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NRP-project LIFESTYLE
Reduction of CO_2 emissions by lifestyle changes

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Abstract

The aim of the Lifestyle project is to analyse the CO_2 emission reduction potential of lifestyle change. The analysis is carried out by examining the direct and the indirect energy contents of the average Dutch household consumption. An overview of the past developments of Dutch sector energy intensities is produced and its consequences for the average household energy requirement are studied.
Also differences in energy requirement related to differences in lifestyle are assessed. Calculations of the Dutch household expenditure survey has resulted in an overview of the energy requirement per income and spending subcategory. The correlations between some relevant household factors are determined and discussed.

Introduction

The Lifestyle project succeeds preliminary studies about the direct and indirect energy contents of an average household consumption pattern.
The aim of the project is to analyse if and how CO_2 emissions can be reduced by changing lifestyles or by changes within lifestyles. Six research stages are discerned.
First, - to serve this goal - it is necessary to enlarge the scope of the methodology to calculate the energy content of consumption patterns and to improve the quality of data (research stages A1 - A3).
Next differences in CO_2 emission related to differences in lifestyle and possibilities of lifestyle changes are to be assessed and evaluated on their potential to reduce the CO_2 emission (research stages B1 - B3).
The six research stages are:

A1. An improvement of the input output energy analysis methodology (including CO_2 emissions) by correction of possible biases and by an assessment of its scope by application on several generic lifestyles.

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A2. An assessment of structural trends with regard to the energy intensities of economic sectors from a time series of Dutch energy consumption data.
A3. Further and deeper analysis of consumption and construction of a database concerning the energy and CO_2 content of consumption activities.
B1. Identification of different lifestyles by correlating income, time budget and consumption with energy requirement and trend analysis on these lifestyles.
B2. Description of the lifestyles in terms of financial and energy/CO_2 costs and trend analysis on these costs.
B3. Assessment of the effects of possible technological developments on energy intensities and on energy and CO_2 content of lifestyles by a scenario approach.

This paper discusses the results of two subprojects: *Energy consumption in relation to economic activities, 1969 - 1988*, addressing the research stages A1 and A2, and *The direct and indirect energy requirements of households in the Netherlands*, addressing the research stages B1 and B2.

Energy consumption in relation to economic activities, 1969 - 1988 [1]

Economic activities, production and consumption, are closely related. Production, in fact, occurs on behalf of consumption (exports included). Therefore, the total energy use of an economy can be attributed to the consumption sectors. So, the indirect energy requirements of households, as a consequence of the purchase of goods and services, are not only determined by the consumption patterns of the households, but also by the cumulative energy intensities of the production sectors. The cumulative energy intensity gives for each sector the total amount of energy, direct and indirect, that is needed for one financial unit of production of that sector.
We aim to obtain an overview of the developments of the cumulative energy intensities for the Dutch production sectors over a period of twenty years (1969-1988). Besides, we attempt to determine the historic trends of the embodied energy of imports and exports and the indirect energy requirements of households.
The cumulative energy intensities of the production sectors are calculated by using input-output energy analysis, which makes use of economic input-output tables. These tables, published by the Netherlands Central Bureau of Statistics annually, describe the transactions in an economy in financial terms. To gain insight in the development in the energy consumption of the whole production system, we calculated the cumulative energy intensity of the total production of the economy. Using the energy intensities, we calculated the energy flows in the economy, especially the embodied energy of the imports and the exports, and the indirect energy requirements of the households. The energy data required are taken from the Dutch Energy Statistics.

Results
In the period 1969-1988, the cumulative energy intensity decreased for 40 of the 56 Dutch production sectors. 31 sectors showed a decrease by more than 10%. This points to an energy efficiency increase for these sectors. The direct and the cumulative energy intensity of total production decreased both by about 20% in the period 1973-1988.

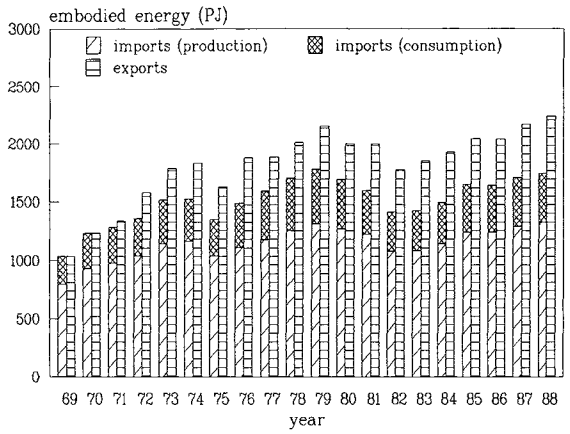

Figure 1 Embodied energy of imports, for production and consumption, and exports (PJ).

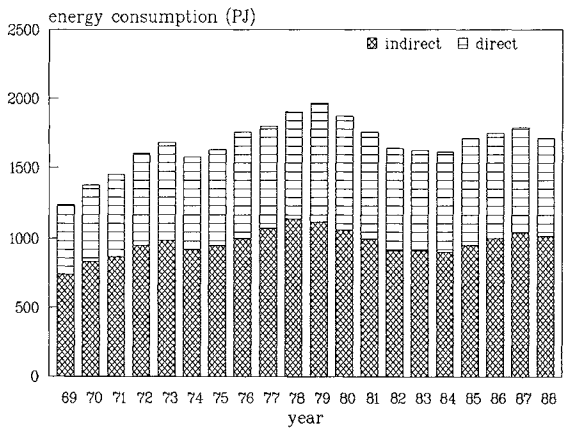

Figure 2 Direct and indirect energy consumption households in 1969-1988.

The energy flows are determined by the energy intensities. Figure 1 shows the embodied energy of the imports versus the embodied energy of the exports during the period 1969-1988. Since 1971 the embodied energy of the exports has increased more than the embodied energy of the imports. In 1988 the embodied energy of the exports was 28% higher than the embodied energy of the imports.

Figure 2 shows the direct and indirect energy consumption of the households during the period 1969-1988. In this period, in which the number of households increased with about 50% the total energy consumption of the households grew with about 30%. In 1988, the total energy consumption of the households was about the same as the total energy consumption in 1973. The energy consumption per household decreased by about 10%, partly caused by a decline of the number of persons per household.

Changes in the indirect energy consumption of the households are caused by changes in the energy intensities of the production sectors and volume and structure changes in the consumption patterns of the households. Figure 3 shows the progression of the indirect energy requirements of the households due to the changes mentioned above with regard to the base year 1969. The progress in the indirect energy requirements mainly resulted from volume changes and the improvement of the energy efficiency of the economic sectors. Changes in the structure of the consumption pattern, i.e. shifts in the purchases from production sectors to other production sectors, hardly affect the indirect energy consumption of the households.

Conclusions

Many energy conservation programs consider only direct energy consumption. Several production sectors and the households have a higher indirect energy consumption than

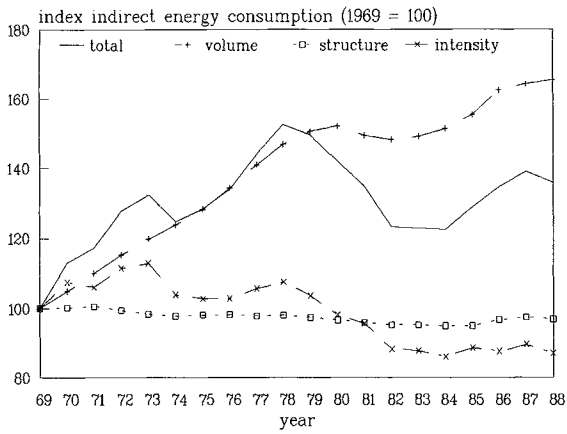

Figure 3 Indices indirect energy consumption households due to changes in volume and structure of the consumption, due to changes in energy intensities of the production sectors, and in total.

direct energy consumption. Therefore, the indirect energy consumption should get more attention in energy policy.

We have found a significant negative correlation between energy prices and energy intensities. A negative correlation means that an increase in energy prices coincides with a decline in energy intensities. The strongest correlation is between the energy intensities and the energy prices three years before. This is consistent with the fact that the energy intensities of some energy intensive sectors started to decrease some years after the first oil crisis. Sectors need some time to react to energy price changes.According to goods and services, the Netherlands has become a net exporter of energy. This means that the CO_2-emission caused by the use of fossil energy in the Netherlands on behalf of other countries is higher than the CO_2-emission in other countries on behalf of the Netherlands. The Dutch production system has concentrated more on exports.

The direct and indirect energy requirements of households in the Netherlands [2]

One way of reducing CO_2 emissions is to reduce direct and indirect household energy requirements by influencing the household consumption pattern. A household not only uses direct energy in the form of gas, electricity and petrol, but it also uses indirect energy embodied in consumer goods such as food, furniture and services. Before discussing the ways in which the household consumption pattern should be influenced, one needs to have quantitative information about these energy requirements.

We aim to obtain an overview of the total energy requirement of households and the energy requirement per consumption category. Also we attempt to quantify the relation of household expenditure, net household income and number of household members to the total energy requirement of households.

To obtain an overview of the cumulative energy requirement of Dutch households, we analysed the total consumption package for its cumulative energy requirement. The energy intensities (in MJ per Dutch guilder (Dfl)) of about 350 basic consumption categories are determined, using a hybrid energy analysis method.

The energy requirement of Dutch households is calculated by combining the 350 energy intensities with data from the Netherlands Household Expenditure Survey of 1990. This

survey gives the expenditure of 2767 representative households in the Netherlands in 1990. The result is an overview of the total energy requirement of Dutch households.

Results

The total average energy demand per household in the Netherlands in 1990 was 240 GJ, of which 54% was indirect. Table 1 gives the average energy requirement and energy intensity of the Dutch households, aggregated into 11 main consumption categories.

Figure 4 shows the relation between the total energy requirement and the household expenditure. We give the 10, 25, 50 (median), 75 and 90 percentile lines in this figure to demonstrate the variance of the energy requirement for the spending subcategories. The 10 percentile line represents the levels for which 10% of the households of the corresponding spending subcategory requires less energy than the level given by this line.

	(GJ)	Energy requirement (% of total)	Energy intensity (MJ/Dfl)
Total	**240**	**100**	**6.3**
Indirect energy requirement	130	54	3.5
Food	41	17	5.6
House	9	4	1.4
Household effects	19	8	5.5
Clothing & footwear	8	3	2.7
Medical care	12	5	3.4
Hygiene	5	2	4.1
Education & recreation	24	10	3.9
Transport & communication	11	5	2.8
Direct energy requirement	110	46	45.0
Electricity	28	12	46.5
Heating	60	25	57.8
Petrol	22	9	22.4

Table 1 Total energy requirement and energy intensity of an average Dutch household in 1990 per main category.

Figure 4 shows - as expected - that the energy requirement increases with household expenditure. But also substantial variance within the spending subcategories is observed: e.g. 10% of the households use 22% less energy than the energy requirement of an average household with the same expenditure.

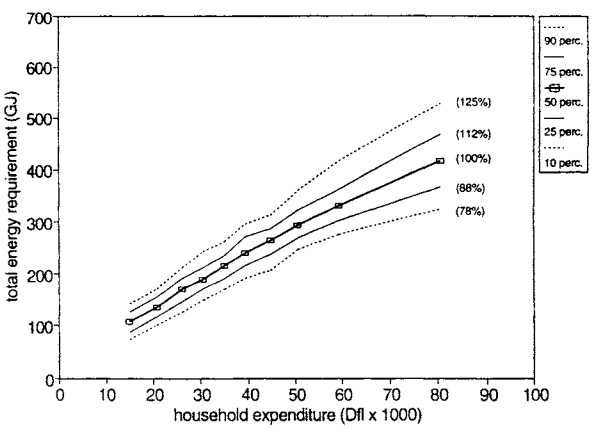

Figure 4 Total household energy requirement versus household expenditure.

The relation between energy requirement and net household income shows also an increasing relationship of the net household income and the energy requirement. But, the variance is larger than the variance shown in figure 5 because of differences between income and expenditure.

In Figure 5 we plot the total energy requirement versus the net income for various household sizes to investigate a possible dependence of these factors apart from the

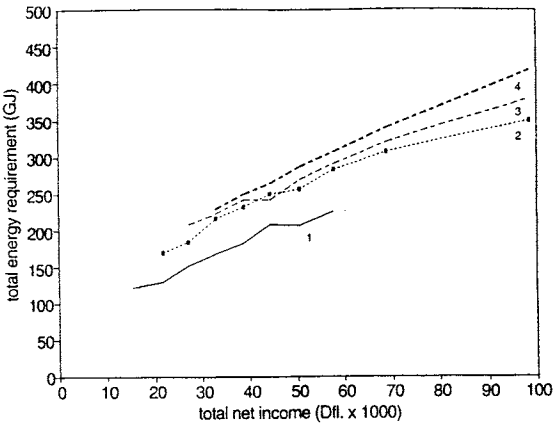

Figure 5 Total household energy requirement versus net household income for 1 to 4 household members.

dependence related to differences in net income. Figure 5 demonstrates that only a significant difference in energy requirement, independent of the net household income, is observed between one-person households and several-person households (approx. 45 GJ).

Conclusions

Because the indirect energy requirement amounts at least 54% of the total requirement of households, further research is needed into the indirect household energy requirement. Future energy policy must pay attention to the indirect energy requirement of households. The strong relation between income and total energy requirement suggests that, with further increases in income levels, the average household energy requirement will probably rise as well.

However, the large differences between the energy intensities of the various consumption categories indicate that the total household energy requirement can be reduced by a change of our consumption patterns.

References

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2. Vringer K., Blok, K., *The direct and indirect energy requirement of households in The Netherlands*, NW&S, 1993, Utrecht