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Preface

This publication summarises the numerical results and methodological findings of a first round of pilot studies of a framework for integrated environmental and economic accounting for subsoil assets. This publication was only possible due to the essential contributions made by the members of the Eurostat Task Force on Subsoil Assets created in 1996. The Task Force met in March 1996, November 1996, January 1998 and June 1999 to discuss and develop a framework for subsoil asset accounting.

Special thanks are therefore due to the members of the Eurostat Task Force on Subsoil Assets:

- I. Fuchs (Statistics Austria),
- G. Brilhault and G. Moreau (INSEE - France),
- M. de Haan, M. Pommée and P. van de Ven (CBS – The Netherlands),
- T. Halvorsen and S. Todsen (Statistics Norway),
- R. Harris, H. Neuburger, S. Penneck and P. Vaze (ONS – United Kingdom)

Contributions to the work of the Task Force on Subsoil Assets and to this publication also came from many other experts. The publication was prepared by Steinar Todsen of Eurostat B1 and Gérard Gie of Planistat Europe under the responsibility of Anton Steurer of Eurostat B1.

This publication is one of the outputs of Eurostat's Environmental Accounting work. It contributes to various EU-wide and international activities in the context of national accounts and of environmental accounting, including the implementation of the European System of Accounts (ESA 1995) and the revision of the United Nations' System of Integrated Environmental and Economic Accounting (SEEA).

The pilot studies benefited from substantial financial support provided by the European Commission's Directorate General Environment, in the context of the Communication from the Commission to the Council and the European Parliament on "Directions for the EU on Environmental Indicators and Green National Accounting - The Integration of Environmental and Economic Information Systems" (COM(94) 670).

As a result of the experience gained from the pilot studies reported in this publication, a set of standard tables is being developed, in order to collect data from more Member States.

Brian Newson
Head of Unit B1
National accounts methodology,
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1 Introduction

In the « Directions for the EU on Environmental Indicators and Green National Accounting »[1], the Commission calls for continuing and enlarging work on satellites to national accounts (environmental expenditures, establishing natural resource accounts, improving knowledge of methodologies for environmental damage assessment and monetary valuation).

The subsoil asset accounts are part of the development of integrated environmental and economic accounts, and are developed as satellite accounts to the ordinary national accounts. Satellite accounts extend the definitions used in the core national accounts framework, as described in the European System of Accounts (ESA)[2] and the System of National Accounts (SNA)[3], or present the information in a different way.

The aim of the subsoil asset accounts is to give a description of stocks and flows of subsoil assets in physical and monetary terms, linked to the ordinary national accounts. The results are presented in the form of balance sheets and accumulation accounts similar to those found in the ESA. The main difference compared to the ESA is that the subsoil accounts use a wider definition of reserves.

In 1996 Eurostat started a Task Force in order to examine the issue of subsoil assets in the context of environmental accounts. The Task Force met four times, in March 1996, November 1996, January 1998 and June 1999. Norway, France, the Netherlands and the UK participated in the four meetings, while Austria joined the Task Force in January 1998.

The Task Force focused on the valuation of reserves more than on broader environmental accounting issues, such as pollution related to extraction and consumption of fossil fuels. It was decided to focus mainly on oil and natural gas, since these are the subsoil assets of greatest economic importance in the EU/EEA countries. The Task Force developed its work in four main directions:

- definition of the reserves to be taken into account,
- definition of the resource rent,
- calculation of the value of reserves,
- ownership issues.

The treatment of “depletion” of resources in a wider national accounts context, such as making adjustments to GDP or NDP was not explicitly discussed, but left to the London Group on Environmental Accounting and to the National Accounts Working Party.

At the January 1998 meeting, a set of tables was agreed upon and volunteer countries carried out pilot studies. The results obtained from the pilot studies were discussed at the final meeting of the Task Force in June 1999 and were presented to the Working Party ‘Economic Accounts for the Environment’ in September 1999[4].

Since September 1999, more work has been done in this area. Denmark compiled asset accounts for oil and gas using the framework agreed upon by the Task Force. The Netherlands made a study comparing the resource rent estimates with the government’s income from taxes and dividends on the extraction of oil and gas and made a preliminary estimate of the value of the reserves based on the government’s income. The UK revised its accounts for oil and gas in both physical and monetary terms, while Norway made some revisions to the monetary accounts, based on the final recommendations of the Task Force. France updated its asset accounts for oil and gas until 1999, and made some revisions to the previous years. Austria revised its physical accounts for oil and gas.

This report reviews the methods used and results obtained in the pilot studies. The objective is to provide an insight into the experience gained and progress made in linking subsoil asset data to the national accounts. This should enable to pave the way for further integration of economic and environmental concerns about subsoil assets.

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[1] Commission of the European Communities (1994).
[2] Commission of the European Communities (1996).
[3] Commission of the European Communities et al (1993).
[4] See Eurostat (1999a).

The presentation of the results of the pilot studies is based on the authors' contributions and views (see references) and does not imply the expression of any opinion of the national statistical institutes involved. The data set out in this report are the result of pilot studies and should not be considered as final.

The report is organised as follows:

Section 2 provides a summary of the main findings from the pilot studies. This summary also illustrates the kind of indicators and accounting aggregates that can be directly derived from the tables of the subsoil accounting framework.

Section 3 gives an overview of the international development in the area of subsoil asset accounting.

Sections 4 and 5 describe the methodological issues that have been addressed in the pilot studies and provide conclusions and recommendations for future refinements.

Section 6 contains comparative tables that are based on the aggregation and analysis of the data provided by the pilot studies.

Annex 1 presents the detailed subsoil accounts tables for each country.

Annexes 2 to 5 present examples that illustrate some specific issues related to the valuation of subsoil assets and their recording in the national accounts.

2 Summary of findings and results

Based on the results of the pilot subsoil asset accounts and some additional information from other sources, the following overview of oil and gas in the European Union (EU-15) and the European Economic Area (EEA, consisting of the 15 EU Member States and Liechtenstein, Iceland and Norway) can be given:

- The total reserves of oil and NGL (natural gas liquids) in the EEA can be estimated to 6.3 billion tonnes at the end of 1996, based on the pilot subsoil asset accounts, and supplemented with estimates from the World Energy Council (1998). This is about 3% of the world total, estimated by the WEC to be around 200 billion tonnes in 1996. The total reserves of oil and NGL in EU-15 are estimated to 2.1 billion tonnes, or 1% of world reserves.

- Based on the same sources, the total reserves of natural gas in the EEA can be estimated at 10.4 trillion cubic meters (m^3) at the end of 1996. The reserves in EU-15 were 4.9 trillion m^3. The WEC estimates the world total to between 300 and 450 trillion m^3.

- At the 1996 rate of extraction, the oil reserves in the EEA would last about 20 years, and the gas reserves 38 years. For the EU-15, oil reserves would last 13 years and gas reserves 21 years.

- In 1996, the gross inland consumption of crude oil was 588 million tonnes in EU-15 and 15 million tonnes in Norway, see Eurostat (1999b). Gross inland consumption of natural gas was 363 billion m^3 in EU-15 and 3 billion m^3 in Norway. At the 1996 rate of consumption, the oil reserves in the EEA would last about 10 years, and the EU-15 oil reserves would last less than 4 years. The EEA gas reserves would last 28 years and those of EU-15 13 years.

- Norway and the UK are the countries with the largest expected reserves of oil in the EEA, with 4.17 and 1.64 billion tonnes respectively, at the end of 1996.

- Norway, the Netherlands and the UK are the countries with the largest expected reserves of gas in the EEA, with 5.49, 1.93 and 1.86 trillion m^3 respectively, at the end of 1996.

- The definitions used by the institutions compiling physical reserve estimates often differ between countries, making direct comparisons of reserves difficult.

- Stocks of reserves generally decrease less over time than the amount extracted. Often, the stocks even increase over time. This reflects new discoveries and reassessments of the stocks.

- The total resource rent, or net income from extraction, in 1996 for oil and gas in Norway, the Netherlands and the UK was about 23 billion ECU. These three countries produced 93% of the oil and 80% of the gas in the EEA in that year. The total value for the EEA can be estimated to be about 26 billion ECU, with 17.5 billion for EU-15.

- The resource rent shows large fluctuations from year to year, following fluctuations of oil and gas prices.

- In the pilot subsoil accounts, the values of the reserves of oil and gas are estimated as the present value of the expected future resource rent. The value estimates are highly dependent on the assumptions made about the future resource rent, and often show large changes from year to year.

- At the end of 1996, the value of the reserves of oil and gas in Norway, the Netherlands and the UK was estimated to about 320 billion ECU. These three countries have about 94% of the total EEA reserves of oil in physical terms, and 89% of the gas reserves. The total value for the EEA can be estimated to be about 350 billion ECU, with about 205 billion for EU-15.

3 European and international context

Accounts for subsoil assets have been developed in several countries over the past decade, as part of the broader development of integrated environmental and economic accounts. Outside Europe, subsoil asset accounts have been compiled in Australia, Canada and the United States and in several developing countries. Among the EU/EEA countries, Austria, Denmark, France, the Netherlands, Norway, Sweden and the United Kingdom have compiled pilot subsoil asset accounts.

The subsoil asset accounts in different countries differ somewhat in methodology and scope. In Europe, the focus has been mainly on oil and gas, which are the subsoil assets of greatest economic importance in this region. Countries like Australia, Canada and the United States, with their wider resource bases, have also included metals and other minerals in the accounts.

Although subsoil assets are included in the balance sheets and accumulation accounts of the standard national accounts, as defined in the SNA and ESA, few countries have implemented this part of the system yet. The subsoil asset accounts have generally been developed as satellite accounts to the ordinary national accounts. Until now there have been few established international standards for the compilation of subsoil accounts. The topic has been discussed, together with other areas of environmental accounting, in a series of international meetings. Since 1994, the discussions have mainly taken place in the annual meetings of the London Group on Environmental Accounting. During the last couple of years, the work of the London Group has focused on the development of a revised version of the United Nations System of Integrated Environmental and Economic Accounting (SEEA), published in 1993 (see United Nations 1993). The revised version will be published in 2001, but a draft version is currently available. The definitions and methods recommended in the Draft SEEA (London Group 2000a and b) are consistent with the conclusions of the Eurostat Task Force on Subsoil Assets, described in sections 4 and 5 of this publication.

Some issues related to subsoil asset accounts have also been discussed in two meetings organised by the OECD in 1998 and 1999. The main topic was how to account for depletion, i.e. the reduction of the value of the resource caused by extraction, and whether or not the main national accounts aggregates, such as GDP or NDP should be adjusted to reflect depletion. Adjusting for depletion would require a change to SNA and ESA. So far, no international agreement has been reached on this. See section 5.7 for more detail on this topic.

4 Physical stocks and flows

Subsoil assets are deposits of minerals and fossil fuels. In the ESA they are classified as non-produced, non-financial assets and are divided into three categories:

AN.2121 Coal, oil and natural gas reserves
AN.2122 Metallic mineral reserves
AN.2123 Non-metallic mineral reserves

The Task Force decided to focus mainly on oil and natural gas, since these are the subsoil assets of greatest economic importance in the European Economic Area. The exploitation of non-energy sub-soil asset accounts for a very small part of economic activity everywhere in the EEA. Examination of the net operating surplus for these activities shows that, in most cases, there is actually no resource rent. Coal and metal ore extraction activities are often subsidised. The only exception was quarrying and extraction of non-metallic minerals but these latter activities are rather small in economic terms.

This section discusses the compilation of physical accounts for subsoil assets. The asset accounts include balance sheet accounts showing the stock at a certain date, and accumulation accounts showing changes in the stocks between two points in time.

4.1 Classification of resources

Stocks of subsoil assets are generally not known with certainty. Both the size of the deposits and the profitability of exploration is uncertain.

Possible sources for the basic data on volumes are energy statistics departments, ministries, petroleum directorates, geological survey institutions or extraction companies.

There is no established international standard classification for subsoil assets. Different classification systems are used by the institutions compiling physical data, according to data availability and user needs.

As a starting point for a discussion of resource classification systems, one may use the McKelvey box, which illustrates the classification of resources based on geological and economic criteria.

Table 1: The McKelvey box

		Physical resource base				
		Discovered			Undiscovered	
		Established		Possible	Hypothetical	Speculative
		Proven	Probable			
Economic	**Developed**	X	-	-	-	-
	Non-developed	X	X	X	X	X
Sub-economic		X	X	X	X	X
Non-economic		X	X	X	X	X

The geological dimension classifies the resources according to the degree of certainty. This can vary over time as a result of exploration and development activity. The economic dimension classifies the resources according to the profitability of exploration. This will vary over time with changes in prices and extraction technology.

The two major categories of the geological dimension are **discovered** and **undiscovered** reserves. Discovered reserves have been confirmed by drilling of test wells, while undiscovered reserves are inferred from seismic data and geological models. The discovered reserves can be subdivided into proven, probable and possible reserves, based on the degree of certainty that the reserves will be extracted. Proven reserves are almost certain to be technically and economically producible, while probable and possible reserves have lower probabilities of being produced. The UK Department of Trade and Industry (1998) defines proven reserves as having an estimated probability of at least 90% of being produced. Probable reserves have a chance of between 50% and 90% of being producible, and possible reserves have a probability of between 10% and 50%.

According to ESA § 7.41, subsoil assets are “proven reserves of mineral deposits located on or below the earth’s surface that are economically exploitable given current technology and relative prices….”.

However, as the cost for proving new reserves is often very high (in particular in the North Sea), oil companies only prove the volume necessary for a limited time of extraction, typically 5 to 10 years. Therefore, the volume of proven reserves is not representative of the overall volume of reserves of oil and gas present on the economic territory of EU/EEA countries.

Based on the arguments above, the Task Force decided to consider not only proven reserves, as recommended by the ESA, but also probable and possible reserves, as well as undiscovered reserves. For monetary valuation, only “economically recoverable” resources have a non-zero value in balance sheets. The best estimate to include in the subsoil asset accounts was considered to be the expected, or probability weighted, level of discovered and undiscovered reserves. However, data on all categories, in particular undiscovered reserves, may not be available in all countries. In some countries, reserve data weighted by probability is readily available from the institution that compiles the basic data. If this is not the case, probability weights may be applied to the available reserve categories, before they are added together. The default weights could be 1.0 for proven reserves, 0.5 for possible reserves and 0.1 for probable reserves. Alternatively, the non-weighted sum of proven and probable reserves can be used as a second best estimate for the expected level of discovered reserves: if the probability distribution is symmetric, the expected mean and the median (the 50% probability level) will coincide.

4.2 Changes in reserves

The reserve estimates change over time for several reasons. With reference to the McKelvey box (see table 1), the changes in the reserve estimates between the beginning and the end of the accounting period may be classified in the following way:

Extraction: only comes from proven economic developed reserves.

Development: records the result of the development (installation of the extraction equipment) of a proven economic reservoir. Development is deemed to occur only for proven economic reserves.

Other changes in volume (geological):

> ***Revisions of previous estimates:*** records all revisions of the physical quantities for a category of reserves (other than changes in classification).
> ***Discoveries:*** records the change from undiscovered to discovered (probable or possible). It is assumed that discoveries result from geological and geophysical studies and exploration wells. As a change in geological classification, discoveries may concern economic as well as sub- or non-economic reserves.
> ***From probable or possible to proven:*** results from appraisal wells. It is assumed that changes from probable or possible to proven only refers to economic reserves (if reserves are deemed to be sub- or non-economic, it is unlikely that appraisal wells will be drilled).

Changes in economic classification:

> ***From economic to sub- or non-economic:*** results from a decrease in the price of the extracted product, or an increase in extraction costs.
> ***From sub- or non-economic to economic:*** results either from an increase in the price of the extracted product, a change in technology or other changes in economic conditions.

4.3 Physical resource stocks – experience from the pilot studies

The Task Force developed a first set of tables in order to describe the stocks and flows of the subsoil assets in physical terms. The tables were based on the McKelvey box and the classification of changes described in section 4.2. The participating countries agreed to test the tables in pilot studies.

The pilot studies showed that the data required to fill in such detailed tables were generally not available. Two countries, Austria and the UK, were able to report on raw (non-weighted) volumes. Denmark, the Netherlands and Norway, due to data availability, reported only already weighted data. France reported proven reserves only. Table 2 gives an overview of the sources and definitions of reserves used in the subsoil asset accounts for oil and gas in the EU/EEA countries, and for USA, Canada and Australia.

Table 2: Sources and definitions of reserves used in subsoil asset accounts for oil and gas

	Source of physical resource data	Reserve definition used
Denmark	Danish Energy Agency	Expected level of discovered reserves
France	French Energy Observatory	Proven reserves
Netherlands	Geological Survey of the Netherlands	Remaining expected reserves (corresponds to expected level of discovered reserves)
Austria	Austrian Geological Survey	Sum of proven, probable, possible and undiscovered reserves, weighted by probability
UK	Department of Trade and Industry	Proven plus probable reserves (corresponds to expected level of discovered reserves) and lower bound of undiscovered reserves
Norway	Norwegian Petroleum Directorate	Expected level of discovered and undiscovered reserves
USA	US Geological Survey	Proven reserves
Canada	Canadian Petroleum Association	Established reserves (corresponds to proven and probable reserves)
Australia	Bureau of Resource Sciences	Economic Demonstrated Resources (corresponds to proven and probable reserves)

It had been assumed that some deposits would be known, but would be sub-economic or non-economic with present prices and technology. However, it appeared from the pilot studies that the countries were not able to report on the categories ‘sub-economic’ and ‘non-economic’ reserves. In addition, although the prices of oil and gas, and hence the resource rent, experienced large fluctuations during the period under review, the pilot studies showed no significant changes in the volume of reserves classified as economic. The pilot studies also showed that it was impossible to identify all the flows listed in section 4.2.

As a conclusion, the tables used for the physical description of reserves in the EU/EEA were simplified, with no reference being made to sub-economic and non-economic reserves. Flows were restricted to extraction and other changes in volume. This last category groups together discoveries, revisions of previous estimates, and changes due to changes in price and classifications. If data are available, discoveries should be shown separately.

4.4 Structure of physical tables

Based on the results of the pilot studies, the following two tables for describing the stocks and flows in physical terms were developed:

Table 3: Physical stocks and flows, by category

	Discovered				Undiscovered	Total
	Proven		Probable	Possible		
	Developed	Non-developed				
Opening stocks						
Extraction						
Other changes in volume						
Of which discoveries						
Closing stocks						

This table is used for weighted reserve estimates, and also for un-weighted data if they are available.

A second table, derived from the first, shows a time-series of the stocks and stock changes for the total weighted reserves.

Table 4: Physical balance sheet

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Opening stocks						
Extraction						
Other changes in volume						
Of which discoveries						
Closing stocks						

The units to be used in the tables are million tonnes for oil and billion standard cubic meters (Sm^3) for gas. In some countries, other units are used in the basic statistics, such as barrels or Sm3 for oil and cubic feet for gas. For adding oil and gas reserves, the unit tonne (or Sm^3) of oil equivalent is often used, which is based on the energy content.

Table 5: Conversion factors for North Sea oil and gas

Crude oil	
1 Sm^3	6.29 barrels
1 Sm^3	0.841 tonnes of oil equivalent
1 tonne	7.48 barrels
1 tonne	42300 MJ
1 barrel	159 litres
Gas	
1 Sm^3	35.3 cubic feet
1 Sm^3	0,00084 tonnes of oil equivalent
1 Sm^3	35.54 MJ

Source: Statistics Norway

4.5 Indicators derived from physical balance sheets and accumulation accounts

Based on the data in the physical balance sheets and accumulation accounts for oil and gas, several indicators may be derived:

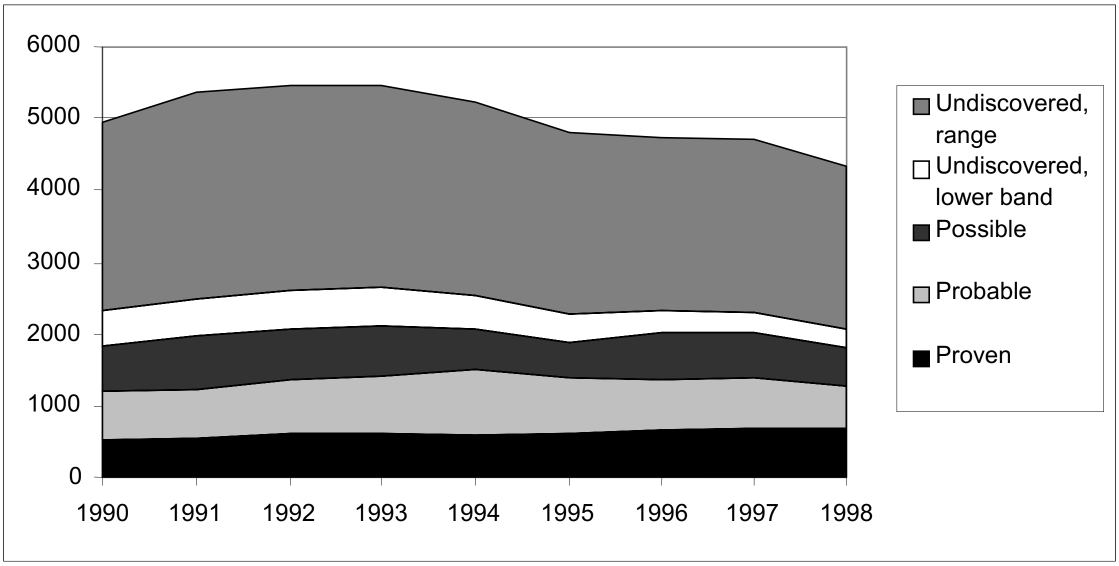
- The level of the stock of reserves.
- The relationship between the different categories of reserves (proven, probable etc.).
- The Reserves/Production (R/P) ratio, which shows the lifetime of the reserves, i.e. the time in years that the reserves would last if production were to continue at the current level.
- The relationship between extraction and other changes in volume is also an indicator for the development of the reserves.

The data used in the examples below are from the pilot studies, for details see section 6 and Annex 1.

4.5.1 Level of different categories of reserves

As an example of a presentation of stock data, figure 1 shows the level of the different categories of oil reserves in the UK. Discovered oil reserves (i.e. proven, probable and possible reserves) have been relatively stable over the period from 1990 to 1998, despite continuing extraction. The estimate of undiscovered reserves, however, has been falling since 1993.

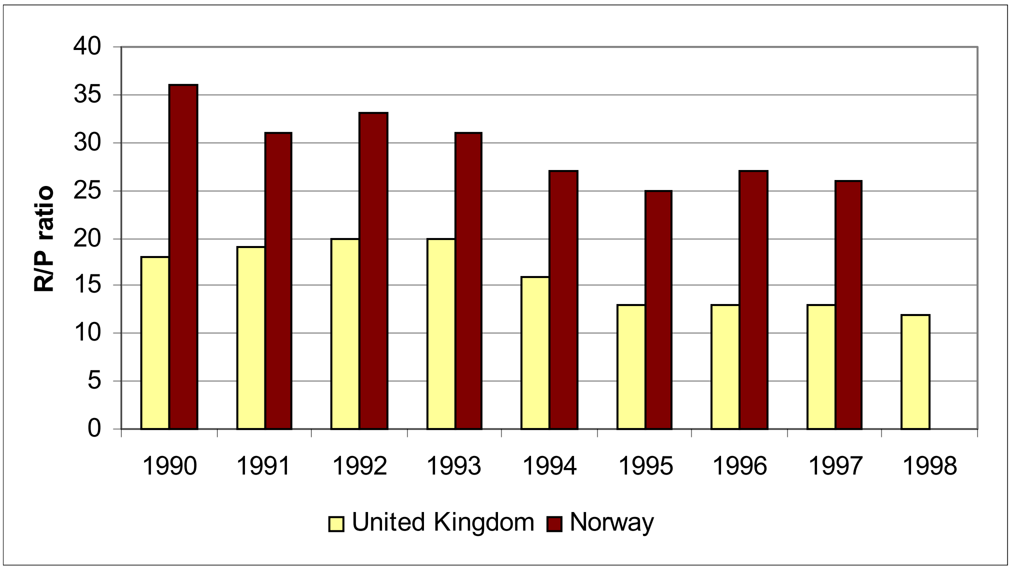
Figure 1: UK oil reserves by category, in million tonnes



4.5.2 The R/P ratio

The Reserves/Production or R/P ratio shows the time in years that the reserves would last if extraction were to continue at the current level. It is calculated by dividing the stock at the end of the year by the extraction in the current year. Changes in the R/P ratio reflect changes both in the stock estimate, e.g. discoveries and reassessments during the year, and in the rate of extraction. Figure 2 shows R/P ratios for oil in the UK and Norway, based on the expected (probability weighted) level of discovered and undiscovered reserves, see also section 4.1.

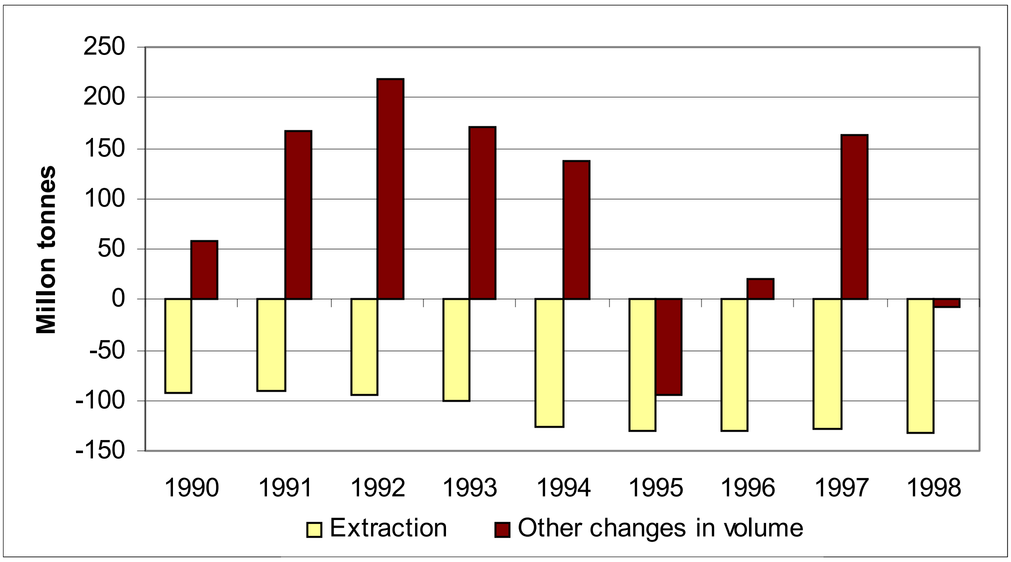
Figure 2: R/P ratio for oil in UK and Norway, based on expected discovered and undiscovered reserves



4.5.3 Extraction and other changes in volume

Figure 3 shows extraction and other changes in volume of oil reserves in the UK. In the years from 1991 to 1994 and in 1997, other changes in volume more than compensated extraction, so reserves increased. It can also be seen that other volume changes are relatively erratic. The increase in extraction from 1993 to 1994 is reflected in the fall in the R/P ratio, see Figure 2 above.

Figure 3: Extraction and other volume changes of oil reserves in the UK, in million tonnes



4.5.4 The characteristics of crude oil

The quality of crude oil can be measured by gravity (or density) and sulphur content. The best quality is light oil with low sulphur content. The pilot subsoil accounts did not include information on physical stocks and flows classified by quality, but according to the World Energy Council (1998), most of the oil produced in 1996 in the six pilot countries was light and had low sulphur content, see table 6.

Table 6: Crude oil characteristics, 1996

	Denmark	France	Netherlands	Austria	UK	Norway
Proportion with less than 1% sulphur	100%	90%	75%	:	90,7%	100%
Light oil	100%	95%	50%	41%	90,2%	100%
Medium oil	0%	5%	16%	59%	3,4%	0%
Heavy oil	0%	0%	24%	0%	6,4%	0%
Production 1996, million tonnes	10	2	3	1	130	156

Source: World Energy Council (1998)

5 Valuation methods for stocks and flows

The monetary value of the stock of resources is an indicator for the part of national wealth that is associated with subsoil assets. The monetary valuation is based on the estimate of the physical stock, as discussed in section 4.

In the national accounts, the preferred valuation method for assets is based on the prices realised in market transactions at the time to which the balance sheet relates, see ESA § 1.53.

Since very few market transactions of subsoil assets in the ground take place in EU/EEA countries, the reserves will have to be valued using an indirect method[5]. For subsoil assets, ESA § 7.41 recommends the present value method:

> 'Proven reserves of mineral deposits located on or below the earth's surface that are economically exploitable given current technology and relative prices are valued by the present value of expected net returns resulting from the commercial exploitation of those assets'.

For the valuation of subsoil assets, the net returns are often called the resource rent. The resource rent is defined as the value of output (at basic "well head" prices) less all costs corresponding to the extraction activity. The costs include intermediate consumption, compensation of employees, other non-specific taxes less subsidies on production, and capital costs corresponding to the fixed capital in place for the extraction, i.e. consumption of fixed capital and return to the fixed capital. The definition and calculation of the resource rent is discussed in more detail in section 5.1.

Section 5.2 discusses the government's appropriation of the resource rent through taxes, royalties etc. on the extraction activities. For those countries where the government is the legal owner of subsoil assets (on behalf of society), the revenue from royalties and taxes may be used as a proxy for the rent itself, based on the assumption that the procedure for distribution of licenses to extractors is fully competitive. The relationship between government revenue and resource rent (calculated as described above) can be seen as a policy indicator for the government's success in appropriating the resource rent.

The present value method requires as inputs a forecast of the future resource rent, and a discount rate. The assumptions used in the calculations are described in section 5.3. The inclusion of decommissioning costs in the present value method is discussed in section 5.4. Valuation of the flows that explain the changes in the asset value from one period to another is discussed in section 5.5, while section 5.6 describes the structure of the monetary balance sheets and accumulation accounts.

Several aspects of subsoil asset accounting are still being discussed internationally, including the treatment of depletion and discoveries, and the role of the government as the legal owner of many resources. These issues are described in section 5.7. Finally, section 5.8 gives some examples of indicators that may be derived from the monetary balance sheets and accumulation accounts.

5.1 The resource rent on subsoil assets

The data source for resource rent calculations is normally the national accounts data for the extraction industries. The definition of the resource rent used in the pilot studies is:

Output (basic "well head" prices) less,
intermediate consumption,
compensation of employees,
other non-specific taxes less subsidies on production,
consumption of fixed capital,
return to the fixed capital,
equals the resource rent.

[5] Even if transaction prices were available, there are difficulties using this approach. A major problem is that a market transaction usually includes other assets and liabilities in addition to the subsoil asset, such as fixed capital and tax liabilities. See also Nordhaus and Kokkelenberg (1999), page 67.

When this calculation gives a negative value, the net resource rent should be set equal to zero.

An equivalent definition of the resource rent is: net operating surplus plus specific taxes less subsidies on production less return to fixed capital.

The terms used in the definition of the resource rent are explained below.

Output should be valued at the "well-head" basic prices, therefore excluding all taxes on products and trade and transport margins. However, when taxes on products are specifically related to the extraction of national reserves, they should be added to estimate the total value of the reserves to the country.

Trade and transport margins, i.e. charges related to transport and delivery from the “well-head” to the place where purchasers take ownership of the extracted oil or gas, may be difficult to separate. Undersea pipelines from offshore wells to cargo terminals are often an integral part of the extractors’ fixed capital. In this case the corresponding operating and capital costs must be charged against output (valued at basic prices at the place of delivery).

Intermediate consumption should be valued at purchasers’ prices.

Compensation of employees is used as an estimate of the value of labour services. If there is a significant number of self-employed persons in the extraction industry, an estimate of the value of their labour services should be added to the compensation of employees.

Other non-specific taxes less subsidies on production refer to taxes less subsidies on production that are not specific to the extraction industry. Taxes that are specific[6] (e.g. area fees or a tax on CO_2 emissions related to extraction) are not considered part of the production costs, but are included in the resource rent.

Consumption of fixed capital applies to the fixed capital used in production, including exploration expenditure in the form of intangible fixed assets (asset category AN. 1121, see ESA § 6.03 and annex 7.1). In the national accounts, consumption of fixed capital is usually calculated together with the net stock of fixed capital, using the perpetual inventory method (PIM). The PIM is based on time-series of gross fixed capital formation and assumptions about asset life times and depreciation profiles (ESA § 6.04).

Return to the fixed capital is calculated by applying a normal rate of return to the net stock of fixed capital in the extraction industry, valued at the beginning of the period.

In economic theory, the normal rate of return to fixed capital may be interpreted as the cost of financial resources for the extracting industry. This can be defined as a weighted average of the rate of interest on bonds issued by the extracting companies and the return on their shares. The cost of financial resources will reflect the risk of investments in the extraction industry.

The normal rate of return used in the calculations should be a real rate, since the holding gains on the net stock of fixed capital “take care” of the adjustment for price changes. See Annex 4 for an example that illustrates this.

After having examined empirical data on the ratio that the net operating surplus bears to the net capital stock for manufacturing industry as a whole, as well as national standards, the Task Force concluded that, for EU/EEA countries, an 8% real rate of return on fixed capital should be taken as the default value in the absence of more detailed information. It was also suggested that a sensitivity analysis should be conducted around the 8% value.

The Task Force also considered an alternative definition of the resource rent, where the consumption of fixed capital and return to fixed capital is not deducted. This may be called the gross rent. In order to calculate a separate value for the subsoil asset the value of the net stock of fixed capital is deducted from the present value of the gross rent. The advantage of this method is that it avoids having to make an assumption about the rate of return to capital. The main problem is that it gives correct results only for developed fields where all fixed capital is in place.

[6] The definition of specific taxes is discussed in section 5.2.

5.1.1 Economic accounts for the extraction industry

As part of the pilot studies, countries were asked to provide the following table for NACE Rev.1 group 11.1 Extraction of crude petroleum and natural gas.

Table 7: Economic accounts and rent calculation

	NACE 11.1	of which oil	of which natural gas
Current transactions			
Market output (well head prices)			
Intermediate consumption			
Gross value added			
Compensation of employees			
Other taxes on production			
"Specific taxes"			
Other subsidies on production			
Consumption of fixed capital			
Construction, equipment, etc. for extraction			
Mineral exploration			
Net operating surplus			
Capital transactions			
Gross fixed capital formation			
Construction			
Equipment and other			
Mineral exploration			
For own final use			
Purchased or otherwise acquired			
Changes in inventories			
Net acquisitions of subsoil assets			
Net acquisitions of leases and other transferable contracts			
Supplementary data			
Labour inputs (number of employees)			
Closing net stocks of fixed assets			
Production equipment and construction			
Exploration expenditure			
p.m. item: Resource rent appropriated by the government			
= Other specific taxes on production			
+ Rent (royalties) on subsoil assets			
+ Specific taxes on income[7]			
p.m. item: Resource rent for the extractor			
= Net operating surplus			
- Rent (royalties) on subsoil assets			
- Specific taxes on income			
- Return to capital			
p.m. item: Total resource rent			
= Net operating surplus			
+ Other specific taxes on production			
- Return to capital			
= Resource rent appropriated by the government			
+ Resource rent for the extractor			

[7] See chapter 5.3.1 for a definition of specific taxes on income.

5.1.2 Distribution of total resource rent between oil and gas

In the national accounts, production costs of the oil and gas extraction industry are generally not divided between oil and gas. In some cases the oil and gas wells are physically distinct and separate data can be compiled, but often this is not possible. As a consequence, except for the UK and to some degree for France, the data supplied by the countries only permitted calculation of the total resource rent for oil and gas together.

Because oil and gas are sold in different markets and normally have different production profiles, it is useful for valuation to estimate resource rents for oil and gas separately. Data that may be used for this purpose are the shares of extraction of oil and gas measured in oil equivalents or the shares oil and gas have in the total output value of the industry.

UK data suggest that production costs per oil equivalent are lower for gas than for oil. The price per unit is also generally lower for gas. Dividing the costs of extraction using physical data led to a negative resource rent for gas in Denmark (Blix 2000) This suggests that dividing the production cost using the output value shares is probably the better of the two alternatives, if separate cost data are not available. A potential problem with this method is that changes in the relative prices of oil and gas can cause fluctuations in the cost shares.

5.2 Government appropriation of the resource rent

The oil and gas resources in the North Sea are legally owned by governments, while extraction is usually carried out by privately owned companies. Through taxes and royalties, the governments appropriate part of the resource rent. The Task Force defined the government's part of the resource rent as the sum of royalty payments and specific taxes on production and income paid by the extracting companies.

If the government appropriation can be assumed to be a large part of the resource rent, it can be used as a proxy of the resource rent itself. This method, developed by Statistics Netherlands, may be called the government appropriation method. It permits the valuation of oil and gas reserves directly as the present value of the government's oil- and gas-related revenues (see van den Berg and van de Ven 2000). Empirically, this valuation may be sufficiently accurate owing to the considerable uncertainties that affect other methods and would also result in some implicit "smoothing" of the resource rent.

In particular, this method would avoid having to make an assumption about the rate of return to fixed capital. It would also avoid a negative resource rent. Furthermore, this method enables valuation of the reserves even if data on net capital stock and consumption of fixed capital are not available, as long as the receipts of general government from specific taxes and/or royalties are known.

The relationship between the government appropriation and the total resource rent is also of interest in itself, as an indicator for policy. It can be interpreted as a measure of the government's success in appropriating as much of the resource rent as possible. However, users of the estimates should be aware of the uncertainties and assumptions involved in estimating both the total resource rent and the government appropriation.

5.2.1 Specific and general taxes

For the purpose of estimating the resource rent, and for allocating it between the government and the extractor, taxes on production and income should be divided into two groups, taxes 'specific' to oil and gas extraction (including 'specific' taxes on production) and taxes of a general nature. The government's part of the resource rent consists of the specific taxes on production and income (and royalties). The remainder of the total resource rent is then the extractor's part.

This raises the question of how to divide the taxes paid by the extracting industry into 'specific' and 'non-specific' taxes. One method is to look at the taxes that according to the tax code are specific to extraction. The results of this method are sensitive to the way the taxation system is set up. If the specific taxes are payable on the extractor's profit after corporate income tax (as is the case in the Netherlands, for example, see van den Berg and van de Ven 2000) then corporate taxes are paid on the part of the rent that later will be appropriated by the government as specific taxes (i.e. government would collect corporate taxes on its share of the resource rent, and corporate taxes on the resource rent will be included in the extractor's part of the rent). See Annex 3 for an example that illustrates the problem, based on the Dutch calculations described in more detail in section 5.4.2 below.

If the tax system involves payment of specific taxes after general corporate taxes, a better solution would be to calculate a “normal” corporate income tax on the normal return to fixed capital. The rest of the income tax is then allocated to the government’s part of the resource rent. The tax rate that is applied to the normal return to fixed capital can for example be calculated as the ratio of corporate taxes paid to net operating surplus for the extraction industry.

5.2.2 Government appropriation in the Netherlands

Statistics Netherlands considers that the auction for exploitation rights in the Netherlands is fully competitive and that it therefore precludes any significant part of the resource rent being appropriated by extracting firms. Under this view, extracting companies receive a “normal” rate of return to capital and the government appropriates the whole resource rent.

Statistics Netherlands agreed to test this hypothesis on their own data, for the period 1975 to 1998. The resource rent was calculated using a real rate of return to fixed capital of 8%. The government appropriation of the rent was defined as the sum of income from prospecting and exploitation rights, “Extra earnings from Groningen” and extraordinary dividend receipts from the company EBN (Energy Management Netherlands). The part of corporate taxes paid by the extraction companies that was estimated to be related to the resource rent (as opposed to the corporate tax on normal return to fixed capital) was also included in the government’s part of the resource rent. The ratio of government appropriation to total resource rent varied between 72% in 1975 and 97% in 1996. The average for the whole period was 85%, while the average for the ten-year period from 1989 to 1998 was 89%.

Van den Berg and van de Ven (2000) drew the following conclusions from this test exercise:

- The Government Appropriation Method is a valid alternative to the Net Resource Rent Method.
- It may be particularly useful when the data for the Net Resource Rent Method are not complete or cannot be used, e.g. due to confidentiality regimes.
- The Government Appropriation Method requires a careful analysis of the tax regimes applied to the natural resources under review.
- Rent calculation with the Net Resource Rent Method based on national accounts data requires testing the representativity of the national accounts data for the resource extraction activity in question. This relates first of all to the ‘purity’ of the industry – ideally data would relate to branches of production rather than industries. Evidently, the Net Resource Rent Method is sensitive to the assumptions on return to capital.
- Calculating the share of the resource rent appropriated by government is useful in itself and also required for properly calculating the values of natural assets in sectoral balance sheets.

5.3 The present value method

The present value method is an indirect valuation method that is used to calculate the value of the reserves of subsoil assets. The value of the reserves is calculated by discounting the future resource rent resulting from the extraction process. In order to apply the present value method, it is necessary to make a forecast of the future resource rent, and to choose a rate of discount. The present value of the future resource rent at the beginning of period t, V_t, is expressed as:

$$V_t = \sum_{i=t}^{t+n} \frac{R_i}{(1+r)^{i-t+1}}$$

where R_i is the net resource rent in period i, and r is the rate of discount.

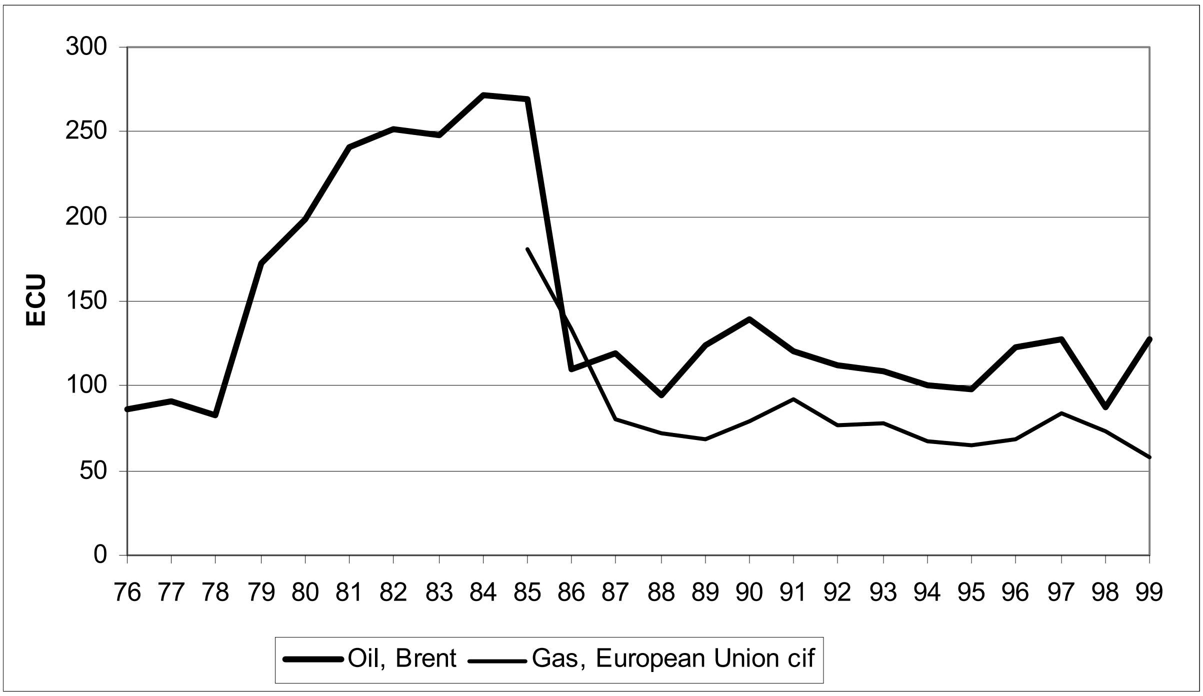
5.3.1 The forecast of the future rent

Making a forecast of the future resource rent requires assumptions about the development of prices, extraction costs and the level of extraction. For accounting purposes it is advisable to use relatively simple and transparent assumptions. In this context, it is useful to divide the resource rent into two components, rent per unit extracted and the level of extraction.

Regarding the per unit resource rent, a possible simplifying assumption is that it grows at the same rate as the rate of discount. The advantage of this method is that it avoids having to make explicit forecasts about future unit rents, extraction profiles and the discount rate. The present value of the future resource rent is simply the current year's unit rent multiplied by the physical stock of the resource, which is also known as the Hotelling valuation principle. It has been used by the BEA in the subsoil asset accounts for the USA, under the names Current Rent Method I and II (Nordhaus and Kokkelenberg 1999), and also in Canada (Born 1997). There is, however, little theoretical and empirical support for this assumption. See the discussion in Nordhaus and Kokkelenberg (1999), page 89.

A better assumption for the unit resource rent seems to be to keep it constant and equal to either the unit rent of the current year or an average over a few years. The reason for considering an average over some years is that unit rents often display large changes from year to year. Oil and gas prices often vary considerably over time (see figure 4), while unit production costs are relatively more stable. This can cause large variations in the unit rent. Using the present value method with constant unit rents, a change in the assumed unit rent will cause a proportional change in the estimated value of the subsoil asset.

Figure 4: Price of oil (ECU per tonne) and gas (ECU per 1000 Sm³), annual average



Sources: BP Amoco (2000), Eurostat.
Cif: Cost, insurance and freight.

When no specific information is available about the path of future extraction, one possibility is to assume a constant level of extraction, equal to extraction in the current year. The number of years extraction will take place is estimated by dividing the resource stock at the end of the year by the extraction in the current year. Alternative assumptions may be an exponentially decreasing rate of extraction or constant extraction for a number of years and then a gradual decrease. In some cases, forecasts of the future levels of extraction are available, e.g. made by ministries as part of their planning process. If this is the case, they should be used.

See Annex 1 for some examples that illustrate the impact of different assumptions about the future resource rent on the values of the stocks of oil and gas in Denmark, the UK and Norway.

5.3.2 Discount rate

The discount rate reflects the investor's time preference and attitude towards risk. The choice of an appropriate discount rate for valuing subsoil assets and other natural resources has been subject to considerable debate internationally.

It is often assumed that governments have a lower rate of time preference and less aversion to risk than private investors. It is thus appropriate to use a lower rate of discount when present values are calculated from the government's point of view, rather than from the point of view of private investors.

In Europe, the governments are the legal owners of most subsoil assets, especially in the North Sea, and appropriate a major part of the rent through taxes, royalties and licenses. For the pilot studies, the Task Force decided that the value of the subsoil assets should be estimated from the government's point of view, and that the rate of discount should be interpreted as a "social" rate of discount. Since the unit resource rent is usually assumed constant over time, a real rate of discount should be applied. A central value of 4% was suggested, which is close to the average real rate of return on government bonds.

5.3.3 The basic valuation model

Using the simple assumptions of constant per unit resource rent and constant production level, the net present value of the future resource rent may be estimated using the following formula:

$$V_t = R_t \frac{(1+r)^n - 1}{r(1+r)^n}$$

where V_t is the stock value at the end of the year, R_t is the (net) resource rent for the current year, r the assumed discount rate and n the life length of the reserves. The life length n is calculated as Q_T/Q_t, where Q_T the total quantity of reserves at the end of the year and Q_t is the quantity extracted during the year. Alternatively, using the per unit resource rent for the current year, rr_t, the value of the reserves is expressed as:

$$V_t = rr_t \left(\frac{Q_T}{n} \right) \frac{(1+r)^n - 1}{r(1+r)^n}$$

5.4 Decommissioning costs

Decommissioning costs are costs for shutting down and possibly dismantling and removing the production equipment and restoring the site.

The net present value of the decommissioning costs should be taken into account when the value of subsoil assets is estimated. One problem is to estimate the size and timing of the costs. For the oil and gas production platforms in the North Sea, very little decommissioning has been carried out so far, so there is not much experience to build upon. An important aspect is what kind of decommissioning will be required by future legislation. Another aspect is whether current legislation requires (or indeed tax laws encourage) corporations to set aside funds for future decommissioning.

The UK ONS has included an estimate of decommissioning costs in its latest estimates of the value of UK oil reserves (Harris and Rossi 2000). The ONS calculations include an estimate of the total decommissioning costs. These are assumed to occur at the end of the life of the reserves, and are converted to an annual provision for every year in which oil and gas will be produced. This annual provision is then deducted from the resource rent before the value of the resources is estimated, in the same way as consumption of fixed capital is deducted from gross operating surplus. The inclusion of decommissioning costs reduces the estimated value of the UK oil and gas reserves at the end of 1998 by about 5%.

5.5 Valuation of the flows

The accumulation accounts show the link between the opening and closing stocks of the assets. In section 4.3 the changes in the physical stocks of subsoil assets were classified into extraction and other changes in volume, with discoveries as a sub-category. The monetary value of the resources, defined as the present value of the expected future resource rent, can change also for other reasons. The first is that as we move one period forward in time, the future rents are discounted one year less in the present value calculation. This is called “revaluation due to time passing”. A second reason is changes in the time profile of extraction, which can affect the present value even if the total amount that remains to be extracted does not change. Finally, there are changes in the present value caused by changes in the unit resource rent and the discount rate.

In section 5.3.3 the basic valuation formula for the stock was introduced:

$$V_t = rr_t \left(\frac{Q_T}{n} \right) \frac{(1+r)^n - 1}{r(1+r)^n}$$

where rr_t is the per unit resource rent for the current year, Q_T the total quantity of reserves at the end of the year, n the life length of the reserves (n = Q_T/Q_t, with Q_t the quantity extracted during the year) and r the assumed discount rate.

The formula allows the identification and calculation of the changes in the components of the value of reserves: other changes in volumes and holding gains/losses, according to the way Q_T, n, r and rr_t change.

The Task Force suggested the following classification and corresponding valuation methods for the changes in the monetary value of subsoil assets.

Table 8: Changes in the value of subsoil assets

Category	Valuation method
Opening stock	Value of reserves at the end of the previous year
Extraction	Value of the resource rent of the current year
Revaluation due to time passing	Value of the opening reserves at conditions of the present year, multiplied by the rate of discount of the previous year
Other changes in volume:	Value of other physical changes
Discoveries and reassessments	Present value of the resource rent corresponding to the future extraction of "new" reserves, according to the assumptions used for the calculation of the value of the closing stock. New reserves are assumed to be extracted after pre-existing reserves.
Due to changes in the expected path of extraction	Change in the value of opening reserves due to the change in the path of extraction of the existing reserves: expected path of extraction of the previous year vs. path of extraction retained for the current year
Nominal holding gains and losses	Change in the value of opening reserves at the conditions of the previous year due to changes in: a) the level of the per unit resource rent from the previous to the current year. b) the discount rate
Closing stock	Present value of remaining reserves at the end of the year

This classification matches the main conclusions of the OECD September 1998 meeting on “Accounting for Environmental Depletion”: factors affecting the extraction profile are generally to be considered changes in volume, while other factors, such as changes in prices or the discount rate, are to be treated as revaluation.

It can be shown that the categories in table 8 explain the total change from opening to closing stocks. However, the value of each category is dependent on the order in which they are calculated. Annex 2 shows an application of the principles explained above to Norwegian data for 1995, assuming the constant extraction model.

5.6 Monetary balance sheets and accumulation accounts

The structure of the monetary balance sheets and accumulation accounts from the pilot studies are similar in structure to the physical time-series table. The item of extraction (the value of the resource rent) provides a link with the economic accounts for the oil and natural gas extraction industry.

Table 9: Monetary balance sheets and accumulation accounts

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Opening stock						
Extraction						
Revaluation due to time passing						
Other changes in volume: discoveries and reassessments						
Other changes in volume: change in expected extraction path						
Holding gains and losses						
Closing stock						

5.7 Some open issues

There are some issues regarding subsoil asset accounts where an international consensus has not yet been reached. They involve the treatment of depletion and discoveries, the flows between the owner of the resource and the extractor, and the role of government as the legal owner of many resources. These topics have been discussed at meetings of the London Group on Environmental Accounting and in two special meetings on “Accounting for Environmental Depletion” arranged by the OECD. They were also discussed by the Task Force, but calculations of this type were not included in the pilot studies.

5.7.1 Depletion and discoveries in the accounts

In the SNA, § 12.29, depletion is defined as “the reduction in the value of deposits as a result of the physical removal and using up of the assets.“ The value of depletion is usually calculated as the resource rent less "revaluation due to time passing": $D_t = R_t - rV_t$. With the constant extraction model, $D_t = R_t/(1+r)^n$, where n is the number of years extraction can take place at the current rate.

In the SNA and ESA, both depletion and discoveries are treated as other changes in volume of assets, and do not affect the level of income and the major national accounts aggregates such as GDP and NDP. An argument for including depletion in income is that depletion reduces the asset’s income generating capacity in the future. If this is not reflected in the main national accounts aggregates, they could send misleading signals to users of the accounts, e.g. policy makers. Often an analogy is drawn between subsoil assets and either fixed capital or inventories of produced goods. In the first case, depletion is treated in the same way as consumption of fixed capital, i.e. NDP, disposable income and savings are reduced by the value of depletion, but GDP is unchanged. If subsoil assets are treated as inventories, NDP, disposable income and savings, as well as GDP will be reduced by the value of extraction, i.e. the resource rent.

If income is reduced by depletion, it can be argued that discoveries should be treated symmetrically, i.e. increase income. Apart from the conceptual controversy over whether or not discoveries of subsoil assets should be treated as production, a problem with this approach is that additions to the stock can be highly erratic, with a few large discoveries with several years of small or no discoveries in between. This can cause large fluctuations in the income estimates. Related to this approach is the suggestion to take not only extraction, but also discoveries and other additions to the stock into account when depletion is calculated[8]. If the lifetime of the reserves is calculated by dividing the closing stock by extraction net of additions, it may increase considerably (and may even become infinite, when additions equal extraction). As a result, (net)

[8] See ABS (1999) for an overview of the different proposals and some test calculations based on Australian data.

depletion decreases. It can be argued that this gives a more meaningful indication of sustainability. The result is similar to using depletion less discoveries as an indicator for sustainability.

5.7.2 The government as owner of the resources

If the subsoil assets are to be introduced into the institutional sector accounts, the ownership of the assets will have to be determined. In Europe, the governments are the legal owner of most subsoil assets, especially in the North Sea, and appropriate a major part of the rent through taxes, royalties and licenses, as discussed above. Nevertheless, there are arguments in favour of treating the subsoil assets as owned by the extracting firms and therefore report these assets in their balance sheets. However, this can create some inconsistencies in the accounts. The wealth of the extractor diminishes with the extraction because the negative “change in net worth due to other changes in volume of assets” (corresponding to depletion) is not compensated by the positive “changes due to saving”, corresponding to what is left to the extractor after all costs including payments to government.

A possible solution is to introduce in the government’s balance sheets a financial asset reflecting the net present value of future tax and royalty payments to the government by the extractor, and a corresponding financial liability in the extractor's balance sheets. The transactions between the government and the extractor would balance tax and royalty payments as payments related to this financial liability. With the resource rent divided between depletion and an "income" element, the payments to the government could be treated as interest and repayment of principal. See Annex 5 for an example that shows the accounting treatment in more detail.

5.8 Indicators derived from monetary balance sheets and accumulation accounts

Based on the data in the monetary balance sheets and accumulation accounts for oil and gas, several indicators may be derived. Some are similar to the indicators derived from the physical balance sheets (see section 4.5) such as the level of the stock of reserves, and the value of depletion compared to the value of other volume changes. One can also compare value and volume data, and calculate the resource rent per unit extracted or the stock value per unit.

Data from the monetary balance sheets and accumulation accounts can also be compared with data from the ordinary national accounts to give information about the economic importance of the subsoil assets. Possible indicators are the stock value, resource rent and depletion in percent of GDP. The value of the stock of reserves can also be compared to other parts of the national wealth, such as the net stock of fixed capital.

A few examples of indicators derived from monetary balance sheets and accumulation accounts are given below. More details can be found in section 6. Figure 5 shows the value of the closing stocks of oil, NGL and natural gas in billion ECU, for the three EEA countries with the largest reserves: the Netherlands, the UK and Norway, from 1990 to 1997. Comparing the results for the three countries, a striking feature is the large variation from year to year in the values for the UK and Norway compared to the stable results for the Netherlands. This is related to the assumptions used in the calculations. The values for the UK and Norway are based on the present value method, with expected future extraction and unit resource rents constant and equal to the values in the year the stock value refers to, see section 5.3 above. The large fluctuations in the unit rents (see tables 7 and 8) are thus reflected in the value estimates[9]. The stock values for the Netherlands are based on the present value of the actually realised government appropriation for the years from 1990 to 1998, and the 1998 value for later years, which gives more stable stock values.

Figure 6 shows the value of the closing stocks of oil, NGL and natural gas in percent of GDP, for the same three countries. Norway, a small economy with large oil and gas reserves has the highest stock value compared to GDP, varying from about 50% in 1996 to more than 100% in 1996 and 1997. In the Netherlands the share is falling gradually from about 20% in 1990 to 16% in 1997. In the UK, the share varies from just over 1% in 1992 to almost 13% in 1996.

[9] The relatively large differences in the unit rent between the UK and Norway are somewhat surprising, since the extraction of oil and gas in the two countries take place in the North Sea under similar conditions. See section 6.3 for some more on this topic.

Figure 5: Closing stocks of oil, NGL and natural gas, billion ECU

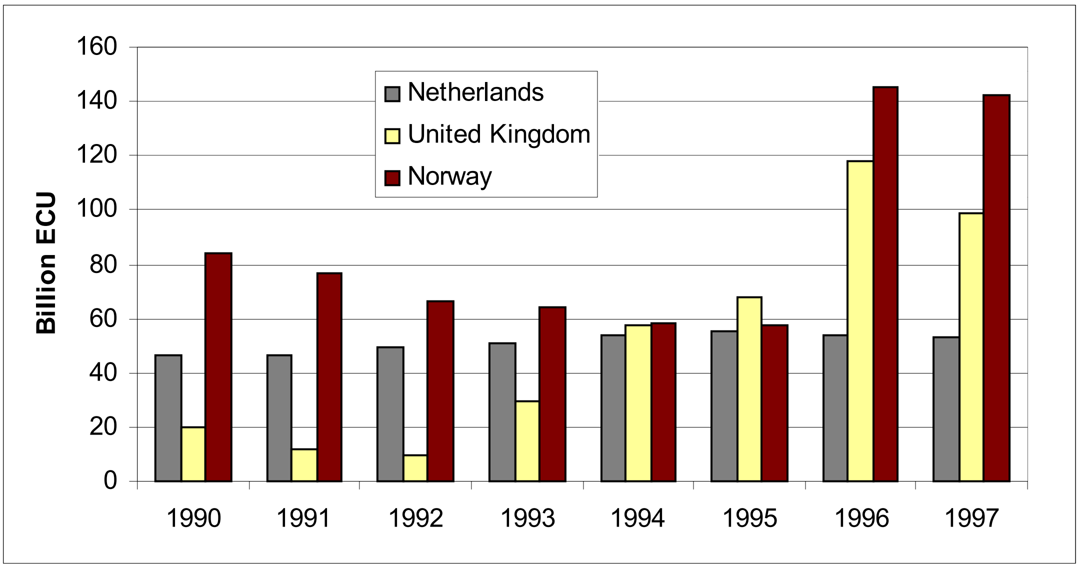


Figure 6: Closing stocks of oil, NGL and natural gas, in % of GDP

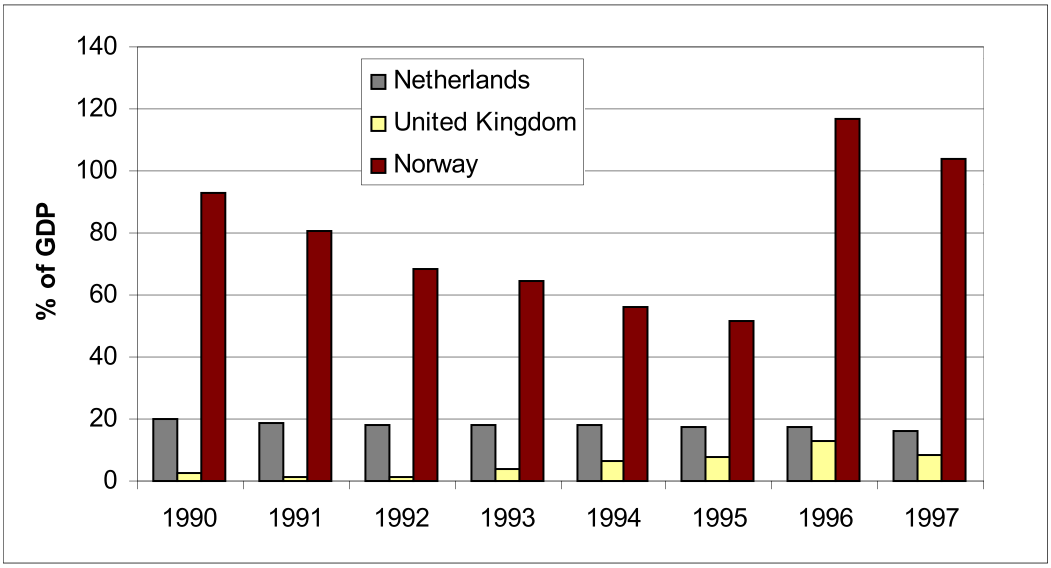


Figure 7: Unit resource rent for oil and NGL, ECU/tonne

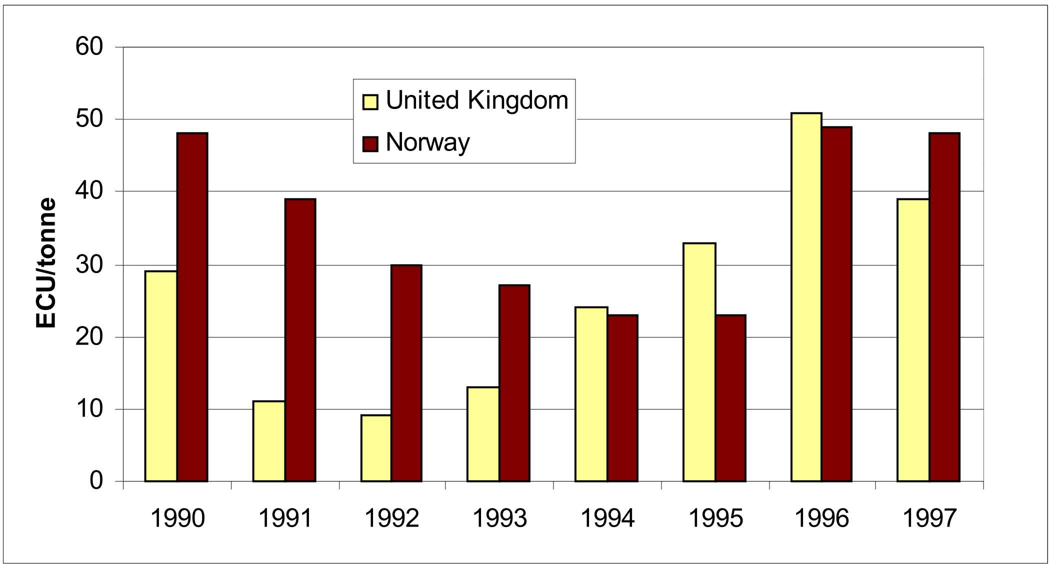
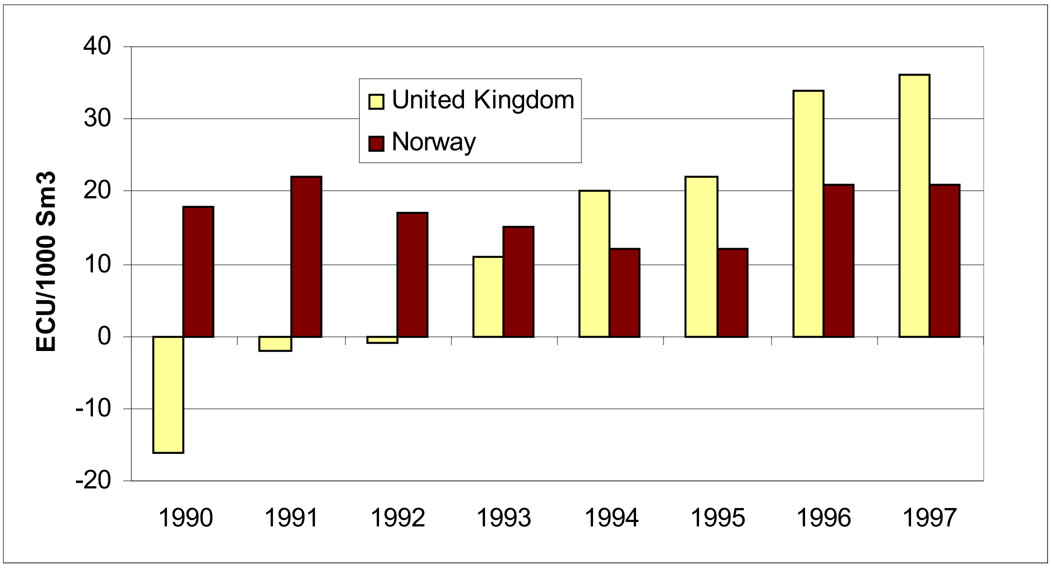


Figure 8: Unit resource rent for natural gas, ECU/1000 Sm^3



6 Comparative tables

This section presents tables that compare the results of the pilot studies. The main definitions and assumptions used in the calculations are listed in section 6.1 below. The tables in sections 6.2 to 6.5 are based on the pilot studies. Section 6.6 contains Eurostat estimates for EU-15 and EEA.

6.1 Assumptions used in the pilot studies

Table 10 gives an overview of the source data and assumptions used for calculating balance sheets for oil and gas reported in this publication.

Table 10: Source data and assumptions used for calculating balance sheets for oil and gas

<table>
<tr><th></th><th>Denmark</th><th>France</th><th>Netherlands</th><th>Austria</th><th>UK</th><th>Norway</th></tr>
<tr><td>Reference</td><td>Blix (2000)</td><td>Moreau (1996) (estimates updated and revised in 2000)</td><td>Van den Berg (2000),
Van den Berg and van de Ven (2000),
Baris and Pommée (1996)</td><td>Fuchs (1999)</td><td>Harris and Rossi (1999)</td><td>Statistics Norway (1998) (some revisions in 2000)</td></tr>
<tr><td>Source of physical resource data</td><td>Danish Energy Agency</td><td>French Energy Observatory</td><td>Geological Survey of the Netherlands</td><td>Austrian Geological Survey</td><td>Department of Trade and Industry</td><td>Norwegian Petroleum Directorate</td></tr>
<tr><td>Reserve definition</td><td>Expected level of discovered reserves</td><td>Proven reserves</td><td>Remaining expected reserves</td><td>Sum of proven, probable, possible and undiscovered reserves, weighted by probability</td><td>Expected level of discovered (Proven + Probable) and lower bound of undiscovered</td><td>Expected level of discovered and undiscovered</td></tr>
<tr><td>Future extraction path</td><td>Actual data to 1999, then constant or forecast from Danish Energy Agency</td><td>Constant</td><td rowspan="2">Government appropriation used as estimate for resource rent. Actual data used for 1990 to 1998, later years set equal to 1998. Extraction period: 25 years.</td><td rowspan="5">Austria did not report value data, because of confidentiality requirements</td><td>Constant. 1998: alternative based on UK Offshore Operators Association forecast.</td><td>Constant. 1997: alternative based on Ministry of Finance forecast.</td></tr>
<tr><td>Future Unit Rent</td><td>Constant, equal to current year's unit rent</td><td>Constant, equal to current year's unit rent</td><td>Constant, equal to current year's unit rent</td><td>Constant, equal to current year's unit rent</td></tr>
<tr><td>Division of costs between oil and gas</td><td>Proportional to revenue</td><td>Extraction company accounts</td><td>None</td><td>National accounts data for operating costs. Capital costs divided by share of development costs</td><td>Proportional to revenue</td></tr>
<tr><td>Real rate of return to fixed capital</td><td>8% (base scenario)</td><td>Did not explicitly deduct a return to fixed capital</td><td>8%</td><td>8%</td><td>8%</td></tr>
<tr><td>Real discount rate</td><td>4% (base scenario)</td><td>5%</td><td>7-8% nominal for 1990 to 1998,
4% real rate for later years</td><td>4%</td><td>4%</td></tr>
</table>

6.2 Physical stocks of reserves

For the countries reporting physical data in the pilot studies, it can be seen from the time series below that the stocks of reserves usually decrease less over time than the amount extracted. Often, the stock even increases from one year to another. This reflects other changes in volume, i.e. discoveries and other reassessments of the stocks. This is the case for Norway in particular, where improved knowledge of the geology of the continental shelf has led to large upward reassessments of the stocks of both oil and gas.

Tables 13 and 17 show that the number of years the reserves would last if extraction were to continue at the current year's level (also known as the R/P ratio) has generally been falling over time. For Denmark, the UK and Norway, this reflects increased extraction more than a reduction in stocks. In France, extraction has been relatively stable, while reserves have been falling. In Austria, both stocks and extraction of oil have been relatively stable, while for gas, both have been increasing.

Table 11: Closing stocks of oil and NGL, million tonnes

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		138	146	150	150	145	179	182	170	185	210	192	181	166
France	30	30	26	24	21	20	21	20	17	16	14	17	13	17
Netherlands														
Austria	18	17	16	16	17	17	17	17	16	17	16	15		
United Kingdom						1695	1770	1895	1965	1975	1750	1640	1675	1535
Norway	1893	1973	1902	2876	2899	2950	2901	3532	3559	3531	3506	4168	4113	

Table 12: Extraction of oil and NGL, million tonnes

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		4	5	5	6	6	7	8	8	9	9	10	11	12
France	3	3	3	3	3	3	3	3	3	3	2	2	2	2
Netherlands														
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Kingdom						92	91	94	100	127	130	130	128	133
Norway	38	43	49	56	75	82	94	108	115	131	141	156	158	

Table 13: Years of reserves*) of oil and NGL

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		38	32	32	27	24	25	24	21	20	23	19	16	14
France	11	10	8	7	6	6	7	7	6	6	6	8	8	10
Netherlands														
Austria	16	15	15	14	15	15	13	14	14	16	14	14		
United Kingdom						18	19	20	20	16	13	13	13	12
Norway	49	46	38	51	39	36	31	33	31	27	25	27	26	

*) The time in years that the reserves would last if extraction were to continue at the current level.

Table 14: Other changes in volume of oil and NGL, million tonnes

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		0	13	9	5	2	41	10	-4	24	34	-8	0	-3
France	3	3	-1	1	0	2	4	2	0	1	1	5	-2	5
Netherlands														
Austria	0	0	0	1	2	1	1	1	0	3	-1	1		
United Kingdom						57	166	219	170	137	-95	20	163	-7
Norway	255	122	-21	1030	98	133	46	739	142	103	116	818	105	

Table 15: Closing stocks of natural gas, billion Sm^3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		175	161	146	155	140	168	180	181	176	165	150	134	120
France	41	41	33	33	38	37	35	28	25	21	19	14	14	11
Netherlands						2113								
Austria	25	25	26	27	29	29	29	29	31	37	36	35		
United Kingdom						1480	1495	1620	1735	1945	1875	1860	1885	1780
Norway	3480	3426	3267	5003	5074	5059	4970	5167	5215	4957	5010	5489	5670	

Table 16: Extraction of natural gas, billion Sm^3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		2	3	3	3	3	4	4	5	5	5	6	8	7
France	5	4	4	3	3	3	3	3	4	4	3	3	3	2
Netherlands						94								
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	2
United Kingdom						49	55	56	65	70	75	90	92	96
Norway	25	26	28	28	29	25	25	26	25	27	28	37	43	

Table 17: Years of reserves*) of natural gas

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		83	62	56	52	45	42	44	40	37	32	24	17	16
France	8	10	9	10	12	12	10	8	7	6	6	5	6	5
Netherlands						22								
Austria	26	28	26	26	25	26	25	23	24	33	24	24		
United Kingdom						30	27	29	27	28	25	21	21	19
Norway	137	134	118	180	177	199	197	201	209	184	179	148	132	

*) The time in years that the reserves would last if extraction were to continue at the current level.

Table 18: Other changes in volume of natural gas, billion Sm^3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark		0	-11	-12	12	-12	32	16	6	0	-6	-9	-9	-7
France	5	4	-4	3	7	2	2	-4	1	-1	2	-2	3	-1
Netherlands														
Austria	1	1	1	3	3	1	1	2	3	8	0	0		
United Kingdom						134	70	181	180	280	5	75	117	-9
Norway	81	-28	-131	1763	100	11	-64	223	73	-231	81	516	224	

6.3 The resource rent

The tables in this section show the resource rent for oil and gas in million ECU and in ECU per unit extracted. The relatively large differences in the unit rent between the UK and Norway are somewhat surprising, since the extraction of oil and gas in the two countries take place in the North Sea under similar conditions. When interpreting the data, the uncertainties and assumptions underlying the rent calculation should be kept in mind. In particular, the division of the costs of the extraction industry between oil and gas and the choice of the rate of return are important for the results. Norway and the UK used different assumptions for the division of costs, see section 6.1, which may explain some of the differences. See also the production accounts for the individual countries in Annex 1, which show the calculation of the rent.

Table 19: Resource rent for oil, NGL and natural gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										168	145			
France	794	378	265	195	202	242	255	217	207	193	172	166	158	111
Netherlands	11984	7422	4348	3033	3254	4064	5229	4233	3843	3652	4111	5177	5031	4056
Austria														
United Kingdom						1827	914	769	1999	4440	5903	9665	8261	5440
Norway	9361	2334	1352	-521	2497	4360	4260	3685	3533	3372	3515	8383	8495	

Table 20: Resource rent for oil and NGL, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										150	132			
France	323	124	136	97	110	152	141	129	114	94	83	88	77	50
Netherlands														
Austria														
United Kingdom						2628	1038	801	1310	3043	4272	6632	4983	1440
Norway	6506	1426	1031	-406	2162	3911	3706	3258	3162	3052	3177	7595	7586	

Table 21: Unit resource rent for oil and NGL, ECU/tonne

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										16	14			
France	122	42	42	29	34	50	48	45	41	34	33	42	43	29
Netherlands														
Austria														
United Kingdom						29	11	9	13	24	33	51	39	11
Norway	171	33	21	-7	29	48	39	30	27	23	23	49	48	

Table 22: Resource rent for natural gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										18	13			
France	471	254	129	99	93	90	114	87	93	98	90	79	82	61
Netherlands														
Austria														
United Kingdom						-801	-124	-33	688	1397	1630	3033	3277	4000
Norway	2855	908	320	-115	335	449	554	428	371	320	337	788	909	

Table 23: Unit resource rent for natural gas, ECU/1000 Sm^3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										4	3			
France	87	60	33	31	30	30	33	26	26	28	27	27	32	28
Netherlands														
Austria														
United Kingdom						-16	-2	-1	11	20	22	34	36	42
Norway	112	35	12	-4	12	18	22	17	15	12	12	21	21	

6.4 Government appropriation of resource rent on oil and gas

The tables in this section show how the resource rent on oil, NGL and natural gas is divided between the government and the extraction companies in the Netherlands, the UK and Norway. See the discussion of the government appropriation method in section 5.2 for an explanation. The data for Norway include all taxes paid by the extraction companies (i.e. also the part called general income taxes in section 5.2.1), but not the dividends paid by the extraction companies fully or partly owned by the government. In the UK, the taxes and royalties on extraction paid in a particular year seem not to be directly linked to the extraction companies' income in that year.

Table 24: Government appropriation of resource rent on oil and gas in the Netherlands, million ECU

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Resource rent	4064	5229	4233	3843	3652	4111	5177	5031	4056
Government appropriation	3345	4645	3853	3679	3109	3858	5012	4497	3498
Extraction companies	719	584	380	165	543	253	165	534	558
Government's share in %	82	89	91	96	85	94	97	89	86

Table 25: Government appropriation of resource rent on oil and gas in the UK, million ECU

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Resource rent	1828	913	769	1999	4440	5903	9665	8176	5439
Government appropriation	3726	2328	2093	1969	2281	2898	4303	5243	5396
Extraction companies	-1898	-1415	-1324	29	2159	3004	5361	2932	43
Government's share in %	204	255	272	99	51	49	45	64	99

Table 26: Government appropriation of resource rent on oil and gas in Norway, million ECU

Year	1990	1991	1992	1993	1994	1995	1996
Resource rent	4360	4261	3686	3534	3374	3516	8386
Government appropriation	3528	3555	3449	3174	3286	3524	5198
Extraction companies	832	706	236	360	89	-8	3188
Government's share in %	81	83	94	90	97	100	62

6.5 Value of the stocks

The value of the stocks of oil and gas reflect the size of the physical stocks, but also the expected resource rent per unit extracted and expected time profile of extraction. When the current year's unit rent is used as the expected unit rent in the future periods, as is the case for the data reported here (except for the Netherlands), the result can be large changes in stock values from one year to another, recorded as holding gains and losses. It can be seen from tables 56, 58 and 60 in Annex 1 that for France, the UK and Norway, holding gains and losses are usually the largest components of the change in the stock value. As a share of the opening stock in the year, it is often higher than 50%, and occasionally over 100%. The stock values for the Netherlands are very stable in comparison. They are based on the present value of the actually realised government appropriation for the years from 1990 to 1998, and the 1998 value for later years, which gives more stable stock values.

Regarding the time profile of extraction, a longer extraction period will result in a lower net present value for a given physical stock and unit rent. It can be seen from the valuation formula in section 5.3.3 that the relationship between the resource rent per unit and the stock value per unit depends on the life length (or R/P ratio) of the reserves and the discount rate. Increasing the life length reduces the stock value per unit compared to the unit rent.

Table 27: Closing stocks of oil, NGL and natural gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										3524	2961			
France	4335	2470	1498	1346	1661	1792	1531	1270	1027	879	836	1039	756	551
Netherlands					45242	46123	46266	49082	50925	53472	55413	53611	53042	
Austria														
United Kingdom						20078	11561	9578	29694	57175	67602	117992	98984	62280
Norway	203169	48178	26775	-11666	48758	84373	76832	66716	64144	58296	57802	145120	142054	

Table 28: Closing stocks of oil, NGL and natural gas, in % of GDP

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										2,8	2,1			
France	0,6	0,3	0,2	0,2	0,2	0,2	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,0
Netherlands					20,9	19,8	18,9	18,9	18,3	18,0	17,5	16,5	16,0	
Austria														
United Kingdom						2,6	1,4	1,2	3,6	6,6	7,9	12,7	8,5	5,0
Norway	242,7	62,7	34,1	-14,0	54,3	92,8	80,7	68,4	64,7	56,3	51,6	117,0	103,9	0,0

Table 29: Closing stocks of oil and NGL, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										3075	2653			
France	1965	1033	669	568	807	901	735	684	460	440	422	709	418	317
Netherlands														
Austria														
United Kingdom						34097	13562	10094	18188	34242	42781	71514	51935	12593
Norway	134485	27429	19196	-8800	40707	73255	62992	56470	54960	50238	49401	125147	119724	

Table 30: Closing stocks of oil and NGL, in % of GDP

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										2,4	1,9			
France	0,3	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,0	0,0	0,0	0,1	0,0	0,0
Netherlands														
Austria														
United Kingdom						4,4	1,6	1,2	2,2	3,9	5,0	7,7	4,5	1,0
Norway	160,7	35,7	24,4	-10,6	45,4	80,6	66,2	57,9	55,4	48,5	44,1	100,9	87,6	

Table 31: Closing stocks of oil and NGL, ECU/tonne

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										16,6	12,6			
France	65,5	34,4	25,7	23,7	38,4	45,1	35,0	34,2	27,0	27,5	29,5	40,8	31,2	19,0
Netherlands														
Austria														
United Kingdom						20,1	7,7	5,3	9,3	17,3	24,4	43,6	31,0	8,2
Norway	71,0	13,9	10,1	-3,1	14,0	24,8	21,7	16,0	15,4	14,2	14,1	30,0	29,1	

Table 32: Closing stocks of natural gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										449	308			
France	2370	1437	829	778	854	890	796	587	567	439	414	330	339	233
Netherlands														
Austria														
United Kingdom						-14019	-2001	-516	11506	22933	24821	46478	47049	49687
Norway	68684	20749	7580	-2866	8051	11118	13840	10246	9184	8058	8401	19973	22330	

Table 33: Closing stocks of natural gas, in % of GDP

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										0,4	0,2			
France	0,3	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,0
Netherlands														
Austria														
United Kingdom						-1,8	-0,2	-0,1	1,4	2,6	2,9	5,0	4,1	4,0
Norway	82,1	27,0	9,6	-3,5	9,0	12,2	14,5	10,5	9,3	7,8	7,5	16,1	16,3	

Table 34: Closing stocks of natural gas, ECU/1000 Sm^3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark										2,6	1,9			
France	57,5	34,9	24,8	23,3	22,8	24,3	22,7	20,8	22,5	21,4	21,5	23,1	23,5	20,5
Netherlands														
Austria														
United Kingdom						-9,5	-1,3	-0,3	6,6	11,8	13,2	25,0	25,0	27,9
Norway	19,7	6,1	2,3	-0,6	1,6	2,2	2,8	2,0	1,8	1,6	1,7	3,6	3,9	

6.6 Estimates for EU-15 and EEA

This section reports estimates of physical stocks, resource rents and the value of the reserves of oil and gas in the European Union (EU-15) and the European Economic Area (EEA, i.e. EU-15 and Iceland, Liechtenstein and Norway). The estimates have been made by Eurostat, based on the pilot studies and other information. They relate to the year 1996.

6.6.1 Physical stocks

Based on the pilot studies and the reserves reported in World Energy Council (1998), one may estimate the stocks of oil and gas in EU-15 and the EEA. The reserve definitions used by the World Energy Council (WEC) are the following:

"Proved amount in place" is the tonnage/volume originally occurring in known natural reservoirs which has been both carefully measured and assessed as exploitable under present and expected local economic conditions with existing available technology.

"Proved recoverable reserves" is the tonnage/volume of the proved amount in place that can be recovered (extracted from the earth in raw form) in the future. (This corresponds to proven reserves in the terminology used by the Task Force, see section 4.)

"Estimated additional amount in place" is the tonnage/volume additional to the proved amount in place that is of foreseeable economic interest. Estimates reflect the existence of entire quantities reported to a reasonable level of confidence. Resources whose existence is merely speculative are not included.

"Estimated additional reserves recoverable" is the tonnage/volume of additional amount in place which geological and engineering information indicates with reasonable certainty might be recovered in the future. (This category includes probable reserves, and also an estimate of undiscovered reserves, see section 4. The exact definition will vary between countries, reflecting the available data.)

In table 35 and 36 below, the sum of "Proved recoverable reserves" and "Estimated additional reserves recoverable" from the WEC have been used for the countries that did not take part in the pilot study, and also for the Netherlands, which did not report physical data for 1996. Among the countries in the European Economic Area, Norway and the United Kingdom have the largest expected reserves of oil. These two countries, along with the Netherlands, are also the countries with the largest expected gas reserves in the EEA. Norway alone has around 2/3 of the total reserves of oil and NGL in the EEA, and more than half of the gas reserves. The UK has almost 80% of the total EU-15 oil reserves, while the Netherlands and the UK each have close to 40% of the total gas reserves. Among the countries that did not take part in the pilot studies, the largest reserves of oil and gas can be found in Germany and Italy.

Table 35: Reserves and extraction of oil and NGL in EU-15 and EEA countries in 1996, million tonnes

	Closing stock	Extraction	Years of reserves
Denmark	192	10	19
France	17	2	8
Netherlands	51	3	16
Austria	15	1	14
United Kingdom	1640	130	13
Total 5	**1915**	**146**	**13**
Germany	56	3	19
Italy	120	5	22
Other EU countries	4	1	4
EU-15	**2095**	**156**	**13**
Norway	4168	156	27
EEA	**6263**	**312**	**20**

Sources: Pilot studies and World Energy Council (1998)

Table 36: Reserves and extraction of gas in EU-15 and EEA countries in 1996, billion Sm^3

	Closing stocks	Extraction	Years of reserves
Denmark	150	6	24
France	14	3	5
Netherlands	1930	90	21
Austria	35	1	24
United Kingdom	1860	90	21
Total 5	**3989**	**190**	**21**
Germany	532	23	24
Italy	345	19	18
Other EU countries	21	3	6
EU-15	**4887**	**235**	**21**
Norway	5489	37	148
EEA	**10376**	**272**	**38**

Sources: Pilot studies and World Energy Council (1998)

6.6.2 Resource rent and value of stocks

Based on the information in the pilot studies and the stock and extraction data in physical terms from the World Energy Council (see tables 35 and 36 above), Eurostat has made estimates of the total resource rent from oil and gas extraction in 1996, and of the value of the closing stock of oil and gas in 1996.

The resource rent has been estimated for all EU countries except the France, Netherlands and the UK, which provided data in the pilot studies. Extraction of oil and gas in physical terms have been multiplied by the per unit resource rent in the UK in 1996. (For Denmark, where the resource rent in 1995 was considerably lower than in the UK, the 1995 unit rents have been adjusted with the growth rate of the UK unit rents.)

The value of the closing stock has been estimated for all EU countries except France, the Netherlands and the UK, which provided data in the pilot studies. The values were estimated by the present value method. Extraction and unit rent were assumed to be constant in future periods, and equal to their 1996 values, see the discussion in section 5.3.

Table 37: Resource rent and closing stocks of oil and gas in EU-15 and EEA in 1996, million ECU

	Resource rent	Closing stock
Denmark	*244**	*3296**
France	166	1039
Netherlands	5177	53042
Austria	*102**	*1331**
United Kingdom	9665	117992
Total 5	***15354****	***176700****
Other EU countries	*1989**	*27001**
EU-15	***17343****	***203701****
Norway	8383	145120
EEA	***25726****	***348820****

Sources. Pilot studies and Eurostat estimates.
* Eurostat estimates.

Annex 1: Individual country tables

Annex 1: Individual country tables

This annex presents tables for physical and monetary balance sheets, accumulation accounts and production accounts for the countries in the Task Force and also for Denmark. To make comparisons easier, the monetary tables have been converted to ECU, by dividing by average exchange rates for the flows and end of the year rates for the closing stocks. Changes in the exchange rate between national currencies and ECU introduce a new element in the accumulation accounts. This has been included with the holding gains in the tables.

Simplified production accounts

Table 38: Revenue, costs and rent for oil and gas in Denmark, million ECU

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total revenues					1155	1170			
Operating costs					371	328			
Return to fixed capital					276	306			
Consumption of fixed capital					341	391			
Total costs					987	1025			
Resource rent					168	145			

Table 39: Rent for oil and gas in the Netherlands, million ECU

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Gross operating surplus	5542	6780	5911	5746	5645	6192	7274	7121	6215
Return to fixed capital	824	859	924	1054	1095	1128	1127	1108	1121
Consumption of fixed capital	654	692	753	849	897	953	970	983	1038
Resource rent	4064	5229	4233	3843	3652	4111	5177	5031	4056

Table 40: Revenue, costs and rent for oil in the UK, million ECU

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total revenues	13224	12556	11968	12557	14632	15425	18165	18553	15165
Operating costs	3288	3844	3588	3746	3972	3749	3839	4554	4651
Return to fixed capital	2707	2762	2727	2684	2804	2785	2902	3535	3666
Consumption of fixed capital	4600	4913	4852	4815	4812	4620	4792	5480	5408
Total costs	10595	11519	11167	11245	11589	11154	11533	13570	13724
Resource rent	2629	1037	801	1311	3043	4271	6632	4983	1440
Extraction, million tonnes	92	91	94	100	127	130	130	128	133

Table 41: Revenue, costs and rent for gas in the UK, million ECU

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total revenues	3609	4712	4621	5190	5914	6086	7635	8840	10025
Operating costs	828	949	979	1006	1062	1046	1087	1489	1705
Return to fixed capital	1327	1399	1323	1250	1272	1283	1325	1598	1745
Consumption of fixed capital	2255	2489	2353	2244	2183	2127	2189	2476	2575
Total costs	4410	4837	4655	4500	4517	4456	4601	5563	6025
Resource rent	-801	-126	-33	689	1397	1630	3033	3277	4000
Extraction, billion Sm^3	49	55	56	65	70	75	90	92	96

The negative resource rent for gas in the UK in 1990 to 1992 may require some explanation. It can be seen from table 42 below that for the UK in 1990, average revenues per unit of gas extracted are lower and capital costs higher than in later years. (Production increased faster than capital costs over the period.) If the return to fixed capital had been set to 3% instead of 8%, the resource rent in 1990 would have been about 0. There is also some uncertainty in the division of the capital costs between the oil and gas extraction activities, as the UK national accounts only provide data on net capital stock and consumption of fixed capital for the oil and gas extraction industry as a whole.

Table 42: Average revenue, costs and rent for gas in the UK, ECU/1000 Sm^3

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total revenues	74	86	83	80	84	81	85	96	104
Operating costs	17	17	17	15	15	14	12	16	18
Return to fixed capital	27	25	24	19	18	17	15	17	18
Consumption of fixed capital	46	45	42	35	31	28	24	27	27
Total costs	90	88	83	69	65	59	51	60	63
Resource rent	-16	-2	-1	11	20	22	34	36	42

Table 43: Revenue, costs and rent for oil and gas in Norway, million ECU

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total revenues	9030	8378	7571	11196	13205	13802	14049	14753	14959	15966	22051
Operating costs	2546	2397	2867	3018	3120	3518	3862	4349	4256	4625	5377
Return to fixed capital	1954	2150	2378	2587	2585	2756	2997	3177	3342	3541	3748
Consumption of fixed capital	2196	2479	2847	3095	3141	3267	3504	3694	3989	4285	4543
Total costs	6696	7026	8092	8700	8846	9541	10363	11220	11587	12451	13668
Resource rent	2334	1352	-521	2496	4359	4261	3686	3533	3372	3515	8383

Physical balance sheets and accumulation accounts

Table 44: Denmark, physical balance sheet, oil and NGL, million tonnes

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks							141	138	146	150	150	145	179	182	170	185	210	192	181
Extraction							-4	-5	-5	-6	-6	-7	-8	-8	-9	-9	-10	-11	-12
Other changes in volume							0	13	9	5	2	41	10	-4	24	34	-8	0	-3
Closing stocks							138	146	150	150	145	179	182	170	185	210	192	181	166
Years of reserves							38	32	32	27	24	25	24	21	20	23	19	16	14

Table 45: France, physical balance sheet, oil and NGL, million tonnes

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	14	16	17	20	25	30	30	30	26	24	21	20	21	20	17	16	14	17	13
Extraction	-1	-2	-2	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2
Other changes in volume	3	3	4	7	7	3	3	-1	1	0	2	4	2	0	1	1	5	-2	5
Closing stocks	16	17	20	25	30	30	30	26	24	21	20	21	20	17	16	14	17	13	17
Years of reserves	11	10	12	15	15	11	10	8	7	6	6	7	7	6	6	6	8	8	10

Table 46: Austria, physical balance sheet, oil and NGL, million tonnes

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	22	22	21	21	19	19	18	17	16	16	17	17	17	17	16	17	16		
Extraction	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
Other changes in volume	1	0	1	0	1	0	0	0	1	2	1	1	1	0	3	-1	1		
Of which discoveries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Closing stocks	22	21	21	19	19	18	17	16	16	17	17	17	17	16	17	16	15		
Years of reserves	15	15	16	15	16	16	15	15	14	15	15	13	14	14	16	14	14		

Until 1994 oil only, since 1995 oil and NGL.

Table 47: UK, physical balance sheet, oil and NGL, million tonnes

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks											1730	1695	1770	1895	1965	1975	1750	1640	1675
Extraction											-92	-91	-94	-100	-127	-130	-130	-128	-133
Other changes in volume											57	166	219	170	137	-95	20	163	-7
Closing stocks											1695	1770	1895	1965	1975	1750	1640	1675	1535
Years of reserves											18	19	20	20	16	13	13	13	12

Table 48: Norway, physical balance sheet, oil and NGL, million tonnes

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks						1677	1893	1973	1902	2876	2899	2950	2901	3532	3559	3531	3506	4168	
Extraction					-35	-38	-43	-49	-56	-75	-82	-94	-108	-115	-131	-141	-156	-158	
Other changes in volume						255	122	-21	1030	98	133	46	739	142	103	116	818	105	
Of which discoveries													40	4	55	43	43	94	
Closing stocks					1677	1893	1973	1902	2876	2899	2950	2901	3532	3559	3531	3506	4168	4113	
Years of reserves					48	49	46	38	51	39	36	31	33	31	27	25	27	26	

Table 49: Denmark, physical balance sheet, gas, billion Sm^3

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks							177	175	161	146	155	140	168	180	181	176	165	150	134
Extraction							-2	-3	-3	-3	-3	-4	-4	-5	-5	-5	-6	-8	-7
Other changes in volume							0	-11	-12	12	-12	32	16	6	0	-6	-9	-9	-7
Closing stocks							175	161	146	155	140	168	180	181	176	165	150	134	120
Years of reserves							83	62	56	52	45	42	44	40	37	32	24	17	16

Table 50: France, physical balance sheet, gas, billion Sm^3

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	65	60	55	50	46	41	41	41	33	33	38	37	35	28	25	21	19	14	14
Extraction	-8	-7	-7	-7	-6	-5	-4	-4	-3	-3	-3	-3	-3	-4	-4	-3	-3	-3	-2
Other changes in volume	3	2	2	2	2	5	4	-4	3	7	2	2	-4	1	-1	2	-2	3	-1
Closing stocks	60	55	50	46	41	41	41	33	33	38	37	35	28	25	21	19	14	14	11
Years of reserves	8	8	8	7	7	8	10	9	10	12	12	10	8	7	6	6	5	6	5

Table 51: Austria, physical balance sheet, gas, billion Sm^3

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	24	25	25	24	25	25	25	25	26	27	29	29	29	29	31	37	36		
Extraction	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
Other changes in volume	2	1	0	2	1	1	1	1	3	3	1	1	2	3	8	0	0		
Of which discoveries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Closing stocks	25	25	24	25	25	25	25	26	27	29	29	29	29	31	37	36	35		
Years of reserves	15	21	22	26	24	26	28	26	26	25	26	25	23	24	33	24	24		

Table 52: UK, physical balance sheet, gas, billion Sm^3

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks											1395	1480	1495	1620	1735	1945	1875	1860	1885
Extraction											-49	-55	-56	-65	-70	-75	-90	-92	-96
Other changes in volume											134	70	181	180	280	5	75	117	-9
Closing stocks											1480	1495	1620	1735	1945	1875	1860	1885	1780
Years of reserves											30	27	29	27	28	25	21	21	19

Table 53: Norway, physical balance sheet, gas, billion Sm^3

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks						3424	3480	3426	3267	5003	5074	5059	4970	5167	5215	4957	5010	5489	
Extraction					-26	-25	-26	-28	-28	-29	-25	-25	-26	-25	-27	-28	-37	-43	
Other changes in volume						81	-28	-131	1763	100	11	-64	223	73	-231	81	516	224	
Of which discoveries													5	19	55	80	35	206	
Closing stocks					3424	3480	3426	3267	5003	5074	5059	4970	5167	5215	4957	5010	5489	5670	
Years of reserves					130	137	134	118	180	177	199	197	201	209	184	179	148	132	

Monetary balance sheets and accumulation accounts

Table 54: Denmark, monetary balance sheets, oil and NGL, million ECU

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks																3075			
Extraction																			
Time passing																			
Other changes in volume																			
Change in extraction path																			
Nominal holding gains																			
Closing stocks															3075	2653			

Table 55: France, monetary balance sheets, oil and NGL, million ECU

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	1129	1622	1950	2243	3121	3223	1965	1033	669	568	807	901	735	684	460	440	422	709	418
Depletion (1)	-157	-226	-225	-232	-317	-324	-124	-134	-96	-110	-153	-141	-129	-114	-94	-83	-88	-77	-50
Other changes in volume	278	377	508	772	939	269	103	-30	28	1	72	169	77	5	30	30	180	-79	121
Nominal holding gains	372	176	10	338	-521	-1203	-910	-200	-33	348	175	-194	0	-115	44	35	195	-135	-172
Closing stocks	1622	1950	2243	3121	3223	1965	1033	669	568	807	901	735	684	460	440	422	709	418	317

(1) Extraction less revaluation due to time passing

Table 56: France, monetary balance sheets, oil and NGL, in % of opening stock

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Depletion (1)	-14	-14	-12	-10	-10	-10	-6	-13	-14	-19	-19	-16	-18	-17	-21	-19	-21	-11	-12
Other changes in volume	25	23	26	34	30	8	5	-3	4	0	9	19	11	1	7	7	43	-11	29
Nominal holding gains	33	11	1	15	-17	-37	-46	-19	-5	61	22	-22	0	-17	10	8	46	-19	-41
Closing stocks	144	120	115	139	103	61	53	65	85	142	112	82	93	67	96	96	168	59	76

(1) Extraction less revaluation due to time passing

Table 57: UK, monetary balance sheets, oil and NGL, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks						19086	34097	13562	10094	18188	34242	42781	71514	51935
Extraction						-2628	-1038	-801	-1310	-3043	-4272	-6632	-4983	-1440
Time passing						1371	538	418	687	1384	1915	2724	1969	562
Other changes in volume						784	897	869	1045	1786	-1772	606	3819	-50
Change in extraction path						4046	100	-249	-691	-6266	-904	199	527	-387
Nominal holding gains						11437	-21031	-3704	8364	22193	13573	31835	-20910	-38026
Closing stocks						34097	13562	10094	18188	34242	42781	71514	51935	12593

Table 58: UK, monetary balance sheets, oil and NGL, in % of opening stock

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks						100	100	100	100	100	100	100	100	100
Extraction						-14	-3	-6	-13	-17	-12	-16	-7	-3
Time passing						7	2	3	7	8	6	6	3	1
Other changes in volume						4	3	6	10	10	-5	1	5	0
Change in extraction path						21	0	-2	-7	-34	-3	0	1	-1
Nominal holding gains						60	-62	-27	83	122	40	74	-29	-73
Closing stocks						179	40	74	180	188	125	167	73	24

Table 59: Norway, monetary balance sheets, oil and NGL, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	137934	134485	27429	19196	-8800	40707	73255	62992	56470	54960	50238	49401	125147	
Extraction	-6506	-1426	-1031	406	-2162	-3911	-3706	-3258	-3162	-3052	-3177	-7595	-7586	
Time passing	5332	1176	816	-298	1685	2934	2618	2110	2211	2005	1991	4441	4882	
Other changes in volume	6990	691	-95	-1436	620	1562	-1381	7267	1164	831	979	15199	1790	
Change in extraction path	8201	1927	1783	-508	6888	3671	4617	2025	1783	2791	1557	4564	651	
Nominal holding gains	-17465	-109424	-9705	-26160	42478	28291	-12410	-14667	-3506	-7297	-2187	59137	-5161	
Closing stocks	134485	27429	19196	-8800	40707	73255	62992	56470	54960	50238	49401	125147	119724	

Table 60: Norway, monetary balance sheets, oil and NGL, in % of opening stock

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	100	100	100	100	100	100	100	100	100	100	100	100	100	
Extraction	-5	-1	-4	2	25	-10	-5	-5	-6	-6	-6	-15	-6	
Time passing	4	1	3	-2	-19	7	4	3	4	4	4	9	4	
Other changes in volume	5	1	0	-7	-7	4	-2	12	2	2	2	31	1	
Change in extraction path	6	1	7	-3	-78	9	6	3	3	5	3	9	1	
Nominal holding gains	-13	-81	-35	-136	-483	69	-17	-23	-6	-13	-4	120	-4	
Closing stocks	97	20	70	-46	-463	180	86	90	97	91	98	253	96	

Table 61: Denmark, monetary balance sheets, gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks											449			
Extraction														
Time passing														
Other changes in volume														
Change in extraction path														
Nominal holding gains														
Closing stocks										449	308			

Table 62: France, monetary balance sheets, gas, million ECU

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	1664	2357	3164	3214	2974	2868	2370	1437	829	778	854	890	796	587	567	439	414	330	339
Depletion (1)	-297	-428	-563	-498	-567	-472	-95	-129	-100	-92	-89	-114	-87	-93	-98	-90	-79	-82	-61
Other changes in volume	82	104	107	121	123	373	202	-103	79	170	51	48	-74	12	-25	45	-45	67	-18
Nominal holding gains	957	1255	664	313	308	-446	-991	-358	-17	-22	77	-28	-75	55	-4	10	46	26	-28
Closing stocks	2357	3164	3214	2974	2868	2370	1437	829	778	854	890	796	587	567	439	414	330	339	233

(1) Extraction less revaluation due to time passing

Table 63: France, monetary balance sheets, gas, in % of opening stock

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Depletion (1)	-18	-18	-18	-16	-19	-16	-4	-9	-12	-12	-10	-13	-11	-16	-17	-20	-19	-25	-18
Other changes in volume	5	4	3	4	4	13	9	-7	9	22	6	5	-9	2	-4	10	-11	20	-5
Nominal holding gains	58	53	21	10	10	-16	-42	-25	-2	-3	9	-3	-9	9	-1	2	11	8	-8
Closing stocks	142	134	102	93	96	83	61	58	94	110	104	89	74	97	77	94	80	103	69

1) Extraction less revaluation due to time passing

Table 64: UK, monetary balance sheets, gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks (1)						-11651	-14019	-2001	-516	11506	22933	24821	46478	47049
Extraction (2)						801	124	33	-688	-1397	-1630	-3033	-3277	-4000
Time passing						-539	-81	-22	428	871	1036	1693	1797	2154
Other changes in volume						-693	-56	-35	694	1993	43	1119	1873	-185
Change in extraction path						1366	131	5	-982	-817	-1219	-4870	-584	-1453
Nominal holding gains						-3302	11899	1504	12571	10778	3656	26747	761	6123
Closing stocks (1)						-14019	-2001	-516	11506	22933	24821	46478	47049	49687

(1) The negative stock values could have been set to zero by definition. They have been left to show the results of the assumptions made in the calculations.
(2) Positive values for extraction are a result of the negative resource rents.

Table 65: UK, monetary balance sheets, gas, in % of opening stock

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks (1)						100	100	100	100	100	100	100	100	100
Extraction (2)						-7	-1	-2	133	-12	-7	-12	-7	-9
Time passing						5	1	1	-83	8	5	7	4	5
Other changes in volume						6	0	2	-134	17	0	5	4	0
Change in extraction path						-12	-1	0	190	-7	-5	-20	-1	-3
Nominal holding gains						28	-85	-75	-2435	94	16	108	2	13
Closing stocks (1)						120	14	26	-2229	199	108	187	101	106

(1) The negative stock values could have been set to zero by definition. They have been left to show the results of the assumptions made in the calculations.
(2) Positive values for extraction are a result of the negative resource rents.

Table 66: Norway, monetary balance sheets, gas, million ECU

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks (1)	70198	68684	20749	7580	-2866	8051	11118	13840	10246	9184	8058	8401	19973	
Extraction (2)	-2855	-908	-320	115	-335	-449	-554	-428	-371	-320	-337	-788	-909	
Time passing	2841	903	318	-113	334	449	554	427	371	320	337	784	903	
Other changes in volume	44	-5	-13	-27	1	0	-1	3	0	-2	1	43	29	
Change in extraction path	-2713	172	609	0	260	-1451	-110	426	-259	591	299	4708	3077	
Nominal holding gains	1168	-48097	-13762	-10420	10656	4518	2833	-4023	-804	-1716	43	6825	-743	
Closing stocks (1)	68684	20749	7580	-2866	8051	11118	13840	10246	9184	8058	8401	19973	22330	

(1) The negative stock values could have been set to zero by definition. They have been left to show the results of the assumptions made in the calculations.
(2) Positive values for extraction are a result of the negative resource rents.

Table 67: Norway, monetary balance sheets, gas, in % of opening stock

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Opening stocks (1)	100	100	100	100	100	100	100	100	100	100	100	100	100	
Extraction (2)	-4	-1	-2	2	12	-6	-5	-3	-4	-3	-4	-9	-5	
Time passing	4	1	2	-1	-12	6	5	3	4	3	4	9	5	
Other changes in volume	0	0	0	0	0	0	0	0	0	0	0	1	0	
Change in extraction path	-4	0	3	0	-9	-18	-1	3	-3	6	4	56	15	
Nominal holding gains	2	-70	-66	-137	-372	56	25	-29	-8	-19	1	81	-4	
Closing stocks (1)	98	30	37	-38	-281	138	124	74	90	88	104	238	112	

(1) The negative stock values could have been set to zero by definition. They have been left to show the results of the assumptions made in the calculations.
(2) Positive values for extraction are a result of the negative resource rents.

The impact of different assumptions on the stock values

The assumptions about the future extraction and unit resource rents may have a large impact on the stock values calculated by the present value method. Three examples, from Denmark, Norway and the UK serve to illustrate this.

Norway calculated the closing stock value of oil and gas in 1997 using two different assumptions of future extraction. In the standard calculation, future extraction is constant and equal to the 1997 level (this is the data reported in section 6 and Annex 1). In the alternative calculation, extraction forecasts made by the Ministry of Finance were used instead, while all other assumptions were unchanged. In the forecast, the extraction of oil and NGL was expected to increase about 25% over five years and then start a gradual decline. The extraction of gas was expected to almost double by 2006, and stay at that level until the end of the planning period in 2065. The effect on the stock value can be seen in table 68 below. The value of oil was little affected by the change of assumptions, but the value of the gas reserves increased by 66 percent. The explanation for the large increase in the value of the gas reserves is that in the Ministry of Finance forecast, extraction will take place over a significantly shorter period of time than when the constant 1997 extraction level is assumed. This means that the associated resource rent will be discounted less in the present value calculation, and the present value increases.

Table 68: Closing stocks of oil and gas in Norway in 1997, million ECU

	Future extraction		% change
	Constant 1997 level	Ministry of Finance	
Oil	119724	115479	-4
Gas	22330	37042	66

A similar calculation for Denmark in 1995 shows a smaller but still significant impact. Denmark used the actual extraction figures for 1996 to 1999, and then either constant extraction equal to the 1999 level or forecasts from the Danish Energy Agency (DEA).

Table 69: Closing stocks of oil and gas in Denmark in 1995, million ECU

	Future extraction		% change
	Constant	DEA	
Oil	2653	2593	-2
Gas	308	245	-20

The United Kingdom used forecasts from the UK Offshore Operators Association (UKOOA) in its alternative estimate for the value of oil and gas reserves in 1998. These show that extraction of both oil and gas will be about constant for four years and then decrease by a roughly constant amount each year, until the reserves are exhausted by 2018 for oil and 2032 for gas. Decommissioning costs are included in both alternatives. The UK also used an average of the unit resource rent over two years in the alternative calculation, instead of just the last years value as in the standard calculation. This latest assumption has a large impact on the value of the oil reserves, since 1998 was a year with a low oil price, and thus a low unit resource rent for oil.

Table 70: Closing stocks of oil and gas in the UK in 1995, million ECU

	Future extraction		% change
	Constant	**UKOOA**	
Oil	12002	28247	135
Gas	47360	43108	-9

Annex 2: Valuation of flows and stocks

The example below shows the calculation of stocks and flows in monetary terms. The example data are from Norway, and refer to oil and NGL for the years 1994 to 1995. The monetary values are in million Norwegian kroner (NOK). The starting points for the value calculations are the physical balance sheet and the resource rent. The example uses the assumptions of constant future extraction and constant future unit rent.

Physical balance sheet for oil and NGL in Norway, million tonnes

	1994	1995
Opening stock	3559	3531
Extraction	131	141
Other changes in volume	103	116
Closing stocks	3531	3506
Duration of life in years	27	25

The duration of life is calculated dividing the closing stock by the extraction of the year.

Resource rent for oil and NGL, Norway

	1994	1995
Resource rent (in million NOK):	25558	26326
Per unit resource rent (in NOK/tonne)	195	187

As described in section 5.2.3, the value of the closing stocks is given by the resource rent times a discount factor. The discount factor is:

$$\Phi(n;r) = [(1+r)^n - 1]/r(1+r)^n,$$

where n is the duration of life of the reserves and r is the discount rate, assumed to be 4.0%.

Value of reserves of oil and NGL, Norway

	1994	1995
Discount factor Φ(n;r)	16,349	15,597
Value of reserves (opening stocks)		417885
Value of reserves (closing stocks)	417885	410616
Value of changes		-7269

The value of changes for the year 1995 is explained by the following items:

Category	Value	Valuation method
Extraction	- 26326	Value of the current year resource rent = R_t
Revaluation due to time passing	16493	Calculated as the discount rate times the value of reserves at the beginning of the year at conditions of present year. Value of the reserves at the beginning of the year at conditions of present year is $V_0 = R_t\Phi(n_1;r)$, where n_1 = opening stock/extraction revaluation = $rR_t\Phi(n_1;r)$
Other changes in volume (due to discoveries and reassessments)	8114	Calculated as the present value of the resource rent corresponding to the extraction of discoveries after the initial reserves have been extracted. $R_t\Phi(n_2;r)/(1+r)^{n1-1}$, where n_2 is the duration of life of additions; when n_2 = 1 (volume of additions = volume of extraction), value of discoveries = depletion
Other changes in volume due to changes in the extraction path	12904	Calculated as the change in the value of the initial reserves due to the fact that the extraction path has changed. $R_t[\Phi(n_1;r) - \Phi(n_{t-1};r)n_1/n_{t-1}]$, where n_{t-1} is the duration of life of previous year
Nominal holding gains/losses	-18424	Calculated as the change in value of initial reserves, at the conditions of the previous year, due to the change in the level of the per unit resource rent: $[R_{t-1}\Phi(n_{t-1};r)][(rr_{t-1}-rr_t)/rr_{t-1}]$, where R_{t-1} is the resource rent of the previous year, rr_{t-1} is the per unit resource rent of the previous year and rr_t the per unit resource rent of the current year

Summarising, we get the following monetary balance sheet:

Monetary balance sheet for oil and NGL in Norway, million NOK

	1995
Opening stocks	417885
Extraction	-26326
Time passing	16493
Other changes in volume	8114
Change in extraction path	12904
Nominal holding gains	-18424
Closing stocks	410616

Annex 3: Specific and general taxes

This annex illustrates how income taxes paid by the extraction industry can be divided into specific and general taxes, for the purpose of calculating the government's share of the resource rent. The example is based on the situation in the Netherlands (see van den Berg and van de Ven 2000), but could be applicable also to other countries. See also the discussion in section 5.3.

The initial assumptions are:

Corporate tax rate: 25%
Specific tax rate on extraction: 70% (on income after corporate taxes)
Net operating surplus: 100
Net capital stock: 125
Rate of return to fixed capital, before corporate taxes: 8%

In this case, we get:

Return to capital, before tax: 10 (= 0.08*125)
Resource rent: 90 (=100 – 10)
Corporate taxes: 25 (= 0.25*100)
Specific tax on extraction: 52.5 (= 0.7*75)
Extractor's after tax income: 22.5 (= 100 – 25 – 52.5)

Government's share of resource rent: 52.5 (= specific taxes)
Extractor's share of resource rent: 37.5 (= 25 + 22.5 - 10)

Using these definitions, the extractor's share of the resource rent includes all corporate taxes, also the part that falls on the rent appropriated by the government as specific taxes.

Two alternative ways to divide the resource rent are proposed:

A) Divide the corporate tax revenue of 25 between government and the extractor in proportion to their shares of the net income after corporate taxes. The shares are:

Government: 0.7 (=52.5/75)
Extractor: 0.3 (=22.5/75)

The total resource rent of 90 will then be distributed as follows:

Government: 70 (= 52.5 + 0.7*25)
Extractor: 20 (=22.5 – 10 + 0.3*25)

Note that in this case the extractor's part of the rent includes the corporate tax paid on this rent (25% of 20 = 5).

B) A "normal" corporate tax for the extractor could be estimated by applying the corporate tax rate (estimated as corporate taxes divided by net operating surplus) to normal return to capital: 2.5 (= 0.25*0.08*125)

The total resource rent of 90 will then be distributed as follows:

Government: 75 (= 25 –2.5 + 52.5)
Extractor: 15 (= 22.5 - 10 + 2.5)

The remaining part of the extractor's after tax income of 7.5 (= 22.5 – 15) is then the after tax normal return to fixed capital.

Annex 4: Rate of return and holding gains

An example from economic theory may be used to illustrate how the holding gains or capital gains enter into the rate of return. The example involves buying a capital good at the beginning of the year, running it for a year and collecting the operating income and selling it at the end of the year.

The nominal rate of return to fixed capital for this "project" may be derived from the following equation:

$$K_B = \frac{I}{(1+r_N)} + \frac{K_E}{(1+r_N)}$$

K_B is the value of the capital stock at the beginning of the period, K_E the nominal market value at the end, and I is the income during the period, which is assumed to accrue at the end of the period. r_N is the nominal internal rate of return, i.e. the rate that ensures that the present value of the operating income and sales revenue equals the initial investment.

The value at the end of the period can be defined as the value at beginning minus depreciation (D) plus any capital gains or losses (G).

$$K_E = K_B - D + G$$

Combining the two equations and rearranging a bit gives this expression for the nominal rate of return (including holding gains or losses):

$$r_N = \frac{I - D + G}{K_B}$$

The capital gains can be defined as the rate of change in the price of the capital (p_C) multiplied by the initial value:

$$G = p_C * K_B$$

This means that the nominal rate of return to capital may be expressed as:

$$r_N = \frac{I - D}{K_B} + p_C$$

This shows that the nominal rate of return is adjusted automatically for changes in the price level of the capital stock.

In national accounts terms, the expression $(I-D)/K_B$ would correspond to net operating surplus divided by the net stock of fixed capital. It can be seen from the expression above that this is a real rate of return.

However, there are a couple of qualifiers to this result that are worth mentioning. The first is that during periods of very high inflation it may be necessary to make an adjustment to the normal rate of return to fixed capital, i.e. to the ratio of net operating surplus and net capital stock. The reason is that net operating surplus is a flow variable that incorporates the price increases during the year, while the net capital stock is assumed to be valued at the prices of the beginning of the year. To adjust for this, the normal real rate of return (e.g. 8%) can be multiplied by the ratio of the average price index (appropriate for the net operating surplus) and the price index at the beginning of the period (appropriate for the net capital stock). As an example, if prices increase by 20% per year, the adjusted rate of return would be 8.8%.

The second point is the relationship between the real rate of return to capital and the real interest rate in the economy. The real rate of interest can be defined as the nominal interest rate minus the change in the general price level, e.g. the GDP deflator. If one wants to ensure that the real rate of return equals the real interest rate, the normal real rate of return will have to be adjusted with the difference between the increase in the general price level and the increase in price of the fixed capital in the extraction industry. Analysis of empirical data show, however, that the difference between the two price indices is very small in the long run. For example, for Norway in the 10-year period from 1987 to 1996, the average growth rates of the two price indices differ by only 0.4 percentage points.

Annex 5: Recording of subsoil assets in the national accounts

The example below shows how a subsoil asset and the associated flows between the government and the extractor may be recorded in the national accounts. The value of the asset is assumed to be 1000, with the resource rent in the current year 100 and depletion 60. The part of the resource rent appropriated by the government is 75, leaving 25 to the extractor.

On the basis of the resource rent appropriated by, respectively, the government (75) and the extractor (25), the value of the asset may be split in two parts: Government 750, extractor 250.

The whole asset is recorded – as a subsoil asset – in the balance sheet of the extractor; a financial asset is created in the balance sheet of the government, for 750, and a corresponding financial liability in the balance sheet of the extractor.

Payments by the extractor to the government (75) are divided in two parts: royalties 30, repayment of the principal 45. At the same time, in the balance sheet of the extractor, the value of the asset is reduced by the value of the depletion (60).

EXTRACTOR

Current accounts

Uses		Resources	
"Royalties"	30	Operating surplus	100
Net Lending =			
Changes in NW	70		
Total	100	Total	100

Financial account

Changes in assets		Changes in liabilities	
F2	25	Net Lending	70
		F..	-45
Total	25	Total	25

Other changes in the volume of assets account

Changes in assets		Changes in liabilities	
K6	-60	Ch. In NW	-60
Total	-60	Total	-60

Opening balance sheet

Assets		Liabilities and Net Worth	
AN212	1000	AF..	750
AF2	0	Net Worth	250
Total	1000	Total	1000

Closing balance sheet

Assets		Liabilities and Net Worth	
AN212	940	AF..	705
AF2	25	Net Worth	260
Total	965	Total	965

GOVERNMENT

Current accounts

Uses		Resources	
Net Lending =		"Royalties"	30
Changes .in NW	30		
Total	30	Total	30

Financial account

Changes in assets		Changes in liabilities	
F2	75	Net Lending	30
F..	-45		
Total	30	Total	30

Other changes in the volume of assets account

Changes in assets		Changes in liabilities	
K6	0	Ch. In NW	0
Total	0	Total	0

Opening balance sheet

Assets		Liabilities and Net Worth	
AF..	750	Net Worth	750
AF2	0		
Total	750	Total	750

Closing balance sheet

Assets		Liabilities and Net Worth	
AF..	705	Net Worth	780
AF2	75		
Total	780	Total	780

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