System of Environmental and Economic Accounting for Energy

SEEA-E

Chapter 7
Presentation and Use of Energy Accounts

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Chapter 7 Presentation and use of energy accounts

A. Introduction

7.1. The focus in this chapter is on giving examples of how main aggregates as well as selected detailed information from the accounts can be presented or used as the basis for analysis of the interaction between economic activities and energy in order to shed light on the distinct and indispensable role that energy plays in the society as the basis of all activities, which take place.

7.2. It is not the purpose to give an exhaustive presentation of all possible uses and applications of the energy accounts. For that purpose, reference is made to the many reports and articles, which deals with analysis of energy issues. A selection of these can be found in the UNSD searchable archive(http://unstats.un.org/unsd/envaccounting/ceea/archive/Introduction.asp).

7.3. It should be noted that manytypes of analysis of energy issues, including the establishment of indicator system, are generally based on energy statistics and energy balances per tradition and due to the widespread availability of these types of statistics.

7.4. Often, the same or similar kind of analysis can be carried out on the basis of information from the energy accounts. In many cases, it does not matter whether the starting point is the energy statistics, the balances or the accounts, since the basic information and the concepts are the same. In other cases, each of these statistical systems has their advantages or disadvantages depending on what exactly is the purpose of the analysis. For instance, the energy statistics and the balances are often more appropriate to use when it comes to analysis focusing on specific energy technologies, while the accounts have their advantages, for instance, when it comes to comparing the physical information with information on the economic activities or to show specific monetary information related to energy issues.

7.5. The presentation of energy related information in this chapter includes to a large extent features, which are specific for the energy accounts, for instance, monetary information, information on industries, coherent comparison of physical and monetary data, use of input-output modelling, etc. Less emphasis has been on presentation of information and indicators, which can also be derived from general energy statistics and energy balances, but as mentioned generally such information could also be presented on the basis of the energy accounts.

7.6. For all the figures and tables presented in this chapter a few remarks is given on the interpretation of the figure both in general terms and more specifically on what the figure tells about the actual development or structure of the economy. The latter is included in order to show the kind of information and conclusions, which actually can be derived from the accounts.

7.7. All figures and tables are supplied with a “source”, which acts as a reference to tables in the previous chapters, which include the type of information, or part of it, which is being presented. It should be noted, however, that in some cases further elaboration of the data have been carried out, and that most of the information in this chapter is oriented towards time series in contrast to the previous chapters, which generally only presents information for one year.

7.8. Section B presents overall information on energy and its contribution national income and wealth. It describes in monetary terms the output, gross value added and operating surplus of the energy industries, including those which extract energy resources and those which otherwise produce and distribute energy products, e.g. refined energy products, electricity, gas and heat. The role of depletion of energy resources is described and depletion-adjusted macro-aggregates are presented. Section B includes also information on to which extent government obtains revenues related to energy resource extraction, production and use for instance through rent and energy tax payments. Data on imports and exports and a trade balance for energy products are presented. Finally, wealth aspects are illustrated through graphs, which show the contribution of energy resources to national wealth, and the development in the value and physical quantities of energy resource stocks. Finally, the (non-) sustainability of current extraction is illustrated by the so-called R/P measure, which puts current extraction in proportion the energy resource stocks.

7.9. Section C shows how information from the energy accounts can be used to monitor the development in energy supply and use both for the total economy and for individual industries and the households. It starts with graphs, which shows the physical supply and use of energy broken down by components such as primary energy production, imports, and uses by households, industries and exports. The use is further subdivided by energy products and industries according to the ISIC classification measured both at physical and monetary units. Further, the expenditures are shown as per cent of total costs for industries and households. A measure of the self-sufficiency, i.e. to which extent does the country relies on imports of energy products is also shown. Finally, Section C shows for which purpose energy is used by households and industries, i.e. is it used for transport, heating or other purposes.

7.10. Section D presents details on the use of renewable energy and waste and clarifies how much of the total use of energy is covered by renewables and waste.

7.11. Section E analyses the energy use in relation to economic growth and the efficiencies of industries. One major question, which is being analysed, is to what extent a decoupling between economic growth and energy is taking place. Related to that, the developments of energy intensities for various groups of industries are presented, and results from so-called decomposition analysis are shown. The results illustrate which factors, which have determined the development, for instance, how much influence economic growth and changes in energy intensities have had.

7.12. Section F goes on with analysis of energy use along the production chains, which ultimately leads to the final use of products. First it is shown how total energy use of a country is related to the main final use categories of the economy including private consumption, government consumption, accumulation and exports. Then, the scope is enlarged for the households consumption by including also the energy uses in the production chains activated abroad by the imports to the country. Thereby a picture of the total global energy use caused by the domestic activities is drawn up.

7.13. Section G deals with energy related air emissions. One important use of the physical use table for energy is the calculation of air emissions, and the first part of this section describes how accounts for energy related emissions may be set up. The second part presents results from modelling based on the energy accounts and the emission accounts. The results show which factors that underlie the development in energy related emissions.

7.14. The last section, Section G, gives a short introduction to how energy accounts also can form the basis for energy indicators, and the section presents a number of energy indicators, which immediately may be produced on the basis of the accounts and corresponding information from the national accounts.

B. Energy and its contribution to national income and wealth

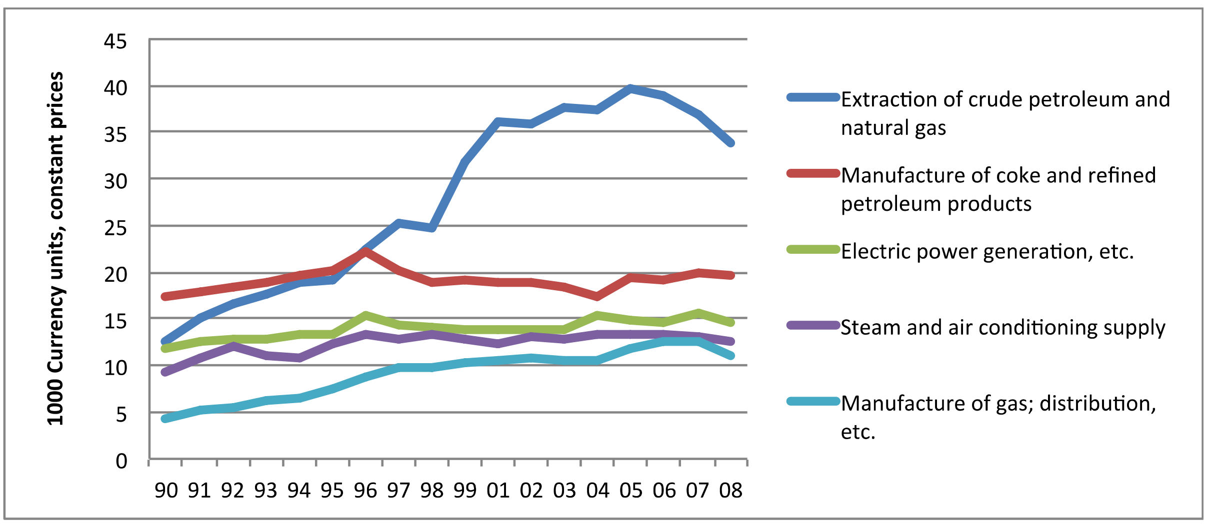
7.15. In this section we take a macroeconomic view. It presents overall information on energy and its contribution to national income and wealth. It describes in monetary terms the output, gross value added and operating surplus of the energy industries, including those which extract energy resources and those which otherwise produce and distribute energy products, e.g. refined energy products, electricity, gas and heat. The role of depletion of energy resources is described and depletion-adjusted macro-aggregates are presented. This section includes also information on to which extent government obtains revenues related to energy resource extraction, production and use for instance through rent and energy tax payments. Data on imports and exports and a trade balance for energy products are presented. Finally, wealth aspects are illustrated through graphs, which show the contribution of energy resources to national wealth, and the development in the value and physical quantities of energy resource stocks. Finally, the (non-) sustainability of current extraction is illustrated by the so-called R/P measure, which puts current extraction in proportion the energy resource stocks.

1. Output and value added from energy industries

7.16. Figure 7.1 shows output measured at constant prices (chained values) from energy industries over time.

7.17. The extraction of crude petroleum and natural gas increased in the beginning of the period, but has in recent years been decreasing. Despite the decrease the extraction of crude petroleum and natural gas contributes with the biggest output of all energy industries. The other energy industries show a more even development over time.

Figure 7.1 The development of output from energy industries



Source: SEEA-E Table X.X

7.18. Table 7.1 presents main aggregates related to the production activities of industries including the energy industries. In the bottom of the table the share of the energy industries in relation to all industries is presented for output, intermediate consumption, gross value added, consumption of fixed capital and net value added.

7.19. It is seen that the energy industries accounts for 5 per cent of all output and 4 per cent of industries' intermediate consumption. For gross and net value added the energy industries contribute a little less than 6 per cent of the totals for all industries.

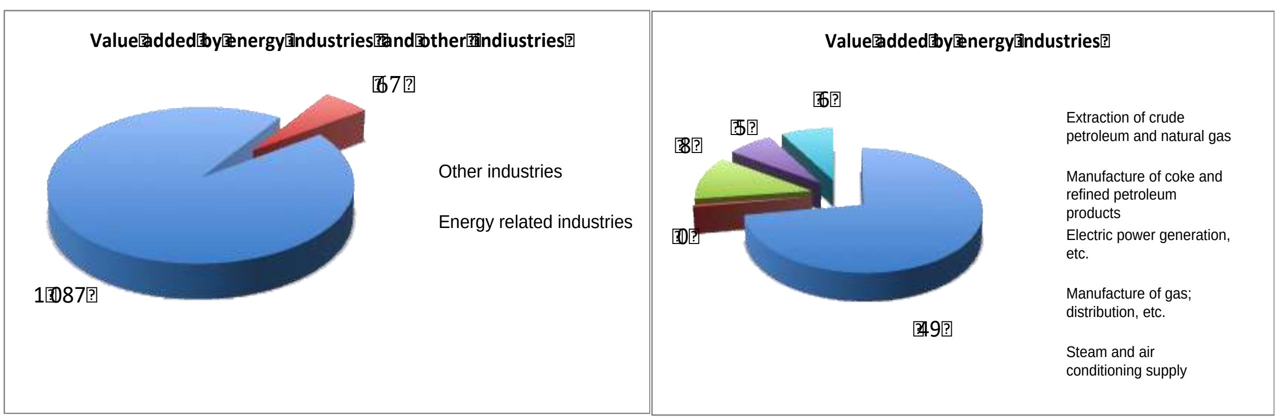
7.20. Within the groups of energy industries it is the extraction of the energy resources, which generates the largest value added, see Figure 7.2. The share of intermediate consumption in relation to the output is much smaller for the mining industry, since the resource itself contributes considerable to the value of output. This is related to the so-called resource rent, i.e. the contribution to the output by the resource itself and the depletion, i.e. the decrease in the value of the resource due to the extraction, cf. below.

Table7.1Energy related industries' share of output and value added, etc. 2006

ISIC		Output	Intermediate consumption	Gross value added	Consumption of fixed capital	Net value addded
		1000 currency units				
A	**Agriculture, forestry and fishing**	**65**	**47**	**18**	**13**	**5**
B	**Mining and quarrying**	**65**	**7**	**59**	**5**	**54**
B. 05	*Mining of coal and lignite*					
B. 06	*Extraction of crude petroleum and natural gas*	*60*	*7*	54	*5*	49
	Other mining and quarrying	*5*		*5*		*5*
C	**Manufacturing**	**611**	415	196	31	**165**
C. 19	*Manufacture of coke and refined petroleum products*	*28*	*27*	1	*1*	**0**
	Other manufacturing	*583*	*388*	*195*	*30*	*165*
D	**Electricity, gas, steam and air conditioning supply**	**57**	**29**	**28**	**10**	**18**
D. 351	*Electric power generation, etc.*	*24*	*12*	12	*4*	**8**
D. 352	*Manufacture of gas; distribution, etc.*	*20*	*13*	7	*2*	**5**
D. 353	*Steam and air conditioning supply*	*14*	*5*	9	*3*	**6**
E	**Water supply; etc.**	**3**	**2**	**1**	**1**	**0**
F	**Construction**	**215**	***136***	**79**	**6**	**73**
G	**Wholesale and retail trade; etc.**	**334**	***145***	**189**	**16**	**173**
H	**Transportation and storage**	**351**	***206***	**174**	**25**	**149**
I-U	**Other service industries**	**1 221**	***554***	**667**	**151**	**516**
	Total industries	**2 923**	**1 541**	**1 411**	**257**	**1 154**
	Energy related industries total (B.05, B.06, C.19, D)	145	63	83	16	67
	Energy related industries, per cent of total industries	**5.0**	**4.1**	**5.9**	**6.0**	**5.8**

Source: SEEA-E Table X.X

Figure 7.2 Energy related industries' net value added, 1000 currency units

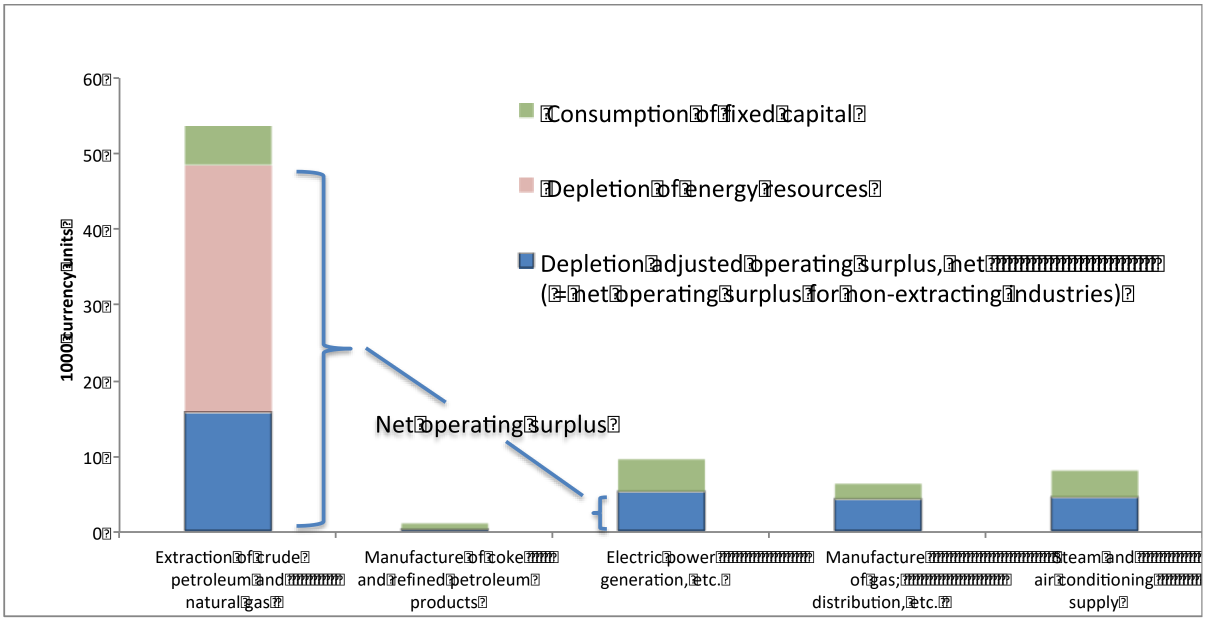


Source: SEEA-E Table X.X

2. Operating surplus of energy industries and the role of depletion

7.21. Figure 7.3 presents the operating surplus of the energy industries. The operating surplus is calculated from the value added by subtracting the compensation of employees and other taxes less subsidies paid by the industries.

Figure 7.3Grossoperating surplus of the energy industries and its components, 1000 currency units



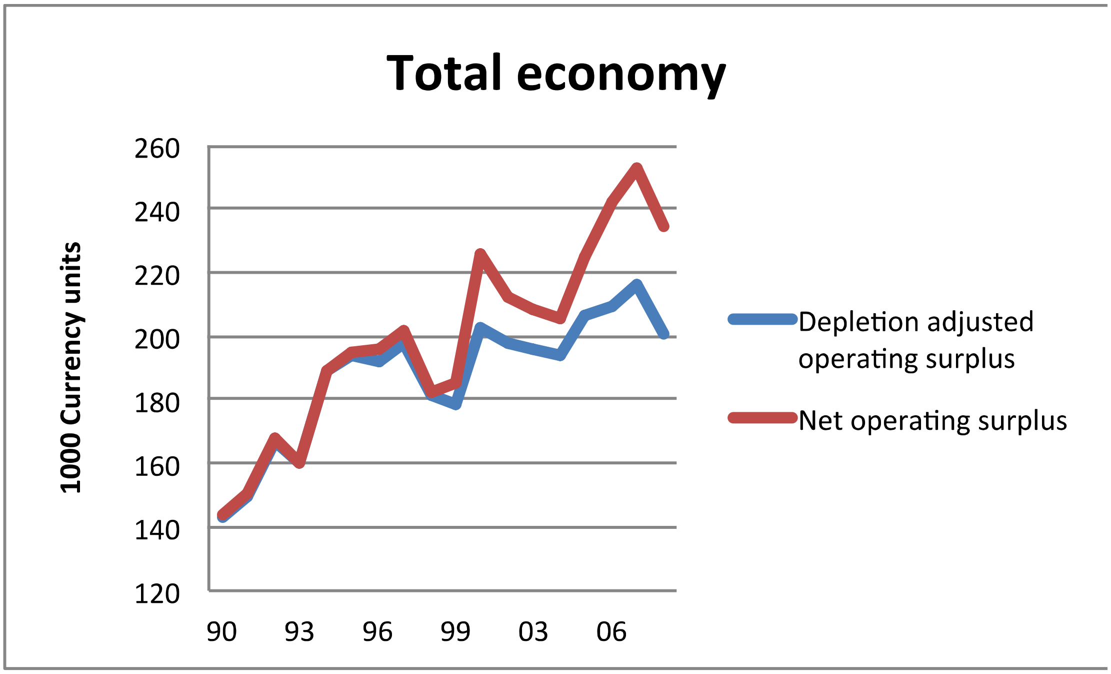
Source: SEEA-E Table X.X

7.22. As for value added, it is the mining industry, which accounts for the main part of the gross and net operating surplus. However it is seen that if the depletion is taken into account by subtracting it from the net operating surplus in line with how the consumption of fixed capital is subtracted, then the role of the mining is considerable less and the difference between the mining industry and the other energy industries are much less pronounced.

7.23. We find that the effect of the depletion on net operating surplus is much higher than the effect from the consumption of fixed capital. However, this is something, which is specific for the mining and quarrying industry. For all other industries no adjustment take place.

Figure 7.4 presents the overall effect on operating surplus of taking the depletion of energy resources into accounts. The two curves presents net operating surplus and depletion adjusted operating surplus. The distance between them corresponds to the depletion. It is seen that the effect of taking depletion into account corresponds to a downward adjustment of the operating surplus by approximately 30,000 currency units to a level of 200,000 currency units in 2007.

Figure 7.4 Net and depletion adjusted operating surplus



Source: SEEA-E Table X.X

7.24. Figure 7.5 shows the role of depletion in relation to gross and net operating surplus at different levels of the economy: total economy, energy industries and the mining industry. The total of the stacked areas at 100 per cent represents the gross operating surplus. This operating surplus is decomposed into consumption of fixed capital, depletion of energy resources and a net operating surplus.

7.25. The bottom part of figure 7.5 shows the relative shares for the mining industry, i.e. extraction of crude petroleum and natural gas. It shows that during the period an increasing share is attributed to the depletion of crude petroleum and natural gas. At the end of the period the depletion corresponds to almost two third of the gross operating surplus. The increase in the share of depletion reflects partly an increase in the physical quantities of energy resources being extracted, but it reflects also that, by convention, the estimate of depletion is influenced by the value of the total stock of energy resources. An energy stock with a high value leads to lower values attributed to the depletion, while energy stocks with a low value leads to higher values attributed to the depletion. Therefore, if the extraction of energy resources is not offset by new discoveries, etc. the depletion increases over time reflecting an increasing scarcity of the energy resource.

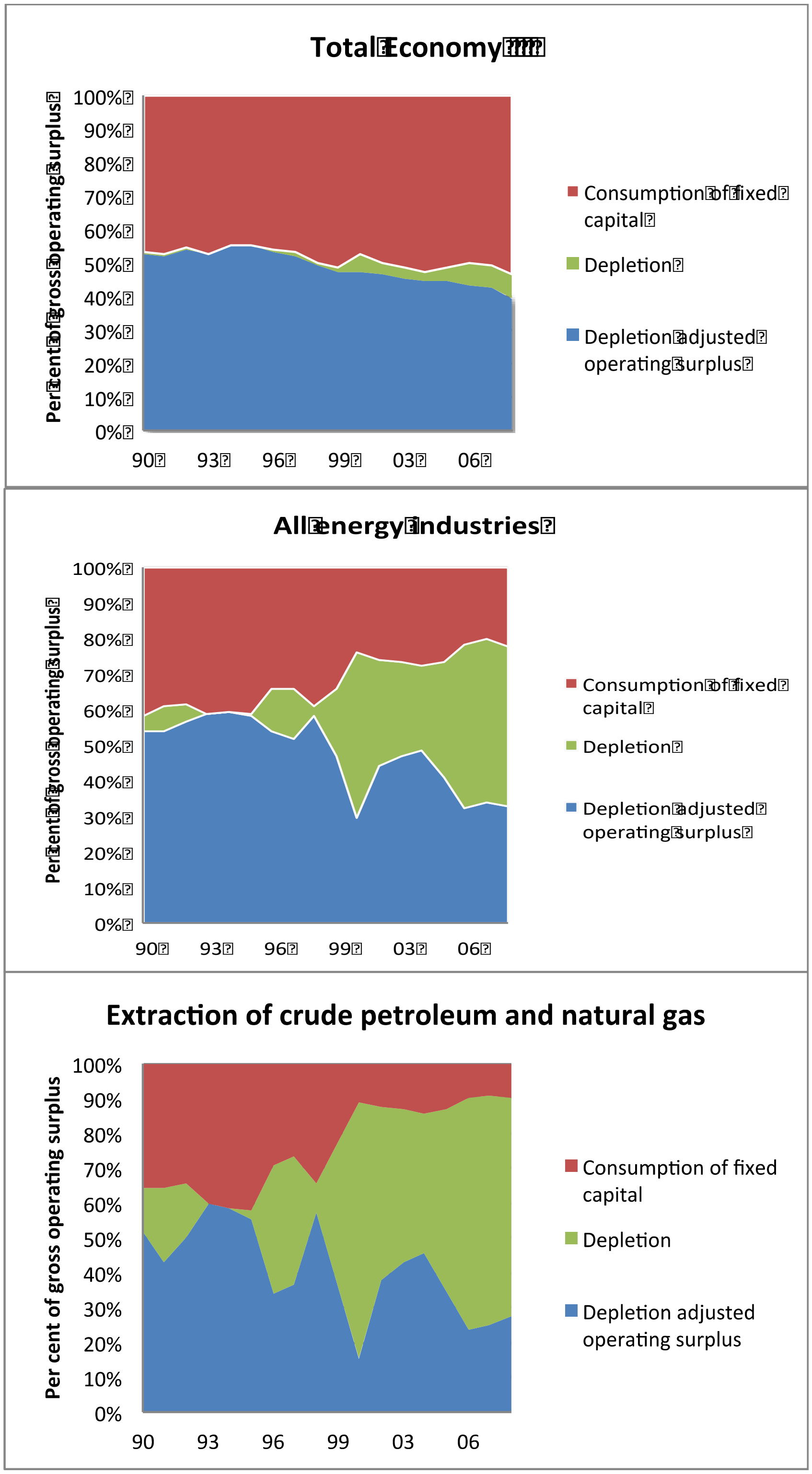
7.26. Related to this, and also reflected in figure 7.5, is that the share of depletion may vary quite a lot from one year to the next, although the physical extraction does not necessarily vary much. In some years the depletion may even be zero or negative. This is again explained by the convention that the total value of the energy resources influences the estimate of the depletion.Consequently, large increases in the stock of the energy resources due to new discoveries and revaluations of the quantities may lead to drastic downward changes in the estimate of the depletion even if the extraction of resources is at the same level when measured in physical quantities.

7.27. In the example the relative role of consumption of fixed capital is decreasing over time. This may, among other things, be due to an increase in productivity leading to more energy resources being extracted by the same input of fixed capital. In addition, an increase in the oil and natural gas prices relative to the prices on fixed assets used for the extraction will lead to a decreasing share for the consumption of fixed capital.

7.28. When the depletion and the consumption of fixed capital is subtracted from the gross operating surplus the depletion adjusted operating surplus is obtained.As can be seen, the share of adjusted operating surplus varies quite much over time reflecting the volatile nature of the depletion estimate especially at current prices. This points at the importance of establishing time series for depletion and the depletion adjusted operating surplus, and the danger of drawing up to firm conclusion based on only accounts for a single year.

7.29. The middle part of figure 7.5 presents the corresponding shares for the energy industries taken together, while the upper part presents the picture for the total economy. Since the depletion does only apply to the mining and quarrying industries, the role of the depletion is becoming less pronounced when more industries are included in the analysis. However, as can be seen in the upper part of the figure, although the depletion constitute one a few per cent of the gross operating surplus at the end of the period, it increasingly diminishes the share of operating surplus left over after the costs of using fixed and natural capital is charged for.

Figure 7.5 Operating surplus and the role of depletion



Source: SEEA-E Table X.X

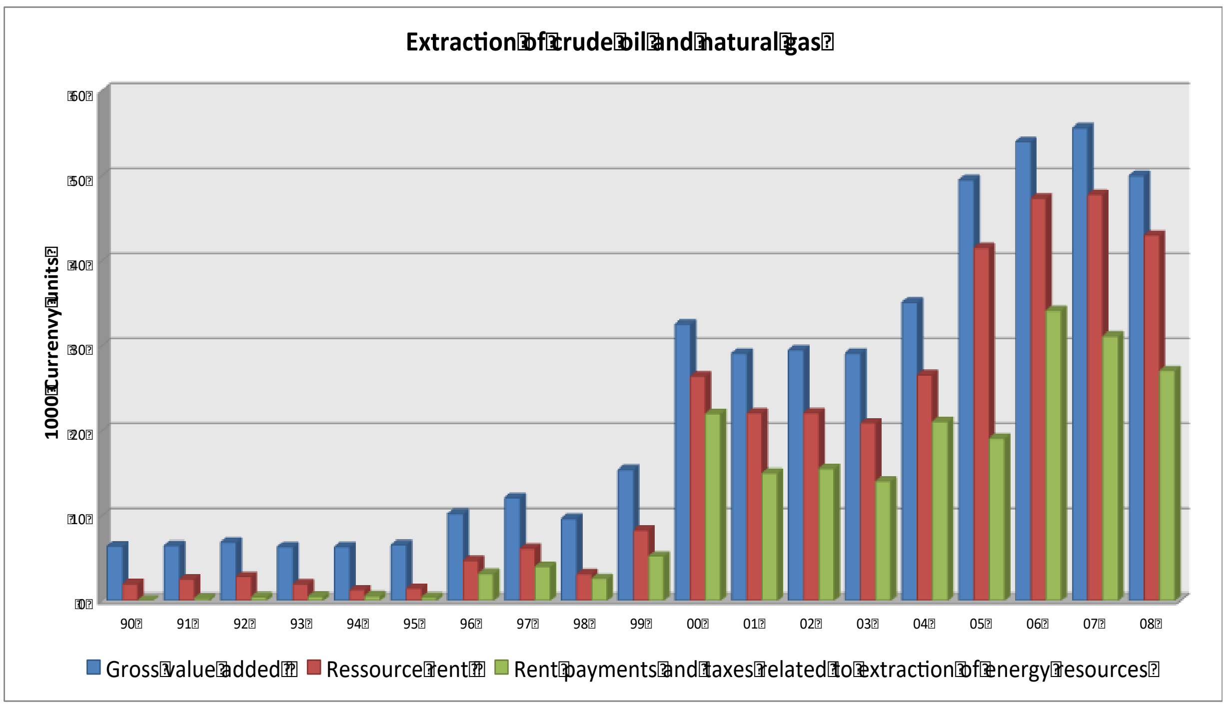
3. Energy, energy taxes and the government budget

Extraction of energy and the appropriation of resource rent by government

7.30. As already mentioned in relation to Figure 7.3, the resource rents make up a considerable part of the value added of the *Extraction of crude oil and natural gas*industry. This is also shown in Figure 7.6, which in addition include information on how much of the resource rent is being appropriated through payments of rents to the owner of the energy resources, in this case the government, and through payments of taxes to the government.

7.31. The share of resource rent in value added was relatively low in the first years when the extraction was low but it gets higher once the extraction is increasing. Similarly, the share of rent payments and taxes was low in the beginning of the period when the extraction started, while in recent years the share has remained high. However, it is also clear that in this case the appropriation of the resource rent does not make up a constant share of neither value added nor the resource rent. Other factors seem to influence the payments of rents and taxes.

Figure 7.6 Value added, resource rent and payments of rent and taxes to the government



Included as taxes are specific taxes and taxes on incomes and wealth, etc. Excluded are non-specific taxes on production.

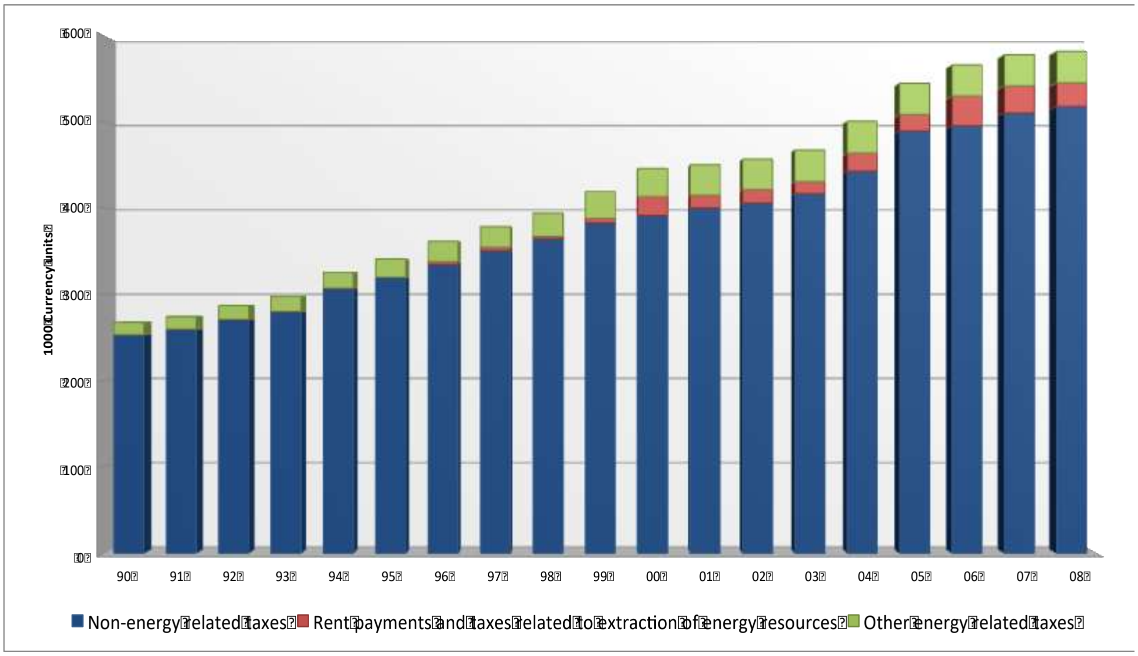
Source: SEEA-E Table X.X

Total taxes paid in relation to extraction, production and use of energy

7.32. Figure 7.7 shows the total revenue from all taxes and rent payments to government including rent payments and taxes on production, income and wealth with a breakdown on payments related to extraction of energy resources, other energy related taxes and non-energy related taxes.

7.33. In recent years the energy related taxes has made up approximately 10 per cent of the total government revenue. Of this half comes from payments related to the extraction of energy resources and half from other energy related taxes, including taxes on CO2 emissions. Thus, while energy taxes play an important role, it is, however, only a minor part of the total government budget, which is being financed by the energy related taxes.

Figure 7.7Breakdown of total taxes (total economy) by energy related and non-energy related taxes



Source: SEEA-E Table X.X

4. Energy and foreign trade

7.34. Unprocessed crude oil is the most important energy product being exported, while processed oil in the form of fuel oil is the most important energy product for imports, cf. Table 7.2. In monetary units there is almost a balance for these two products. Altogether the imports and exports end up with a trade balance surplus in recent years.

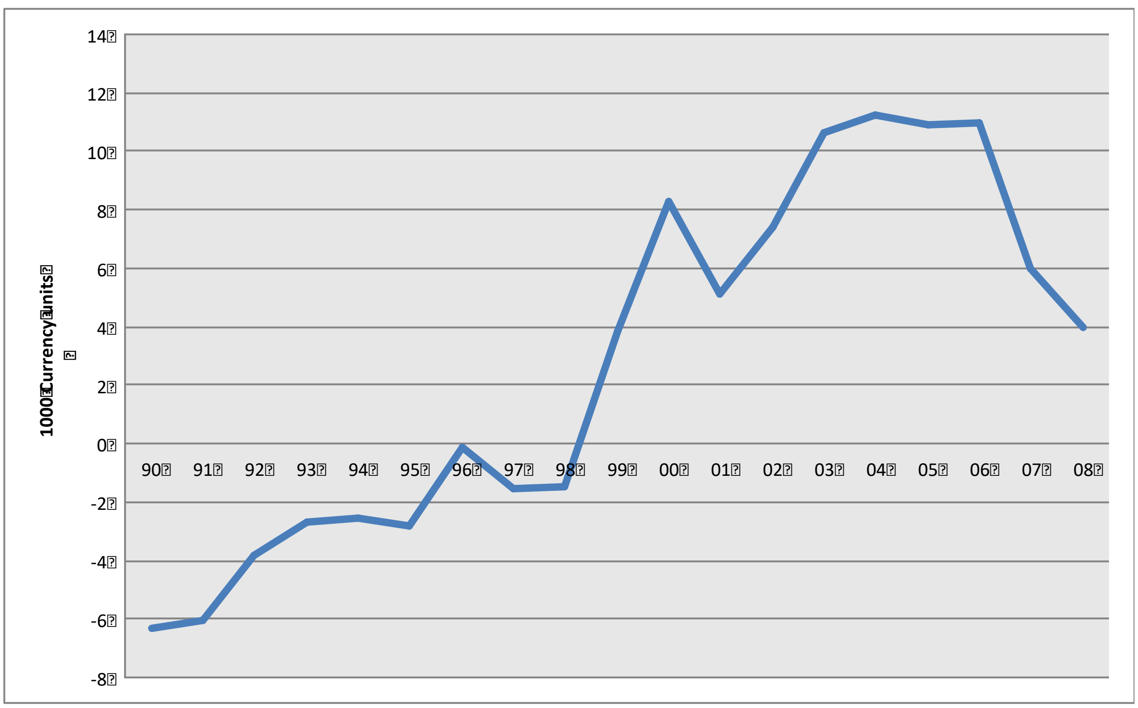
7.35. This trade surplus for energy products is made possible through the extraction of crude oil and natural gas. From Figure 7.8 it is seen that the trade surplus occurred for the first time in 1999 and that it was increasing until 2004, when it gradually began to fall. By comparing with Figure 7.1, which shows the output of the extraction industry it is obvious that there is a close connection between the extraction activities and the trade balance surplus for energy products.

Table 7.2 Imports and exports of energy products, 2006

	Imports	Exports	Trade balance
	1000 Currency units		
Crude oil	8	32	24
Natural gas	0	9	9
Electricity	2	4	3
Gasoline and diesel	7	8	1
Others	6	5	-1
Coal	3	0	-3
Fuel oil	33	10	-23
Total, energy products	**59**	**69**	**10**
All products	520	538	18
Energy products share of all products, per cent	**11**	**13**	**53**

Source: SEEA-E Table X.X

Figure 7.8 Trade balance for energy products



Source: SEEA-E Table X.X

5. Wealth

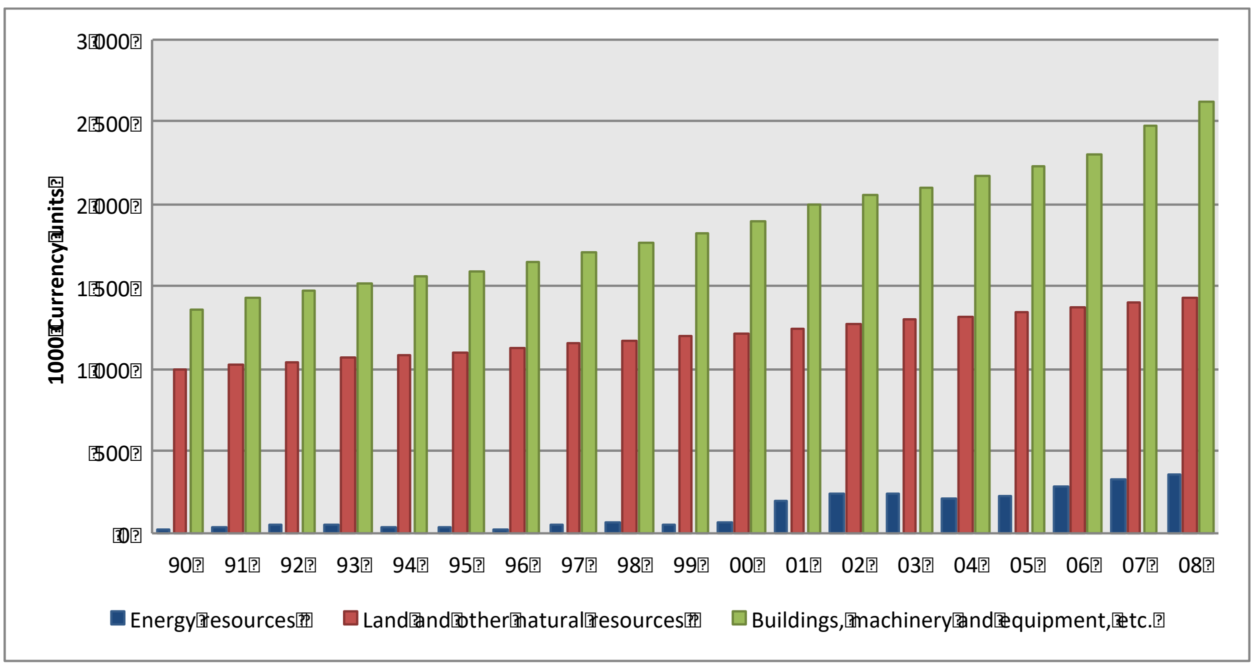
7.36. The value of natural resources comprises only one component of the total value of the assets belonging to a country. Other components are human capital, land and other natural resources and fixed assets in the form buildings, machinery and equipment. These assets contribute to the wealth of a country.

7.37. Leaving aside the value of human capital, the market values of man-made and natural capital are presented in Figure 7.9.

7.38. In this case we find that the fixed assets (buildings, machineries and equipment, etc.) without comparison make up the biggest part of the value of the assets. Although the energy resources are important for the economy (the trade balance, for instance) they only contribute little to the total wealth when measured as the value of the assets. Land and other natural assets is the second most important group.

7.39. It should be noted that the value of the energy resources is increasing over time, although in physical terms the energy resources have been in place throughout the period. However, even though the resources have been in place they have not acquired a market value before exploration and evaluation activities have been carried out. Further, increases in oil prices have affected the value of the resources, and when the oil price increases more than the general price level, the value of the assets will also tend to increase relatively to the value of other assets.

Figure 7.9Contribution to national wealth by fixed assets, energy resources, land and other natural resources



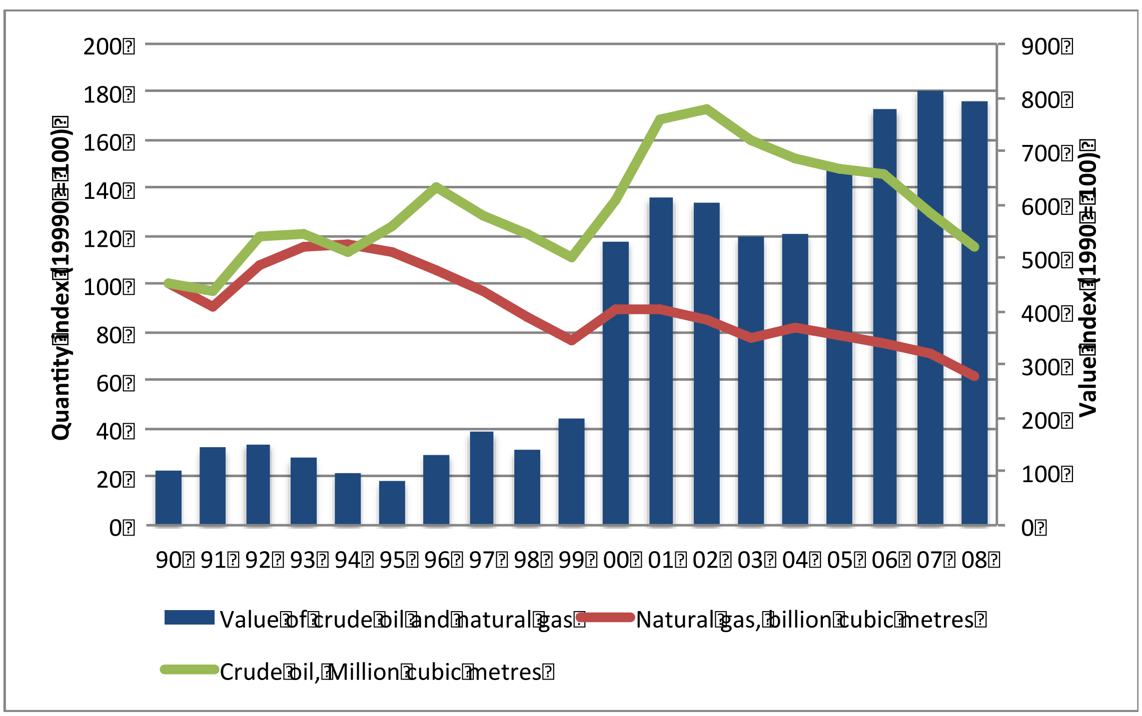
Source: SEEA-E Table X.X

7.40. Figure 7.10 illustrates how the value of the energy resources have developed compared to the physical quantities. The value index is calculated from the current price value deflated by the GDP deflator, and therefore the changes in the index is influenced by the fact that the energy prices have developed differently than the general price level. Besides those price related changes also changes due to new discoveries, etc. influence the index.

7.41. The physical stock of oil resources increased by 15 per cent over the period as a whole. In contrast, the physical stock of natural decreased substantially by almost 40 percent. The GDP deflated value was almost 8 times higher in the end of the period than in the beginning of the period.

7.42. To further shed light on the size of the energy resources Figure 7.11 presents the so-called R/P proportion for oil and natural gas resources. It represents the number ofyears of extraction left before the energy resources have been fully worked out contingent on current levels of stocks and extractions. It is seen that for natural gas 50 years of extraction was left at the beginning of the period, while a little more than 10 years is left at the end of the period. This decrease is due to the gradual exhaustionof the natural gas deposits and the increasing level of extraction. For oil, the R/P proportion decreased from 25 years to a little more than 10 years at the end of the period. It is worth noting that despite a high level of extraction in all years, the R/P proportion remains fairly constant above 10 years since 2000. This stabilization of the R/P proportion is often seen, and is partly a result of increased exploration and evaluation activities, which brings new deposits into the picture as other deposits are being exhausted.

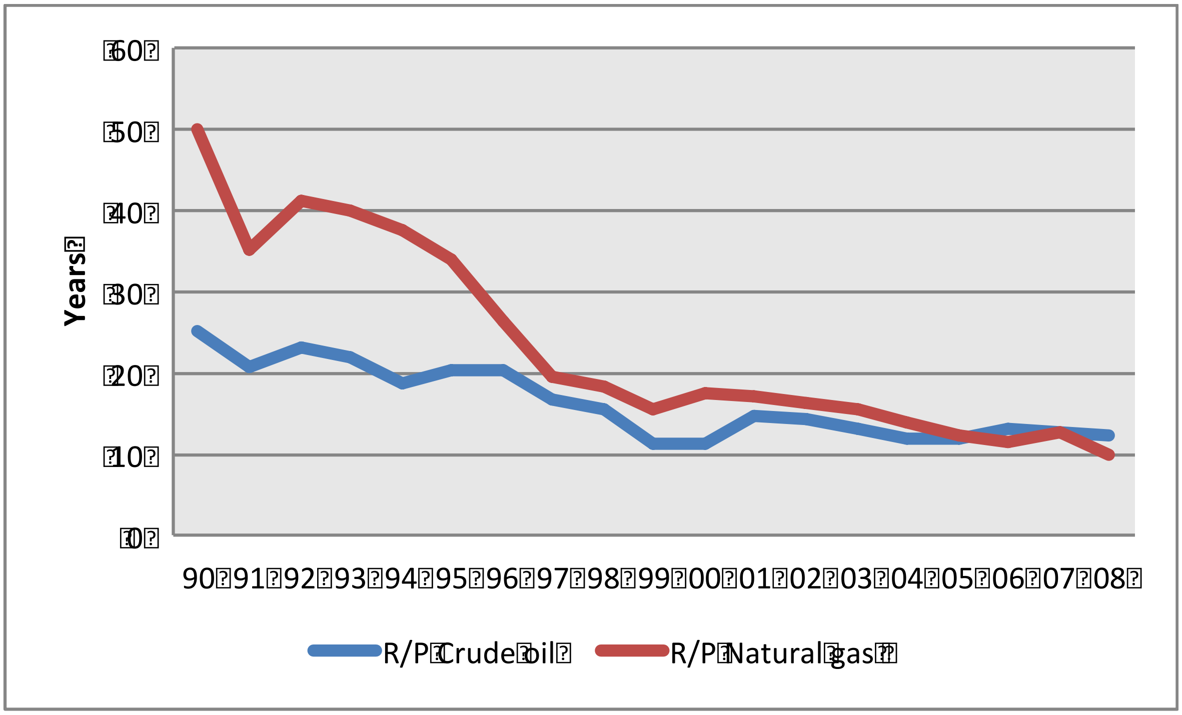
Figure 7.10 Quantity and value index for the development of the stock of energy resources



Note: The value of the stock of energy resources has been deflated by the GDP deflator

Source: SEEA-E Table X.X

Figure 7.11Years of extraction left with current levels of stocks and extractions



Note: The R/P relationship is estimated as the quantities energy resources (Class A Economic resources, cf. Chapter 3) divided by the current extraction of energy resources. (R denotes Reserves and P the Production).

Source: SEEA-E Table X.X

C. Monitoring the development in energy supply and use

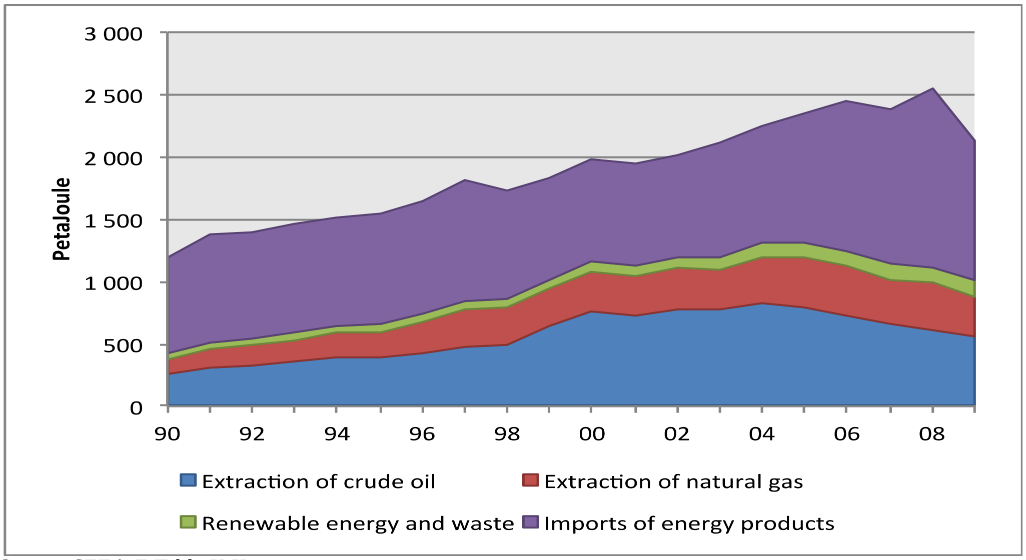
7.43. This section shows how information from the energy accounts can be used to monitor the development in energy supply and use both for the total economy and for individual industries and the households. It starts with graphs, which shows the physical supply and use of energy broken down by components such as primary energy production, imports, and uses by households, industries and exports. The use of energy is further subdivided into energy products and industries according to the ISIC classification measured both at physical and monetary units. The expenditures are shown as per cent of total costs for industries and households. A measure of the self-sufficiency, i.e. to which extent does the country relies on imports of energy products is also shown. Finally, this section presents graphs, which illustrates for which purposes energy are used in households and by industries, i.e. whether is it used for transport, heating or other purposes.

1. Overall supply and use of energy

7.44. The total quantities of energy entering a country during a year can be measured as the sum of the production of primary energy and the imports of energy products. Measuring the supply in this way avoids problems of double counting, which occurs when, for instance, both the production of crude oil and the production of refined oil products are included.

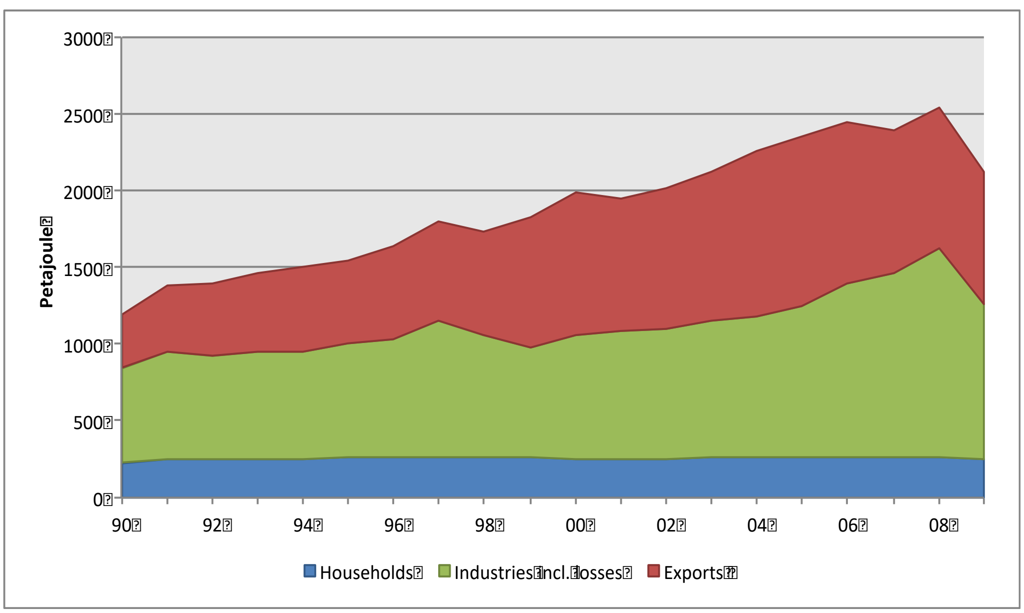
7.45. Figure 7.12 shows how the supply has been influenced by an overall increase in both extraction of fossil energy resources and production of renewable energy. In recent years the extraction of energy resources has eased off to some degree. The imports have generally increased and despite a drop in recent years due to the economic crisis, the level is almost double the level in the beginning of the period. Imports constitute more than half of the total supply of energy.

Figure 7.12 Total primary supply and imports of energy



Source: SEEA-E Table X.X

Figure 7.13End use of energy incl. losses



Note: Industries' consumption of energy includes also changes in inventories

Source: SEEA-E Table X.X

7.46. The use of energy is presented in Figure 7.13. The total use corresponds exactly to the total primary production and imports shown in Figure 7.12. The use is allocated to industries, households and exports. In doing this, the conversion and distribution losses have been allocated to the users of energy according to their end use.

7.47. Corresponding to the large and increasing imports we find that the exports show a similar magnitude and development. The use of energy by households makes up a small part of the total use, only 10 per cent of total use including exports at the end of the period. The use by industries is more than three times as big as the use by households. The sudden drop in industries' energy use and exports should be seen in the light of the decrease in economic activities at the end of the period.

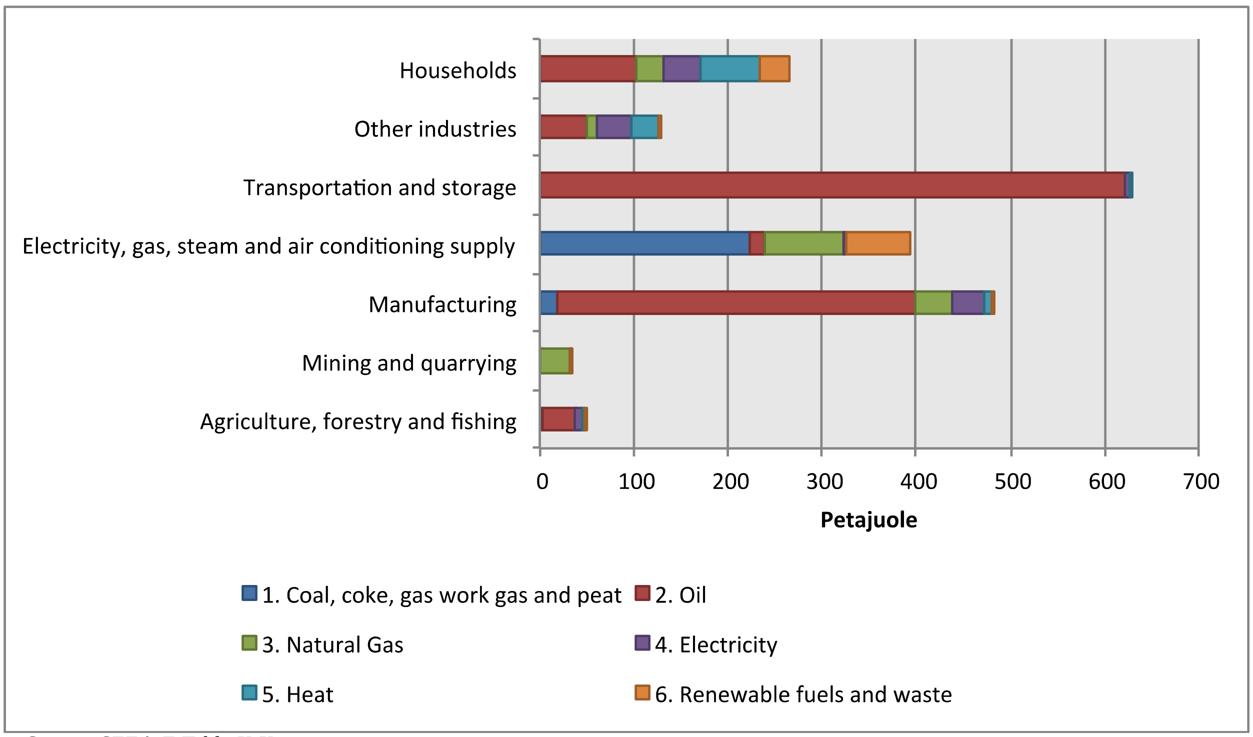
2. Use of energy and expenditures by industries and households

7.48. Figure 7.14 shows for households and each industry group how much energy is being used and how different energy products make it up. The measurement unit is petajoule. Figure 7.15 shows the corresponding expenditures in currency units.

7.49. It should be noted that Figure 7.14 includes some double counting of energy, since both primary and secondary energy products are included, but this is consistent with the recording of the monetary flows.

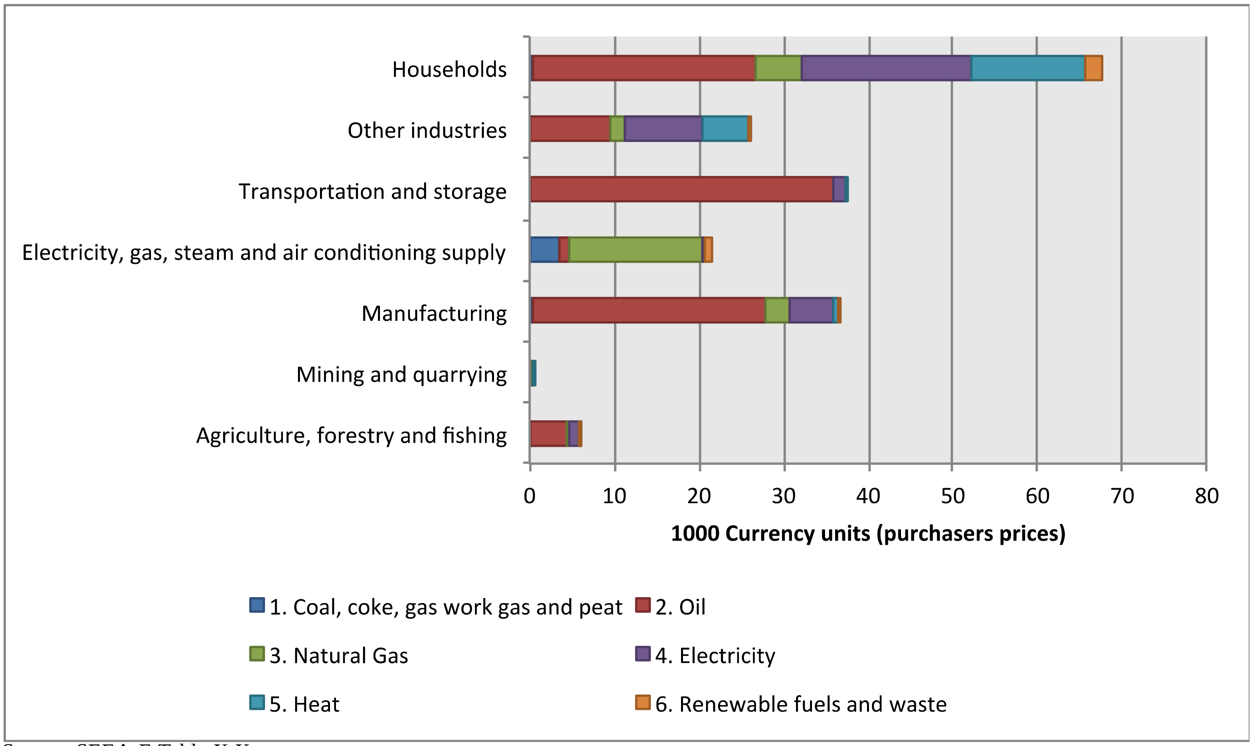
7.50. It is seen, for instance, that the share of household expenditures for energy is much larger than their share of the physical use.

Figure 7.14 Physical use of energy by industries and households, 2006



Source: SEEA-E Table X.X

Figure 7.15 Expenditures for energy by industries and households, 2006



Source: SEEA-E Table X.X

7.51. Figure 7.16 presents for the main industry groups, the share of expenditures for energy of the total expenditures for intermediate consumption for the same groups.

7.52. Similarly, Figure 7.17 gives the share of households' expenditures for energy of the total expenditures for household consumption.

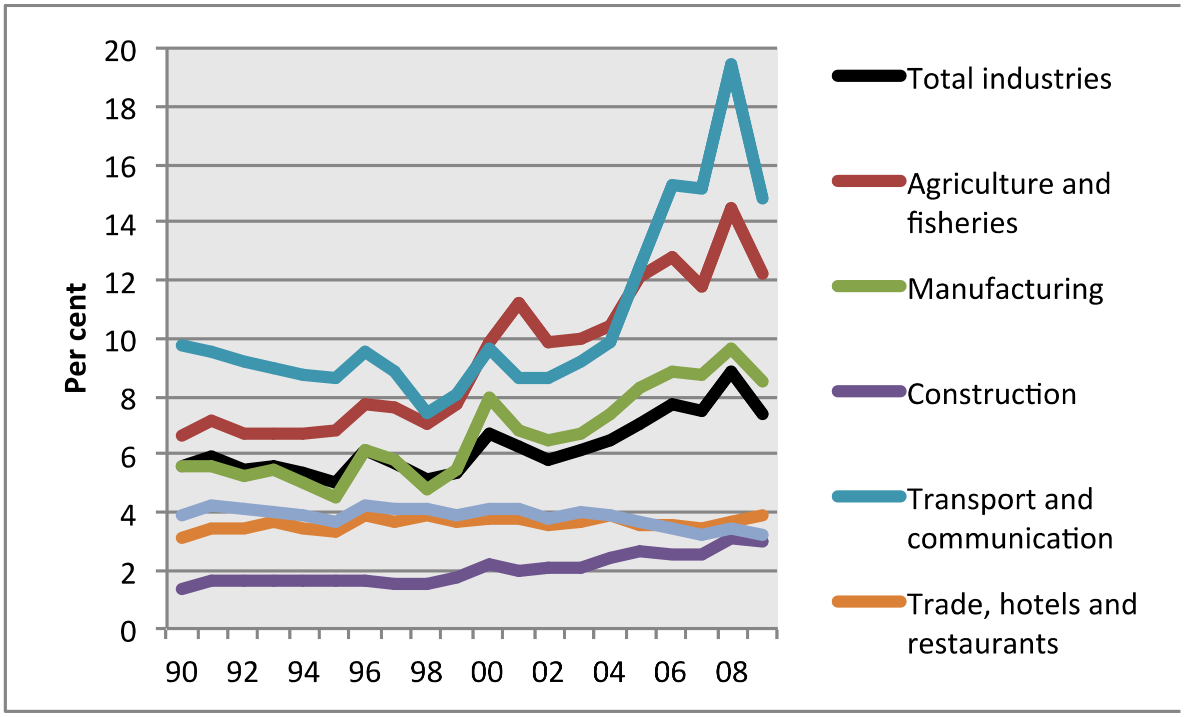
7.53. For industries we see generally a moderate increase in the share with a sharp fall in the end of the period due to price drops. For households the share has been rather constant in the period.

7.54. Due to taxes on energy products the purchasers' prices paid by the households are relatively larger compared to the purchasers' prices paid by the industries. Since many energy product taxes are fixed taxes per litre or tonnes energy products, the effect of changes in basic prices has a relative smaller effect on households than on industries.

7.55. Figure 7.18 shows the share of energy use (petajoule), expenditures (purchasers prices) and energy taxes for main industry groups and for households. From these graphs it is also clear that the share of total expenditures paid by households is much higher than the share of physical use of energy by households, and that this is due to energy taxes charged to households and to a much lesser extent to industries. The households use 10-15per cent of the energy, but pays more than 60 per cent of the energy taxes. However at the same time it is seen that the industries' share of the energy taxes and the energy expenditures have actually gone up in recent years.

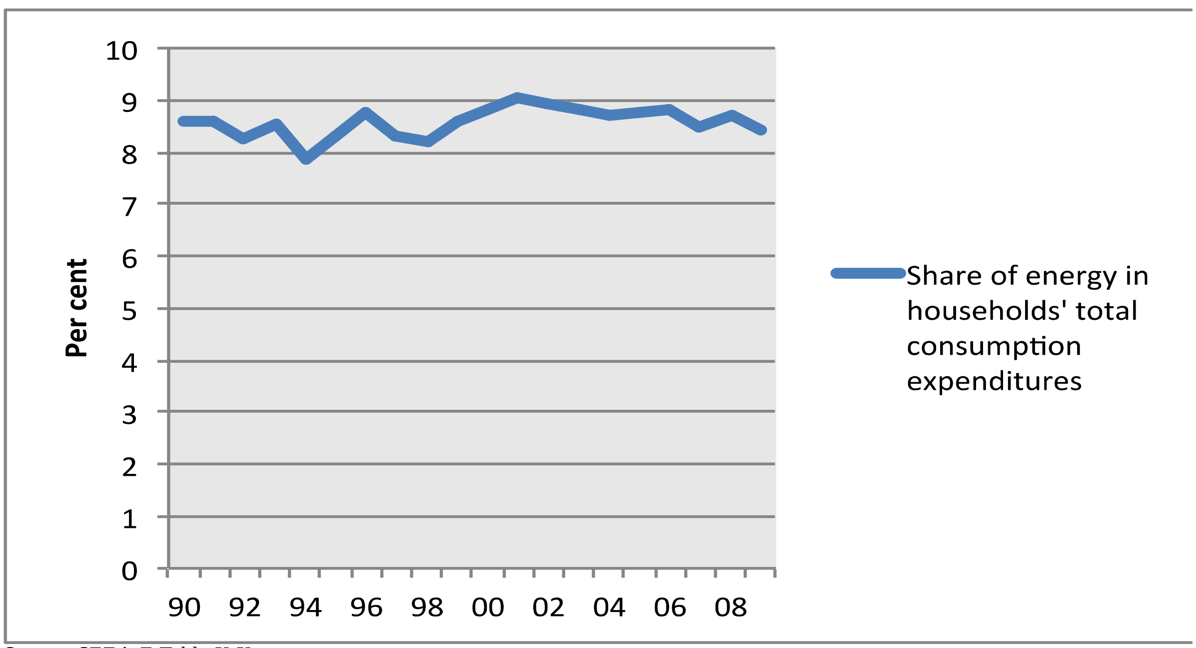
Figure 7.19 presents the development in energy use by main industry groups. It is obvious that most industries have had an almost constant energy use throughout the period. A remarkable exception is the transport services, which have realised a sharp increase in energy use, and more specifically the use of oil products, i.e. diesel and gasoline.

Figure 7. 16 Share of energy costs in intermediate consumption



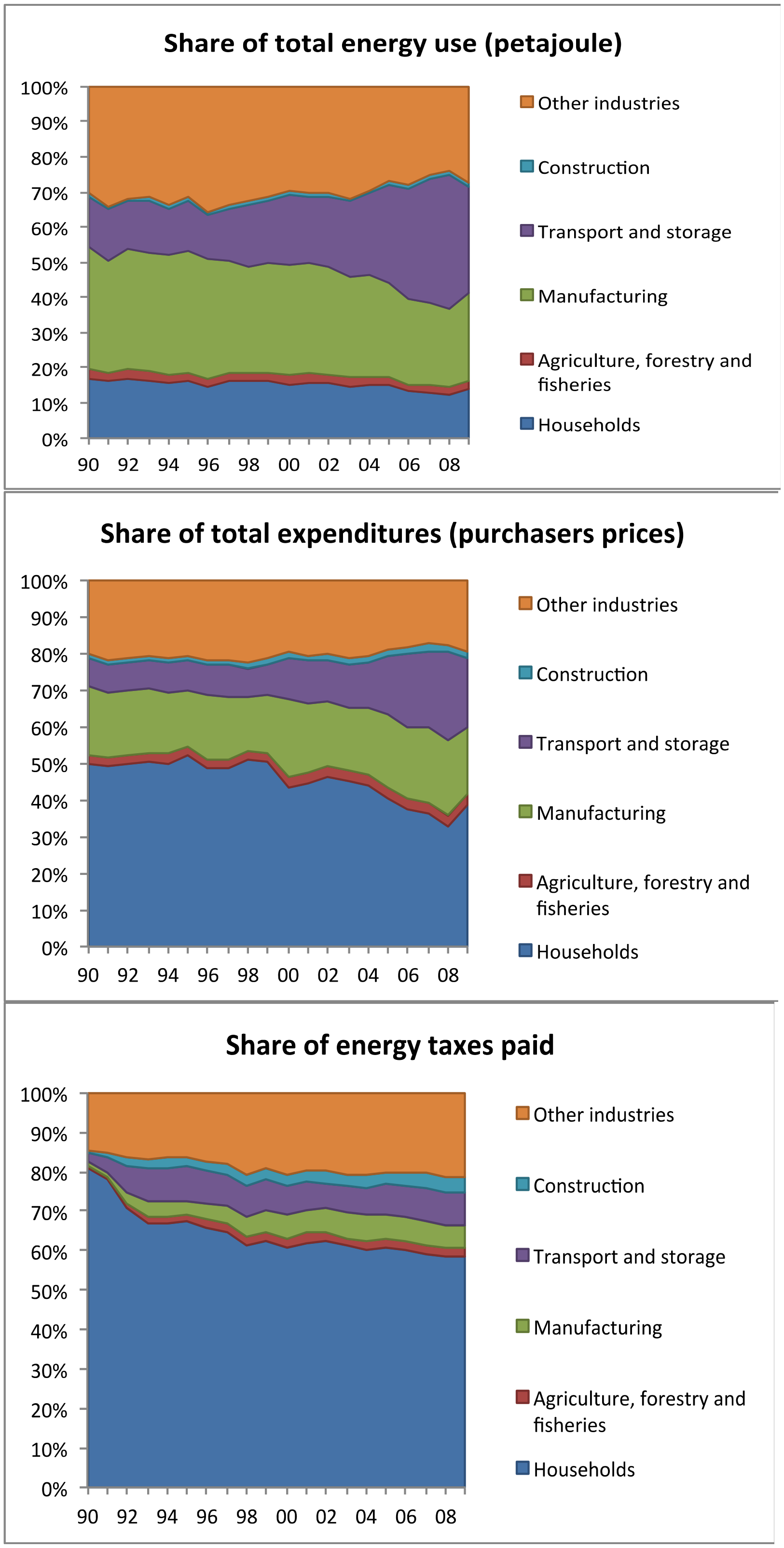
Source: SEEA-E Table X.X

Figure 7. 17 Share of energy costs in households' total consumption expenditures



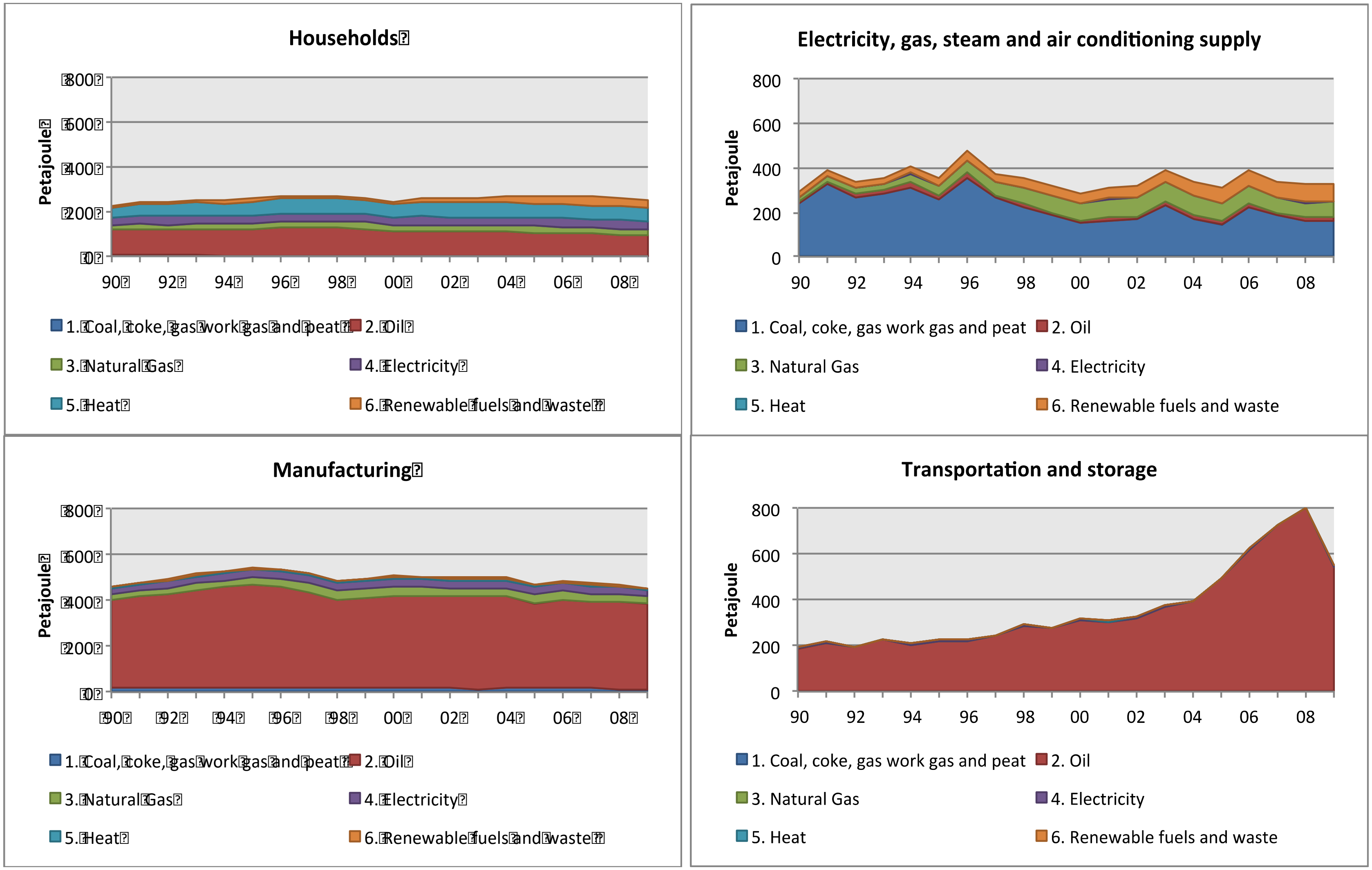
Source: SEEA-E Table X.X

Figure 7. 18 Shares for energy use, expenditures and taxes



Source: SEEA-E Table X.X

Figure 7.19Development in energy use by main user groups



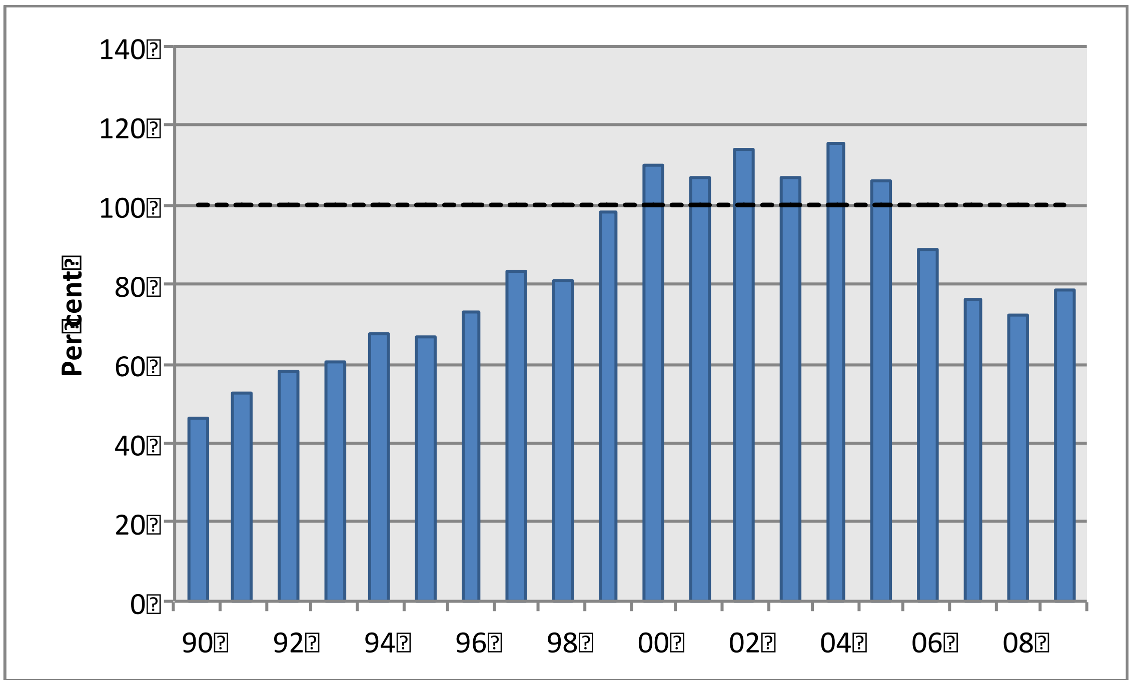
Source: SEEA-E Table X.X

3. Degree of energy self-sufficiency

7.56. A high degree of independence of imports of energy is generally a priority area for countries. To illustrate the degree of independence of import or self-sufficiency Figure 7.20 shows the relation between the primary energy production and the domestic end use inclusive of conversion and distribution losses.

7.57. Figure 7.20 shows that the degree of self-sufficiency increased fromless than 50 per cent in the beginning of the period to more than 100 per cent in the middle of the period. After some years with full self-sufficiency the reliance of import have again increased in recent year. This development has a close connection with the pattern of extraction of energy resources presented in previous sections.

Figure 7.20Degree of energy self-sufficiency



Source: SEEA-E Table X.X

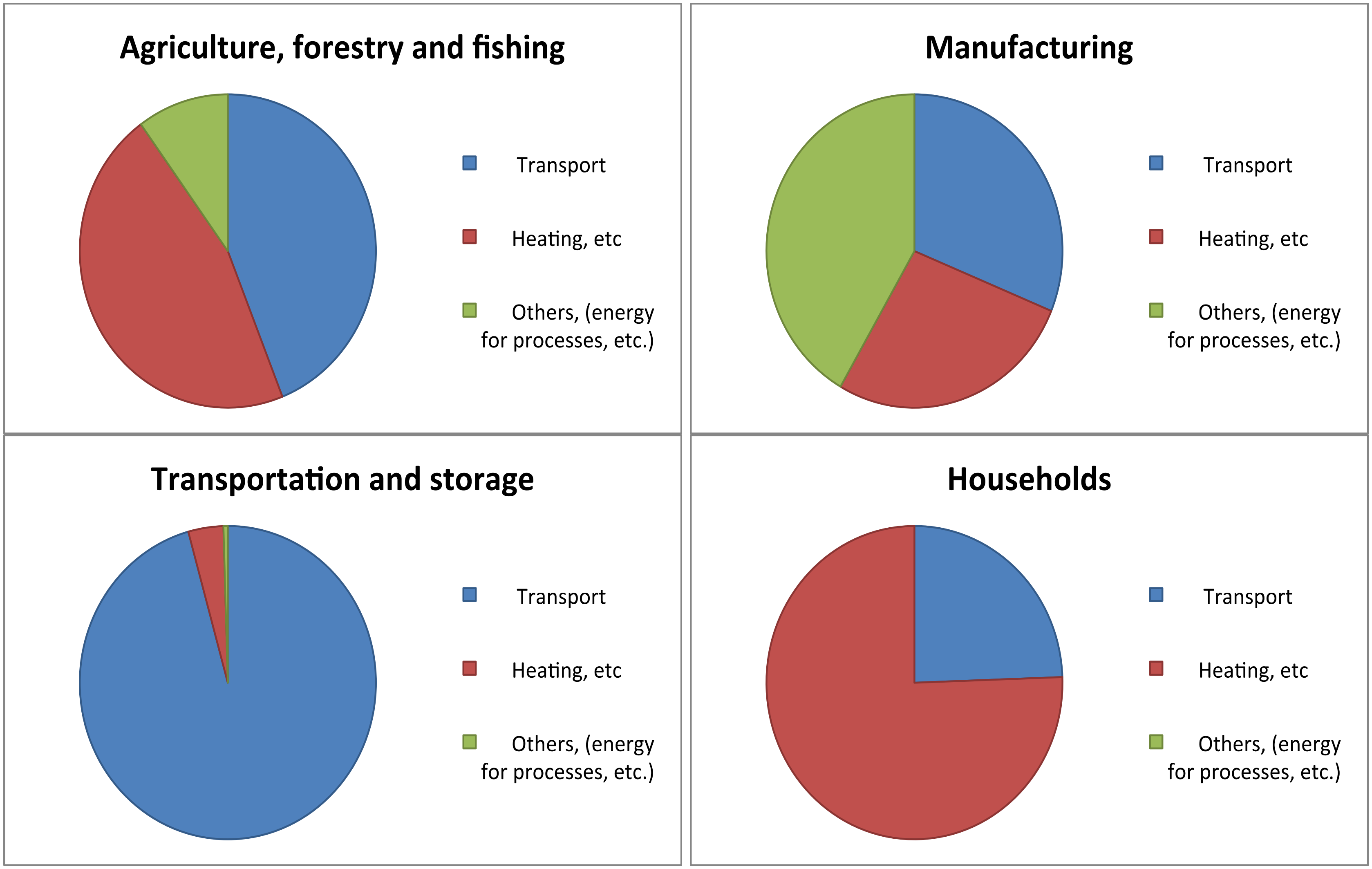
4. Energy use by purpose

7.58. Energy is used for different purposes: Transport, heating and processes, etc. Figure 7.21 shows the distribution of energy by purpose for the main user groups.

7.59. Transport has a high share for all user groups, especially the transport service industry and agriculture, forestry and fisheries. The share of heating is especially large for households and for agriculture, forestry and fisheries. For manufacturing the energy use for processing, etc. makes up 40 per cent of total energy use.

7.60. For the economy as a whole the share of energy used for transport were approximately one third and the use for processes including energy used for conversion was 43 per cent.

Figure 7.21 Energy by purpose for selected industry groups and households



Source: SEEA-E Table X.X

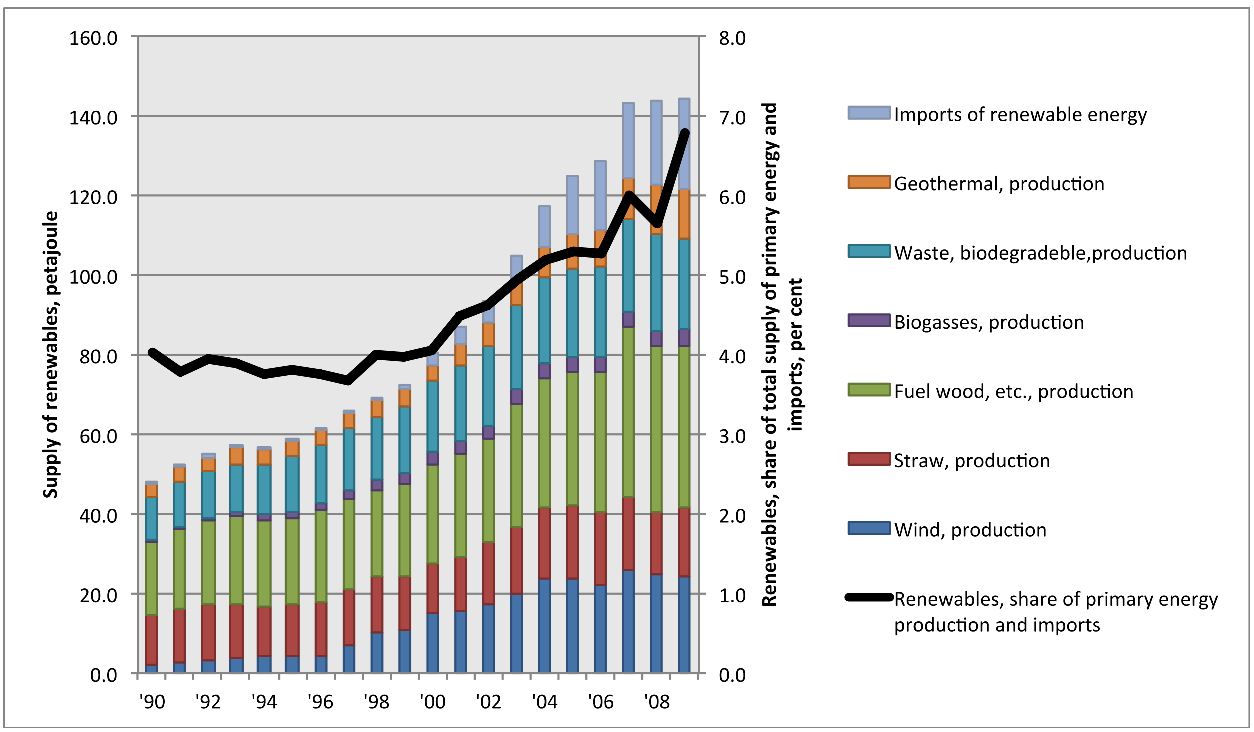
D. The role of renewable energy and waste

7.61. Renewable energy is high on the policy agenda in many countries, and therefore it is important to monitor the development in the production and use of renewable energy and to assess the share of renewable energy of the total energy supply and use. This section presents details on the use of renewable energy and waste and clarifies how much of the total use of energy is covered by renewables and waste.

7.62. Figure 7.22 shows the development in the supply (production and imports) of various types of renewable energy, and the share of renewables of the total primary production and imports of energy products.

7.63. Especially the production of wind energy and the imports of renewable energy products have been increasing, but also the production if fuel wood and biodegradable waste used for energy production have been increasing. Altogether the share of renewables has increased from 4 per cent to close to 7 per cent of the total supply during the period.

Figure 7.22Supply of renewable energy and share of total primary energy production and imports



Source: SEEA-E Table X.X

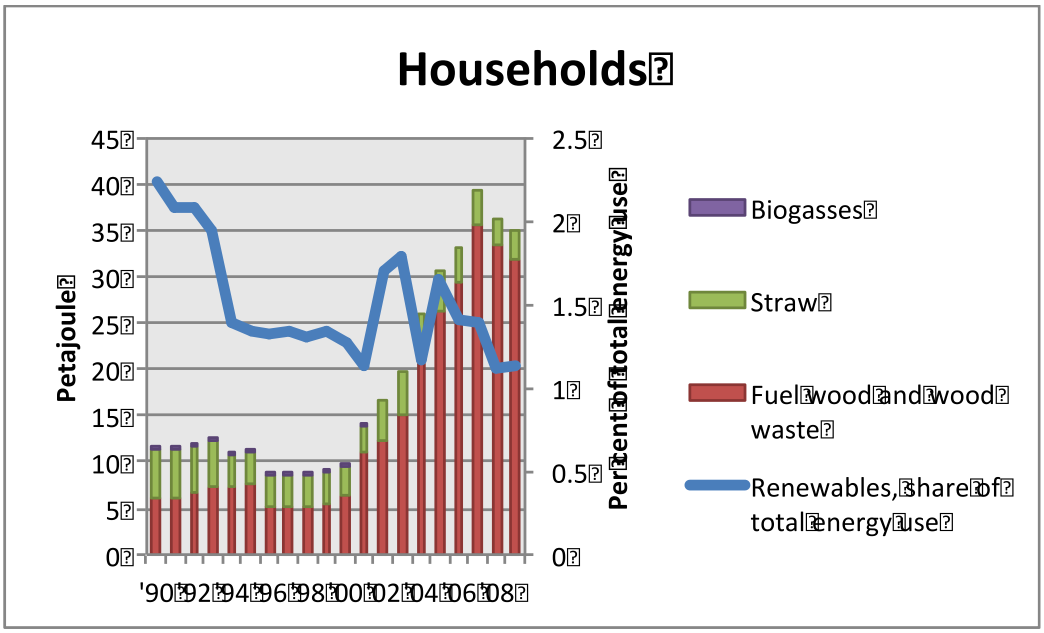
7.64. Renewable energy is used both by households and industries. Figure 7.23 presents the use by households, by the manufacturing industry and by the electricity, gas, steam and air conditioning supply industry.

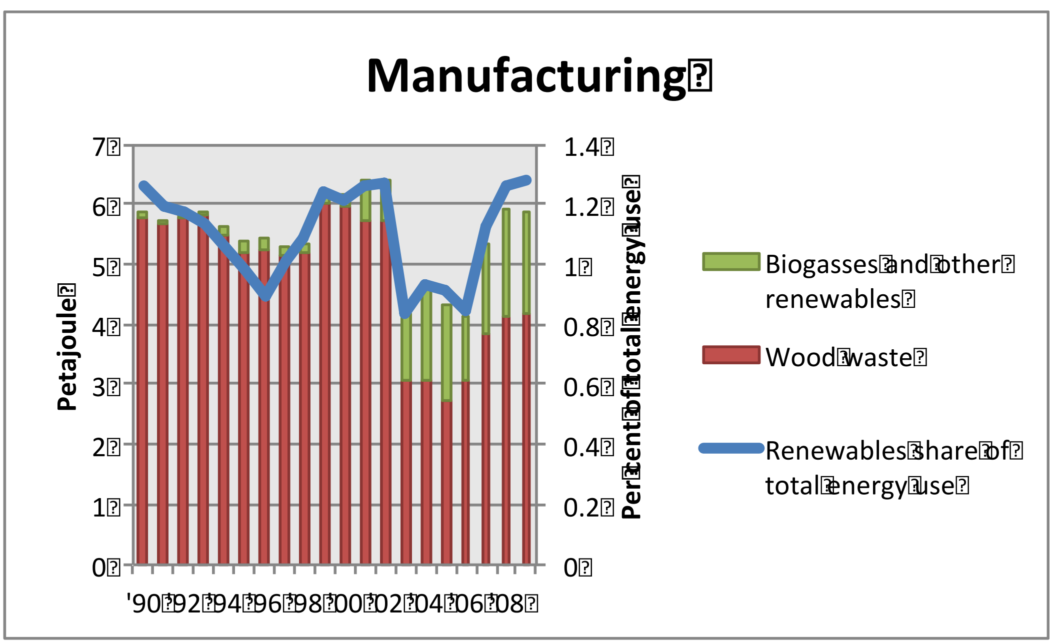
7.65. The households use of fuel wood increased drastically during the period, but despite of this the share of renewable energy was reduced by half from 2 per cent to 1 per cent of the total energy use by households.

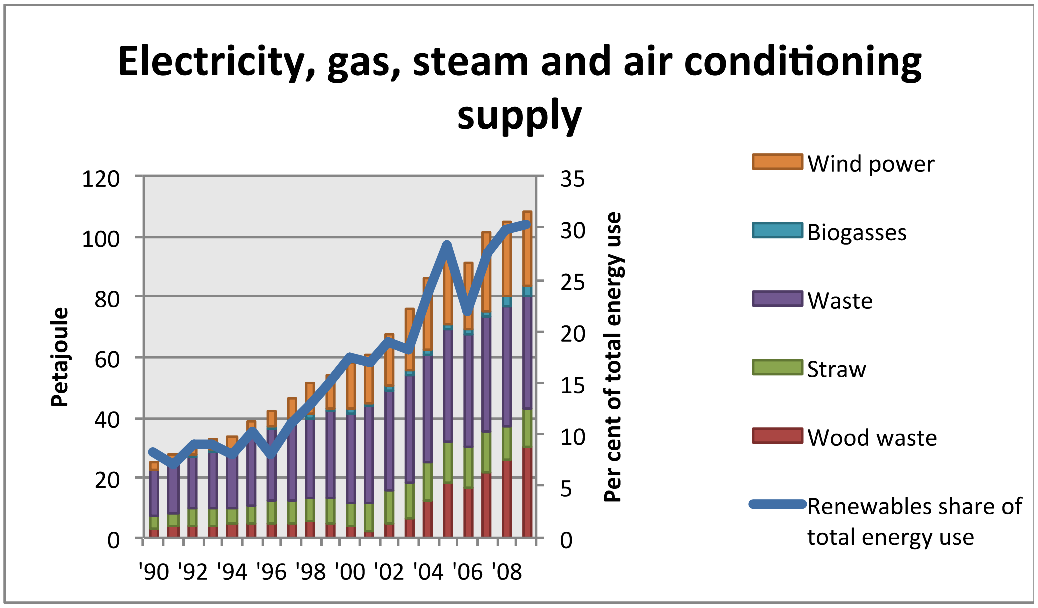
7.66. For the manufacturing industries the share was constant over the period as a whole, but this covers over a drop in the share in the beginning of the century.

7.67. The electricity, gas, steam and air conditioning supply industry increased its use of renewable energy considerable from 10 per cent to 30 per cent of its total energy use. It should be noted that part of this increase is due to an increase in the production of wind power, which is recorded as an use (and subsequent production) of this industry.

Figure 7.23Use of renewable energy by main users and share of total energy use







Source: SEEA-E Table X.X

E. Analysis of economic growth and energy use

7.68. This section analyses the energy use in relation to economic growth and the efficiencies of industries. One important question, which is being analysed, is to what extent a decoupling between economic growth and energy is taking place. Related to that the developments of energy intensities for various groups of industries are presented, and results from so-called decomposition analysis are shown. The results illustrate which factors, which have determined the development, for instance, how much influence economic growth and changes in energy intensities have had.

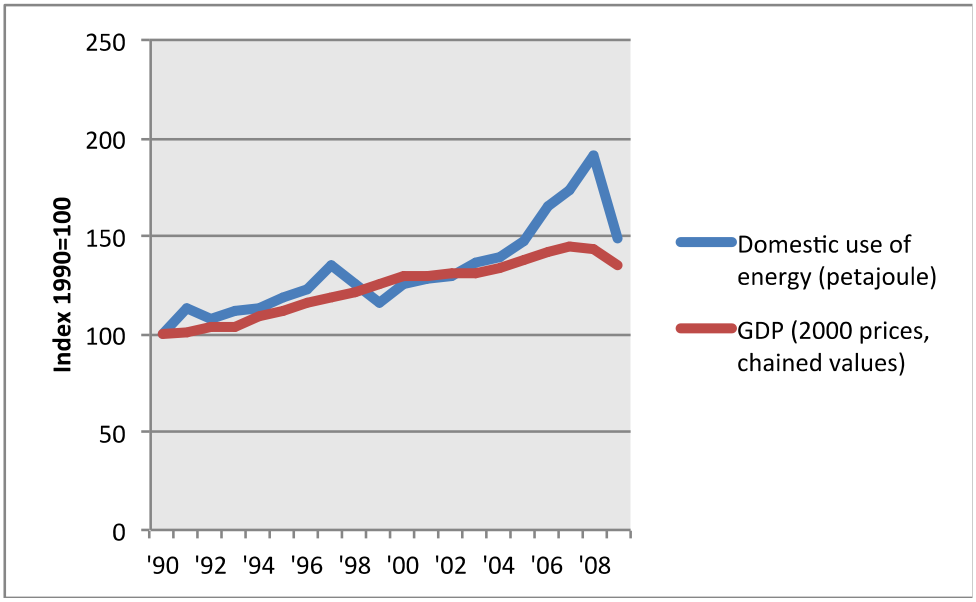
1. Decoupling of energy use and economic growth

7.69. Since the use of renewable energy is limited and the price of renewable energy is generally higher than fossil energy, decoupling of energy use and economic growth is generally seen as a necessity to ensure a sustainable development.

7.70. The extent to which such a decoupling takes place can be illustrated by comparing the development of GDP with the development of domestic use of energy as in Figure 7.25.

7.71. In this examplewe find that no decoupling has taken place. In fact, there has been a parallel development in GDP and energy use in most years during the period. At the end of the period we find first a much bigger increase in energy use and then a steep decrease until the energy use ends up with a growth over the period, which have been a little bigger than the overall growth in GDP.

Figure 7.24 Economic growth and domestic use of energy



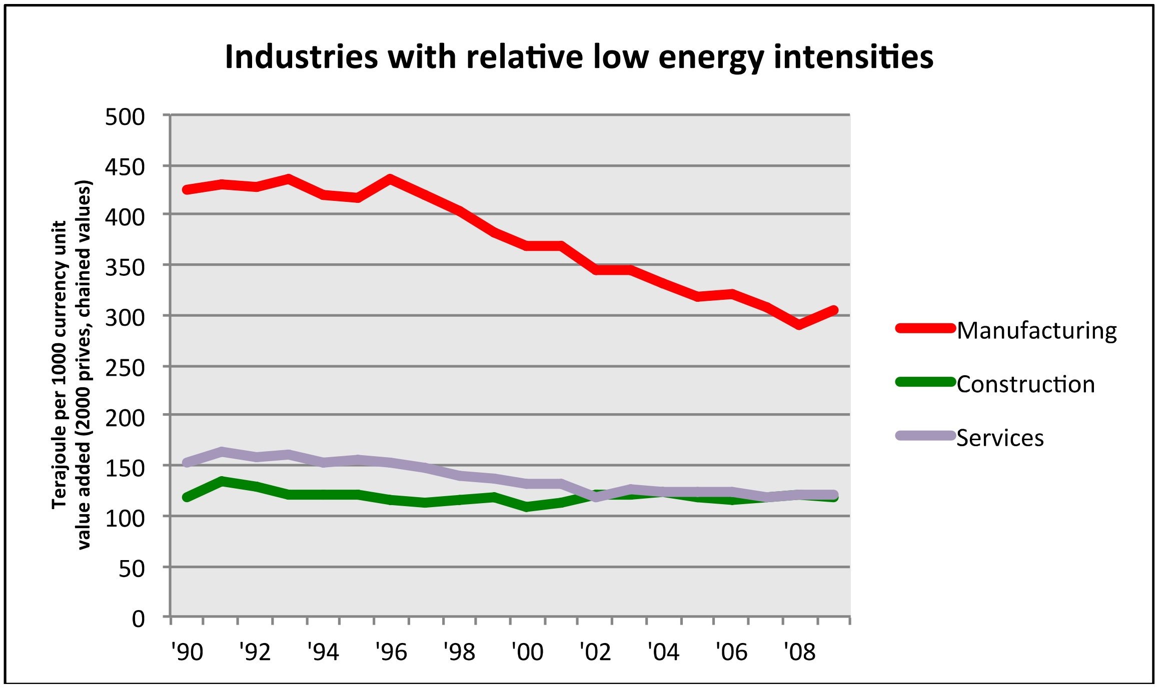
Source: SEEA-E Table X.X

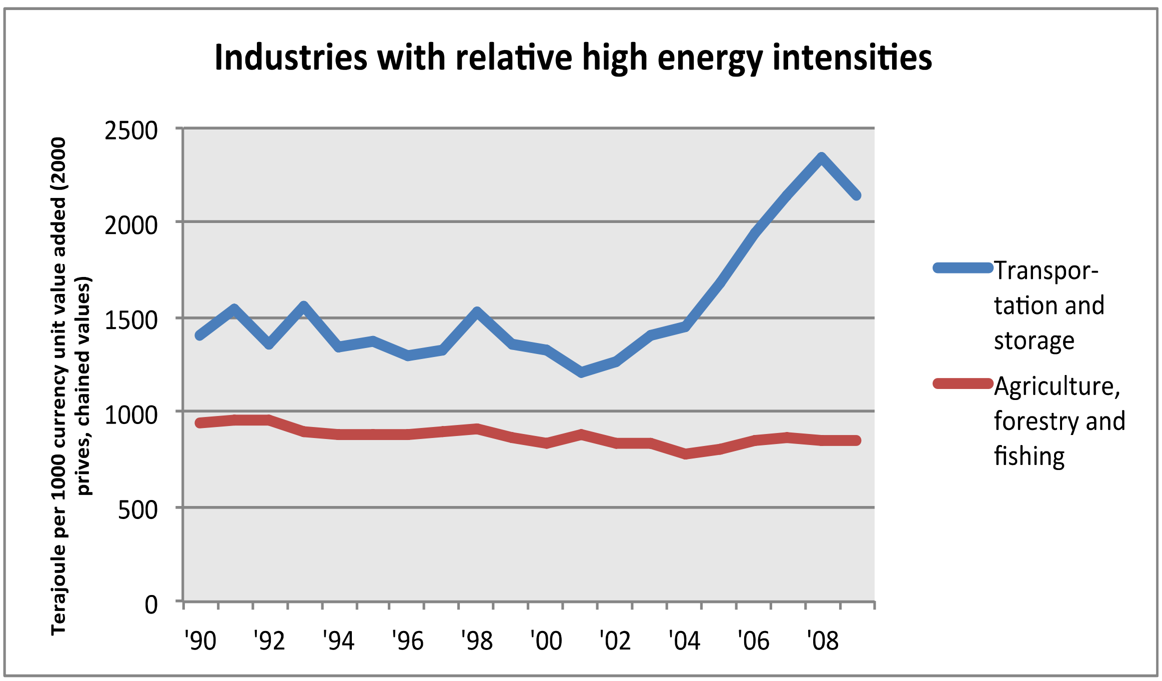
7.72. Figure 7.25 sums up the development of economic activity and energy use for selected industries by presenting energy intensities. The energy intensities are calculated as the relation between energy use and value added.

7.73. The first graph shows the development for industries with relative low intensities. The industries are manufacturing, construction and service industries. Especially manufacturing shows decreasing intensities, which indicates that they use energy more efficiently or that they increasingly uses converted energy instead of converting the energy themselves. For construction and services we see that the energy intensities now lie at a constant low level after a decrease in the beginning of the period.

7.74. The second graph shows the energy intensities of transport services and agriculture, etc. Both industries have high intensities. While the intensities for agriculture have decreased slightly during the period, the opposite is the case for transport services. In contrast, we see a sharp rise followed by a decrease at the end of the period.

Figure 7.25 Energy intensities for selected industries

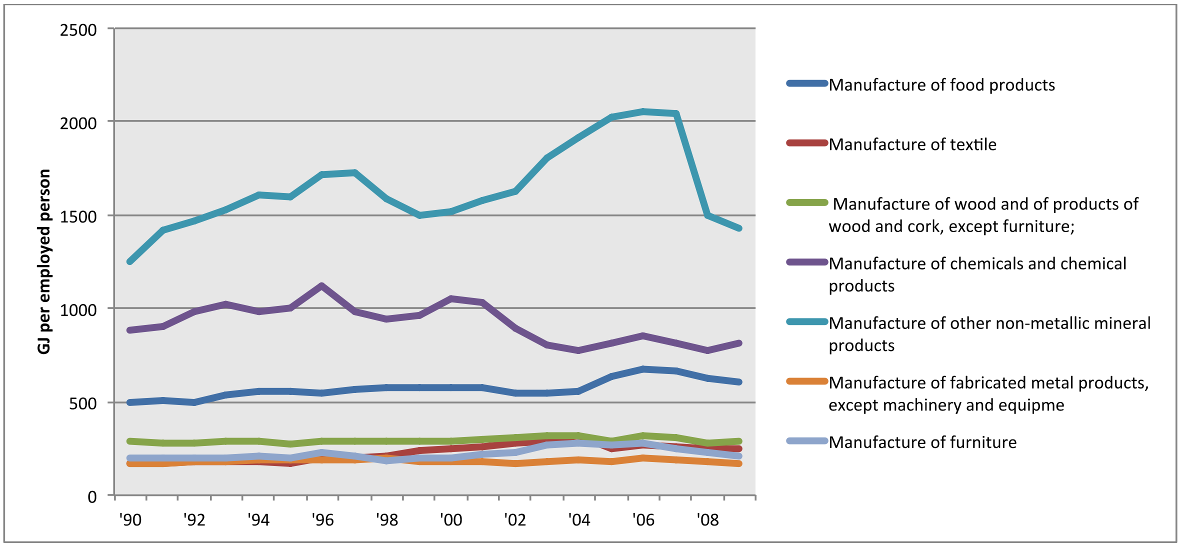




Source: SEEA-E Table X.X

7.75. Figure 7.26 puts energy use by manufacturing industries in relation to the number of persons employed by the same industries. The energy use per person varies considerable between the manufacturing industries. Further, it can be seen that there has not been a decoupling between energy use and employment for the period as such. This is connected to an increased productivity measured as value added per person. However, in periods we observe a fall in the energy use per person, for instance at the end of the period. This can be interpreted as a result of a productivity fall during the crisis, which have curbed the production activities and the energy use, but not the employment to the same degree.

Figure 7.26 Use of energy per person employed in selected manufacturing industries



Source: SEEA-E Table X.X

2. Factors behind the development in energy use

7.76. In order to shed light on the factors behind the development in energy use so-called structural decomposition analysis based on input-output modelling can be applied. Structural decomposition analysis is a well-established method and reference can be made to a large number of articles of reports describing the method and presenting results (e.g. <references>).

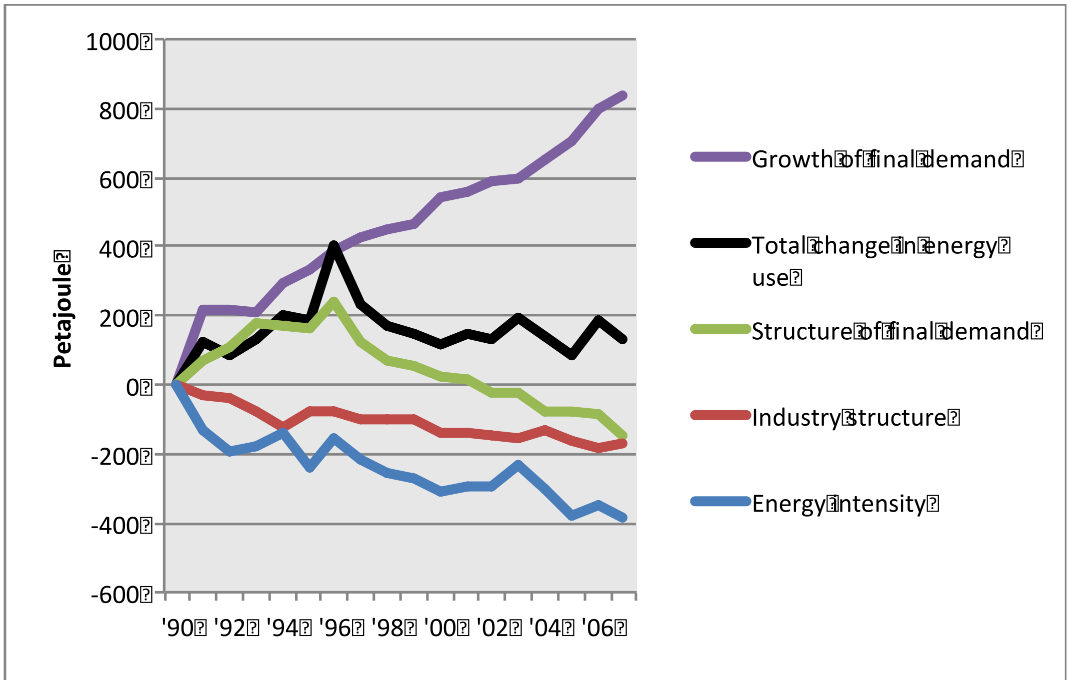
7.77. Figure 7.27 presents the results of such an analysis. The black curve shows thetotal change in actual energy use by industries excluding the transportation services (the transportation services have been excluded here because they show a pattern which is much different from the other industries). Over the period the actual energy use increased by more than 100 petajoules. The other curves show how the development in actual energy use can be explained by the increase in the growth of final use/demand (i.e. private and government consumption, exports, gross fixed capital formation, etc.), the composition of the final demand, the industry structure and the energy intensities of the industries.

7.78. The interpretation of the steep increasing curve for final demand is that if all other factors (energy intensities of the industries, composition of final demand, etc.) had been the same during the period then the use of energy would have increased by more than 800 petajoules instead of the 100 petajoule.

7.79. However the otherfactors pulled energy use down. Most noteworthy is the effect from reduced energy intensity in industries, i.e. their use of energy per unit of output. This factor alone pulled energy use down by close to 400 petajoules. Changes in the composition of final demand (i.e. which products were demanded) and the industry structure (i.e. how did the industries interact) both contributed to reduced emissions at a little less than 200 petajoules each.

7.80. It should be noted that this analysis, and others based on input-output modelling, cover a shorter period than many of the other time series in this chapter. This is due to the fact that that input-out put tables are normally published with a larger time lag than other statistics.

Figure 7.27The change in industries[1)] energy use and the factors behind the change



[1)]Excluding transportation services

Source: Based on SEEA-E Table X.X and input-output modelling

F. Consumption, production chains, imports and energy use

7.81. This section extends the analysis of energy use along the production chains, which ultimately leads to the final use of products. First it is shown how total energy use of a country is related to the main final use categories of the economy including private consumption, government consumption, accumulation and exports. Then, the scope is enlarged for the households consumption by including also the energy uses in the production chains activated abroad by the imports to the country. Thereby a picture of the total global energy use caused by the domestic consumption is drawn up.

1. Energy use caused by final use of products

7.82. Increasingly, in relation to sustainable production and consumption policies, there is focus on the fact that resource use and environmental pressures can be seen from the perspective of the final use and consumption of products. The rationale is that any kind of final use initiates a production chain including domestic and foreign activities. Therefore, the resource uses and the environmental pressures, which occur at the production level, can in fact be seen as being caused by the final use, which have initiated the production chain.

7.83. The allocations of energy use by final use categories or specific products used can be done by the application of input-output analysis.

7.84. Figure 7.28 shows the results of an input-output model based allocation of the total domestic energy use to the overall final use categories, which lies behind the production and corresponding energy use in all industries.

7.85. The figure shows that the steep increase in energy use between 1990 and 2007 was mainly related to an increase in export activities. In contrast the private and government consumption and the gross fixed capital formation, etc. caused almost the same energy use in industries in 2007 as in 1990. It is also worth noting that it is the export activities, which lies behind most of the energy use by industries.

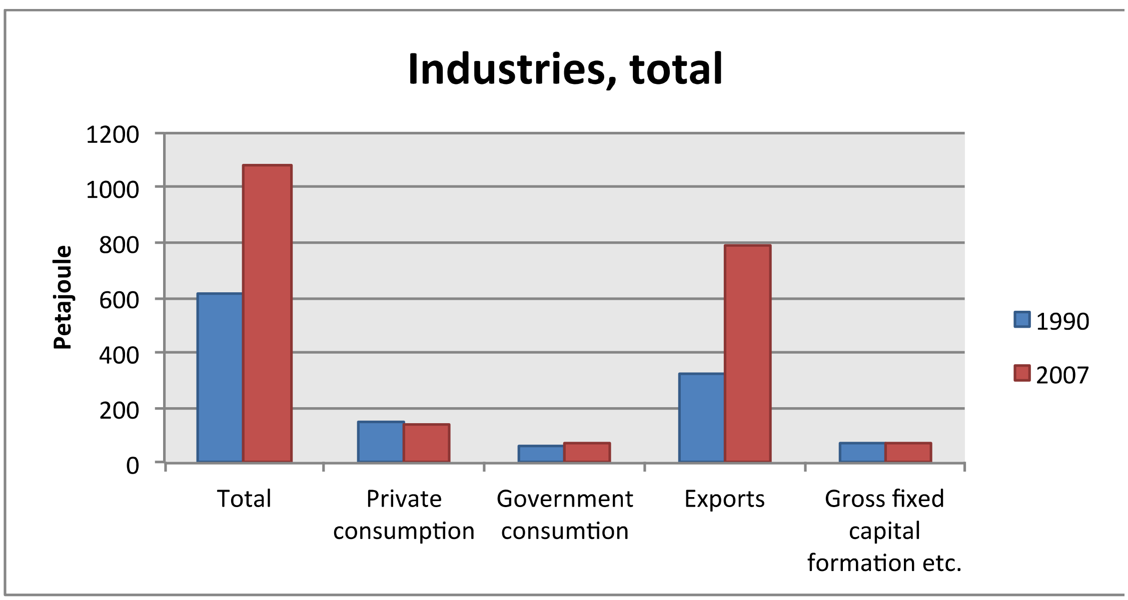
7.86. Figure 7.29 shows the same analysis but now broken down by industry groups. The figure clearly shows that the activities and energy use of the different industries are prompted by different final use categories

7.87. Exports are behind the energy use of agriculture, etc., manufacturing, and transport services, and it is the increase in exports of transport services that lies behind much of the increase in energy use.

7.88. Private consumption is the main factor behind the energy use in the energy supply industries, wholesale and retail trade industries and the finance and business activities.

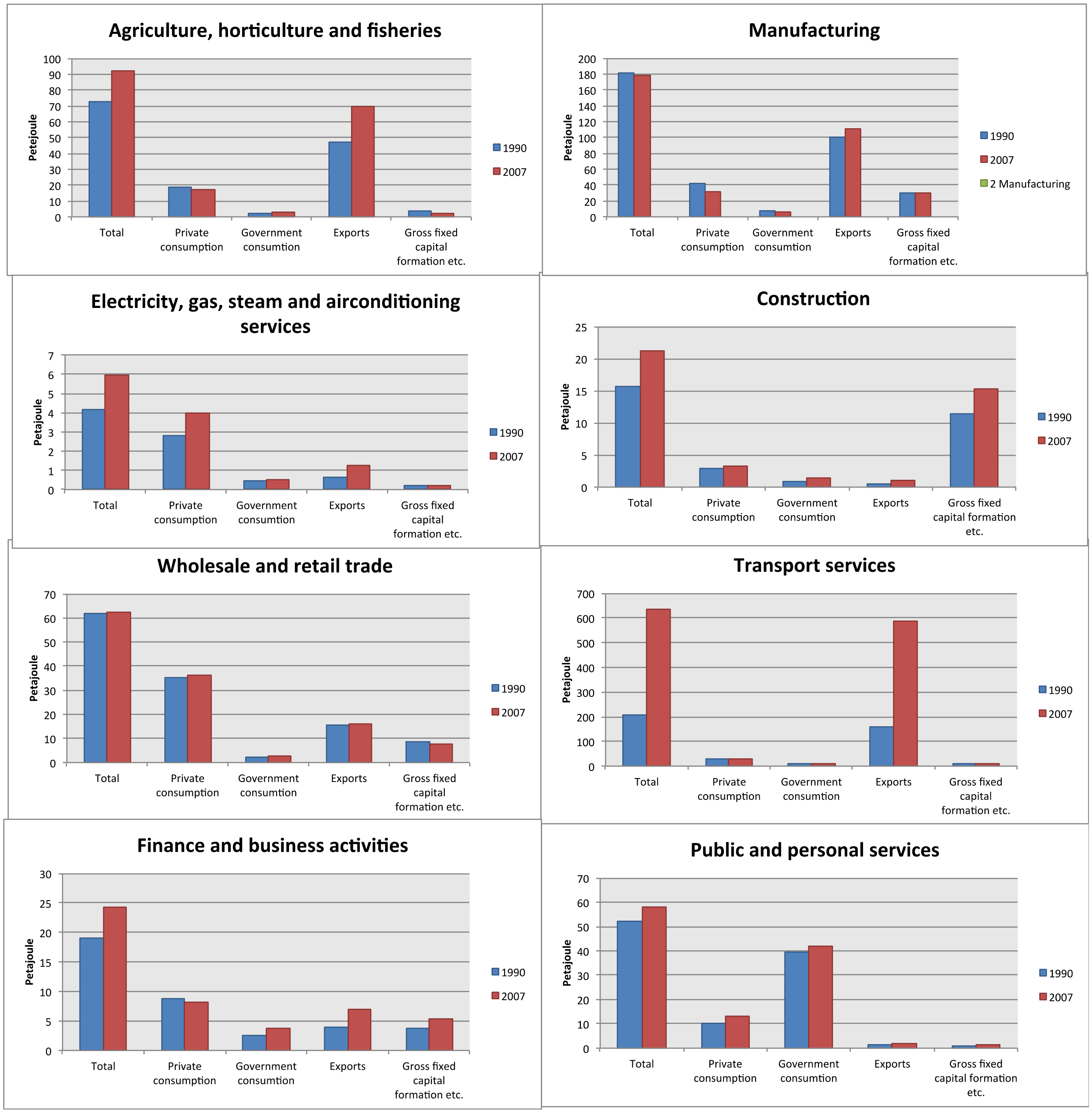
7.89. Finally, gross fixed capital formation and government consumption are the driversof energy use in the construction industry and public and personal services industry, respectively. However for the latter the private consumption is not without significance.

Figure 7.28Industries'energy use by causing final use categories



Source: Based on SEEA-E Table X.X and input-output modelling

Figure 7.29Energy use of industry groups by causing final use categories



Note: the scales of the y-axis of the different figures are not the same.

Source: Based on SEEA-E Table X.X and input-output modelling

2. Domestic and global energy use caused by household consumption

7.90. For each of the final use categories it is possible to analyse the energy use in the production chains further by distinguishing between the final uses of different products. As an example of such analysis Figure 7.30 presents results for the household consumption. The upper part of the figure shows how much energy is used directly and indirectlywhen one currency unit is spend on the product by households. In the example hot water and steam, etc. is the most energy intense of the energy products, while gasoline and diesel, etc. is the least energy intensive. It should be noted that the intensities are calculated from purchasers' prices, which means that energy taxes are included. Therefore, products, which are heavily taxed appears to have lower energy intensity per unit of currency.

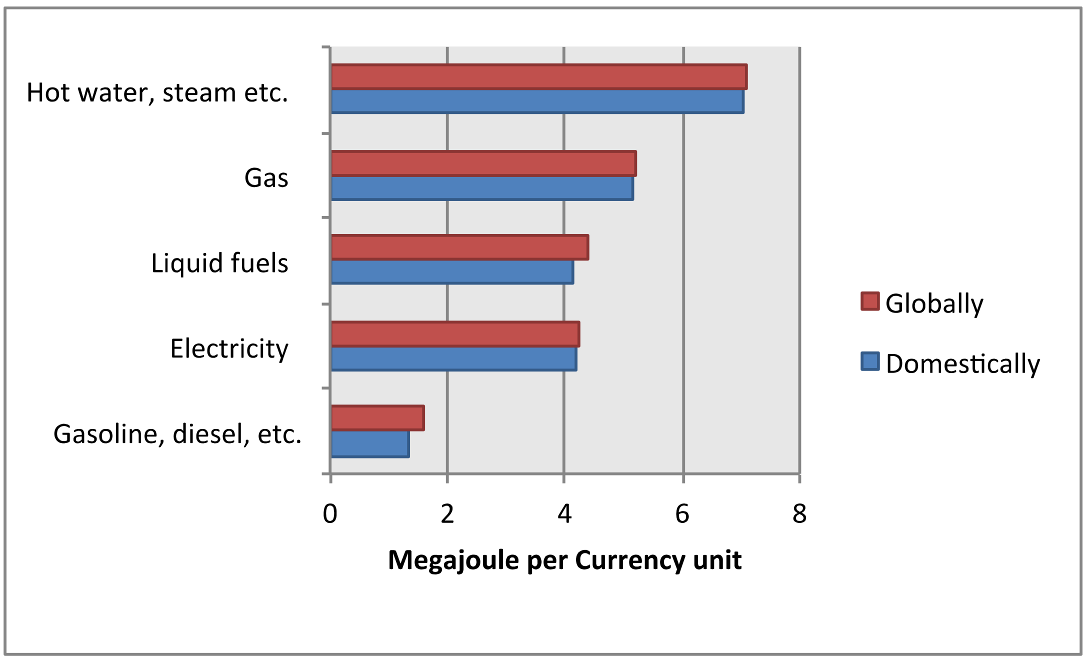
7.91. For other types of products it is clear that food is the most energy intensive product group followed by beverages and tobacco, furnishing and clothing, etc.

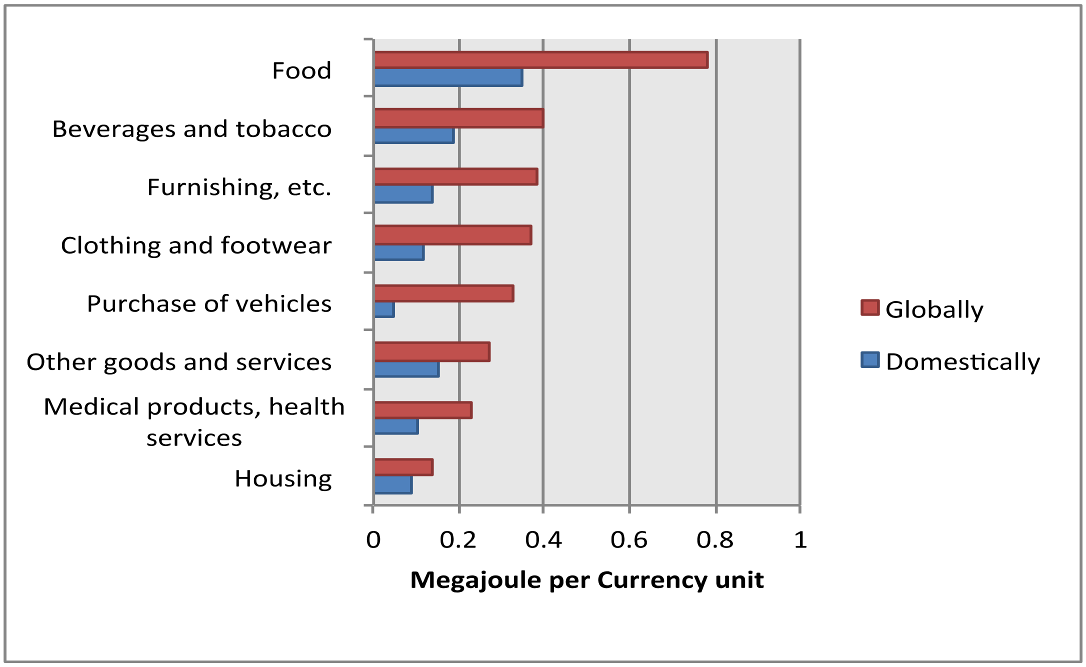
7.92. The blue bars illustrate the energy used domestically, while the red bars illustrate energy used in the production processes both domestically and abroad. The latter production processes are those that are activated abroad from the imports of both products used directly by the households and products used for intermediate consumption by the industries in the production chain.

7.93. For energy products the difference between embedded domestic energy use and global energy use is not big in this example case since most energy products used by households are produced domestically by the use of energy extracted domestically.

7.94. For other products there are a considerable difference between the domestic and the global emissions. Generally, the global energy intensities are two times bigger than the domestic intensities. This reflects partly that many of the products used by households have been imported, partly that the industries in the production chain also uses imported products, which require energy use abroad.

Figure 7.30 The domestic and global energy intensities of private consumption





Note. The scales on the x-axis of the two figures are different

Source: Based on SEEA-E Table X.X and input-output modelling

G. Energy use and air emissions

1. Introduction

7.95. This section deals with energy related air emissions. One important use of the physical use table for energy is the calculation of air emissions, and the first part of this section describes how accounts for energy related emissions might be set up. The second part presents results from modelling based on the energy accounts and the emission accounts. The results show which factors that underlie the development in energy related emissions.

7.96. Energy related air emissions contribute to the main part of most types of air-emissions because almost all economic activities are connected to the combustion of energy. Combustion processes take place in many production and consumption activities, such as heating of houses and buildings, production of electricity, various industrial processes and transportation.

7.97. The SEEA-E energy accounts may be used as the basis for the establishment of accounts of energy-related air-emissions. Such emissions accounts is then compatible with the SEEA and the SEEA-E physical flow accounts, and, more generally, with the National Accounts principles with regard to the definition and classification of economic activities.

7.98. The term ‘Air Emissions Accounts’ is distinguished from the term ‘emission inventories’. The latter is commonly used when referring to data on greenhouse gas emissions and emissions of air pollutants assembled following certain formats as agreed upon under international conventions (e.g. United Nations Framework Convention on Climate Change, UNFCCC and the Convention on Long Range Transboundary Air Pollution, CLRTAP). Emission inventories are rather technology-oriented and may serve as the appropriate data basis for technology oriented questions and analyses. In contrast, air emissions accounts are economically oriented and assign air emissions to those economic entities that actually are carrying out the activities from which the air emissions are originating. Air emissions accounts are developed to answer more economically oriented questions and analyses. Both information systems – emission inventories and air emissions accounts – complement each other. (Eurostat, 20091, p.9).

7.99. The presentation of energy related air emission accounts in this section is developed in continuation and accordance with Chapter 5 of SEEA-E on the physical flow accounts on energy.

2. Use of energy accounts for estimation of emissions

Table 7.30 shows a detailed supply table for CO_2 emissions. Similar tables are relevant for all types of air emissions originating primarily or to a significant degree to the use of energy, and they can be established in the same way as the account for CO_2 emissions.

Generally, the emission accounts for energy related emissions can be established on the basis of the energy use table (Table 5.6) by multiplying the energy use recorded in the energy use table by a technical emission factor expressing the emission per unit of energy use. Formally it can be expressed by:

Emissions (E) = Energy use (EU) x Emission Factor (EF)

It should be noted that in practice, it is necessary to carry out the estimations at a more detailed level detailed level than presented in Table 5.6 and 7.30 in order to ensure that the emission factors are representative for the activity and the energy use in question. Thus, it is necessary to distinguish between all energy products, which have different emission factors, and for other air emissions types than CO_2it may also be appropriate to make a breakdown by types of technologies within industries if the choice of technologies influences the amount of air emissions per unit of energy used. In *Manual for Air Emissions Accounts*[2] published by Eurostat, more information can be found on how air emission accounts can be established on the basis of energy accounts.

7.100. The table presents the quantities of CO_2 emissions generated by the use of the various types of energy. Thus, the items in the leading column of table 7.30 correspond to those items in the energy use table (Table 5.6), which are of interest in relation to air emissions. The items in Table 5.6, which represent extraction of energy resources are not relevant for the air emissions accounts, and are not included in Table 7.30.

7.101. In order to underline the correspondence to the energy use table, the detailed breakdown, identifying those industries, which usually are major users of energy, and thus usually also major emitters of CO_2, are presented specifically.

7.102. The air emissions data related to energy use are allocated to the economic activities in consistency with how the energy use is recorded. In other words, if for a specific unit (industries and households) use of energy for combustion is recorded, then the corresponding emissions are attributed to the unit in question.

7.103. It follows that the use of certain types of converted energy does not lead to recording of emissions. This is the case, for instance, for the use of electricity and heat by industries and

[1]Manual for Air Emissions Accounts.Methodologies and working papers, Eurostat, 2009.

[2]*Manual for Air Emissions Accounts*. Theme: Environment and energy. Methodologies and working papers. Eurostat, 2009

households. Instead emissions are recorded for the electricity and heat producers' use of e.g. coal and oil for the production of the electricity and the heat. Since the main part of the production often takes place within ISIC D Electricity, gas steam and air conditioning supply, this is where the main part of these emissions is normally recorded. Other parts of these emissions are recorded for other industries, to the extent that combustion of energy products for electricity and heat generation takes place there for own use or for sale.

7.104. Emissions related to the use of gasoline and diesel, etc. for transport are similarly attributed to the units carrying out the transport activities. Thus, only parts of the emissions are allocated to ISIC H Transportation and storage, while other parts are attributed to the households and industries, which use the petrol and diesel, etc. For households, the transport related emissions include the use of energy for private cars. Energy use and emissions caused by public transport are attributed to ISIC H.

7.105. In order to complete the picture of the CO2 emissions, the non-energy related CO_2 emissions are presented in the table in the bottom of the table. These non-energy related emissions has to included based on additional information, for instance, from the emission inventories made up in relation to for instance the United Nations Framework Convention on Climate Change, UNFCCC.

Table 7.30 Supply table for CO_2 emissions based on the SEEA-E energy use table

	Industries by ISIC																	Consumption			Capital	Total residents	ROW		Total supply
	A	B	of which B. 05	of which B. 06	C	of which C. 19	of which C. 2011	D	of which D. 351	of which D. 352	of which D. 353	E	F	G	H	I-U	A-U								
	Agriculture, forestry and fishing	Mining and quarrying	*Mining of coal and lignite*	*Extraction of crude petroleum and natural gas*	Manufacturing	*Manufacture of coke and refined petroleum products*	*Manufacture of basic chemicals*	Electricity, gas steam and air conditioning supply	*Electric power generation, etc.*	*Manufacture of gas; distribution, etc.*	*Steam and air conditioning supply*	Water supply; etc.	Construction	Wholesale and retail trade; etc.	Transportation and storage	Other Industries	**1. Total industries**	*of which residents in the rest of the world*	Own account transport	Other consumption	**2. Total Consumption**	**3. Emissions from equipment, durables, landfills, etc.**	**4. Total supply of air emissions by residents**	**5. Cross boundary inflows from the ROW by air currents**	**6. Emissions by non-residents on national territory**	**7. Supplied by residents and RoW (=1.-6.)**
	1000 tonnes																								
Energy related emissions																									
1. Coal, coke, gas work gas and peat																									
a) Coal, coke and peat	203	14			1 693			21 472	*16 207*		*5 265*						**23 382**			59	**59**		23 441			**23 441**
Use of products received from other units	203	14			1 693			21 472	*16 207*		*5 265*						23 382			59	59		23 441			23 441
Own use, etc.																										
b) Gas work gas					1									1		1	**3**			24	**24**		27			**27**
Use of products received from other units					1									1		1	3			24	24		27			27
Own use, etc.																										
2. Oil	2 039	149		*1*	2 693	*930*	*1*	1 263	*978*	*5*	*280*	2	1 406	1 130	48 160	1 214	**58 056**	*43 509*	5 950	2 504	**8 454**		66 510		100	**66 610**
Use of products received from other units	2 039	149		*1*	2 583	*930*	*1*	1 263	*978*	*5*	*280*	2	1 406	1 130	48 160	1 214	57 946	*43 509*	5 950	2 504	8 454		66 400		100	66 500
Own use, etc.					110	*110*											110						110			110
3. Natural Gas	115	1 728		*1 603*	2 211	*2*	*1*	4 705	*2 664*	*29*	*2 013*		21	236	26	433	**9 475**			1 606	**1 606**		11 081			**11 081**
Use of products received from other units	115	125			2 211	*2*	*1*	4 705	*2 664*	*29*	*2 013*		21	236	26	433	7 872			1 606	1 606		9 478			9 478
Re-injection																										
Own use, etc.		1 603		*1 603*													1 603						1 603			1 603
4. Electricity																										
Use of products received from other units																										
Own use, etc.																										
5. Heat																										
Use of products received from other units																										
Own use, etc.																										
6. Renewable fuels and waste																										
a) Solid biomass and wastes	263	9			396			6 636	*2 355*		*4 282*					85	**7 389**			3 391	**3 391**		10 780			**10 780**
Use of products received from other units	263	9			396			2 944	*1 493*		*1 452*						3 613						3 613			3 613
Own use, etc.								3 692	*862*		*2 830*						3 692						3 692			3 692
b) Liquid biofuels and biogas	25				14			126	*87*		*39*						**165**						165			**165**
Use of products received from other units																										
Own use, etc.	25				14			126	*87*		*39*						165						165			165
Energy related emissions, total	**2 645**	**1 900**		***1 604***	**7 008**	***931***	***2***	**34 202**	***22 290***	***34***	***11 879***	**2**	**1 427**	**1 367**	**48 186**	**1 733**	**98 471**	***43 509***	**5 950**	**7 584**	**13 534**		**112 004**		**100**	**112 104**
Non-energy related emissions, total		**425**		***425***	**1 465**												**1 890**						**1 890**			**1 890**
Total air emissions	**2 645**	**2 324**		***2 029***	**8 473**	***931***	***2***	**34 202**	***22 290***	***34***	***11 879***	**2**	**1 427**	**1 367**	**48 186**	**1 733**	**100 360**		**5 950**	**7 584**	**13 534**		**113 894**		**100**	**113 994**

Source: Calculation based on SEEA-E Table X.X and technical emission coefficients (at detailed level)

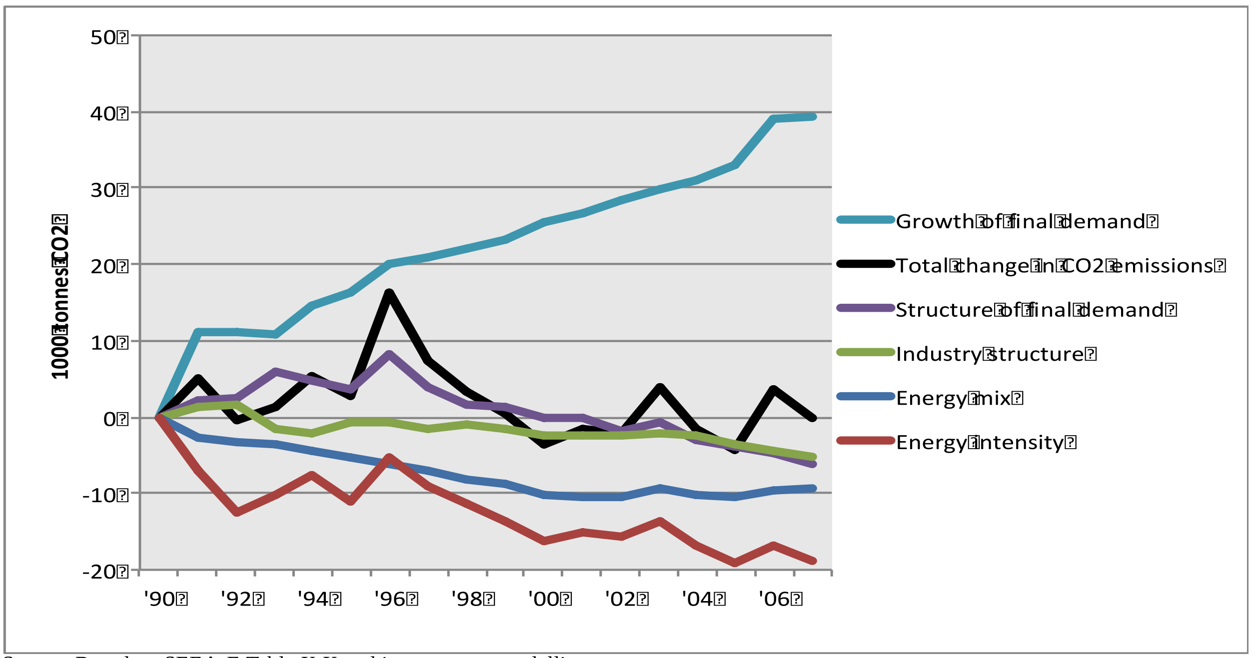
3. Analysis of energy related emissions based on the energy accounts

7.106. Once the emissions accounts have been set up based on the energy accounts it is possible to extend the analysis presented in Section E.2 (Figure 7.27) above to deal with the factors underlying the development of the energy related emissions. Figure 7.31 presents the results of such analysis.

7.107. The black curve presents the change in CO_2 emissions since 1990, and the other curves the underlying factors: Growth of final demand, structure of final demand, industry structure, the energy mix and the energy intensity.

7.108. In parallel to the case of energy use it can be seen that the growth would have increased CO_2 emissions considerable in the period if it hadn't been for other factors dampening the total emissions. In addition to the structural changes in both final demand and industries and the reduction in energy intensities also a change in the energy mix have contributed to dampen the CO_2 emissions. Changes in the energy mix means that industries and household increasingly are using other and less CO_2 intensive energy products. Examples of such a change in energy mix are substitution of natural gas for coal and substitution of fossil based electricity for wind energy.

Figure 7. 31 The change in industriesCO_2 emissions and the factors behind the change



Source: Based on SEEA-E Table X.X and input-output modelling

H. Summarising the development - Indicator systems

7.109. The SEEA-E Energy accounts can be used as basis for the establishment of energy indicator systems.

7.110. Energy indicators are useful tools to summarize information and monitor trendsreflecting various aspects of a country energy situation over time. The choice of the set of indicators compiled by a country depends on the nationalcircumstances and priorities, sustainability and development criteria and objectives, as well asdata availability. (IRES, 2011, 11.27-11.28). Often indicator systems focus on the long-term trendsand they are often intended to show the overall development and the big picture.

7.111. Using SEEA-E as basis for an energy indicator system is instrumental in increasing the transparency, quality, completeness and coherence of the energy indicators.The advantage of using SEEA-E as a basis for an energyindicator systemis that all information on the energy is consistent and coherent with information on economic activities from the national accounts, for instance the gross domestic product, GDP.

7.112. It is not the aim of this section to present a comprehensive and complete energy indicator system, but merely to flag that the SEEA-E energy accounts include much of the information, which countries normally wish to present in relation to energy indicator systems.

7.113. Table 7.6 presents an example of energy indicators, which can be derived directly from the SEEA-E accounts. The indicators are related to non-exclusive areas of broad areas of interest such as energy use, decoupling, efficiencies, etc. In relation to indicator systems a grouping of the indicators according to whether they reflect economic, social or environment issues are seen (see e.g. IRES, 2011, 11.29). However, table 7.6 uses broader categories in order to underline the diversity of the indicators, which can be derived from SEEA-E and the national accounts.

7.114. Some of these indicators have already been presented in the previous sections of this chapter to which reference is made for additional information and actual examples of howthe indicators can be presented and used in practice

Table 7.6Examples of energy indicators, which can derived from SEEA-E

Area of interest [1]	**Main Indicators**	**Sub-indicators**	**Information obtained from SEEA-E and national accounts, etc.**
Energy use	**Energy use** **Energy use per capita**	By industries/households and by products	Total domestic end use of energy including transformation and distribution losses Population
Decoupling and Environment	**Energy use per GDP (decopupling)** **Share of renewable energy** **CO_2 emissions from energy use**	By industries/households, By renewable/non-renewable energy	Use of renewable energy Energy related CO_2 emissions
Energy efficiencies	**Energy intensity/efficiencies** **Efficiency of energy conversion and distribution** **Direct and indirect energy use by consumption groups**	By industries By consumption groups	End use incl. losses Losses of energy in transformation Direct and indirect energy use by consumption groups (production chain) – IO-based
Trade and dependencies	**Energy trade balance** **Energy import dependency/self sufficiency** **Inventories of energy products**	By energy products	Imorts and exports expenditures Primary supply/end use incl. losses, imports in physical units Inventories of energy products
Government budget	**Government revenues releted to energy** **Energy taxes** **Energy subsidies**	By energy product and tax type	Revenues from energy related rent payments, energy taxes less subsidies, curent and capital transfers Energy taxes, including CO_2 taxes Energy related subsidies
Industries	**Industries' energy costs, share of intermediate consumption** **Industries' energy costs, share of value added**	By industries	Households' total consumption expenditures and expendiures for energy Industries' expenditures for intermediate consumtion
Household and social issues	**Share of energy energy costs in households' total consumption expenditures** **Direct energy use by purpose**		Industries' value added
Resources and wealth	**Energy resource stock value, share of GDP** **Reserves to production ratio (R/P)** **Depeletion of energy resources, share of GDP**	By type of energy ressource	Commercial energy resources, physical stocks Extraction of energy, physical Opening stock value

[1] These areas are not mutually exclusive