

# **The direct and indirect household energy requirements in the Republic of Korea from 1995 to 2010**

**- An input-output analysis -**

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## **Overview**

Often discussed are only direct energy requirements in the form of electricity, fuel oil, gasoline, town gas and district heat by households. Many households are not paying much attention to energy conservation as a relatively small portion of their income is spent for direct energy use. In 2010 the Korean households spent only 6.1% of their incomes to pay energy utility bills and to buy gasoline, diesel and Liquefied Petroleum Gas (LPG) for their cars according to the 2010 input-output-table of the Bank of Korea (BOK).

However, the households use lot of energy embodied in the goods and services they consume. The Korean households spent Won 617 trillion (about US\$ 533.6 billion) or 53.5% of the GDP for private consumption in 2010. The so-called indirect or grey energy requirement depends on energy intensities of products consumed and on the mix of products consumed, hence on the household consumption behavior/ pattern. Energy conservation can be realized, if consumption can be directed towards less energy intensive products.

## **Methods**

The first step for such energy conservation is the quantification of total (direct and indirect) household carbon emissions. This study aims to quantify direct and indirect household energy requirements in Korea from 1995 to 2010 by using 168 sector classification input-output tables. As detailed data on energy consumption in physical terms are missing, monetary input-output tables will be converted in energy terms first with the help of uniform (average) fuel prices. However, this kind of construction of energy input-output tables results in an overestimation of direct household energy requirement and concomitantly an underestimation of indirect household energy requirement. Thus, this study tries to differentiate energy prices between intermediate demand and final demand minus imports. Furthermore, this study analyses the causes of the increase in total energy requirements by decomposing the increase in total household energy consumption by activity, structure and carbon intensity effects.

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## Results

The average direct household energy intensities show a decreasing trend from 4.67 kJ/Won in 1995 to 3.84 kJ/Won in 2009 while the total household energy intensities decreased from 20.71 kJ to 15.16 kJ/Won in the same period. The share of the direct household energy requirement was with 1558.6 PJ 16.2% while the direct and indirect household energy requirement was with 5427.2 PJ 56.6% of the country's total energy consumption. Korean households consumed energy indirectly about 3.5 times as directly. This shows that the indirect household energy consumption should be the main concern for energy conservation policy.

## Conclusion

This study shows that average direct, indirect and total energy intensities declined rather substantially in the 1995 to 2010 period in Korea. This means that the Korean industry moved to a higher value added production structure as the value added of the Korean production grew faster than the energy input (use) for the production.

The Korean household sector was responsible for about 52% of the national primary energy requirement (TPES) in the period from 1995 to 2010. And more than 60% of household energy requirement was indirect. Thus, the household sector is the main economic sector (driver) in energy consumption and not only direct but also indirect household energy requirement should be the target of energy conservation policies.

The ratio of direct use to the total household energy requirement in Korea was smaller and concomitantly that of indirect use was bigger than in other countries like the Netherlands and India. This is probably because higher fuel prices for gasoline and electricity discouraged direct household energy use while lower fuel prices for the industry lead to an energy intensive industrial structure and with it to higher ratio of indirect use. It exemplifies that higher energy prices are a strong measure for energy conservation. Another reason for the high ratio of indirect energy requirement could be found in a relatively high share of heavy industry in the economy as well as in the total final energy consumption (TFC).

Information on energy intensities of more disaggregated sectors/ products will encourage household energy conservation. Many consumers do not pay adequate attention to energy conservation as they do not have such information (Hassett and Metcalf, 1993; Ü rge-Vorsatz et al., 2006). In this context, it is interesting to note a Dutch experiment according to which households were given information on how much energy they use by consuming (purchasing) individual goods and services. 14 Dutch households under experiment could cut in two years direct energy requirement by 16.7% from 60 to 50 GJ and indirect energy requirement by 34% from 200 to 132 GJ while spending 20% more income for consumption (Blok, 2004).

More research should be done on indirect household energy use. A future Korean study should apply a hybrid method as used in the Netherlands to assess indirect household energy requirement

more accurately. Intensities of energy intensive products and expenditure strong products need to be assessed by the process analysis as to reduce errors occurred by using uniform (average) prices in constructing energy input-output tables and as to make energy intensities of different years more comparable.

**Keywords:** Household energy requirements; Indirect energy; Energy input-output