Chapter 7

Long-term scenarios for the direct and indirect energy requirement of Dutch consumers[1]

► Abstract

Common economic models for the analysis of private consumption generally do not distinguish demographic, economic and technological changes or changes in consumer purchasing behaviour, which are related to different policy fields. This makes common economic models less suitable for the analysis of changes in consumption patterns and the accompanying environmental pressure. The aim of this chapter is to estimate the composition of the whole private consumption for 2030 and the accompanying energy requirement on a detailed level from a consumer's point of view. Besides economic changes the method also distinguishes non-economic driving forces such as technical and demographic changes, and changes in consumer purchasing behaviour.

From our analysis of the effect of two business-as-usual scenarios for the Netherlands, where total private consumption per capita doubles or triples between 1995 and 2030, we estimated the accompanying energy requirement per capita to increase by about 30% to 60% in this period. This means an expected autonomous decrease of 40% in the energy intensity, representing a reduction of 1.5% a year.

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1 This study is a substantially adapted and translated version of Vringer K., Aalbers, Th.G., Drissen, E. Hoevenagel, R., Bertens, C.A.W., Rood, G.A., Ros, J.P.M. and Annema, J.A. 'Nederlandse consumptie en energiegebruik in 2030. Een verkenning op basis van twee lange termijn scenario's' (Consumption and energy requirement for Dutch consumers in 2030. A survey based on two long-term scenarios) National Institute for Public Health and the Environment, Bilthoven, The Netherlands (2001).

Two-thirds of the reduction in the energy intensity is due to changes in both energy efficiency of consumer goods and energy efficiency of the production of the consumer goods. Changes in consumer purchasing behaviour are responsible for the remaining one-third reduction in the energy intensity, expressed in a relatively low growth of the energy-intensive fuels for transport, heating the dwelling and the consumption of hot water. Economic changes and demographic changes hardly affect the energy intensity.

If governments want to achieve at a more sustainable consumption in the future, they will have to take into account that autonomous energy-efficiency improvements and autonomous changes in consumer purchasing behaviour cannot compensate for the effect of the ongoing growth in disposable income.

1 ► Introduction

In the so-called Brundtland Report, the World Commission on Environment and Development of the United Nations states that ‘we must learn to care for the needs of the present generation without compromising the ability of future generations everywhere to meet their own needs’ (WCED, 1987). A (more) sustainable production structure and consumption pattern are necessary to achieve this. Several autonomous trends are threatening this desired aim. One of the threats is the ongoing growth of consumption and the accompanying environmental pressure. From 1948 to 1996 the private consumption per capita for the Netherlands tripled, along with the accompanying total energy requirement (Vringer and Blok, 2000). Almost all this total energy requirement is associated with the emission of greenhouse gases, which are expected to affect the earth’s climate (IPCC, 2001). A further growth in the consumption is expected (CPB, 1996). With an expected economic growth of about 3% a year, the Dutch consumption per capita doubles or triples again between 1995 and 2030 (CPB, 1996; Drissen and Braat, 2002).

To analyse the future environmental pressure of consumption, a fairly detailed description of the whole consumption pattern is a prerequisite. It is also preferable to distinguish the effect of demographic, economic and technological changes, and changes in consumer purchasing behaviour, on the consumption pattern, because each kind of change is related to a different policy field. The Netherlands Bureau for

Economic Policy Analysis (CPB) determined the expected total consumption pattern for 2020, but on a very aggregated level based on an expected production structure (CPB, 1996). To establish future consumption patterns, demographic, technological effects, and effects of changes in consumer purchasing behaviour, were not separately taken into account by the CPB. Economists often use general equilibrium models to analyse future consumption (see Dixon et al., 1982 and Shoven and Whalley, 1992). Most models of this type distinguish a limited number (a few dozens at the maximum) of consumption categories. However, there are exceptions, for example, an Australian model that goes back to Dixon et al. (1982) distinguishing 115 commodities, and the Keller model for the Netherlands that contains 65 commodities (Cornielje and Zeelenberg, 1991). Unfortunately, general equilibrium models in general only take account of 'economic' behaviour (the effect of changes in prices and income on the demand for commodities), whereas we also want to take demographic and technological effects into separate consideration. This makes most of these economic models less suitable for the analysis of changes in the consumption pattern and the accompanying environmental pressure, which is necessary for advising on policy to reduce the future environmental pressure.

The aim of this chapter is to estimate the composition of total private[2] Dutch consumption and the total accompanying energy requirement for 2030 on a detailed level and from a consumer's point of view. The total energy requirement includes all energy that is attributed to private consumption; i.e. all primary energy required for the production of goods and services is allocated to consumers that use these goods and services.

We used a method to estimate a complete future consumption pattern on a detailed level, which derives the expected consumption pattern from driving forces that affect consumer decisions. Apart from economic changes, non-economic driving forces such as technical and demographic changes, and changes in consumer purchasing behaviour, are taken explicitly into account. The method takes the effects of each driving force into separate account with the help of an appropriate approach for each driving force concerned.

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2 Private consumption is total consumption less public consumption, e.g. infrastructure, medical care and (other) public services.

We will first describe the method in general and, second, the determination of the expected consumption pattern and the accompanying direct and indirect energy requirement for Dutch consumers in 2030. The estimated private consumption patterns presented here are based on two business-as-usual scenarios for 1995 to 2030, taking only the current policy into account. The analysis thus aims to describe the *autonomous* development of private consumption.

2 ► A method to calculate private consumption patterns

We developed a four-step method to estimate the future private consumption pattern[3] and the accompanying energy requirement. The first step is choosing the scenario context, which is a coherent description of future society. Note that government policies can be part of the scenario cxontext. In the second step the effects of the scenario context on five driving forces are determined. These driving forces are demographic changes, economic changes, changes in consumer purchasing behaviour (e.g. trends, lifestyles etc.), energy-efficiency changes in the consumption phase of consumer goods and energy-efficiency changes in the production phase of consumer goods. Each driving force is related to a different policy field. In the third step the effects of the driving forces on the consumption pattern are determined. The consumption pattern is related to the total primary energy requirement (which is the sum of the direct and indirect energy requirement[4]). This can be regarded as an indicator of environmental pressure. The fourth step results in determination of the energy requirement (see Figure 7-1).

3 A consumption pattern is characterised by the distribution of expenditures among consumption categories. A consumption category is a set of consumer products (goods and services) with the same product characteristics.

4 The direct energy requirement is the total primary energy required for the production of all energy carriers that consumers consume (such as electricity, fuels and natural gas). The indirect energy requirement is the total primary energy required for the production of all the other products and services that consumers consume.

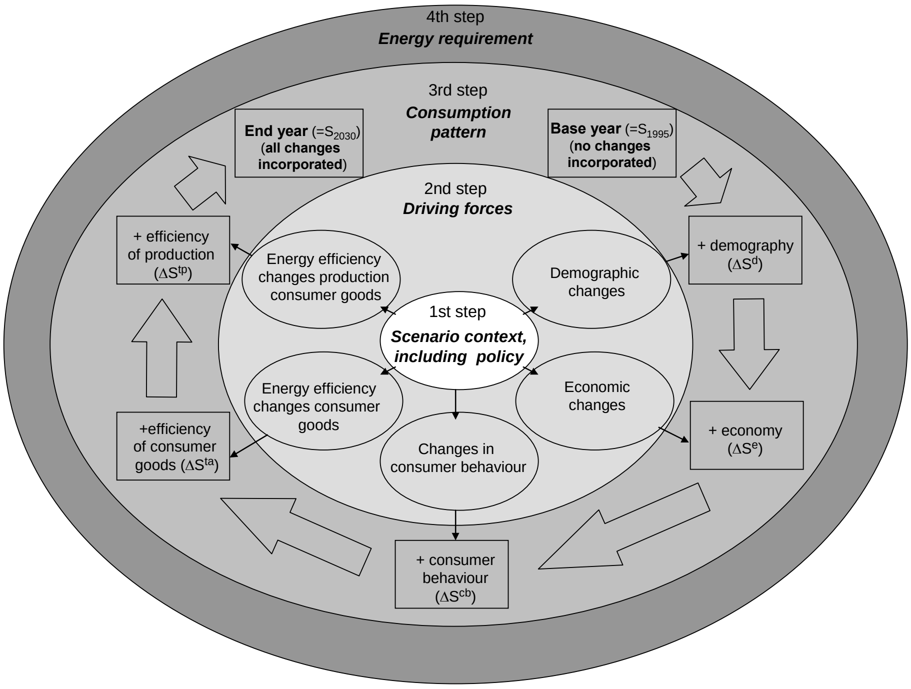

Figure 7-1 The four steps of the method illustrated, along with the five driving forces.

To calculate the future average consumption pattern we have to start with a given consumption pattern in a base year. The effects of the five driving forces are added in succession. Of course, the effects of the driving forces are not independent of each other, so the method checks for consistency with the scenario context. In the following sections we will describe each step of the method in determining the consumption pattern and energy requirement in 2030 for Dutch consumers for two different scenarios.

2.1 ► First step: scenario context

Before a future consumption pattern can be calculated, we need information about possible future developments of the driving forces. Such information can be constructed by forecasting the possible future developments or by constructing scenarios for the future, which describe different, plausible future developments of the driving forces in a consistent way. The use of scenarios is widely accepted for the time span (1995-2030) chosen (IPCC, 2000 and CPB, 1996). We used two long-term scenarios from the Netherlands Bureau for Economic Policy Analysis (CPB, 1996, 1997)[5]:

- Global Competition (GC), with an economic growth of 3¼% a year (CPB, 1996, 1997). Individuals are more concerned about their own (material) interests. Competition and the liberalisation of local and world markets are strong driving forces in this scenario, forming a factor, which leads, inter alia, to great technological progress.
- European Co-ordination (EC), with an economic growth of 2¾ % a year. Individuals take more account of public interests and interests of others (compared to GC). Although there is an ongoing liberalisation of markets in EC, it is not as strong, compared to GC. Cooperation remains an important mechanism for decision making.

The two scenarios provide explicit characteristics of demographic and economic changes but do not give quantitative information on changes in consumer purchasing behaviour and (energy-)efficiency changes, although they give qualitative information about the underlying socio-cultural and technological changes (CPB, 1996). On the basis of this qualitative information, we present a method in the next section to specify the changes in consumer purchasing behaviour.

5 Originally, these two scenarios were developed for1995-2020. Drissen and Braat (2002) made an extrapolation for the period 2020-2030. The scenario context of GC has much in common with the A1 scenario of the IPCC context, whereas the EC context is more or less similar to the B2 context (IPCC, 2000).

2.2 ► Second and third steps: Driving forces and their influence on the consumption pattern

For each driving force we present the net effect on the consumption pattern in 2030. The total consumption in 2030 can be written as:

$$\sum_{y=1}^{z} S_{2030,y} = \sum_{y=1}^{z} (S_{1995,y} + \Delta S_y^d + \Delta S_y^e + \Delta S_y^{cb} + \Delta S_y^{ta} + \Delta S_y^{tp}) \quad (1)$$

where:

$S_{2030,y}$	=	Expenditure on consumption category *y* in the end year 2030;
$S_{1995,y}$	=	Expenditure on consumption category *y* in the base year 1995;
z	=	Number of consumption categories;
ΔS^d_y	=	Effect of demographic changes on the expenditure of category *y;*
ΔS^e_y	=	Effect of economic changes on the expenditure of category *y;*
ΔS^{cb}_y	=	Effect of changes in consumer purchasing behaviour on the expenditure of category *y;*
ΔS^{ta}_y	=	Effect of changes in energy efficiency of consumer goods belonging to category *y*, on the expenditure of category *y;*
ΔS^{tp}_y	=	Effect of changes in energy efficiency in the production of consumer goods belonging to category *y*, on the expenditure of category *y*.

In this section we will discuss each element of Equation (1).

2.2.1 ► Consumption pattern for the base year

We assumed 1995 as base year for the private consumption pattern because of the availability of data for that year. The consumption pattern (in financial terms) for that year was derived from the Household Expenditure Survey (CBS, 1996). This survey contains the private expenditure pattern of a representative sample of 2069 Dutch households in 1995 consisting of approximately 350 consumption categories.

Note that the total private expenditure is not equal to the disposable income[6]; the differences are mainly due to loans received, and savings and investments made (CBS, 1996).

6 The disposable income is the net income, available for private expenditures and investments (see also Vringer and Blok, 1995).

2.2.2 ► Demographic changes

To estimate the effect of demographic changes we made a static micro-simulation (De Beer, 1998), which is a multiplicative weighing (CBS, 1999) of the individual households from the expenditure survey of 1995. Individual households from the expenditure survey, of which the type is expected to become more (less) common in 2030, are more (less) heavily weighted, when calculating the average consumption pattern. Which household types are expected to become more (less) common in 2030 is derived from the expected future developments of several demographic characteristics, as described by Drissen and Braat (2002).

Table 7-1 The four characteristics of main demographic changes for 1995 and 2030 according to the EC and GC scenarios.

	1995	2030 EC	2030 GC
(1) **Age** (proportion of all Dutch inhabitants of 65 years and older)	13%	22%	24%
(2) **Participation of women on the employment market** (proportion of all Dutch women from 20 to 65 years)	22%	18%	14%
(3) **The number of persons per household** (part of all Dutch households)*			
- 1-person households	31%	36%	46%
- 2-person households	33%	33%	30%
- 3-person households	14%	13%	10%
- 4 or more person households	22%	18%	14%
(4) **Educational level** (proportion of all Dutch inhabitants from 20 to 65 years)			
- Elementary education	16%	9%	7%
- Lower secondary education	28%	23%	21%
- Higher secondary education	38%	42%	43%
- Higher education	19%	27%	29%

* In 1995 the average number of members per household was 2.34, which in 2030 will be 2.19 (EC) or 1.95 (GC) (Drissen and Braat, 2002).

To estimate the effect of demographic changes on the consumption pattern, we concentrate on four main demographic changes mentioned by CBS/CPB (1997), namely, education, households, population and working population. Taking the four main demographic changes into account, we chose four characteristics of these main demographic changes, available in the expenditure survey of 1995 and quantified in the scenario context (see Table 7-1)[7].

The resulting expenditure on consumption category *y*, considering the demographic changes between 1995 and 2030, can be expressed as: $S^d_{1995\text{-}2030,y}$. Now the effect of demographic changes on the expenditure of consumption category *y* can be written as[8]:

$$\Delta S_y^{\ d} = S^d_{1995-2030,y} - S_{1995,y} \qquad (2)$$

Note that the demographic changes not only affect the consumption pattern but also the disposable income per capita.

2.2.3 ► Economic changes

The economic changes as described in the EC and GC scenario form our starting point for the calculation of the consumption pattern. The most important economic characteristics, which may affect the consumption pattern, are the prices and the disposable income. In this chapter, we ignore the effect of changes in relative prices on the consumption pattern because the scenarios that we use do not give prices changes for the consumption categories. We can construct changes in prices on an aggregated level, for example, food products and services. However, on this level we cannot expect substantial substitution effects if prices change, since substantial effects will only occur if goods are close substitutes. Therefore we concentrate on the effect of changes in disposable income on the consumption pattern. The disposable income changes if demographic characteristics such as education level and labour participation change (see previous section). These demographic changes lead to a change in the size, composition and quality of the labour force and, therefore, to a change in labour productivity. In addition to this demographic-related change, labour productivity may also change because of changes in economic

7 One important demographic change is excluded in our analysis, i.e. the growth of the Dutch population, which is expected to increase from 15.5 million to 18.4 (EC) and 17.1 (GC) million people in 2030 (Drissen and Braat, 2002). We excluded the growth of the population because all results are presented per capita.

8 See Appendix 7B for a recapitulation of all symbols used in this chapter.

characteristics such as technology, business organisation or (for labour productivity on a macro level) the sector structure. The economic-related change in labour productivity also leads to a change in disposable income. We will refer to the economic-related change in labour productivity as the change in disposable income due to economic changes.[9] The EC and GC scenarios give only information on the change in income level and expenditure level (see Table 7-2). The economic-related change in income can be obtained by subtracting the demographic-related change in income, which is the sum of the demographic-related change in the expenditure for each consumption category as determined by Equation (2), from the total change in income.

Table 7-2 Development (1995 = 100) of the disposable income and expenditure for the EC and GC scenario (Source: Drissen and Braat, 2002, based on CPB, 1996).

	EC 2030	**GC 2030**
Disposable income per capita	220	299
Private expenditure on private consumption, per capita	216	277
Total disposable income for all Dutch inhabitants	262	331
Total private expenditure on private consumption for all Dutch inhabitants	258	307

A static micro simulation is not suitable for the calculation of the effect of the economic-related change in disposable income on the consumption pattern. Using this would mean that a few households from the expenditure survey with a relatively high income would be highly determinative in choosing the consumption pattern. This would also lead to problems for specific consumption categories; e.g. detached houses would not be available for a much larger group.

Instead of a static micro-simulation, we used income elasticities for expenditures to estimate the effect of a change in income on the expenditure of a consumption category. We first determined the income elasticity for the nine consumption

9 The economic-related change in labour productivity is dominant in the long term. Note that we ignore the impact of changes in the productivity of other production factors on income: energy, for example, which leads to a change in the energy efficiency. The same applies to changes in consumer purchasing behaviour.

domains using the expenditure survey of 1995 (CBS, 1996). A consumption domain consists of all expenditures made on one kind of activity[10]. The income-expenditure elasticity for consumption domain *x* in 1995 (α_x) is determined by Equation (3):

$$S_{1995,x} = \beta_x * I_{1995}{}^{\alpha_x} \qquad (3)$$

where:

$S_{1995,x}$ = Expenditure on consumption domain *x* in 1995;
I_{1995} = Total disposable income in 1995;
β_x = A constant factor for consumption domain *x;*
α_x = Income elasticity of consumption domain *x.*

Table 7-3 gives the income elasticities for all consumption domains derived from the expenditure survey of 1995 (CBS, 1996).

Table 7-3 Income elasticities (α_x) for the nine consumption domains (CBS, 1996).

Domain	Income elasticity
Food	0.72
Dwelling	0.41
Household effects	0.89
Clothing	1.0
Personal care	0.8
Leisure indoors	0.6
Leisure outdoors	1.2
Holidays	1.4
Employment	1.0

If consumption category *y* belongs to consumption domain *x*, we assume the income-expenditure elasticity for this consumption category (α_y) to be equal to α_x. This implies that we used the same elasticity for all consumption categories

10 For example, domain 'food' does not only consist of food products, but also transport of these products from the shop to the dwelling, natural gas for cooking them and warm water to wash up. See also Appendix 7A for an extended classification.

belonging to one domain, which is not necessarily correct[11]. Assuming that the total disposable income is similar to the total expenditure, the effect of the economic changes on the expenditure of consumption category *y* can be written as:

$$\Delta S^{e}_{y} = S^{d+e}_{1995-2030,y} - S^{d}_{1995-2030,y} = S^{d}_{1995-2030,y} * \left[\left(\frac{G^{CPB}}{S^{d}} \right)^{\alpha_y} - 1 \right] \quad (4)$$

where[12]:

$S^{d+e}_{1995\text{-}2030,y}$	= expenditure on consumption category *y*, concerning the economic changes and demographic changes between 1995 and 2030;
$S^{d}_{1995\text{-}2030,y}$	= expenditure on consumption category *y*, considering the demographic changes between 1995 and 2030;
G^{CPB}	= total expenditure in 2030 according to the CPB scenario;
S^{d}	= total expenditure in 1995, considering the demographic changes between 1995 and 2030;
α_y	= income elasticity of consumption category *y*.

By calculating ΔS^{e}_{y} we used the linear approach of Equation (3)[13]. The total expenditure can now be calculated by adding up the expenditures for each consumption category. The consequence of this method is that the total expenditure calculated here might not be equal to the total expenditure given in the scenario. The sum of ΔS^{e}_{y}, as calculated with the linear approach of Equation (3), is about 90% of the total expenditure given by the scenario. There is a difference because the

11 This procedure assumes the elasticity in the short term to equal the elasticity in the long term, which may lead to an additional bias.

12 See Appendix 7B for a recapitulation of all symbols used in this chapter.

13 The error in the expenditure due to this linear approach varies between 0% (household effects) and 9% (holidays) of the expenditure of a consumption domain. See the discussion for the effect on the calculated total energy requirement.

weighted sum of the income elasticities is not equal to one, where the weights are determined by the budget shares of the consumption domains. To equate the calculated total expenditures with the total expenditures from the scenario, we distributed the remaining 10% of the total expenditure proportionally over the consumption domains. We will return to this point in the discussion.

2.2.4 ► Changes in consumer purchasing behaviour

By taking the demographic and economic changes (ΔS^d_y and ΔS^e_y) into account we obtained an extrapolation of the consumption pattern for 1995. This means that although the average income and demographic situation has been changed, a specific consumer in 2030 with the same demographic characteristics and the same income level will still consume in the way as he/she did in 1995. However, so far, we have ignored the effects of changes in consumer purchasing behaviour on the consumption pattern, which may be caused by cohort effects, changes in consumers' preferences, trends and technical changes[14]. We used three types of sources, listed below, to explore the effect of changes in consumer purchasing behaviour on the consumption pattern. The second and third types of sources are additional to the first type. The three types are:

a. *Expert sessions* for changes in the expenditure on products and services. For approximately 55% of the total expenditure, the effect on changes in consumer purchasing behaviour was estimated with this source ($\Delta S^{cb}_{y(expert)}$);
b. *Additional research* on changes in expenditure in a few categories requiring a closer analysis. We restricted ourselves to categories, which are, or will probably become, relatively large. For approx. 25% of the total expenditure, the effect on changes in consumer purchasing behaviour was estimated with this source ($\Delta S^{cb}_{y(add)}$);
c. *Energy and transport models* for the changes in expenditure on energy carriers and transport. We used these models because they are quite detailed and because the direct energy requirement covers approximately 50% of the total energy requirement

14 Such changes include the development of e.g. mobile telephones and DVD players. The technical developments mentioned here do not include technological changes concerning the (energy) efficiency.

in 1995. For approximately 15% of the total expenditure, the effect on changes in consumer purchasing behaviour was estimated with this source (=$\Delta S^{cb}_{y(use)}$).

Each source will be discussed below[15].

Expert sessions: we organised four *expert sessions* about 'clothing', 'food', 'dwellings'[16] and 'recreation'[17] for 7 of the 9 consumption domains. Six to ten experts on trends, marketing, sales and technology who work at large retailers, branches of trade, design departments of producers and consumer organisations participated in each session. Before a session started, the participants were extensively informed about the consumption domain concerned (Hoevenagel et al., 2000) as well as about the results of a qualitative literature study on factors and trends that may influence the consumption pattern (Slob et al. (1999); Van der Pijll and Krutwagen (2000); TNO (2000); CREM (2000); Van de Heiligenberg et al. (2000); Vergragt (2000) and Young and Vergragt (2000)). An electronic decision-support system was used to give structure to the sessions.

We asked the experts of each session how consumers would divide the total expenditure over all consumption domains, taking into account the consumption pattern of 1995 and the above-described demographic and economic changes between 1995 and 2030. Taking the new proportions of the consumption domains into account[18], the experts were asked how consumers divide the expenditure among clusters of consumption categories of the relevant domain[19]. We asked the experts to motivate and discuss their vision on possible trends. In most cases consensus on the

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15 About 9% of the total expenditure (responsible for 3% of the total energy requirement) in 1995 was not covered by one of the sources. This concerns expenditure on two domains: labour (excl. the expenditures on petrol), and personal care (excl. the expenditures on natural gas, electricity, medical care and day-care centres), and expenditures not classified in a consumption domain. For these expenditures we assumed no developments in consumer purchasing behaviour (ΔS^{cb}_{y}=0).

16 In this session two consumption domains were discussed: the 'dwelling' and 'household effects'.

17 In this session three consumption domains, 'leisure indoor', 'leisure outdoors' and 'holidays', were discussed.

18 The proportion of the consumption domains in 2030 that the experts expected deviate from the originally presented proportions. Although these deviations differ per session, nearly all the deviations point in the same direction. For calculating the shares of the consumption domains we took the average of the proportions expected in the expert sessions.

19 To offer the experts a limited number of categories, the consumption categories) were clustered according to CBS (1997). Each cluster will require a substantial amount of energy or expenditure (either now or in the future).

trends was obtained. The results are extensively discussed in Hoevenagel et al. (2000).

Additional research was carried out for a few consumption categories, of which the expenditures are already, or are expected to become, relatively large. In looking closer at the dwelling in 2030, we find that the expenditures per capita are expected to be 10% higher due to larger dwellings, 8% (EC) and 17% (GC) higher due to having fewer persons per household and, finally, 20% higher due to having a more luxurious home, all compared with 1995. For medical care and day-care centres additional information from Stokx (2000) and Brink (2000) did not supply arguments to adapt the expenditure on the basis of the demographic and economic changes. An extensive description of the additional research is given by Vringer et al. (2001).

Energy and transport models: for changes in the expenditure due to changes in the use of appliances and transport services, we used three detailed physical-based-energy and transport models to establish consumers' expenditure on the energy carriers (natural gas, electricity, petrol) and transport services. Using these models Feimann et al. (2001), Jeeninga (2000a) and Crommentuijn et al. (1999) calculated the energy required on the basis of the EC and GC scenarios, and taking the current policy up to the year 2000 into account. They distinguish the changes in required activity level and the energy-efficiency changes of the appliances. The energy requirement of the consumption categories concerned can be expressed as:

$$E_y = \frac{P_y}{Ef_a} \qquad (5)$$

where:

E_y = Energy requirement of consumption category *y* for an energy carrier or transport service (in required energy units);

P_y = Activity level for consumption category *y* (in units such as distance travelled or kg washed clothes);

Ef_a = Energy efficiency of the relevant appliance *a* (in units per required energy unit).

Changes in the required activity level (ΔP_y) are the result of changes in purchasing behaviour. We assumed that since changes in price of the energy carrier or transport service (Pr_y) and changes in energy efficiency (Ef_a) are not a result of changes in purchasing behaviour, they are, therefore, kept constant. Now the changes in expenditure on energy carriers and transport services due to changes in the use of appliances ($\Delta S^{cb}_{y(use)}$) can be written as[20]:

$$\Delta S^{cb}_{y(use)} = \Pr_y * \Delta E^{cb}_{y(use)} = \frac{\Delta P_y}{Ef_a} * \Pr_y \qquad (6)$$

Then the effect of changes in consumer purchasing behaviour on the expenditure on a consumption category *y* can be expressed as:

$$\Delta S_y^{cb} = \Delta S^{cb}_{y(\text{expert})} + \Delta S^{cb}_{y(add)} + \Delta S^{cb}_{y(use)} \qquad (7)$$

In Appendix 7A, the effects are quantified of changes in consumer purchasing behaviour on the consumption pattern.

After taking into account all the changes in consumer purchasing behaviour, we needed to increase the expenditures on all consumption categories by 2% (EC) and 7% (GC) to get the total expenditure level given by the scenario.

2.2.5 ► (Energy-) efficiency changes of consumer goods

The three energy and transport models (Feimann et al., 2001; Jeeninga, 2000a and Crommentuijn et al., 1999) also specify the changes in the energy requirement due to changes in the (energy) efficiency of consumer goods (ΔE^{ta}_y). Activity level (P_y) and price (Pr_y) changes are not due to efficiency changes, so both are kept constant (see Equation (5). The effects of efficiency changes of the appliance concerned, *a* (ΔEf_a), on the expenditure on energy carriers and transport services belonging to consumption category *y* (ΔS^{ta}_y) can be written as:

$$\Delta S^{ta}_y = \Pr_y * \Delta E^{ta}_y = \frac{P_y}{\Delta Ef_a} * \Pr_y \qquad (8)$$

20 See Appendix 7B for a recapitulation of all symbols used in this chapter.

The results on the expenditure of the consumption categories concerned (=ΔS^{ta}_{y}) are described in detail in Vringer et al. (2001).

After taking into account the efficiency changes of consumer goods, we increased the expenditures on all consumption categories by 2% (EC) and 1% (GC) to get the total expenditure given by the scenario.

2.2.6 ► Efficiency changes in the production of consumer goods

Because in most cases the expenditure on energy paid by the supplying sectors is of minor importance on the consumer price[21], we assumed that energy-efficiency changes within the supplying sectors do not affect the consumption prices. Therefore the changes do not affect the consumption pattern, but they do have an effect on the energy requirement of the consumption pattern. So, the influence of these changes in efficiency will be discussed in the next section. The assumption mentioned above implies:

$$\Delta S^{tp}_{y} = 0 \qquad (9)$$

2.3 ► Fourth step: Total energy requirement due to private consumption

Now that the expected consumption pattern of 2030 is determined, the total energy requirement for private consumption can be calculated. If both the expenditure and the energy intensity[22] of all the consumption categories are known, the total energy requirement for consumption in 2030 can be calculated according to:

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21 The average energy intensity of consumer goods and services (excl. direct energy requirement) was about 8 MJ/€ for 1995 (Vringer et al., 1997). The price paid by the supply sectors for one MJ is less than 0.01€/MJ (CBS, 2002). An annual energy-efficiency improvement of 0.9% (RIVM, 1997) reduces the energy costs with 35% between 1995 and 2030. Energy-efficiency improvements in the production of consumer goods will then reduce the consumer price on average by less than 5%.

22 The energy intensity of a consumption category is defined as the total primary energy requirement for that category divided by the consumer price of the product (incl. VAT and other taxes) given in MJ/€.

$$E_{2030} = \sum_{y=1}^{z} \varepsilon_{2030,y} * S_{2030,y} \qquad (10)$$

where:

E_{2030}	=	total primary energy requirement for private consumption in 2030;
$\varepsilon_{2030,y}$	=	energy intensity of consumption category *y* in 2030;
z	=	number of consumption categories and
$S_{2030,y}$	=	expenditure on consumption category *y* in 2030.

The energy intensity of a group of products and the energy intensity of the total consumption pattern can be calculated similarly. We used the energy intensities from Vringer and Blok (1995) and Vringer et al. (1997)[23] based on a hybrid energy analysis method. This hybrid method combines two methods for determining the cumulative energy requirement of goods and services: process analysis and input-output analysis (see Van Engelenburg et al. (1994).

2.3.1 ▶ Efficiency changes in the production of consumer goods

Energy-efficiency changes in the production of consumer goods will affect the energy intensities of consumption categories. The effects of these changes in energy efficiency on the energy intensity can be described as:

$$\varepsilon_{2030,y} = \varepsilon_{1995,y} + \Delta\varepsilon^{tp}_{1995-2030,y} \qquad (11)$$

where:

$\varepsilon_{2030,y}$	=	energy intensity of consumption category *y* in 2030
$\varepsilon_{1995,y}$	=	energy intensity of consumption category *y* in 1995
$\Delta\varepsilon^{tp}_{1995\text{-}2030,y}$	=	change in the energy intensity of consumption category *y* between 1995 and 2030 due to changes in efficiency in the production of consumer goods

23 These energy intensities are based on figures of 1990 (See Vringer and Blok, 1995), but indexed for the inflation between 1990 and 1995. The energy-efficiency developments of the supply sectors between 1990 and 1995 are taken into account by reducing all results for the energy requirement and energy intensities (Table 7-4) by 2% (See Vringer et al., 1997 and the discussion).

Analogue to Equation (5) we calculated $\Delta\varepsilon^{tp}_{1995\text{-}2030}$, assuming that the changes in energy efficiency in the production of the goods belonging to consumption category *y* (ΔEf_y) equals the changes in energy efficiency of the consumption domain *x*, to which consumption category *y* belongs (ΔEf_x). We also assumed that the activity level of the sectors (that produce goods for the relevant consumption domain *x* (P_x) and the expenditure on consumption category *y* (S_y), will only slightly change if the efficiency in the production of consumer goods changes. We ignored the minor changes in P_x and S_y, in which case we can state that:

$$\Delta\varepsilon^{tp}_{1995-2030,y} = \frac{\Delta E^{tp}_{y}}{S_y} = \frac{\left(\frac{P_x}{\Delta Ef_x}\right)}{S_y} \qquad (12)$$

where[24]:

ΔE^{tp}_y = the change in energy requirement of consumption category *y* due to efficiency changes in the production of consumer goods.

S_y = expenditure on consumption category *y*

Analogous to Vringer et al. (1997), ΔEf_x is estimated by weighing the changes in energy efficiency of the relevant supply sectors. Weighing was based on the share of the supply sectors had in the total energy requirement necessary for that consumption domain. This share is taken from Biesiot et al. (1995). The expected annual efficiency improvements for the supply sectors are derived from RIVM (1997)[25]. These improvements hold for the period between 1995 and 2020. We assumed that these annual improvements would also hold for the period between 2020 and 2030.

24 See Appendix 7B for a recapitulation of all symbols used in this chapter.

25 RIVM (1997) gives an average annual energy-efficiency improvement of 0.9%. For retail and (public) services the improvements are somewhat higher (approx. 1.1% per year) than for the industry (approx. 0.7% per year).

The energy requirement of an average consumer in 2030 can now be described as:

$$E_{2030} = \sum_{y=1}^{350} \{ (\varepsilon_{1995,y} + \Delta\varepsilon^{tp}_{1995-2030,y}) * [(S_{1995,y} + \Delta S^{d}_{y} + \Delta S^{e}_{y} + \Delta S^{cb}_{y} + \Delta S^{ta}_{y} + \Delta S^{tp}_{y}) * c] \} \qquad (13)$$

where *c* is a correction factor to retain the total expenditure level per capita given by the scenario context[26].

3 ► Consumption pattern and energy requirement for 2030

First we present the expected effects of all driving forces on the consumption pattern in 1995 and 2030 in monetary units, as described in the previous sections. This is followed by the expected energy requirement of this consumption pattern. Finally, we will discuss the development in the total energy requirement due to consumption from 1948 to 2030 and the change in the total energy intensity. All results are presented per capita, while the monetary values are converted from Dutch guilders (Dfl., 1995) to Euros. One Dfl. is 0.45 Euro. In 1995 one Euro (€) was about equivalent to 0.90 Dollar (US$).

3.1 ► Consumption patterns for 1995 and 2030

In the scenarios, the total private expenditure level is expected to increase from about € 8700 per capita to € 19,200 (+120%, EC scenario) and € 24,400 (+ 180%, GC scenario) between 1995 and 2030. Figure 7-2 gives the expenditures for each consumption domain for 1995 and 2030, and for EC and GC as calculated with Equation (1).

26 See Appendix 7B for a recapitulation of all symbols used in this chapter.

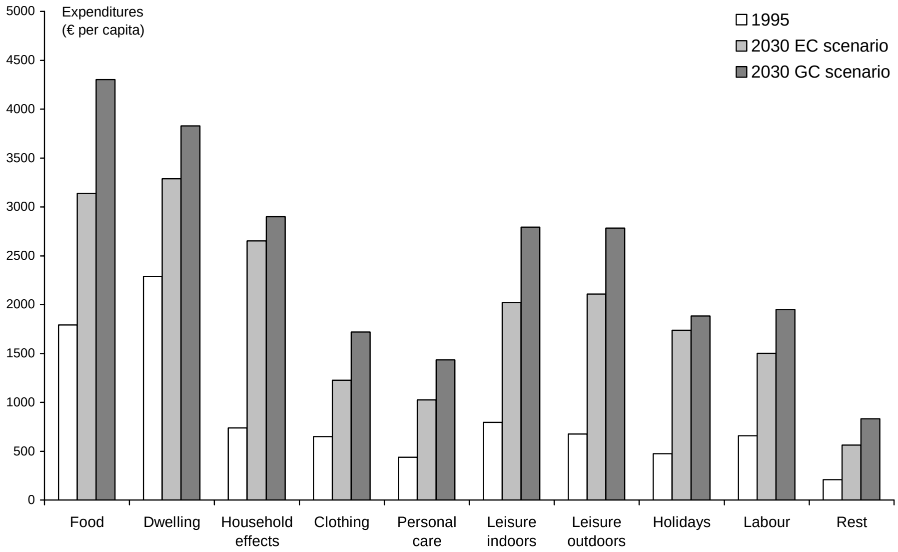

Figure 7-2 Annual expenditures (in €) on private consumption per capita for each consumption domain for 1995 and 2030 in the EC and the GC scenarios (1995 euro).

The expenditure increases for each consumption domain. For the more luxury domains of household effects, leisure and holidays, there is a more than average growth, whereas the growth for the more basic domains – food and the dwelling – is less than average. The distribution of the expenditures over the domains differs slightly between the two scenarios.

3.2 ► Energy requirement for private consumption, 1995 - 2030

The total primary energy requirement for private consumption is expected to increase between 1995 and 2030 from about 101 GJ per capita to 131 GJ in EC (+30%) and to 160 GJ in GC (+ 58%). If the expected growth of the Dutch population is taken into account, the energy requirement for the total Dutch private consumption increases by 54% in EC and 74% in GC between 1995 and 2030. However, the CO_2 emissions due to private consumption for the Dutch population increase by 40% (EC) and 55% (GC). The lower growth is due to expected changes in the Dutch energy supply system, of which the CO_2 intensity (CO_2 emission per acquired unit primary energy) is about 10% lower in 2030 than in 1995 (Van Wee et al., 2000).

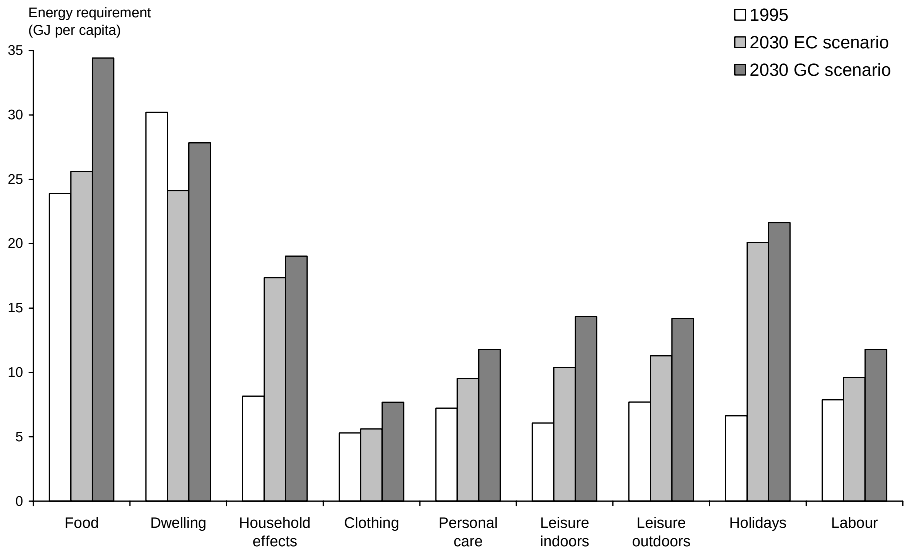

Figure 7-3 Annual energy requirements for private consumption per capita for each consumption domain in 1995 and 2030, for the EC and GC scenario.

Figure 7-3 shows the energy requirement in both scenarios for each consumption domain per capita for 1995 and 2030, as calculated with Equation (13).

The energy requirement for almost all consumption domains increases due to the increase in the disposable income. Note that the energy requirement for the consumption domains ‘household effects’ and ‘holidays’ become relatively much more important. The energy requirement for the dwelling is the only consumption domain with an expected decrease in energy requirement. This is due to the current Dutch energy policy, which focuses on the building of energy-efficient new dwellings and the retrofit of existing dwellings (see also Crommentuijn et al., 1999).

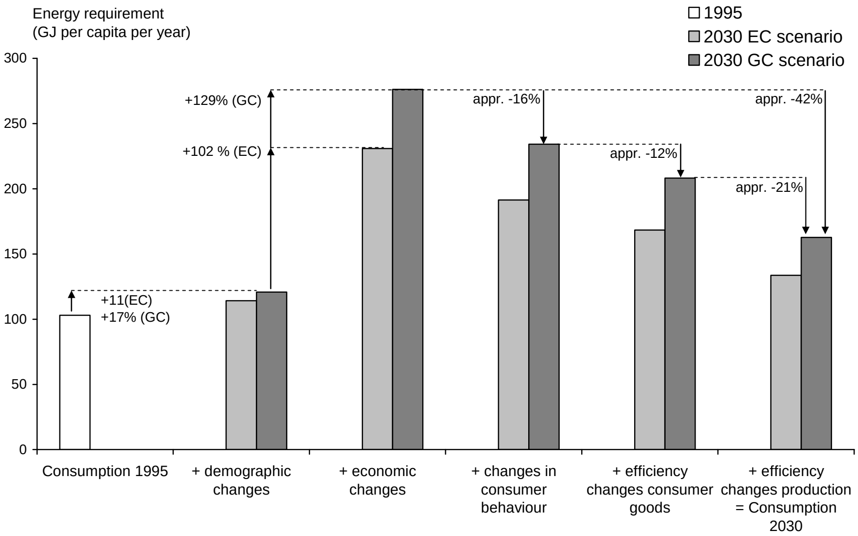

Figure 7-4 Energy requirement for private consumption per driving force and per capita in the years 1995 and 2030 for the EC and GC scenario.

3.3 ► Effects of the separate driving forces on the energy requirement

Figure 7-4 shows the expected effects for the energy requirement for each driving force[27]. Demographic changes lead to an increase of 11% in the energy requirement in EC and 17% in GC; economic changes lead to an increase of 102% (EC) and 129% (GC) per capita. Changes in consumer purchasing behaviour reduce the energy requirement by about 16%, efficiency changes of consumer goods by about 12% and efficiency changes in the production of consumer goods by about 21% for both scenarios. The reduction of the energy requirement caused by changes in consumer purchasing behaviour is mainly expressed in a relatively low growth of

27 Note that in this figure the expenditure levels for each column (except for '1995' and 'demographic changes') are retained at the same income level. The difference in the energy requirement between the two columns, excluding the columns for '1995' and 'demographic changes', then represents the difference in energy intensity.

the energy intensive fuels for transport, heating the dwelling and hot water. The total energy requirement in 2030 is still higher than in 1995.

3.4 ► Dematerialisation in past and future

It is interesting to show how the developments in the energy requirement in the past decades relate to future developments. In Figure 7-5 we present the expected energy requirement between 1995 and 2030, as well as the realised energy requirement between 1950 and 1995 according to Ros et al. (2000)[28] (see also Vringer and Blok, 2000).

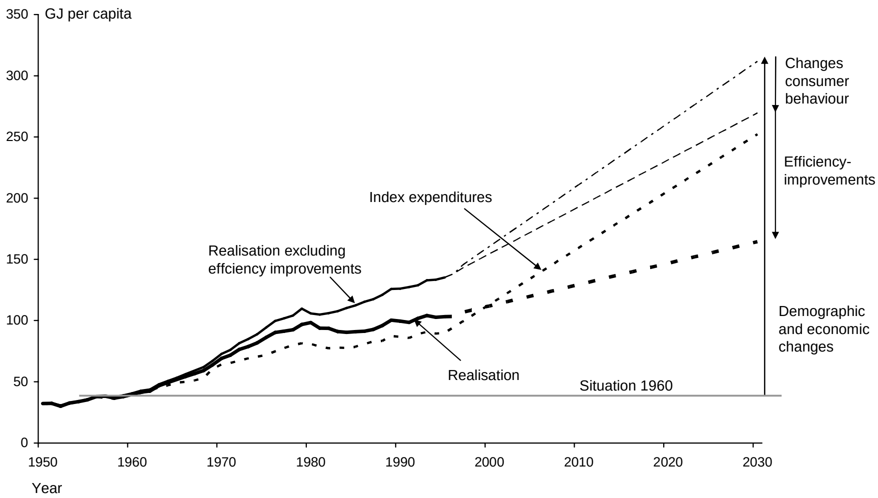

Figure 7-5 Total energy requirement per capita for the period between 1950 and 1995, and the expected energy requirement for the period from 1995 to 2030 for GC scenario. Note that for the 1995-2030 period, we calculated only the energy requirement for 2030 and not the energy requirements in the intermediate years.

28 The realised energy requirement for 1950 to 1995 is based on Ros et al. (2000), but we have subtracted the energy requirement for public consumption, which is about 15% of the total energy requirement (Ros et al., 2000). Public consumption concerns medical care, infrastructure and other public services.

Between 1950 and 1995 the total Dutch energy requirement per capita tripled from about 30 to about 100 GJ per capita, which is an annual growth of 2.6%. Between 1995 and 2030 the energy requirement per capita is expected to increase from about 100 GJ to 130 GJ in EC (+30%, annual +0.8%) and 155 GJ in GC (+60%, annual +1.3%).

Figure 7-5 also shows the expected growth of expenditures between 1995 and 2030 to be much larger than the expected growth of the energy requirement, which is due to a reduction in the energy intensity. The energy intensity of consumption can be seen as an indicator of the requirement of materials per consumption unit. Bernardini and Galli (1993) define a reduction of the energy intensity as a form of dematerialisation. Dematerialisation (here, delinking the energy requirement from consumption) is assumed to contribute significantly to the alleviation of environmental problems (Wieringa et al., 1992).

Between 1948 and 1980, the energy intensity of Dutch private consumption increased by 10 to 15%, which was due to an increasing share of direct energy requirement. A slight dematerialisation of Dutch consumption seems to have started between 1980 and 1995 (Vringer and Blok, 2000). This dematerialisation is expected to increase up to 2030. Between 1995 and 2030 the Dutch private consumption is expected to dematerialise by about 40% (-1.5% per year), mainly because of changes in consumer purchasing behaviour and efficiency changes (see Table 7-4).

A reduction in the share of direct energy requirement in the total energy requirement from about 50% in 1995 to one-third in 2030 is responsible for 40% of the total dematerialisation. The dematerialisation found for the period between 1995 and 2030 is about the same for all consumption domains, except holidays (-18%) and leisure indoors (-33%) and leisure outdoors (-54%).

Table 7-4 Energy intensities in MJ/€ for 1995 and 2030 according to the EC and GC scenarios, and the influence from the five driving forces on this energy intensity.[29]

	EC scenario (MJ/€)	**GC scenario** (MJ/€)
Energy intensity in 1995	**11.6**	**11.6**
+ demographic changes	11.3	11.4
+ economic changes	11.8	11.1
+ changes in consumer purchasing behaviour	9.7	9.4
+ efficiency changes in consumer goods	8.5	8.3
+ efficiency changes in the production of consumer goods = **Expected energy intensity 2030**	**6.8**	**6.6**

4 ▶ Discussion

Several comments should be made on the method; the uncertainty of the results and the consistency of the possible consumption pattern for 2030 calculated here.

4.1 ▶ Method

The method is not fully matured and must be regarded as a first step to quantifying future consumption patterns. The influences of the five driving forces on the energy requirement of the possible future consumption patterns can be distinguished with this method. Economic changes have the largest influence, followed by energy-efficiency changes in the production phase of consumer goods and the influence of demographic changes. Energy-efficiency changes in the consumption phase have the smallest influence, although this influence is still substantial. Notwithstanding the large effort to examine changes in consumer purchasing behaviour, they have a limited influence on the total energy requirement. However, the changes in consumer purchasing behaviour cannot be ignored. The expert sessions are important for the underlying details; and the experts substantially adapted the size of

29 The 1995 energy intensity is based on the energy requirement of 1990 according to Vringer and Blok (1995). We indexed the 1995 intensity to € and took efficiency developments of the supply sectors into account for the 1990-1995 period by reducing the energy intensity by 2% (see Vringer et al. 1997)

the specific consumption categories and ultimately confirmed the consumption pattern used for our calculations.

4.2 ► Consistency

For a possible future consumption pattern, consistency has, ideally, to be maintained for all relevant aspects of the scenario context and for boundary conditions, which are connected with this scenario context. Examples of boundary conditions which may affect the future consumption pattern are: the total expenditure, consumer's time, the supply and demand of goods and required space (see also Rood et al., 2001). In this chapter only one, important, boundary condition is taken into account for determining the future consumption pattern: the total expenditure level per capita has to be equal to the expenditure level per capita given by the scenario context. We ignored other boundary conditions such as:

- consistency between the consumption pattern estimated and the structure of the supply sectors,
- an equilibrium between the supply and demand of labour and
- consistency in the time expenditure of consumers.

These boundary conditions are not discussed in this study. The development of a consistent method, taking more boundary conditions into account, is recommended. Rood et al. (2001) took the first step.

4.3 ► Uncertainties

To establish the energy requirement for the possible future consumption pattern in 2030, several assumptions had to be made. These assumptions influence the uncertainty in the calculation of the energy requirement and the consistency of the consumption pattern. *Uncertainty* can be divided into two types: unreliability and structural uncertainty (Van Asselt, 2000). *Structural uncertainty* can hardly be quantified and is the result of uncertainties about the future developments of, for example, economy or demography. To capture the effects of this type of uncertainty, we used two scenarios that are comparable with the A1 and B2 scenarios of IPCC (2000). However, these scenarios do not reflect the most extreme possible situations. The A2 (low growth) and B1 ('green' growth) scenarios of the IPCC reflect more extreme possible situations.

Unreliability results from the impossibility of measuring and from inaccuracy, which can be quantified (Van Asselt, 2000). The main sources of unreliability on the total energy requirement are:

- The unreliability of the total energy requirement for 1995, due to the unreliability in the expenditure, is about 1%. It is plausible that by taking into account the demographic changes, the introduced unreliability is smaller than 1%.
- The maximum unreliability of the income elasticities for the consumption domains from the expenditure survey (CBS, 1996) varies between 2% to 5% with a reliability interval of 95%.
- By calculating the energy requirement of 2030, the introduced maximum reliability is less than 1%. This is done assuming for the most energy-intensive domains (food, holidays and household effects)- a maximum value for the income elasticity and – for the lowest energy-intensive domains (labour, personal care and leisure indoors) – a minimum value for the income elasticity.
- As mentioned earlier, we used a linear approach for Equation (3). The effect of this approach on the relative share of each domain has a maximum effect of 0.8% on the total expenditure. Taking the energy intensities of each domain into account, the maximum structural unreliability, introduced by using the linear approach of Equation (3), is less than 1% of the total energy requirement.
- As mentioned previously, we distributed 10% of the total expenditure proportionally over the consumption domains when we calculated the influence of the economic changes. If we had distributed these 10% with the help of income elasticities, the total energy requirement would have been less than 1% higher. Therefore, the maximum structural unreliability, introduced by a proportional distribution is less than 1%.
- After taking into account the changes in consumer purchasing behaviour and the efficiency changes of consumer goods, we increased the expenditures on all consumption categories by 2% (EC) / 7% (GC) and 2% (EC) / 1% (GC), respectively, to equal the total expenditure at the level given by the scenario. The unreliability introduced in this way is not larger than the unreliability introduced by the proportional distribution of 10% of the total expenditure, when calculating the influence of the economic changes (see above). The maximum unreliability introduced by this proportional distribution is then less than 1%.
- Despite the elaborated information given to the experts and the careful selection of them, the number of experts assessing the changes in consumer purchasing

behaviour is small. However, the information of the experts makes the extrapolated consumption pattern (taking only the demographic and economic influences into account) more consistent and coherent. In most cases consensus on the possible trends determined was obtained. The influence of these experts on the total energy requirement was about 5%. It is very plausible that the maximum unreliability due to the small number of experts is less than 5%.

- The models we used to estimate the energy requirement for electricity and transport both have an estimated unreliability of about 10% (Jeeninga, 2000b; Annema, 2000). The model we used for fuels for heating the dwelling and hot water (mainly natural gas) has an unreliability of about 15-20% (Crommentuijn et al., 1999). Therefore the unreliability of the results for electricity, transport and natural gas on the total energy requirement comes to 1%, 1% and 2%, respectively.
- The unreliability of the efficiency improvements of the supply sectors is not given by RIVM (1997). If this unreliability is comparable with the energy and transport models (10%), the unreliability of the total energy requirement due to the unreliability of efficiency improvements of the supplying sectors comes to 2%.
- In calculating the effects of changes in the economy, we used the same income-expenditure elasticity of 1995 for all consumption categories within one consumption domain. Furthermore, we assumed the short-term elasticity to be equal to the long-term elasticity. It is plausible that the errors caused by these assumptions are mitigated by our analysis of changes in consumer purchasing behaviour. Therefore this approach mainly affects the shares of changes in the economy and changes in consumer purchasing behaviour in the total energy requirement, but will hardly affect the total energy requirement.

It is plausible that the unreliabilities mentioned above are independent and random. In this case, the impossibility of measuring and inaccuracy lead for a given scenario context to a maximum unreliability in the total energy requirement in 2030 of about 10%.

5 ► Conclusions

In this chapter we determined the effect of long-term changes in the consumption pattern on the energy requirement due to consumption. The impact of important driving forces can be distinguished and quantified. All five distinguished driving forces have a substantial influence on the energy requirement, where economic changes have the largest influence.

We used this method to estimate the total primary energy requirement for consumption per capita in the year 2030 for two business-as-usual scenarios. Between 1995 and 2030 private consumption increases by 120% (EC scenario) and 180% (GC scenario) per capita. The required primary energy is expected to increase by 30% (EC) and 60% (GC) per capita. This is an annual growth of 0.8% and 1.3% per capita, respectively. The relative shares of the consumption domains of food, dwelling and clothing decrease, while the relative shares of the domains: household effects, holidays, leisure indoor and leisure outdoors increase. The energy requirement for the dwelling is the only domain that is expected to decrease in absolute terms. The indirect energy requirement becomes more important, with its share increasing from about one-half in 1995 to two-thirds in 2030.

In 1995 the energy intensity of private consumption is 11.6 MJ per €, decreasing the next 35 years by 40% (-1.5% per year). This expected reduction indicates that consumption will be relative de-linked from the energy requirement for consumption (dematerialisation). Two-thirds of the reduction in the energy intensity is due to changes in energy efficiency of consumer goods and changes in energy efficiency of the production of the consumer goods. A third driving force, changes in consumer purchasing behaviour is responsible for the remaining one-third reduction in the energy intensity. This is caused by a relatively low growth of the energy intensive fuels for transport, heating the dwelling and the production of hot water. The driving forces ‘economic changes’ and ‘demographic changes’ hardly affect the energy intensity.

The expected dematerialisation between private consumption and the energy requirement does not lead to an absolute reduction in the required primary energy or the accompanying CO_2 emissions due to private consumption. This is because of the growth of expenditures for consumption, particularly because the disposable income grows. Thus, if governments aim at a more sustainable consumption, they have to take into account that the autonomous dematerialisation is not expected to compensate for the negative effects of the ongoing growth in disposable income caused by economic growth.

► Acknowledgements

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Appendix 7A ► Effects of changes in consumer purchasing behaviour on the consumption pattern

Table 7A-1 quantifies the effects on the expenditures ($\Delta S^{cb}{}_y$) due to changes in consumer purchasing behaviour estimated for the EC scenario. Table 7A-1 also specifies the source used to establish these effects. The total expenditure after taking the changes in consumer purchasing behaviour into account is about 2% too high, compared with the expenditure level according to the scenario context.

Table 7A-1 Expenditures (in € of 1995 per capita) for 1995 and 2030 EC, and excluding and including changes in consumer purchasing behaviour ($\Delta S^{cb}{}_y$), if only the demographic ($\Delta S^{d}{}_y$) and economic changes ($\Delta S^{e}{}_y$) are taken into account.

	1995	2030	2030	Source behaviour
	Basic year	Democraphic + economic change		
		Excl. behaviour	Incl. behaviour	
Total expenditure	**8,707**	**19,262**	**18,894**	
Food	**1,791**	**3,642**	**3,055**	
Purchase	103	220	128	
- Public transport	6	13	6	model
- Cycle, moped	9	18	8	model
- Car	88	188	102	model
- Delivery	1	2	12	experts
Preparation	120	255	221	
- Electrical appliances (like food processors and kitchen utensils)	21	46	39	experts
- Refrigerators, deep-freezers	13	26	22	experts
- Cookers	3	8	6	experts
- Natural gas	6	11	6	model
- Electricity	31	65	74	model
- Other	46	99	74	experts

Table 7A-1 Expenditures in € of 1995 per capita… (Cont.)

	1995	2030	2030	Source behaviour
	Basic year	**Democraphic + economic change**		
		Excl. behaviour	Incl. behaviour	
Food products	1,269	2,525	1,553	
- Potatoes, pastry and rice	33	62	42	experts
- Fresh vegetables	67	142	96	experts
- Fresh fruit	63	132	90	experts
- Preserved vegetables and fruit	30	59	40	experts
- Meat (beef, veal and horse meat)	39	77	35	experts
- Meat (pork, sausages)	175	329	151	experts
- Fish and poultry	55	109	50	experts
- Milk and milk products and eggs	182	359	159	experts
- Ready-to-use meals	16	34	105	experts
- Delivered meals	31	68	210	experts
- Bread and sandwich filling	110	209	96	experts
- Rusks and other sorts of bread	17	37	17	experts
- Cakes, biscuits, candies and sugar	126	252	116	experts
- Peanuts and nuts	12	26	12	experts
- Non-alcoholic Beverages	67	128	70	experts
- Alcoholic beverages	127	269	148	experts
- Coffee and tea	47	91	50	experts
- Other (like margarine and oil)	72	142	65	experts
Dining out / consumption outdoors	299	641	1,154	
- French fries, rolls, ice-cream and snacks	58	118	224	experts
- Restaurant	67	153	283	experts
- Café	53	110	170	experts
- Other	120	260	476	experts
Dwelling	**2,287**	**3,972**	**3,360**	
Rent and rental value	1,727	2,940	2,379	
- Rent	689	1,144	949	additional research
- Rental value	1,038	1,796	1,430	additional research
Taxes, insurance, maintenance, installations	336	566	701	
- Taxes	171	284	352	experts
- Fixed equipment	7	13	16	experts

Table 7A-1 Expenditures in € of 1995 per capita… (Cont.)

	1995	2030	2030	Source behaviour
	Basic year	**Democraphic + economic change**		
		Excl.	Incl.	
		behaviour		
- Maintenance fixed equipment	58	100	124	experts
- Rented office equipment	10	18	22	experts
- Other	90	151	187	experts
Heating and lighting	224	466	280	
- Natural gas and other fuels	175	373	191	model
- Electricity	44	81	81	model
- Solid and liquid fuels	5	12	9	experts
Household effects	**737**	**1733**	**2482**	
Purchase	22	53	55	
- Public transport	1	3	1	model
- Bike, moped	1	3	4	model
- Car	19	46	47	model
- Delivery	0	0	3	experts
Furniture and furnishing	513	1,190	1,551	
- Furnishing	146	342	395	experts
- Bedding and household linnen	35	79	91	experts
- Furniture	171	373	537	experts
- Plants and flowers	51	121	162	experts
- Garden	77	191	256	experts
- Other	33	84	109	experts
Maintenance	202	491	877	
- Domestic services, window cleaning services	55	152	368	experts
- Electrical appliances	26	55	145	experts
- Repairs and rental of appliances	6	14	57	experts
- Other	115	269	307	experts
Clothing	**649**	**1,565**	**1,187**	
Purchase	23	57	39	
- Public transport	1	3	1	model
- Bike, moped	2	4	3	model
- Car	19	48	32	model
- Delivery	0	0	3	experts

Table 7A-1 Expenditures in € of 1995 per capita… (Cont.)

	1995	**2030**	**2030**	**Source behaviour**
	Basic year	**Democraphic + economic change**		
		Excl. behaviour	Incl. behaviour	
Maintenance	78	173	106	
- Electrical appliances (like irons and sewing machines)	14	29	14	experts
- Sewing & knitting needles, and needlework tools	2	3	2	experts
- Electricity	10	22	20	model
- Repairs	8	19	8	experts
- Laundry, dry-cleaning	5	14	22	experts
- Detergents	25	56	28	experts
- Requisites, haberdashery	14	31	13	experts
Clothes and shoes	548	1,335	1,042	
- Outer wear	349	852	655	experts
- Underwear	29	74	57	experts
- Sportwear	15	37	28	experts
- Other	13	31	21	experts
- Clothes	1	2	1	experts
- Rental of clothes	2	4	7	experts
- Finery	47	117	79	experts
- Shoes	82	196	172	experts
- Sport shoes	9	19	17	experts
- Rental of footwear	1	3	5	experts
Personal care	**438**	**1,033**	**997**	
Energy	51	118	83	
- Electricity	12	39	37	model
- Natural gas	39	79	46	model
Products and services	259	583	583	
- Nursery, babysitting etc.	38	97	97	additional research
- Other e.g. water, toilet articles and other services	222	486	486	-
Medical care	127	331	331	additional research

Table 7A-1 Expenditures in € of 1995 per capita… (Cont.)

	1995 Basic year	2030 Demographic + economic change Excl. behaviour	2030 Incl. behaviour	Source behaviour
Leisure indoors	**794**	**1,510**	**1,962**	
Purchase	11	22	64	
- Public transport	0	1	0	model
- Bike, moped	1	1	4	model
- Car	10	19	58	model
- Delivery	0	0	1	experts
Various products	783	1,488	1,898	
- Electricity	21	47	69	model
- Education and courses	12	21	24	experts
- Computer and stationery	65	124	166	experts
- Journals, periodicals and magazines	128	256	229	experts
- Other	57	100	117	experts
- Smoking	89	156	95	experts
- Telephones and postal expenses	158	308	514	experts
- Radio, television, video, audio and photo equipment	196	373	531	experts
- Pets	56	103	152	experts
Leisure outdoors	**675**	**1,851**	**2,087**	
Materials	23	66	185	
- Sport	12	34	95	experts
- Other	10	32	90	experts
Entrance and course fees	170	463	579	
- Sport	66	175	241	experts
- Course fees and contributions	62	169	205	experts
- Entrance fees	39	112	126	experts
- Other	3	6	7	experts
- Public transport	36	105	37	model
- Bike, moped	23	60	128	model
- Car	419	1,145	1,101	model
- Delivery	3	11	58	experts

Table 7A-1 Expenditures in € of 1995 per capita… (Cont.)

	1995 Basic year	2030 Democraphic + economic change Excl. behaviour	2030 Incl. behaviour	Source behaviour
Holidays	**473**	**1,769**	**1,714**	
Holidays abroad	346	1,423	1,166	
- Organised holiday trips	172	715	580	experts & additional research
- Other holiday costs	174	708	586	experts & additional research
Holidays in the Netherlands	58	150	326	
- Organised holiday trips	21	49	107	experts
- Other holiday costs	37	100	218	experts
Other	68	197	223	
- Camping equipment	25	67	76	experts
- Other	43	130	147	experts
Labour	**657**	**1,647**	**1,510**	
Education	140	346	346	-
Mobility	517	1,302	1,164	model
Other	**207**	**539**	**539**	-

Appendix 7B ► Symbols used in chapter 7

I_{1995}	=	Total disposable income in 1995
S_{1995}	=	Total private expenditure in 1995
S_y	=	Expenditure on consumption category *y*
$S_{y(use)}$	=	Expenditure on consumption category *y* for an energy carrier or transport service.
$S_{1995,y}$	=	Expenditure on consumption category *y* in 1995
$S_{1995,x}$	=	Expenditure on consumption domain *x* in 1995
$S_{2030,y}$	=	Expenditure on consumption category *y* in 2030
$S^{d}_{1995\text{-}2030,y}$	=	Expenditure on consumption category *y*, considering the demographic changes between 1995 and 2030
$S^{d+e}_{1995\text{-}2030,y}$	=	Expenditure on consumption category *y*, considering the economic changes and demographic changes between 1995 and 2030
ΔS^{d}_{y}	=	Effect of demographic changes on the expenditure of category *y*
ΔS^{d}	=	Effect of demographic changes on the total private expenditure
ΔS^{e}_{y}	=	Effect of economic changes on the expenditure of category *y*
ΔS^{cb}_{y}	=	Effect of changes in consumer purchasing behaviour on the expenditure of category *y*
$\Delta S^{cb}_{y(expert)}$	=	Effect of changes in consumer purchasing behaviour on the expenditure of category y, established with expert sessions.
$\Delta S^{cb}_{y(add)}$	=	Effect of changes in consumer purchasing behaviour on the expenditure of category y, established with additional information.
$\Delta S^{cb}_{y(use)}$	=	Effect of changes in consumer purchasing behaviour on the expenditure of category y, established with energy and transport models
ΔS^{ta}_{y}	=	Effect of changes in energy efficiency of consumer goods belonging to category *y*, on the expenditure of category *y*
ΔS^{tp}_{y}	=	Effect of changes in energy efficiency on the production of consumer goods belonging to category *y*, on the expenditure of category *y*.
E_y	=	Energy requirement of consumption category *y*
$\Delta E^{cb}_{y(use)}$	=	Effect of changes in consumer purchasing behaviour on the energy requirement of category y, established with energy and transport models
ΔE^{ta}_{y}	=	Effects of changes in the energy efficiency of consumer goods on the energy requirement of consumption category *y*

ΔE^{tp}_y = Effect of changes in energy-efficiency changes of the production of consumer goods on the energy requirement of consumption category y

Ef_a = Energy efficiency of relevant appliance *a*

ΔEf_a = Energy efficiency change of relevant appliance *a*

ΔEf_y = Changes in energy efficiency of the production of the goods belonging to consumption category *y*.

ΔEf_x = Changes in energy efficiency of the production of the goods belonging to consumption domain *x*.

P_y = Activity level for consumption category *y* (in units such as distance travelled or kg washed clothes)

ΔP_y = Changes in activity level for consumption category *y*

P_x = Activity level of the sectors, producing goods for the relevant consumption domain *x* (in units such as numbers of consumer goods produced)

Pr_y = Price of the energy carrier or transport service for consumption category *y*

$\varepsilon_{2030,y}$ = Energy intensity of consumption category *y* in 2030

$\varepsilon_{1995,y}$ = Energy intensity of consumption category *y* in 1995

$\Delta\varepsilon^{tp}_{1995\text{-}2030,y}$ = Change in the energy intensity of consumption category *y* between 1995 and 2030 due to changes in efficiency in the production of consumer goods.

G^{CPB} = The total expenditure in 2030 according to the CPB scenario

α_x = Income elasticity of consumption domain *x*

α_y = Income elasticity of consumption category *y*

β_x = A constant factor for consumption domain *x*

c = Correction factor to retain the total expenditure level per capita given by the scenario context

z = Number of consumption categories