

# Energy embodied in trade, 1970-2009

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## Overview

Historical evidence shows that the relationship between energy use and economic growth in the developed countries has been tightly coupled until about 1970s. The period thereafter is marked by stabilization in energy use per capita and economic growth without a proportional increase in energy use.

Several factors have been put forward to explain the changing trend in energy consumption after 1970. (i) The most common explanation relates to the structural transformation or changes in composition of national output toward lighter manufacturing industries and services that, on average, used less energy per unit of output than the heavy industries that had been dominant in the past. (ii) Another major factor contributing to the decline in energy consumption after 1970s has been technological change and significant improvements in thermal efficiency of energy conversion. (iii) Changes in the composition of energy supply, in particular relative increase of electricity inputs (electricity is high quality form of energy, thus less electricity is required to produce the same amount of output) and fluid fuels (petroleum and natural gas) which were in many ways more flexible than solid fuels in the uses to which they could be put into.

These factors turned out to be important, but they provide only partial explanation. Another element that is in general less obvious and often omitted but is crucial in explaining the trend change since 1970s is energy embodied in traded goods. International trade allows a country to partially disconnect its domestic economic and ecological systems as some goods can be produced and imported from other countries.

Between 1970 and 2008 global trade grew by an average of 7.2 % each year. Compared with 1970s, in 2006 the value of trade was almost a factor of 10 higher for manufactured products, 2.3 higher for fuels and mining products and more than 3 times higher for agricultural products.

In light of this evidence a relevant question is to what extent the change in energy - gdp ratio can be attributed to the international trade (i.e. energy embodied in imported goods also known as grey energy).

Understanding the drivers behind falling energy-gdp ratio and the interplay between them has significant policy implications. If the decline in energy intensity comes from simply increasing imports of energy intensive goods and producing less of them domestically, then the observed pattern would not be replicable in other less developed countries. However, if the gains come from technology, then policies encouraging technology transfers, economies of scale and learning by doing effects could be encouraged and replicated.

## Methods

Multi-Region Input-Output (MRIO) and Single-Region Input-Output (SRIO) models are used to estimate the total energy embodied in trade of the UK, USA and France from 1970s to 2009. The analysis is split into two parts. For the first part from 1970s to 1990 we use the single region input-output tables from the OECD and data for energy come from IEA. We assume that imports are produced with domestic technology. The data for the second part 1995-2009 come from the World input-output Database (WIOD).

## Results (preliminary)

The main results of this study are presented in the table below. From 1970s to 2009, GDP grew more than 200% among all of the selected countries. Gross energy use during the same period increased only by about 30% in the US and France and in the UK it has remained virtually unchanged. This evidence supports the story that many industrialized countries such as Great Britain, France and the US have achieved a relative (weak) decoupling between economic growth and energy consumption. In the case of the UK, energy consumption has declined fractionally since 1970s, reflecting a sign of absolute decoupling. Taking into account energy embodied in imports (Energy – EE + EI) does not affect the decoupling between growth and energy, but it alters the level of energy consumption by shifting it upwards.

We find that in the beginning of the study period all countries display positive balance of energy embodied in trade meaning that energy embodied in exports is higher than energy embodied in imports. The balance deteriorates and turns negative by late 1970s mid-1980s. It is important to note that with a few exceptions energy embodied in exports display no significant changes and remains stable over the period in all countries. In contrast energy embodied in imports has grown substantially in all countries. The faster growth of energy embodied in imports is reflected in a negative net balance over the period.

	pre-1973	mid-1970s	mid-1980s	1990	1995	2000	2005	2009
<b>UK</b>								
GDP (trillion)	596	785	829	1020	1134	1328	1525	1532
Energy (PJ)	13594	14564	12458	13782	14859	15306	15148	13454
EE	4242	6036	5466	5128	3813	4398	4567	4397
EI	4026	6151	6096	5767	5306	7938	11133	8186
Net (EE-EI)	216	-115	-631	-640	-1494	-3541	-6566	-3789
<b>USA</b>								
GDP (trillion)	5197	6009	7687	9064	10299	12713	14408	14595
Energy (PJ)	103986	117672	110253	121928	135269	148217	153662	141902
EE	6309	15412	13569	15108	13671	13697	13496	15398
EI	6589	11161	15296	17086	19630	32481	42522	32204
Net (EE-EI)	-281	4251	-1726	-1978	-5959	-18784	-29026	-16806
<b>France</b>								
GDP	869	1030	1219	1440	1535	1772	1923	1960
Energy (PJ)	13029	13543	13045	14099	15991	17017	17636	16259
EE	2947	4059	4260	4096	3723	4351	4405	3625
EI	2922	3985	4404	4411	6064	6995	9257	8926
Net (EE-EI)	25	74	-145	-315	-2341	-2644	-4852	-5300

## Conclusions (preliminary)

First, the evidence suggests that all countries considered in this study have managed to decouple economic growth from energy use. This is not only true for traditional measure of energy use but also for energy use that takes into account energy embodied in imports. Second, developed countries display a negative balance of energy embodied in trade i.e., energy embodied in imports is higher, than energy embodied in exports. Third, energy-gdp ratio is decreasing in all economies, even after energy embodied in imports is taken into account.