System of
Environmental and Economic Accounting for Energy

SEEA-E

Draft Chapter 4 Monetary Asset Accounts

United Nations Statistics Division

DESA

January 2011

Table of Contents

Chapter 4 Monetary asset accounts

A. Introduction

4.1. Monetary asset accounts for energy resources builds a bridge between the physical asset accounts presented in Chapter 3 and the general balance sheets and asset accounts for all types of economic assets included within the SNA 2008 asset boundary. The monetary asset accounts for energy resources provide a market based valuation of the physical stocks of energy resources and the changes in them.

4.2. Although, the use of fossil energy is considered to be a main factor when it comes to the greenhouse effect and global warming, energy resources is at the same time still an important input required to support economic activity, and the value of these resources are highly relevant in relation to the measurement of country's total wealth including not only manmade capital such as buildings, machineries and transport equipment but also the natural resources. When all types of assets are measured at the same currency units it is possible directly to assess to what extent decreasing energy resources are counterbalanced by increases in other types of capital. Thereby, the monetary asset accounts for energy resources can be used in relation to an assessment of so-called weak sustainability.

4.3. The scope of the accounts is discussed in section B. Section C describes the accounting structure and accounting items for the monetary asset accounts. Section D explains the differences between the terminology used in the SEEA-E monetary asset accounts and in the SNA 2008 asset accounts. Section E and F outline the valuation principle for the stocks of resources, while the valuation principle for of changes in the stocks is presented in Section G. The conversion of the accounts into constant prices is the subject of section H.

4.4. Section I describes the monetary asset accounts for inventories of energy products. Section J deals with the SNA 2008 accounts for energy-related fixed assets, i.e. buildings, machineries and transport equipment, etc. The fixed assets include also exploration and evaluation, etc. used by the energy extraction industries.

4.5. While the presentation of the monetary asset accounts generally refer to the energy resources as a whole and assumes that it is not necessary to make a distinction between the extractor of the energy resources and the owner of energy resources. Section K introduces, however, the possibility that the extractor is not necessarily the same as the owner, and recognizes at the same time that the institutional arrangements may be such that the extractor is in fact the economic owner of parts of the resources. This leads to a presentation of separate monetary asset accounts for the owner and the extractor.

4.6. The Annex is related to Section G. It includes detailed formulas for how the change in stock values may be decomposed into different underlying factors.

B. The scope of the monetary asset accounts

1. SEEA-E monetary asset accounts

4.7. Setting up the monetary asset accounts corresponds to attributing market values to the physical opening and closing stock of the energy resources, and to identifying the causes of the changes in the market values that have taken place in the period.

4.8. The starting point is that all of the energy resources described by the physical asset accounts should be associated with a market value. In that sense, all of the known deposits are in principle within the scope of the monetary asset accounts. If market values for the stocks and changes in them can be observed and identified by statistical surveys, these observed values should be used for the accounts.

4.9. However, in practice, many deposits of energy resources are seldom or never exchanged on a market and therefore, even if the energy resources have a market value, these can often not be observed. Thus, the market valuation of the energy resources must be based on assumptions of what the market prices would have been, if the energy resources were traded in a hypothetical market.

4.10. An estimate of these hypothetical market values can be based on the assumption that a market value should reflect the expected future net income an investor would get from owning the resource. This expected future income is determined partly by the quantities (number of physical units) of the energy resources that can be expected will be extracted from the resource in the future, and partly from the economic surplus each physical unit brings the owner and extractor.

4.11. It follows, that we can only expect that quantities of energy resources have an associated positive market value if there is an expectation that the energy resources will be extracted and sold with a profit at some point in the future. Obviously, not all energy resources are the subject of such expectations, and therefore the market value of these parts of the energy resources is assumed to be zero.

4.12. In order to identify, which parts of the energy resources that we can expect to be extracted and which therefore is the subject of the monetary asset accounts for energy we turn to the UNFC based SEEA-E classification of energy resources by characteristics as presented in Section B of Chapter 3. The energy resources are divided into three classes:

A. Commercial Energy Resources

B. Potential Commercial Energy Resources

C. Non Commercial and Other Quantities in Place

This division indicates that the different parts of the deposits have different characteristics when it comes to economic, project feasibility and geological aspects.

Class A Commercial Energy Resources includes per definition energy resources for which extraction is currently taking place or is underway or for which the feasibility of extraction has been demonstrated. Further, the extraction of the energy resources in this class is expected to be economic viable on the basis of current market conditions and realistic assumptions of future market conditions, cf. Chapter 3.

The second class *B. Potential Commercial resources* may also be extracted in the future, but since the feasibility of extraction is subject to further evaluation and since extraction and sale has not yet been confirmed to be economic, the uncertainty related to whether future extraction will take place is quite high. Therefore, this part of the energy resources is not considered as assets having a positive market value.

Further, since the uncertainty related to future extraction of energy resources included in *Class C Non Commercial and Other Quantities in Place* is even higher than for energy resources included in *Class B*, these resources are not associated with any market value.

By convention, the valuation of energy resources included in *Class A Commercial Energy Resources* should be based on the moderate (sometimes also called best) estimate of the quantities to be extracted, cf. Chapter 3.

4.13. Using this approach for the valuation based on a hypothetical market implies that a quite conservative valuation principle is used. Market values are simply assumed to be zero if specific projects have not confirmed that the resources will actually be extracted, and thus only Class A Commercial Energy Resources falls within the scope of the SEEA-E monetary asset accounts.

2. The link to SNA 2008

4.14. The scope of the SEEA-E monetary asset accounts and the SNA 2008 asset accounts for energy resources are in principle the same but, by making reference to the UNFC, the scope of the monetary asset accounts is more precisely defined in SEEA-E than in the SNA 2008, which, without reference to any specific classification system, states:

> Mineral and energy resources consist of mineral and energy reserves located on or below the earth's surface that are economically exploitable, given current technology and relative prices. (SNA 2008, 10.179).
>
> and
>
> In the SNA 2008, sub-soil assets are defined as those proven subsoil resources of coal, oil and natural gas, of metallic minerals or of non-metallic minerals that are economically exploitable, given current technology and relative prices. (SNA 2008, 12.17)

4.15. Thus, SNA 2008 makes reference both to *economically exploitable reserves* in general and to *proven resources*. Although these terms are not a well-defined, the condition that the resources should be economically exploitable, given current technology and relative prices indicates that the scope of the SNA 2008 asset accounts for energy resources is the same as that for SEEA-E, namely *Class A Economic Energy Resources*, and that energy resources belonging to Class B and Class C falls outside the asset boundary of SNA 2008.

4.16. The SNA 2008 general reference to *reserves* can be assumed to relate to a high estimate of the quantities of energy resources that can be extracted (G1+G2+G3, cf. Chapter 3), while the specific reference to proven resources (reserves) probably relate to the low estimate (G1 only). In contrast, SEEA-E recommends that the moderate (best) estimate (G1+G2) of the commercial recoverable resources are used.

4.17. Since the principal scope of the SEEA-E monetary asset accounts and the SNA 2008 are the same a deviation between the scope of the SEEA-E and SNA 2008 accounts with respect to the quantification of the energy resources is not useful. Since the SNA 2008 lacks precision with regard to which estimate of the quantities to use, it is recommended that the moderate (best) estimate is used for both the SEEA-E and SNA 2008.

4.18. Table 4.1 sums up the scope of the asset accounts for energy resources.

Table 4.1 Scope of asset accounts

SEEA-E classification		SEEA-E asset accounts		SNA 2008 asset accounts
		Physical asset accounts	**Monetary asset accounts**	
A	Commercial Energy Resources	Quantities	Market value assigned to the moderate (best) estimate (G1+G2)	Market value assigned, but some ambiguity about which estimate to use
B	Potential Commercial Energy Resources	Quantities	Market value assumed to be zero	Outside asset boundary
C	Non Commercial and Other Known Deposits	Quantities	Market value assumed to be zero	Outside asset boundary
	Potential resources	Outside asset boundary		

C. The structure and accounting items of the monetary energy asset accounts

4.19. The structure of the monetary asset account for energy resources is shown in Table 4.2. All entries should be made in the same currency unit. Both current prices and constant prices may be applied. A monetary asset account as illustrated in Table 4.2 may be set up for each energy resource, crude oil, natural gas, coal, etc., which are of interest relevant (cf. the energy resource classification by type Table 3.1). Further, if the asset accounts have been set up for the individual energy resources, they can be added to one monetary asset account, which shows the total market value of the openings stocks and closing stocks and changes for all energy resources taken together.

4.20. All entries, besides two, in the monetary asset account for energy resources are the same as applied for the physical asset accounts in Chapter 3. The two entries, which are particular for the monetary accounts as compared to the physical accounts are the *Depletion* and *Revaluation (holding gains and losses).*

4.21. In the monetary asset account a value is attached to each of the corresponding accounting items in the physical asset accounts. As will be explained below, the valuation of the physical items should generally not be carried out as a simple price multiplied by volume calculation. Instead the valuation should be based on the expected pattern of future extraction. The valuation, for instance, of the present period discoveries should be made from an assessment of the future extraction of these discoveries and the corresponding future economic surplus from the extraction.

Table 4.2 SEEA-E monetary energy asset account

	Commercial Energy Resources
	1000 currency units
Opening stocks (LS)	**253**
Changes due to transactions	
Acquisitions less disposals (NP1)	0
Increases in stocks	
Discoveries (K11)	50
Reappraisals (upwards) (K12)	2
Decreases in stocks	
Depletion (K21)	-29
Reappraisals (downwards) (K22)	-6
Other changes in stocks	
Catastrophic losses (K3) and uncompensated seizures (K4)	
Changes in classifications and structure	
Revaluation	
Holding gains and losses (K7)	104
Closing stocks (LE)	**374**

Note. Codes in parenthesis refer to the SNA 2008 classification and coding structure (K1 divided into K12 and K13)

4.22. Below, the various accounting items of the monetary asset accounts are explained:

Opening stock is the value of the resources at the beginning of the year. It is equal to the closing stock of the previous year. The value excludes any costs of ownership transfer[1]

Changes due to transactions:

Acquisitions less disposals of energy resources is the value related to the corresponding physical flow explained in Chapter 3. This item will often be zero since in many cases the resources are not traded.

If acquisitions or disposals actually take place between institutional sectors the value of the transaction, which should be recorded, is the value of the deposit itself, excluding any costs of ownership transfer. Costs of ownership transfer are regarded as fixed capital formation and are not recorded in the asset account for energy resources[1].

[1] Note that the SNA 2008 *include* the capitalised costs of ownership transfer in the value of the energy resources, but *excludes* it from the value of acquisitions less disposals of the energy resources (SNA 2008, 10.97, 13.16 and 13.34). By excluding the costs of ownership transfers from all items of the asset accounts, consistency is ensured across the SEEA-E asset accounts. However, since ownership transfer of energy resources seldom takes place this is in fact without any big significance.

Increases in stocks:

Discoveries include the value of gross additions to the stock of the resources and refer to the value of findings of resources previously unknown.

Reappraisals (upwards) is the value related to the corresponding physical flow explained in Chapter 3. It should be noted, that this item include effects of price changes, which affect how much of the resource that actually has an economic value, i.e. how much of the resource that can be expected to be extracted economically. It does on the other hand not include the effect on the total stock due to price changes, cf. the *revaluation* item below.

Decreases in stocks

Depletion is used to record the change in the value of the energy resource as a result of the physical removal and using up of the energy resource, i.e. due to the extraction. It should be noted that the value is to be recorded as the value before extraction i.e. in ground, and not as the value of the extracted products i.e. the sales value of the extracted resources. The sales value after extraction is higher since it has to allow for the extraction costs, and return to capital, etc. The term depletion is used for the monetary accounts, instead of extraction, which is the term used for the physical asset accounts. The interpretation and estimation of the depletion item is described in more detail later in this chapter.

Reappraisals **(downwards)** records the value of the corresponding physical flows explained in Chapter 3. It is the counterpart to the upward reappraisals, cf. above.

As in the case of the physical asset accounts, upwards and downwards reappraisals may be combined in one item if information is not available to separate them. Further, they may be combined with new discoveries, in one item *Discoveries and reappraisals*, if appropriate.

Other changes in stocks

Catastrophic losses and ***uncompensated seizures*** records the value of the corresponding physical flows explained in Chapter 3, section B.

Changes in classifications and structure records the value of the corresponding physical flows explained in Chapter 3. This item will often be zero.

Revaluation

Holding gains and losses is an item specific to the monetary asset account for energy resources, and is not found in the physical asset accounts. It reflects the effect of price changes on the value of the existing stock because the value of each unit of the stock increases or decreases as prices go up or down. It should be noted that besides affecting the value of the existing stock, price changes might also affect how much of the resource that actually has an economic value, but these quantity/volume effects of the price changes are not accounted for as holding gains and losses but instead as *reappraisals* under increases in stocks (if prices goes up) or decreases in stock (if prices go down).

Closing stock is the value of the stock of resources at the end of the year. It is equal to the opening stock of the subsequent year. As for the opening stock, the value excludes any costs of ownership transfer.

4.23. The method for actual valuation of the various accounting items is presented in section E and F in this chapter.

D. Correspondence between SEEA-E and the SNA 2008 asset accounts

4.24. The SEEA-E monetary asset accounts for energy resources is based on the same principles and includes overall the same items as can be found in corresponding SNA 2008 accounts. However, the terminology used is not exactly the same and the levels of aggregation in the two set of accounts are slightly different. This is because the SEEA-E accounts highlight some of the features specific to natural resources, while the SNA 2008 cover assets in general. In Table 4.3 the terminology and level of detail used in SEEA-E on one hand and the SNA 2008 on the other hand is presented. Corresponding SNA 2008 codes are also presented.

4.25. Increases in the value of energy resource stocks due to discoveries or reappraisals are called economic appearance in the SNA 2008. The use of this term reflects that previously un-discovered energy resources have been discovered and are considered as being economic to extract. Alternatively, already discovered stocks previously regarded as non-economic to extract are now being seen as economic e.g. because of new technology or price changes. In any case, the resources are now regarded as part of the assets. In contrast to SEEA-E, the SNA 2008 does not distinguish between whether the economic appearance is due to new discoveries or reappraisals.

4.26. Similarly the decrease in stocks is called economic disappearance in the SNA 2008. It includes the depletion and the economic disappearance caused by reappraisals, meaning that some parts of the resources are no longer considered economic to extract, for instance, because of lower prices on the output from the extraction.

4.27. *Changes in classification (and structure)* are further subdivided in SNA 2008. The first sub-category is changes in sector classification and structure (K61). In relation to the asset accounts this item is only relevant when the asset accounts, like the one presented in Table 4.2, is set up for individual institutional sectors, and when, for example, an unincorporated government enterprise becomes a public non-financial quasi-corporation and moves from general government to non-financial corporations. The second sub-item is changes in classification of assets and liabilities (K62). It applies when the purpose for which an asset is used changes.

4.28. Revaluations due to nominal holding gains and losses are divided into two components in the SNA 2008, namely neutral holding gains and losses and real holding gains and losses. Nominal holding gains are the monetary value accruing to the owner as a result of price increases over time. Neutral holding gains are the part of the nominal value increase that would have accrued if the price had increased in the same proportion as the general price level. Real holding gains are the remaining part of the nominal holding gains and correspond to value increases due to price increases relatively to the prices of products in general. If resource prices increase at the same rate as the general price level, nominal holding gains are equal to neutral holding gains, and no real holding gains occur. Holding losses stemming from price decreases are defined analogously.

Table 4.3 SEEA-E and SNA 2008 terminology for asset accounts for energy resources

SNA 2008 code	SEEA-E	SNA 2008	
	Asset accounts for energy	Accounting items	Accounts
LS	Opening stock levels	Opening stock	Opening balance sheet
	Changes due to transaction[1)]		
NP1	Acquisitions less disposals	Acquisitions less disposals	Capital account
K1	Increases in stocks Discoveries (K11) Reappraisals (K12)	Economic appearance	Other changes in the volume of asset account
K2=K21+K22	Decreases in stocks	Economic disappearance	
K21	Depletion	Depletion	
K22	Reappraisals	Other economic disappearance	
	Other changes in stock levels		
K3+K4	Catastrophic losses and uncompensated seizures	Catastrophic losses and uncompensated seizures	
K6 = K61+K62	Changes in classifications and structure	Changes in sector classification and structure Changes in classification of assets and liabilities	
	Revaluation		
K7	Capital gains and losses	Nominal holding gains and losses	Revaluation account
LE	Closing stock levels	Closing stocks	Closing balance sheet

E. Valuation of stocks of energy resources - the net present value method (NPV)

1. The basic idea

4.29. In SEEA-E and SNA 2008 market prices should be used when a monetary value is assigned to the energy resources, i.e. when the values for the opening and closing stocks of the energy resources are established (cf. LS and LE in Table 4.2). However, as mentioned, the natural energy resources are often not sold on the market and market prices are therefore normally not observable. The SNA 2008 suggests that in the case of assets for which the returns are spread over a lengthy period the so-called net present value method should be used if no market values are observable.

4.30. While the present net value method will often be the only available option for valuation of an energy resource, any available information from companies about market transactions and sales prices should of course be taken into account. Partly available information about market transactions of energy resources can be combined with the net present value method, if such information exist..

4.31. Economic theory asserts that the net present value of future benefits accruing from holding or using the assets equals the market prices of the 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. The net present value is therefore, in principle, compatible with market values.

4.32. The calculation of the net present value of the future extraction can be described by the following steps:

- The future extraction profile in physical terms is established.

- Actual resource rent and per unit resource rent ("economic surplus") for the current period extraction are calculated.
- The expected future unit resource rent is determined.
- The expected resource rents in all future years are calculated from expected future physical extraction and expected future unit resource rent.
- Total net present value is calculated by adding up all future resource rents discounted to present period value.

These steps are further described in the following sections.

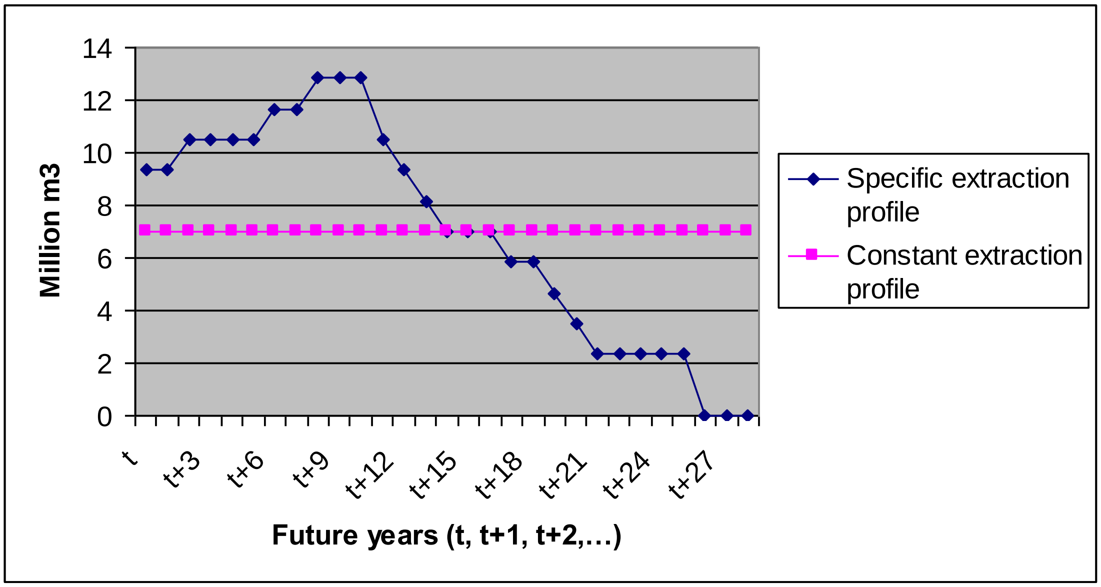
2. Future extraction profile

4.33. The first step is to determine the profile for the future extraction. If profiles are available from experts, energy agencies, geological institutes, etc. these profiles should be used. Care should be taken to ensure that the extraction profile is consistent with the moderate (best) estimate of the commercial recoverable resources. Thus, the sum of future year's extraction should be equal to the moderate (best) estimate of the quantity of class *A.* Commercial Energy Resources as shown in the physical asset account, cf. chapter 3.

4.34. If no information on the expected resource extraction profile is available, a profile may be constructed by assuming that the extraction will be constant at the current level until the resource extraction stops. Alternatively, for instance, the extraction may be assumed to be constant until a certain point and linearly decreasing after that point and until all economic energy resources are extracted.

4.35. Figure 4.1 shows examples of such extraction profiles. In both cases the area under the curves i.e. the total amount of energy resources extracted, should correspond to the physical opening stock of commercial energy resources as presented in Table 3.2.

Figure 4.1 Future extraction profiles for an energy resource



Note: The total extraction (corresponding to the areas under the corves should be equal to the total quantity of economic energy resources as presented in table 3.3

3. Actual resource rent and per unit resource rent

4.36. When a given quantity of any energy resource, for instance crude oil, have been extracted and is ready for sale by the extractor, the appropriate price to use for valuation of the extracted resources is the observable market price of one unit of the energy product. However, when it comes to valuation of the corresponding quantity of energy *before* it is extracted, this market price overestimates the price of energy resources in the ground. This is because the market price of an energy product ready for sale above ground also covers all the costs of the extraction. Generally, one would expect that the price above ground is equal to the price in ground plus any cost involved in bringing the energy resources to the surface and prepare it for sale.

4.37. The energy resources in ground are seldom exchanged on the market, and their values are normally not observable. In contrast, prices/values of energy products and the costs of extractions are often observable. By assuming that the price above ground is equal to the subsoil price plus the extraction costs it is, however, possible to calculate the price of the resource in ground.

4.38. The value of the resource in ground is called *resource rent*. The resource rent is calculated by subtracting all extraction costs from the total output of products, i.e. the extracted energy resources. The extraction costs should in addition to intermediate consumption, compensation of employees and relevant taxes, net also include the costs of holding and using fixed capital such as platforms, buildings and equipments.

4.39. Often the value of output (or operating surplus) and most of the costs data can be obtained from the national accounts of the extraction industry. Care must be taken to ensure that the national accounts data for the extraction industry does not include secondary activities, which have no direct reference to extraction activities itself. In addition, care must be taken to ensure that the resource rent does not end up including any so-called specific taxes (see below). Due to this, most often it may be necessary to consult more detailed national accounts data compared to what is normally published.

Box 4.1. Calculation of resource rent and per unit resource rent

Resource rent
= Output
- Intermediate consumption
+ Specific taxes less subsidies on products
- Compensation of employees
- Non-specific other taxes less subsidies on production
- Consumption of fixed capital
- Return to fixed capital

= Gross operating surplus
+ Specific taxes less subsidies on products
+ Specific other taxes less subsidies on production
- Consumption of fixed capital
- Return to fixed capital

= Net operating surplus
+ Specific taxes less subsidies on products
+ Specific other taxes less subsidies on production
+ Return to fixed capital

Per unit resource rent
= Resource rent / Quantity of resources extracted.

4.40. The resource rent represents the total value of the economic energy resources, while the *per unit resource rent* is obtained by dividing the resource rent by the total physical quantity of the commercial energy resources. The per unit resource rent can be taken to represent the price of the energy resources in ground. The calculation principle for the two items is presented in Box 4.1.

4.41. The specific items used for the resource rent calculation are:

Output is the value of the extracted energy resources above ground at the wellhead or mine. The output is measured at basic prices, i.e. excluding all taxes and subsidies on products and trade and transport margins related to transport and delivery from the wellhead or mine to the buyer.

Intermediate consumption is the value of products used by the extraction industry. The intermediate consumption is valued at purchasers' prices i.e. including trade margins and all taxes and subsidies, on products.

Specific taxes and subsidies on production are instruments which the government uses to partly appropriate or subsidise, respectively, the resource rent. Since they are in fact representing an income distribution specifically related to the extraction industry the calculation of resource rent should, by convention, be neutral in relation to these specific distributional transactions. They are divided into specific taxes and subsidies on products and specific other taxes and subsidies on production.

Non-specific taxes and subsidies on production, on the other hand, apply to all industries and not only the extraction industry. Although, they are also transactions redistributing income, they are in SEEA-E seen as general costs of production, which apply to all, or most, industries. They are divided into non-specific taxes and subsidies on products and non-specific other taxes and subsidies on production.

Since intermediate consumption at purchasers' prices includes all taxes and subsidies on products, the resource rent is being affected by the *specific taxes and subsidies on products* when intermediate consumption is subtracted from the output. Therefore, it is necessary to add them back to the resource rent in order not to let them influence the estimation of the resource rent. One could say that first they are subtracted (together with intermediate consumption) and then they are added back.

Non-specific other taxes and subsidies on production are, as described, considered general costs of production applying to all or most industries and they should therefore be subtracted from the output when resource rent is calculated.

Compensation of employees is the value of labour services. If some persons are self-employed in the extraction industry, an estimate of the value of their labour services should be added to the compensation of employees.

Consumption of fixed capital applies to all fixed capital used in production, including mineral exploration and evaluation activities. Also consumption of fixed capital related to any terminal costs, cf. section G should be included.

Return to the fixed capital reflects the cost of having capital tied up in platforms, buildings, transport equipment, mineral exploration and evaluation etc. The return to fixed capital is sometimes also interpreted as that part of the operating surplus, which can be attributed to the use of the fixed assets in the process of extracting the energy. Any terminal costs incurring at the end of the life time of the fixed assets are not taken into account, cf. Section I.

The quantity of resources extracted is the amount of resources extracted in the current year in focus. The total resource rent for the same year is divided by this quantity in order to get the per unit resource rent, i.e. the price of the commercial energy resources in ground.

4.42. Instead of departing from the output, the resource rent may be calculated by starting from the national accounts' aggregates *gross* or *net operating surplus* for the extraction industry and then subtract or add the appropriate remaining cost items to obtain the resource rent as seen in Box 4.1. This follows immediately from the fact that the gross operating surplus, by definition, is obtained by deducting intermediate consumption, compensation of employees, and all taxes and subsidies on production from the output. Further, net operating surplus is obtained by deducting consumption of fixed capital from the gross operating surplus.

4.43. When the starting point is the gross or net operating surplus which excludes all taxes and subsidies on production it is necessary to add back both specific taxes and subsidies on products and specific other taxes and subsidies on production in order to ensure that the size of resource rent is unaffected by the specific taxes and subsidies.

4.44. Table 4.4 presents an actual calculation of resource rent and per unit resource rent. The quantities of output corresponds to extraction of economic energy resources, cf. Table 3.3. The monetary information can often be obtained from the national accounts. More information on this is presented in Chapter 6, Section F. It should be noted that in Chapter 6 two versions of the resource rent are calculated, one excluding adjustments for specific taxes and subsidies, and the other is the adjustments. It is the latter version that is presented in the present chapter.

Table 4.4 Resource rent calculation

	Extraction of energy resources
	currency units
Output	**60 744**
- Intermediate consumption	6 487
+ Specific taxes and subsidies	100
- Compensation of employees	802
- Non-specific other taxes and subsidies on production	- 17
- Consumption of fixed capital	5 084
- Return on fixed capital	5 519
= Resource rent	**42 969**
Quantities of output, million m^3	20
Per unit resource rent (currency units per million m^3)	**2 148**

4. Future per unit resource rents

4.45. In order to calculate the future income associated with the future physical extraction, the expected future per unit resource rent must be determined. 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.

4.46. The simplest assumption is that the resource rent will be the same in constant price terms in all future years. The starting point is the unit resource rent for the most recent year available, calculated according to the principles described in the previous section.

4.47. However, the unit resource rent for subsoil assets varies typically quite much from one year to the next since the prices of energy products, for instance oil, rises faster or slower than the costs of extraction. To smooth out the short term fluctuations in resource rents, it may therefore be appropriate to use a weighted average of previous years per unit resource rents, when the expected future resource rent is determined.

4.48. Assuming that the accounting takes place at the beginning of period t and that estimates of the per unit resource rents in previous periods t-1, t-2 and t-3 is available, for instance, a three-year weighted average unit rent, p^w_t, may be calculated the following way:

$$p^w_t = 0.5 * rr_{t-1} + 0.3 * rr_{t-2} + 0.2 * rr_{t-3}$$

where rr_i refers to the realized per unit resource rent in period i (i=t-1, t-2, t-3), measured at constant period t prices. The per unit resource rent in period t-1 is given the weight 0.5 while the per unit resource rents in the two previous periods are given the weights 0.3 and 0.2, respectively. Using decreasing weights corresponds to the assumption that the nearest years influence the expectations most.

4.49. This weighted average of previous periods' per unit resource rents may be used at the beginning of period t as a measure of the expected per unit resource rent for period t and all future years:

$$p^w_t = p_t = p_{t+1} = p_{t+2} = \ldots$$

4.50. Note that these future per unit resource rents all are measured at the period t-1 price level.

4.51. The three-year weighted average can be used as a default in order to ensure consistency between different energy asset accounts. An alternative to using the three year weighted average unit resource is to make projections, building on assumptions about the likely future evolution of revenues and costs included in the resource rent calculation. If reliable projections are available they should be preferred for the weighted average mentioned above.

Table 4.5 Calculation of expected future per unit resource rent

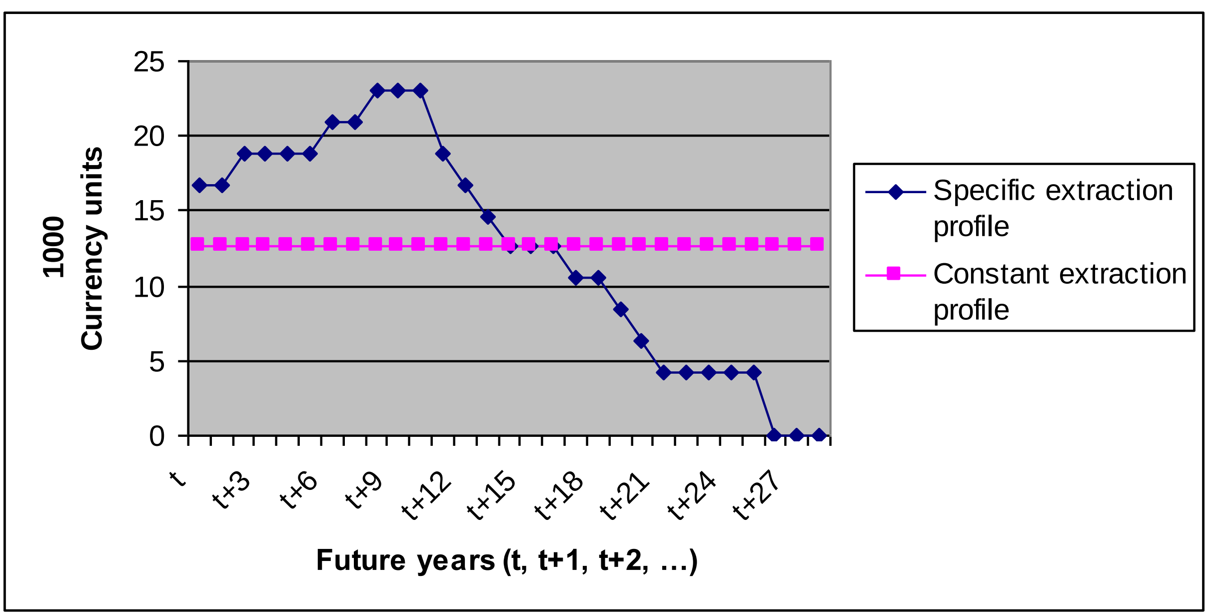
	Year t-3	Year t-2	Year t-1	Year t, t+1, t+2, …
	Currency units (constant year t-1 prices)			
Output	33 217	45 917	60 744	
- Intermediate consumption	6 118	6 362	6 487	
+ Specific taxes and subsidies	87	95	100	
- Compensation of employees	742	779	802	
- Non-specific other taxes and subsidies on production	- 16	- 17	- 17	
- Consumption of fixed capital	4 509	4 848	5 084	
- Return on fixed capital 1)	4 859	5 264	5 519	
= Resource rent	17 091	28 776	42 969	
Quantities of output, million m^3	14	18	20	
Per unit ressource rent (currency units per million m3)	**1 221**	**1 599**	**2 148**	
Weight	0,2	0,3	0,5	
Weighted per unit ressource rent (currency units per million m3)	244	480	1 074	**1 798**

5. *Total future resource rents*

4.52. Having established the expected profile for future physical extractions and the expected future resource rents it is straightforward to calculate how much resource rent in total that will accrue in each of the future years until the resource extraction stops.

4.53. This is done by multiplying the physical extraction in the year by the per unit resource rent. If the per unit resource rent is held constant over time, the profile of expected total future resource rents is exactly the same as the profile of the physical extraction, although the level and units are different.

Figure 4.2 Future resource rents (at constant per unit resource rents)



4.54. Once the yearly resource rents have been calculated, they have to be discounted back to the reference year. The background for this is that a given next year income is considered to be worth less than the same income this year, and the difference in value is reflected by the discount rate. A discount rate at e.g. 4 per cent means that $104 next year corresponds to $100 this year. The rationale for discounting is described further below.

4.55. Having discounted the future resource rents, they can be added up to a total net present value of the future extraction, which then is assumed to correspond to the value of the total quantity of economic energy resources.

4.56. Assuming that the income from the extraction falls in the beginning of the year, the value of the opening stock in year t can be calculated as:

$$V^{opening}{}_t{}^b = (p_t e_t) + (p_{t+1} e_{t+1}) / (1+r)^1 + (p_{t+2} e_{t+2}) / (1+r)^2 + \ldots + (p_{t+n} e_{t+n}) / (1+r)^n$$

4.57. If, more realistically, we assume that the income in a given year is spread over the year and we assume that on average all the income falls in the middle of the year, each of the yearly incomes have to be discounted half a year in addition to the discounting already done. The formula for calculating the opening stock in year t is then:

$$V^{opening}{}_t =$$

$$[1/(1+r)^{0.5}]*[(p_t e_t) / (1+r)^0 + (p_{t+1} e_{t+1}) / (1+r)^1 + (p_{t+2} e_{t+2}) / (1+r)^2 + \ldots + (p_{t+n} e_{t+n}) / (1+r)^n]$$

This can also be written

$$V_t^{opening} = \frac{1}{(1+r)^{0.5}} \sum_{i=t}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t}}$$

where

$V^{opening}{}_t$ is the value of the resource at the beginning of period t.

p_i, i = t , … , n is the unit resource rent at period i as expected at the beginning of period t.

e_i , i = t , … , n is the physical extraction of the resource taking place during period i as expected at the beginning of period t.

r is the discount rate.

n is the number of periods in which extraction take place.

4.58. Table 4.6 presents the calculation of the value of the economic energy resources as the present value of the future resource rents. The table includes to alternative calculations, one using a specific extraction profile, and one using a constant extraction profile (cf. Figure 4.1). In both cases the per unit resource rent from Table 4.5 and a discount rate at 4 per cent per year is used. It is assumed that the at average the resource rent falls in the middle of the year, and all resource rent is discounted back to the beginning of year t (following the formula for $V^{opening}_t$ given above).

4.59. In the fictitious case presented in Table 4.6 a somewhat lower opening stock value is estimated when the constant extraction profile is used compared to when the specific extraction profile is used. In the latter case relatively larger quantities of energy resources are extracted in the first years, and since the corresponding resource rents are discounted less than resource rents which falls in later years a higher present value of the resource rents is obtained. The example shows that it is important that care is taken when the extraction profile used for the estimation is determined, since realistic extraction profiles increases the reliability of the stock value estimates.

Table 4.6 Calculation of the value of economic energy resources

	Specific extraction profile					Constant extraction profile				
	1. Specific extraction profile	2. Per unit resource rent	3.Un-discounted resource rent (=1*2)	4. Discount factor (4 per cent per year)	5. Present value of ressource rent (=3*4)	1. Specific extraction profile	2. Per unit resource rent	3.Un-discounted resource rent (=1*2)	4. Discount factor (4 per cent per year)	5. Present value of ressource rent (=3*4)
Year	Million m3	Currency units/ Million m3	Currency units		Currency units	Million m3	Currency units/ Million m3	Currency units		Currency units
t	9	1 798	16 781	0.98	16 455	7	1 798	12 586	0.98	12 342
t+1	9	1 798	16 781	0.94	15 823	7	1 798	12 586	0.94	11 867
t+2	11	1 798	18 879	0.91	17 116	7	1 798	12 586	0.91	11 410
t+3	11	1 798	18 879	0.87	16 457	7	1 798	12 586	0.87	10 972
t+4	11	1 798	18 879	0.84	15 824	7	1 798	12 586	0.84	10 550
t+5	11	1 798	18 879	0.81	15 216	7	1 798	12 586	0.81	10 144
t+6	12	1 798	20 977	0.77	16 256	7	1 798	12 586	0.77	9 754
t+7	12	1 798	20 977	0.75	15 631	7	1 798	12 586	0.75	9 379
t+8	13	1 798	23 074	0.72	16 533	7	1 798	12 586	0.72	9 018
t+9	13	1 798	23 074	0.69	15 897	7	1 798	12 586	0.69	8 671
t+10	13	1 798	23 074	0.66	15 285	7	1 798	12 586	0.66	8 338
t+11	11	1 798	18 879	0.64	12 025	7	1 798	12 586	0.64	8 017
t+12	9	1 798	16 781	0.61	10 278	7	1 798	12 586	0.61	7 709
t+13	8	1 798	14 684	0.59	8 647	7	1 798	12 586	0.59	7 412
t+14	7	1 798	12 586	0.57	7 127	7	1 798	12 586	0.57	7 127
t+15	7	1 798	12 586	0.54	6 853	7	1 798	12 586	0.54	6 853
t+16	7	1 798	12 586	0.52	6 589	7	1 798	12 586	0.52	6 589
t+17	6	1 798	10 488	0.50	5 280	7	1 798	12 586	0.50	6 336
t+18	6	1 798	10 488	0.48	5 077	7	1 798	12 586	0.48	6 092
t+19	5	1 798	8 391	0.47	3 905	7	1 798	12 586	0.47	5 858
t+20	4	1 798	6 293	0.45	2 816	7	1 798	12 586	0.45	5 633
t+21	2	1 798	4 195	0.43	1 805	7	1 798	12 586	0.43	5 416
t+22	2	1 798	4 195	0.41	1 736	7	1 798	12 586	0.41	5 208
t+23	2	1 798	4 195	0.40	1 669	7	1 798	12 586	0.40	5 007
t+24	2	1 798	4 195	0.38	1 605	7	1 798	12 586	0.38	4 815
t+25	2	1 798	4 195	0.37	1 543	7	1 798	12 586	0.37	4 630
t+26						7	1 798	12 586	0.35	4 451
t+27						7	1 798	12 586	0.34	4 280
t+28						7	1 798	12 586	0.33	4 116
Total quantity extracted	203					203				
Total undiscounted value			364 994					364 994		
Total discounted value of economic energy ressource (opening stock year t)					**253 450**					**217 990**

F. Additional issues related to the valuation of stocks of energy resources

1. Allocating the resource rent to specific types of products resulting from combined production

4.60. Sometimes extraction takes place as a combined process in which more than one type of energy resources are extracted by the same extraction process. In such cases it is necessary either to set up the asset accounts for the energy resources as a whole, or to allocate all inputs and outputs related to the extraction process to the different energy resources involved.

If for example oil and gas are extracted in combination one possibility is to calculate the total resource rent for and the total quantity of oil and gas at a common unit, e.g. standard oil equivalents. The other possibility is to split the resource rent is described further below, and keep the quantities of oil and gas separate.

4.61. The split of the resource rent is made made by dividing all the items used for the resource rent calculation into parts which reflects the share of the specific energy resources extracted through the combined process.

4.62. Information on the allocation of output is normally available since the various energy products are sold separately. In contrast, no information on the costs is normally available since, by nature, the extraction in this case takes place as a combined process. It is then necessary to apply assumptions in order to make the cost allocation. When no - or only partial - specific information about the distribution of the extraction costs between products is available the total costs or - some cost items - can either be allocated by the shares of physical output or by the shares of the value of output.

4.63. If the prices of the different energy products resulting from the combined extraction are the same, it doesn’t matter whether the allocation is made on the basis of quantities or values, the two options will lead to the same result. However, if the prices are different and there is no reason to assume that this is because extraction of one of the products uses more of the combined inputs, than the other(s), it seems more reasonable to use the physical output converted to a common energy unit as allocation key for the costs. If output prices are different, the use of physical output for allocation of costs means that the part of the combined energy resource which has the highest output price will also have the highest resource rent per unit of extracted energy resource.

4.64. The allocation of the costs of production by the distribution of outputs should, however, be used as the last option and only if no information on the cost allocation is available from companies or other experts.

2. Determining the return on fixed assets

4.65. The return to fixed capital reflects the cost of having capital tied up in platforms, buildings, transport equipment, mineral exploration and evaluation etc., and this cost is one of the components included in the resource rent calculation, cf. Section E.3.

4.66. The return to a fixed asset is that part of the operating surplus, which can be attributed to the use of the given asset in production. If only fixed assets are used in the production process, the net operating surplus represents exactly the return to the fixed assets. For extracting industries, however, a part of the operating surplus is assumed to come from the natural resources, and in such cases, it would be misleading to let the entire net operating surplus represent the return to the fixed assets. It would correspond to an assumption of zero resource rent (looking, for the moment, away from the specific taxes on production). See Chapter 6, Section F.4 for a further explanation.

4.67. Therefore, it is necessary to use other assumptions and methods to calculate a return on the fixed assets. Three approaches can in principle be used. They all focus on determining a rate of return on fixed assets, which can be multiplied by the net capital stock of fixed assets in order to estimate the total return to fixed assets.

4.68. In the first approach, the rate of return is determined as the ratio between net operating surplus and the fixed net capital stock in an industry, which do not extract natural resources, but which nevertheless is assumed to have similar performance characteristics as the extracting industry.

4.69. The second approach assumes that the interest rate on bonds issued by resource companies or the return on shares in resource industries reflects the rate of return. This 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 both returns on fixed capital and the resource, as well as being influenced by external factors in the market. Therefore, while the use of the interest rate on bonds seems appropriate as a proxy for estimating returns on capital, the use of return on shares does not.

4.70. 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 fixed capital in the accounts. The disadvantage with the use of the long-term government bond rate as an appropriate return to capital is that it is a riskless rate. The rate does not include a premium to cover the risk and uncertainty involved in extractive industry operations.

4.71. For SEEA-E it is recommended to use the second approach, i.e. to use the rate of return on corporate bonds issued by resource companies to derive the returns on capital in the particular industry under consideration. Where there are few corporate bonds issued, then either of the other approaches may be adopted provided an allowance is made to counter the deficiencies in the approaches.

4.72. More specifically, the following can be used as a point of departure when the return on fixed capital is calculated:

- It is recommended that the return on fixed capital used by the extraction industry is calculated as the value of the fixed capital multiplied by the rate of return on corporate bonds issued by the resource companies.
- If the latter is not available a rate of return on fixed capital of the general non-financial sector, excluding agriculture, etc. and the extraction industries can be used.
- Finally, as an alternative, an interest rate on long-term government bonds can be used. Since this rate does not include adequate risk premium in extractive industries the rate will probably be to low, and might be adjusted upwards.
- Sensitivity analysis should be carried out using different rates of return to the fixed asset, e.g. 4, 6 and 8 per cent. The values of the energy resource by different rates of return should be presented together with the basic estimate.

4.73. If the net present value calculations are carried out based on future resource rent measured at constant prices, care must be taken to that the rate of return on capital is a real rate excluding the general level of inflation.

3. Determining the discount rate

4.74. The discount rate reflects a time preference, namely the preference of an asset’s owner for income today rather than in the future and also the owner’s attitude towards risk

4.75. If extraction takes place over a long time horizon, the choice of rate used for discounting future resource rent back to present value has significant impact on the resulting value of the energy resource. A higher discount rate assigns lower present values to future resource rents and result in a lower resource value, while a lower discount rate assigns higher present values to the future resource rents and result in a higher energy resource value.

4.76. Theoretically two arguments can be used for discounting. The first theoretical argument is utility/pure time preference: People think it is worth more to obtain something (utility) now than in the future because they are impatient. The second theoretical argument is the diminishing marginal utility of consumption: Income and consumption is expected to grow while the utility of one unit of extra consumption at the same time decrease.

4.77. It is often assumed that the discount rate is revealed and observable at the market, for instance through the interest rent of the capital market, since this is likely to reflect the time preference of investors.

4.78. It can be argued that if all assets are identified and measured accurately, and if perfect competition prevails, 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. However, since it cannot be assumed that perfect competition actually prevails and that markets are perfect, some difference between the return to capital and the discount rate is not unlikely.

4.79. For SEEA-E a market-based discount rate should be used. Such a rate can be assumed to be higher than a socio-economic discount rate. While impatience is relevant for individual firms it is doubtful whether it should be used in relation to socio-economic analysis. Societies do to a lesser extent take the impatience of individuals into account. Furthermore, the market does not take external costs of e.g. pollution into account, and the attitude towards risk is often different at business level and at government level. For these reasons, a higher market oriented discount rate compared to a socio-economic discount rate should be expected.

4.80. By nature, the discount rate is non-observable and therefore it always has to be determined based on assumptions and judgements. However, the following general recommendations can be made in relation to SEEA-E:

- The discount rate should be market oriented (as opposed to a lower socio-economic discount rate)
- The discount rate should be based on market observations. In practice a capital market interest rate before tax may be used.
- The discount rate may differ from the rate of return on capital, due to imperfect markets. However, wide and persistent differences between the two rates should be examined for plausible explanations.
- If the net present value calculations are carried out based on future resource rents at constant prices care must be taken to ensure that the discount rate is a real rate, and that the general level of inflation has been excluded.

4.81. When the discount rate has been determined and the value of the resource has been estimated based on the NPV method, it is recommended that a sensitivity analysis is carried out. Thus, the value of the energy resource should be carried out using different discount rents. The values of the energy resources at different discount rates should be presented together with the basic estimate. Table 4.7 presents an example. In addition to the 4 per cent discount rate, which was used for the calculations presented in Table 4.6, discount rates at 2 and 6 per cent have been used. It is clear that, as expected, a lower discount rate leads to a higher value of the energy resources, while a higher discount rate leads to a lower stock value.

Table 4.7 Sensitivity analysis – The value of economic energy resources at different discount rates

	2 per cent discount rate	4 per cent discount rate	6 per cent discount rate
	Currency units		
Value of opening stock year t	301 490	253 450	216 444

G. Changes between opening and closing stocks of natural resources

Valuation of the individual change items of the asset account

4.82. According to Section C the following change items of the monetary asset account for energy resources explains the difference between opening and closing stock of energy resources: a) acquisitions less disposals, b) Discoveries, c) Reappraisals (upwards), d) Depletion, e) Reappraisals (downwards) f) Catastrophic losses and uncompensated seizures, g) Changes in classifications and structure, and h) Holding gains and losses.

4.83. As in the case of the opening stock the changes in values are often not observable at any market, and an estimation of the changes in values must in practise also often rely on the net present value method.

4.84. In the following the use of the net present value method for estimation of changes in stock values is described. It should be noted, however, that if market values are directly observable, for instance in relation to acquisitions and disposals of energy resources, those values should be used for the recording instead.

4.85. A decomposition of the change in the stock value between the beginning and the end of a period may formally be deducted by subtracting the net present value formula for the closing stock (= next year opening stock) from the formula for the opening stock. Such a decomposition based on the net present value formulas shows that generally the change in value between opening and closing stock may be attributed to four factors: i) The extraction in the period valued at unit resource rent, ii) the change in value due to change in the unit resource rent, iii) the change in value due to changed extraction profile, and iv) an increase in value due to less discounting of the future resource rents because time have passed. The Annex shows the formal deduction of this result.

4.86. The formal decomposition of the changes in the net present values provides useful insight into the functioning of the net present value method and gives a theoretical background for the valuation of the change items of the asset accounts. However, in practice the theoretical decomposition of the changes into i)-iv) is not used directly. Instead, an applied version of the decomposition is used, which reflects the specific change items a) – d) of the asset accounts and, further, a specific convention on how to calculate the effect on the stock value of the physical removal of the energy resources, i.e. the depletion.

4.87. *First*, the depletion, i.e. the effect on the stock value of the physical removal of the energy resources is calculated as the change in the total net present value of future extractions under the assumption that that only changes due to the extraction takes place. Hereby, the increase in value due to less discounting of the future resource rents because time have passed, the so-called unwinding of the discounting, is attributed to the depletion.

4.88. *Secondly*, it is made explicit how the various changes due to discoveries, reappraisals, catastrophic losses, etc. in one period change the extraction in future periods in physical terms and the net present value of these future changes is consequently calculated.

4.89. *Thirdly*, other changes in stock value is calculated as a residual and attributed to the revaluation item of the asset account.

4.90. Table 4.8 shows the relation between the change items of asset accounts for energy resource and the factors which can be identified from the formula for the difference between the present value of the closing stock and opening.

Table 4.8 Stock changes in the asset accounts and the net present value method

Items for changes in the monetary asset accounts (cf. Table 4.2)		**Corresponding elements of formal decomposition based on net present value method (cf. Annex)**
Depletion (d)	A	Physical extraction valued at unit resource rent (i) Increase in value due to less discounting of the future resource rents (iv) + Practical adjustments
Acquisitions less disposals (a) Discoveries (b) Reappraisals (upwards) (c) Reappraisals (downwards) (e) Catastrophic losses and uncompensated seizures (f) Changes in classifications and structure (g)	B	Change in value due to changed extraction profile (iii) + Practical adjustments
Holding gains and losses (h)	C	Change in value due to change in the unit resource rent ii) Change in value due to changed extraction profile, if stock neutral (iii) + Practical adjustments C = Closing stock - Opening stock - A - B

4.91. The next subsections describe the estimations and the linkages in more detail.

Depletion, the value of stock changes due to extraction

4.92. By convention, the depletion, i.e. the value of the stock change due to the extraction, is in SEEA-E measured as the total change in the stock value, which cannot be attributed to neither any of the other physical changes (and consequently changed extraction patterns) nor to revaluation effects due to changes in the resource rent in period t.

4.93. Assuming there are no changes in expected future extractions nor in expected future resource rents, the difference between the opening stock and the closing stock can formally be written as (cf. Annex):

$$V_t^{closing} - V_t^{opening} = -(1+r)^{0.5}\, p_t e_{t} + r V_t^{opening}$$

4.94. The interpretation of this formula is that the change in value between opening and closing stock consists of two factors. The first is a decrease due to the fact that the expected extraction in period t, which was included in the calculation of the opening stock, is not included in the calculation of the closing stock. The second is an increase in the value because all future resource rents are discounted one period less. The total value of this latter effect is $rV_t^{opening}$.

4.95. This formula does use the unit resource rent, p_t, and extraction, e_t, as expected at the beginning of period t. Further, the formula multiply the resource rent by the discounting factor $(1+r)^{0.5}$ because the left hand side relate to the difference between opening and stock values while the resource rent is assumed to fall in the middle of the period.

4.96. However, when the asset account for a period t, is set up, information about the realized extraction and per unit resource rent in period t is often available, and in addition, it seems appropriate to consider the depletion as referring to the middle of period t. Thus, instead of using the above formula directly, the depletion is, by convention, defined in SEEA-E by the following:

$$\text{Depletion} = -rr_t e'_t + rV_t^{opening}$$

Where rr_t denotes the realized per unit resource rent, and e'_t the realized extraction in period t.

4.97. The difference between the two above expressions is

$$\begin{aligned}
(V_t^{closing} - V_t^{opening}) - \text{Depletion} &= rr_t e'_t - (1+r)^{0.5} p_t e_t \\
&= (1+r)^{0.5} rr_t e'_t - (1+r)^{0.5} p_t e_t + (1-(1+r)^{0.5}) rr_t e'_t \\
&= (1+r)^{0.5} (rr_t e'_t - rr_t e_t + rr_t e_t - p_t e_t) + (1-(1+r)^{0.5}) rr_t e'_t \\
&= (1+r)^{0.5} (rr_t - p_t) e_t + (1+r)^{0.5} rr_t (e'_t - e_t) + (1-(1+r)^{0.5}) rr_t e'_t
\end{aligned}$$

4.98. The first of these elements can be interpreted as a difference caused by the fact that the measure of depletion uses realized unit resource rent, rr_t, while the gap between opening and closing stock values is measured from the expected resource rent, p_t. The second element reflects a difference caused because the depletion measure uses realized extraction, e'_t, instead of the expected extraction, e_t. Finally, the third element is related to the fact that the depletion is valued at average (mid-period) prices while the opening and closing stock is valued at the beginning and the end of the period, respectively.

4.99. In order to keep the accounting identities and to get an exhaustive accounting for the changes between opening and closing stock it is necessary to add these differences by allocating them to the other accounting items in the asset accounts. By convention, the second element related to the difference between expected and realized extraction is attributed specifically to the reappraisal item, cf. below, since it often has its origin in a changed assessment of the resources available. In contrast, the two other elements are implicitly attributed to the revaluation item.

Table 4.X < Table with example >

Interpretation of the measure of depletion

4.100. Depletion, i.e. the change in the value of the asset as a result of the physical removal and using up of the asset, relate to the total change in the value of the stock from the beginning of the period to the end of the period assuming that the only change in the physical resource comes from the extraction.

4.101. This change in the stock values is calculated as a difference between two elements: the actual resource rent, $rr_te'_t$ and the value of the opening stock multiplied by the discount rate, $rV_t^{opening}$.

4.102. The second element comes from the fact that the stock value increases during the period because all future resource rents, p_ie_i, moves one period closer, and thus are discounted one period less. This increase in the value due to the one period less discounting is subtracted from the decrease in the stock value related to the resources extracted in the period, i.e. the resource rent, in order to obtain the total change in the stock value, which would have occurred if no changes in extraction patterns and resource rents had taken place.

4.103. A further interpretation of the formula for the depletion can be made by rearranging it slightly into:

$$rr_te'_t = -\text{Depletion} + rV_t^{opening}$$

4.104. The resource rent of the period is now divided into an element corresponding to the depletion (with opposite sign) and rV_t, which can be interpreted as a return to the natural capital. In other words, the surplus of the extraction activity, i.e. the resource rent, corresponds exactly to what is needed to compensate for the depletion and in addition give an income (return to natural resource) corresponding to $rV_t^{opening}$.

4.105. By defining depletion as the total change in the value of the asset, i.e. including the effect on the stock value of the one period less discounting, depletion is in principle measured in exactly the same way as consumption of fixed capital. It follows from the characterisation of the measurement of consumption of fixed capital and by the description of the capital service theory presented in SNA 2008 Chapter 6 and 20, respectively.

> … Consumption of fixed capital is measured by the decrease, between the beginning and the end of the current accounting period, in the present value of the remaining sequence of expected future benefits. … (SNA 2008, 6.246)

4.106. Under certain conditions a strict application of the above formula for depletion will lead to a depletion which is positive, i.e. the effect of the resource extraction is that the value of the resource stock increases. This happens if the resource stock value (and thus the $rV_t^{opening}$ element) is big compared to the resource rent. This means that while a physical extraction always decreases the physical stock, the corresponding depletion can be either positive, zero or negative depending on the relative size of the two elements included in the calculation.

4.107. Chapter 6 on the monetary flow accounts presents further description of the interpretation of the depletion, and how depletion enters the so-called depletion-adjusted accounts for generation and allocation of income.

Valuation of physical stock changes except extraction

4.108. In the monetary asset accounts for energy assets all the change items except the depletion item and the revaluation item (holding gains and losses) may be valued based on the change in the physical amount of resources underlying the asset.

4.109. When it comes to valuation of these physical changes, the principle is the same as used for valuing the stocks, i.e. to calculate the net present value of the expected future extraction. However, since it is change items, which are in focus, it is now the net present value of the *changes* in future extraction, which is calculated.

4.110. First it is made explicit how the various stock changes due to acquisitions less disposals,, discoveries, reappraisals (upwards and downwards), catastrophic losses and uncompensated seizures, and changes in classifications and structure in year t affect the extraction in future periods (t+1, t+2, etc.). Let the term C_g denote the change in period t (in physical units) due to one of the mentioned reasons, denoted by g, and let $c_{g,i}$ denote the subsequent change (in physical units) in expected extraction in period i (i=t+1,…,t+h) due to reason g, where h is the last period in which a change in the extraction takes place. Then we have:

$$C_g = \sum_{i=t+1}^{t+h} c_{g,i}$$

4.111. The effect on the period t opening stock value of the physical change C_g - at the period t per unit resource rent - is then obtained by calculating the net present value of the corresponding changes in future extractions.

$$V(C_g) = \frac{1}{(1+r)^{0.5}} \sum_{i=t+1}^{t+h} p_i c_{g,i} \frac{1}{(1+r)^{i-t}}$$

4.112. It is the per unit resource rents as expected at the beginning of period t, which is used for the valuation of the physical changes. The effect of any changes in unit resource rents during period t are entirely attributed to the revaluation item, cf. below.

4.113. This formula can be used to value the separate effects of acquisitions less disposals, discoveries, reclassifications/reappraisals, catastrophic losses and uncompensated seizures, as well as changes in classifications and structure if it is known (or rather expected/assumed) how these changes affect the future extraction.

4.114. Acquisitions less disposal, however, reflect actual changes in ownership during the period and transaction values should in principle be observable. If this is the case the market transaction values should be used in stead of the net present value method.

4.115. There is no reason a priori to assume that, for example, a discovery of a new oil deposit leads to a relative change in the future extraction profile in exactly the same way as for example a change due to catastrophic losses. A discovery of a new deposit may not affect the extraction profile before the end of the extraction period, while a catastrophic loss of an oil field where extraction already is ongoing probably may affect the extraction in the nearest years.

4.116. However, it should be recognized that information on how exactly the changes in the expected future extraction is caused by the different change items is often not available, and that assumptions then has to be made, for example that the effect on the extraction profile is the same for some or all of the change items. If no information is available at all, it can be assumed that the change will be proportional to the general extraction profile.

4.117. If no knowledge exists on how the extraction profile is influenced by the various change items, it may also be appropriate to merge the change items when it comes to the valuation and only show one or a few aggregates for them.

4.118. “Neutral” changes in the extraction profile may occur in addition to the changes in expected future extractions due to changes in the quantities in period t. Neutral changes are changes which are unrelated to the changes in the total extraction, but instead come from a reallocation of extractions from one period to another. Such neutral changes in the extraction profile is regarded as part of revaluations, cf. below. The value of neutral changes may be calculated explicitly by the formula above, but it is also included implicitly in the revaluation item when this is calculated as a residual, cf. below.

4.119. Further, in addition to the value changes caused by the change in physical extraction in future periods it is necessary to account for the difference between the expected extraction in period t, which are used in the calculation of the opening stock value, and the realized extraction, which are used in the calculation of the depletion, cf. above. The difference is as calculated above in the section on depletion:

$$\text{Additional reappraisals} = (1+r)^{0.5}\, rr_t (e'_t - e_t)$$

4.120. By convention this item is included as part of the reclassifications/reappraisals. If the realized extraction, e'_t, is smaller than the expected, e_t the appraisal will be downwards, and if the realized extraction is bigger than the expected, the reappraisal will be upwards.

Table < Table with example >

Revaluation

4.121. Changes between opening and closing stock caused by price changes are included in the revaluation item of the asset accounts. The revaluation comes partly from the difference between the unit resource rent, p_i, used for opening stock valuation at the beginning of period t and the unit resource rent, p'_i, used for closing stock valuation at the end of period. In addition, the difference between the expected resource rent in period t included in the opening stock value estimate and the realized resource rent included in the depletion has to be accounted for. If applicable, the net present value of neutral changes (cf. above) in the extraction profile should also be added to the revaluation. However, if all other, items are determined in the account, the simplest way to estimate the revaluation item is to calculate it as a residual.

4.122. The revaluation, RV_t, can then be calculated as:

$$RV_t = V_t^{closing} - V_t^{opening} - \sum_{s=1,..,7} V(C_s)$$

where $V(C_s)$, s=1,..,7, are the seven other items in the account: 1. Acquisitions less disposals, 2. Discoveries, 3. Reclassifications/reappraisals upwards, 4. Depletion, 5. Reclassifications/reappraisals downwards, 6. Catastrophic losses and uncompensated seizures, and 7. Changes in classifications and structure.

4.123. Table 4.8 presents a generic overview of the changes between opening and closing stock, how it affects the future extraction, and the general formulas for estimation of the corresponding values.

Revisions of the data used for the net present value calculations

4.124. Determination of expectations of future extractions and resource rents are always involved when the net present value method is used to calculate a stock value. In principle, the stock value should be valued based on the expectations, which was prevailing at the point in time for which the estimate of the stock value belongs. This means that, in principle, the opening stock value of e.g. 2005 should be based on the expectations that prevailed at the 1st January 2005, while the closing stock value should be based on the expectations prevailing at the 31st December 2005.

However, since the valuation often takes place at later points in time (e.g. the opening stock and closing stock of 2005 is calculated at the end of 2007) it is necessary to assume what the expectations were at the reference points. Further, it is possible that, as time goes by, other assumptions about the expectations at the reference points are introduced in the accounts. This could be the case, for example, because preliminary national accounts data are substituted for final national accounts data when the resource rent is calculated. Therefore, the opening and closing stock values for a given year may be revised due to changed assumptions about what the expectations were. These revisions are similar to revisions of national accounts data belonging to the some reference point, and should not be confused with changes in the accounts from opening to closing stock because of “real” events like new findings, price changes, etc.

Table 4.9. Physical stocks and changes and allocation by expected extraction year

Period	t	t	t+1	…	t+h		
	Quantities						Valuation
	Stocks (S) and changes in stocks (Cs)	Expected extraction (e) and changes in expected extractions (c)				Sum of expected extraction	
Opening stocks	$S_t^{opening}$	e_t (=expected extraction)	e_{t+1}	…	e_{t+h}	$S_t^{opening} = \sum_{i=t}^{t+h} e_i$	$V_t^{opening} = \frac{1}{(1+r)^{0.5}} \sum_{i=t}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t}}$
1. Acquisitions less disposals	C_1	$c_{1,t} = 0$	$c_{1,t+1}$	…	$c_{1,t+h}$	$C_1 = \sum_{i=t}^{t+h} c_{1,i}$	$V(C_1) = \sum_{i=t}^{t+h} p_i c_{1,i} \frac{1}{(1+r)^{i-t}}$ $V(C_1) \geq 0$ if $C_1 \geq 0$; $V(C_1) < 0$ if $C_1 < 0$
2. Discoveries	C_2	$c_{2,t} = 0$	$c_{2,t+1}$	…	$c_{2,t+h}$	$C_2 = \sum_{i=t}^{t+h} c_{2,i}$	$V(C_2) = \sum_{i=t}^{t+h} p_i c_{2,i} \frac{1}{(1+r)^{i-t}}$ $C_2 \geq 0$ and $V(C_2) \geq 0$
3. Reclassifications/ reappraisals upwards	C_3	$c_{3,t} = 0$	$c_{3,t+1}$	…	$c_{3,t+h}$ 3,t+h	$C_3 = \sum_{i=t}^{t+h} c_{3,i}$	$V(C_3) = \sum_{i=t}^{t+h} p_i c_{3,i} \frac{1}{(1+r)^{i-t}}$ if $e'_t <= e_t$ or $V(C_3) = \sum_{i=t}^{t+h} p_i c_{3,i} \frac{1}{(1+r)^{i-t}} + (1+r)^{0.5} rr_t(e'_t - e_t)$ if $e'_t > e_t$ $C_3 \geq 0$ and $V(C_3) \geq 0$
4. Depletion	$C_4 = e'_t$	$c_{4,t} = C_4 = e'_t$	$c_{4,t+1} = 0$	…	$c_{4,t+h} = 0$	$C_4 = \sum_{i=t}^{t+h} c_{4,i}$	Depletion $= V(C4) = -rr_t e'_t + r V_t^{opening}$ $C4 \geq 0$; Depletion ≤ 0 if $rV_t^{opening} \leq rr_t e'_t$ Depletion > 0 if $rV_t^{opening} > rr_t e'_t$
5. Reclassifications/ reappraisals downwards	C_5	$c_{5,t} = 0$	$c_{5,t+1}$	…	$c_{5,t+h}$	$C_5 = \sum_{i=t}^{t+h} c_{5,i}$	$V(C_5) = \sum_{i=t}^{t+h} p_i c_{5,i} \frac{1}{(1+r)^{i-t}}$ if $e'_t >= e_t$ or $V(C_5) = \sum_{i=t}^{t+h} p_i c_{5,i} \frac{1}{(1+r)^{i-t}} + (1+r)^{0.5} rr_t(e'_t - e_t)$ if $e'_t < e_t$ $C_5 \leq 0$ and $V(C_5) \leq 0$
6. Catastrophic losses and uncompensated seizures	C_6	$c_{6,t} = 0$	$c_{6,t+1}$	…	$c_{6,t+h}$	$C_6 = \sum_{i=t}^{t+h} c_{6,i}$	$V(C_6) = \sum_{i=t}^{t+h} p_i c_{6,i} \frac{1}{(1+r)^{i-t}}$ $C_6 \leq 0$ and $V(C_6) \leq 0$
7. Changes in classifications and structure	C_7	$c_{7,t} = 0$	$c_{7,t+1}$	…	$c_{7,t+h}$	$C_7 = \sum_{i=t}^{t+h} c_{7,i}$	$V(C_7) = \sum_{i=t}^{t+h} p_i c_{7,i} \frac{1}{(1+r)^{i-t}}$ $C_7 \leq 0$ and $V(C_7) \leq 0$
8. Revaluation	$C_8 = 0$	$c_{8,t} = 0$	$c_{8,t+1}$	-	$c_{8,t+h}$	$C_8 = \sum_{i=t}^{t+h} c_{8,i} = 0$	$RV_t = V_t^{closing} - V_t^{opening} - \sum_{s=1,..,7} V(Cs)$ $c_{8,t+i}$ are neutral changes in extraction (the value is implicitly included in the formula for RV_t)
Closing stocks	$S_t^{Closing}$		e'_{t+1}	…	e'_{t+h}	$S_t^{closing} = \sum_{i=t+1}^{t+h} e'_i$	$V_t^{closing} = \frac{1}{(1+r)^{0.5}} \sum_{i=t+1}^{t+m} p'_i e'_i \frac{1}{(1+r)^{i-t-1}}$
	$S_t^{Closing} = S_t^{opening} + \sum_{s=1}^{8} C_s$	e'_t (=actual extraction in period t)	$e'_{t+1} = e_{t+1} + \sum_{s=1}^{8} c_{s,t+1}$	…	$e'_{t+h} = e_{t+h} + \sum_{s=1}^{8} c_{s,t+h}$	$S_t^{closing} = S_t^{opening} + \sum_{s=1}^{8} C_i$	

H. Constant prices and volume measures

4.125. In order to facilitate analysis of the development in the value of energy resources over time, it is useful to apply so-called volume or constant price measures, which excludes the effect on the values caused by changes in the prices.

4.126. At least three approaches for constructing constant price measures of energy resources may in theory be applied, and they will generally lead to different measures of the energy resources. The three approaches are a) the single deflator approach, b) the double deflator approach, and c) the single extrapolation approach.

4.127. *The single deflator approach* obtains asset accounts at constant prices by deflating the items of the asset accounts for energy resources by a measure of the price development. Since the price is not observable a proxy for the price development, a price index, has to be used. The proxy could be a price index for similar energy product above ground, based on the assumption that there is a close link between the price of the energy resource in ground and above ground. In the case of an oil deposit, for instance, the deflation could be carried out using a price index for crude oil. Using the single deflator approach corresponds to assuming that the items of the accounts corresponds to a homogenous product (the energy resource in the ground), for which the value can be calculated simply as a quantity multiplied by a price.

4.128. *The double deflator approach* is closely linked to the use of the net present value method to estimate the energy resource values. It calculates the resource rent for a given year at base year prices by deflating each component of the resource rent calculation by a price index for that specific component. Thus, the output is deflated by a price for the specific product, while the various cost components are deflated by price indices reflecting the specific cost categories. After the time series of double deflated per units rents for each year have been calculated, the formulas given in Section F and G for present values are applied.

4.129. To the extent that, for instance, intermediate consumption and compensation of employees decrease relative to the output over time because of increasing productivity, the constant price values of one unit of energy resources will increase. Further, it will be higher according to this method compared with the constant price values obtained by the single deflator approach. While, at first glance, it seems counterintuitive that productivity gains end technological development over time should mean that the price of one unit of energy resources in ground is higher in year t+1 than in year t, it may be argued that in fact the prices refer to different products. An energy resource, which is easy and cheap to extract could be considered as another product than an energy resource, which is difficult and costly to extract, and therefore they have different prices. The technological development and the productivity gains are according to this interpretation external factors, which changes the character or quality of the energy resources. If this interpretation is applied, one can argue that the double deflated values for energy resources correspond to volume measures of the energy assets rather than to quantity measures. The latter concept includes a quality aspect in addition to the quantity aspect (cf. SNA 2008, 15.B).

4.130. To put this interpretation of the double deflated values for energy resources into perspective a similar interpretation of land values can be mentioned. The value of a piece of land depends, among other things, on its accessibility to the public infrastructure and whether it is located in a land zone or in a build up area. Therefore, the constant price value of the same piece of land may change over time if, for instance, the infrastructure close to the piece of land changes. Also in this case we would say that the quantity (the area) of the land is the same, but the volume (quantity and quality) of the land has changed.

4.131. *The single extrapolation approach* involves that all items of the asset accounts for all years are calculated from the formulas for present values by using the per unit resource rent of the base year instead of the per unit resource rent for the actual year at current prices. The single extrapolation approach corresponds in principle to the single deflator approach in the sense that it also assumes that the value of the asset can be expressed as the quantity multiplied by a price of a homogenous product.

4.132. A practical difficulty with the single extrapolation approach may arise since the unit rent is highly variable. There may be years when the price is negative or zero even when, for instance, the three years weighted price averaging (cf. Section E.4). If such a year were chosen as the base year, the value of asset would be zero for the entire time series.

4.133. It is clear that the three approaches to constant price valuation of the stock of energy resources and changes in them will provide quite different results, and that especially the double deflation approach will provide higher estimates than the two other approaches when technological development and productivity gains makes it cheaper to extract the energy resource.

4.134. If detailed price indices are available, it is recommended to use the double deflation approach to estimate the constant price values, since it leads to results which best reflects the volume concept of the SNA 2008. As a second best option the single deflator approach can be used if a good proxy for the price index of the energy resource is available.

I. Monetary asset accounts for inventories of energy products

4.135. Corresponding to the physical accounts for inventories of energy products, cf. Chapter 3, Table 3.4, monetary asset accounts for the inventories of energy products can be set up. All items included in asset accounts for inventories are included in the SNA 2008.

4.136. The monetary asset accounts for inventories show for each type of energy product the values of opening and closing stocks and the changes in-between.

Table 4.10 A monetary asset account for inventories of energy products

	1. Coal, coke,gas work gas and peat		2. Oil	3. Natural Gas	4. Electricity	5. Heat	6. Renewable fuels and waste	
	a) Coal, coke and peat	b) Gas work gas					a) Solid biomass and wastes	b) Liquid biofuels and biogas
	Currency units							
Opening stocks (LS)	**753**	**7**	**15 189**	**5 319**				
Changes due to transactions								
Changes in inventories (P52)	- 254		2 279	138				
Other changes in the volume								
Catastrophic losses and uncompensated seizures (K3 and K4)								
Other changes in inventories n.e.c. (K5)	22		- 430					
Changes in classifications (K6)								
Revaluation								
Holding gains and losses (K7)	17		516	207				
Closing stocks (LE)	**537**	**7**	**17 554**	**5 664**				

Note. Codes in parenthesis refer to the SNA 2008 classification and coding structure (K1 divided into K12 and K13)

4.137. The various accounting items are explained below (see also the explanation of the corresponding items of the physical asset accounts for energy products, Chapter 3, Section C). In most cases only the closing and opening stock (LS and LE) and the changes in inventories (P52) will be relevant to record.

Opening stocks (LS): The value of the inventories at the beginning of the year. It is equal to the value of the closing stock of the previous year.

Changes due to transactions

Changes in inventories **(P52):** measures the value of the entries of energy products into inventories less the value of withdrawals and less the value of any recurrent losses of energy products held in inventories during the accounting period. (cf. SNA 2008, 10.118). The recurrent losses include losses that normally take place and should be expected. *Changes in inventories* are also recorded in the monetary supply and use tables, cf. Chapter 6, Table 6.2

Other changes in the volume

Catastrophic losses and uncompensated seizures **(K3 and K4**). This item, records the effects on the value of inventories from earthquakes, volcanic eruptions, tidal waves, hurricanes, droughts, floods and other natural disasters as well as wars. Conflagration of oil in pipelines falls under this category. Uncompensated seizures rarely occur but could take place.

Changes in classifications **(K6)** involve no change in the value of the total inventories as such but relate mainly to the change of a unit from one institutional sector to another (e.g. the owner of the inventories moves from the household sector to the non-financial corporations sector). This is only relevant if the asset account is set up for individual institutional units, and not if the accounts is set up for the total economy. Also changes from work-in-progress to finished energy products may be recorded here if such a distinction between inventories of products is made in the accounts.

Other changes in inventories n.e.c. **(K5)** If the assumption about the value of normal shrinkage/recurrent losses of inventories is mistaken (cf. changes in inventories above) this should be corrected as other changes in inventories (cf. SNA 2008, 12.50).

Revaluation

Holding gains and losses is an item specific to the monetary asset accounts and an equivalent is not found in the physical assets accounts for inventories. It reflects the effect of price changes on the value of the inventories during the period, see also textbox.

Closing stocks (LE): The value of the inventories at the end of the year. It should be equal to the value of the opening stock of the subsequent year.

4.138. Box 4.2 includes an extract from SNA 2008 concerning the principle which should used for the valuation of inventories in general

Box 4.2. Valuation of inventories

Inventories should be valued at the prices prevailing on the date to which the balance sheet relates, and not at the prices at which the products were valued when they entered inventory. In the balance sheets, figures for inventories frequently have to be estimated by adjusting figures of book values of inventories in business accounts, as described in chapter 6 [of the SNA 2008].

As is the case elsewhere in the SNA, inventories of materials and supplies are valued at purchasers' prices, and inventories of finished goods and work-in-progress are valued at basic prices. Inventories of goods intended for resale without further processing by wholesalers and retailers are valued at prices paid for them, excluding any transportation costs that have been separately invoiced to the wholesalers or retailers and included in their intermediate consumption.

For inventories of work-in-progress, the value for the closing balance sheet should be consistent with the value of the opening balance sheet, plus any work put in place during the current period, less any work completed and reclassified as finished goods. In addition, an allowance for any necessary revaluation for changes in prices in the period must be included. As explained in chapter 6 and chapter 19 [of the SNA 2008], the time series of the value of work in progress put in place over a period of time should reflect the increase in value of work put in place earlier as the delivery date approaches.

Source: SNA 2008, 13.38-13.40

J. Asset accounts for other assets used by the extraction industries

4.139. In addition to the asset accounts for the energy resources it is useful to show explicitly asset accounts for other assets owned and used by the extraction industry for exploration, evaluation and exploitation of the energy resource. Equipment used for transportation of the energy products e.g. pipelines transporting the oil from the wellhead to the point of processing or sale at land should also be included if it is owned by the extraction industry.

4.140. Information on the assets used for the extraction and handling of the energy can be interesting in its own right but the information is also needed for the calculation of the consumption and return to fixed capital, which are part of the total extraction costs, and thus needed for the calculation of resource rent, cf. the section above on net present value calculations. See also Chapter 6, Section E and F.

4.141. Asset accounts for these types of assets are part of the SNA 2008. In principle all types of fixed assets and non-produced non-financial assets (except the mineral and energy resources) listed by the SNA 2008 could be used by the mining and quarrying industry, but in practice fixed assets like AN113 Machinery and equipment and AN1172 Mineral exploration and evaluation activities are often the most important.

Table 4.11 Other assets[1)] possibly used by the extraction industries

AN1 Produced non-financial assets

AN11 Fixed assets

AN111 Dwellings

AN112 Other buildings and structures

AN113 Machinery and equipment

AN114 Weapons systems

AN115 Cultivated biological resources

AN116 Costs of ownership transfer on non-produced assets

AN117 Intellectual property products

Of which AN1172 Mineral exploration and evaluation

AN2 Non-produced non-financial assets

AN21 Natural resources

AN211 Land

AN213 Non-cultivated biological resources

AN214 Water resources

AN215 Other natural resources

AN22 Contracts, leases and licences

AN221 Marketable operating leases

AN222 Permissions to use natural resources

AN223 Permissions to undertake specific activities

AN224 Entitlement to future goods and services on an exclusive basis

AN23 Purchases less sales of goodwill and marketing assets

1) Included are fixed assets and non-produced non-financial assets other than AN212 Mineral and energy. Not included are AN12 Inventories and AN13 Valuables.

Source: SNA 2008 Annex 1 section B.4.

Table 4.12 SNA 2008 asset account for other assets[1)] owned by the mining and quarrying industry

	Total	AN11 Fixed assets	*Of which: AN1172 Mineral exploration and evaluation*	*Terminal costs (part of AN116)*	AN2 Non-produced non-financial assets 1)	*Of which: AN22 Contracts, leases and licenses*
	Currency unit					
Opening stock	**68 987**	**54 967**	***43 900***		**14 020**	***14 020***
Total changes in assets	**11 514**	11 514	*4 008*			
Of which						
Gross fixed capital formation (P51g)	**5 399**	5 399	*3 027*			
Consumption of fixed capital (P51c)	**-1 117**	-1 117	*- 875*			
Acquisitions less disposals of non-produced assets (NP)	**300**	300	*413*			
Other changes in the volume of assets						
Revaluation						
Closing stock	**85 083**	**71 063**	***50 473***		**14 020**	***14 020***

1) Excludes commercial energy resources

4.142. The asset accounts for other assets used by the extraction industries, Table 4.7, are presented in a short form in which the item *Other changes in the volume of assets* is an aggregate. It includes the various items belonging to the SNA 2008 Other changes in the volume of assets account, for instance, economic appearance and disappearance of assets (K1 and K2) and catastrophic losses (K3) (cf. SNA 2008, Annex 2).

Mineral exploration and evaluation

Mineral exploration and evaluation consists of the value of expenditures on exploration for energy resources and subsequent evaluation of the discoveries made. Mineral exploration and evaluation activities include (cf. SNA 2008, 10.106) activities such as:

- Pre-licence costs
- Licence and acquisition costs
- Appraisal costs and the costs of actual test drilling and boring
- Costs of aerial and other surveys
- Transportation costs, etc., incurred to make it possible to carry out the tests

4.143. Exploration and evaluation activities may be undertaken on own account by enterprises engaged in the extraction of energy resources. Alternatively, specialized enterprises may carry out the exploration and evaluation and sell the information to the extracting enterprises. Anyhow, the knowledge 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 not as intermediate consumption, but instead as expenditures on the acquisition of an intellectual property product and included as gross fixed capital formation of the enterprise, which acquires the knowledge. (SNA 2008, 10.107). The values of the stocks, capital formation and consumption of the asset, etc. are thus included in the asset accounts as a specific item, AN1172.

4.144. It should be noted, that although it can be argued that the value of an energy asset is closely linked or rather dependent of mineral and exploration activities the energy asset and the exploration and evaluation asset is seen as two separate assets, the former as a non-produced and the latter as a produced fixed asset. This does also mean that the value of the exploration and evaluation as an 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. When the activities are carried out by contractors the prices charged by these contractors, including their operating surplus, become part of the value of the expenditures incurred (SNA 2008, 10.108).

Terminal costs

4.145. In the case of some significantly large and important fixed assets, such as oil rigs and other mining equipment, there may be major costs associated with the decommissioning (dismantling and removal) of the asset at the end of its productive life. Similarly, there may be costs to restore the environment when a mining facility is closed down. These costs are called terminal costs, and they are according to SNA 2008 classified as part of costs of ownership transfer (SNA 2008, 10.51). Costs of ownership transfer (AN116) are in turn regarded as gross fixed capital formation (AN116).

4.146. According to SNA 2008 terminal costs leads to the creation of a fixed asset which has to be recorded as gross fixed capital formation (P5g) in the asset accounts. Similarly, the asset account should in each period reflect a consumption of this fixed asset (P6).

4.147. The timing of recording of terminal costs in the asset accounts are, however, different from other fixed assets (including other costs of ownership transfer) because the terminal costs does take place at the end of the productive life time of the related asset, and not at the beginning. This means that the gross fixed capital formation are recorded at the end of the life time of the related asset, while the recording of the consumption of fixed capital takes place during the life time of the fixed asset.

4.148. In order to estimate and record the consumption of fixed capital before the terminal costs actually has taken place it is necessary to estimate an expected terminal cost, which can be used as basis for the calculation of consumption of fixed capital.

4.149. Based on the expected terminal costs the consumption of fixed capital is period for period entered into the asset account for the other assets owned by the mining and extraction industry. Since there is no initial capital formation to write off the consumption of fixed capital against, the capitalised terminal stock will be negative from the first period the consumption of fixed capital is deducted, and gradually this negative item will grow larger until the last period in which the terminal costs are entered as gross capital formation. The apparent oddity of an asset with negative value reflects the fact that the owner not only could not sell it but would have to pay another unit to take over responsibility for the terminal costs (SNA 2008, 10.161).

4.150. Normally, the accumulated consumption of fixed capital related to the terminal costs will not match the actual terminal costs, since the former will always be based on expectations and predictions of the terminal costs, which may take place perhaps twenty or thirty years later. Thus, it is necessary to make an adjustment to the asset accounts in the period when the terminal costs occur in order not to have any remaining (negative or positive) items left on asset accounts once the terminal activities are finished.

4.151. If the estimate of the terminal costs have been to low and the accumulated consumption of fixed capital is lower than the final actual terminal costs, the difference should according to SNA 2008 (10.162) be written off at the time the costs are incurred as consumption of fixed capital. This would also be the case if the terminal costs have not been taken into account at all before they actually occur.

4.152. SNA 2008 seems not to be explicit about how the difference should be recorded if the terminal costs are overestimated compared to actual terminal costs subsequently incurred. However, this overestimate should according to SEEA be corrected in the asset account through a recording of the difference as *other changes in the volume of fixed assets*, when the final terminal costs are observed.

4.153. A re-current inclusion of the consumption of fixed capital related to the terminal costs influences the net present value of the energy resource because it increases the costs of extraction. And since higher costs means lower resource rent this will in turn reduce the value of the stock of the energy resource compared to a situation without terminal costs related to the fixed assets used by the mining and quarrying industry.

4.154. With respect to the return on the fixed capital which is included as a cost in the calculation of the resource rent, cf. section E.3, an inclusion of a return on the terminal cost capital would lead to a reduction of the costs, since the terminal cost asset is negative until the very last period when the costs are incurred. Thus, period after period the resource rent becomes higher, resulting in a higher total stock value. It could of course be argued that it brings a benefit to the owner corresponding to the return on the terminal costs if these are postponed to the end of the lifetime of the assets instead of being paid at the beginning of the period. However, this benefit is already implicitly included in the resource stock value, since the value is higher than it would have been if the terminal costs were actually being paid year by year during the lifetime of the fixed asset. For this reason no return on the negative terminal cost capital should be included in the resource rent calculation.

K. Accounting for ownership

4.155. The SNA 2008 states that the whole of an energy reserve should be shown on the asset account of the legal owner (and the payments by the extractor to the owner shown as rent). This is also the case even if it the extractor who determines how fast the resource will be depleted and it appears as if there has been a change of economic ownership to the extractor (SNA 2008, 13.50). When a unit extracts from a mineral deposit under an agreement where the payments are made each year dependent on the amount extracted, the payments (sometimes described as royalties) are recorded as rent (SNA 2008, 17.342).

4.156. The owner (in many, but not in all cases government) does not have a productive activity associated with the extraction and yet the wealth represented by the deposit declines as extraction takes place. In effect, the wealth is being liquidated with the rent payments covering both a return to the asset and compensation for the decline in wealth. Although the decline in wealth is caused by the extractor, even if the deposit were shown on the balance sheet of the extractor, the rundown in wealth would not be reflected in the extractor's production account because it is a non-produced asset and thus not subject to consumption of fixed capital. For these reasons, simple recording of payments each year from the extractor to the owner as rent and changes in the size and value of the deposit as other changes in the asset accounts of the legal owner is recommended. (SNA 2008, 17.334). More specifically the changes in the asset value due to the extraction should be accounted for as depletion on the owners' asset account for the energy resource.

4.157. An extractor is always assumed to be a resident unit. As soon as an enterprise starts to establish for extraction, for example by obtaining the requisite licences, it is assumed to become a resident unit at that time (SNA 2008, 10.172). If necessary a notional resident unit must be established to preserve this convention (SNA 2008 17.332).

4.158. The above accounting conventions are used if energy asset accounts are set up and used in relation to the SNA 2008.

4.159. However, according to SEEA principles a somewhat different recording should be used in cases where it appears that there has been a change of economic ownership to the extractor, for instance when the extractor determines how fast the resource will be depleted and when there is a sharing of resource rent between the extractor and the legal owner. According to SEEA such an arrangement should be treated as a so-called financial lease.

4.160. A financial lease is one where the lessor as legal owner of an asset passes the economic ownership to the lessee who then accepts the operating risks and receives the economic benefits from using the asset in a productive activity. Under a financial lease, the legal owner is shown as issuing a loan to the lessee with which the lessee acquires the asset. Thereafter the asset is shown on the balance sheet of the lessee and not the lessor; the corresponding loan is shown as an asset of the lessor and a liability of the lessee. Payments under the financial lease are treated not as rentals but as the payment of interest and repayment of principal. (SNA 2008, 17.304).

4.161. Under this treatment the energy resource is valued as the present of the future expected stream of resource rents arising from its extraction, and the benefits arising from use of the resource beyond the life of the present extractive licence are attributed entirely to the legal owner.

4.162. Benefits arising during the life of the present extractive licence are split between the legal owner and the extractor according to their relative shares of expected future resource rents and expected future royalties (Comisari, 2007)[2].

4.163. Table 4.8 presents a monetary asset account in which the opening and closing stocks of the energy resource and the changes in the period is split between the owner and the extractor according to their shares of the resource rents. The depletion should always be recorded in the asset account of the extractor (see Chapter 6), while the changes in present values of the resources rents caused by discoveries, reappraisals, should be recorded according to whether it accrues to the extractor or owner. In the example in Table 4.8 it is assumed that it accrues to the extractor.

4.164. The loan corresponding to the financial lease should in addition be recorded as a financial asset of the owner and a liability of the extractor. This recording is not presented here.

4.165. Compared to the aggregated monetary asset account, Table 4.2, one extra item for other changes in volume n.e.c. (K5) has been introduced. This item does not reflect any actual volumes or price changes, but is introduced because the convention to allocate the depletion element to the extractor necessitates that an amount corresponding to a return on the owners opening stock of energy resources is re-allocated from the extractor to the owner.

4.166. This has to do with the fact that by convention the depletion is calculated as the difference between the actual resource rent and the value of the total opening stock multiplied by the discount rate where the latter can be interpreted as a return to the energy resource, cf. Section G. Since this return in its entirety implicitly is allocated to the extractor through the depletion element, it is necessary to transfer a part of it back to the owner of the resource. Only then can it be ensured that the change in value between the extractor's and owner's opening and closing stocks correctly reflects that the values increases because the future resources rents are being discounted one period less when the closing stock is calculated.

4.167. In the example in Table 4.8 an amount at 7 000 currency units is reallocated from the extractor to the owner via the other changes in volumes n.e.c. This amount corresponds to the owners opening stock value at 178 000 currency units multiplied by a discount rate at 4 per cent.

4.168. It should be emphasised that this reallocation does not correspond to any transaction in reality, and that it cannot be given any specific interpretation. It is only recorded in order to keep the consistency and book keeping identities of the asset accounts.

4.169. With regard to the mineral exploration knowledge asset (exploration and evaluation), it is clear that a business purchasing, or creating on own account, a mineral exploration knowledge asset for use in their extractive business is both legal and economic owner of the mineral exploration knowledge asset and the asset should be recorded in their (the extractor's) balance sheet. The specialist mineral exploration enterprise that develops a mineral exploration knowledge asset is the owner of this asset prior to its sale. In all cases, it is appropriate to record the asset in the balance sheet of the legal owner (Comisari, 2007).

[2] Peter Comisari: Recording the ownership of mineral-related assets- issue paper for the London Group Meeting. Rome ,17-19 December 2007. Australian Bureau of Statistics Centre of Environment and Energy Statistics. http://unstats.un.org/unsd/envaccounting/seearev/docs/LG12_15a.pdf

Table 4.13 Split monetary asset account for energy resources by owner and extractor

	Total	Extractor	Owner
	1000 currency units		
Opening stocks (LS)	**253**	**75**	**178**
Changes due to transactions			
Acquisitions less disposals (NP1)			
Increases in stocks			
Discoveries (K11)	50	50	
Reappraisals (upwards) (K12)	2	2	
Decreases in stocks			
Depletion (K21)	-29	-29	
Reappraisals (downwards) (K22)	-6	-6	
Other changes in stocks			
Catastrophic losses (K3) and uncompensated seizures (K4)			
Changes in classifications and structure			
Other changes in volume n.e.c. (K5)		-7	7
Revaluation			
Holding gains and losses (K7)	104	40	64
Closing stocks (LE)	**374**	**125**	**249**

Annex: General decomposition of the change in net present value between opening and closing stock

4.170. To establish a complete asset account for an energy asset based on the net present value method it is necessary that the values of both the opening and the closing stock are estimated independently i.e. based on the resource rents and extraction profiles, which are appropriate for the two separate stock estimates. 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.

4.171. General formulas for the value of the stocks and the changes in-between are presented below. It should be noted that these formulas for the change items are not all used directly in SEEA-E, but are, by convention, adjusted to reflect the accounting structure and the specific interpretations and assumptions made with regard to, for instance, the estimation of depletion, cf. section 6.G.

The opening stock at period t is, as shown in sub-section E.5, given by

$$V_t^{opening} = \frac{1}{(1+r)^{0.5}} \sum_{i=t}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t}}$$

Where p_i, and e_i reflects the expectations at the beginning of year t of the units resource rent and yearly extractions in year i. t+n is the last period in which extraction is expected to take place

4.172. The value of the closing stock corresponds to the value of the opening stock for period t+1. At the end of the year the expectations for future resource rents and extraction has changed. Let p'_i and e'_i express the new expected resource rents for the coming years, and let t+m be the last period in which extraction is now expected to take place. The value of the closing stock of year t is then given by

$$V_t^{closing} = \frac{1}{(1+r)^{0.5}} \sum_{i=t+1}^{t+m} p'_i e'_i \frac{1}{(1+r)^{i-t-1}}$$

4.173. The total change in value between the opening stock and the closing stock is calculated as the difference between the two expressions. By re-arranging it (see textbox), a formula for the relation between the total change in value between opening and closing stock on one hand and, on the other hand, the contribution to this change due to changes in the expectations about future unit resource rents, extraction profile, etc. appears:

$$V_t^{closing} - V_t^{opening}$$
$$= -(1+r)^{0.5} p_t e_t + \frac{1}{(1+r)^{0.5}} \left(\sum_{i=t+1}^{t+h} (p'_i - p_i) e'_i \frac{1}{(1+r)^{i-t-1}} + \sum_{i=t+1}^{t+h} p_i (e'_i - e_i) \frac{1}{(1+r)^{i-t-1}} \right) + r V_t^{opening}$$

h designates the highest of the numbers m and n.

4.174. The interpretation of this formula is that the changes in the stock value between the beginning and end of period t can be attributed to four factors:

Expected extraction in period t valued at unit resource rent

$-(1+r)^{0.5} p_t e_t$

4.175. This term is the expected extraction in period t valued at the unit resource rent of period t as expected at the beginning of the period. This value was included in the opening stock but is not included in the value of the closing stock. Therefore it is subtracted when we go from opening stock to closing stock. The value of the extraction is here multiplied by the revaluation factor $(1+r)^{0.5}$ because it is assumed that the extraction takes place in the middle of the period. The factor brings the reduction in value due to extraction forward to the end of period t.

Change in value due to change in unit resource rent

$$\frac{1}{(1+r)^{0.5}} \sum_{i=t+1}^{t+h} (p'_i - p_i) e'_i \frac{1}{(1+r)^{i-t-1}}$$

4.176. This term reflects the net present value of the changes in the expected unit resource rents for all periods from t+1 to t+h. The change in expected unit resource rent in period i is $(p'_i - p_i)$, which is multiplied by the extraction in period i as expected at the end of period t. The change in value due to the changes in per unit resource rent is calculated for each period from t+1 to t+h, and discounted back to the beginning of period t+1.

4.177. h is equal to n if the extraction period is longer according to the expectations at the end of period t than according to expectations at the beginning of period t. $p_i = 0$ for the periods between m and n since initially there were no expectations for extractions.

4.178. h is equal to m if the extraction period is shorter according to the expectations at the end of period t than according to expectations at the beginning of period t. $p_i' = 0$ for the periods between n and m since there are no extractions for these periods according the expectations at the end of period t.

4.179. $(p'_i - p_i) < 0$ if the change in expectations from the beginning to the end of period t adjusts the unit resource rent downwards. This contributes to a lower value of the resource towards the end of period t. In contrast, if the expected resource rent goes up, it contributes to a higher resource stock value.

Change in value due to changed extraction profile

$$\frac{1}{(1+r)^{0.5}} \sum_{i=t+1}^{t+h} p_i (e'_i - e_i) \frac{1}{(1+r)^{i-t-1}}$$

4.180. This term reflects the net present value of the changes in the expected physical extraction for all periods from t+1 to t+h. The change in expected physical extraction in period i is $(e'_i - e_i)$, which is multiplied by the unit resource rent in period i as expected at the beginning of period t. The change in value due to the change in extraction is calculated for each period from t+1 to t+h, and discounted back to the beginning of period t+1.

4.181. $(e'_i - e_i) < 0$ if the change in expectations from the beginning to the end of period t adjusts extractions downwards. That contributes to a lower value of the resource towards the end of period t. In contrast if the expected extraction goes up it contributes to higher resource stock value.

4.182. In the two last expressions above the factor

$$\frac{1}{(1+r)^{0.5}}$$

is a revaluation factor which discounts the current incomes an extra half period assuming that the incomes do not fall in the beginning of a period but instead at the middle of the period.

Change in value due to time passing (return to the energy asset)

$$rV_t^{opening}$$

4.183. This term reflects that in addition to the change in value due to extraction during the year and changed expectations for unit resource rent and extraction profile there will be an “automatic” increase in the resource asset value from the beginning to the end of period t. The increase is equal to opening stock value multiplied by the discount rate. It is explained by the fact that the number of periods for which income in a period i is discounted back to period t is one less at the end of period t than it was at the beginning of period t. The present value is therefore higher at the end than at the beginning of period t. The increase in value can be seen as a premium, a return to the energy asset, the owner gets for holding the resource and having capital bound in it.

4.184. It should be noted that this specific formula for the return to the energy asset (as well as the other formulas above) is closely linked to the net present value method. If instead a market existed and a valuation was based on observed values, there is no guarantee that the return to the asset is exactly equal to the discount rate times the value of the opening stock. The return to the asset would in that case be influenced by the actual market price changes for the asset. However, at least as an average over a range of years the return to the energy asset should not deviate too much from the discount rate times the value of the asset.

4.185. By convention, the change in stock value due to the time passing is in SEEA-E seen as a factor which reduces the value of the depletion. Thus, depletion is in SEEA-E, estimated by deducting from the resource rent the change in value due to time passing, rV_t, cf. section E.

Deduction of formula for decomposition of changes in total stock value by underlying factors (changes in unit resource rent, extraction profile and time passing)

$$V_t^{closing} - V_t^{opening}$$

$$= V_t^{closing} - V_t^{opening} - r\,V_t^{opening} + r\,V_t^{opening}$$

$$= V_t^{closing} - (1+r)\,V_t^{opening} + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(\sum_{i=t+1}^{t+m} p'_i e'_i \frac{1}{(1+r)^{i-t-1}} - (1+r)\sum_{i=t}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t}}\right) + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(\sum_{i=t+1}^{t+m} p'_i e'_i \frac{1}{(1+r)^{i-t-1}} - \sum_{i=t}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(-(1+r)p_t e_t + \sum_{i=t+1}^{t+m} p'_i e'_i \frac{1}{(1+r)^{i-t-1}} - \sum_{i=t+1}^{t+n} p_i e_i \frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(-(1+r)p_t e_t + \sum_{i=t+1}^{t+h}\left(p'_i e'_i - p_i e_i\right)\frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(-(1+r)p_t e_t + \sum_{i=t+1}^{t+h}\left((p'_i - p_i)e'_i + p_i(e'_i - e_i)\right)\frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$$= \frac{1}{(1+r)^{0.5}}\left(-(1+r)p_t e_t + \sum_{i=t+1}^{t+h}(p'_i - p_i)e'\frac{1}{(1+r)^{i-t-1}} + \sum_{i=t+1}^{t+h} p_i(e'_i - e_i)\frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$$= -(1+r)^{0.5} p_t e_t + \frac{1}{(1+r)^{0.5}}\left(\sum_{i=t+1}^{t+h}(p'_i - p_i)e'\frac{1}{(1+r)^{i-t-1}} + \sum_{i=t+1}^{t+h} p_i(e'_i - e_i)\frac{1}{(1+r)^{i-t-1}}\right) + r\,V_t^{opening}$$

$V^{opening}{}_t$ is the value of the resource at the beginning of period t.

p_i, i = t , … , n is the average unit resource rent at period i as expected at the beginning of period t

p'_i, i = t , … , n is the average unit resource rent at period i as expected at the end of period t

e_i , i = t , … , t+n is the physical extraction of the resource taking place during period i as expected at the beginning of period t.

t+n is the last period in which extraction takes place according to the expectation at the beginning of period t.

e'_i , i = t , … , t+m is the physical extraction of the resource taking place during period i as expected at the end of period t

t+m is the last period in which extraction takes place according to the expectation at the end of period t.

h is the maximum of m and n (h=m if m>n and h=n if n>m).

r is the discount rate (no changes in this is assumed between the beginning and end of the period)

$V^{closing}{}_t$ is the value of the resource at the beginning of period t.

Note: This is not the only decomposition of the change that can be made. In this decomposition the change in net resource rent is multiplied by the extraction as expected by end of period t, and the change in expected extraction is multiplied by the price as expected at beginning of period t. Instead the change in unit resource rent could have been multiplied by the extraction expected at the beginning of period t, and the change in extraction should then be multiplied by the unit resource rent as expected at end of period t.