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Classification Issues for Mineral and Energy Resources

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1. Introduction

1. The asset classification of mineral and energy resources of the SEEA-2003 does not provide clear guidance on the extent of the resources to include in the physical asset accounts nor on the definitions of the different categories of resources. This has consequences in the implementation of the accounts as countries use different classifications for their mineral and energy resources thus affecting the international comparability of the accounts.

2. This paper continues the discussion on the issue of definition of physical reserves (identified in the preliminary list of issue concerning mineral and energy accounts) and follows up on the classification issue raised in Hass and Kolshus (2006) during the 10th London Group meeting which questioned the basis of the mineral and energy classification of the SEEA: whether the SEEA should continue to base its classification on the McKelvey box or refer to the new UN Framework Classification (UNFC) for Fossil Energy and Mineral Resources[2]. The UNFC was developed under the auspices of the UN Economic Commission for Europe (UNECE) and endorsed in 2004 by the UN Economic and Social Council (resolution 2004/233). Member States of the United Nations, international organizations and regional commissions were invited to consider taking appropriate measures for ensuring its worldwide application.

3. This paper also describes other issues linked with the lack of a clear classification scheme and definitions of mineral and energy resources. They include: (a) the aggregation across different categories of reserves and (b) the extent of physical stock that should be value in the monetary asset accounts.

4. This paper does not put forward possible solutions to the issues described above, but it proposes a way forward to address them. It is organized in the following sections. Section 2 addresses the issue of terminology: the SEEA-2003 seems to use the terms *resource* and *reserves* interchangeably. For example, while the asset classification refers to mineral and energy resources, the asset account presented in the text refers only to reserves. This raises the questions: Are resources and reserves synonymous? How do common classification schemes for mineral and energy define these terms? Are they consistent with the SEEA-2003? Should these terms be more precisely defined in the updated SEEA?

5. Section 3 describes the issue of classification of mineral and energy resources. There are a number of classification systems used by countries both at government and business level which make use of a similar terminology but differ in the substance. Thus a company may report different figures for proven reserves, for example, depending on the classification and guidelines used. Section 4 and 5 describe the issue of aggregation across different categories of reserves and the extent of resource that should be valued in the monetary asset accounts. Finally Section 6 proposes a way of addressing these issues and poses some questions to the London Group.

2. Resources/reserves definitions

6. In the draft glossary of the SEEA-2003 *Mineral and energy resources* (category E.A. 11) are defined as 'Subsoil deposits of fossil fuels, metallic minerals and non-metallic minerals. They include not only the proven reserves but also probable, possible potential and speculative resources/reserves' (SEEA-2003 paragraphs 7.147 and 7.43). Thus, given that the asset boundary of the SEEA-2003 which covers all environmental entities which provide option, bequest and existence benefits, *mineral and energy resources* include all the accumulation of fossil fuels and minerals based (only) on geological considerations. The SEEA-2003 text seems to use the terms resource and reserve almost interchangeably.

7. There is generally a distinction between *resource* and *reserve* in other classification systems such as the UNFC for Fossil Energy and Mineral Resources and national standards for public reporting on

[2] The document is available online at http://www.unece.org/ie/se/pdfs/UNFC/UNFCemr.pdf

mineral and energy. The term *reserve* seems to be commonly used to denote a part of the *resource* which is commercially/economically (even though different criteria are used) recoverable. Selected definitions for resource and reserves are presented next.

Resource

8. The term *resource* is used in some context to refer to accumulations which have some prospects of extraction. This is the case, for example, of national standards used for public reporting on mineral resources for a number of countries such as Canada, Chile, South Africa, United Kingdom, USA, Australia and New Zealand[3]. If we take, for example, the *South African Code for Reporting of Mineral Resources and Mineral Reserves*[4] which sets out minimum standards, recommendations and guidelines for public reporting in South Africa, mineral resources are defined as follows:

> A '*Mineral Resource*' is a concentration [or occurrence] of material of economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated from specific geological evidence and knowledge, or interpreted from a well constrained and portrayed geological model.
>
> A *deposit* is a concentration [or occurrence] of material of possible economic interest in or on the Earth's crust. Portions of a deposit that do not have reasonable and realistic prospects for eventual economic extraction must not be included in a Mineral Resource.

9. According to this definition, a mineral resource is the part of the deposit which has 'reasonable and realistic prospects of eventual economic extraction' thus it corresponds to a subset of the asset as defined in the SEEA-2003. The definition of *deposit* seems to correspond to the concept of resource of the SEEA.

10. It is unclear whether the UNFC's definition of mineral and energy resources corresponds to that of the SEEA-2003. In the UNFC, the *energy resource* is defined as 'all non-renewable energy resources of both inorganic and organic origin discovered in the earth's crust in solid, liquid and gaseous form' and *mineral resources* as 'all inorganic or organic substances in the earth that may be exploited, wholly or partly, for the benefit of mankind'. Depending on the meaning of the term *discovered*, the definition of energy resource could be considered consistent with the SEEA. However, if discovered refers to a series of testing of the resources (such as drilling wells), the definition of energy resource in the UNFC corresponds to a subset of the SEEA-2003 asset. Similarly, for mineral resources the extent of 'exploitability' in the definition of the UNFC has consequences on the consistency with the SEEA-2003 asset boundary.

11. The concept of resource of the SEEA-2003 seem to be consistent with the concept of *total petroleum-initially-in-place* used in the *Petroleum Reserves and Resources Classification, Definitions, and Guidelines*[5] (Society of Petroleum Engineers (SPE)/American Association of Petroleum Geologists (AAPG)/ World Petroleum Council (WPC)/ Society of Petroleum Evaluation Engineers (SPEE), 2006):

> *Total petroleum-initially-in-place* is that quantity of petroleum that is estimated to exist originally in naturally occurring accumulations.
>
> It includes that quantity of petroleum that is estimated, as of a given date, to be contained in known accumulations prior to production plus those estimated quantities in accumulations yet to be discovered.

[3] See http://www.jorc.org/main.php?action=6 for the list of these documents.
[4] The CIM Standards on Mineral Resources and Reserves – Definitions and Guidelines is available online at: http://www.cim.org/committees/stdsapprnov14.pdf
[5] These guidelines, definitions and the related classification system are in common use internationally within the petroleum industry.

Reserves

12. The SEEA-2003 does not provide a definition of *reserves*. As mentioned in paragraph 7, the term *reserve* seems to be commonly used to denote the part of the resource which is commercially/economic recoverable, even though the criteria to define recoverability differ according to the classification used and the type of resource. Examples of definitions from selected classification schemes are reported next.

13. The South African Code for Reporting of Mineral Resources and Mineral Reserves defines:

> A 'Mineral Reserve' is the economically mineable material derived from a Measured and/or Indicated Mineral Resource. It is inclusive of diluting materials and allows for losses that may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. Mineral Reserves are sub-divided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves.

14. The SPE/AAPG/WPC/SPEE (2006) for petroleum defines the following:

> *Reserves* are those quantities of petroleum anticipated to be commercially recoverable from known accumulations from a given date forward under defined conditions. Reserves must satisfy four criteria: they must be discovered, recoverable, commercial, and remaining based on the development project(s) applied. Reserves are further subdivided in accordance with the level of certainty associated with the estimates and their development and production status.

15. Statistics Canada defines *reserves* as follows:

> Term *reserves* is used to refer to deposits of subsoil assets that can be assumed with a high degree of certainty to be profitable under current technological and economic conditions. The exact criteria used to define a reserve differ from one subsoil asset to another.

Summary

16. The terms *resource* and *reserve* are not synonymous and should be clearly defined and consistently used in the SEEA. In general, *reserve* refers to a subset of the *resources* based on some criteria such as the economic recoverability of the resource given current conditions. *Resources* seem to encompass a larger part of the *reserves* ranging from whatever is discovered (as in the UNFC) to whatever is in the ground (SPE/AAPG/WPC/SPEE) based on geological knowledge (this latter case seems to be more in line with the asset boundary of the SEEA-2003).

17. The issue of terminology is very much linked to the issue of classification of *resources* and *reserves,* which is discussed in the next section. The terminology and classification issues should be looked at simultaneously.

3. Resources/reserves classification

18. The classification of mineral and energy resources and more in particular of reserves is not well developed in the SEEA-2003. This section reviews several classification systems of mineral and energy resource/reserves used by countries in order to see the applicability of the SEEA-2003 classification and definitions and determine whether there is a need to take into consideration different classification schemes (especially in light of the new UNFC Fossil Energy and Mineral Resources).

19. The classification systems reviewed can be grouped as follows:

(a) Security Disclosure (e.g. US Security and Exchange Commission (SEC), U.K. Statement of Recommended Practices (UK-SORP), Canadian Security Administrators (CSA-2002). These classifications consist primarily of a set of rules for defining proved and/or probable reserves

estimates to be disclosed to security investors for publicly traded oil and gas companies to guarantee consistent volume and associated value assessments to compare financial performance. Typically these rules consist of strict guidelines with specifications on the type of tests necessary and the time frames in order for reserves to qualify as proven.

(b) Government and industry reporting. These classifications aim at capturing 'the full resource base in order to project future production potential for the country and are not primarily concerned to show recoverable volumes and values accruing to individual companies. Governments need this information regarding production and reserves to implement and modify legislation and policy (fiscal terms, licensing incentives, etc.) on resource development to manage energy supply' (SPE, 2005). This group includes classifications developed by governmental agencies (e.g. Norwegian Petroleum Directorate, Russian Ministry of Natural Resources and China Petroleum Reserves Office) as well those developed by ad-hoc committee (e.g. the SAMREC Code for South Africa[6], the JORC Code for Australia and New Zealand[7] for reporting of mineral resources and mineral reserves).

(c) International classifications. This group includes classifications developed at international level to promote the international consistency of terminology and definitions. The most notable classification is the UNFC for Fossil Energy and Mineral Resources which was endorsed by ECOSOC. The UNFC incorporates the SPE classification and definition for petroleum within an overall classification system which is applicable to all the energy minerals (including coal and uranium). SPE and UNFC committees are currently coordinating to ensure their classifications are synchronous and have a common set of application guidelines (SPE, 2005) This group also includes the Petroleum Reserves and Resources Classification, Definitions, and Guidelines of SPE/AAPG/WPC/SPEE (2006) and the International Reporting Template of the Committee for Mineral Reserves International Reporting Standards[8] (CRIRSCO). The UNFC is working with the SPE/AAPG/WPC/SPEE and CRIRSCO for a complete harmonization of classification for mineral and energy resource.

(d) Geological surveys by government agencies that use a combination of both enterprise data, geological studies etc. The best known is perhaps the United States Geological Survey (USGS) that provides periodic reviews of world petroleum reserves. These classifications are based on the McKelvey Box which classifies resources according to two criteria: geological certainty and economic feasibility. Countries have adapted the original McKelvey box to their own situation, which gave rise to a number of classification systems.

20. The results of the comparison of these classifications can be summarized as follows:

(a) Most of the classification schemes use the feasibility of economic recovery and degree of geological certainty as well as the project status to classify mineral and energy resources. Project status appears to have become increasingly important over the years. This has lead to a distortion of McKelvey's original two axes set-up, and the fact that most countries have adapted the original McKelvey setting to fit local needs seems another demonstration of the need to consider additional classification criteria.

(b) While most of the classification schemes recognize the category of proven reserves, different criteria are used to define them.

[6] Available online at http://www.saimm.co.za/codes/samrec_version.pdf

[7] Available online at http://www.jorc.org

[8] CRIRSCO is a committee of the National Mineral Reserve Reporting Organisations of Australia, Canada, Chile, South Africa, USA, UK / Ireland and Western Europe. The template is being used as the basis for discussions that CRIRSCO is having with international organisations responsible for global harmonisation of accounting standards, as well as reporting in associated industries such as oil and gas. These include the International Accounting Standards Board, the United Nations Economic Commission for Europe and the Society of Petroleum Engineers.

(c) There is a general agreement that, according to the uncertainty on the estimate of the recoverable quantity given the current condition, reserves are further classified in proven, probable and possible, which also corresponds to (cumulative) low, best and high estimates respectively (which corresponds to different level of uncertainty (namely, 0.9, 0.5 and 0.1) associated to the quantity that can at least be extracted).

4. Aggregation

21. The issue of aggregation refers to the question whether it is possible to aggregate over the different categories of reserves (e.g. proven, probable and possible) on the basis of some probability (such as probability of existence). The SEEA-2003, paragraph 7.216, describes the two option for aggregation: the first being by weighted average, the second – being a simple sum (which corresponds to the SEEA-2003 recommendation):

> The SNA specifies the coverage of subsoil resources to be valued in the balance sheet as proven reserves only. A number of countries work, even in the SNA context, with proven plus probable reserves rather than proven only. This is sometimes because the information on the two classifications is not available separately and sometimes simply to have a more realistic assessment of established reserves. One possibility is that probable reserves should be added to proven reserves with a weighting factor reflecting the probability of their being converted to proven and even to extend the same procedure to possible reserves (with a lower probability factor). Though theoretically appealing, this process is likely to encounter data problems in implementation. The simple use of proven plus probable seems a preferable, generally applicable recommendation for the SEEA.

22. The Eurostat taskforce[9] on subsoil assets advised:

> The best estimate to include in the subsoil asset accounts is considered to be the expected, or probability weighted, level of discovered and undiscovered reserves. However, data on all categories, in particular undiscovered reserves, may not be available in all countries. In some countries, reserve data weighted by probability is readily available from the institution that compiles the basic data. If this is not the case, probability weights may be applied to the available reserve categories, before they are added together. The default weights could be 1.0 for proven reserves, 0.5 for possible reserves and 0.1 for probable reserves.

23. It should be noted that the in the two cases different weighting factors seems to be suggested. In the first case it is the probability of being converted into the next category of reserve. In the second it is the probability of existence.

24. If reserves are further classified into proven, probable and possible according to different uncertainty associated with the estimates of reserves (such as there is .9 probability that at least an amount x_1 is recovered, 0.5 that at least an amount x_2 is recovered, and 0.1 that at least an amount x_3 is recovered, with $x_1 < x_2 < x_3$), then it would seem reasonable to estimate the reserves with the median of the probability distribution defined above which would correspond to x_2. In this case, there would not seem to be necessary any weighting across proven, probable and possible reserves. However, this argument may not hold if the categories of reserves are defined and classified differently.

25. In addition, the issue goes also beyond the aggregation across different categories of reserves, but it extents to the aggregation across different categories of resources. Thus, the aggregation issue should be addressed after a classification scheme is defined (or chosen) in the SEEA

5. Valuation

26. Another issue with mineral and energy asset accounts deals with the extent of the physical asset to be valued. If the physical stocks of mineral and energy resources include discovered and undiscovered resources, recoverable and unrecoverable resources, should all the physical stock be valued in the

[9] *Subsoil asset accounts for oil and gas – Guidelines for the set of standard tables* Revised version, January 2003, by the Eurostat Task Force on Subsoil Assets.

monetary asset account? This will have an impact on the life-time of the asset that is used to calculate the Net Present Value.

27. Examples of the different options are that the valuation of asset is based on: (a) *resources*, (b) *reserves*, or (c) *proven reserves* (as in the 1993 SNA). There are different arguments for each choice as well as different consequences on the value of the asset.

6. Way forward

28. In light of the discussion presented in the previous section, it would be advisable that the revised SEEA-2003 should include a clearly defined classification scheme taking into account existing classification schemes/standards, possibly mapping existing classifications to that of the revised SEEA-2003. The UNFC for Fossil Energy and Mineral Resources is a good candidate for a number of reasons: firstly it has been endorsed by ECOSOC and it is being implemented in an increasing number of countries, secondly it is flexible enough that countries can map their classifications into the UNFC categories. Only after a classification scheme for mineral and energy resource is defined, the other issues can be more easily addressed.

29. Since there are a number of questions with regards to the use of the UNFC (linked, for example, to the terminology, to understanding the reasons for having different classifications for mineral and fossil energy resources, the applicability of the classification to unconventional resources, etc.), we would suggest that a proposal for a classification of mineral and energy be developed in close cooperation with experts from UNFC. UNSD can take the initiative to prepare this proposal with the collaboration of members of the subgroup on mineral and energy accounts to be discussed at the next London group meeting.

Questions to the London Group

30. We would like to seek the London Group views on this report and in particular on the following points:

(a) Do you agree that the terms *resources* and *reserves* refer to different parts of the mineral and energy deposits? While the term reserve can be defined after the classification issue is addressed, it is important to agree on the asset boundary of the *mineral and energy resources* in the SEEA-2003. Do you agree that the asset boundary of *mineral and energy resources* include the accumulation of fossil fuels and minerals based (only) on geological considerations (as introduced in paragraph 6)?

(b) Do you agree that the revised SEEA-2003 should explicitly define a classification scheme/system of mineral and energy resources based on existing classifications?

(c) Do you agree with the description of the aggregation issue in paragraphs 21 and 25?

(d) Do you agree that the 'boundary of physical resource to be valued in the monetary asset accounts' (as described in paragraphs 26 and 27) is an issue to be addressed?

(e) Are there other issues related to the classification and terminology issues that need to be added in the issue list? For example:

i) Is the 'Aggregation of estimates across different fields' an issue to be addressed?[10] If so should it be addressed in the revised SEEA-2003? Or is it an implementation issues to be covered in the handbook on Mineral and Energy Accounts?

ii) Is the 'Heterogeneity of resources' an issue to address? Heterogeneity of the resources may refer to the composition of the resource which can be a mix of different types of energy or mineral resources, with the problem of how to separate the resource rent. Heterogeneity may also refer to the quality of the mineral or energy resources. How to reflect in the accounts the different quality of the deposit (and the associated different values)?

(f) Do you agree with the way forward as suggested in paragraph 29?

Reference

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[10] "Distributions of resources estimates can be aggregated deterministically or probabilistically, and the results can be quite different. The quantity associated with P90 of an independent probabilistic, aggregation is significantly larger than that derived by arithmetic summation of the P90 quantities of individual projects. In statistical terms, this illustrates the central limit theorem. In business terms, this is the benefit of the portfolio effect. The larger and more diversified the portfolio (more independent), the greater the portfolio effect. Conversely, the 3P arithmetic summations are also significantly larger than the P10 from a probabilistic aggregation. This underlines the difficulty in performing reconciliation using the probabilistic method. An increase in Proved Reserves in a project may be due to both technical improvements and to changes in the portfolio mix, which must then be allocated back to the project. This certainly complicates resources auditing" *Guidelines for the Evaluation of Petroleum Reserves and Resources, SPE/WPC/AAPC, 2001*