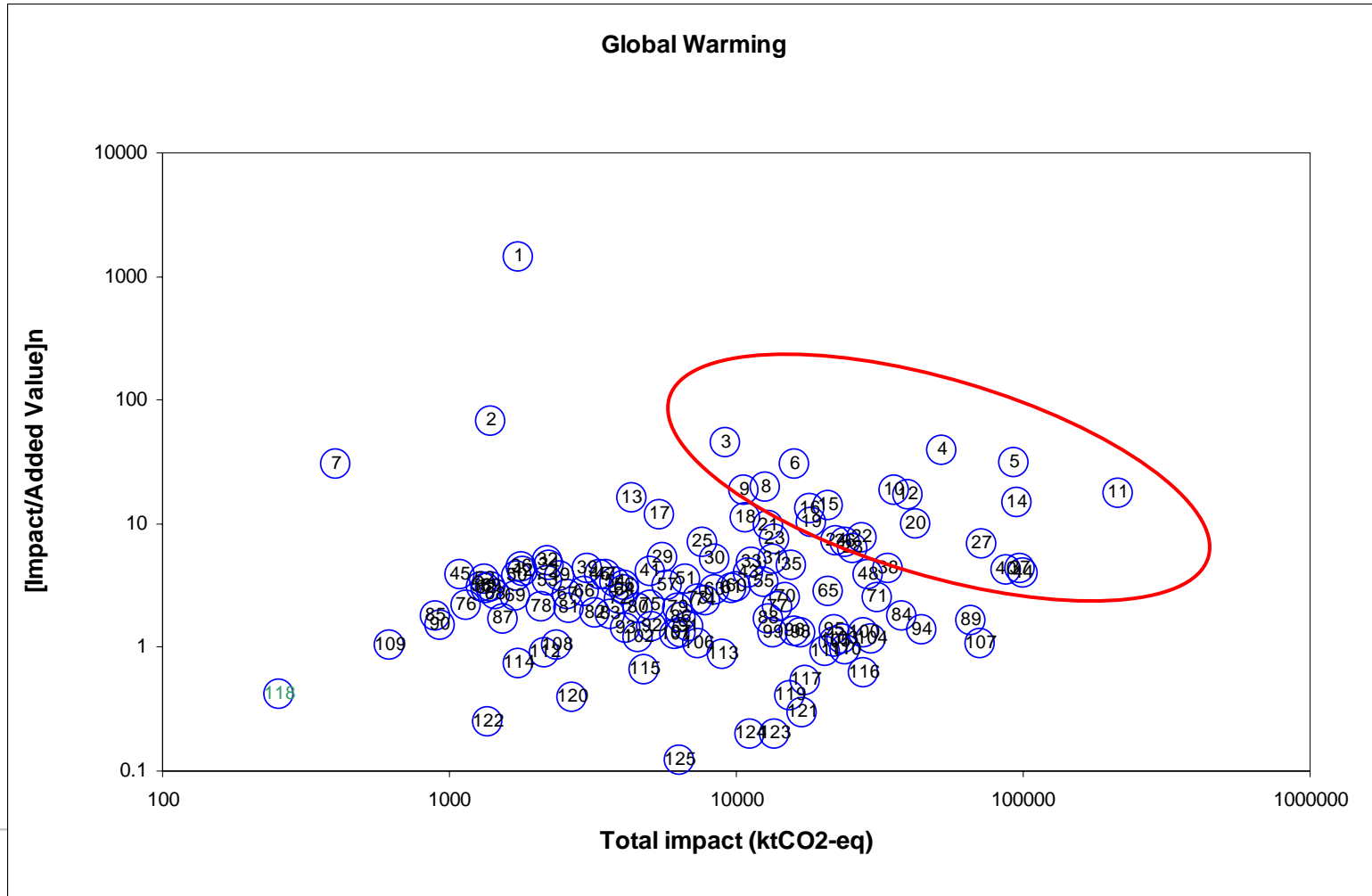
Global Warming per Added Value

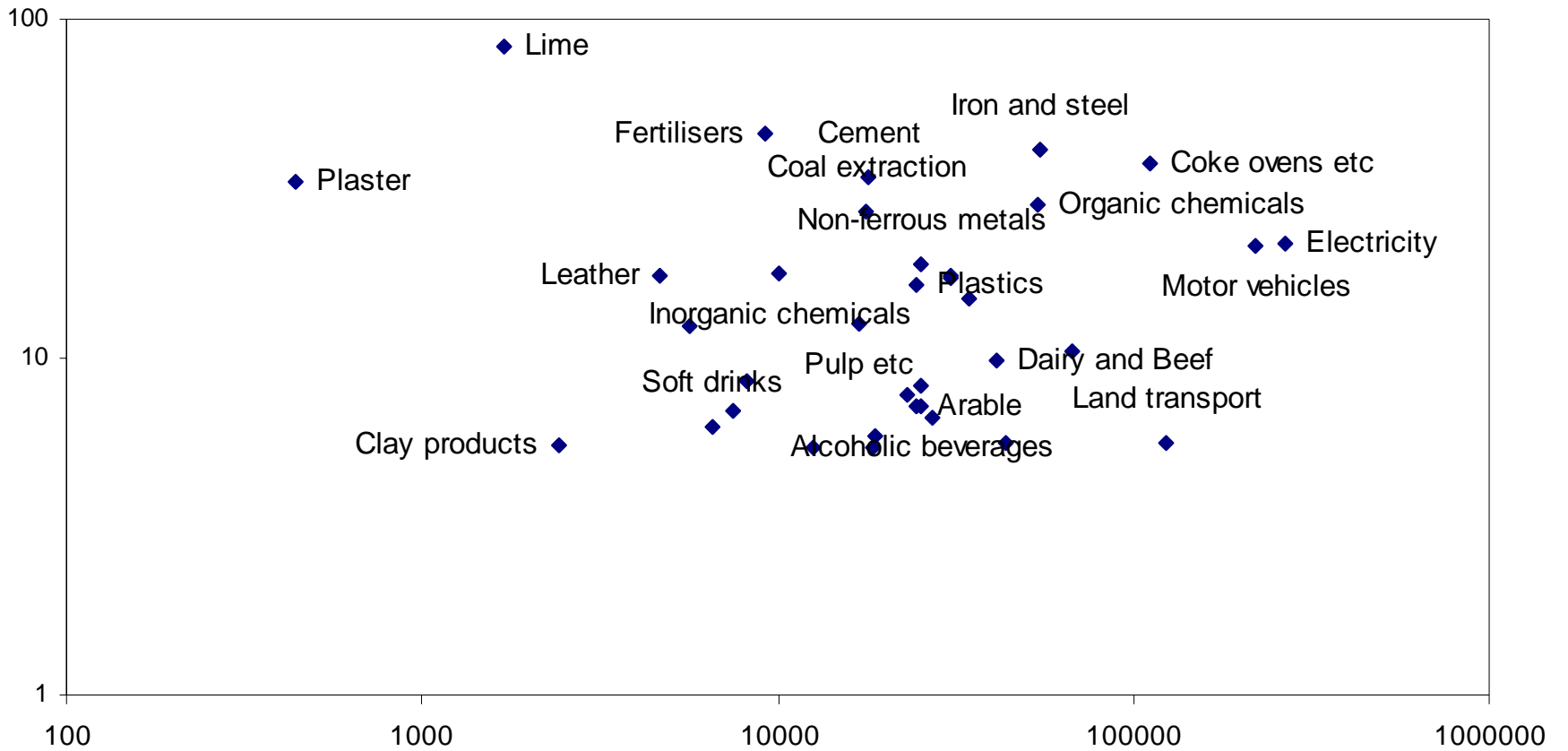
Global Warming - kg CO₂-eq/£



Example of Results

Use of normalised impact intensity and total impact to target sectors

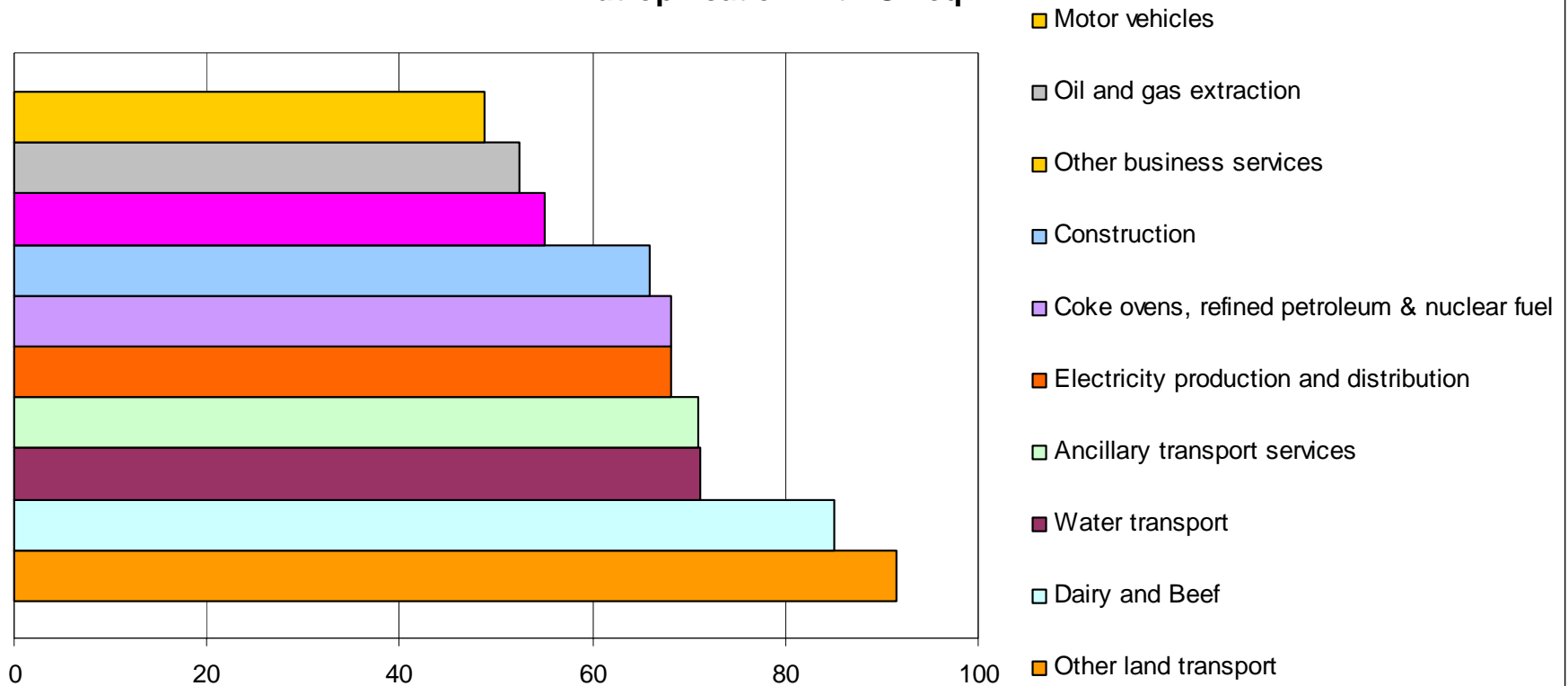




Example of Results

Eutrophication

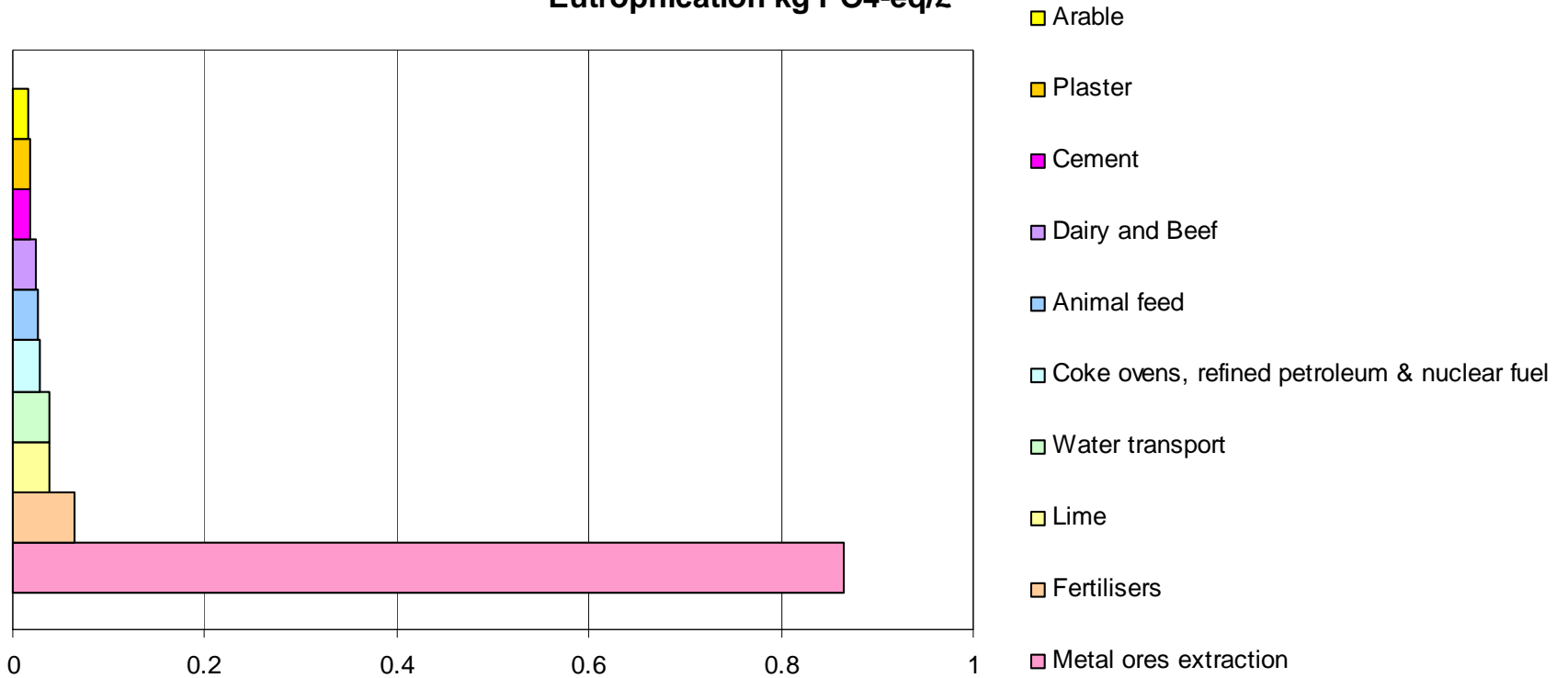
Eutrophication - kt PO4-eq



Example of Results

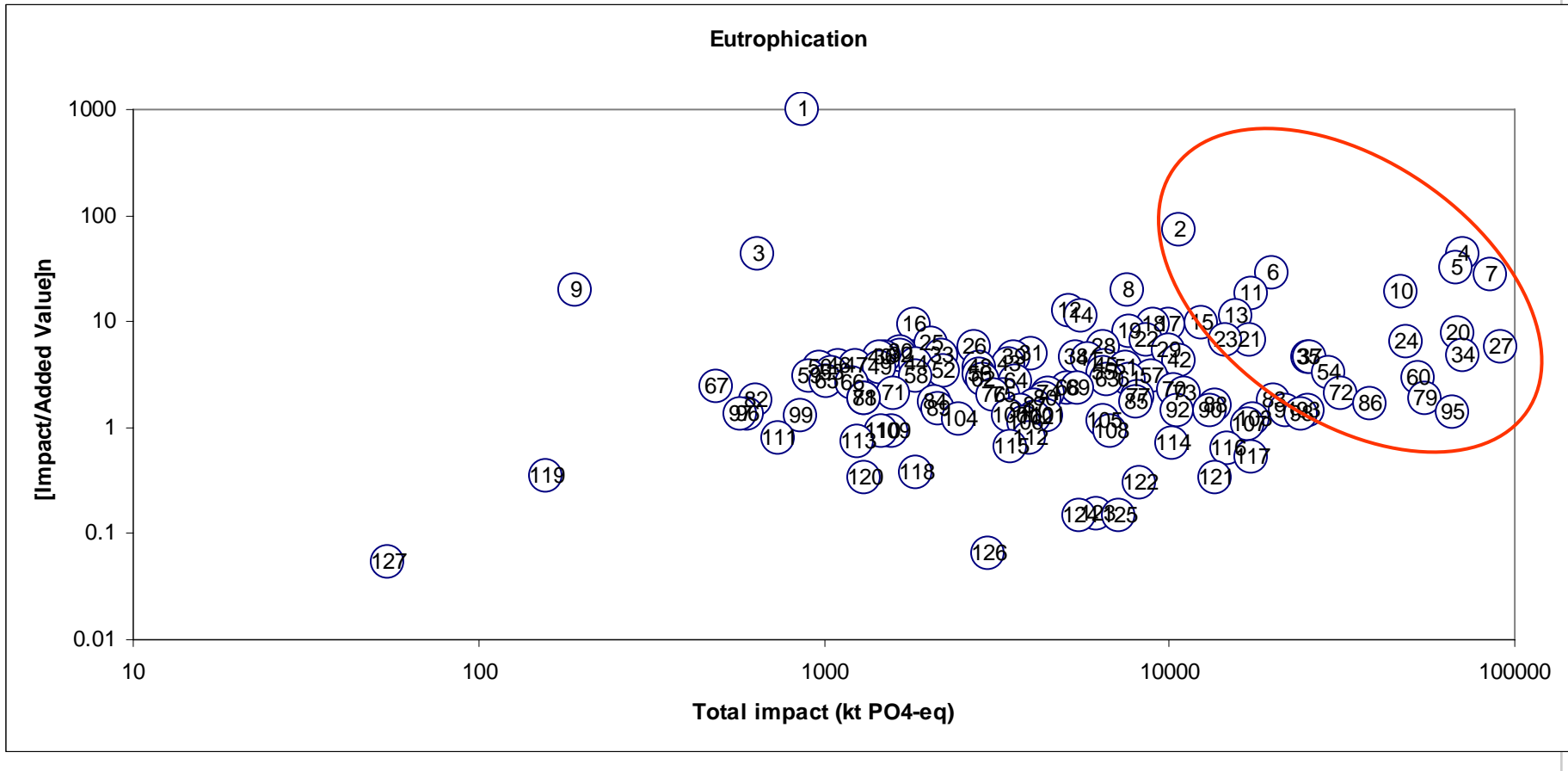
Eutrophication per Added Value

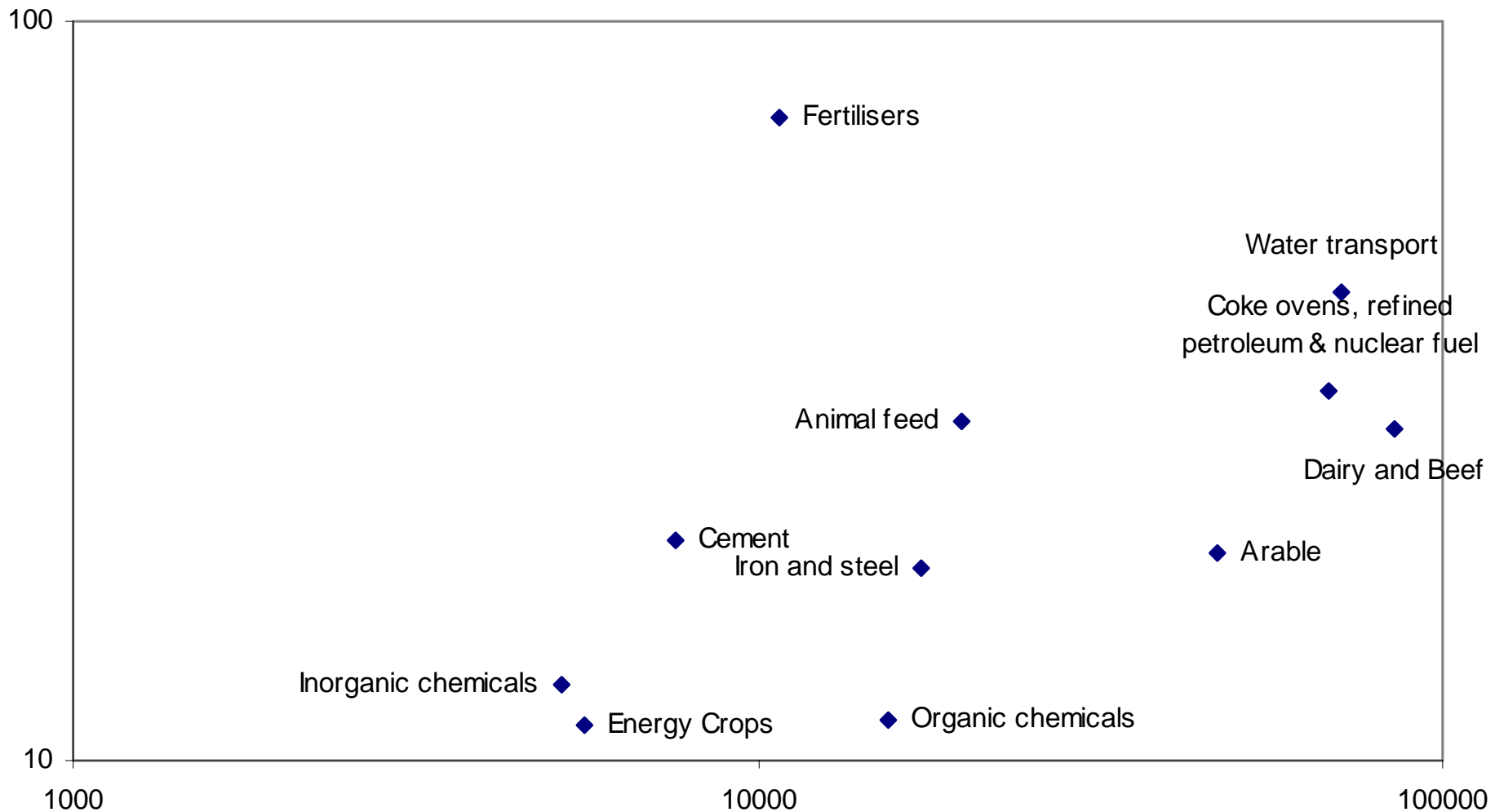
Eutrophication kg PO4-eq/£



Example of Results

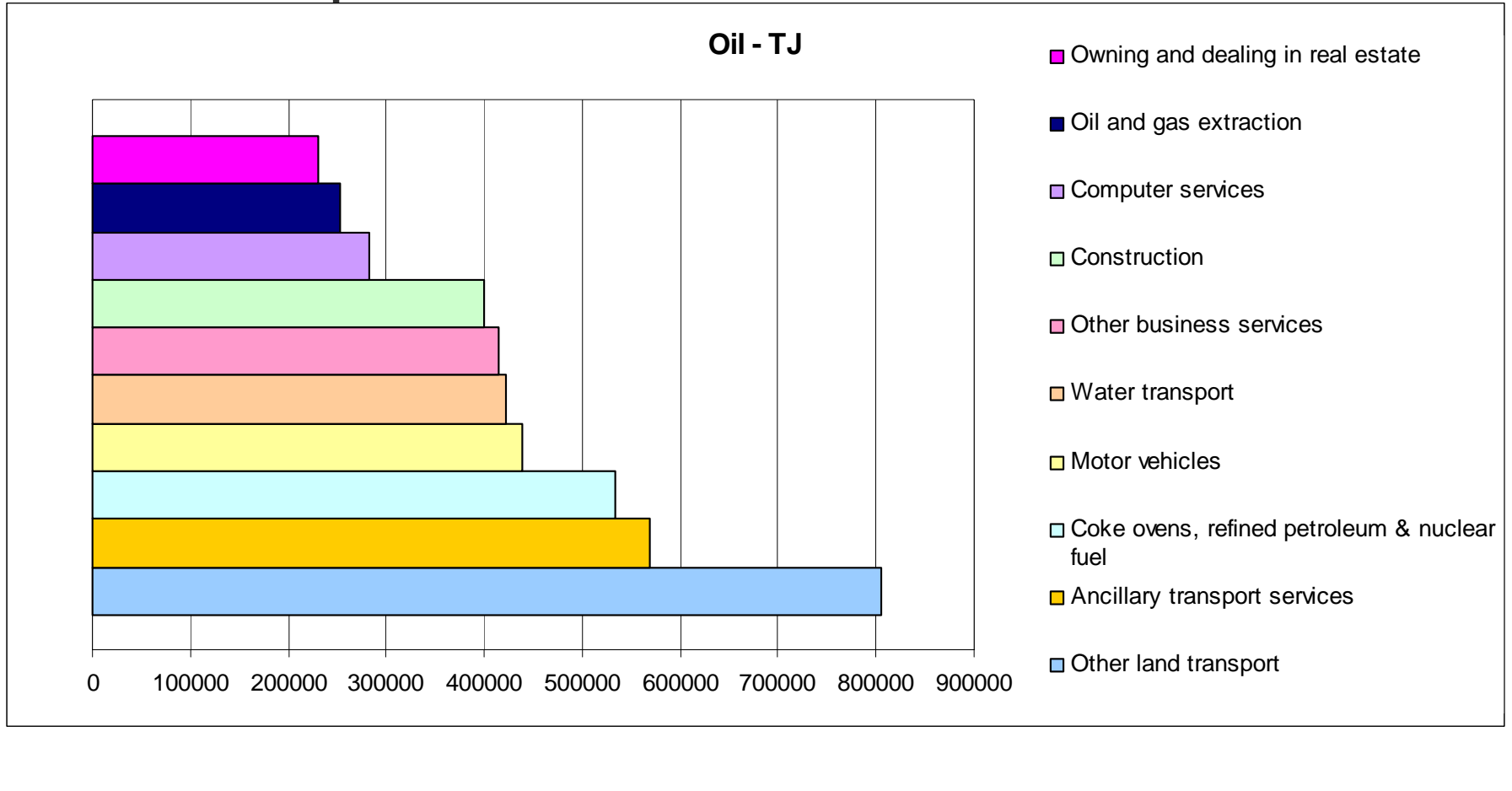
Use of normalised impact intensity and total impact to target sectors





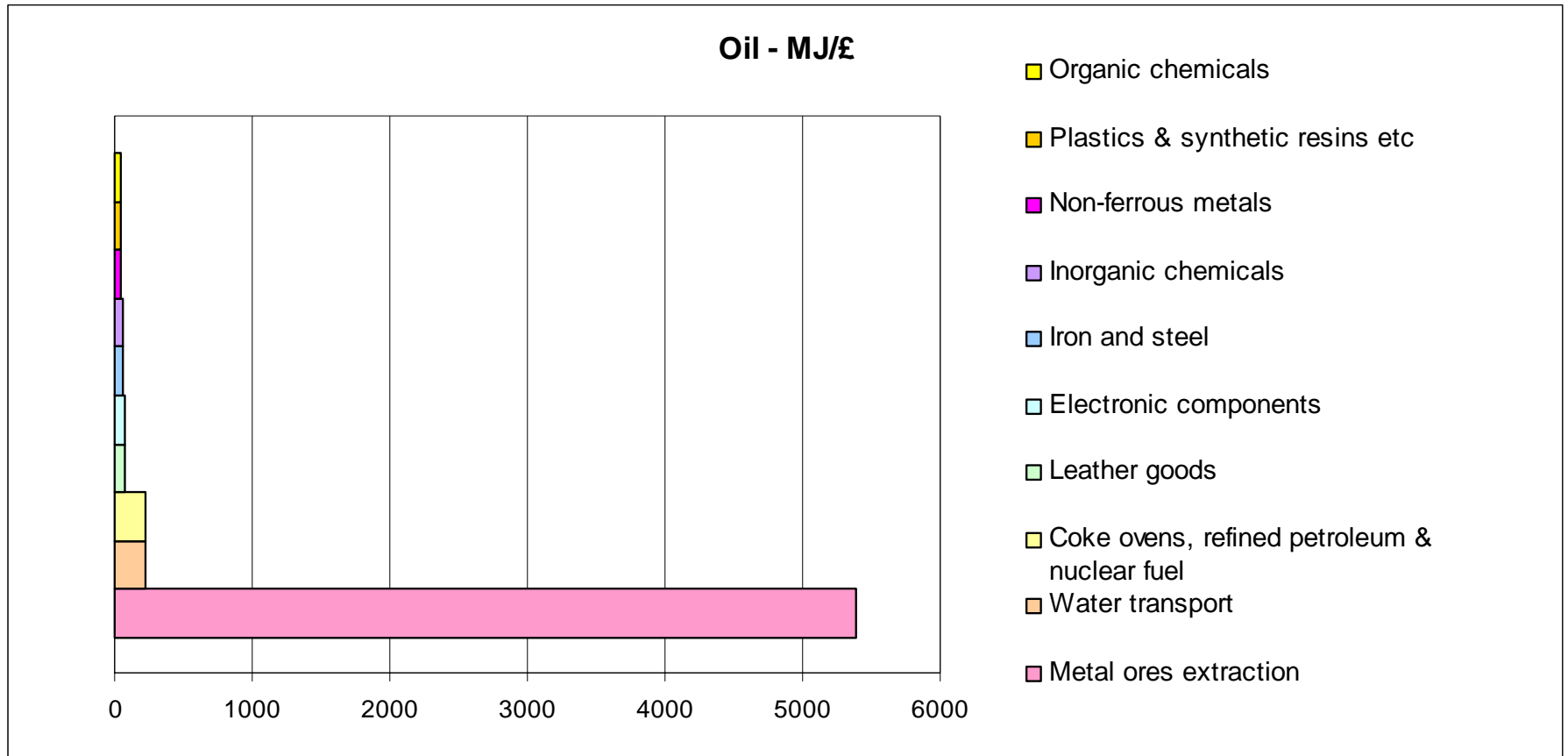
Example of Results

Oil Consumption



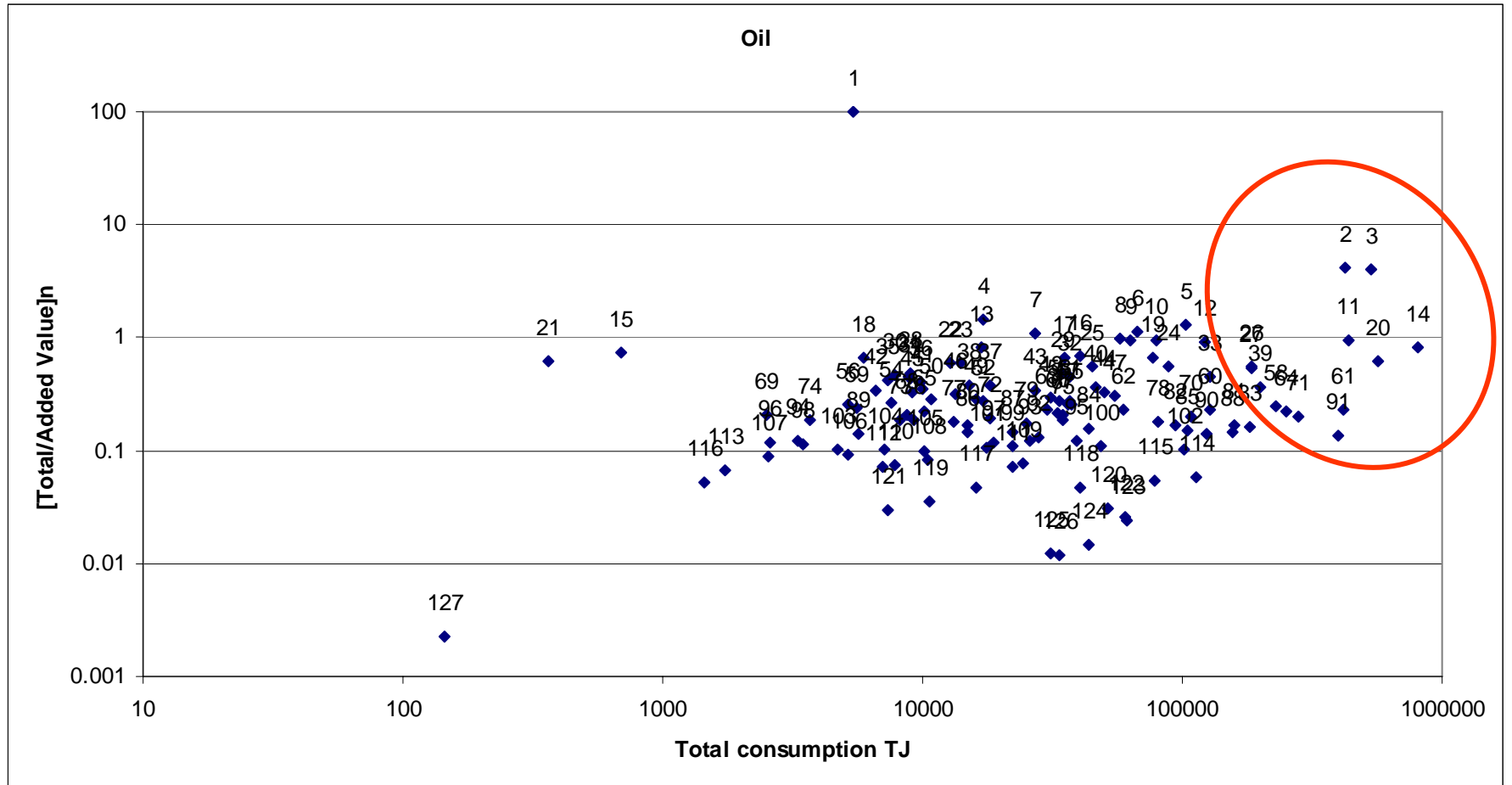
Example of Results

Oil Consumption per Added Value

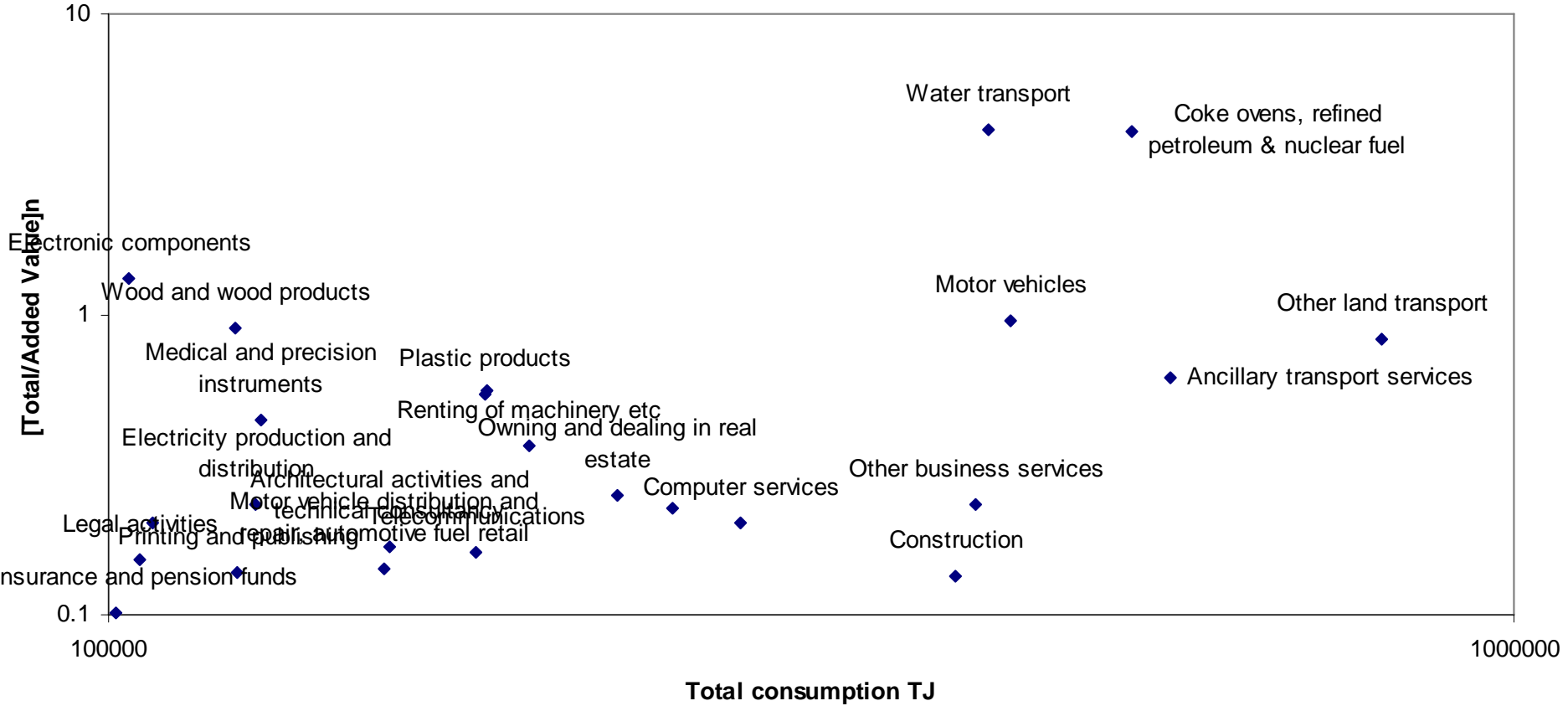


Example of Results

Use of normalised impact intensity and total impact to target sectors



Oil



How will these results be used?

- **To identify sectors/activities that have most environmental impact**
- **To carry out LCA for the chosen sectors**
- **To identify sectors/activities with the greatest potential for environmental improvement**

Potential future work

- **Link I/O tables to consumption (final demand)**
 - Make the IO methodology more product related using COICOP headings (Classification Of Individual Consumption Of Purpose)
 - Sustainable Production and Consumption
 - Environmental impacts of different life styles