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Energy Efficiency Indicators in the Netherlands

Dutch contribution to the project ‘Cross country comparison on energy efficiency - Phase 4’

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Preface

This study has been carried out in the framework of the SAVE project ‘Cross-country Comparison on Energy Efficiency Indicators - Phase 4’. This project is co-ordinated by the French agency ADEME. The project was financed to a large extent by the Dutch Ministry of Economic Affairs, together with the EU SAVE program under contract number 98 10 013. The ECN project number was 7.7157.

Abstract

The study uses energy efficiency indicators to present and review the energy efficiency situation in the Netherlands in the last decades. The indicators are calculated along a common methodology, using the ODYSSEE database and national data. In addition, an account is given of energy efficiency and environmental policy initiatives in the Netherlands in 1996-1998.

In the period 1982-1996, total final demand has increased with 25%. The service sector doubled whereas households remained relatively stable. There were no remarkable shifts in the fuel mix. The improvement of the final energy intensity since 1982 was 13%. Corrected for average outside temperature this was 15%. Among the factors influencing the intensities, the fuel prices, the sectoral structure (influenced by economic growth), and the effort and funds devoted to energy conservation policy are analysed. The developments with regard to these factors in the Netherlands explain the development of the final energy intensity to some extent.

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SUMMARY

The study uses energy efficiency indicators to present and review the energy efficiency situation in the Netherlands in the last decades. The indicators are calculated along a common methodology, using the ODYSSEE database and national data. In addition, an account is given of energy efficiency and environmental policy initiatives in the Netherlands in 1996, 1997, and 1998.

One problem encountered with regard to the data collection is the disruption in Dutch statistics as a result of the adoption of the NACE code since 1993. For some sectors, consistent data can only be presented from 1993 on.

In the period 1982-1996, total final demand has increased with 25%. The service sector doubled whereas households remained relatively stable. There were no remarkable shifts in the fuel mix. The improvement of the final energy intensity since 1982 was 13%. Corrected for average outside temperature this was 15%. Among the factors influencing the intensities, the fuel prices, the sectoral structure (influenced by economic growth), and the effort and funds devoted to energy conservation policy are analysed. The developments with regard to these factors in the Netherlands explain to some extent the development of the final energy intensity.

In industry, the energy intensity has decreased between 1982 and 1996 with 25%. After 1990, the relatively large growth of the chemical industry compared to total manufacturing has made the structure of the economy more energy intensive. The recent high growth of the energy intensive industry has offset the energy intensity improvements in the industry sector.

In the residential sector, the energy intensity has decreased in the period from 1980 to about 1990, mainly due to improved insulation and 'good housekeeping'. After 1990, the rise in electricity use per household and the stabilisation of the use of natural gas per dwelling have lead to a rising energy intensity in the household sector.

Both for freight transport and passenger transport, an increase in the number of vehicles and the distance travelled per year, combined with a decrease in the energy consumption per vehicle-kilometre (improved efficiency) has resulted in an overall increase in the energy consumption.

The total energy intensity in the service sector has remained more or less stable after 1984. The electricity intensity however has doubled in the same period, probably due to growth in office equipment. This is compensated by improvements in labour productivity and building insulation.

With regard to the transformation sector, the implementation of combined heat and power, mostly by end-users, has increased the overall efficiency of power generation considerably. The increased share of coal for electricity generation has a negative effect.

SUMMARY (IN DUTCH)

In dit rapport worden energie efficiëntie indicatoren gebruikt om de ontwikkelingen in de laatste 15 jaar met betrekking tot energiebesparing in Nederland te analyseren. Deze indicatoren zijn berekend volgens een gemeenschappelijke methode, ontwikkeld in het kader van het SAVE-project 'Cross country comparison of energy efficiency indicators' waarbij alle EU landen betrokken zijn.

In de database ODYSSEE worden energieverbruiksgegevens, aangeleverd door de landen zelf, gebruikt om deze indicatoren op een uniforme manier te berekenen. De energiestatistieken in Nederland zijn herzien in 1993. In tegenstelling tot de rapportage van 1997 is in dit rapport de nieuwe indeling gebruikt, die goed aansluit bij internationale conventies. Volgens deze nieuwe indeling zijn geen consistente tijdreeksen over een langere periode beschikbaar dan 1993-1996.

Het rapport geeft ook een overzicht van de belangrijkste beleidsmaatregelen op het gebied van energiebesparing in Nederland in 1996, 1997 en 1998.

In de periode 1982-1996 is het finale energieverbruik gegroeid met 25%. In de dienstensector verdubbelde het energieverbruik terwijl het verbruik bij de huishoudens betrekkelijk stabiel bleef. Er waren geen grote verschuivingen in de brandstofmix. De finale energie-intensiteit is met 13% gedaald. Gecorrigeerd voor jaargemiddelde buitentemperatuur is deze intensiteitsdaling 15%. De energie-intensiteit wordt beïnvloed door brandstofprijzen, de sectorstructuur, en de intensiteit van het besparingsbeleid. In de beschouwde periode kunnen ontwikkelingen in deze factoren het verloop van de intensiteit ten dele verklaren.

In de industrie is de finale energie-intensiteit tussen 1982 en 1996 met 24% gedaald. Na 1990 is de structuur van de economie meer energie-intensief geworden, met name door groei van de chemie. De laatste jaren heeft de groei van de energie-intensieve industrie de effecten van genomen besparingsmaatregelen tenietgedaan.

In de huishoudens is de meeste besparing gerealiseerd tussen 1980 en 1990, met name door isolatiemaatregelen en gedragsverandering. Na 1990 treedt een stabilisatie op in het verbruik van aardgas, terwijl het toegenomen bezit en gebruik van elektrische apparaten een groei in het elektriciteitsverbruik veroorzaakt.

De voortgaande groei van het energieverbruik in de transportsector wordt vooral veroorzaakt door groei in het wegverkeer. Het aantal voertuigen en de afgelegde afstand per jaar nemen nog steeds toe, hetgeen het effect van technische verbeteringen tenietdoet.

In de dienstensector is de totale energie-intensiteit sinds 1984 ongeveer gelijk gebleven. De intensiteit van het elektriciteitsverbruik is in dezelfde periode meer dan verdubbeld, waarschijnlijk door een sterke groei van kantoorapparatuur. Dit wordt gecompenseerd door verbeteringen in arbeidsproductiviteit en isolatie van gebouwen.

1. INTRODUCTION

This national report for the Netherlands is one in a series of national reports for the SAVE project 'Cross-country Comparison on Energy Efficiency Indicators-Phase 4'. This project is co-ordinated by the French agency ADEME. The project was financed to a large extent by national contributions, together with the EU SAVE program under contract number 98 10 013.

The aim of the project is to calculate energy efficiency indicators for all EU countries, based on national data, which, harmonised to a common format, are stored in one database 'ODYSSEE'.

Energy efficiency indicators are used for various purposes, such as:
- To support policy makers in answering different types of questions related to energy efficiency, for the evaluation of programmes and policies, for target monitoring, or for the definition of research programmes.
- To compare energy efficiency levels, both within a country through time (monitoring) and between countries.
- To provide a source of data for forecasting models.

This report uses energy efficiency indicators to present and review the energy efficiency development in the Netherlands in the last decades. To facilitate the comparison between countries, all national reports have been set up along a common structure. First, in Chapter 2, the general context with regard to data collection, macro-economic developments, and recent energy efficiency and environmental policy in the Netherlands is described. Chapter 3 gives an overall assessment of energy efficiency trends on the national level. In Chapters 4 to 7 an analysis is made to determine energy efficiency and savings in the main end-use sectors. Chapter 8 gives a short account of some developments in the transformation sector.

Unless indicated otherwise, the source of data for the figures and tables in this report is the ODYSSEE database, for the Netherlands mainly based on CBS data from the energy database NEEDIS.

2. GENERAL CONTEXT

This chapter provides a general background to national and sectoral information presented in the other chapters. It starts with an overview of data sources and obstacles encountered in the collection of the data submitted to the ODYSSEE database. After that, the economic trends and energy consumption trends are reviewed. The remainder of the chapter consists of a description of energy efficiency and environmental policy initiatives in the Netherlands in 1996, 1997 and 1998.

2.1 Review of data collection

One of the most important sources of energy data for the Netherlands is the Dutch energy database NEEDIS (National Energy and Efficiency Data Information System), operated by ECN Policy Studies (Blok et al., 1997). This database has been set up with the aim of providing a consistent framework for collecting data with regard to energy consumption and energy conservation. NEEDIS contains both energy data and sectoral economical data. Important sources of data are the Dutch Energy Statistics (*Nederlandse Energie Huishouding* - NEH), and the Production Statistics. Other publications of Statistics Netherlands are also used regularly. At the moment, data are generally available for the years 1983-1996/1997, and updates are carried out each year.

NEEDIS contains data for the main end-use sectors, i.e. households, industry, transport, other energy consumers, and for the transformation sectors. In the industry sector, a further desaggregation into branches is supported. For each industrial branch or main sector from Table 2.1 and for each energy carrier, final consumption (for energy and non-energy purposes), purchased energy, fuel input for cogeneration and other transformations are available. For most of these sectors/branches the value of production, value added and number of employees is also covered in NEEDIS. On a more detailed level, economic production statistics are available that include apparent energy consumption of natural gas, electricity and a category ‘other’. These observations can differ from the energy statistics.

One major problem with regard to the data collection is the disruption in Dutch statistics as a result of the adoption of the NACE code since 1993. Although in principle this should improve the comparability with other countries, it is a major undertaking to achieve consistency with the years before 1993. In the years 1993-1994, data are available along both classifications. For the 1997 report it was decided to stick to the previous classification in this phase of the project, and reconsider the issue next year. This 1998 report is the first using the new system of classification. As data according to the new system are not available for years before 1993, some time series are still short. Table 2.1 gives an overview of corresponding sectors in both classifications. An important difference, not visible in the table, is that in the SBI-’74 classification all companies employing less than 10 persons were included in the category ‘Other energy consumers’, whereas these companies have been included in their respective branches in the SBI-’93 classification.

Economic data concerning value added are derived from National Accounts which is a consistent framework covering all sectors.

Table 2.1 *Sector classifications for energy statistics in the Netherlands compared, before and after 1993 (Blok et al., 1997)*

Former classification 'SBI-'74'	Code [1]	New classification 'SBI-'93'	Code
Food, beverages and tobacco	20, 21	Food, beverages and tobacco	15, 16
Textile	22	Textile, clothes, leather and leather products	17, 18, 19
Paper	26	Paper, paper products, publishing and printing	21, 22
Fertilisers	29.1	Fertilisers	2415
Other chemical industry	29.1-9, 30	Organically chemical industry Inorganic chemical industry Other basic chemical industry Chemical products	24141, 24142 2413 rest 241, 247 rest 24
Building materials, ceramics and glass industry	32	Building materials	26
Basic metal industry	33	Basic metal - iron and steel Basic metal - non-ferrous	271-273 (partly), 2751, 2752 274, 2753, 2754
Other metal industry	34, 35, 36 37	Metal products industry	28-32, 34-36
Other industry	23, 24, 25 31, 38, 39	Rubber and plastic products, instruments, other industry	20, 25, 33, 37
Transport	-	Transport	-
Households	-	Households	-
Other energy consumers (agriculture, services and government, construction and non-energy mining, small companies)	0, 1, 5, 6 7, 8, 9	Other energy consumers (agriculture, services and government, construction and non-energy mining)	01-05, 14, 45, 5, 6, 7, 8, 9 (partly)

To derive results for the required industry sectors for ODYSSEE, sometimes adjustments have been made based on production statistics. For instance, to calculate the chemical sector, energy statistics for sector 24 are combined with production statistics for sector 25, etc. A complete overview is presented in the Appendix.

The services and government sector includes:

- trade, repairs, lodging and catering,
- transportation (excluding fuels for transport), warehousing, telecommunication,
- financial services,
- private services,
- public administration,
- education,
- health care,
- culture, recreation.

These sectors have limited data on energy consumption. For all sectors, the consumption of motor fuels for transport has been accounted for in the transportation section.

1 In this report, the SBI-'93 classification has been used.

Apart from NEEDIS, other sources from which data for ODYSSEE were collected are the Dutch monitoring tool MONIT (Boonekamp, 1998) and various publications from Statistics Netherlands and the Dutch utilities (Basisonderzoek Elektriciteitsverbruik, Basisonderzoek Aardgasverbruik, 1997).

2.2 Economic context

GDP in the Netherlands has grown with 3.8% in 1997 which is above average. Figure 2.1 presents the trends in the main macro-economic indicators between 1970 and 1997. The Dutch GDP has grown by 2.6% annually on average, with a recession in the beginning of the eighties. From 1990 to date, the average growth is 2.7%. Economic development in the Netherlands is steady.

The recession between 1980 and 1983 is also visible in the value added in the industry as well as in the private consumption. The average growth in private consumption is almost equal to GDP growth. The average growth in value added in the industry sector is 1.9% per year. Industry is gradually decreasing its share of GDP, in the nineties average growth was 1.6%.

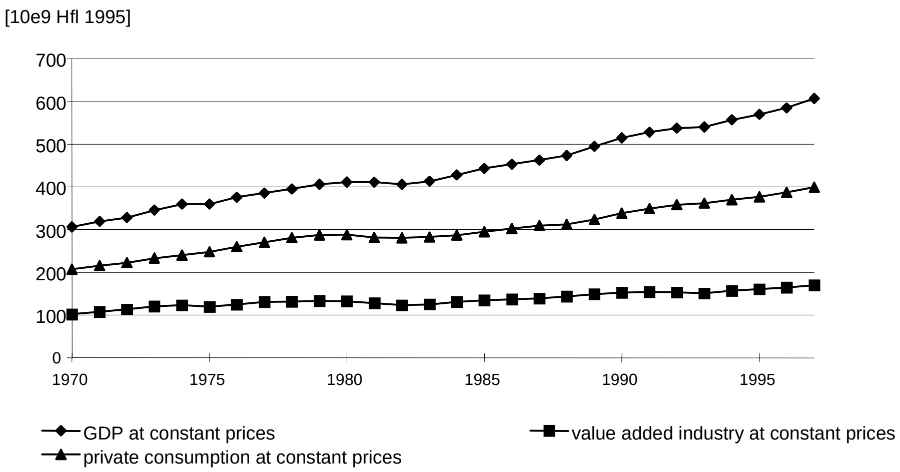

Figure 2.1 *Macro-economic developments in the Netherlands*

2.3 Energy consumption trends

In this section, the focus is on final energy consumption, because energy efficiency is mainly calculated for end users.

2.3.1 Definitions

A short overview is given of the definitions used in ODYSSEE and in this report. For CHP, the conventions used for the Netherlands are different from the international accounting method. In ODYSSEE, the final consumption corresponds to the energy used by final consumers for energy purposes, including non conventional fuels (ADEME/Enerdata, forthcoming). Excluded from the final consumption are:

- non energy uses of fuels,
- fuels used for electricity generation (auto-producers),
- the energy consumption of energy industries, including gas and oil piping,
- the oil products used for international maritime transport (bunkers) and international air transport.

With regard to the accounting of self generation, the conventions in IEA/EUROSTAT statistics are followed in ODYSSEE. This means that, as stated above, the fuel inputs for self-generation of electricity appear in the transformation sector. For CHP, only the part corresponding to the electricity generation is included in transformations. In Dutch statistics, CHP inputs and outputs are observed, therefore heat output is directly registered as final consumption. To get conformity with IEA/EUROSTAT, instead of heat output a calculated part of fuel inputs is assigned to final consumption (see Appendix).

Whenever temperature corrections have been imposed on the final consumption data, it is explicitly stated (see also Section 3.2). Temperature corrections are made only for fuel use for space heating in the residential and tertiary sectors.

Final consumption (by definition) does not occur in energy mining, refineries or any other energy company. This is to some extent different in Dutch Statistics, adjustments have been made for the ODYSSEE database.

Non-energy use only applies to fuels, not to electricity. Non-energy use of electricity in Dutch Statistics (e.g. chlorine production and primary aluminium) is assigned to final energy for the ODYSSEE database.

2.3.2 Final consumption trends

Total final energy demand has increased in the Netherlands with 25% between 1982 and 1996. In the period 1982-1990, total final consumption remained more or less stable around 40 Mtoe, after 1990 there was an increase to 44-45 Mtoe.

In Figure 2.2 the final consumption by energy carrier is presented. The increase in electricity consumption is relatively large; 57% between 1982 and 1997. The consumption of natural gas is practically stable over these years. The fluctuations in gas consumption can partly be explained by climatic influences, as natural gas is the main fuel used for space heating in the Netherlands. The demand for crude oil and oil products has increased with about 10%. Solids fuels are mainly used in the iron and steel industry as far as final consumption is concerned. Since 1984, this consumption is fluctuating around 1.5 Mtoe.

There have not been any remarkable shifts in the fuel mix recently. The fuel mix is dominated by natural gas, due to the domestic supply of this energy carrier, and oil products. In 1996, natural gas had a share of 46% in final demand, followed by crude oil and oil products (18%). The share of electricity is increasing, from 12% in 1982 to 15% in 1996. Compared to other EU countries, the electricity consumption is relatively low in the Netherlands. On the other hand, the share of purchased heat is relatively high in the Netherlands. This is due to the emergence of joint ventures that operate cogeneration plants and supply the industry.

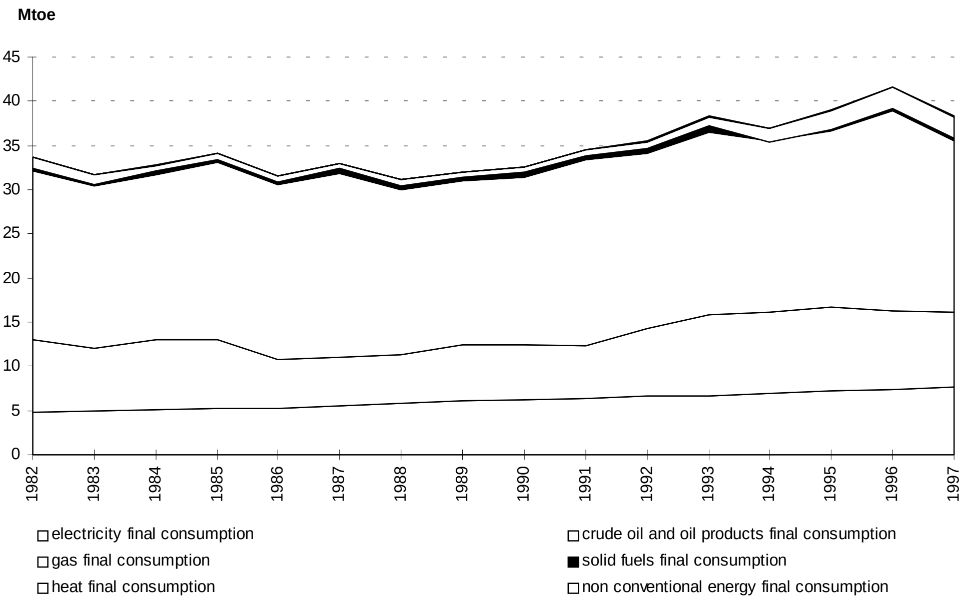

Figure 2.2 *Final energy consumption by energy carrier in the Netherlands (conventional equivalence, excluding non-energy uses)*

Figure 2.3 shows the final energy consumption by sector for the years 1982 and 1996. In this period, total final demand has increased with 25% from 39.3 Mtoe to 49.3 Mtoe (excluding non-energy uses). This increase was a result of growth of the energy consumption in all sectors. Concerning relative shares, services gained at the expense of households.

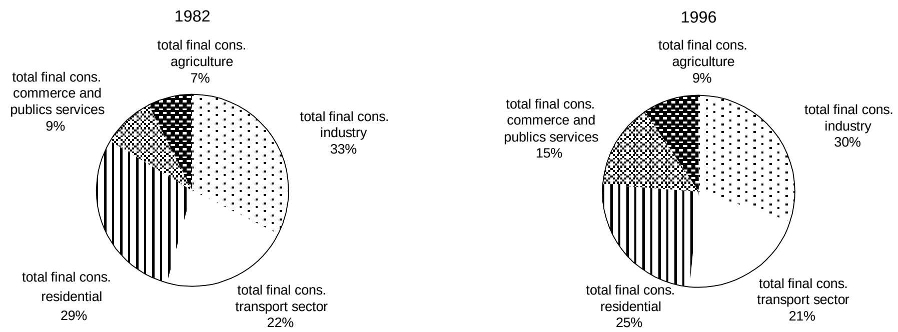

Figure 2.3 *Shares of sectors in final energy consumption in the Netherlands in 1982 and 1996*

Energy demand in the transport sector has grown steadily, and has increased with 23% since 1982. It mainly concerns road transport, and although there have been efficiency improvements, the annual distance travelled has increased. Energy demand in the agricultural sector has also grown significantly, from 2.9 to 4.2 Mtoe between 1982 and 1996. Greenhouse horticulture is the main energy consuming sector within agriculture (80% of final demand) and the increase is both due to growth of this subsector, and to the use of more energy intensive cultivation me thods.

The Netherlands has a large energy intensive industry, which accounts for about 30% of the total final consumption (excluding non-energy uses). Although the share of the sector has decreased (Figure 2.3), energy consumption has increased in absolute terms. Since 1982 the final energy consumption in the industry sector has grown with 16% partly as a result of growth of the energy intensive subsectors.

Final energy demand in the residential sector, mostly for space heating, fluctuates between 10 and 12 Mtoe, depending on temperature variations. 1996 was a relatively cold year, so natural gas consumption in household rose sharply 17% compared to 1995. From 1982 to 1996, electricity demand for households has increased with 33% because of a growing penetration of electrical appliances and changes in lifestyle, despite the higher efficiency of most appliances.

2.4 Recent energy efficiency and environmental policy

In this section, existing and new energy and environmental policy is described. Developments in 1998 are framed (IEA, 1996, 1997; EVN95, 1996; EVN96, 1997; EVN97, 1998).

2.4.1 Institutions

In the Netherlands, the national government has the main responsibility for energy matters, in particular the Directorate-General for Energy in the Ministry of Economic Affairs. The Ministry of Housing, Spatial Planning and the Environment also has an important influence, having the responsibility for climate policy and air quality. In 1996-1997, there have not been any institutional changes related to energy efficiency.

Project Bureau Renewable Energy established

In 1998, the Ministry of Economic Affairs has founded the Project Bureau for Renewable Energy, as had been announced in the Renewable Energy Action Plan of March 1997. The Project Bureau is meant to stimulate the development and use of renewable energy as the central point for parties that want to participate in renewable energy projects and as central information point. The Project Bureau is a foundation. The Ministry of Economic Affairs participates for 50%, while equal shares of 25% are taken by the organisations of electricity producers (Sep) and energy distribution utilities (EnergieNed).

2.4.2 National programmes

There is no single energy efficiency law in the Netherlands. The energy policy framework has been formed since the first oil crisis in several White Papers and Environmental Policy Plans. The foundation for the current energy policy has been laid down in the Third White Paper on Energy Policy, submitted to Parliament in December 1995.

Most measures and targets identified in the Second Memorandum on Energy Conservation (1993), have been replaced by the energy policy as outlined in the Third White Paper. Only the target set in the National Environmental Policy Plan Plus of reducing emissions of CO_2 by 3-5% in the year 2000, relative to the level of 1989/1990, still holds. However, this will be overruled by the National target of -6% in 2010 compared to 1990, a result of the post-Kyoto negotiations.

In the Third White Paper on Energy Policy, the two general objectives of the Dutch energy policy are outlined. The first objective is to attain a *sustainable energy supply* by:

- Improving energy efficiency by one-third in the next 25 years, which means an improvement of 1.5% annually.
- Increasing the share of renewables in primary energy supply to 10% by 2020.

Secondly, the White Paper strives towards *market liberalisation* both with regard to electricity and natural gas.

For achieving a sustainable energy economy, a number of measures are proposed, some of which will be described more extensively in the next sections. Energy efficiency is to be improved by Long Term Agreements in industry, introduction of standards and an energy tax (preferably on EU-level), fiscal instruments, and efficiency improvements in the transportation sector. In March 1997, the 'Renewable Energy Action Plan' was sent to Parliament. This plan is a further elaboration of concrete measures to achieve the goal set in the White Paper of 10% renewables in the primary energy supply. The plan focuses on improvement of the price-performance ratio of renewables, stimulating market penetration and eliminating administrative barriers. To a large extent this has to be achieved by fiscal measures (see below). A large share of the 10%-goal will be reached by the generation of electricity from renewable sources.

With regard to market liberalisation, the White Paper formulates a number of steps. Gradually, all customers will be enabled to select their own supplier of electricity and natural gas, starting with the largest (industrial) energy consumers. This will be made possible by further separation of management of the grid, the production and the distribution; non-discriminatory free access to the grid and independent supervision of the grid functions. The government will ensure protection of captive customers when the market is liberalised.

For implementation of the policy objectives, tasks have been given to municipalities, counties, agencies, and 'target groups'. This illustrates the general observation that the Dutch energy policy is more based on co-operation than on regulation.

Memorandum on Energy Saving (Energiebesparingsnota)
The Dutch government published a Memorandum on Energy Saving in April 1998, containing proposals for extra energy saving policies till 2010, in order to reach 10 to 15 Mtons less CO_2 emissions. This means that the energy efficiency growth rate has to rise from 1.6% to 2% per year. It was estimated that yearly 3 to 4 billion guilders will have to be invested in energy efficiency, of which the government will have to pay 600 million guilders per year. The Memorandum did not aim at making decisions on measures and budgets. Because elections were at hand when the Memorandum was published, these decisions were left for the next government to take. However an energy tax raise is foreseen. Also measures in the built environment are considered, like an energy performance standard for new building locations, and an energy performance test for existing houses. An action plan is to be published in the spring of 1999.

Goal set for greenhouse gas emission reduction: -6% for the Netherlands
In June 1998 the European Environmental Council in principle agreed on the EU burden sharing of greenhouse gas emission reduction. The Netherlands agreed on 6% emission reduction in 2008-2010 compared to 1990, on the conditions that a European energy efficiency policy will implemented, and a carbon/energy tax will be established by 2002 and flexible international instruments may be applied. The Dutch government will work out the extra measures to reach this emission reduction in an Act that will appear at earliest towards the end of 1998.

Publicity campaign for renewable energy
The Ministry of Economic Affairs launched a publicity campaign for renewable energy in September 1998. The campaign is meant to enhance the knowledge and the support of renewable energy. The communication is by television, radio, newspapers and a leaflet. The campaign aims at citizens, but also on decision-makers in the local and regional authorities and in building projects. The campaign will last for two years.

2.4.3 Budget

After substantial cuts in the energy policy budget in 1994, the budget was increased again in 1996 as a result of the White Paper and within the framework of climate policy. Cuts were mainly made in investment subsidies for energy conservation, and also in specific R&D subsidies (nuclear, fuel cells). One of the measures compensating for the cuts in subsidies for energy conservation and pollution control is the 'Energy Regulatory Tax' discussed further below. The White Paper proposes increases in R&D budgets, demonstration and market introduction of technologies, and fiscal measures.

Total government expenditure in energy policy was 536 million guilders in 1993. After cuts in 1994 and 1995 it rose to 642 million guilders in 1998, including new fiscal allowances. Within the budget, an important shift in expenditure has occurred from subsidies to fiscal measures, and to research and demonstration.

In addition, a CO_2 reduction plan involving a one time expenditure of 750 million guilders (375 million ECU) was agreed upon by the government in the 1997 budget. Half of this budget will be used for projects that improve the flexibility of the energy infrastructure in buildings, greenhouse horticulture, and industry, such as heatpumps and cold storage. Approximately 25% of the budget will be spent on the development of renewable energy sources, and the remaining 25% will be used for support of 'break-through technologies'.

Total government expenditure in energy policy in 1999
The total government expenditures on energy policy are estimated to amount to 765 million guilders in 1999. Expenditures in 1998 amount to 642 million guilders.

CO_2-reduction plan approved by European Commission
Two large subsidy programs can be executed, now that the European Commission has approved of the so-called CO_2 reduction plan. With a second round of 250 million guilders, the Dutch government now has reserved 1 billion guilders for subsidies in 1997 for projects that reduce CO_2 emissions. Tenders had already been given out and parties had been selected, but before the money could be given to the selected parties, the approval of the EC had to be awaited. For the large part of the projects this approval was given. The money is granted in two subsidy programs of about 500 million guilders each: the Decree Subsidies CO_2 Reduction Plan of the Ministry of Economic Affairs and a subsidy for Non Industrial Surplus heat Infrastructure (NIRIS) of the Ministry of Environment.

2.4.4 Utilities

Since 1990, the Dutch energy distribution sector has been contributing to the national energy efficiency policy, by implementing Environmental Action Plans (MAPs). The utilities have agreed on a number of energy conservation and emission reduction goals with the national government. The measures used to achieve these goals are financed by a 'MAP-levy' on the tariffs for electricity and natural gas. Measures for end-users include subsidies for insulation in dwellings and energy efficient lighting. On the supply side, CHP and renewable energy supply is stimulated. In addition, the market introduction of technologies such as heat pumps, high efficiency boilers, and CFLs is supported.

The legal framework for these Environmental Action Plans has been improved in 1996, in the Energy Distribution Law. The law requires utilities to justify their expenditures for energy conservation on the basis of the revenues of the MAP-levy. It also prevents unfair competition by utilities that have started commercial activities in recent years, both in not energy-related activities such as cable TV or waste handling, and in offering energy services.

In January 1997, the utilities have established a fund based on revenues of the MAP-levy, that enables Small and Medium sized Enterprises to finance investments in energy efficiency with a reduced discount rate.

> *MAP future*
> Because of the liberalisation and related reorganisation of the electricity sector the MAP is now expected to be terminated after 2000.

A recent phenomenon is 'green electricity' supplied by utilities. Some consumers are willing to pay more (voluntarily) for electricity that is generated from renewable sources. The revenues are used for investments in renewable energy.

> *New electricity law with obligation to stimulate energy efficiency and renewable energy*
> On 1 August 1998 a new electricity law, the Electricity Law 1998, partly came into force. The new law will liberalise the Dutch electricity market in three phases. From the start, the largest users are eligible customers. In 2002 also medium sized users will be free. Small users will follow in 2007. The Dutch law is in accordance with the European Directive on the internal electricity market, but the liberalisation is faster than the Directive demands. With respect to energy efficiency the Electricity Law contains an article that says that both producers and distributors of electricity (> 10 GWh) have the general task to strive for renewable energy and energy efficiency and have to report on this every two years. A directive has been included for the back supply to the electricity grid of renewably produced power. On the basis of the new law, the Minister of Economic Affairs can oblige the consumers of electricity to take a minimum share of renewable electricity, by means of a system of green certificates.
>
> Otherwise, utilities presently have tasks in energy efficiency and renewable energy that have been set in the Environmental Action Plan (MAP) agreements between government and distribution sector, made in 1991 and renewed in 1994 and 1997.
>
> The part of the new law that handles on prices and tariffs is not yet in force. The old law, the Electricity Law 1989, still holds for the tariff system. It is expected that this will not be replaced by the new law before 1999.

Association of Energy distributors have started experiment with Green Labels
A trial for a Green Label System was launched by the Dutch association of energy distributors, EnergieNed, in January 1998. For the first two years the trade and creation of Green Labels will be recorded, but no binding targets have to be met. Creation of Green Labels is done by producing 10,000 kWh renewable electricity, and have this registered under a serial number at the nation-wide registration office. This office publishes information on the production and trade at the Green Label website, where also labels can be bought and sold.

The first binding target is set for the year 2000. In this year, the distribution companies together are to produce 1.7 billion kWh renewable electricity. The quota of renewable electricity that is allotted to each of the distributors will be based on the volume of past sales and will have to be met by handing over Green Labels, so it does not have to be produced by this distributor itself.

Green electricity is intended to be free of the Regulatory Energy Tax, this exemption is approved by the European Commission.

2.4.5 Prices and taxes

In Table 2.2, recent energy price developments are stated for the Netherlands. Industry prices vary considerably, depending on demand size and pattern. For smaller industrial consumers tariffs are similar to household prices. For the largest consumers, costs may be 10% lower than the stated value.

Table 2.2 *Energy prices in the Netherlands, including energy taxes, excluding VAT. For households, VAT = 17.5% (EVN97, 1998)*

	1990	1991	1992	1993	1994	1995	1996	1997
Natural gas, households ct/m^3	43.2	49.0	49.3	45.4	47.2	46.6	47.0	53.8
Natural gas, industry ct/m^3	21.6	22.8	22.9	20.5	20.4	20.6	22.6	24.3
Electricity, households ct/kWh	19.5	19.4	19.1	19.7	20.1	20.3	22.7	23.0
Electricity, industry ct/kWh	10.1	9.9	9.8	10.1	10.0	10.4	10.9	11.1
Natural gas, electricity generators Dƒ/GJ	6.4	6.3	5.8	5.9	5.6	6.1	6.1	6.7
Oil, electricity generators Dƒ/GJ	5.6	5.8	7.1	7.8	7.2	5.9	5.9	6.1
Coal, electricity generators Dƒ/GJ	4.3	4.4	4.5	4.4	4.1	4.0	3.9	4.3

The prices for domestic energy use in the Netherlands (mainly natural gas and electricity) are relatively low compared to most other European countries. After several attempts to propose a EU-wide carbon/energy tax, the Dutch government has decided to introduce an energy tax unilaterally, to achieve the national CO_2 emissions target in an economy that is growing faster than expected (also causing the emissions to rise faster than expected). January 1st, 1996, the 'Energy Regulatory Tax' was introduced. The tax is limited to small and medium users only, thus preventing undesirable effects on the international competitiveness of the Dutch manufacturing sector. The rise in 1997 for households is mainly caused by this tax.

The tax is levied on the use of natural gas, light fuel oil, heating oil, LPG and electricity by households and small and medium sized firms. The tax on gas is introduced in three steps, with an annual increase. As the objective of the tax is stimulating energy efficiency, and not to raise public funds, revenues are to be returned through reduction of direct taxes paid by households and firms. Tax rates are based on the proposed EU directive for a carbon/energy tax, and are given in Table 2.3.

In order to exempt large energy users from the tax, a ceiling applies of 170,000 m^3/year of natural gas and 50,000 kWh of electricity. In addition, consumption of the first 800 m^3/year of natural gas and 800 kWh of electricity is free of taxation, as a protection of low income groups.

Table 2.3 *Rates small user carbon/energy tax in the Netherlands (excl. VAT) (EVN96, 1997)*

[ct]	1996	1997	1998
Electricity per kWh	2.95	2.95	2.95
Natural gas per m^3	3.20	6.40	9.53
Light fuel oil per litre	2.82	5.64	8.46
Heating oil per litre	2.84	5.68	8.53
LPG per kg	3.36	6.72	10.09

The tax encourages renewable energy in the following way. Electricity produced from renewable sources (wind, solar, hydro, biomass) is levied when used, however, the proceeds are returned to the producer instead of the tax payer. The tax is expected to lead to a 1.5% reduction of total CO_2 emissions.

Future taxation
In the Government Agreement of the new government, a doubling of the energy taxes is foreseen.

2.4.6 Efficiency standards

The Energy Performance Standard (EPS) for new dwellings came into effect in December 1995 as part of the Building Act. The EPS not only takes into account the energy required for space heating, but also for hot water use, ventilation, and lighting. The EPS is based on the design, materials and installations and standardised behaviour and electricity end use. It is an integrated calculation, and the maximum value of 1.4 is equivalent to a total energy use in the most common new dwelling of 1400 m^3 natural gas equivalents in 1996. The standard is to be tightened to 1.2 in 1998 and to 1 in 2000. A comparable standard is operational for new buildings in the tertiary sector, where cooling is also taken into account. A distinction in the tightness of the standard is being made along the type of building, e.g. offices, hospitals, schools, shops etc. An Energy Performance Standard for Locations (EPL) for new building areas is currently being developed, and will take into account the design of the local energy infrastructure.

A EU directive on minimum efficiency standards for refrigerators and freezers was established in 1996, and included in the Dutch Energy Saving Appliances Act in 1997. On the basis of an EU directive, energy labels for washing machines and tumble dryers have been introduced in the Netherlands in April 1996. A similar label had already been implemented for refrigerators, freezers and hot water boilers in 1995.

2.4.7 Other regulation

As mentioned before, the Dutch energy efficiency policy is mainly based on co-operation instead of regulation. However there are many regulations applying to emissions, in particular of SO_2 and NO_x, in the transport, manufacturing and electricity production sectors.

In the Netherlands, covenants or Long Term Agreements (LTA's) are used as an alternative to imposing regulation to large industrial energy consumers. Environmental permits are regarded as a supplement for those firms not participating in LTA's, or a safety net for firms failing to meet their LTA-obligations.

Covenants containing energy efficiency targets are signed between the Minister of Economic Affairs, a sector organisation, and Novem, the government agency monitoring most long term agreements. The target is stated in terms of efficiency improvement (energy consumption by unit production), and has been formulated in a negotiation process preceding the agreement. Individual companies draw an 'energy savings plan' to implement the agreement. They receive support from Novem in identifying saving measures, and the requirements of the Environmental Protection Act are assumed to be met.

There are now 29 LTA's in the industrial sector, and 9 with other sectors, including health care, freight transport and greenhouse horticulture. Small and Medium-sized Enterprises are difficult to reach because of the lack of sector organisations. Some new LTA's are encountered in 1998 in sectors of minor importance.

2.4.8 Fiscal or economic incentives

Fiscal measures for energy conservation are increasingly important in the Netherlands, mainly replacing subsidies. Advantages of fiscal incentives are that they make better use of the market mechanism. However, for non-profit organisations adjustments had to be made. Recent mea sures are the VAMIL and EIA.

The Accelerated Depreciation of Environmental Investments programme (VAMIL), gives a corporate tax advantage to companies that invest in specific energy saving measures or environmentally friendly technologies. This measure only applies however, to those companies obliged to pay corporate taxes, excluding for instance hospitals.

New subsidies: Energy Investments for Non Profit sector
The subsidy measure Energy Investments for the Non Profit Sector (EINP) was introduced in the course of 1997 to grant subsidies to the non-profit sector investments in energy efficiency. Commercial companies may use the Energy Investment Allowance (EIA), introduced in January 1997, to subtract the investments from their corporate tax. Since non-profit institutes do not pay this tax, they cannot use the EIA. The subsidy budget was 15 million guilders in 1997 and 20 million guilders in 1998. In 1998 the EINP was extended to wind energy for the agricultural sector. They do pay corporate tax, but the Inland Revenue do not consider the buying of a wind turbine an investment that may be subtracted. For wind energy 12,5 million guilders is reserved.

Cleaner Producing for SME's
For the target group Small and Medium Sized Enterprises a program Cleaner Producing (Schoner Produceren) has been started, that also contains two subsidy measures: Information and screening and Energy efficiency and environmental advice. The budget for the first subsidy published in August was 1,7 million guilders.

The Energy Investment Allowance offers a lower corporate tax in the first year by deducting 30-40% of the investment sum from the profit in that year. This is equivalent to a subsidy of 14-18%. The investment must concern energy saving technologies or renewables, and again only applies to those companies obliged to pay corporate taxes.

An economic incentive for the development of CHP, wind, water and photovoltaic systems is the obligation for utilities to buy any surplus electricity produced privately, at prices reflecting avoided costs. In the process of liberalisation of the electricity market, this obligation will be limited to electricity generated by captive consumers.

The interest offered by ‘green’ investment funds or saving accounts is not subject to income taxation, compensating for the fact that the interest rate usually is lower than that offered by other accounts. This enables investors in renewable sources, district heating etc. to borrow money at a lower interest rate.

Extension of the Green Investments measure
The fiscal measure Green Investments (Groen Beleggen) has been extended. The measure was introduced in 1995 to make investments in environmentally sound projects more profitable. By this measure interest and dividend that private investors receive from ‘green investment funds’ are free of income tax. The measure already applied among other to renewable energy projects and sustainable building projects, and offered the possibility of a ‘green mortgage’. In October 1998 among other types of projects the energy efficient ‘green label greenhouse’ was added to the list of green investments. Also the measure was extended to projects in foreign countries on environmental technology, nature protection, biological agriculture and energy efficiency and to Joint Implementation of CO_2 emission reduction projects in Central and Eastern Europe. A similar measure was introduced in the Netherlands Antilles and Aruba.

3. OVERALL ASSESSMENT OF ENERGY EFFICIENCY TRENDS

3.1 Primary and final energy intensity

Three general indicators have been selected for characterising overall energy efficiency trends (Energy Efficiency Indicators, 1998) The first one is the primary energy intensity, that relates the total amount of energy used in a country to the GDP in constant prices. This indicator includes both efficiency changes in the energy transformation sector and efficiency changes at the level of final consumers, and various other effects.

The second indicator concentrates on final consumers only: the final energy intensity. This is the ratio of final energy consumption over GDP. Since energy efficiency policy often focuses on final consumers, this indicator is suitable for monitoring the overall development of end-use energy efficiency. The third indicator denotes the relation between the previous ones, and will be discussed further below.

In Figure 3.1 the trends in these indicators are presented. The improvement of the final energy intensity since 1982 was 13%. In the nineties, it has remained below 0.2 koe/ECU 1990. However, compared to other countries, the level of this indicator is high, mainly because of the energy intensive industry in the Netherlands.

In the period 1982-1996, the overall energy productivity of the economy, as measured by the primary energy intensity, has improved by 7%, about 0.5% annually.

The difference between the primary energy intensity and the final intensity is indicated by the transformation share [2]. It is the share of primary energy that is consumed in energy sectors, e.g. conversion losses for electricity generation and refineries, together with non-energy uses of fuels and bunkers. It is relatively large in the Netherlands, because of the large chemical industry and refinery sector (Uyterlinde, Koutstaal, 1998).

[2] This is equal to 1-ratio final/primary energy consumption.

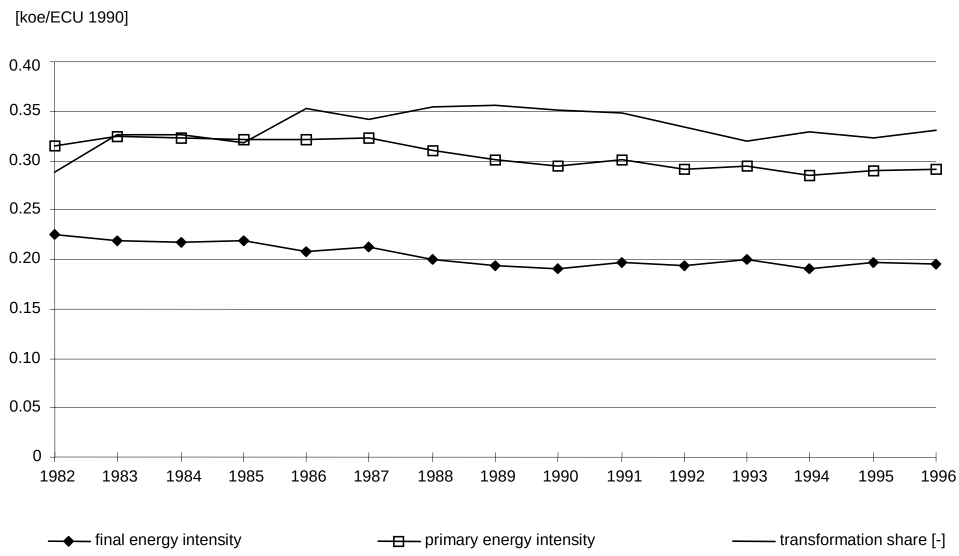

Figure 3.1 *Primary and final energy intensity in the Netherlands*

Naturally the trends in primary and final intensities are a result of many factors in the different economic sectors, which are analysed in more detail in Chapters 4-8. The main factors that are supposed to influence the intensities at macro level are the fuel prices, the sectoral structure (influenced by economic growth), and the effort and funds devoted to energy conservation policy. Three periods can be distinguished, based on developments with regard to these factors in the Netherlands (Boonekamp, 1998).

- 1982-1986: high fuel prices, economic recession, and active conservation policy,
- 1986-1991: low fuel prices, economic recovery, and less attention paid to energy conservation,
- 1991-1996: low fuel prices, economic growth, and increasing effort in conservation policy.

In Table 3.1, the average annual decrease in intensities is given for these periods. In the first period after the second oil shock the effect of high fuel prices can be seen in final consumption. In this period, old inefficient industrial capacity was scrapped and replaced. The primary energy intensity rose because of increasing non-energy uses in the basic industries. After 1986, the economic growth picked up again and the intensity development may reflect autonomous trends with few structural changes. In addition, a series of mild winters after 1986 also caused a further decrease in the final energy intensity (see also Figure 3.3). After 1991, increased energy efficiency stimulated by policy efforts is offset by various intensifying trends, e.g. relative high growth of electricity consumption, more energy intensive industries, larger cars.

Table 3.1 *Average annual change in primary and final energy intensity in the Netherlands*

[%/year]	1982-1986	1986-1991	1991-1996
Primary energy intensity	0.5	-1.3	-0.6
Final energy intensity	-1.8	-1.2	-0.1
Final climate corrected energy intensity	-2.5	-1.0	-0.3

The difference between final and primary energy intensity gives an indication of the consumption and losses in the transformation sector, the role of non energy uses and bunkers for international transport that have been excluded from the final consumption.

In the Netherlands, the ratio of final and primary energy intensity has an average value of 65% in the considered period, implying that about 35% of the primary energy consumption goes to the transformation sector, non-energy uses and bunkers, with 14% for non-energy uses and bunkers. This share of non-energy use is large, mainly because of the large petrochemical industry sector.

The transformation share indicator is also presented in Figure 3.1. In the 1986-1991 period, it was relatively high at 0.35, compared to the other periods. This could be consistent with the achieved capacity expansion of basic chemical industries and related non-energy consumption, compared to the modest growth of the economy as a whole.

The average overall supply losses and consumption in the transformation sector in this period amount to approximately 21%. This share of overall supply losses is not extremely large, compared to other countries, because the share of electricity in final demand is relatively low, and natural gas is used directly for space heating, causing no additional losses at the supply side. There is a downward trend in the transformation share since 1989. The increasing share of electricity in the final consumption would suggest a different trend. With regard to the transformation sector, there are a number of opposite effects. The efficiency of electricity generation has increased, almost 30% is nowadays combined with heat generation. More electricity is imported, for which there are no domestic conversion losses. However, the share of coal plants has increased, compared to more efficient gas plants. The energy consumption of refineries has increased too, due to higher upgrading of oil products. The consumption for gas production has increased because of depletion of the Groningen gas field (Boonekamp, 1998).

3.2 Interpretation of final energy intensity

Although the final energy intensity does give an indication of the energy efficiency in the Netherlands, it is influenced by many other factors as well. One of the most obvious factors is the weather. The severeness of winters has a significant impact on the consumption of natural gas, which is the main fuel used for space heating in the Netherlands. As space heating accounts for about 15% of the final energy consumption in the Netherlands, the overall final intensity is also affected considerably.

Figure 3.2 gives an illustration of this relationship. It is clear that the cold winters of 1985-1987, 1991, 1993 and 1996 caused a peak in the consumption of natural gas in these years. The final consumption of other energy carriers is not significantly influenced by climatic variations (see Figure 2.2).

The final energy intensity with climatic corrections is a better indicator of final energy efficiency, as it is cleaned from these annual variations. This indicator is presented in Figure 3.3. It must be mentioned that the role of climatic variations is less important when looking at long periods, but it is useful for understanding the differences between individual years.

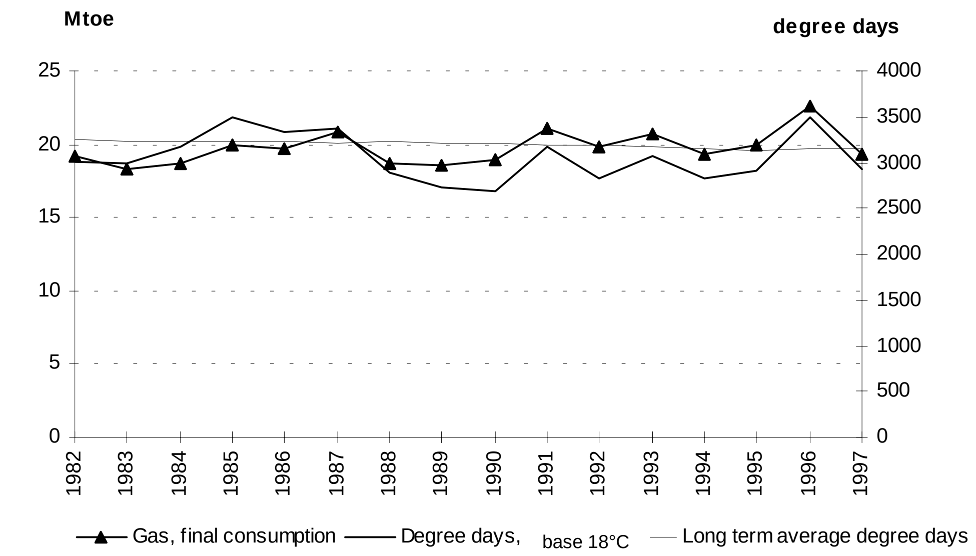

Figure 3.2 *Comparison between number of degree days and final consumption of natural gas in the Netherlands*

In Figure 3.3, the intensity with climate correction is fluctuating less than the uncorrected intensity. It is higher than the 'regular' final intensity after 1990, which is consistent with the relatively mild winters in that period.

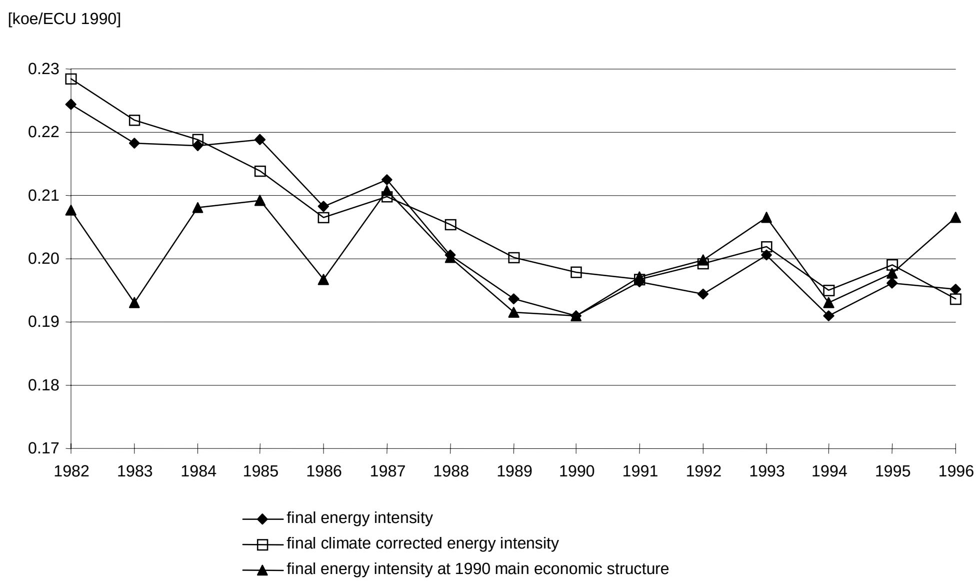

Figure 3.3 *Final energy intensity: role of climate and structural changes*

Another factor influencing variation in final energy intensities is the change in economic structure. A change in the GDP structure between sectors, for instance a decreasing contribution of energy intensive branches, will also result in a decrease of the final energy intensity. However it should not be regarded as a result of energy efficiency improvement efforts. Therefore another indicator is also presented in Figure 3.3, the final energy intensity at constant (main) structure. This indicator leaves out the influence of macro-economic structural changes, because sectoral intensities are calculated at the economic structure of 1990.

The final energy intensity at main economic structure is based on developments in agriculture, total industry and total services. Structural effects within industry are only available for a few years and are not determined here, but in Chapter 4. Intensity at constant main structure is fluctuating around 0.2 koe/ECU 1990. This means that the gradual decrease of the original intensity in the observed period is due to a less intensive main economic structure. Higher growth in the service sector compared to industry is the main cause for this phenomenon.

3.3 Energy efficiency

The energy intensity at constant structure does not take into account other structural changes within the sectors, and therefore is still quite a soft indicator for assessing energy efficiency trends for final consumers. A better assessment can be made by a ‘bottom-up’ approach, aggregating energy savings resulting from energy efficiency improvements at a detailed level in all end-use sectors.

In the methodology used in ODYSSEE, energy savings are calculated from ‘technico-economic effects’. For each (sub-) sector, the energy consumption variation, compared to 1990, is explained by two main effects (Energy Efficiency Indicators, 1998):
- The *quantity* effect (or volume effect), capturing the influence of growth in an activity indicator (number of cars, appliances, tons produced) affecting the energy consumption.
- The *unit consumption* effect, measuring the influence of change in the unit consumption or specific consumption in a (sub)sector on the energy consumption (for instance kWh per appliance, litre/100 km, toe/ton).

For some sectors the unit consumption effect itself can be further explained by changes in technology, behaviour, or substitutions between energy carriers. The amount of detail depends on the sector and the availability of information.

The energy efficiency effect is used as a measure of energy savings by sector (in Mtoe, compared to 1990). The exact definition of this effect differs by sector, but generally it is a result of aggregating the unit consumption effects in subsectors or energy services. This way, an assessment of the Mtoe saved in each end-use sector is obtained (see also the next chapters). The sum of these savings by sector gives an estimate of energy savings at national level.

In Figure 3.4 these energy savings are presented. The calculation could only be done for a limited number of years, because the unit consumption effect in all end-use sectors is used. As all kinds of dissaving structural effects are not incorporated, a clear downward trend is found. The tertiary sector has been omitted, because inconsistencies in the data cause large fluctuations that disturb the overall picture (see Chapter 7). Savings progress between 0.3% and 1.3% of final consumption in the observed years.

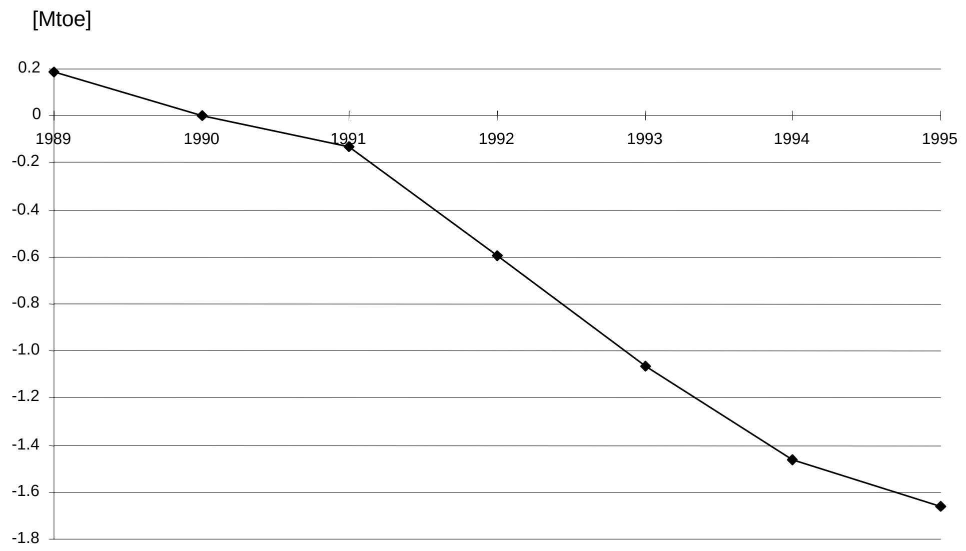

Figure 3.4 *End use energy savings in the Netherlands: space heating in households; LTA-results for industry; efficiency improvement of cars and trucks. Energy savings are >0 before 1990 and <0 after 1990*

4. INDUSTRY

Data from this section are based on the sectoral energy balance sheets of the Netherlands Energy Statistics (CBS, NEH). Economic data are derived from National Accounts (CBS). It is in particular in the industry sector that the differences between the Dutch statistics and the international conventions become apparent (see Sections 2.1 and 2.3.1).

4.1 Energy consumption by industrial branch

Industrial branches include manufacturing industry, construction and non-energy mining. The manufacturing industry is subdivided in several main branches. The oil industry and coke factories are not included in the manufacturing sector, but in the transformation sector. In Figure 4.1, the development of final energy consumption is depicted for manufacturing and total industry, the difference being solely the construction sector. In Figure 4.2, shares of the different main industry branches are presented for 1982 and 1994, the first and last years within the available time series.

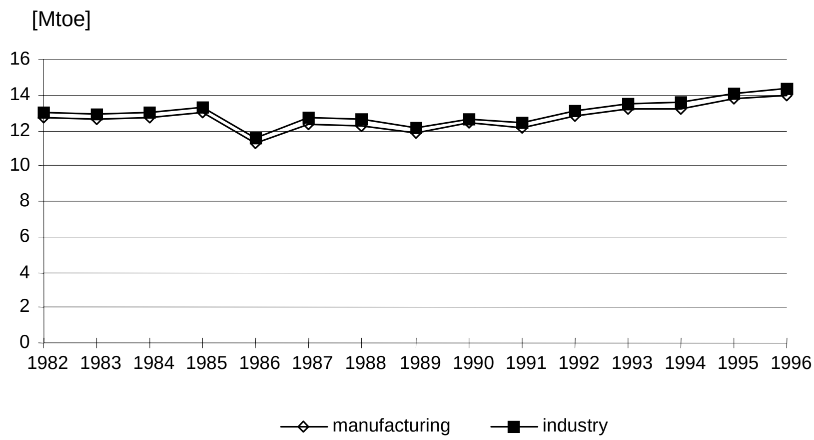

Figure 4.1 *Development of final energy consumption in industry and manufacturing*

The Dutch chemical sector is dominant with respect to energy consumption, and the growth of total industrial energy consumption reflects the activities in this sector. Basic metals (including foundries) is the second largest sector with respect to energy. Equipment refers to all other metal sectors, metal products, machinery; transport equipment and electrotechnical equipment. The structure of energy consumption by sectors is relatively stable, but fluctuates with the cyclical movements of the chemical and basic metals sector.

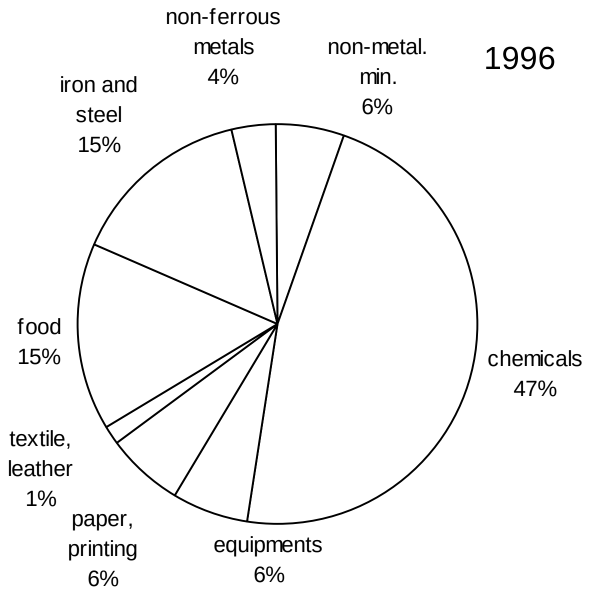

Figure 4.2 *Final energy consumption shares of main industry branches*

4.2 Energy intensities by industrial branch

For the main branches of industry, final energy intensities are calculated, based on the added value from each branch. Figure 4.3 indicates energy intensity of industry and manufacturing respectively, the difference indicating the low energy consumption and considerable contribution to GDP of the construction sector. Figure 4.4 presents intensity developments within separate manufacturing branches.

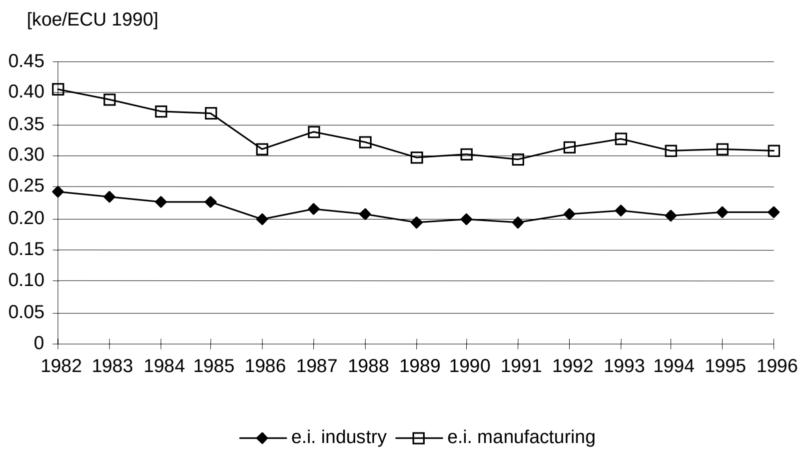

Figure 4.3 *Final energy intensity of industry and manufacturing*

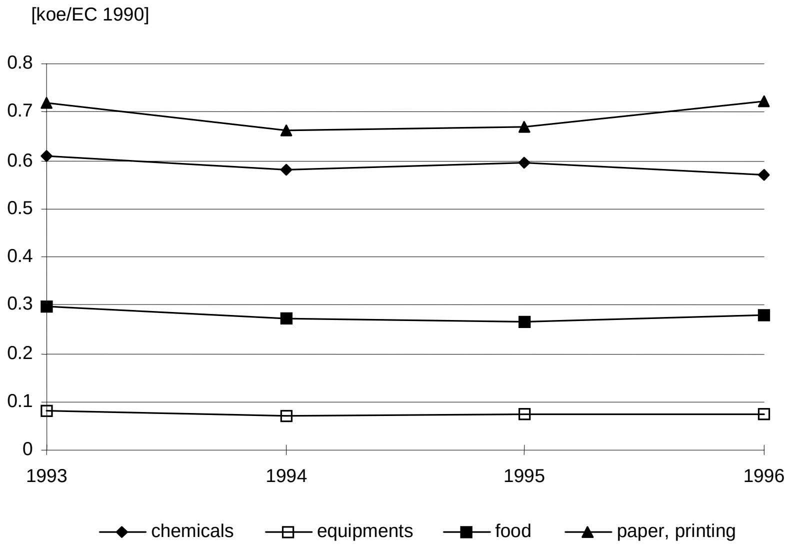

Figure 4.4 *Energy intensity of manufacturing branches*

The chemical industry is clearly energy intensive, as it includes a large basic chemicals production section. Over the few years where consistent time series are available, intensity has decreased by 6%. Basic metals is twice as energy intensive as chemicals but it is not depicted here because of data problems. In basic metals all coal and coke inputs for iron production are included. Food industry is energy intensive as far as dairy, sugar and starch production is concerned. The energy intensity of most branches has decreased in the eighties with about 2% annually. After that the intensity has hardly decreased. In the next section, underlying factors will be analysed. These include different sectoral growth and technical energy efficiency improvements.

4.3 The influence of the sectoral structure

In this section, the influence of structural effects on energy intensity is discerned. The effect of sectoral growth in manufacturing branches is separated from total energy intensity. In Figure 4.5, energy intensity development is depicted in two different ways. The first way is total manufacturing energy consumption divided by total manufacturing value added (at constant prices). The second way is the energy intensity development that would have occurred if value added growth was equal in all sectors.

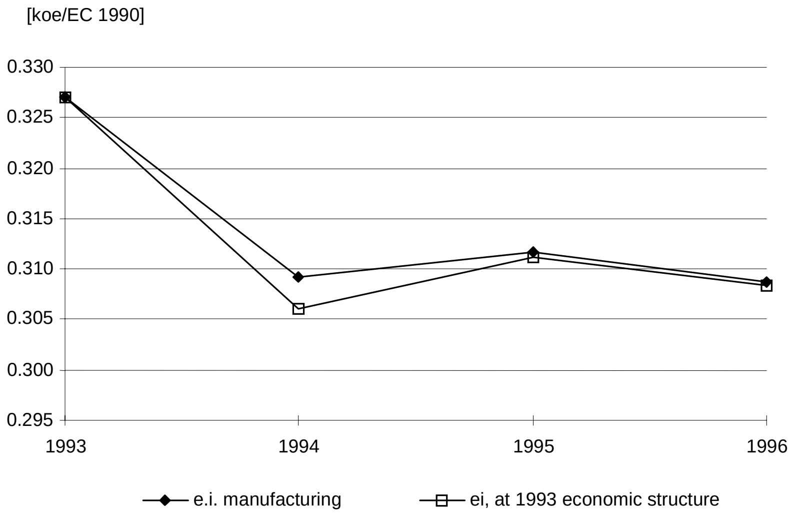

Figure 4.5 *Effect of economic structure on energy intensity in manufacturing*

Before 1993, the relatively large growth of value added of energy intensive industry, mainly chemicals, compared to total manufacturing, has made the structure of the economy more energy intensive (Uyterlinde, 1997). This effect is absent in recent years.

4.4 Energy efficiency

When energy consumption in some process or branch can be related to a meaningful physical indicator, energy efficiency can be calculated from a technological viewpoint, e.g. as specific consumption or unit consumption. In Dutch statistics, physical indicators are fragmentary. The most meaningful in terms of energy consumption would be olefins, ammonia, oxysteel, primary aluminium, paper, chlorine, carbon black, etc. Of these, only steel comes in a consistent time series up to 1996.

Energy efficiency policy for Dutch industry is largely built on Long Term Agreements (LTA's, see Section 2.4.7). From the monitoring of these agreements, a meaningful physical indicator is derived. It is based on a large array of products that are discerned in the monitoring process. Of these products, the required energy in 1989 is established as a reference. For the current year, the reference consumption is derived by multiplying product output growth figures with 1989 specific energy requirements. It is therefore equal to the energy requirement at frozen 1989 technology.

In Figure 4.6, LTA results are depicted, indexed on 1989 along with ODYSSEE indicators. LTA efficiency results are 13% up to 1996, whereas energy intensity has increased. This counterintuitive phenomenon is explained by a number of reasons.

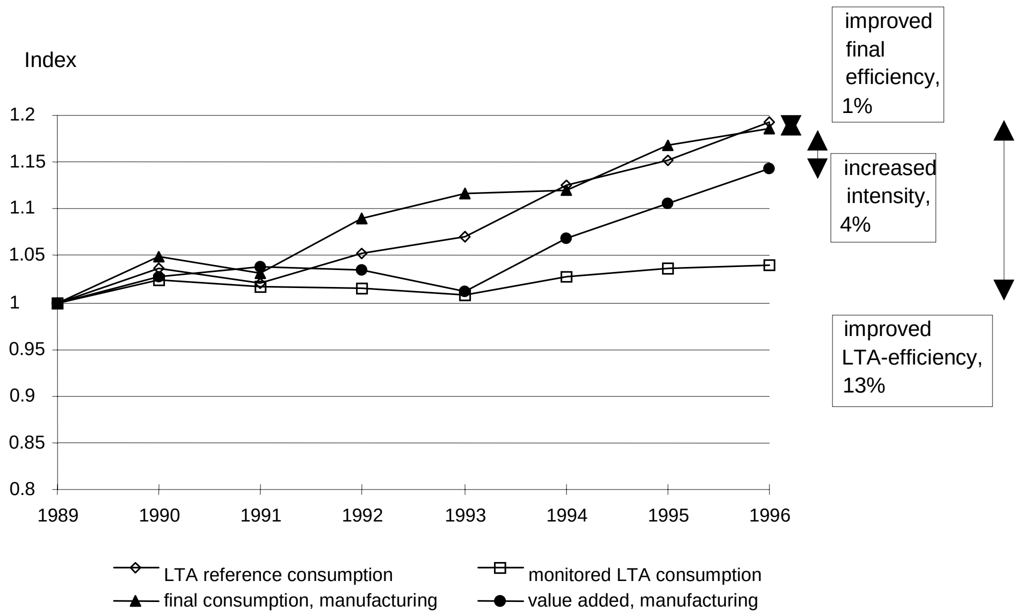

Figure 4.6 *Energy efficiency improvement based on LTA-monitoring (index 1989=1)*

First, physical production has increased more than value added, especially in 1992 and 1993. This means that production output became more energy intensive. Second, final consumption rose substantially compared to monitored LTA consumption. This is caused by:

- CHP has been a dominant efficiency improvement option, this is not visible in the development of final consumption.
- Large unexplained observation differences, mainly in chemicals.
- Coverage differences between LTA's and total manufacturing, these are relatively small.

Using the LTA reference consumption as a representation of relevant physical output in manufacturing, final energy efficiency has improved very little. Over the observed period it was only 1%. The effect of CHP-accounting is a large factor in the difference between final consumption and monitored LTA-consumption. Hidden structural effects like a large output growth of energy intensive products are not further separated in LTA-monitoring.

5. HOUSEHOLDS

5.1 Energy consumption by end-use

The share of space heating in total primary energy use is slowly decreasing from about 65% in 1980 to 56% in 1995. Water heating is growing in importance from 10% to 13% over the same period, as well as electrical appliances and lighting from 23 to 29% (‘specific uses of electricity’). The energy use for cooking is underestimated, since only the use of natural gas is considered in the calculation of the share of cooking in total energy consumption.

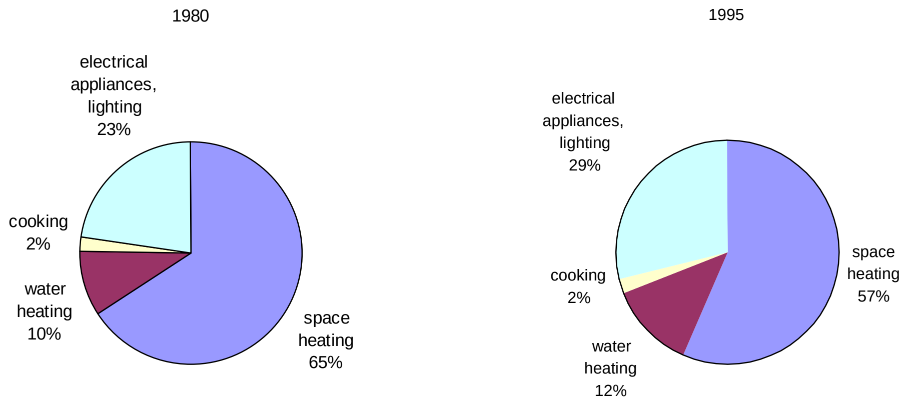

Figure 5.1 *Household primary energy consumption the trends in the energy consumption of households by end-uses*

5.2 Unit consumption trends for households

Figure 5.2 shows the trends in the average consumption per household for all end-uses, for space heating and for specific uses of electricity.

The two first indicators are given with climatic corrections. Because of the dominant role of space heating, the total unit consumption is roughly following the trends of the unit consumption for space heating; with however a faster reduction for the latter one.

In the period 1980-1994, the average unit consumption per dwelling with climatic corrections is decreasing by 2.6%/year, from 2.55 to 1.76 toe/dwelling. In the period 1994-1996 however, the unit consumption increases on average with 4.0%/year. For space heating, the reduction is about the same in the period 1980-1994 and the rise about 2.8%/year in the period 1994-1996. An explanation of this rise has to be found in behavioural aspects, such as the average indoor temperature. The unit consumption for specific uses of electricity (lighting, electrical appliances) has decreased regularly until 1988 at an average rate of 1.5%/year (1980-1988). After 1988, it rises with on average 1.9%/year (1988-1996).

Summarising, the trend in this unit consumption can be characterised by the following aspects:

- A regular decrease between 1980 and 1994 for space heating and total energy use; 2.7%/year for space heating and 2.6%/year for total energy use.
- A slight increase after 1994 for space heating and total energy use; 2.8%/year for space heating and 4.0%/year for total energy use.
- A reduction of electricity consumption between 1980 and 1988 of 1.5%/year.
- An increase of electricity consumption after 1988 of 1.9%/year.

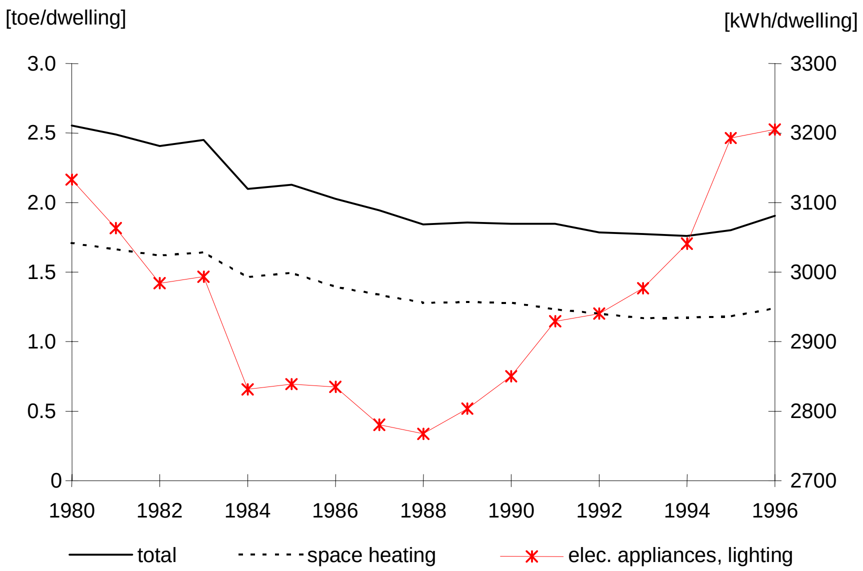

Figure 5.2 *Unit consumption of households total[(1)], space heating[(1)] and specific uses*
[(1)] with climatic corrections.

5.3 Space heating

The thermal regulations for new dwellings have been reinforced several times since the first oil price shock in 1975 (Figure 5.3). On average, the final energy use related to space heating in new dwellings decreases on average by about 4.9%/year. New dwellings built according to the latest standards consume about 50% less energy than dwellings built before 1980.

To measure the impact of the insulation standards of new dwellings on the changes in the average unit consumption of dwellings for space heating, it is necessary to account for the number of new dwellings compared to the existing stock. When more new dwellings are constructed each year, the higher will be the penetration rate of more efficient dwellings in the total stock.

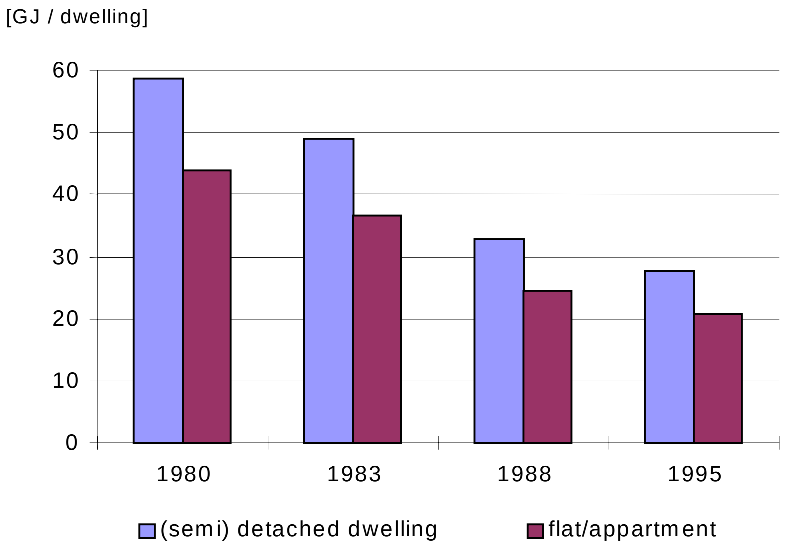

Figure 5.3 *Specific consumption of new dwellings*

In the Netherlands, 100 000 dwellings are built on average every year; this represents about 1.9% of the total stock. In the period 1980-1995, about 1651.000 dwellings were built.

Several indicators can be derived to measure the influence of the thermal regulation of new dwellings:

- The energy savings, compared to a situation before the standards (the 'reference year'), in terms of cumulated savings or annual savings.
- The energy efficiency improvement for new dwellings, i.e. the percentage reduction of specific consumption compared to the reference year.
- Finally, the rate of reduction of the average unit consumption of all dwellings linked to the efficiency standards for new dwellings.

Such an evaluation will be strongly dependent on the reference year. For the Netherlands, all estimates are calculated taking 1980 as the reference year. If we were to take a more recent year, the savings and efficiency progress would be lower.

The cumulated energy savings brought about by the reinforcement of standards (see also Figure 5.3) are in 1995 about 31 PJ natural gas equivalents annually. In Figure 5.4, the annual and cumulated energy savings due to reinforcement of building standards for new dwellings are given. Cumulated refers to the whole dwelling stock whereas annual refers to the effect of dwellings built in the current year.

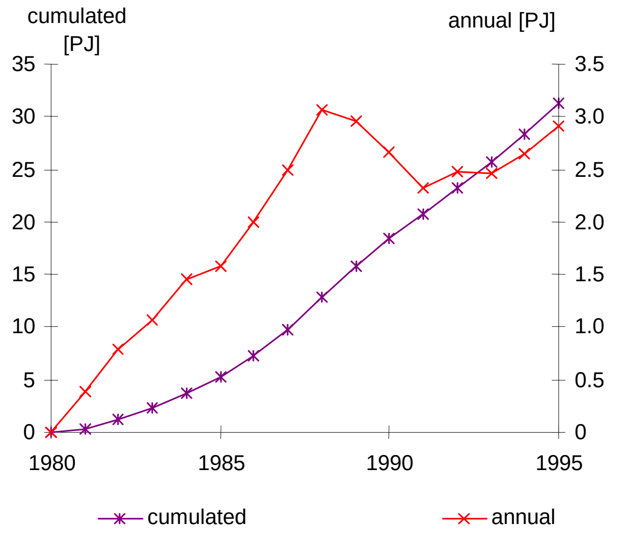

Figure 5.4 *Energy savings (PJ) from efficiency standards of new dwellings*

If we consider the stock of dwellings built since 1980 with improved efficiency standards, their average unit consumption is regularly decreasing: in 1995 they consume 42% less than in 1974, compared to 34% in 1990 and 19% in 1980 (Figure 5.4).

In the Netherlands, substitution of energy carriers has only minor effects with respect to energy savings for space heating. Over 90% of all dwellings is connected to the natural gas grid, and most of the others have natural gas based block or district heating. The share of natural gas in total energy consumption for space heating is almost constant in the period 1980-1995.

5.4 Electrical appliances

Figure 5.5 shows the trends in the specific consumption of electricity for the major households appliances : refrigerators, freezers, washing machines and dishwashers.

These trends reflect the influence of three components:
- *Energy efficiency*: changes in the average technical efficiency of appliances, either coming from general improvements in the electricity performance or from a consumer choice for more efficient new appliances.
- *Performance*: changes in the average appliance size, e.g. refrigerators or freezers with a larger capacity.
- *Behaviour*: changes in the use or conditions of use of appliances, e.g. increasing use of energy saving cycles for dish washers or washing machines.

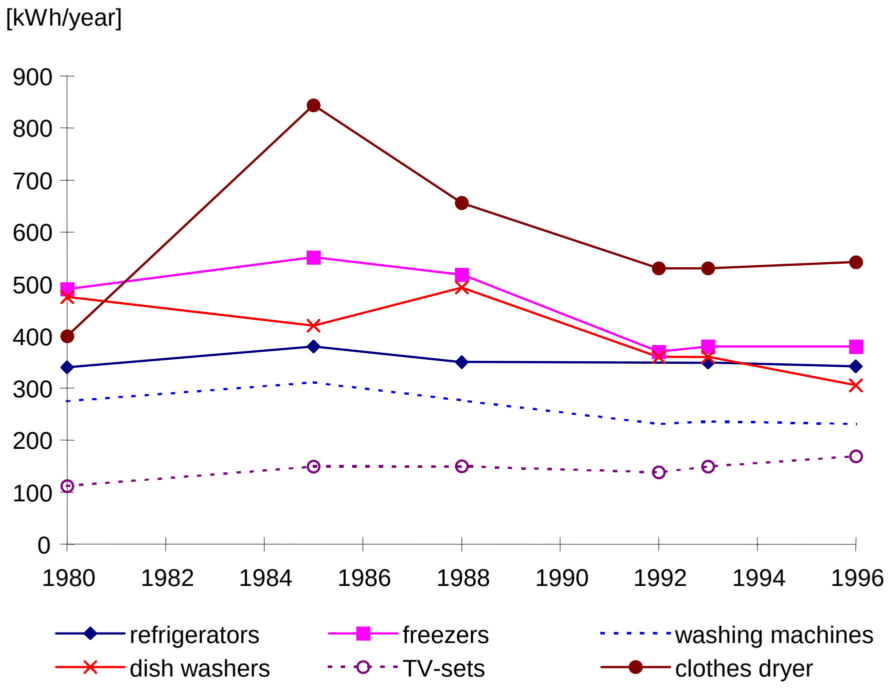

Figure 5.5 *Specific consumption of household electrical appliances*

The specific consumption in the period 1988-1996 is based on the same survey that is conducted on a yearly bases. The values of the specific consumption in 1980 and 1985 are less reliable.

The specific consumption of the most efficient electrical appliances on the market is compared to the average specific consumption. For washing machines and dish washers, the best types consume less than 50% compared to the average. The best clothes dryer on the market consumes about 35% less energy compared to the average dryer (see Figure 5.6).

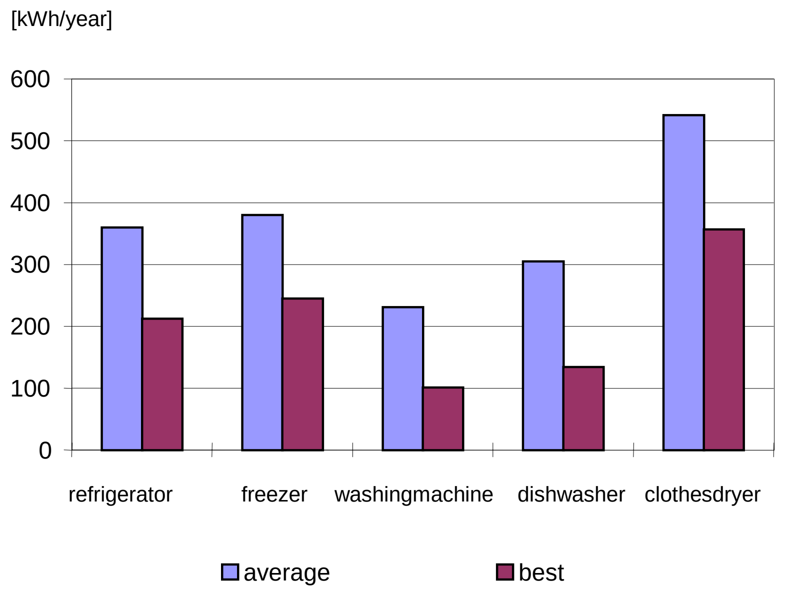

Figure 5.6 *Specific consumption of the most efficient household electrical appliances on the market compared to average appliances in 1995*

6. TRANSPORT

In this chapter, energy consumption in transport is dealt with. By definition, it refers to energy consumption of vehicles on public territory. In an appendix of this report, data collection for Dutch transport statistics is elaborated.

6.1 Transport consumption by mode

Since 1980 the energy consumption in the transport sector has increased with 55%. Figure 6.1 shows the energy consumption in the transport sector for the different modes. Air transport includes the consumption for domestic and also international traffic. The energy consumption for domestic air travel in the Netherlands is rather low (0.1 Mtoe). The figure on navigation is based on the energy consumption of inland vessels in the Netherlands (Annema, 1997)[3]. It includes estimations of the energy consumption of foreign vessels and it excludes the energy consumption of Dutch vessels in other countries. The figure contains no data on the energy consumption of sea going vessels. Also the small amount of electricity consumption by trams, metro's and trolleys (0.015 Mtoe) is not included (Kalverda, 1997).

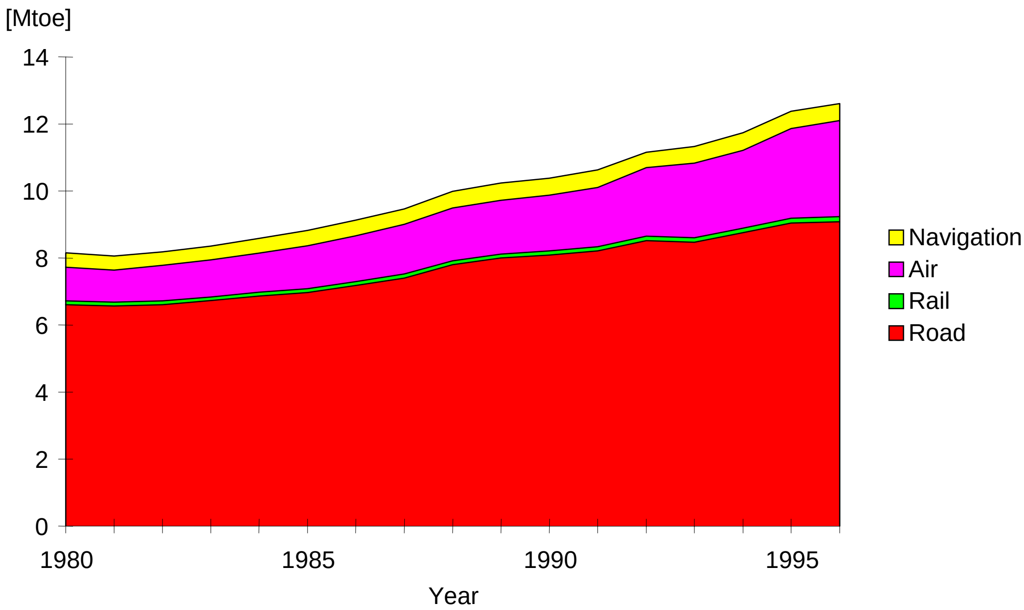

Figure 6.1 *Transport energy consumption by mode*

Between 1980 and 1996 the energy consumption for road transport increased with 38%. Only air transport increased faster (187%). Navigation increased with 16% and rail transport with 29%. A special aspect on rail transport is the switch from diesel to electricity[4]. In 1980 37% of the energy consumption by trains was diesel; in 1996 only 19%. In Figure 6.1 electricity consumption of rail transport is not transferred into primary energy.

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3 CBS collects data on the total consumption of Dutch vessels and the amount of diesel sold for inland shipping (incl. international traffic). Due to price differences with other countries and an unclear market (many oil is sold via intermediate trade) the latter figure varies much in time. So model calculations are the only source of oil consumption for inland shipping in the Netherlands.

4 The figures for 1980-1992 are based on data published by the Dutch railway company (NS). NS has stopped publishing these data, so for recent years CBS data on electricity consumption for the total sector are used corrected, by ECN, for other energy users.

In 1980 the shares of the different modes in energy consumption are 81% road; 12% air, 5% navigation, and 1% rail. In 1996 these shares are changed in 72% road, 23% air, 4% navigation, and still 1% rail. Without air transport the share of road transport has slightly risen from 92% to 93%.

Despite an increase in vehicle efficiency, the energy consumption shows an upward trend for road transport. Until 1985 the energy consumption has a low growth rate. The high growth rate between 1985 and 1989 is expected to be caused by the lower fuel prices. In 1985 the prices of motor fuels dropped drastically by 20%.

The general upward trend is related to the economic growth, which was relatively high in the late eighties. From 1990 onward, high growth is continued. The economic growth has its effect on passenger transport and freight transport. The number of vehicles has increased, and also the yearly performance of the vehicles (distance travelled per year).

Figure 6.2 presents the total energy consumption by service; passenger transport and freight transport. Again the general upward trend is related to the economic growth and the resulting income development. In this figure, compared to Figure 6.1, air transport is excluded. For road transport also special vehicles (e.g.: fire engines, ambulances, cranes) and light vehicles (vans) are excluded[5]. The energy consumption of rail transport is divided by ECN between passenger en goods transport[6].

For freight transport the total energy consumption increases, while the energy consumption per vehicle decreases because of an improved efficiency. The growth in the total energy consumption is the result of an increase in the number of vehicles and the vehicle performance. The slight decrease around 1983 is caused by a decrease in transport demand, related to an economic decline.

The energy consumption for passenger transport increases mainly because of the developments with private cars (see Figure 6.3). In 1990 en 1993 energy demand decreased. In 1990 this was caused by a fast rising and strong environmental concern in the Dutch population and government. In 1993 the economic growth slowed down, and people waited to see what would happen with the economy. Car sales decreased dramatically in that year. As a result of less new cars, the growing of private car mobility stagnated in 1993.

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5 In the Netherlands a still growing number of ‘vans’ is used as a passenger car for private transport. Those private vans account for about 7% in 1980 and 20% in 1996 of the energy demand of vans.

6 The division of energy use of rail transport between goods en passengers is published in the statistics. ECN made a division based on figures for one year of several studies.

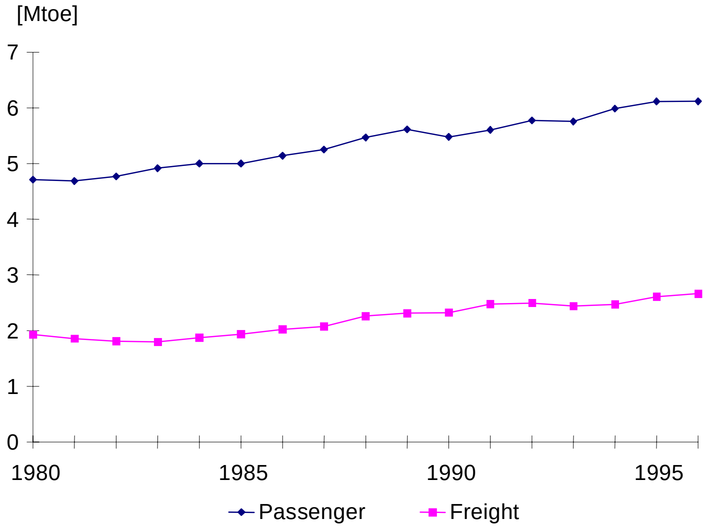

Figure 6.2 *Transport energy consumption by service: passenger and freight*

Furthermore, just as for passenger transport, the same holds for freight transport: an increase in the number of vehicles and the vehicle performance and a decrease in the energy consumption per vehicle (improved efficiency) results in an overall increase in the energy consumption. The ratio of energy consumption between freight and passenger transport is with 30:70 almost constant in time. Only in the period 1981-1985 freight transport stagnated and the ratio became 27:73 (1983).

The road transport energy consumption by type of vehicle is given in Figure 6.3. The total energy consumption has risen with 37% between 1980 and 1996. Private cars dominate this energy consumption, followed by trucks and light vehicles (vans). Busses and motorcycles both only have a small share in the energy consumption by type of vehicle. The energy consumption of buses and motorcycles remains more or less constant, despite the increase in overall energy consumption for passenger transport. Thus the increasing energy consumption for passenger transport (see Figure 6.2) is mainly a result of the increase in energy consumption for private cars. The total energy consumption for private cars has increased from 1982 to 1996 with 30%. The energy consumption of trucks (+46%) and vans (+127%) has increased even more. The (small) energy consumption of special vehicles declined with almost 45% over time.

The share of energy consumption for the different vehicles has changed between 1980 and 1996. The share of private cars, trucks and vans has changed from 66%, 22% and 6% respectively in 1980 into 63%, 23%, and 10% in 1996. The growth rate for trucks is higher than for private cars. This seems contradictory with the conclusions from Figure 6.2 (passenger and goods transport have the same growth rate). It appears that the higher growth rate for trucks is compensated with a lower growth rate for inland shipping and rail transport.

The development of the person kilometres shows a high growth rate (Annema, 1997). The increase of energy consumption of private cars is caused by a combined effect of an increasing number of private cars and a higher yearly performance of the cars. On the other hand the efficiency of the cars has improved. This is further discussed in section 6.2.

The upward trend in the energy consumption of trucks is also the result of decreasing energy consumption per vehicle kilometre together with a growing performance of the trucks and a growing number of trucks. This is discussed in more detail in section 6.3.

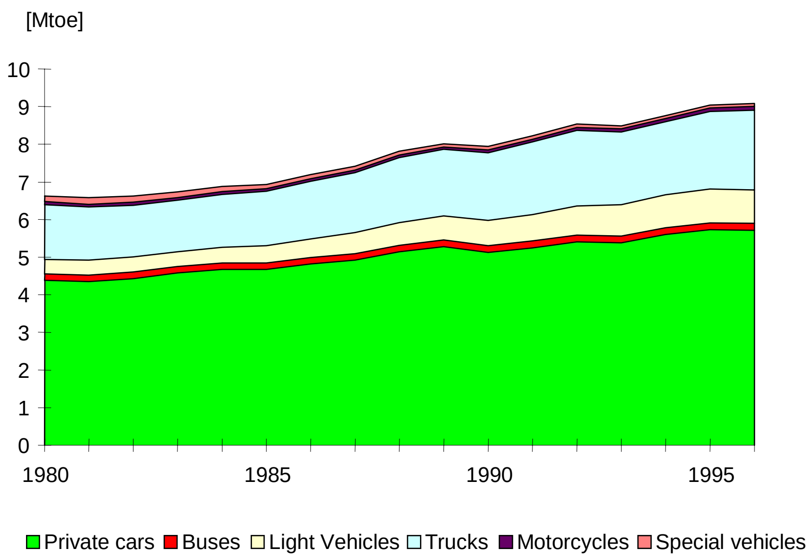

Figure 6.3 *Road transport energy consumption by type of vehicle*

6.2 Cars

6.2.1 Specific consumption

For road vehicles the overall efficiency can be monitored with the average specific consumption, expressed in litres/100 km. For cars, the average specific consumption is calculated from the total energy consumption of Dutch cars, the stock of cars (active fleet) and the average yearly performance of Dutch cars in the Netherlands. Figure 6.4 shows the specific energy consumption of cars. The average consumption is presented in litre gasoline equivalent per 100 km.

Until 1990 the specific consumption of cars decreases. This trend is partly due to a general efficiency improvement and to a shift in the fuel mix. In the year 1978 an agreement was made within the European Union with the car manufacturers about a higher efficiency of private cars. In 1985, new cars should be 10% more efficient compared to 1978 cars. This goal has been more than achieved, actually in 1985 new cars were 14% more efficient.

During the years the share of diesel cars has grown. Diesel cars are more efficient than gasoline cars and as a result, the total specific energy consumption has decreased. Also the introduction of the APK (obligatory general periodic inspection) had a positive effect on the energy consumption of cars. The APK was introduced in 1988.

Another important development is the increase in energy consumption because of environmental legislation. The introduction of the controlled three-way catalyst for passenger cars and light vans resulted in a 3% increase in energy consumption.

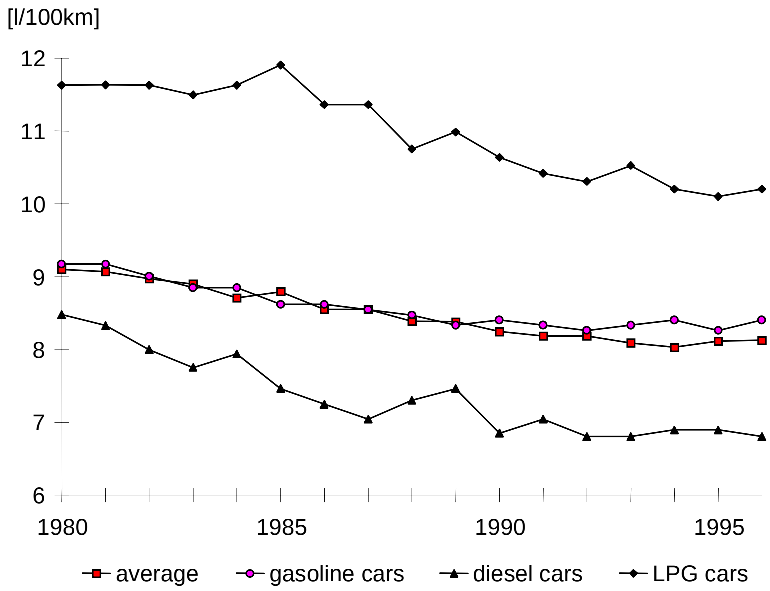

Figure 6.4 *Specific consumption of passenger cars*

From 1990 on, the specific consumption of cars more or less stabilises, at least for gasoline and diesel cars. This stabilisation is caused by the vehicle weight. The motor industry succeeded in increasing the engine efficiency with 10%, but the average engine power increased during the past years due to an increase in vehicle weight. More extra parts and equipment were built in the vehicles for a higher level of comfort and safety.

6.2.2 Unit consumption

The unit consumption of cars (toe/vehicle) depends on the average specific consumption of cars (l/100 km) and the average distance travelled per year. The distances driven in other countries by Dutch cars are substantial. In 1980 an average Dutch passenger car drove 15180 km of which 1300 in other countries. In 1997 those figures are 16550 km (+9%) respectively 1270 (-2%). Combined with the energy improvement of passenger cars in the same period (11%), the unit consumption of passenger cars (toe/vehicle) changes less than 2%. In other words the efficiency improvement is almost completely compensated by driving more km with one car. The growth of energy use of Dutch passenger cars in the Netherlands almost equals the growth of the number of cars.

6.2.3 Savings

The variation of the unit consumption between years, the unit consumption effect, can be divided into three effects:

- the kilometre effect, the variation in yearly performance of cars,
- the technology effect, the variation in efficiency of cars,
- the behavioural effect, the variation in the driving behaviour, this is a residual effect.

In the Netherlands there are no technical data available to determine the difference between the technology effect and the behaviour effect.

In Figure 6.5 the modal split of passenger transport can be seen. It is clear that the only important change is an increase in transport with passenger cars. The increase in air travel is not included in this figure.

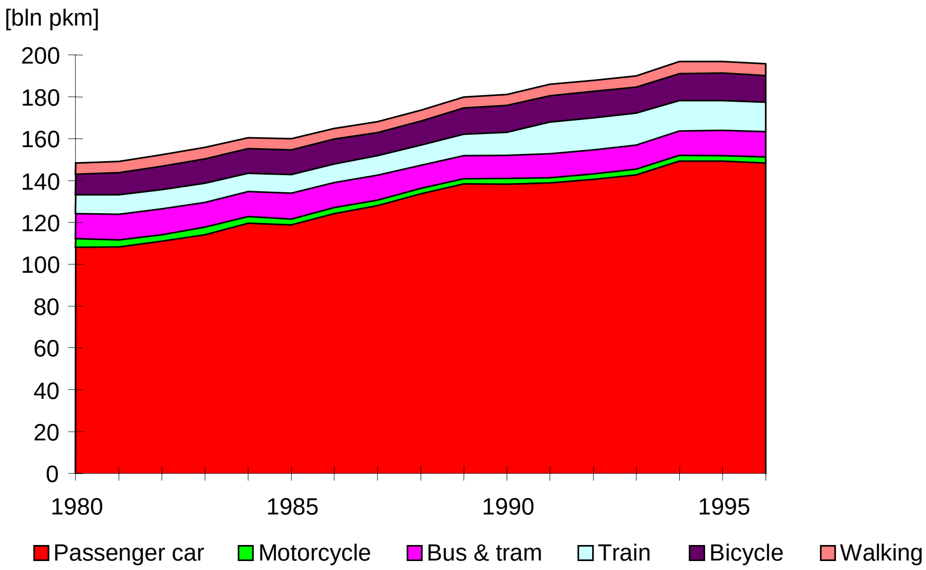

Figure 6.5 *Modal split passenger transport*

The development of the energy efficiency of passenger transport can be seen in Figure 6.7 (total includes walking and bicycles) The biggest change takes place with the motorcycles. First, the energy use of motorcycles (and mopeds) per km increases. Second, mopeds use less energy per km, but the market share of mopeds declines in favour of a rising share of motorcycles. As can be seen in Figure 6.5, the changes in efficiency of the passenger car are the main factor for the specific consumption of passenger transport as a whole.

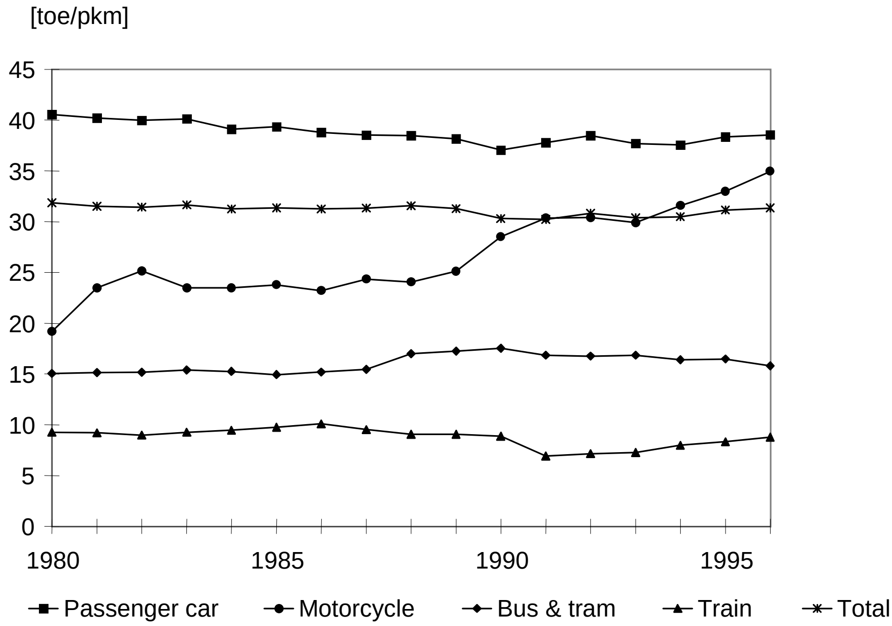

Figure 6.6 *Specific consumption passenger transport*

6.3 Trucks

6.3.1 Specific consumption

The specific consumption of trucks in litres/100 km can be considered as an indicator of the vehicle efficiency.

Over the years, vehicles became more efficient but on the other hand some factors resulted in stabilisation of the specific consumption of trucks between 1980 and 1994 (see Figure 6.7). First of all, trucks became heavier. From 1981 to 1989 the average vehicle weight increased with 12% (Bureau Goudappel Coffeng, 1994). Secondly, the weight of the load increased over the years. The specific consumption of trucks also increased because of the environmental legislation. The introduction of the EURO 3 emission norm for trucks resulted in an increase in the energy consumption of 0.5%-4% (Dings, 1996).

The improved efficiency of the trucks together with an increase in the weight of the vehicle/load and the introduction of emission norms results in a stabilisation of the specific consumption/km.

6.3.2 Efficiency

The efficiency of freight transport by trucks can be monitored with the unit consumption per ton-kilometre. Changes in the unit consumption per ton-km depend on:

- energy efficiency of vehicles: variation in the specific consumption of trucks (per vehicle kilometre), which is an indicator of vehicle efficiency;
- tonnes capacity per vehicle: in the Netherlands there is a change form lorries to tractors (bigger loads possible per vehicle), so even a higher consumption per vehicle can result in an efficiency improvement;
- load factor or fleet management: efficiency of transport services provided by the vehicles, this is expressed in a variation of the ratio ton-km performed per vehicle-km.

Figure 6.7 gives the energy consumption of trucks per ton-km and per vehicle-km.

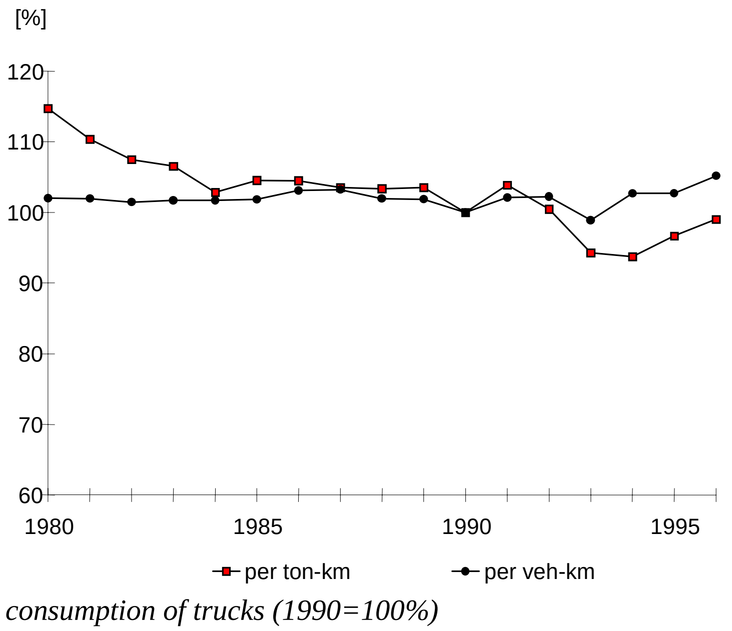

Figure 6.7 *Energy consumption of trucks (1990=100%)*

There are two reasons for the different slopes in the curves for specific consumption of trucks and unit consumption per ton-km. First there is a shift towards bigger trucks, with a higher load capacity. Secondly, the load factor is increasing. Both effects are the consequence of better fleet management and result in a decreasing unit consumption per ton-km. The two effects increase the specific consumption per vehicle but, because of the efficiency improvements of the trucks, the overall specific consumption decreases. It is not clear why energy consumption is rising after 1994. This could have statistical reasons. Due to the integration of Europe, data collection at the borders has become a problem, and there is limited experience with the new way of data collection.

6.4 Energy savings for road transport

The energy savings for road transport are calculated in ODYSSEE from the technical and the behavioural/management savings for cars and trucks (Figure 6.8).

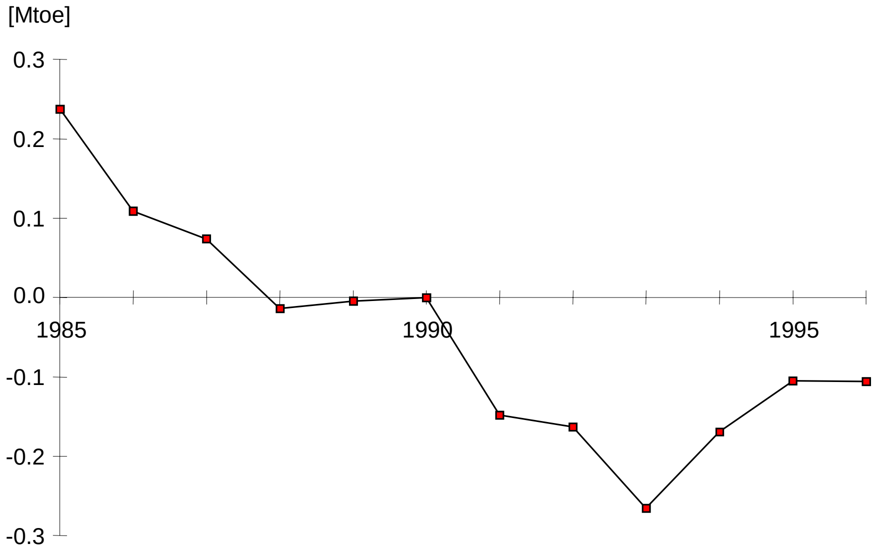

Figure 6.8 *Energy savings for cars and trucks*

Energy savings for cars:
- Technical savings; these are based on the variation in the theoretical (test) value of the specific consumption of new cars.
- Behavioural savings; the difference between the theoretical and the actual specific consumption.

Energy savings for trucks:
- technical savings; these are related to the actual specific consumption,
- management savings; the variation of the load factor.

The reference year for the energy savings is 1990, which means that savings before 1990 are > 0 and savings after 1990 are < 0. Because of the stabilisation of the savings for cars it can be concluded that the savings after 1990 are mostly due to savings for trucks.

6.5 Water and rail transport

There is limited data available to draw conclusions on the energy efficiency of water and rail transport. For rail, in the statistics only combined data for passenger and freight transport are available. For navigation, models are used to calculate the energy consumption.

In Figure 6.9 freight transport is depicted by mode. In the period 1980-1996 road transport shows a steady increase. Rail transport declined with about 10% and navigation grew with about 5%. Because road transport is the most energy intensive per tonkm, for the whole freight transport sector a growth in energy demand (by the growing amount of ton-km) and specific energy demand (by the growing market share of road transport) can be expected.

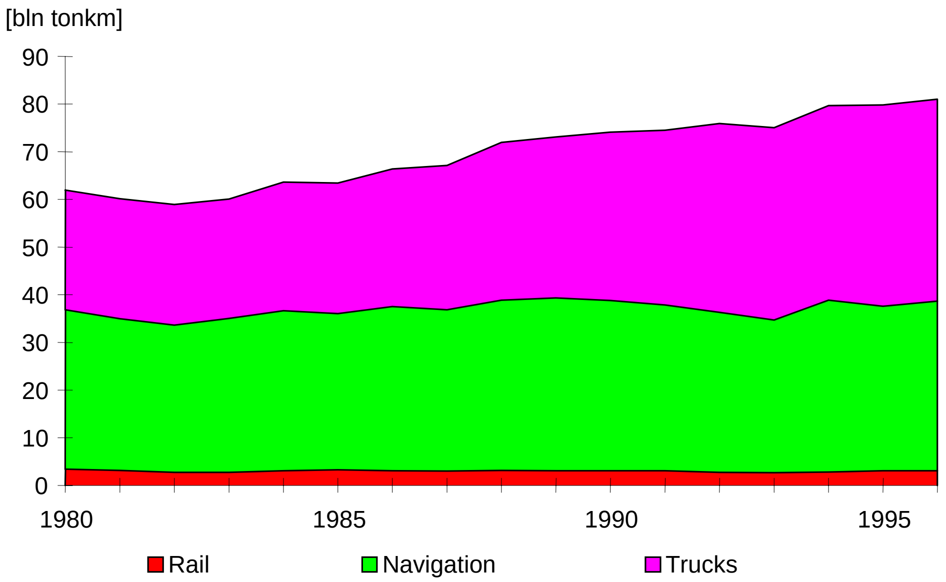

Figure 6.9 *Modal shift in freight transport; ton-km per mode*

In Figure 6.10 the impact of the modal shift in the specific energy consumption can be seen. The specific consumption of rail transport decreased with almost 25% (1980-1996) due to electrification and energy improvements. In primary energy terms the decrease is lower. The specific energy consumption of navigation increased with 8%. There is no clear explanation for this; it might be an effect due to the model calculations of the energy consumption, but is can also be caused by an increase in speed. Finally the energy efficiency of truck transport declined 18% between 1980 and 1993 but rose again with 5% in 1994-1996. Overall energy consumption per ton km rose with 5% mostly after 1990. Before 1990 the energy improvements compensated for the change in mode. After 1990 there were hardly any energy technology improvements, so changes in mode resulted directly into changes in overall energy efficiency.

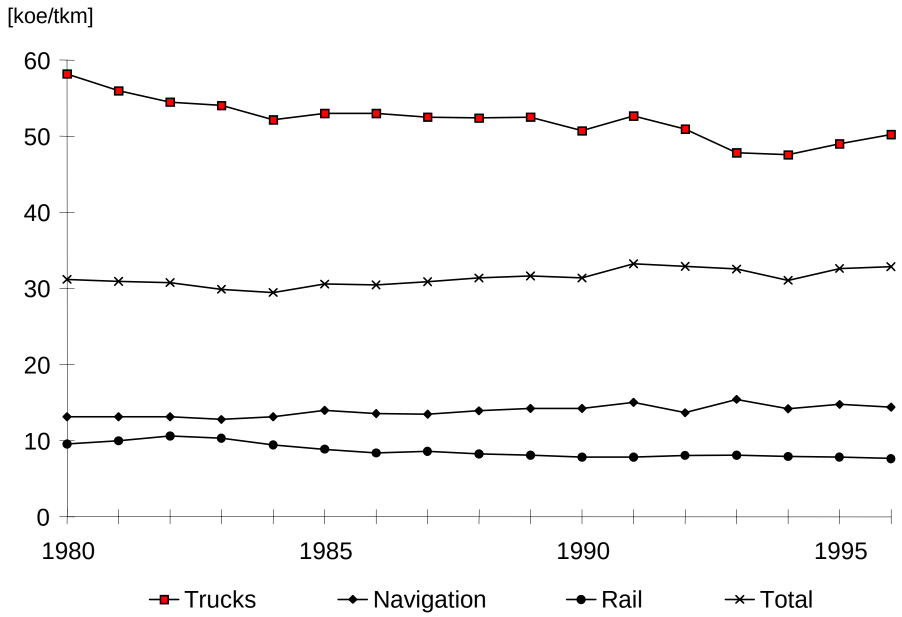

Figure 6.10 *Impact of modal shift on freight transport: energy consumption*

7. SERVICE SECTOR

7.1 Overall energy performance

Three types of energy indicators are considered for the service sector:
- energy intensity,
- unit consumption per employee,
- unit consumption per m^2.

Figure 7.1 shows the variation of the total and electricity intensities.

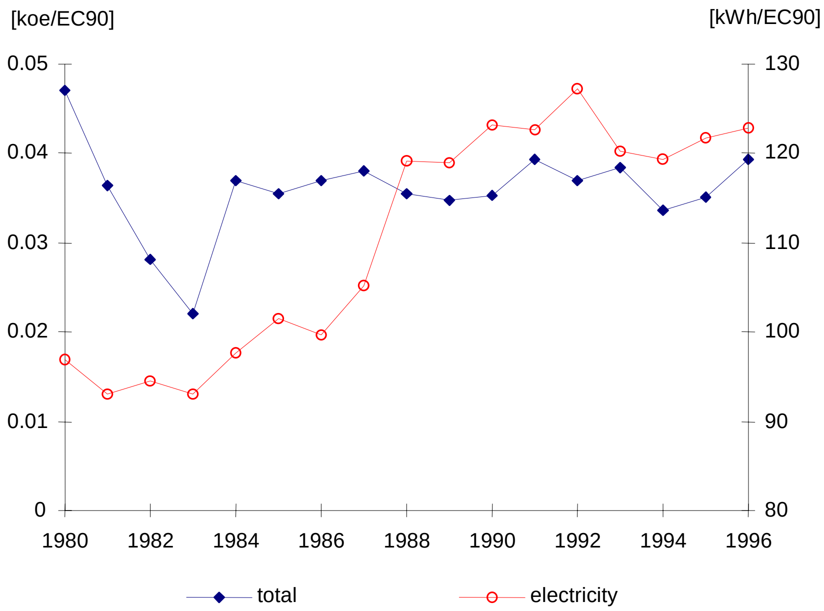

Figure 7.1 *Energy intensity in the service sector*

In the period 1984-1996, the total intensity is relatively stable at on average 0.036 koe/EC90. For electricity, the general trend is an increasing intensity of 1.5%/year on average between 1980 and 1996. Part of the increasing use of electricity is due to penetration of equipment for office automation and climate control.

The unit consumption per employee increases in the period 1981-1996 with 1.6%/year. (Figure 7.2).

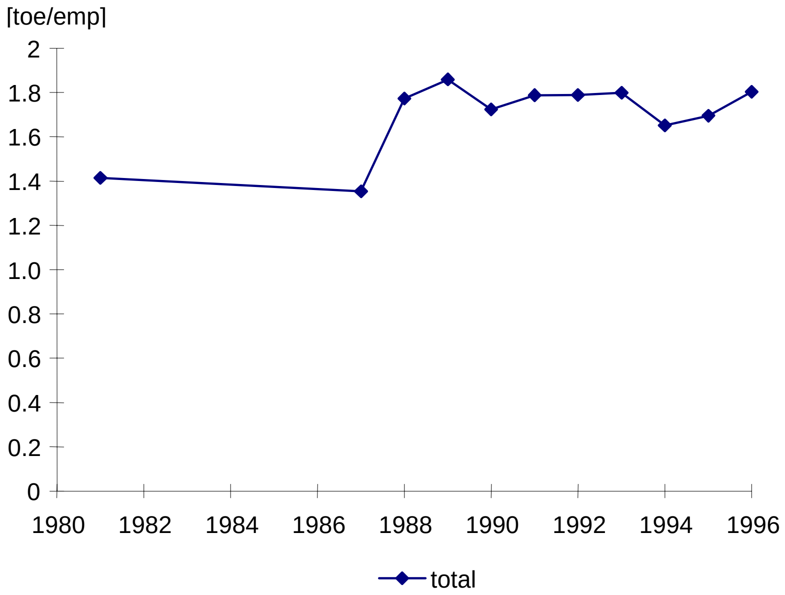

Figure 7.2 *Unit consumption per employee in the service sector*

The difference between growth of total energy intensity and growth of unit consumption per employee is almost zero, meaning that the change in average labour productivity within the service sector is small within this period. These two indicators can provide an assessment of energy efficiency trends in the sector from an economic viewpoint.

7.2 Energy indicators by branch

Five activities are considered in the service sector:
- commerce: wholesale and retail trade,
- hotels and restaurants,
- education,
- hospitals,
- government.

These activities correspond to economic branches, which means that the value added and employment are available, and energy intensities and unit consumption can be calculated.

The hotels and restaurants branch turns out to be more than three times as energy intensive than commerce and the average of the sector (see Figure 7.3). The intensity of these the hotel and restaurant branch and commerce increases by about 2.2%/year in 1993-1996, government by 1.4%/year and education by 1.8% year.

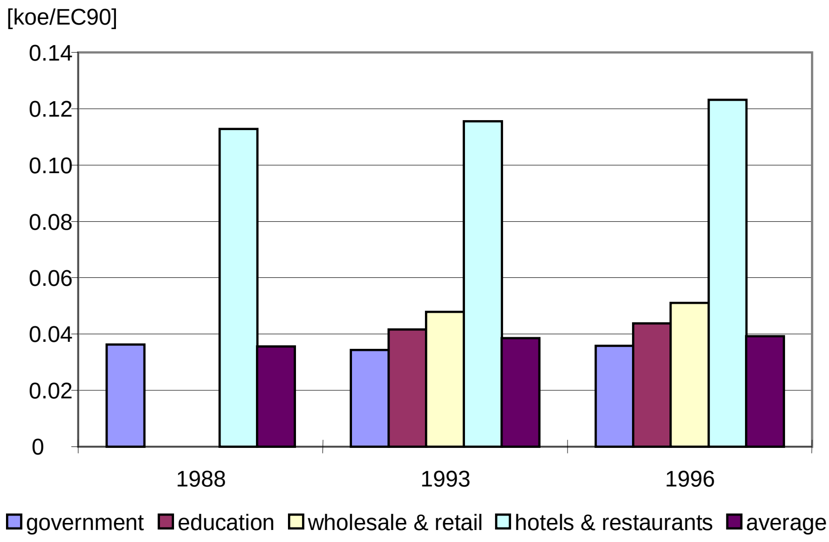

Figure 7.3 *Energy intensity per activity*

Figure 7.4 shows the development of the intensity of use of electricity per activity. Again, hotels and restaurant are the most energy intensive branches within the sector. The intensity of wholesale and education decreases with respectively 0.3%/year and 0.8%/year between 1993 and 1996. The intensity for hotels and restaurants however increases with about 2.1%/year in the same period. On average, the increase amounts to 1.4%/year.

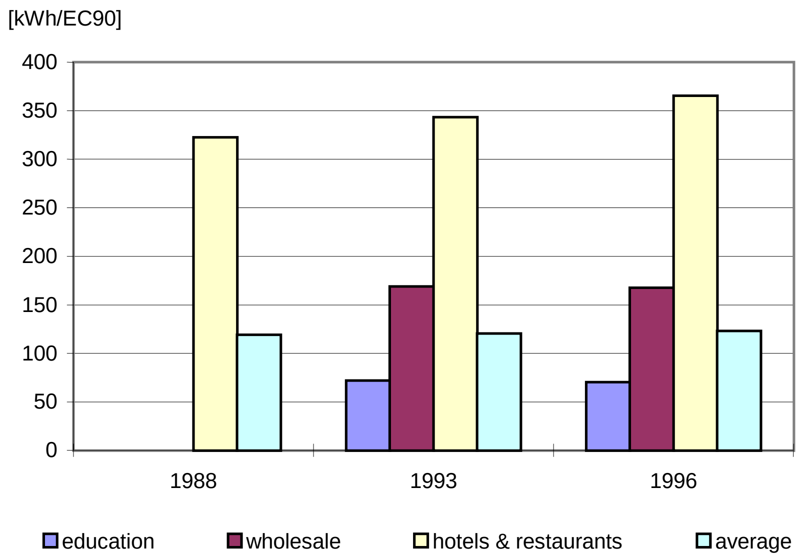

Figure 7.4 *Energy intensity per activity*

In Figure 7.5 and Figure 7.6 the unit consumption of total energy and electricity are given. Unit consumption of total energy is highest for hospitals and hotels and restaurants (two times higher than the average consumption). However, the unit consumption of electricity for hospitals is only about 15% higher than the average unit consumption.

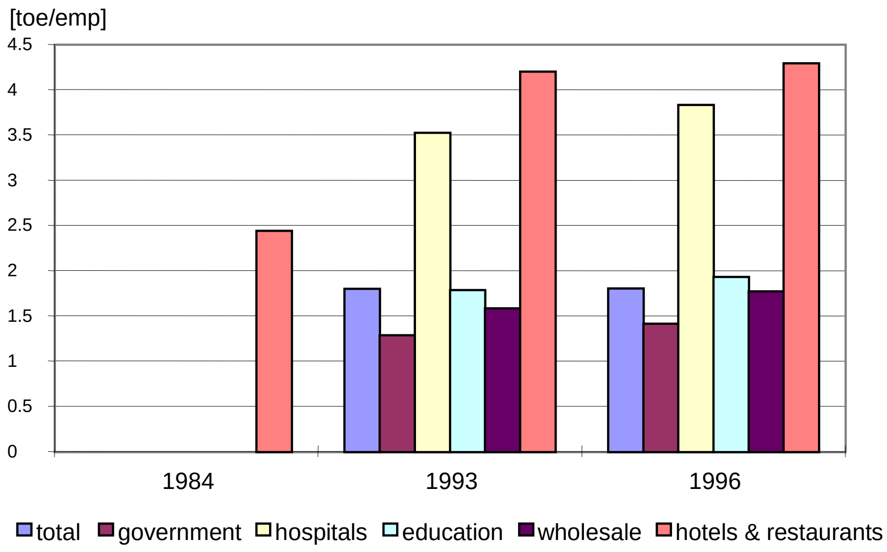

Figure 7.5 *Unit consumption of total energy per activity*

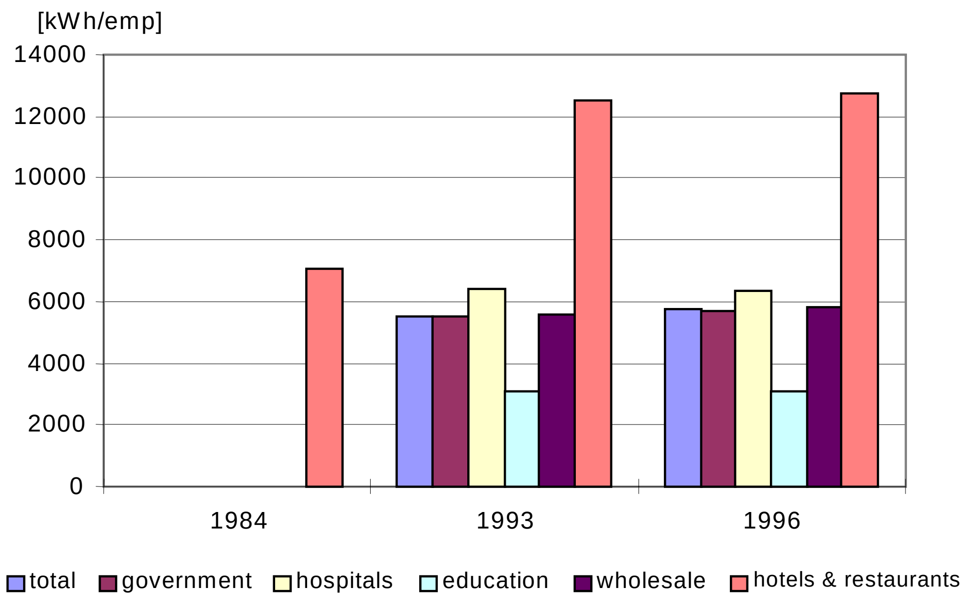

Figure 7.6 *Unit consumption of electricity per activity*

8. TRANSFORMATIONS

This chapter will focus on the electricity production sector in the Netherlands. In 1996, about 65% of the final consumption of electricity was produced in power plants, 25% was the result of cogeneration, and the remaining 10% was imported. About 80% of electrical cogeneration power is in control of auto-producers, mostly chemical industry, refineries, paper and food industry and greenhouse horticulture. Since 1980, central production in power plants has hardly increased. The growth in the consumption has been addressed by cogeneration and imports (Boonekamp, 1998). The estimated total savings accomplished by cogeneration are about 1.5 Mtoe, taking the 1990 centralised electricity generation efficiency (40%) as a reference. This estimate cannot be compared with Odyssee indicators in a straightforward manner.

The fuel mix for electricity production is shown for one year in Figure 8.1. In the eighties, the share of oil has been reduced, due to the international energy policy of the IEA, and stricter emission regulations. In 1982-1984, oil was mainly substituted with natural gas, but since the end of the eighties, a further diversification towards (clean) coal was carried out.

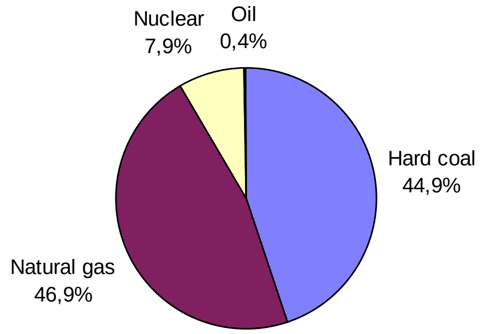

Figure 8.1 *Fuel input for electricity generation in the Netherlands in 1994 (Blok et al., 1997)*

Figure 8.2 shows the average efficiency of electricity generation, excluding imports (Boonekamp, 1998). This efficiency is almost identical to the efficiency of thermal plants only, because the share of nuclear and renewables is very small in the Netherlands.

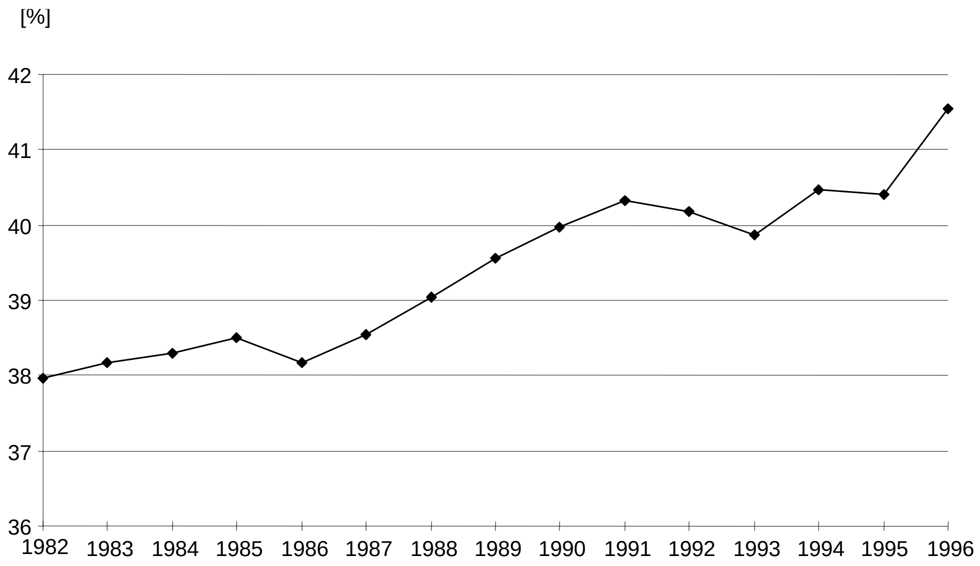

Figure 8.2 *Development of the efficiency of centralised electricity production in the Netherlands*

The efficiency of electricity generation has increased in the eighties, for instance by placing gas-turbines in existing plants. However, the number of coal plants has also increased, which has a reverse effect on the average efficiency. Recently two natural gas plants with a high efficiency (55%) have been put into operation, increasing the average efficiency in 1996 (EVN95, 1996; Boonekamp, 1998).

9. CONCLUSIONS

Overall energy efficiency has improved most rapidly in the years 1980-1986, with an average annual decrease of the final energy intensity of 2.5%, when fuel prices were high due to the second oil shock, the economy was in a recession, and an active energy conservation policy was carried out. When the prices dropped and the economy recovered, the overall energy efficiency improvement slowed down to an average rate of 0.8% annually.

The development of overall energy efficiency in the Netherlands is a result of developments within the different end-use sectors. For all sectors, energy efficiency improvements have been slowing down after 1990, some sectors even showing increases in energy intensity.

In industry, the relatively large growth of value added of the chemical industry compared to total manufacturing has made the structure of the economy more energy intensive after 1990. The recent high growth of the energy intensive industry has offset its energy efficiency improvements.

In the residential sector, the rise in electricity consumption per household and the stabilisation of the consumption of natural gas per dwelling have lead to an overall decrease in energy efficiency after 1990.

Despite an increase in vehicle efficiency, the energy consumption for road transport keeps growing. Both for freight transport and passenger transport, increases in the number of vehicles and in the distance travelled per year counterbalance the technical efficiency improvements.

The total energy intensity in the service sector has remained more or less stable after 1984. The electricity intensity however has doubled in the same period, probably due to growth in office equipment. This is compensated by improvements in labour productivity and building insulation.

With regard to the transformation sector, the implementation of combined heat and power, mostly by end-users, has increased the overall efficiency of power generation considerably.

Data collection according to ODYSSEE requirements has considerably improved but is still not optimal. Matters to be dealt with are:
- The lacking data for industry sectors before 1993 due to changes in classification.
- The matching of Dutch vehicle data with transport data within Dutch territory.
- Finding meaningful (physical) output time series for calculating energy savings in industry, agriculture and services.
- Establishing the energy efficiency of the transformation sector.
- The use of standardised technological data for cars and appliances.

APPENDIX A ON DATA ISSUES

A.1 Review of data supply problems

Industry

Data on final consumption and transformations are available from 1982 on. In 1993 the sectoral classification was altered, which caused disruptions. In this report, data are based on the new classification, some time series are thus only available from 1993 on.

Manufacturing sectors are observed in energy surveys and production surveys. Both surveys include energy consumption data, but these are not based on the same observations, and differ to some extent, both in quantities and method.

Final consumption of manufacturing sub-branches, e.g. paper and glass are not observed separately in the energy surveys. Adjustments between both surveys have to be made to comply with Odyssee requirements.

Deflated value added data are derived from National accounts, that have consistent time series from 1986 on, but do not cover the same sector classification as the energy survey nor the production survey. For instance, non-metallic minerals, iron and steel, non-ferrous metals are not available.

Data for energy intensive products are limited: only steel and aluminium production are published in a useful way.

Tertiary

Data on tertiary sub-sectors, value added, energy consumption and employment are defined for different years, addition of sub-sector is only possible for one year 1987.

Households

Total energy and natural gas consumption data do not match data from bottom up surveys. There are no data on specific energy consumption of appliances. There are no data on behaviour components regarding energy consumption.

Transport

No technical data for new cars available. No data on the water traffic for freight. No subdivision of rail passenger and freight transport into fuels.

A.2 Review of Eurostat data

A comparison between the availability of data from Eurostat and National Statistics is summarised in Table A.1. In general, National data are more elaborate and better updated. The comparison is made on the supplied Eurostat information by Enerdata. No extensive inventory is made of all published and unpublished data of the statistical bureau's and other regular data collecting.

Table A.1 *Availability and updating of data from National Statistics and Eurostat*

Type of data	Updating/number of data series[7]			
	National sources		Eurostat	
Final energy consumption by sector	1996	(29 fuels)	1996	(6 fuels)
Macro-economic data	1997		1997	
Value added by industrial branch	1997	(16 branches)	1995	(11 branches)
Industrial production index	1997	(6 branches)	1995	(7 branches)
Production of energy intensive products	20%		none	
Energy consumption by industrial branch	1996	(29 fuels, 20 branches)	1996	(5 fuels, 6-10 branches)
Stock of vehicles	1997	(very extensive)	1996	(3 categories)
Traffic	1996	(4 fuel types, 6 vehicle types)	1995 & 1996	(10 categories)
Energy consumption by transport	1997	(6 fuel types)	1996	(4 categories)
	1996	(6 vehicle types)		
	1994	(10 branches)		
Specific consumption of road vehicles	none		none	
Dwelling, service sector buildings	1996	dwellings	none	
Employment/value added in service by branch	1997	(20 branches)	1995	(3 branches)
Household electrical appliances				
- stock	none		none	
- specific consumption	none		none	
Energy consumption household/service by end-use	1996	(3 categories)	none	

7 Indicates the last year available followed in bracket by the number of data series available: e.g. 1996 (10).

In Table A.2, an energy weighted average is estimated on the differences between Eurostat and National Statistics. Differences can be substantial and mostly there are no obvious explanations.

Table A.2 *Differences between Eurostat and National data (1996)*

Type of data	Differences ODYSSEE/EUROSTAT
Final energy consumption	
- Total	1%
- Industry	20%
- Transport	1-10%
- Households	0.5%
- Services	3%
GDP by sector	
- Total	5%
- Industry	5%
- Services	incorrect
Energy consumption by industrial branch	
- Steel	unknown
- Chemical	5%
- Non metallic minerals	unknown
- Food	5%
- Textile	unknown
- Pulp and paper	unknown
Stock of vehicles	
- Cars	5%
- Trucks	unknown
- Light vehicles	unknown
Traffic of goods GOODS (ton-km)	
- Road	0%
- Rail	large
- Water	large
Energy consumption by transport modes	
- Road	inconsistent

APPENDIX B ON CONVERSION OF DUTCH NATIONAL STATISTICS TO THE ODYSSEE DATABASE

B.1 Energy data

From Dutch statistics (NEH) are used:
A: Sectored Energy balances (table series 1- 4 NEH Part 1), final consumption data.
B: In case balances are not available: additional data (table series 5-10 NEH Part 2) from other observations, apparent consumption is interpreted as being final, and if necessary added to the most plausible fuel categories of the balances.

Table numbers refer to NEH 1993.

B.2 Calculation of final consumption

The following adjustments are made to final consumption data:

- Final consumption in sectors SBI 23 (refineries and coke factories) Table 2.2.2 and 2.2.1; SBI 11 (energy mining) table 2.1; and SBI 40/41 Tables 2.2.3, 2.2.4 and 2.2.5 is not added to final consumption of industry, but regarded as transformation energy.
- Final non-energetic electricity consumption in NEH is added to final consumption of electricity, other non-energetic consumption is not added.
- Final energy consumption of heat/hot water is not used, instead only purchased (verbruikssaldo) heat/hot water is used. Furthermore, inputs for cogeneration are added to final consumption of the respective fuels, as far as production of heat/hot water is concerned, not when electricity generation is concerned. For each fuel input for cogeneration, a part is calculated to be added to final consumption. This part is for all fuels: (heat/hot water output in PJ) / (total cogeneration output in PJ). This is in conformity with Eurostat practise, and usually leads to an increase of total final consumption compared to Dutch statistics

For example:
NEH:
natural gas: purchased 20; input cogen 10; final consumption 10
oil: purchased 3; input cogen 2; final consumption 1
electricity: purchased 5; produced by cogen 3; final consumption 8
heat/hot water: purchased 1; produced by cogen 5; final consumption 6
total final consumption = 25
cogen efficiency (3+5) / (10+2) = 2/3; conversion loss cogen = 4
EUROSTAT:
cogen heat/hot water output share = 5 / (5+3)
natural gas: final consumption = $10 + (5/8) \times 10 = 16.25$
oil: final consumption = $1 + (5/8) \times 2 = 2.25$
electricity: final consumption = 8
heat/hot water: final consumption = 1
total final consumption = 27.5
conversion loss electricity = $(3/8) \times (10+2) - 3 = 1.5$

B.3 Fuel types

GNA = natural gas (aardgas)
GAD = manufactured gas (cokesovengas en hoogovengas)
GAZ = natural + manufactured gas

GZL = diesel (gas-, diesel-, stookolie < 15 cSt)
HOL = heating fuel oil (leeg)
FOL = heavy fuel oil (zware stookolie => 15 cSt)
PDV = other petrol (raffinaderijgas, chemisch restgas, nafta's, aardolie-aromaten, petroleum, overige lichte oliën, smeeroliën en vetten, bitumen, overige aardolieproducten)
PET = total petroleum products (totaal aardolieproducten)

ESS = gasoline (motorbenzine)
GPL = LPG (LPG, propaan, butaan)
ESA = aviation gasoline (vliegtuigbenzine)
CAR = jet fuel (zowel op basis van benzine als van petroleum)

CHA = hard coal (steenkool en bruinkool)
LIG = brown coal (leeg)
COK = cokes (steenkoolcokes)
OSF = other solid fuel (overige steenkoolderivaten)
CMS = hard coal + brown coal + cokes + other solid fuel

ELE = electricity (electriciteit)
VAP = steam, heat (stoom en/of warm water)
OTH = other energy (fermentatiegas)
ENC = other energy (fermentatiegas)

B.4 Sector divisions

Industry is composed out of:
1. manufacturing industry Nace 15-35, excluding Nace 23 (oil industry, coke factories)
2. the energy sector Nace 23 and Nace 40+41 electricity, heat, water production and distribution
3. construction Nace 45
4. mining Nace 10-14

From NEH is used:
1. industrie, SBI 15-37 excluding 23, table 3.1.x
2. omzettingsbedrijven
   - raffinaderijen en cokesfabrieken (refineries and coke factories), SBI 23 + 27(part); tables 2.2.1 and 2.2.2
   - elektriciteit- en warmteproducerende bedrijven centraal en decentraal (electricity and heat generation), SBI 40(part); tables 2.2.3 and 2.2.4
   - vuilverbrandingsinstallaties, SBI 90(part); table 2.2.5
3. distributiebedrijven (distribution and trade)
   - handelaren in vaste brandstoffen, SBI 51(part); table 2.3.1.
   - aardolieproductenhandel+ -opslagbedrijven, SBI 51(part); table 2.3.2.
   - distributiebedrijven voor gas, elektriciteit en warmte (energy distribution and trade) SBI 40 (part); table 2.3.3
   - winning en distributie van water, SBI 41; table 2.3.3.

4. bouw (construction) CON,
    - SBI 45, table 5.16, in case of non-energy final consumption: bitumen from table 3.4.
5. winningsbedrijven (mining)
    - (energy mining) SBI 11, table 2.: oil and gas mining, coal mining is non existent,
    - overige delfstoffenwinning (other mining and quarrying) SBI 14, table 5.14;

    All final energy consumption in this sector is put to zero.**

Manufacturing industry in Odyssee is composed out of:

1. Food IAA, (Nace 15+16)
2. Textile TEX, (Nace 17+18+19)
3. Paper and printing PPP, (Nace 21+22)
    - paper and board PAP, (Nace 21)
4. Chemical industry CHI, (Nace 24+25)
    - basic chemicals CHB, (Nace 24.1)
    - other chemicals and pharmacy CMP, (Nace 24 + 25 - 24.1)
    - rubber and plastics PHA, (Nace 25)
5. Non-metallic minerals NMM, (Nace 26)
    - glass VER, (Nace 26.1)
    - cement CIM, (Nace 26.51 **or** 26.5)
6. Primary metals PRM, (Nace 27)
    - steel industry SID, (Nace 27.1->27.3, 27.5)
    - non ferrous MNF, (Nace 27.4)
    - aluminium ALU, (Nace 27.42)
    - ferro alloys FAL, (Nace ??)
7. Equipment's EQP, (Nace 28-35)
8. Other industry IDV, (Nace 20, 37)

From NEH is used:

1. Voedings- en genotmiddelenindustrie (food and tobacco), table 3.1.1 for all years
2. Textiel, kleding en leerindustrie (textile, clothing, leather), table 3.1.2 for all years
3. Papier en grafische industrie (paper and printing) SBI 21+22, table 3.1.3 after 1992
    - papier (paper and board) SBI 21, table 3.1.3. before 1995
4. Chemie, 5 sectoren (chemical industry) SBI 24, tables 3.1.4 to 3.1.8 *plus* kunststof- en rubberverwerkende industrie (plastic and rubber processing industry) table 9.5.2
    - basic chemicals, tables 3.1.4-> 3.1.7
    - other chemicals and pharmacy, table 3.1.8
    - rubber and plastics, table 9.5.2.
5. Bouwmaterialen, aardewerk en glasindustrie (building materials, pottery and glass) SBI 26, table 3.1.9
    - glass, table 9.5.2 companies with more than 20 employees.
6. Basismetaalindustrie, 2 sectoren (basic metals industry) SBI 27, total of tables 3.1.10 and 3.1.11
    - basismetaal ijzer en staal SBI 27.1-27.3(ged.), 27.51,27.52, table 3.1.10
    - basismetaal non ferro SBI 27.4, 27.53, 27.54, table 3.1.11
7. Overige metaalindustrie, (metal processing industry) SBI 28-32 and 34-36, table 3.1.12
8. Kunststoffen, rubber en overige industrie (plastic, rubber and other industry) SBI 20+25+33+37 , table 3.1.13 *minus* kunststof- en rubberverwerkende industrie (plastic, rubber and other industry) SBI 25 table 9.5.2.

Table B.1 *Energy consumption in publishing and printing [PJ]*

Year	Natural gas	Electricity	Other
SBI'74 27			
1988	1.67	1.45	0.08
1989	1.89	1.59	0.06
1990	2.31	2.17	0.05
1991	2.63	2.17	0.05
1992	2.74	2.36	0.05
SBI'93 22 = Nace 22			
1993	2.99	2.49	0.06
1994	2.86	2.55	0.06
1995	2.72	2.57	0.06

Remarks:

- until 1990 only factories with 20 and more employees, later on all factories.
- from 1993 new definitions.

APPENDIX C ON TRANSPORTATION STATISTICS

Transportation is an important sector in the Netherlands. Not only from the economic point of view but also from environmental, congestion, and governmental expenses view. So, the Netherlands has an extensive amount of transportation statistics. The Dutch Central Bureau of Statistics published the last three years 20 different transportation statistics[8], a monthly bulletin[9], a pocket yearbook of traffic and transportation statistics[10] and a report with time series[11].

A way of calculation the energy use of road traffic is multiplying the number of vehicles (per type of vehicle) with the average annual distance and the average consumption of fuel per kilometre. The availability of these three factors will be illustrated using transport statistics.

The number of vehicles is yearly published in 'the Statistics on Motor Vehicles'. This is based on the data of all the registration numbers of Dutch cars. This statistic distinguishes passenger cars, delivery vans, lorries, tractors, special purpose vehicles, buses, and motorcycles. Overviews are given of all cars by year of construction and technical characteristics (fuel type, weight, carrying capacity, model, number of cylinders). The number of cars per province and for the main cities is also given. For passenger cars, year of construction, the make and the type, the contents of cylinder class, and the catalyst equipment are available. The actual number of motor vehicles in use is calculated in the same statistic, by correcting the registered cars for dealer stocks and for unregistered demolition. When using the actual data from Dutch motor vehicle registration, it must be noted that it differs considerably from motor vehicles on Dutch roads: Dutch cars drive also in foreign countries and foreign cars drive also on Dutch roads.

A second annual statistic is 'the Mobility of the Dutch population'. For 168.000 households the exact mobility of one day is investigated with a postal survey. Data are collected on social aspects (e.g. income and schooling), mode, travelled distance, vehicles possession, mobility motive, and vehicle type and fuel. The data are transferred into figures on passenger cars (just like the statistics on motor vehicles), average annual distance of passenger cars, and use of public transport.

The use of passenger cars is also investigated by a monthly postal survey of about 1000 owners of a passenger cars a ('the car panel'). The survey includes ownership aspects (e.g. purchase motive, new car of second hand car), fuel type, average monthly distance, distance travelled inland and abroad, and specific fuel consumption. Just like the 'Mobility of the Dutch Population' this statistic gives figures on average annual distance of passenger cars, but this time also specified for inland and abroad. Because the specific fuel consumption is directly available from the passenger car owners for the specific Dutch circumstances there is no need to construct figures based on test cycles with new cars (ECE15 and EUDC cycles)[12].

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[8] Internet: http://www.cbs.nl/eng/lib/listof.htm.

[9] Monthly bulletin of transport statistics.

[10] Pocket yearbook traffic and transport statistics 1997.

[11] Time series on traffic and transport 1996.

[12] See for instance: Sanger, R.P. et. al.: Motor vehicle emission regulations and fuel specifications part 1 summary and annual 1996 update. Report no 5/97. Brussel, CONCAWE, march 1997. And Sanger, R.P. et. al.: Motor vehicle emission regulations and fuel specifications part 2 detailes information and historic review (1970-1996). Report no 6/97. Brussel, CONCAWE, march 1997.

About 2% of the owners of commercial vehicles is approached every four years with a postal survey[13]. This survey includes ownership aspects, average annual distance (inland and foreign), and specific fuel consumption. Because the mailing list is based on the registration numbers, the collected data can be combined with vehicle aspects (weight, loading capacity, fuel type, year of construction). The survey includes vans, lorries, tractors, special vehicles, and buses. A comparable survey is held among 4500 owners of motor cycles every four years.

For passenger transport a separate statistic is available[14]. Companies with a licence for private bus transport report monthly about their transport performance (in bus-km and in passenger-km). The performance of public transport is derived from the sold tickets. The registrations of the public transport companies are used for vehicle-kms. Therefore this statistic is a second source for the performance of buses.

The actual traffic on Dutch roads including the amount of kilometres driven with foreign cars is registered on counting points. In the Netherlands, at 600 places outside urban areas the intensity of traffic is measured. Electronically, five classes can be measured: personal cars and light duty vehicles, heavy duty vehicles and special vehicles, heavy duty vehicles with a trailer, busses, and motorcycles. A division between Dutch and foreign cars can only be made by visual observation of license plates. Based on different sources, the statistical bureau makes every year an approximation of kilometres driven by foreign vehicles of different types in the Netherlands. Data on traffic intensity can be combined with the length of available roads[15]. This determines traffic mobility, which must be consistent with other mobility data.

The discussed statistics give enough information for calculation the energy consumption of road transport in the Netherlands. The calculated total use of petrol, diesel, and LPG can be compared with the monthly oil delivery statistics[16]. This results in a statistical difference that fluctuates over time. Oil delivery is mostly higher. The difference in historical years varies between 1% and 10% of the total energy use for road transport[17]. There are some factors which can cause a statistical difference ('border tanking', pleasure crafts, and mobile equipment), but they are not sufficient to explain all the differences.

An extensive amount of data on rail transport is collected and submitted to the statistical bureau by the Dutch railway company (NS). The yearly energy use is divided in oil en electricity and there are only estimations about the division between passenger and goods transport for these energy carriers.

For inland vessels[18] data of energy cost per type of ship are transferred into energy consumption for all ships of that type. Based on transport performance also the energy consumption of foreign ships in the Netherlands is estimated. Due to border crossing aspects, it is not possible to check this consumption with oil delivery figures. The use of inland vessels and pleasure crafts can be checked with the data of counting points. On a number of locations (at the Rhine in Lobith, at bridges and locks) the passage of ships is registered. Data on sea going vessels (e.g. load capacity; actual load, country of origin and destination) are registered by harbour authorities. The CBS makes also a detailed overview of Dutch vessels and planes specified for different aspects.

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13 Ownership and use of commercial motor-vehicles 1993.
14 Statistics on passenger transport 1996.
15 Statistics of roads.
16 Energy supply in the Netherlands: results of monthly and quarterly enquiries in energy supply.
17 Energy supply in the Netherlands : annual figures (2 parts) 1996.
18 Consumption of energy by inland vessels. Monthly Bulletin of Transport Statistics, volume 59 1996-1 pag.6-8.

The energy consumption (inland and bunkering) of air traffic is registered in the monthly energy statistics of oil deliveries. The different airports collect data on aircraft movements (per type) and passengers. The relatively small amount of inland energy consumption for air traffic in the Netherlands is influenced by the consumption for military use.

The statistical bureau makes[19] a monthly statistic about the transport performance in tons, locations of loading and unloading, and type of load. This statistic is based on information of companies with a licence for the transport of goods. With these statistical data also the performance in ton-km is calculated. Based on custom documents, an other statistic is made of the import, export en transit of goods.

[19] Statistics of goods transport in the Netherlands 1996.

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