Handbook on Mineral and Energy Asset Accounting

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A first outline

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Preface

At the 9th London Group meeting in Copenhagen September 2004 - and again at the 10th London Group meeting in New York, June 2006 - it was concluded that the *sub group of the London Group on mineral and energy accounting could aim at developing an annotated outline for guidelines for subsoil assets before the next London Group meeting. The Eurostat guidelines can be used as a starting point.*

Furthermore, the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) established by the United Nations Statistical Commission endorsed the work being carried out by the subgroup of the London Group on Mineral and Energy Accounts and in particular the preparation of a handbook on mineral and energy asset accounts.

In 2005 the European Commission represented by Eurostat awarded Statistics Denmark a grant for developing an outline for guidelines for subsoil assets[1]. On that background this first outline of a handbook on mineral and energy asset accounts has been worked out.

At the London Group meeting in New York June 2006 it was recommended that flows in addition to stocks (assets) should be presented in the handbook. However, the Group noted that the (energy) flow accounts are the responsibility of the Oslo Group, and that London Group work on a Handbook should initially focus on the stock accounts awaiting agreement with the Oslo Group as far as the flow accounts are concerned.

Anyhow, consistency with the flow accounts, will be an important part of this handbook and will be underlined, when appropriate.

This first outline is to a large degree inspired by and based on text from *SEEA 2003* and the Eurostat *Guidelines for the set of standard tables*. From SEEA 2003 it is the text and tables from chapter VII and VIII that relates to mineral and energy accounts, which are the starting point.

The sources of the text can – when reading it on the computer screen or printing in colours - be identified by the following colours:

Blue: Reproduction of SEEA text

Green: Reproduction of Eurostat subsoil guidelines text

Brown/red: Reproduction of text from UNFC guidelines on classification

Black: Other/new text added by the author.

It should be noted that this document is exactly *an outline*, which can be used for discussion of what the handbook should look like, and what it should include. Thus, a lot of the suggested chapters and sections are empty or only filled in a very incomplete way. At the same time the editing of language, language check, layout, etc. is very incomplete. So are the references.

[1] European Commission agreement 71401.2005.001-2005.292. The sole responsibility for this report lies with the author and the Commision is not responsible for any use that may be made of the information contained in this repport.

Part I Introduction to mineral and energy asset accounting

1 Purpose of the handbook

The main purpose of this handbook is to give an overview of mineral and energy asset accounts and to give practical advice to how mineral and energy asset accounts can be set up and filled out.

The handbook includes guidelines and show actual examples of mineral and energy asset accounting from countries which have already implemented mineral and energy asset accounting according to the SEEA standards.

When it comes to the practical guidelines the handbook can be viewed as a step by step manual, starting from the collection of basic data, going through the making up of the physical accounts, the valuation of the assets, and changes in them, i.e. the monetary accounts. Finally, it includes some advices concerning publication and analyses of the accounts.

The handbook is a supplement to the SEEA version, which are expected to be published by 2010 as an international statistical standard for environmental-economic accounting. At the same time the Handbook should describe how SNA accounts for mineral and energy accounts can be established and what the links between the SNA and SEEA accounts are.

For readers who are not familiar with the SEEA and SNA asset accounts this handbook gives in this first part an overview of the fundamentals of what mineral and energy asset accounting is about. It present some of the theoretical background for the standards in SEEA.

2 Overview of this handbook

The handbook is build in three parts, which to a large extent can be read separately.

Part I gives a description of the fundamentals of mineral and energy asset accounting including some theory and a listing of concepts. Chapter 3 and 4 present a general introduction to asset accounting. Chapter 5 describes a classification of mineral and energy asset accountings in order to outline what type of natural resources we are talking about and to build the ground for a systematic accounting approach. Chapter 6 is about physical asset accounts, while chapter 7 goes on with the monetary accounts. Then in chapter 8 some associated issues are described. It concerns mineral exploration activities, mineral extraction and decommissioning costs.

Readers familiar with the appearance and concepts of mineral and energy asset accounts can skip part I and go on to part I or part II.

Part II of this handbook is intended to be a practical guide to mineral and energy asset accounting. It deals with collecting and converting of physical data, with resource rent calculation in practice, with valuation of stocks and changes in stocks, with setting up the accounts, and finally with issues like publicationa and revision processes.

In part III actual examples of mineral and energy asset accounts and examples of uses of the accounts are shown.

An EXCEL file with templates for basic tables, etc. could be developed and attached to the handbook.

3 What is mineral and energy asset accounting?

The purpose of asset accounts for mineral and energy is to describe the stocks and flows of mineral and energy in a consistent way. Thus, from the accounts it is possible not only to see what is the quantity or value of the stocks but also to analyze how the change in stocks over time is a result of the flows, i.e. extraction, new findings, changes in the economic conditions, etc.

Viewed narrowly, the process of accounting for subsoil assets are confined to define and measure the level of stocks in physical terms and to place a value on these.

The structure of a very simple asset account is shown in Table 3-1.

The account starts with the opening stock of the asset at a given point of time, e.g. at the beginning of a given year. Then it shows the changes in the stock during the year, i.e. the decreases and increases in the stock during the year. When the decreases are subtracted and the increases are added the closing stocks at the end of the year appears.

Thus, from an asset account the stock levels at the beginning and end of the year can be identified, but the asset accounts also show the reasons for changes in the stock level over time.

In the very simple asset account shown in Table 3-1 discoveries and extractions are identified explicitly, but also other decreases and increases are hinted at. We will come back to these other changes but can already now mention, that changes can occur due to natural disasters, technological advances or reclassifications of the assets. For the monetary accounts also changes due to price changes and revaluations can take place.

Table 3-1 A generic asset account for a mineral and energy asset

	year 1	year 2	year 3	year 4	…
Opening stock levels (1 January)					
+ Increases in stocks					
Discoveries					
Other increases					
- Decreases in stocks					
Extractions					
Other decreases					
= Closing stock levels (31 December)					

Table 3-1 illustrates a situation where the accounting takes place for a number of subsequent years. When this is the case the opening stock of one year will be equal to the closing stock of the previous year. However, the account can of course be made up for one on year if this is found appropriate.

Mineral and energy asset accounts can be made up as either a physical accounts or as a monetary account. The unit used for the physical accounts can be tonnes, cubic metres, oil equivalents, PJ, etc. depending on what is most appropriate for the asset in focus. The important thing is of course that the same unit is used throughout the account so that the book keeping system of the account can be maintained (i.e. adding changes to the opening stock gives the closing stock).

For the monetary accounts the currency unit of the country owning the assets will typically be used. Both current prices and fixed prices can in principle be applied.

4 Basic concepts

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5 Definitions and classifications of mineral and energy

Different classification systems are used by the institutions compiling physical data on mineral and energy assets, according to data availability and user needs.

The classification issue includes *two aspects*.

The first aspect concerns how much of a given class of mineral or energy that should be accounted for. This has to do with the technical and economic feasibility and availability of the stocks. Should, for example, an oil field be included in the accounting if it is technical impossible or economic unfeasible to extract the oil? This dimension has traditionally been handled by the so-called McKelvey box, and are now further developed by the UNFC approach, see sections 5.1 and 5.2, respectively.

The second aspect concerns how detailed the assets are divided into groups or classes according to the specific physical (material) characteristics. this concerns, for example, whether fossil fuels are regarded as one group or whether it is divided into coal, oil, gas, and further on whether for example oil is classified according to the quality of the oil. This is the kind of classification that the SEEA and the SNA so far mainly have been are dealing with, cf. section 5.3 below, when it comes to the "pure" classification. In addition both the SEEA and the SNA include in the texts recommendations of a more general character on how much that should be accounted for (i.e. the first aspect mentioned above).

In the part on the practical implementation of the asset accounts we will come back to the issue on how to combine the two aspects of the classification.

/* Also the link to the classification used in the flow accounts and MFA could perhaps be described */

5.1 The McKelvey Box

Resources of oil are grouped into different categories depending on the certainty of knowledge concerning them. Though different categories are used in different parts of the world most of them are based on the so-called McKelvey box, cf. Box 5-1

In the traditional McKelvey box 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/commercial *dimension* classifies the resources according to whether the resources are anticipated to be extracted. This can vary over time with changes in prices and extraction technology.

The two major categories of the geological dimension are discovered and undiscovered resources. *Discovered resources* have been confirmed by drilling of test wells, while *undiscovered* resources are inferred from seismic data and geological models.

Along the economic/commercial dimension the main distinction is whether it is commercial profitable or not to extract the resource or not. The part of the discovered resources that are expected to be extracted commercially with some degree of certainty is called *reserves.*

Box 5-1 The McKelvey Box Resource Classification System

	Discovered			Undiscovered	
	Proven	Probable	Possible	Hypothetical	Speculative
Commercial	Reserves				
Sub-commercial	Resources				

Proven reserves of are estimated quantities that analyses of geological and engineering data have demonstrated to be economically recoverable in future years from known reservoirs and under current economic conditions, operating methods, and government regulations.

Current economic conditions include historical petroleum prices and associated costs.

Unproven reserves are less certain to be recovered than proved reserves and may be further sub-classified as probable and possible reserves to denote increasing uncertainty regarding their extraction.

Example

As an example of the classification of reserves, the UK Department of Trade and Industry 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%.

The table presents a classification of the oil reserves of the United Kingdom at the end of 1999. The most certain reserves are in the cell at top left. As one moves to the right across the columns or down the rows, there is a decrease in the economic or technical feasibility of extracting the reserves. The associated uncertainty is indicated by the fact that the figures for the two lowest categories are given as ranges rather than point estimates.

Table 5-1 McKelvey box for continental shelf oil reserves, United Kingdom, 31 December 1999

Millions of tons

	Discovered reserves				Undiscovered reserves
	Proven Over 90 per cent	Probable 50-90 per cent	Possible 10-50 per cent	Potential additional Less than 10 per cent	Hypothetical or speculative
Economic	665	455	545	85 – 370	250 – 2,600
Marginally economic					
Sub-econoc					

Source: United Kingdom Office for National Statistics, 2001.

5.2 The UNFC system

Introduction

The United Nations Framework Classification (UNFC) for Energy and Mineral Resources is a flexible scheme for classifying and evaluating energy and mineral reserves resources. It is intended to meet the basic needs for an international standard.

The Framework classification has been developed gradually. Originally (1992) it was a classification for solid fuels and mineral commodities. This original UNFC for solid fuels and mineral commodities has been applied in more than 60 countries worldwide. In some countries UNFC is used as a national system, in other countries the national systems have been adjusted in the direction of the UNFC principles (UNFC, p. 4).

Since then the classification has been extended to cover also other energy resources (oil, natural, gas and uranium). The extension was undertaken by the UNECE Intergovernmental Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology, cf. http://www.unece.org/ie/se/adhocsuppl.html.

In February 2004, the UN Economic Commission for Europe endorsed the United Nations Classification for Energy and Mineral Resources and proposed to the United Nations Economic and Social Council (ECOSOC) that it recommend its application worldwide.

(This following is reproduced/extracted from UNFC,
http://www.unece.org/ie/se/pdfs/UNFC/UNFCemr.pdf - not all are included here)

Basic principles

The total resources initially in-place of naturally occurring energy and mineral resources, are described in terms of:

- Produced quantities
- Remaining recoverable quantities
- Additional quantities remaining in-place

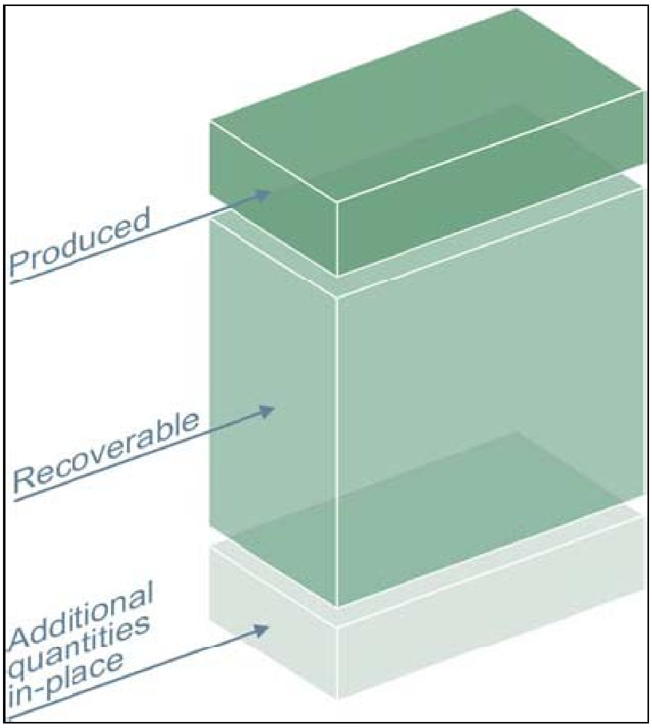
The main focus of the UNFC is on remaining recoverable quantities.

For non-renewable resources, the total resources initially in-place is constant. In inventories, material balance is therefore maintained. If any change appears, this must be explained by a re-evaluation.

Produced quantities are included in the UNFC to facilitate explanation of changes in remaining recoverable quantities resulting from production that has already occurred. Produced quantities are the sum of sales quantities and non-sales quantities as determined at their respective reference points between a specified initial time (often the time of first recorded production) up to a given date and time (normally the time of the evaluation). Non-sales quantities are considered to have intrinsic economic value.

Remaining recoverable quantities are the sum of sales quantities and non-sales quantities estimated to be produced at the respective reference points from a given date and time forward.

Figure 5-1 Total initial in-place resources.



Additional quantities remaining in-place are quantities estimated to be in-place at the initial time, less the sum of the produced quantities and the estimated remaining recoverable quantities. Additional quantities remaining in-place are described in non-economic terms only. Their recoverability and, as a result, their economic viability, has not been assessed. Alternatively quantities may be non-economic in the sense that they may not be recovered in the future, although they may be an integral part of the recovery operations. Both forms of additional quantities remaining in place may hold intrinsic economic value, as do the recoverable non-sales quantities.

Classification

Total remaining resources (*i.e. remaining recoverable quantities plus additional quantities remaining in place, ed.)* are categorized using the three essential criteria affecting their recoverability:

• Economic and commercial viability (E).

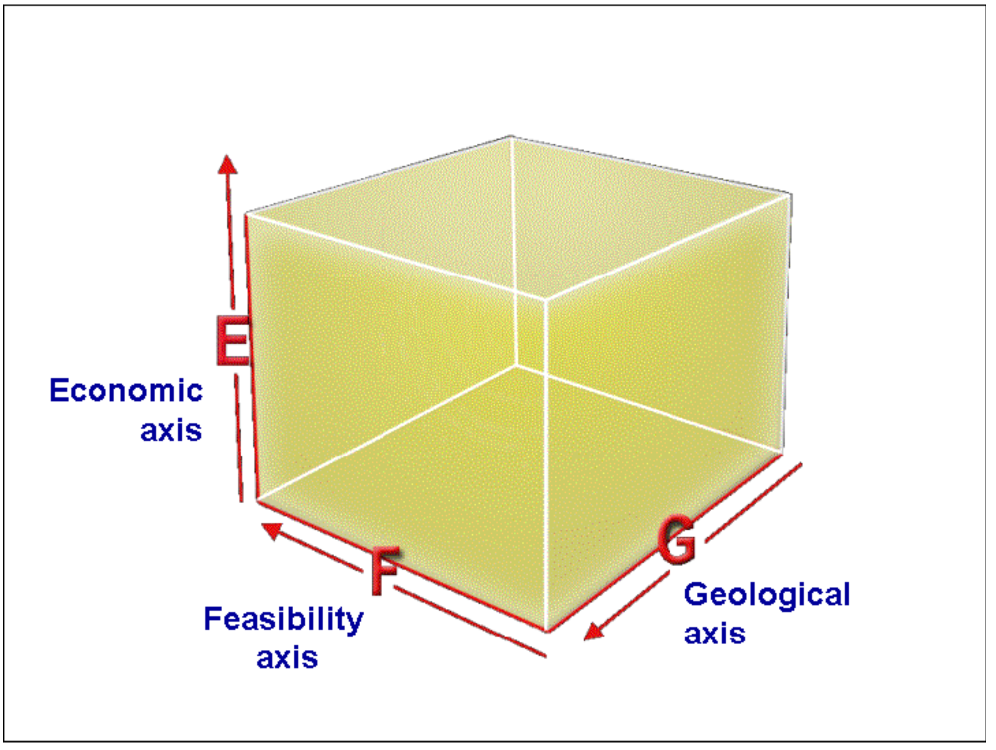
• Field project status and feasibility (F).

• Geological knowledge (G).

Most of the existing resource classifications recognize these explicitly or implicitly. By making them explicit, the UNFC becomes a framework that allows for harmonization of existing classifications.

The three criteria are easily visualized in three dimensions as shown in Figure 5-1.

Figure 5-2 Principal elements of the UNFC



Three main categories are used to describe economic and commercial viability, three to describe field project status and feasibility and four to describe the level of geological knowledge. Further subdivision of the main categories is useful for special applications. Resource quantities are then grouped into classes that are defined by an E a F and a G category represented by the sub-cubes in Figure 5-3

A class of quantities may be a single sub-cube, i.e. 111, or a collection of sub-cubes. Total resources are an example of such a class where all sub-cubes are included in the class.

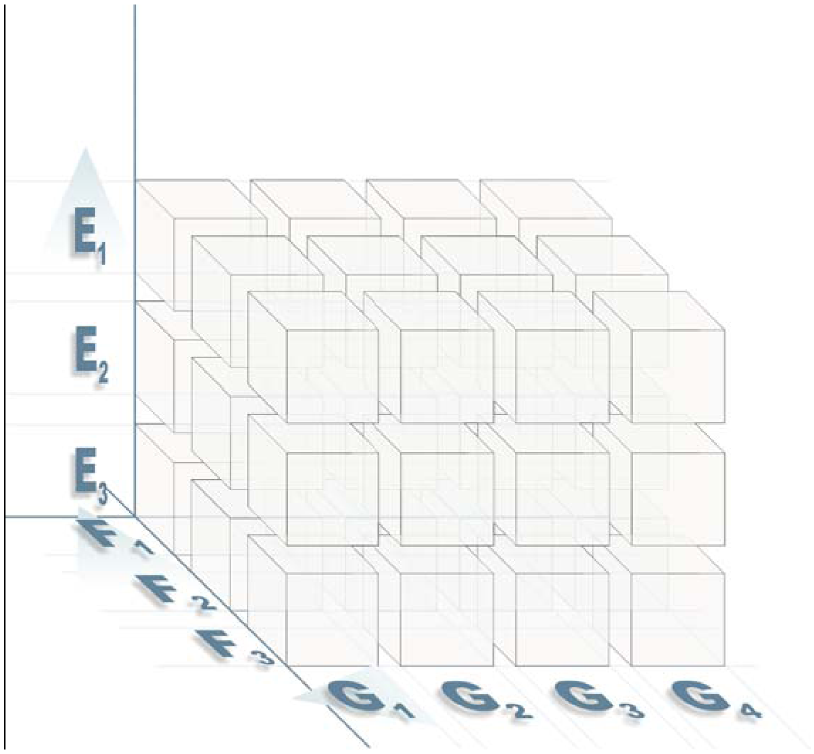
The three dimensions of categorization are represented by the edges of a cube. The digits are quoted in the order EFG firstly because the alphabetical order is easy to memorize, and secondly because the first digit refers to the economic viability, which is of decisive interest to producers, investors and host countries. Numbers are used to designate the different classes. Number 1, in accordance with the usual perception that the first is the best, refers to the highest degree of economic viability on the E axis, the most advanced project status on the F axis and the highest quality assessment on the G axis. The use of categories is different for fluids and for solids. This is primarily due to the fact that fluids may flow in a reservoir, irrespective of the level of geological knowledge. In the case of solids, recovery will normally be restricted to rock bodies that have been reliably assessed.

Codification

Due to variation between terminologies in different systems and languages, it is recommended to use only three-digit numeric codes for individual categories, so that they will be universally understood. For this to be possible, the sequence is always fixed, so that the quantity characterized as E1;F1;G1 may be written in number form as 111, independent of languages. In practice, only a limited number of combinations (classes) are valid.

Class 111 is of prime interest to an investor. It refers to quantities that are: economically and commercially recoverable (number 1 as the first digit); have been justified by means of a feasibility study or actual production to be technically recoverable (number 1 as the second digit); and are based on reasonably assured geology (detailed exploration for solids) (number 1 as the third digit).

Figure 5-3 Classification



Subcategories may be added under the main categories when required. Categories and subcategories shall be numbered. A sub-category shall be separated from the main category number by a decimal point, e.g. E1.1. In such cases the categories have to be separated by a semicolon to distinguish the different categories that are included in the codified unit, e.g. 1.1;1;1 for the subcategory defined by E1.1, F1 and G1.

A single geological deposit or accumulation of a recoverable quantity may be subject to production by several separate and distinct projects that are at different stages of exploration or development. The estimated remaining recoverable quantities obtained through each such project may be categorized separately.

The practical application of the UNFC and the link between some of the McKelvey box and the UNFC categories on one hand and the link between existing national classifications and the UNFC categories are taken up in part II of this handbook.

5.3 SEEA 2003 and SNA 93 classifications of mineral and energy assets

SEEA 2003 and SNA 93

SEEA 2003 annex 1 presents a general classification as regards the specific types of natural resources that can be accounted for.

Table 5-2 shows the relevant items for the mineral and energy assets.

Table 5-2 Mineral and energy assets in SEEA 2003 and SNA93

SEEA 2003 classification	Corresponding SNA 93 classification
EA.11 Mineral and Energy resources	AN.212 Subsoil assets
EA.1 11 Fossil fuels	AN. 2121 Coal, oil, and natural gas reserves
EA.112 Metallic minerals	AN.2122 Metallic mineral reserves
EA.113 Non-metallic minerals	AN.2123 Non-metallic mineral reserves

Box 5-2 Classification of subsoil assets according to SNA93

SNA93, p. 309 (ESA § 7.41)

Subsoil assets (AN.212): Proven reserves of mineral deposits located on or below the earth's surface that are economically exploitable, given current technology and relative prices. Ownership rights to the subsoil assets are usually separable from those to the land itself. Subsoil assets consist of coal, oil and natural gas reserves, metallic mineral reserves and non-metallic mineral reserves, as defined below.

Coal, oil and natural gas reserves (AN.2121): Anthracite, bituminous and brown coal deposits; petroleum and natural gas reserves and fields.

Metalic mineral reserves (AN.2122): Ferrous, non-ferrous and precious metal ore deposits.

Non-metalic mineral reserves (AN.2123): Stone quarries and clay and sand pits; chemical and fertilizer mineral deposits; salt deposits; deposits of quartz, gypsum, natural gem stones, asphalt and bitumen, peat and other non-metallic minerals other than coal and petroleum.

As can be seen from the classification of SEEA 2003 and SNA 93 are as such quite similar although different words/terms are being used.

The SNA 93 includes explicitly the word *reserves*, and in the description, cf. Box 5-2, even refer to proven reserves, while this is not the case for SEEA 2003, which uses the term *resources*. The difference in wording underlines a fundamental difference when it comes to how much of the resources that should be accounted for in the two systems.

In SNA93 only the *proven reserves*, should be included. This difference in scope is connected with the fact that SEEA 2003 includes both physical and monetary accounting, while SNA93 only include monetary aspects, and has a focus on *economic asset* , "entities over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived by their owners by holding them, or using them, over a period of time" (para. 10.2).

SNA93 gives the following definition of proven reserves (SNA93, 21.152: "the estimated quantities at a specific date, which analysis of geological engineering data demonstrate, with reasonable certainty, to be recoverable in the future from known reservoirs under the economic and operational conditions at the same date".

From this it is evident that the SNA93 applies the terminology and definitions from the McKelvey box approach, cf. section 5.1

However, since the cost for proving new reserves is often very high 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 the reserves. Therefore, a number of countries work, even in the SNA context, with proven plus probable reserves rather than with proven only. Another reason for doing this can be that the information on the two classifications is not available separately.

In SEEA 2003 *in principle* all parts of the mineral and energy resources can be taken into consideration when it comes to the *physical accounts*, i.e. also the parts of the resources which are probable, possible and speculative or hypothetical, and regardless of whether they are economic or sub-economic.

When it comes to the monetary SEEA 2003 accounts both proven and probable reserves are typically included as assets.

The revised SNA, SNA 93 rev. 1

The classification and terminology of non-financial assets has been an issue in relation to the update and revision of the SNA 93. Regarding mineral and energy resources (as part of so-called non-produced assets) there is no change as compared to the SNA93 classification. However, to put the classification of subsoil assets into perspective and to show related classification items, the entire classification of non-financial assets is shown in Box 5-3

The proposed text for the SNA 93 rev. 1 reads:

Natural resources are classified as part of the *non-produced assets*. As a subcategory of natural resources we find the category *subsoil assets*. *Subsoil assets is the lowest standard level suggested for the SNA 93, rev 1.* Below the standard level we find the *optional classification of subsoil assets* as

Coal, oil and mineral gas reserves
Metallic mineral reserves
Non-metallic mineral reserves

Other assets which in principle can be of relevance in relation to the mineral and energy assets are costs *of ownership transfer* and *Mineral exploration and evaluation* (both recorded under produced assets), and *Permissions to use natural resources* (recorded under non-produced assets).

Box 5-3 Suggestion for classification of non- financial assets according to SNA 93 rev. 1

- **Non financial assets**
  - **Produced assets**
    - **Fixed assets**
      - **Dwellings**
      - **Other buildings and structures**
        - **Non-residential buildings**
        - **Other Structures**
        - **Land improvements**
      - **Machinery and equipment**
        - **Transport equipment**
        - **ICT equipment**
        - **Other machinery and equipment**
      - **Military assets**
      - **Cultivated assets**
        - **Livestock for breeding, diary, draught etc.**
        - **Vineyards, orchards and other plantations of trees yielding repeat products**
      - **Costs of ownership transfer of non-produced assets**
      - **Intellectual property rights**
        - **Research and development expenditure**
        - **Mineral exploration and evaluation**
        - **Computer software and databases**
        - **Entertainment, literary and artistic originals**
        - **Other intellectual property products**
    - **Inventories**
    - **Valuables**
  - **Non produced assets**
    - **Natural resources**
      - **Natural land**
        - **Natural land under buildings and structures and associated surface water**
        - **Natural land under cultivation and associated surface water**
        - **Natural recreational land and associated surface water**
        - **Other natural land and associated surface water**
      - **Subsoil assets**
        - **Coal, oil and mineral gas reserves**
        - **Metallic mineral reserves**
        - **Non-metallic mineral resources**
      - **Non-cultivated biological resources**
        - **Natural forests**
        - **Other crop and plant resources**
        - **Wild stocks of fish and aquatic mammals**
      - **Water resources**
        - **Aquifers**
        - **Other**
      - **Other natural resources**
        - **Radio spectra**
        - **Other**
    - **Contracts, leases and licences**
      - **Third part property rights**
        - **Marketable operating leases**
        - **Permissions to use natural resources**
      - **Entitlement to future goods and services on an exclusive basis**
    - **Goodwill and marketing assets**

5.4 (Revised) SEEA standard classification of mineral and energy assets

SEEA standard classification of minerals

From the UNFC a *revised* SEEA standard classification is developed.
Bridge tables to UNFC and SNA 93 rev.1 classification.

-- To be developed --

Table 5-3 SEEA classifications of minerals

SEEA	UNFC	SNA 93 rev. 1
		Metallic mineral reserves
		Non-metallic mineral resources

SEEA standard classification of energy

From the UNFC a SEEA 2010 standard classification is developed.
Bridge tables to UNFC and SNA 93 rev.1 classification.

-- To be developed --

Table 5-4 SEEA classification of energy

SEEA	UNFC	SNA 93 rev.1
		Coal, oil and mineral gas reserves

5.5 Read more about classifications

http://www.unece.org/ie/se/reserves.html

http://www.unece.org/ie/se/pdfs/UNFC/UNFCemr.pdf

Read more on how proved (oil) reserves are specified:
http://www.spe.org/spe/jsp/basic/0,,1104_12169,00.html

http://www.spe.org/specma/binary/files/5806700Revised%20Definitions%20Draft.pdf

6 Physical asset accounts for mineral and energy

6.1 General description

As the name indicates physical asset accounts present the quantity in physical units of the stocks and how the change in stocks over time is a result of the flows, i.e. extraction, new findings, etc.

The structure of a physical asset account is shown in Table 6-1.

Table 6-1 A generic physical asset account

	Year 1	Year 2	Year 3	Year 4	…
Opening stock levels					
Changes due to transactions					
Acquisitions less disposals					
Increases in stocks					
Discoveries					
Reappraisals					
Decreases in stocks					
Extractions					
Reappraisals					
Other changes in stock levels					
Catastrophic losses and uncompensated seizures					
Changes in classifications and structure					
Closing stock levels					

The different accounting items explained below.

Opening stock levels: The level of the resources at the beginning of the year. It should be equal to the closing stock of the previous year.

Changes due to transactions:
Acquisitions less disposals of mineral and energy assets relates to the purchase and sale of mineral and energy resources.

Increases in stocks:
Discoveries include gross additions to the level of the resources and refer to findings of resources previously unknown.

Reappraisals (upwards): are relevant if the physical asset accounts refer to a specific class of resources. As more is learned about the characteristics of a particular oil well or mine, the estimate of the stock will be adjusted in the light of new knowledge. If the resource is bigger than expected or if it proves technically easier to extract than was previously thought, or if the world price of the resource increases so that a greater quantity can be extracted at a profit, then there will be an upward reappraisal of the previously classified stock level. This may lead to a revision of the estimate of the total level or simply to a shift of some possible reserves to the probable category and some probable reserve to the proven category if the McKelvey box classification scheme is used.
If the necessary information is not available to separate new discoveries from reappraisals, the term "discoveries and reappraisals" should be used in full to cover the combined item. In the case that appraisals are counted for net, i.e. upwards reappraisals minus downwards reappraisals (see below) and there for example are no discoveries the "discoveries and reappraisals" item will lead to a negative entry.

Decreases of stocks
Extractions
The volume of the asset, which are extracted during the year.

***Reappraisals* (downwards)** can take place if the asset account refer to specific class of resources. It is the counterpart to the upward reappraisals. If for example the asset account refer to proven reserves (using a McKelvey type classification scheme), then a reappraisal of part of the reserves from proven to probable reserves will decrease the stock of proven reserves.

Other changes in stock levels
Catastrophic losses cover the effects of earthquakes, volcanic eruptions, tidal waves, hurricanes, droughts, floods and other natural disasters as well as wars. Catastrophic losses are fairly seldom in relation to mineral and energy resources. However, flooding of mines is possible and fire may destroy an oil well. *Uncompensated seizures* rarely occur but can in theory take place.

Changes in classifications and structure involve no change in the volume of an asset but relate mainly to the change of ownership from one type of unit to another.
/** this might need to be clarified/exemplified – e.g. how does it relate to acquisitions less disposals ?? **/

Closing stocks: The level of reserves at the end of the year. It should be equal to the opening stock of the subsequent year.

6.2 Units to be used in the physical accounts

Physical accounts may be compiled in any unit, as long as all the elements of the account can be measured in the same unit. For oil, both cubic metres and tons are frequently used, as well as barrels, which is the unit often used in connection with international oil prices. Conversion rates from one unit to another are not always constant. Allowance has to be made for the quality of the oil in terms of its specific gravity. For gas, allowance has also to be made for the fact that the volume of gas expands as the temperature rises.

7 Monetary asset accounts

7.1 The generic SEEA asset account for mineral and energy resources

The structure of a monetary SEEA asset account is shown in Table 7-1. All entries should be made in the same currency unit.

Table 7-1 A generic SEEA monetary asset account for mineral and energy assets

	Year 1	Year 2	Year 3	Year 4	…
Opening stock levels					
Changes due to transactions					
Acquisitions less disposals					
Increases in stocks					
Discoveries					
Reappraisals					
Decreases in stocks					
Extractions					
Reappraisals					
Other changes in stock levels					
Catastrophic losses and uncompensated seizures					
Valuation changes (capital gains and losses)					
Changes in classifications and structure					
Closing stock levels					

As can be seen all entries besides one are the same as applied for the physical asset accounts, cf. 6.1.

/* Should *additions to the value of non produced assets* be included here as well, cf. section 7.2 ??? */

The entry which is particular for the monetary accounts as compared to the physical accounts is the ***valuation changes (capital gains and losses)*** under other changes in stock levels.

The item ***valuation changes (capital gains and losses***) reflects the effect of price changes on the value of the stock. Observe, that besides affecting the value directly through the impact on the price component of the price x volume equation, price changes can also affect the volume component, since resources can be reclassified e.g. from probable to proven reserves, and thus causing a change in the amount of resources, which enters the account, cf. section 6.1. The latter effect of price changes are not accounted for in relation to valuation changes (capital gains and losses) but instead as reappraisals under increases in stocks (normally, if prices goes up) or decreases in stock (normally, if prices goes down).

7.2 The SNA 93 asset account for subsoil assets

The generic asset account for mineral and energy assets is quite close to the kind of asset account for mineral and energy assets that can be drawn from the SNA 93. It is based on the same principles, but the terms used are somewhat different from the SEEA 2003 account.

The 1993 SNA presents a general asset (and liabilities) account in the appendix to the annex to chapter II (SNA 93, table 2.7, p. 59) and again in the annex V, table A.V.2, accounts III and IV, p. 607-613). The principles behind this relationship are explained in paragraph 10.15 of the 1993 SNA and shown schematically in its table 13.2.

The SNA 93 asset account for a *non-financial asset* consist of two *balance sheets – one for opening balance (stock) and one for closing balance (stock) , and two so-called accumulation accounts,* which together give the *changes in the balance sheets*[2].

In terms of the SNA accounts, the following identity must hold:

stock levels as in the *opening balance sheet*

plus entries on non-financial assets in the *capital account*
(gross fixed capital formation, acquisitions less disposals, etc.)

plus entries from the *other changes in assets account*
(economic appearance and disappearance, catastrophic losses, revaluations, etc

equals stock levels as in the *closing balance sheet*

In the general capital account and other changes in asset account for non-financial assets quite a lot of different items are included in order to allow for the different kind of non-financial assets (produced assets, non-produced assets, tangibles, intangibles, valuables, biological resources, etc.). However, when it comes to mineral and energy resources the number of different accounting items on the accumulation accounts can be narrowed considerable. The relevant accounts and accounting items are shown in Table 7-2.

The table shows the accounting items relevant for mineral and energy asset accounts together with the specific SNA 93 transaction codes (e.g. P 5.1) and the SNA accounts (e.g. the Capital Account) to which the items are associated as well. We will come back to the correspondence between the SEEA and the SNA asset accounts in section 7.3. For the moment it suffices to note that the terminologies are somewhat different, and that there is not a strict one- to one relationship between the SEEA accounting items on one hand and the SNA 93 accounting items on the other hand.

Opening stocks. This item presents the value of the stock at the beginning of the year. It should be equal to the closing stock of the previous year. Observe, that for SNA 93 the starting point is *proven reserves*, although some countries may wish also to include probable reserves. The stock of mineral and energy is part of the overall asset group AN. 22 Intangible non-produced assets in the SNA 93 (natural resources, subsoil assets in SNA 93, rev. 1).

In the capital account we find the first *(possible)* item for changes in the stock under gross fixed capital formation: *P. 513 Additions to the value of non-produced non-financial assets*. it is unclear whether this item is in fact relevant for mineral and energy asset accounting, and it seems not to be included in the SEEA 2003 for mineral and energy assets. SEEA 2003 refer to restoration or decontamination of quarries and landfill sites as well as measures designed to improve the quality of agricultural land. (SEEA 2003, 7.96). Observe that mineral exploration is not included under this item. Mineral exploration is accounted for as a separate (produced asset), cf. Box 5-3 and Section 8-3.

/* Question: should this item be ruled out completely for energy and mineral assets. What if a mine is cleaned up or being emptied for water after a flooding?? /

The second relevant item of the capital accounts *is K.2. Acquisitions less disposals of non produced non-financial assets.* This item refer only to those subsoil assets over which ownership rights have been established and the item is only relevant if the assets is moved among sectors in the economy.

[2] Non-financial assets: see Box 5-3. For non-financial assets an additional socalled financial account exists in SNA 93, but this is of no relevance for the mineral and energy assets.

Table 7-2 SNA 93 asset account for mineral and energy/subsoil assets

SNA 93 Asset account for subsoil assets	SNA 93 accounts		
Opening stocks	Opening balance sheet SNA 93 Table A.V.2 , Account IV.1)		
P.51 Gross fixed capital formation P.513 Additions to the value of non-produced non-financial assets K.2 Acquisitions less disposals of non-produced non-financial assets	Capital account (SNA 93 Table A.V.2, Account III.1)		Changes in balance sheet SNA 93 Table A.V.2 , Account IV.2)
K.3 Economic appearance of non-produced assets	*Other changes in volume of assets account (SNA 93 Table A.V.2, Account III.3.1)*	Other changes in assets account (SNA 93 Table A.V.2, Accounts III.3)	
K.6 Economic disappearance of non-produced assets K.61 Depletion of natural assets K.62 Other economic disappearance of non-produced assets K.7 Catastrophic losses K.8 Uncompensated seizures K.9 Other volume changes in non-financial assets n.e.c K.12 Changes in classifications and structure K.12.1 Changes in sector classification and structure K.12.2 Changes in classification of assets and liabilities			
K.11 Nominal holding gains (+)/losses(-) K.11.1 Neutral holding gains (+)/losses(-) K.11.2 Real holding gains (+)/losses(-)	*Revaluation account* *(SNA 93 Table A.V.2, Account III.3.2)*		
Closing stocks	Closing balance sheet (SNA 93 Table A.V.2 , Account IV.3)		

Acquisitions or disposals of deposits takes place by purchases or sales, barter or transfers in kind; in other words, they consist of transactions in which the ownership of such assets passes from one institutional unit to another. By convention, all owners are resident institutional units, and therefore all transactions whereby subsoil assets are acquired or disposed of take place between resident units SNA93 10.126-10.129).

The SNA 93 account *Other changes in volume of asset accounts* includes some items specific for non-produced assets like subsoil assets. These are K.3 Economic appearance of non-produced assets, and K 6 Economic disappearance of non-produced assets. In addition the items K.6 Catastrophic losses and K.8 Uncompensated seizures, K.9 Other volume changes in non-financial assets n.e.c., and K.12 Changes in classifications and structure are part of the account.

K.3 Economic appearance of non-produced assets covers the discovery of new mineral deposits. In addition subsoil assets may appear economically – and thus be included in the account - because of a change in conditions whereby something that had no economic value previously acquires one. This may be due to changes in relative prices, or to the possibilities opened up by new technologies or changes in legislation, etc. If for example a change in prices or the technological possibilities means that part of the resources moves from the probable or possible to the proven reserves category (following the McKelvey box terminology, cf. section 5.1) the rise in (proven) reserves is accounted for here.

It should be noted that economic appearance does not mean appearance in a physical sense, but rather that the conditions have changed in a way, which means that the resources are now accounted for.

Within the SNA, the existence of an associated physical quantity is irrelevant to whether something is treated as an asset or not. These examples of how items come to be treated as an asset show that there may or may not be an associated physical quantity and, that even when there is, there may or may not be a change in this quantity. It is only the acquisition (or loss) of economic value that determines when economic appearance (or disappearance) is recorded.

K 6 Economic disappearance of non-produced assets consists of two sub-items. The first covers depletion of natural assets (K.61) and here the loss of value when the asset is extracted is recorded. The second K.62 Other economic disappearance of non-produced assets allows for the changes in the value of the subsoil asset due to changes in conditions whereby something that had an economic value previously now looses it.. This may be due to changes in relative prices or changes in legislation, etc. If for example the mineral prices fall part of the resources might move outside the proven reserves category (following the McKelvey box terminology, cf. section 5.1), and thus disappear in the economic sense although not in a physical sense.

K.7 Catastrophic losses accounts for large scale, discrete, and recognizable events that may destroy the asset. They include the effect of major earthquakes, volcanic eruptions, tidal waves, exceptional severe hurricanes, and other natural disasters well as acts of war, riots and other political events or technological events that destroy the subsoil asset and decreases its value (SNA93 12,35-36).

K.8 Uncompensated seizures take place when governments or other institutional units take possession of the subsoil assets of other institutional units, including non-resident units without full compensation for reasons other than the payment of taxes or similar levies. If the compensation falls substantially short of the market or related values of the assets as shown in the balance sheet, the difference should be recorded in the entry for uncompensated seizures of assets, as an increase in assets for the institutional unit doing the seizing and a decrease in assets for the institutional unit losing the asset (SNA93, 2.38-12.39).

K.9 Other volume changes in non-financial assets n.e.c. This item account for other (primarily unexpected) events that influences on the value of a general non-financial asset. In practice and for subsoil assets it might be difficult to think of such events not already covered by the accounting items mentioned above, but it is suggested to include this item in the general account in order to allow for any such possible change.

The last cause of value change included under other changes in volume is K.12 Changes in classification and structure, which further is subdivided in K.12.1 Changes in sector classification and structure and K.12.2 Changes in classification of assets and liabilities. The former sub-item (K.12.1) is relevant when for example, an unincorporated government enterprise becomes a public non-financial quasi-corporation and moves from general government to non-financial corporations. The latter sub-item (K.12.2) is relevant when the purpose for which an asset is used changes. Probably, this can hardly be the case for subsoil assets, but it is included here for completeness**.**

The SNA93 account Revaluation account allows for entering the so-called holding gains during the accounting period. Three types of holding gains can be entered. K.11 Nominal holding gains which is the sum of the sub items K.11.1 Neutral holding gains and K.11.2 Real holding gains.

The *K.11 Nominal holding gains* on a given quantity of an asset is defined as the monetary value accruing to the owner of the asset as a result of change in its price over time. *K.11.1 Neutral holding gains* is the value of the holding gain that would accrue to the owner *if* the price of the asset changed in the same proportion as the general price level. Finally, *K.11.2 Real holding gains* is the value accruing to the holding of an asset as a result of price changes relatively to the prices of goods and services in general in the economy. (SNA 93, 12.63-12-64).

Holding gains on subsoil assets should be calculated with reference to a specific quantitative and qualitative subsoil asset that is assumed unchanged during the period for which the holding gain is calculated. Thus, the value effect of the *volume* changes of proven reserves (e.g. from probable reserves) due to price changes should not be accounted for as holding gains, but instead as economic appearance as described above.

Holding losses is accounted for symmetrically to holding gains.

7.3 Correspondence between the monetary SEEA and the SNA asset account for mineral and energy

As should be clear from sections 7.1and 7.2 above there is no fundamental difference between how the SEEA 2003 monetary mineral and energy asset account and the SNA93 subsoil asset account look like, although some differences in terminology and how items are grouped together exist.

Table 7-3 shows the correspondence.

Table 7-3 Correspondence between SEEA 2003 and SNA 1993 terminology for subsoil asset accounts

SEEA 2003	Corresponding SNA 93 accounting concept
Opening stock levels	Opening stock
Changes due to transactions	No corresponding head item, but SNA 93 presents additions to the value of non-produced non-financial assets and acquisitions less disposals on the capital account, which exactly deals with changes due to *transactions*
????Additions to the value of non-produced non-financial assets	**Additions to the value of non-produced non-financial assets**
Acquisitions less disposals	Same
Increases in stocks	Economic appearance
Discoveries	Not specified, but included in economic appearance above
Reappraisals	Not specified, but included in economic Appearance
Decreases in stocks	Economic disappearance
Extractions	Depletion of natural resources Note: Depletion is suggested changed to extraction in SNA 93, rev. 1
Reappraisals	Other economic disappearance of non-produced assets
Other changes in stock levels	No corresponding head item
Catastrophic losses and uncompensated seizures	Same, but subdivided in two components SNA 93
Valuation changes (capital gains and losses)	*Holding gains and losses*, but subdivided in two components in SNA93
Changes in classifications and structure	Same, but subdivided in two components in SNA 93
Closing stock levels	Closing stocks

8 How are the activities of the mining and quarrying industry described by the national accounts ?

In this chapter we look at some issues and accounts which can be relevant to look at in connection with mineral and energy asset accounting either because they shed light on issues which generally can be of interest when analyzing the developments of the mineral and energy resources and also because they contain information which can be used when constructing the energy and mineral asset accounts, first of all as basis for the calculation of the resource rent which accrues from the mineral and energy assets.

Some issues are taken up here are:

1) The SNA93 *production account* and the *generation of income* for the mineral extraction industry. A knowledge and understanding of this type of account is important in order to understand some of the concepts and sources of the data which is going to be used for the calculation of resource rents which again is an important input to the calculation of the net present value (NPV, cf. chapter 10) of the future income from resource extraction and thus for the value of the mineral end energy stocks. This is dealt with in section 8.1.

2) Asset account for assets other than mineral and energy used in the extraction industry, …… more text ….. cf. section 8.2

3) Included among the assets which the mining and quarrying use is *mineral exploration and evaluation.* In the SNA mineral exploration and evaluation activities are regarded as gross fixed capital formation of a produced asset (cf. Box 5-3) ………..more text………. The accounting for mineral exploration is described in section 8.3.

4) Decommissioning costs. This deals with how accounting can be done for the decommissioning of capital equipment (i.e. produced capital), after having used it up. In many cases the decommissioning of for example old oil rigs , etc. is associated with huge costs, and the question is whether/how allowance should be done for that during the (productive) life time of the oil rigs, etc. Section 8.4 describes the accounting of decommissioning costs.

5) Recording of ownership and payments between an extractor and the owner of mineral and energy assets are dealt with in section 8.5 and 8.6. This relates to how ….more text …

6) Permissions to use natural resources ……….. more text ………. Section 9

8.1 Current production and generation of income

The current productive and economic activities of the industries that extract the mineral and energy from the resource deposits is described in the SNA 93 current accounts i.e. the *Production account* and *the Distribution and use of income accounts* for the industries in question. These are described in SNA 93 in part VI. p. 121 ff.

Familiarity with – and access to - these accounts are useful when the economic surplus/value added accruing from the mineral and energy deposits are going to be calculated and analysed as basis for calculation of the resource rent, cf. section 10. This is because the current accounts presents costs like intermediate consumption (e.g. energy used for the extraction), wear and tear of machineries and buildings, etc., compensation of employees, and production taxes paid.

The SNA 93 production account cover the result of production (output) and the using up of goods and services when producing this output (intermediate consumption) (SNA93, 2.108).

Table 8-1 Production Account (SNA93, Table A.V.2. I)

	SNA 93 code	Year 1	Year 2	Year 3	...
Output	P.1				
- Intermediate consumption	P.2				
= Value added, gross	B.1g				
- Consumption of fixed capital	K.1				
= Value added, net	B.1n				

------------text explaining the items/concepts ----------

The calculation of consumption of fixed capital will normally be calculated (should be consistent) with the data included in the asset accounts for fixed assets, cf. section 8.2 on other than mineral and energy .

The *generation of income account* is presented in Table 8-2.

Table 8-2 Generation of Income Account (SNA93, Table A.V.2. II.1.1)

	SNA 93 code	Year 1	Year 2	Year 3	...
Compensation of employees	D.1				
+ Other taxes on production	D.29				
- Other subsidies on production	D.39				
+ Gross (or net) operating surplus	B.2g (or B.2n for net)				
= Gross (or net) value added	B.1.g (or B.1n for net)				

------------ text explaining the concepts -----------

The entities for which the information of the production accounts and the generation of income accounts are relevant are the *extraction industries*. In the national accounts the information will typically be organised according to the classification of ISIC or similar classification (NACE for the EU).[3]

Information on the ISIC classification can be found at United Nations Statistics Division's web page **http://unstats.un.org/unsd/cr/family2.asp?Cl=17** .

ISIC section C deals with the mining and quarrying activities. Section C is further subdivided into 5 divisions:

10 - Mining of coal and lignite; extraction of peat
11 - Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12 - Mining of uranium and thorium ores
13 - Mining of metal ores
14 - Other mining and quarrying

By clicking at the numbers links to the UNSD web page is activated, and a further sub-division by groups and classes appears.

[3] SNA explains: " ..an industry consists of a group of establishments engaged on the same, or similar, kinds of activity. At the most detailed level of classification, an industry consists of all the establishments falling within a single Class of ISIC and which are therefore all engaged on the same activity as defined in the ISIC. At higher levels of aggregation corresponding to the Groups, Divisions and, ultimately, Sections of the ISIC, industries consist of groups of establishments engaged on similar types of activities." SNA93, 5.40

Box 8-1 ISIC explanatory note concerning Section: C - Mining and quarrying

Mining and quarrying include the extraction of minerals occurring naturally as solids (coal and ores), liquids (petroleum) or gases (natural gas). Extraction can be achieved by underground or surface mining or well operation.

This section includes supplementary activities aimed at preparing the crude materials for marketing, for example, crushing, grinding, cleaning, drying, sorting, concentrating ores, liquefaction of natural gas and agglomeration of solid fuels. These operations are often accomplished by the units that extracted the resource and/or others located nearby.

Mining activities are classified into divisions, groups and classes on the basis of the principal mineral produced. Divisions 10, 11 and 12 are concerned with mining and quarrying of energy producing materials (coal, lignite and peat, hydrocarbons, uranium ore); divisions 13 and 14 concern non-energy producing materials (metal ores, various minerals and quarry products).

Some of the technical operations of this section, particularly concerning the extraction of hydrocarbons, may also be carried out for third parties by specialized units as an industrial service.

This section also includes:
- - agglomeration of coals and ores

This section excludes:
- - processing of the extracted materials, see section D
- - usage of the extracted materials without a further transformation for construction purposes, see section F
- - bottling of natural spring and mineral waters at springs and wells, see 1554
- - crushing, grinding or otherwise treating certain earths, rocks and minerals not carried on in conjunction with'
  mining and quarrying, see 2699
- - collection, purification and distribution of water, see 4100
- - site preparation for mining, see 4510
- - mineral prospecting, see 7421

Source: **http://unstats.un.org/unsd/cr/registry/regcs.asp?Cl=17&Lg=1&Co=C**

----------- More text on why, how, which information from the current accounts that can/should be used for the resource rent calculations and further link to the section on resource rent (Chapter 10) -----------

8.2 The use of assets other than mineral and energy

In addition to the information on intermediate consumption, compensation of salaries, etc. from the current accounts it is useful to apply information from the SNA93 balance sheets about the about the level of produced assets - i.e. AN. 11 Fixed assets (Machineries, transport equipment, buildings, constructions) - used by the mining and quarrying industries in order to calculate the return to capital, since this is part of the total extraction costs, and thus important in relation to the calculation of resource rent, cf. section 10.2**.**

In principle all types of assets can be used of the mining and quarrying industry, but in practice some of them are normally not used and are thus without relevance.

Box 8-2 lists some assets which is not unlikely that the mining and quarrying industry uses (the full list of assets can be seen in Box 5-3.

Box 8-2 Assets other than mineral and energy relevant for the mining and quarrying industry.

Non financial assets
- **Produced assets**
  - **Fixed assets**
    - **Dwellings**
    - **Other buildings and structures**
      - **Non-residential buildings**
      - **Other Structures**
      - **Land improvements**
    - **Machinery and equipment**
      - **Transport equipment**
      - **ICT equipment**
      - **Other machinery and equipment**
    - **Costs of ownership transfer of non-produced assets**
    - **Intellectual property rights**
      - **(Research and development expenditure)**
      - **Mineral exploration and evaluation**
      - **Computer software and databases**
      - **Other intellectual property products**
  - **Inventories**
- **Non produced assets**
  - **Contracts, leases and licences**
    - **Third part property rights**
      - **Marketable operating leases**
      - **Permissions to use natural resources**
    - **Entitlement to future goods and services on an exclusive basis**
  - **Goodwill and marketing assets**

In its most simple form the asset account/balance sheet for assets other than mineral and energy shows the opening stock, the changes during the year and the closing stock of the assets.

Table 8-3 SNA 93 asset account for assets other than mineral and energy/subsoil assets owned by the mining and quarrying industry

	Year				SNA 93 account
	Mineral exploration and evaluation	Permits to use Natural Resources	Other assets (other than mineral and energy)	Total assets (other than mineral and energy)	
Opening stock					Table A.V.2 , Account IV.1
Total changes in assets					Table A.V.2 , Account IV.2
Of which consumption of fixed capital					Transaction K.1
Closing stock					Table A.V.2 , Account IV.3

---- Explanation of the table and how/why the information in the asset accounts for other assets than mineral and energy – and in which parts of the handbook the information is used.

The treatment of mineral exploration and evaluation is presented in more detail in section 8.3.

The treatment of decommissioning cost is presented in more detail in section 8.4

8.3 Mineral exploration and evaluation

Mineral exploration and evaluation activities include activities such as:

- acquisition of rights and licences to explore mineral and energy deposits;
- topographical, geological, geochemical and geophysical studies;
- test drillings;
- aerial and other surveys
- activities in relation to evaluating technical feasibility and commercial viability of extracting a mineral resource.

These activities are undertaken in order to discover new deposits of minerals or energy that may be exploited commercially. Such exploration may be undertaken on own account by enterprises engaged in mining or the extraction of fuels. Alternatively, specialized enterprises may carry out the exploration.

Mineral exploration and evaluation activities are essential in relation to extraction of mineral and energy. The information obtained from the activities are used in relation to the extraction activities typically over a number of years, and not only in the year when the exploration and evaluation activities take place. Therefore, according to the SNA93 the expenditures on exploration and evaluation should be treated as *gross fixed capital formation.*

Even though the benefit of carrying out mineral exploration and evaluation is related to fact that it facilitates that the mineral and energy deposits can be extracted the SNA93 (and the SNA93 rev. 1 is clear in stating that assets for mineral and energy deposits on one hand and mineral exploration and evaluation on the other hand should be recorded as separate assets, the first as a non-produced asset and the second as a produced asset, cf. the list of assets (according to SNA93 rev.1) in section 5.3, where mineral exploration and evaluation is recorded as a sub-item under *intellectual property rights*.
In agreement with the treatment of mineral exploration and evaluation as a fixed asset also *consumption of fixed capital* has to be calculated for the *mineral exploration and evaluation* and included in the national accounts. This is reflected, for instance, in the production accounts and the balance sheets, cf. Table 8-1 and Table 8-3..

Mineral exploration and evaluation according to the SNA 93:

10.90 Mineral exploration is undertaken in order to discover new deposits of minerals or fuels that may be exploited commercially. Such exploration may be undertaken on own account by enterprises engaged in mining or the extraction of fuels. Alternatively, specialized enterprises may carry out exploration either for their purposes or for fees. The information obtained from exploration influences the production activities of those who obtain it over a number of years. The expenditures incurred on exploration within a given accounting period, whether undertaken on own account or not, are therefore treated as expenditures on the acquisition of an intangible fixed asset and included in the enterprise's gross fixed capital formation.

10.91 The expenditures included in gross fixed capital formation include not only the costs of actual test drillings and borings, but also the costs incurred to make it possible to carry out tests, for example, the costs of aerial or other surveys, transportation costs, etc. The value of the resulting asset is not measured by the value of new deposits discovered by the exploration but by the value of the resources allocated to exploration during the accounting period. Consumption of fixed capital may be calculated for such assets by using average service lives similar to those used by mining or oil corporations in their own accounts.

Source: SNA 93

This guidance of the SNA on valuation could be seen as misleading. The recommendation to value output at cost is most often used in connection with production on own account where there is no comparable market activity and valuation at the sum of actual costs incurred is recommended as a minimum valuation to place on the activity. Not all mineral exploration is carried out on own account. A reading of the SNA recommendation consistent with the general advice on valuation would be that mineral exploration is to be valued at the market price of such exploration where possible and at cost only when such an alternative is not possible.

In relation the update of the SNA 93 it has been clarified that when exploration is carried out on own account, this is indeed how it would have been valued. (In accordance with other recommendations of the Canberra II Group, in future even own account production should include an estimate of the return to the capital being used.) However, when the activity is undertaken by a separate enterprise the full amount charged by this enterprise, including their net operating surplus, should be included in the value of mineral exploration and evaluation. (UN website concerning the SNA93 rev. 1.)
Enterprises engaged in exploration may make payments to the owners of surface land in exchange for the right to make test drillings or investigate by other means the existence and location of subsoil assets. Such payments are also to be treated as rents even though no extraction may take place.

/* Check chapter 10 in the revised SNA93 with regard to how the issues regarding mineral and evaluation activities are now described */

8.4 Decommissioning / terminal costs

When the fixed assets (machineries, mining facilities, oil platforms etc.) of the mining and quarrying industry is used up and they are without further economic benefit for the industry so-called decommissioning costs (terminal costs) might occur. They can be very large for assets, such as offshore oil platforms.

The SNA93 did not mention decommissioning costs. However the SNA93 rev. 1 specify how this costs should be accounted for. According to SNA93 rev. 1 decommissioning costs are regarded as part of the so-called *ownership transfer costs*, which again is regarded as part of fixed capital formation.

According to SNA93 rev. 1 terminal costs should be *recorded as gross fixed capital formation* at the point in time when they occur i.e. at the end of the life of the capital equipment in question. Thus, the value of the capital stock as recorded by the balance sheet for produced assets cf. section 8-3 should be increased by the decommissioning costs at that point in time. Further, and in agreement with this, the SNA93 rev. 1 prescribes that the value of this capital formation should be written of as *consumption of fixed capital* during the lifetime of the capital equipment, i.e. from the acquisition (or formation) of the capital equipment until it has been decommissioned.

This means that the writing of (accounting for the consumption of fixed capital) takes place *before* the actual expenditures for the decommissioning occurs, and that it is necessary to estimate/forecast what the decommissioning costs will be in the future in order to make allowance for the decommissioning costs as part of the consumption of fixed capital during the lifetime of the capital equipment. Since, in fact, it might be very difficult to anticipate what the costs will be and how long time the capital equipment will be in productive service the SNA rev. 1 opens for the possibility that, when terminal costs are either not anticipated or cannot be predicted with reasonable accuracy, they are still recorded as gross fixed capital formation when they occur but may be written off as consumption of fixed capital immediately, i.e. not before the costs actually occur.

The inclusion of decommissioning/terminal costs as part of the gross fixed capital used by the mining and quarrying industry and as part of their consumption of fixed capital influences the calculation of resource rent: The extra costs entails a lower resource rent and thus typically a lower value of the reserves/resources.

Further background and explanation of the treatment of terminal costs can be found on the UNSD web site on the SNA revision process. Especially the issue paper *Costs of ownership transfer on non-financial assets* (SNA/ M2.04/10) includes useful information and a graphical exposition of the principle. Link: HTTP://UNSTATS.UN.ORG/UNSD/SNA1993/DESCRIPTION.ASP?ID=15

8.5 Recording of ownership

Recording of ownership of the mineral and energy assets

The SNA does not discuss how to determine the ownership of non-produced assets and thus in which balance sheet to place them. By virtue of the lack of any alternative advice, the guidance must be assumed to be that the assets should be recorded in the balance sheets of the legal owners.

Suppose that government is the legal owner of oil reserves with an agreement that a particular unit may extract them. Then in the SNA, the value of the oil reserves appears in the balance sheet of the government.

The SEEA makes extensive use of the asset account. For any asset, the asset account shows the whole range of impacts on the asset between the opening and closing balance sheet. In the SNA, attention focuses on balance sheet rather than on asset accounts. When the owner of an asset is the unit that uses it in production, there is no difficulty in assimilating the asset accounts for all the assets owned and used by the producer into a single balance sheet. However, further consideration is needed when the unit that uses the asset is not the (sole) owner of the asset. This is very frequently the case in respect of mineral deposits, especially in countries where government has ownership of the asset on behalf of the nation at large.

/* What is the difference between balance sheets and asset accounts ??? */

The question of attribution of the ownership of a deposit extracted by a unit not the legal owner is deferred to a future meeting when leases and licenses will be discussed more generally.

/* check what the final recommendation is */

Recording of the ownership of mineral exploration and evaluation

Attributing the ownership of the mineral exploration may be less easy. If the extractor has carried out the exploration either on own account or via a contractor, then clearly the entries for this asset will be in the balance sheet of the extractor.

However, as noted above, there may not be an extractor during some early periods of exploration. This may be carried out at the behest of the owner of the putative discoveries even though the owner has no productive activity related to either exploration or extraction. Nevertheless, the appropriate step must be to record the mineral exploration as an asset of the owner. Knowledge of whether a mineral deposit exists and the extent of it is the basis on which the owner can enter into an agreement with an extractor at a later stage. When such an agreement is reached and the extractor starts production, he acquires this knowledge, hence the asset must be transferred to his balance sheet and is written off by the extractor over time as part of the costs of production. In fact, the payments by the extractor to the owner must be sufficient to reimburse the owner for the costs he incurred to acquire the knowledge about the deposit besides representing a return to the deposit itself.

8.6 Recording of payments from the extractor to the owner of the mineral and energy assets

The 1993 SNA makes it clear that payments made by the exploiter to the legal owner of the mineral deposit are to be treated as property income. The description of this treatment is given in SNA 93 Para 7.133.

AEG: Payment by the extractor to the owner of the resource should be recorded as property income (rent) regardless of the label given to the payments

.
The AEG agreed that, in principle, payments by the extractor to the owner of the deposit are property income. However, when the owner is government and the payments are described as taxes, adhering to this principle introduces a discrepancy between taxes in the SNA and in government accounts. This needs further consideration.

/* check final recommendations */

The owners of the assets, whether private or government units, may grant leases to other institutional units permitting them to extract such deposits over a specified period of time in return for the payment of rents. These payments are often described as royalties, but they are essentially rents that accrue to owners of the assets in return for putting them at the disposal of other institutional units for specified periods of time and are treated as such in the System. The rents may take the form of periodic payments of fixed amounts, irrespective of the rate of extraction or, more likely, they may be a function of the quantity or volume of the asset extracted.

Sometimes, when the owner of the resource is the government, the payments may be described as taxes even though they are still effectively appropriation of part of the resource rent.

There is no necessity that the payments to the legal owner of the resource should be equal to the total resource rent… either on a year by year basis or even over time. It is often the case that the legal owner will allow the extractor to retain some of the resource rent. Alternatively the payments may have been agreed some time in the past and not always reflect current circumstances on the commodity price of the mineral concerned. For this reason, if estimates of the value of the resource to the legal owner are based on the revenues the owner receives from the extractor, an apparent value of the resource will be derived which differs from the resource rent derived as described above via the net present value of the residual element of gross operating surplus of the extractor. The use of the latter method to value the deposit should be preferred to methods depending on payments to the legal owner.

9 Permissions to use mineral and energy resources

???

10 Valuation of mineral and energy assets - the net present value method (NPV)

10.1 Introduction – the basic idea

According to the SNA 93 market prices are to be used when mineral and energy assets are being valued. However, often the assets are not sold on the market and market prices are therefore normally not observable

Sales of subsoil deposits do sometimes take place, albeit infrequently, and the information on market prices for them may thus be very limited. The extent of information available may depend on institutional arrangements. For countries where the subsoil deposits are held privately, there is likely to be more information on sales than in countries where all subsoil deposits are owned by the government. In practice, therefore, the value of the stock level of mineral and energy resources will often be estimated by means of the net present value techniques.

Economic theory asserts that in fact the net present value of future benefits accruing from holding or using the assets equals market prices of assets. If the value of the future benefits did not at least equal the market price, the asset would not be a cost-effective purchase. Thus, the net present value should in principle be compatible with market prices.

There are three steps involved in establishing this net present value:

a) First, the level of the resource rent in the current period must be estimated.

/* short text explaining what resource rent means

b) It is then projected into the future.

/* why and how */

Projecting the resource rent into the future depends on a number of parameters as reflected in the following questions: How long will the mine remain in operation? How will the life length of the mine be affected if the rate of extraction alters? What effect do new discoveries have on the expected life length of the mine? What happens to the projections if the unit resource rent varies? There are different possible answers to most of these questions (and the effects of each parameter on the total will vary accordingly).

c) Finally, the set of future resource rents must be discounted to a value in the present period.

/* Why discounting */

10.2 What is resource rent - how is it calculated ?

/* simple text explaining what resource rent means */

The resource rent is that part of gross operating surplus unattributable to other identified assets, specifically fixed assets including mineral exploration and evaluation.

Calculation of the resource rent

Income from sale of oil and gas = Value of output
- Intermediate consumption
= Gross value added
- Compensation of employees
- Net taxes on production

Costs connected with production = Gross operating surplus

- Consumption of fixed capital
= Net operating surplus
- Normal return to capital

= Net resource rent

10.3 Formula and mathematics of NPV calculations of the total asset value

The resource value (RV) can be written as a function of the resource rent (RR), the years the resource is expected to last until exhaustion (n) and a discount rate (r). For minerals and subsoil deposits, if no better information is available, it is often assumed that the rate of extraction will be constant from year to year. In such a case, the value of the resource rent will stay constant in constant price terms and the value (also in constant price terms) can be written as

$$\underline{\mathrm{RV}} = \mathrm{RR}\sum_{k=1}^{n}\frac{1}{(1+r)^k} = \mathrm{RR}\left[\frac{(1+r)^n - 1}{r(1+r)^n}\right]$$

/* explanation and generalisation of the mathematics – including non constant extraction profile */

Part II Guide to Mineral and Energy accounting in Practice

11 Mineral and energy accounting in practice – introduction and overview

Establishing and updating mineral and energy accounts in practice is a stepwise procedure, including the following:

Defining what to include

Collecting the physical data

Setting up the physical accounts

Collecting economic data

Estimating the resource rent

Estimating total value of the mineral and energy asset

Estimating the flow items of the mineral and energy asset accounts

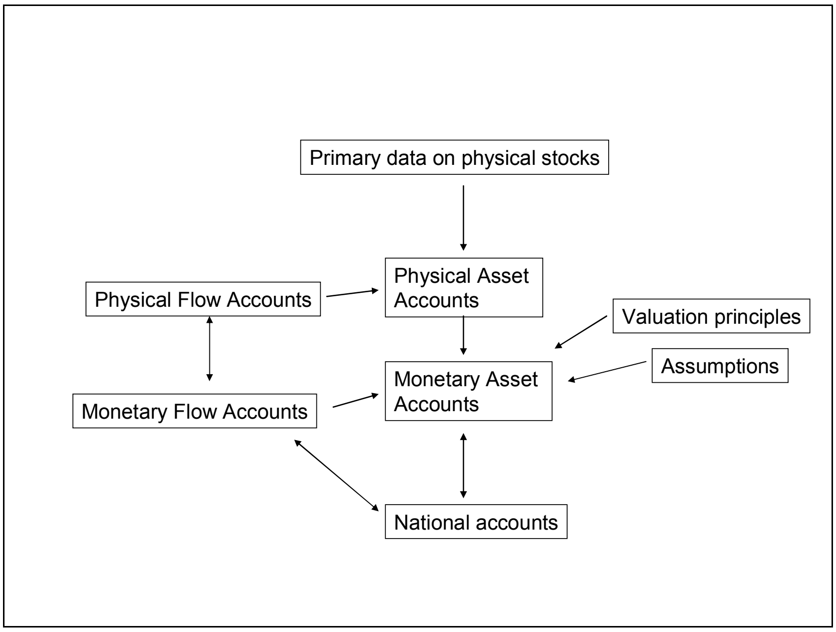
Setting up the monetary accounts

Up dating and revising the accounts

Documentation and quality check

After a brief introduction and overview of this stepwise procedure, section XX, the various steps will be described in separate sections in this part of the handbook.

Figure 11-1 The process of a physical and monetary accounting



12 Determining the assets to include

The reference is the SEEA/SNA classification presented in Part I.

But countries have to start from what is available, i.e. national classifications and inventories (Energy Agency, Petroleum Directorate, etc.)

Then a conversion of national classifications into the SEEA classification should be done if possible.

12.1 Overview of reserve definitions used by selected countries

From Hass and Kolshus (2006):

Figure 12-1. Sources and definitions for oil and gas reserves from Eurostat's first collection of subsoil accounts for oil and gas from countries in the European Economic Area.

Country	Source of reserve data	Reserve definitions		Physical stock used in stock value estimates	Follow SEEA or SNA?
		Discovered reserves	Undiscovered reserves		
Denmark	Danish Energy Agency	The sum of the expected proven, probable and possible reserves	No data available	Discovered reserves	SEEA
Germany	Niedersächsisches Landesamt für Bodenforschung	The un-weighted sum of proven and probable reserves	No data available	no information available	no informa-tion
France	Secrétariat à la Conservation des Gisements d'Hydrocarbures, Ministère de l'Industrie	Includes proven reserves only	No data available	Proven reserves	SNA
Nether-lands	Netherlands Ministry of Economic Affaires	Remaining expected reserves	Future additions to natural gas reserves as a result of exploration	Estimated based on government appropriation of resource rent. ¤	unclear
Austria	Austrian Geological Survey, extraction companies	The weighted sum of proven developed (weight=1), proven undeveloped (0.9), probable (0.5) and possible (0.1) reserves	No data available	Discovered reserves	SEEA with weights
United Kingdom	UK Department of Trade & Industry	The un-weighted sum of proven and probable reserves	Upper and lower range of the estimated undiscovered reserves	Discovered and (lower range of) undiscovered reserves	More than SNA but less than SEEA
Norway	Norwegian Petroleum Directorate (NPD)	Expected level of discovered reserves, estimate by NPD	Expected level of undiscovered, estimate by NPD	Discovered and (expected level of) undiscovered	SEEA

For calculation methodology: Van den Berg, A. and P. van de Ven, Statistics Netherlands (2001) Valuation of oil and gas reserves in the Netherlands. Eurostat Working paper No. 2/2001/B/3.
Source: Eurostat (2002), Natural Resource Accounts for Oil and Gas, 1980-2000 (pages 15 and 34)

Source: Hass and Kolshus (2006)

12.2 Converting country specific classification systems into the SEEA classification

/* If it is decided to use a the UNFC as basis for the SEEA classification something like the following can be included */

From Kolshus and Hass (2005):

The UNFC is now working towards the international adoption of this system for asset classification. This will take some time since it means that country specific systems need to be converted to this new system.

However, there has been no direct conversion system devised between the McKelvey system and the UNFC system. This means that there is no easy conversion that can simply be applied to the existing SEEA-2003 guidelines.

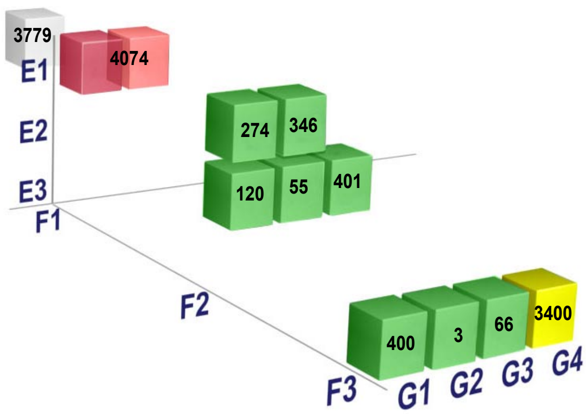
An example of conversion of classification – Norway

An example of this conversion can be found for Norway. The original classification system has 3 main categories, prospective resources (shown in yellow in the following figure), contingent resources (green, 4A-7F) and reserves (red, 1-3F). When this is converted into the new UNFC system the reserves are in cell 111 and 112 (red squares), the contingent resources are shown in green and the prospective resources are in cell 334 and are shown in yellow. The conversion is shown in the following figure.

Figure 12-1 Norway's Resource Account Presented in the UNFC Classification, account as of 31.12.2003.

Million Sm³ o.e.

NPD				UNFC
Class	*Type*	*Category*	*Mill Sm³ o.e.*	
	Fields	0	3779	
Reserves	*Fields*	1	2837	
Reserves	*Fields*	2A	36	
Reserves	*Fields*	2F	387	
Reserves	*Fields*	3A	412	
Reserves	*Fields*	3F	402	
Reserves	*Fields*	Sum	**4074**	**111-2**
Contingent resources	*Fields*	4A	274	121
Contingent resources	*Fields*	4F	49	122
Contingent resources	*Fields*	5A	120	221
Contingent resources	*Fields*	5F	55	222
Contingent resources	*Fields*	7F	3	332
Contingent resources	*Fields*	7A	400	331
Contingent resources	*Discoveries*	4F	297	122
Contingent resources	*Discoveries*	5F	401	223
Contingent resources	*Discoveries*	7F	66	333
Contingent resources	*Discoveries*	Sum	**1665**	
Prospective resources		8 & 9	**3400**	334



Source: Blystad, The United Nations Framework Classification for Fossil Energy and Mineral Resources, UNFC
http://www.unece.org/ie/se/pdfs/UNFC/nov05/9nov/Blystad_NorPetDirect_9Nov1.pdf or **http://www.ssb.no/ocg/blystad_unfc_oslocitygroup2006.ppt**

This figure shows that the UNFC system has a greater amount of variation allowed than the current Norwegian system for the contingent resources category (green) and fewer for the reserves portion (red).

13 Collecting the physical data

13.1 National data sources

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

13.2 International data sources

14 Setting up the physical accounts

Guidelines for how the numbers are entered – book keeping identities – checks etc.

15 Collecting economic data

The national accounts is a good source for economic data .

What to do if data are not available – the use of assumptions

16 Estimation of the resource rent[4]

16.1 Standard method

The resource rent is the net income from extraction, defined as the value of output less all costs of extraction, including capital costs (i.e. consumption of fixed capital and return to fixed capital). 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 mineral and energy asset accounts is:

Output (basic "well head" prices)
+ Specific taxes less subsidies on products
– Intermediate consumption
– Compensation of employees
– Other non-specific taxes less subsidies on production
– Consumption of fixed capital
– Return to fixed capital
= Resource rent

Most of the variables are standard national accounts variables, except the return to fixed capital and the classification of taxes and subsidies into specific and non-specific.

Return to fixed capital is calculated by applying a normal real rate of return to the net stock of fixed capital in the extraction industry, valued at the beginning of the period. For EU/EEA countries, an 8% real rate of return on fixed capital should be taken as the default value.

/** Advice on what discount rate to use in all countries or which principles countries should use in determining the return rate **/

Specific taxes and subsidies are those that apply only to the mineral and energy extraction industry,

[4] This chapter is based on a draft paper by Ole Gravgård and Martin Lemire on NPV calculations. To be presented at the London 11th Group meeting Pretoria, South Africa, March 2007.

while non-specific taxes and subsidies apply to other industries as well. Specific taxes are considered part of the resource rent (appropriated by government). Specific subsidies for oil and gas extraction are probably negligible in some countries, for instance in Europe (but may be of importance for other countries. /** what more can we say about these – give examples ?? */

An equivalent definition of the resource rent is:

Net operating surplus
+ Specific taxes less subsidies on products
+ Other specific taxes less subsidies on production
– Return to fixed capital
= Resource rent

Table 2 shows the variables that are part the definition of the resource rent, and some related variables that describe the production process and capital transactions of the extraction industry. Most of the variables are standard national accounts variables, except the specific taxes and the resource rent estimates. The variables in bold are the most important for the rent calculations.

The table should be filled in in national currency, in the unit normally used for publishing the national accounts.

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 less subsidies on products and trade and transport margins. However, when taxes and subsidies on products are specifically related to mineral and energy extraction they should be included, to estimate the total value of the reserves to the country. This is the item called Specific taxes less subsidies on products.

/** Examples of specific taxes and subsidies ?? **/

Trade and transport margins, i.e. charges related to transport and delivery from the "wellhead" 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 and subsidies on production that are not specific to the extraction industry. Taxes that are specific, i.e. taxes that according to the tax code are paid only by the extraction industry, are not considered part of the production costs, but are included in the resource rent. Specific subsidies on production are not included in the resource rent, but non-specific subsidies are.

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.

Table 16-1 Economic accounts and resource rent calculation

Table 2: Economic accounts and resource rent for
NACE 11.1 Extraction of crude petroleum and natural gas

	Year 1	Year 2	Year 3
Current transactions			
Output (basic "well head" prices)			
Intermediate consumption			
Gross value added			
Compensation of employees			
Other taxes on production			
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			
Return to fixed capital			
Specific taxes less subsidies on products			
Other specific taxes less subsidies on production			
Specific taxes on income			
Rent (royalties) on subsoil assets			
Resource rent			
= Net operating surplus			
+ Specific taxes less subsidies on products			
+ Other specific taxes less subsidies on production			
- Return to fixed capital			
Resource rent appropriated by the government			
= Specific taxes less subsidies on products			
+ Other specific taxes less subsidies on production			
+ Rent (royalties) on subsoil assets			
+ Specific taxes on income			
Resource rent for the extractor			
= Net operating surplus			
- Rent (royalties) on subsoil assets			
- Specific taxes on income			
- Return to capital			
Resource rent, oil			
Resource rent, gas			

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. 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. This is based on national standards, and on an examination of empirical data on the ratio between the net operating surplus and the net capital stock for manufacturing industry as a whole.

Resource rent

The resource rent for mineral and energy extraction may be divided into different categories. In Table 1, the total resource rent is divided between oil and gas, and between the government (in many countries the legal owner of the resources) and the extractor. The methods that can be used to make these estimates are discussed below.

/** insert SNA references above instead – in addition to ESA references **/

/** The table should be generalized and probably shortened subdivided into different parts */

16.2 Alternative resource rent calculation — using capital service measures

An alternative method uses the theory of capital service flows to determine how much of the gross operating surplus represents the *capital services* rendered by the stock of produced capital. What is then left is deducted from gross operating surplus is then resource rent attributable to the non-produced assets in use

For the revised SEEA it is proposed that it still mentions that if good quality capital service data is available for the fixed capital used by the extraction industry this can be used directly when calculating the resource rent instead of calculating use of capital and return on capital separately and deducting this from gross operating surplus.

The background for this suggested treatment in the revised SEEA is that the revised SNA is based on the following concerning the treatment of capital services, cf. ***http://unstats.un.org/unsd/sna1993/description.asp?ID=14***

The Advisory Expert Group

- confirmed the importance of including the concept of capital services in the updated SNA

- strongly supported including the estimates of capital *services in supplementary tables rather than in the core accounts* of the SNA

Thus, the capital service approach should be acknowledged as an option when calculating resource rent, but it should not be given particular weight.

16.3 Allocating the resource rent to specific types of products

For some subsoil resources, a single deposit may yield several products. An oil well often contains gas also. Silver, lead and zinc frequently occur together and can be extracted only together. In this case, the resource rent used in the calculation of the value of the resources needs to be divided by commodity. However, in practice, data are available by establishment only. In such cases, a separation of the unit costs of extraction for each product is not possible except by using some rule of thumb.

/* prioritized list of procedures for the allocation by products/resources based on the text below*/

One possibility is to allocate total extraction costs in proportion to each product's contribution to net revenue from the mine. If no extraction cost data at all are available, then extraction costs may be estimated by pro-rating total operating expenses between extraction and non-extraction costs. This may be done by asking a sample of mining companies what they expect the breakdown between operating and extraction costs to be. Once this is done, net revenue data is then used as an indicator to derive extraction costs by commodity. As a final option (if the above solutions are not possible), costs could be estimated by commodity by assuming a ratio of extraction cost/price for each commodity.

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.

Because oil and gas are sold in different markets and normally have different production profiles, it is useful for valuation purposes to estimate resource rents for oil and gas separately. Separate output data for oil and gas is usually available, but this is often not the case for the extraction costs.

Extraction costs are defined as the sum of the following items from the resource rent calculation:

Intermediate consumption
Compensation of employees
Other non-specific taxes less subsidies on production
Consumption of fixed capital
Return to fixed capital

When no specific information about the distribution of the extraction costs between oil and gas is available, they should be divided with the shares that oil and gas have in the total value *of output.* If there are specific net taxes on oil and/or gas, these should be added to the output in basic prices before the output shares are calculated. When this method is used, the resource rent is distributed between oil and gas in proportion to output.

16.4 The future resource 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 consider two elements separately, rent per unit extracted and the level of extraction.

Historically, the unit resource rent for subsoil assets varies from year to year. Since it is calculated in effect as a residual, if the world price of oil rises faster or more slowly than the costs of extraction, other things being equal, the resource rent will fluctuate in the same direction. Projections made about the level of unit resource rent over a future period, usually assumed that it will remain constant in constant price terms. The question that remains is whether to use the unit resource rent observed in the most recent period, or an average over a number of recent years, or to make projections building in assumptions about the likely evolution of relative prices over the period in question. This issue is discussed further in the section on prices below.

The stock value estimates should be calculated using a future unit rent (resource rent per unit extracted) that is constant, and equal to a three-year symmetric moving arithmetic average of the unit rents. The figure for year t is calculated as the arithmetic average of years t-1, t and t+1. Before the average is calculated, the unit rents should be converted to the prices in the current year (year t) using the GDP deflator.

Usually, the estimate for year t is compiled at a time when the unit rent data for t+1 are already available, but if this is not the case, a forecast of the t+1 unit rent should be made based on available short-term data for year t+1. The stock value estimates should then be revised at a later date, using unit rate data for the whole year t+1. Possible short-term data sources for the unit rent are the quarterly national accounts and price statistics for oil and gas. Unit extraction costs are relatively stable in the short run, so if no short-term data are available, the costs of the previous period can be used.

A prioritized list of methods, e.g. :

1) Use Actual forecasts of future price if it exists.

2) Use an 3 year weighted average of the price in recent years,

$$= 0{,}5 * P(t+1) + 0{,}3 * P(t) + 0{,}2 * P(t-1)$$

4) Use an 3 year weighted average of the price in previous years

= 0,5 *P(t) + 0,3 *P(t-1) + 0,2 *P(t)

3) Use price the previous year, i.e. P(t-1)

16.5 Determining the pattern of resource rents

Independently of assumptions about the unit resource rent, an assumption must be made about the pattern of extraction to be followed over the course of the future. The assumption most often used is that it will stay constant in physical terms, but there is no reason why this should necessarily be so. As resources approach extinction, there may be a decline in output as some deposits become completely exhausted if there are no new deposits to take their place. … There may be information available from government or from enterprises on projected levels of extraction that could be used

Stock value estimates for the latest available year and for annual updates should be based on an explicit forecast of the future extraction path, if one is available. If no specific information is available about the path of future extraction, the estimates should be based on a constant level of extraction, equal to extraction in the year the estimates refer to. When a new year is added to the series, the forecasts used for the stock value estimates for previous years should not be revised using the actual extraction for the latest year.

The assumed future extraction path should be consistent with the estimate of the physical resource stock. This means that the sum of the assumed extraction in year t+1 and future years should be equal to the stock at the end of year t.

The establishment of a historic time series should ideally be based on the same principles as those used for the latest year (i.e. based on forecasts available at the time the estimates refer to), but this may be difficult in practice, so a simplified method is acceptable as a second-best solution.

In this case, the estimate of the future extraction path should be based on one of the following methods:

a) Actual extraction data up to a certain year, and a forecast for future years, if such a forecast exist

or

b) Constant extraction, equal to the level in the year the estimates refer to.
The method used should be the one that is deemed to be the best approximation to forecasts made in the past for the country in question.

If a new field is discovered with an expected life length of, say, 20 years, equal by itself to the existing reserves of a country, it is not realistic to automatically assume that this new field will be extracted in years 21 to 40. On the other hand, neither is it realistic to automatically assume that it will be extracted in years 1 to 20 and thus double the total extractions in these years. It always takes a little while to prepare for extraction thus there is a built-in delay initially. Further, in cases where there is such a large new discovery, the impact on the rate of extraction of pre-existing reserves should be taken into account explicitly. For these reasons, it is desirable, if at all possible, to make projections of the impacts of new discoveries and reappraisals separately.

16.6 Determining the discount rate

/* we need to come up with some firm suggestions for how the discount rate should be determined */

As discussed above, resource assets for which returns are either delayed (growing timber) or spread over a lengthy period of time (mineral deposits) can be valued by discounting the expected future income to a present value. Doing so first requires the choice of a discount rate, a choice that is often the subject of considerable debate.

The discount rate (that is, the rate used to discount future income) reflects a time preference: the preference of an asset's owner for income today rather than in the future and also the owner's attitude towards risk. These factors will vary depending on the ownership of the asset. In general, individuals and businesses will have higher rates of time preference than Governments, that is, individuals and businesses will tend to demand a quicker return from ownership of a resource asset than will Governments. Higher rates of time preference translate into higher discount rates. Higher degrees of risk aversion will also lead to higher discount rates.

Some commentators argue that "social" discount rates should be used to derive the net present value of non-produced assets. The rationale is that these rates take into account inter-generational issues which suggest the discount rate (time preference) should be closer to zero.

A discount rate of 4% should be used. This is close to the average real rate of return on
government bonds. /* ???????? */

16.7 Determining the rate of return

/** How can we deal with this? can we give some clear advice on how to determine the rate? What does SNA, OECD manuals etc. say */

As discussed above, the return to an asset is that part of value added, specifically part of net operating surplus, that can be attributed to the use of the given asset in production. The rate of return is a ratio, usually shown as a percentage, which relates this income flow to the value of the stock that generates it. The simplest way of calculating such a rate is therefore to divide the return to the asset by its capital value.

This simple ratio, however, assumes that the value of capital stock covers all the assets used in production or, put another way, that there is no income arising from assets which have not been included in the measures of capital stock. If there are such assets, then the rate of return will be overstated because returns to unidentified assets will be attributed to those that have been identified. Obviously the issue of greatest interest in this handbook is the identification of the value of natural assets used in production, but it is worth remarking that there are serious concerns about other types of assets which may be captured either poorly or not at all. One example of these is so-called intangible assets such as those associated with trade marks and brand names. Another concerns the role of education and training in enhancing human capital.

The means of identifying the part of operating surplus attributable to these sorts of assets is to use an exogenous rate of return for the identified assets and treat the rest of the operating surplus as the return to the unidentified assets. This is the basis of two of the three means of estimating resource rent described above. Sometimes, however, an exogenous rate of return will be applied even when it is thought that all assets have been identified and correctly valued to determine "normal profits" for the enterprise in question. Any difference from net operating surplus as calculated in the production account is described as "pure profit" or "pure loss", depending on sign. It is usually assumed that a pure profit exists only when there is some distortion on the market, for example, when a new product is first launched and can command a premium on its price.

There are at least three views about how to determine an exogenous rate of return. The first is that it is determined by the net operating surplus generated from the capital stock of the particular industry in question. Or, the return to produced capital could be seen as covering the cost of financing the acquisition of the produced capital stock. Alternatively, it can be interpreted as the opportunity cost of the investment in the produced capital assets. This opportunity cost could be estimated as the average real rate of return on investment elsewhere in the economy.

In the first approach, the concept of a "normal" rate of return is often applied to the value of fixed capital stock. This normal rate is sometimes determined by reference to the ratio between net operating surplus (rate of return) and capital stock in an industry that is assumed to have performance characteristics similar to those of an industry without natural resources but is without the presence of a natural resource.

The second approach assumes the interest rate on bonds issued by resource companies or the return on shares in resource industries is appropriate for use as the rate of return. The financing cost approach has the advantage that the returns are directly related to the risks associated with the operation of the capital (in the case of the bond price). However, returns on shares reflect returns both on capital and on the resource, besides being influenced by external factors in the market. Therefore, while the use of the rate of interest on bonds seems appropriate as a proxy for estimating returns on capital, the use of return on shares does not.

The third approach relies solely on the opportunity cost of capital elsewhere in the economy. An interest rate based on long-term government bond rates is taken as the value of the rate of return for use in estimating the return to produced capital in the accounts. The disadvantage of the long-term government bond rate as an appropriate "return to capital" is that it is a "risk less" rate. The rate does not include a premium to cover the risk and uncertainty involved in extractive industry operations.

The first and second approaches attempt to approximate the internal rate of return, whereas the third is clearly an external rate that, it is supposed, should hold more generally. The rate of return on corporate bonds could be used to derive returns on capital in the particular industry under consideration. Where there are few corporate bonds issued in the country that is compiling asset values, then any of the three approaches may be adopted, provided an allowance is made for countering the deficiencies in the approaches.

16.8 Relationship between the discount rate and rate of return

In an enterprise where all the assets are identified and measured accurately, and where conditions of perfect competition prevail, the discount rate and the rate of return should be equal. If the discount rate is higher than the rate of return to capital, the entrepreneur would be advised to lend money rather than invest in more equipment. If the rate of return is higher than the discount rate, there will be a shortage of funds to lend and the discount rate should rise to attract more funds. Ultimately, both rates depend on the opportunity cost of capital and the time preference of the asset owners for money now or in the future.

As noted above, however, there are several reasons why this equality may not hold. When the extractor and the owner are two different units with different time preferences and attitudes towards risk, a difference between the two rates can be justified. However, wide and persistent differences between the two rates should be examined for plausible explanations. It is important for the statistician to try to ensure that errors of measurement are eliminated as far as possible and, to this end, alternative estimates of resource rent and the calculation of "pure profits" may be helpful in establishing confidence in the estimates to be used in calculations depending on resource rent.

16.9 Nominal and real rates

Net present value calculations express future incomes in terms of the prices at a given point in time. If the time series of rents to be discounted and added is expressed in constant prices, the discount rate or rate of return should be a real rate (that is, one from which the general level of inflation has been removed). If the time series of rents is expressed in prices with a built-in level of inflation, then the rates used must also allow for this inflation so that the process of discounting removes the effect of inflation as well as brings the valuation back to one at the date of interest.

Usually, the models underlying both the PIM and the capital service flows approach are calculated in constant prices, in which case the discount rate should be in real terms (that is, adjusted for the general rate of inflation). However, if future rents are estimated allowing for price inflation, then the same level of price inflation should be allowed for in the discount rate used. Ambiguities arise if different rates of inflation are allowed in the different elements in the calculations.

16.10 Potential problems – negative or zero resource rent

Calculating resource rent as the residual between revenue and costs (operating plus capital) can give very erratic results which may sometimes be negative. One reason is that, for many basic commodities, the price is set on the world market and thus reflects global supply and demand, while the local costs remain fairly constant from one year to the next. If the return to the fixed capital is determined based on a long-run average, then this will give a stable measure of the return to produced capital but a very volatile measure of the resource rent. This issue is discussed further in Born (1995).

As noted above, and especially when negative resource rents result, it is important to investigate and eliminate as far as possible any fluctuations in the estimates for resource rent caused by errors in methodology or underlying assumptions. Sometimes, though, the fact that the resulting series is erratic and may even be negative on occasion will be correct. This is likely to be the case when it is not possible to make major changes to the rate of extraction for an industry even when the world price drops because of the need to keep machinery operating or because the extractors think the fall in price is temporary and will recover shortly. It may even be the case that an enterprise can afford to extract some deposits only in some circumstances, for example, coal in much of Europe if it is subsidized. In such a case, the economic rent of the coal deposit is clearly zero and the value is also zero. It is only in such cases though, where there are strong social pressures to continue an uneconomic activity, that exploitation of uneconomic deposits is likely to persist over a period of time.

It should be noted also that if a stock of natural resources is so abundant that no amount of extraction has an effect on the prospective lifetime of the remaining deposit, there is no scarcity of the resource and thus its depletion and the value of the stock are both zero. The whole of the economic rent, or gross operating surplus, represents a return to the capital and thus income. This is the rationale that underlay the accounting for environmental assets in the 1968 SNA9UN, 1968) namely, that there was no shortage of resources and thus that it was not necessary to attribute a value to them. On the other hand, it is not sufficient to realize that current extraction procedures may lead to a shortage of some resources in the near future without considering of the impact on a nation's wealth and its assessment of its current income. This argument is reinforced by the fact that even a resource that is abundant at the global level may not be plentiful for an individual country or region.

16.11 From unit resource rent to total value of the asset

/* show the calculation leading from unit resource rent over extraction profile and discounting etc. to the estimate of total value of the stock of mineral and energy asset */

17 Constant price calculations

Two different approaches are used for stock value estimates for mineral and energy assets in constant price or volume terms. They may be called the production approach and the income approach.

A) The production approach
The value of the stock of oil and gas in year t is calculated in the prices of the previous year using the same formula and data as for the current price stock, by replacing the unit resource rent used for year t with the unit rent used for year t-1. (Strictly speaking, the resource rent is an accounting residual that does not have price and volume dimensions, so the unit rent is not a price, but the terms volume and price are used here for convenience.) The unit rents used here are the three-year moving averages. This results in time series of stock values for oil and for gas where each year is expressed in the previous years prices. These can then be combined with the current price data and chain volume indices can be compiled using the same methods as in the standard national accounts. These volume indices show the changes in the stock values caused by changes in the physical stocks and the future extraction path.

B) The income approach
This is a measure of the value of the stock in real terms, estimated by deflating the nominal stock values with a general price index. Compared to the production approach, this will not only show the effect of changes in physical stocks and extraction path, but also changes in the relative price (or rather relative unit rent) of oil and gas. This will give a measure of the development in the purchasing power of the monetary value of the stock. (The method is similar to that used in the ESA95 for measuring income flows in real terms.) The price index used should be the same as the one used to

estimate the neutral holding gains, i.e. the price index for final national uses, excluding changes in inventories (ESA 95 §8.57).

The proposal is to add two rows for each approach to the current price monetary balance sheets for oil and gas. The first row shows the value of the closing stock in the previous year's prices, the second row shows the value in the prices of a reference year. The reference year should be the same as that used by Eurostat for the national accounts data, currently it is 1995.

18 Estimating the flow items of the monetary mineral and energy asset accounts

To establish a complete asset account for a mineral and energy asset it is necessary that the values of both the opening and the closing stock is estimated (according to the principles described above). But in addition, it is necessary to put a monetary value on the different components of the changes in the stock in between the opening and the closing dates. In this chapter focus is on the valuation of these changes.

/* here it is necessary/appropriate to link more generally to the flow accounts, cf. chapter 3 and 4 of SEEA */

As explained in chapter 7 the SEEA and the SNA 93 asset account include almost the same accounting items. Table 7-3 summarised the relevant items and the different terminology used in SEEA and SNA 93, respectively.

Now, Table 18-1 reproduces Table 7-3 with regard to the items reflecting the changes/flows of the asset accounts.

Table 18-1 Correspondence between SEEA 2003 and SNA 1993 terminology for *changes* in asset accounts

SEEA 2003	Corresponding SNA 93 accounting concept
Changes due to transactions	No corresponding head item, but SNA 93 presents additions to the value of non-produced non-financial assets and acquisitions less disposals on the capital account, which exactly deals with changes due to *transactions*
????Additions to the value of non-produced non-financial assets	**Additions to the value of non-produced non-financial assets**
Acquisitions less disposals	Same
Increases in stocks	Economic appearance
Discoveries	Not specified, but included in economic appeareence above
Reappraisals	Not specified, but included in economic Appearance
Decreases in stocks	Economic disappearance
Extractions	Depletion of natural resources Note: Depletion is suggested changed to extraction in SNA 93, rev. 1
Reappraisals	Other economic disappearance of non-produced assets
Other changes in stock levels	No corresponding head item
Catastrophic losses and uncompensated seizures	Same, but subdivided in two components SNA 93
Valuation changes (capital gains and losses)	*Holding gains and losses*, but subdivided in two components in SNA93
Changes in classifications and structure	Same, but subdivided in two components in SNA 93

In the following sections principle and method for putting a monetary value on the item will is described.

18.1 Additions to the value of non-produced non-financial assets

18.2 Acquisitions less disposals

18.3 Discoveries and reappraisals

While there are some reasons why it may be desirable to separate reappraisals from new discoveries (see below), often the necessary information is not made available by oil companies. In such cases, the word “discoveries” is often used to cover both reappraisals and new discoveries. The case where there are no new discoveries and reappraisals have been downward will lead to a seemingly counter-intuitive negative entry in “discoveries” when the two are combined. In general, if there are negative entries for discoveries, it is probable that they are really a combination of both discoveries and reappraisals. To avoid such apparent anomalies, it is suggested that the term “discoveries and reappraisals” should be used in full when the two items are not available separately.

The value of discoveries is the amount by which the NPV of the whole deposit increases as a result of new finds and upward reappraisals. The additions should be added to any existing volume estimates of proven plus probable reserves, with the same rate of extraction and the same discount rate as for the initial volume. The value of discoveries is then the difference between the NPV of the enlarged volume and the volume before the new discoveries. If the life length of the reserves before the discovery was n years and after discovery it is $\underline{n}+\underline{t}$ years, then the increase in value is the NPV of extraction in years $\underline{n}+\underline{1}$ to $\underline{n}+\underline{t}$. The addition to value of the discoveries is much smaller than the value of a similar quantity of resources at the time of extraction, and very much lower than the market price for the extracted resource. Further, the value of the discoveries also depends on the level of existing proven reserves. If these are high, the value of the discoveries is lower than the value of the same volume when existing proven reserves are lower or zero, reflecting the relative scarcity of reserves in these two cases.

If the size of the discoveries is so large that the average level of extraction permanently increases, then there will be consequent changes in the value of the total resource stock on this account.

18.4 Extractions

/* explain valuation principle */

The other change in the physical levels of oil (and other non-gaseous subsoil) reserves during a year is due to the extractions carried out in the period. For gas, the situation is rather more complicated. Gas is often found with oil and it is the pressure exerted by the gas that causes the oil (and some gas) to gush up the well. Some of the gas may be flared rather than put to direct use. Some may be reinjected, especially after extraction has been continuing for some time, to increase the pressure on the remaining oil and allow more oil to be expelled. In such cases, if the gas associated with the oil is being accounted for, an allowance must be made for the decrease in the amount of gas available for other uses due to flaring and reinjection.

18.5 Reappraisals

/* explain valuation principle */

18.6 Catastrophic losses and uncompensated seizures

/* explain valuation principle */

18.7 Valuation changes

/* explain valuation principle */

18.8 Changes in classification and structure

/* explain valuation principle */

18.9 Summary of valuation principles for the changes in assets

/* the following Eurostat guidelines could be used as the starting point or could be incorporated in the text above */

The accumulation accounts show the link between the opening and closing stocks of the assets. In Table 1 the changes in the physical stocks of subsoil assets are 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 following classification and corresponding valuation methods for the changes in the monetary value of subsoil assets are suggested:

Opening stock	Value of reserves at the end of the previous year, t-1: $PV_{t-1}(rr_{t-1}, E_{t-1})$
Nominal holding gains and losses	Change in the value of opening reserves due to change in the level of the unit resource rent: $PV_{t-1}(rr_t, E_{t-1}) - PV_{t-1}(rr_{t-1}, E_{t-1})$ $= (rr_t/rr_{t-1}) * PV_{t-1}(rr_{t-1}, E_{t-1}) - PV_{t-1}(rr_{t-1}, E_{t-1})$ $= (rr_t/rr_{t-1} - 1) * PV_{t-1}(rr_{t-1}, E_{t-1})$
Neutral holding gains and losses	The part of the nominal holding gains and losses that can be attributed to change in the general price level: $PV_{t-1}(rr_{t-1}*I_t/I_{t-1}, E_{t-1}) - PV_{t-1}(rr_{t-1}, E_{t-1})$ $= (I_t/I_{t-1} - 1) * PV_{t-1}(rr_{t-1}, E_{t-1})$
Real holding gains and losses	The part of the nominal holding gains and losses that can not be attributed to change in the general price level: $PV_{t-1}(rr_t, E_{t-1}) - PV_{t-1}(rr_{t-1}*I_t/I_{t-1}, E_{t-1})$ $= (rr_t/rr_{t-1} - I_t/I_{t-1}) * PV_{t-1}(rr_{t-1}, E_{t-1})$
Other changes in volume	Change in value due to other changes in the volume of reserves and change in the future path of extraction: $PV_{t-1}(rr_t, (e_t, E_t)) - PV_{t-1}(rr_t, E_{t-1})$ $= PV_{t-1}(rr_t, (e_t, E_t)) - (rr_t/rr_{t-1}) * PV_{t-1}(rr_{t-1}, E_{t-1})$
Extraction	Quantity extracted multiplied by the present year's per unit resource rent: $- rr_t * e_t$
Revaluation due to time passing	Value of the opening reserves at the conditions of the present year (i.e. calculated using the unit resource rent and extraction of the present year), multiplied by the rate of discount: $r * PV_{t-1}(rr_t, (e_t, E_t))$
Closing stock	Value of the remaining reserves at the end of the present year, t: $PV_t(rr_t, E_t)$

In the table above,

- rrt is the three-year moving average unit rent for year t,
- et is extraction in year t,
- Et is the expectation in year t of future annual extraction from year t+1 until the stock is exhausted in year t+n, i.e. it is a vector (et+1, et+2,….., et+n),
- r is the rate of discount (which is assumed to be constant over time),
- PVt is the present value calculated at the end of year t, which is a function of the unit rent, future extraction and the discount rate. The formula for PVt is:

$$PV_t(rr_t, E_t) = \frac{rr_t e_{t+1}}{(1+r)} + \frac{rr_t e_{t+2}}{(1+r)^2} + \frac{rr_t e_{t+3}}{(1+r)^3} + \ldots\ldots + \frac{rr_t e_{t+n}}{(1+r)^n}$$

It represents an index of the general price level, and is used for partitioning the nominal holding gains into neutral and real holding gains. According to the ESA 95 §8.57, the price index for final national uses, excluding changes in inventories, should be used for this purpose.

19 Completing the monetary accounts

Completing the monetary accounts – linking stocks and flows – table lay out and presentation issues

20 Up-dating and revising of the accounts

principles for update, revision policy when new information becomes available

How to calculate values for past years.

/* Should new information on the development of e.g. oil prices be used when the resource rent for a previous year is estimated, or should only the information available at reference time be used (normally all information would be used, but a NPV calculation is based on expectations about future prices */

21 Publication and use of the accounts

22 Documentation and quality check

Part III Examples and use of accounts

/* In this part of the handbook real country examples of asset accounting and methods are presented.

Furthermore examples of the use of the accounts for analysis are presented. */

23 Country examples

24 Examples of analysis

24.1 Sensitivity analysis

Because the stock values are so dependent on the assumptions used in the calculation, it is useful to include a sensitivity analysis in the accounts. Table 4 shows the current price values of the closing stocks of oil and gas for the latest year, based on different combinations of assumptions for the discount rate, the rate of return and the unit rent. The shaded cells represent the 'standard' set of assumptions, used in Table 3.

Table 4: Value of closing stock of oil and gas, based on different assumptions

	Crude oil and NGL				Natural gas			
	Unit rent				Unit rent			
	3-year moving average			Current year	3-year moving average			Current year
	Rate of return			Rate of return	Rate of return			Rate of return
Discount rate	6%	8%	10%	8%	6%	8%	10%	8%
0%								
2%								
4%								
6%								
8%								

24.2 Government appropriation of the resource rent

In many countries, Governments are the primary owner of the nation's natural resources. As landlords, Governments could in theory collect the entire rent derived from extraction of the resources that they own. Resource rent is normally collected by Governments through fees, taxes and royalties levied on companies that carry out extraction. One approach to estimating the economic rent attributable to a resource entails equating it with the fees, taxes and royalties collected from the companies involved in the resource extraction. However, in practice, fees, taxes and royalties tend to understate resource rent, as they may be set by Governments with other priorities in mind, for instance, implicit price subsidies to extractors, and encouraging employment in the industry. Also, the rate of payments to government may not move in line with market prices for the extracted product though one would expect the true economic rent to do so. When these data are not separately identifiable, or suitable, resource rent must be imputed using various indirect methods. However, if the two sets of data are available, publishing a comparison of the values may be useful for economic policy analysis.

The oil and gas resources in EU/EEA countries are usually legally owned by governments, while extraction is carried out by separate companies. Through taxes and royalties, the governments appropriate part of the resource rent from extraction. The government's part of the resource rent can be defined as the sum of royalty payments and revenue from production and income taxes that are specifically related to extraction.

The relationship between the part of the resource rent that is appropriated by the government and the total resource rent 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.

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. 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 avoids having to make an assumption about the rate of return to fixed capital.

In order to estimate the government's share of the resource rent, taxes on production and income are 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. This works well for taxes on production, but for income taxes the results of this method are sensitive to the way the taxation system is set up. If specific taxes on income are payable on the extractor's profit after the general (non-specific) corporate income tax, then corporate taxes are paid on the part of the rent that later will be appropriated by the government as specific taxes. This means that the government would collect corporate taxes on its share of the resource rent.

If the tax system involves payment of specific taxes after general corporate taxes, a better solution is 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. See Annex 1 for an example, based on the situation in the Netherlands.

Annex 1: Government appropriation of the resource rent
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, but could be applicable also to other countries.

The initial assumptions are:

Net operating surplus: 100
Net capital stock: 125
Rate of return to fixed capital, before corporate taxes: 8%
General corporate income tax rate, payable on net operating surplus: 25%
Special income tax rate on extraction, payable on income after corporate taxes: 70%

In this case, we get:

Return to fixed capital, before tax: 10 (= 0.08*125)
Resource rent: 90 (=100 – 10) (Net operating surplus less return to fixed capital)
General corporate income taxes: 25 (= 0.25*100)
Special income tax on extraction: 52.5 (= 0.7*75)
Extractor's after tax income: 22.5 (= 100 – 25 – 52.5)

Using the tax code's definition of specific taxes on income, we get:

Government's share of resource rent: 52.5 (=Special income tax on extraction)
Extractor's share of resource rent: 37.5 (= 25 + 22.5 - 10)

With these definitions, the extractor's share of the resource rent includes all general corporate income taxes, also the part that falls on the rent appropriated by the government as special income tax on extraction.

Two alternative ways to divide the corporate tax revenue are possible (method B is recommended):

A) Divide the general 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), i.e. the rent is measured "pre-tax".

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

The total resource rent of 90 will then be distributed as follows:
Government: 75 (=52.5+25 –2.5)
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 return to fixed capital.

24.3 Valuation related to parameter changes

Because the value of the reserve stock depends on the stock level, the extraction rate and the unit resource rent, it is possible to consider the effect on the value of changes in the stock level due to extraction, due to changes in the extraction rate, due to discoveries and due to changes in the unit rent. Suppose that in addition to the value at the end of the year, RV_t, values under three other conditions are considered, denoted by subscripts 1, 2 and 3 and the variables relating to the previous year have subscript t-1. The difference between the end-of-year point t and condition 1 is the level of discoveries, D_t. Between conditions 1 and 2, the difference is the extraction E_t. Between conditions 2 and 3, it is the extraction rate that changes, to E_t from E_{t-1}. Between condition 3 and t-1, the start of the year or, equivalently the end of the previous year, it is the unit resource rent rr_t that has changed, from rr_{t-1}. This is shown schematically in Table 24-1.

Table 24-1. Parameters for valuation under different assumptions

Value	Subscript	Unit resource rent	Extraction rate	Stock level	Life length
RV_t	t	rr_t	E_t	$S_t = S_{t-1}-E_t+D_t$	$n_t = S_t/E_t = (S_{t-1}-E_t+D_t)/E_t$
RV_1	1	rr_t	E_t	$S_{t-1}-E_t$	$n_1 = (S_{t-1}-E_t)/E_t = n_2-1$
RV_2	2	rr_t	E_t	S_{t-1}	$n_2 = S_{t-1}/E_t$
RV_3	3	rr_t	E_{t-1}	S_{t-1}	$n_3 = n_{t-1} = S_{t-1}/E_{t-1}$
RV_{t-1}	t-1	rr_{t-1}	E_{t-1}	S_{t-1}	$n_{t-1} = S_{t-1}/E_{t-1}$

The change in the value of the stock over the whole year is RV_t-RV_{t-1}. This can be decomposed into a number of stages in each of which only one of the parameters changes, thus

$$RV_t - RV_{t-1} = (RV_t - RV_1) + (RV_1 - RV_2) + (RV_2 - RV_3) + (RV_3 - RV_{t-1})$$

The example shows how each of the expressions affects the total value of the stock of the asset. Putting all these together, the total change in the value of the stock of the resource between the start and the end of the year can be decomposed as shown into five elements:

Effect of discoveries and reappraisals

Effect of extraction;

Return to the natural resource (effect on the NPV of time passing)

Effect of changing extraction

Effect of changing resource rent

Of these, the first and the last two may be zero but the other two will always coexist and always exist as long as any extraction takes place.
Note that this decomposition is dependent on the order in which the effect of the changes in parameters is evaluated. A different ordering will give somewhat different results.

Box 24.1. Derivations of the decomposition of change in stock valuation

Discoveries and reappraisals (RV_t-RV_1)

Supposing the discoveries are positive, then the new life length n_t is greater than n_1 and this expression can be written as

$$RV_t - RV_1 = rr_t E_t \sum_{k=1}^{n_t} \frac{1}{(1+r)^k} - rr_t E_t \sum_{k=1}^{n_1} \frac{1}{(1+r)^k}$$

$$= rr_t E_t \sum_{k=n_1+1}^{n_t} \frac{1}{(1+r)^k}$$

$$= \frac{rr_t E_t}{(1+r)^{n_1}} \sum_{k=1}^{n_t-n_1} \frac{1}{(1+r)^k}$$

If there are net negative reappraisals, then n_t is less than n_1 and the expression becomes

$$RV_t - RV_1 = \frac{-rr_t E_t}{(1+r)^{n_t}} \sum_{k=1}^{n_1-n_t} \frac{1}{(1+r)^k}$$

If there are no discoveries in the year, n_t is exactly equal to n_1 and the term for RV_t -RV_1 is exactly zero.

Extraction (RV_2-RV_1)

The value of the stock after deducting E_t from the previous stock level, can be written as

$$RV_2 = rr_t E_t \left[\sum_{k=1}^{n_2} \frac{1}{(1+r)^k} \right] = \frac{rr_t E_t}{1+r} + \frac{rr_t E_t}{1+r} \left[\sum_{k=1}^{n_2-1} \frac{1}{(1+r)^k} \right]$$

$$= \frac{rr_t E_t + RV_1}{(1+r)}$$

and so

$$RV_1 - RV_2 = -rr_t E_t + rRV_2$$

Thus the change in value due to extractions in a year can be expressed as the sum of a decrease equal to the value of the resource rent and an increase equal to the return on the value at the start of the year. This is a more formal derivation of the equation described in **Fejl! Henvisningskilde ikke fundet.**.

Changes in the extraction rate (RV_2-RV_3)

Changing the extraction rate changes the expected life length and is similar in its impact to discoveries and reappraisals, but with the unit resource rent unchanged, the total stock value alters as follows:

$$RV_2 - RV_3 = rr_t E_t \sum_{k=1}^{n_2} \frac{1}{(1+r)^k} - rr_t E_{t-1} \sum_{k=1}^{n_3} \frac{1}{(1+r)^k}$$

$$= rr_t E_t \left[\sum_{k=1}^{n_2} \frac{1}{(1+r)^k} - \frac{E_{t-1}}{E_t} \sum_{k=1}^{n_3} \frac{1}{(1+r)^k} \right]$$

Change in the unit resource rent (RV_3-RV_{t-1})

$RV_3 - RV_{t-1}$ represents the change in value due to a change in resource rent:

$$RV_3 - RV_{t-1} = rr_t E_{t-1} \sum_{k=1}^{n_{t-1}} \frac{1}{(1+r)^k} - rr_{t-1} E_{t-1} \sum_{k=1}^{n_{t-1}} \frac{1}{(1+r)^k}$$

$$= E_{t-1} \sum_{k=1}^{n_{t-1}} \frac{1}{(1+r)^k} [rr_t - rr_{t-1}]$$

Table 24-2 gives an example of such a decomposition for Norway for 1995. The life length for the resource at the beginning of the year was 25 years.

Table 24-2. Decomposition of changes in oil reserves

	Volume (million tons)	Value (billions of Norwegian kroner)
Opening stocks	3 531	418
Discoveries and reappraisals	116	8
Extraction (resource rent)	-141	-26
Return to natural capital		16
Change in the rate of extraction		13
Change in the unit resource rent		-18
Closing stocks	3 506	411

Source: Statistics Norway.

24.4 Other Uses of physical asset accounts

The most immediate and obvious use of physical accounts is to compile an indicator that shows whether the stock levels of a given resource are declining and, if so, how quickly. This may be done in terms of the absolute levels or in terms of year-to-year changes. Though mineral and energy resources can never be used in a wholly sustainable way, because they are not renewable on a human timescale, proven reserves may appear to be sustainable if the rate of discoveries and reappraisals keep pace with extractions. Even when this is not so, if the rate of depletion of a deposit decreases from one year to the next, it may indicate that the resource is being used more sparingly than in the past. For some deposits, this may be linked to the possibility of recovering material from recycling or due to technological developments that increase the efficiency of use of the material. All of these are useful indicators for those interested in the degree of sustainability of a nation's resources.

APPENDIX - Explanation of terms used

A vehicle, building or piece of heavy machinery may be bought by an enterprise to assist in the production process. The items are valued, whenever possible, by the price paid for them on an open market. However, the costs are regarded not as part of intermediate consumption but as *fixed capital formation*. The reason is that the items provide services over a period of time and are "paid for" over the same period, the life length of the asset in question. Another is to regard the asset as disappearing over a period of time by an amount representing the reduction in value of the asset in each year in question. The extent of the disappearance is referred to as the *consumption of fixed capital* (CFC).

The *gross operating surplus* of an enterprise represents the *benefit* to the owner of using all his assets in the year in question. It can also be described as the value of the flow of *capital services* rendered by the assets in the same period or the *economic rent* generated by the use of the assets. The value of the assets can, in principle, be estimated by calculating the *net present value* (NPV) of the gross operating surplus or economic rent to be generated for each of the future years in which when the assets will be still in service. Since a higher value is put on money today than on money in the future, the economic rent for each future year is discounted to reach an appropriate value in today's terms. The discount rate is applied once for each year for which the economic rent is distant. The sum of all the discounted rents throughout the life of the asset is called the net present value of the asset.

With use, and over time, the value of assets generally declines. The value of capital services rendered, or used up, entail a decline in value. Set against this is an income element,. Stemming from the fact that the future benefits have become one year closer and may be called *the effect on the NPV of time passing*. If the value of the assets at the start of the year is V and the discount rate is r, then the income element can be expressed as rV. For this reason, the income is regarded by economists as representing the *return to the capital* used by the firm. For the firm as a whole, this item is the *net operating surplus*. The decline in the value of the asset is referred to as the *consumption of fixed capital* and is the difference between the value of the capital service flows rendered (and thus used up) and the income element that arises in the same period.

The expressions "gross operating surplus", "net operating surplus" and "consumption of fixed capital" are very familiar to national accountants and are widely used in the SNA. The other formulations come from economic theory but are increasingly being incorporated into national accounting work as evidenced by two recent manuals, one on the measuring of capital stocks and one on measuring productivity (OECD, 2001a and 2001b). These various concepts are interrelated and different identities can be used to express the inter-relationships (assuming for simplicity's sake at present that there are no taxes or subsidies on production). Because of the interchangeability of the terminology, all these formulations represent the same relationship between the variables. Some of these are spelled out in **Fejl! Henvisningskilde ikke fundet.**for easy reference. The value of consumption of fixed capital can be deducted from gross operating surplus to yield the figure of net operating surplus and from gross fixed capital formation to yield the figure of net fixed capital formation. Almost everywhere in the SNA, the use of the word "net" means that the consumption of fixed capital has been deducted from the aggregate in question. This is true for measures of domestic product and national income as well as for measures restricted to capital only.

Box **Terminology for the use of capital**

Gross operating surplus	= benefit from the asset
	= economic rent
	= value of capital service flows
Net operating surplus	= return to capital
	= effect on the NPV of time passing
	= gross operating surplus *less* consumption of fixed capital
Consumption of fixed capital	= decline in the value of asset between two points in time
	= gross operating surplus *less* net operating surplus
	= gross operating surplus *less* effect of time passing
	= value of capital service flows *less* return to capital
Return to capital	= economic rent *less* consumption of fixed capital
	= value of capital service flows *less* consumption of fixed capital

References and links

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