United Nations Framework Classification for Fossil Energy and Mineral Resources

Abbreviations

AAPG	American Association of Petroleum Geologists
AASB	Australian Accounting Standards Board
CMMI	Council of Mining and Metallurgical Institutions
CRIRSCO	Combined Reserves International Reporting Standards Committee
ECOSOC	United Nations Economic and Social Council
EFG	European Federation of Geologists
IAEA	International Atomic Energy Agency
IASB	International Accounting Standards Board
IEC	International Electrotechnical Commission
IRGO	Institute for Mining, Geotechnology and Environment, Ljubljana, Slovenia
ISO	International Organization for Standardization
IVSC	International Valuation Standards Committee
MNR	Ministry of Natural Resources of the Russian Federation
MOL	Hungarian Oil and Gas Plc.
NEA	The Nuclear Energy Agency of OECD
NPD	Norwegian Petroleum Directorate
OPEC	Organization of Petroleum Exporting Countries
SCMR	State Commission of Ukraine on Mineral Resources
SPE	Society of Petroleum Engineers
TKI	Turkish Coal Enterprises
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNESCWA	United Nations Economic and Social Commission for West Asia
UNFC	United Nations Framework Classification for Energy and Mineral Resources
UNSD	United Nations Statistical Division, N.Y.
USGS	United States Geological Survey
VIEMS	Institute for Economics of Mineral Resources and the use of the Subsoil, Russian Federation
WEC	World Energy Council
WPC	World Petroleum Congress

I Introduction

The United Nations Framework Classification (UNFC) for Energy[1] and Mineral Resources[2] is a universally applicable scheme for classifying/evaluating energy and mineral reserves[3] resources. Most importantly, it allows a common and necessary international understanding of these classifications/evaluations. The Classification is designed to allow the incorporation of currently existing terms and definitions into this framework and thus to make them comparable and compatible. This approach has been simplified through the use of a three-digit code clearly indicating the essential characteristics of extractable energy and mineral commodities in market economies, notably (i) degree of economic/commercial viability; (ii) field project status and feasibility; and (iii) level of geological knowledge.

The UNFC is a flexible system that is capable of meeting the requirements for application at national, industrial and institutional level, as well as to be successfully used for international communication and global assessments. It meets the basic needs for an international standard required to support rational use of resources, improve efficiency in management, and enhance the security of both energy supplies and of the associated financial resources. Furthermore, the new classification will assist countries with transition economies in reassessing their energy and mineral resources according to the criteria used in market economies.

The Classification is harmonized with the SPE/WPC/AAPG Petroleum Resource Classification [1][4]; with the IAEA/NEA Classification of Uranium Reserves/Resources [2]; and with the CMMI/CRIRSCO Definitions for Mineral Reserves/Resources [3]. During its completion, intensive consultations were held with a number of professional and intergovernmental organizations dealing with reserves evaluation, management and accounting.

This document is an updated version of the "United Nations International Framework Classification for Reserves/Resources - Solid Fuels and Mineral Commodities", which was adopted by the United Nations Economic and Social Council in 1997 [4] and recommended for worldwide application (ECOSOC Decision 226/1997). Furthermore, following a decision taken by the UNECE Committee on Sustainable Energy at its annual session in 2001 (Document ECE/ENERGY/47, para.13) the Classification has now been extended in order to include and harmonize all the extractable energy commodities, e.g. petroleum[5], coal and uranium.

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[1] In the context of this classification, *energy resources* means all non-renewable energy resources of both inorganic and organic origin discovered in the earth's crust in solid, liquid and gaseous form.

[2] In the context of this classification, mineral resources means all inorganic or organic substances in the earth that may be exploited, wholly or partly, for the benefit of mankind. Water resources are not a subject of this classification.

[3] Reserves do not appear within the title, however they are properly defined by the UNFC as a part of the total resources.

[4] For references, see the bibliography.

[5] Petroleum is a naturally occurring mixture consisting predominantly of hydrocarbons in the gaseous, liquid or solid phase. In this document, it therefore means both oil and natural gas.

II Background

The UNECE Working Party on Coal initiated the first version of the United Nations Framework Classification for Solid Fuels and Mineral Commodities in 1992, on the basis of a proposal made by the German Government. The same principles had already been applied in a classification originally developed by Mr. Dietmar Kelter, Federal Institute for Geosciences and Natural Resources, Hanover, in 1991 [5]. Over a period of six years, the UN Task Force, chaired by Mr. Kelter, designed and elaborated it with the substantial contribution and support of more than 50 countries and organizations worldwide. At its annual session in 1997, the ECOSOC recommended to all UN member countries to apply the Classification to their coal and mineral sectors (ECOSOC Decision 226/1997). Since then, the Classification has been applied in more than 60 countries worldwide, a number of them introduced the UNFC as a national system, and others adapted their national systems to the UNFC principles.

In October 1998, the UNECE Task Force and CMMI Expert Group reached an agreement to integrate their respective definitions into a single, universally applicable set of definitions. The joint UN/CMMI definitions for mineral and reserves and resources were completed in November 1999 (Document ENERGY/2000/11) [3].

After considering the successful work done by the UN Task Force on UNFC for Solid Fuels and Mineral Commodities, the UNECE Committee on Sustainable Energy decided, at its eleventh session in November 2001, to create an Intergovernmental Ad Hoc Group of Experts on the Harmonization of Energy Reserves/Resources Terminology (ECE/ENERGY/47, para.13) [6]. The main purpose of the Ad Hoc Group of Experts was to extend the principles of the UNFC for Solid Fuels and Mineral Commodities to other energy resources (oil, natural gas and uranium) covering the specific aspects of each energy commodity, and thus to define the different terms and definitions.

In order to achieve this objective, the Ad Hoc Group of Experts was split into three sub-groups, covering separately coal and minerals, petroleum, and uranium, and they attempted to harmonize each commodity classification with the three major internationally recognized energy resource classifications, namely: the UN/CMMI for coal; the SPE/WPC/AAPG for petroleum; and the IAEA/NEA for uranium. Substantive work was done in cooperation with the above-mentioned organizations. In addition to this, several national classification systems played an important role in the harmonization process including the recently revised national classification of the Russian Federation.

At its thirteenth session in November 2003, the UNECE Committee on Sustainable Energy adopted the Classification and recommended its application to all countries worldwide whilst recognising the fact that the majority of energy and mineral deposits are located outside the UNECE region [7]. In order to facilitate such an acceptance on a worldwide scale, the Committee asked the UN Economic Commission for Europe to endorse the Classification and submit a proposal for ECOSOC consideration, at its annual session in June 2004 (Document ECE/ENERGY/53/Corr.1, para.16 (v)) [8].

In addition, the Committee requested that the Ad Hoc Group should continue its work for another two-year period and recommended appropriate initiatives to cooperate with relevant institutions and to promote the practical implementation of UNFC. This includes following the development of related standards and ensuring further harmonization between these and the UNFC. If required,

this may involve issuing guidelines for the application of the UNFC. An example of such standards is the foreseen International Financial Accounting Standards for the Extractive Industries, under consideration by the International Accounting Standards Board (IASB). Promotion of the UNFC also includes the holding of regional seminars, and the creation of national teams and international expert groups, to provide advisory assistance to countries and regions in harmonizing national classifications with the UNFC principles. The first seminar following this recommendation was organized jointly by UNECE, the United Nations Economic and Social Commission for Western Asia (UNESCWA), the Organization of Petroleum Exporting Countries (OPEC) and the United Nations Statistical Division (UNSD), in Beirut, Lebanon, in June 2004, for the benefit of OPEC/UNESCWA Middle East Member States.

At its fifty-ninth session in February 2004, the UN Economic Commission for Europe endorsed the United Nations Classification for Energy and Mineral Resources and proposed to the ECOSOC that it recommend its application worldwide (document E/2004/37- E/ECE/1416).

III Acknowledgements

The UNFC was developed by an Intergovernmental Ad Hoc Group of Experts, under the Chairmanship of Mr. Sigurd Heiberg (Statoil ASA, Norway) and Vice-Chairmen: Mr. Andrej Subelj (IRGO, Slovenia) with special responsibility to oversee issues related to coal and minerals; Mr. Thomas Ahlbrandt (USGS, United States of America); the late Mr. Oleg V Zaborin, Chairman of State Commission of Mineral Reserves of Russian Federation; and Mr. Slav Slavov (UNECE Project Manager). The Coordinators of the three sub-groups were: Sub-Group on Petroleum – Mr. Per Blystad (NPD, Norway); Sub-Group on Coal & Minerals – Ms. Mücella Ersoy (TKI, Turkey); Sub-Group on Uranium – Mr. Jean René Blaise (IAEA Secretariat, Vienna). To all of them the UNECE secretariat wishes to express its most sincere thanks.

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IV Normative reference

The following normative reference document contains provisions which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to or revisions of the publication do not apply. However, Parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. The members of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) maintain registers of currently valid International Standards.

ISO1000:1992, SI Units (Système International d'Unités) and recommendation for the use of their multiples and certain other units.

V Bibliography

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THE CLASSIFICATION

1. General

1.1. Basic principles

Total Initial Resources

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

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

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

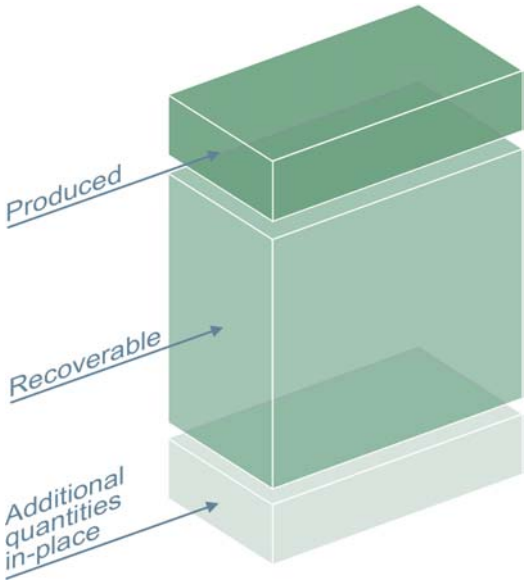

Figure 1. Total initial in-place resources.

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

Produced quantities

Produced quantities are included in the UNFC to facilitate explanation of changes in remaining recoverable quantities resulting from production that has already occurred.

Produced quantities are the sum of sales quantities and non-sales quantities as determined at their respective reference points between a specified initial time (often the time of first recorded production) up to a given date and time (normally the time of the evaluation). Non-sales quantities are considered to have intrinsic economic value.

Remaining recoverable quantities

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

Additional quantities remaining in-place

Additional quantities remaining in-place are quantities estimated to be in-place at the initial time, less the sum of the produced quantities and the estimated remaining recoverable quantities.

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

1.2. Classification

Total remaining resources are categorized using the three essential criteria affecting their recoverability:

- Economic and commercial viability (E).
- Field project status and feasibility (F).
- Geological knowledge (G).

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

The three criteria are easily visualized in three dimensions as shown in Figure 2

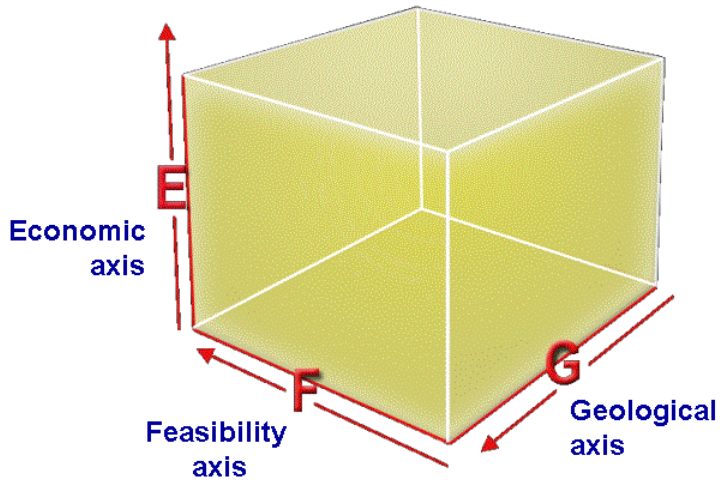

Figure 2. Principal elements of the UNFC

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

Figure 3 A class of quantities may be a single sub-cube, i.e. 111, or a collection of sub-cubes. Total resources are an example of such a class where all sub-cubes are included in the class.

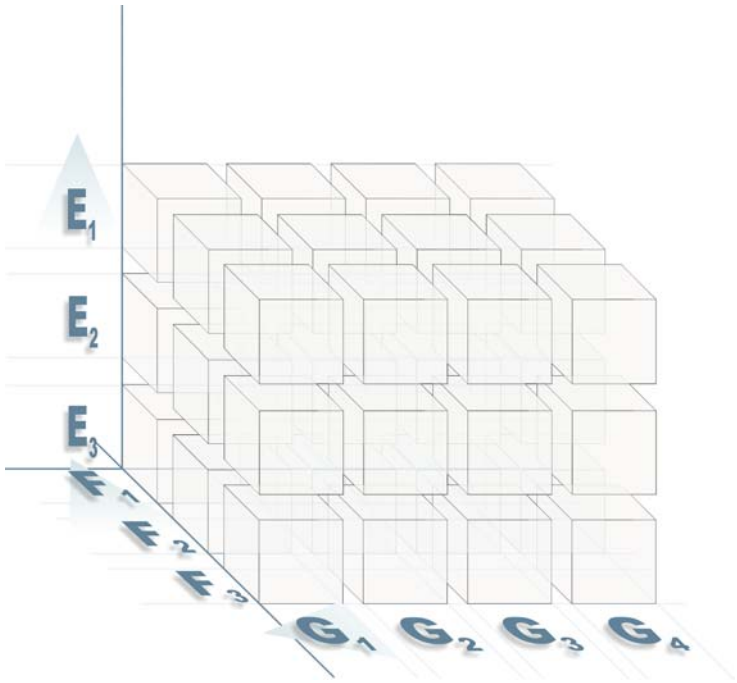

Figure 3. Classification

The three dimensions of categorization are represented by the edges of a cube. The digits are quoted in the order EFG firstly because the alphabetical order is easy to memorize, and secondly because the first digit refers to the economic viability, which is of decisive interest to producers, investors and host countries.

Numbers are used to designate the different classes. Number 1, in accordance with the usual perception that the first is the best, refers to the highest degree of economic viability on the E axis, the most advanced project status on the F axis and the highest quality assessment on the G axis. The use of categories is different for fluids and for solids. This is primarily due to the fact that fluids may flow in a reservoir, irrespective of the level of geological knowledge. In the case of solids, recovery will normally be restricted to rock bodies that have been reliably assessed.

1.3. Codification

Due to variation between terminologies in different systems and languages, it is recommended to use only three-digit numeric codes for individual categories, so that they will be universally understood. For this to be possible, the sequence is always fixed, so that the quantity

characterized as E1;F1;G1 may be written in number form as 111, independent of languages. In practice, only a limited number of combinations (classes) are valid.

To illustrate, the UNFC for coal, uranium and other solid minerals, shown in Figure 5 may be expanded in Figure 4.

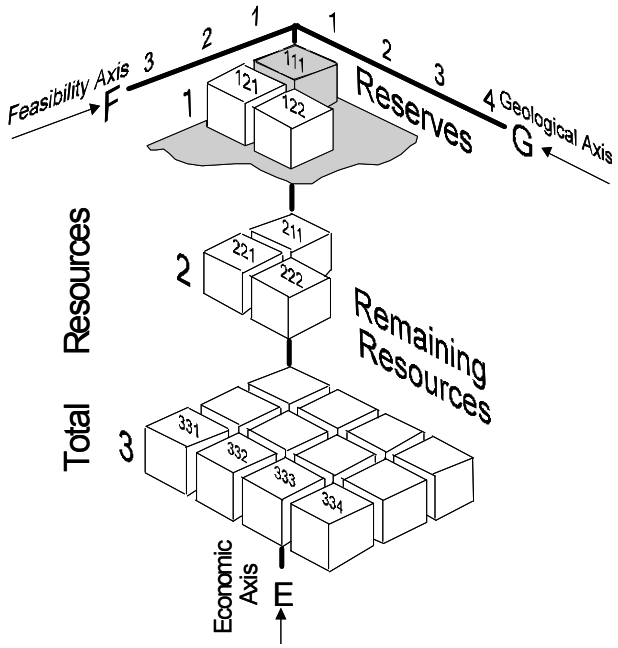

Figure 4. Three-digit codification

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

Subcategories may be added under the main categories when required. Categories and sub-categories shall be numbered. A sub-category shall be separated from the main category number by a decimal point, e.g. E1.1. In such cases the categories have to be separated by a semicolon to distinguish the different categories that are included in the codified unit, e.g. 1.1;1;1 for the subcategory defined by E1.1, F1and G1.

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

1.4. Harmonization

The incorporation of existing classification systems into the UNFC and their comparison is simplified by means of codification acting as an interface. Existing resource inventories that are classified using one or two of the sets of criteria may initially be retained projecting the resources onto the relevant axis or plane of the UNFC. As resources are being re-evaluated, the missing categories are easily identified, allowing the old inventory to be migrated into a full UNFC inventory. Taking examples from petroleum, this may apply to a pre-existing Russian inventory [9], categorized primarily with respect to the level of geological knowledge (the G-axis); an inventory based on the SPE/WPC/AAPG classification, categorized primarily with respect to field project status (the F-axis), or an inventory based on McKelvey's classification [10,11] in the G-E plane.

1.5. Quantification

Quantities in classes may be represented by one or more discrete estimates or by a probability distribution that reflects the range of uncertainty in the estimate of that quantity.

When a quantity is represented by a probability distribution, a low, a best and a high estimate shall be quoted:

- The low estimate shall have a 90% probability of being exceeded and shall be designated P_{90}.
- The best estimate shall be any of the mean (expected) value, the most probable (mode) value or the median (P_{50}) value. It shall be stated which statistical measure has been used for the estimate.
- The high estimate shall have a 10% probability of being exceeded and shall be designated P_{10}.

When a quantity is represented by several discrete estimates there shall be quoted, as a minimum, a low, a best and a high estimate, where such estimates shall reflect the same principles, and approximately the same probabilities, as would be associated with estimates derived from a probability distribution and quoted above.

When a quantity is represented by a single discrete estimate, this shall be the best estimate unless otherwise stated.

1.6. Data registration

Codification has the advantage of providing a short, unambiguous identification of the reserve/resource categories that facilitates computer processing of data and exchange of information. This is particularly important when using information on probabilities.

For practical use in deterministic applications, the three-dimensional model can also be presented in a two-dimensional matrix, showing the third (economic) dimension within the individual boxes.

Table 1 illustrates how information may be recorded in a matrix for coal, uranium and other solid minerals. The main consecutive stages of geological knowledge are shown on the horizontal axis. They define reserve/resource categories according to degree of geological and, where relevant,

geotechnical assurance. Along the vertical axis, the main feasibility assessment stages are introduced as a yardstick to rank reserves/resources according to the amount of detail with which the feasibility assessment has been carried out. These reflect the degree of assurance of the reserve/resource figures with respect to economic viability. The actual result of the feasibility assessment, i.e. the economic viability of the deposit, is depicted using the third dimension. The matrix presentation of the classification is shown in Table 1. Similarly, Table 2 shows the matrix for petroleum.

Table 1. The UNFC in matrix form applied to coal, uranium and other solid minerals

UN International Framework / National System	Detailed Exploration	General Exploration	Prospecting	Reconnaissance
Feasibility Study and/or Mining Report	1 (111) 2 (211)	usually		
Prefeasibility Study	1 (121) 2 (221)	+ (122) + (222)	not relevant	
Geological Study*)	3 (331)	3 (332)	3 (333)	3 (334)

Economic Viability Categories: 1: economic; 2: potentially economic; 3: intrinsically economic (economic to potentially economic)

Table 2 UNFC in matrix form applied to petroleum

UNFC / National system	Reasonably assured geological conditions	Estimated geological conditions	Inferred geological conditions	Prospective geological conditions
Justified	1 111 3 311	112 312	113 313	
Contingent	1 121 2 221 3 321	122 222 322	123 223 323	
Project undefined	3 331	332	333	334

Economic Viability Categories: 1: E1 (Economic) 2: E2 (Potentially Economic) 3: E3 (Intrinsically Economic)

1.7. Determination of commerciality

Quantities in classes may be considered commercially producible if the entity, company or government claiming commerciality (the reporter) has the intention of developing and producing them and such intention is based upon:

- A reasonable assessment of the future economics of such production being satisfactory;
- A reasonable expectation that there is a market for all or substantially all the expected sales quantities of production;
- Evidence that the necessary production and transportation facilities are available or can be made available; and
- Evidence that legal, contractual, environmental and other social and economic concerns will allow the recovery project to be realized.

The commercial value of the quantities would generally be the present value of future cash flows obtainable as a result of the production of the recoverable quantities. The calculation shall reflect:

1. The expected quantities of production whose value is measured.
2. The estimated costs associated with the project to develop, recover and produce the quantities of production at its reference point, including environmental and abandonment costs charged to the project based on costs already incurred and the reporter's view of the costs expected to apply in future periods.
3. The estimated revenues from the quantities of production based on the reporter's view of the prices expected to apply to the respective commodities in future periods. Such prices are to be based on reliable data, the basis of which and reason why the reporter considers such price assumptions to be appropriate should be disclosed. Examples of such reliable data are agreed contract prices, the published forward price curve for the appropriate commodity, an average of a group of analysts' forecast prices and an average of historic achieved prices if this is considered to be a good estimate of the applicable future price.
4. The portion of the costs and revenues accruing to the reporter.
5. Future production and revenue related taxes and royalties expected to be paid by the reporter.
6. The application of discount rates that reflect a specific risk or uncertainty associated with the estimated future cash flows. Where risk is reflected in the discount rate, estimates of future revenues and costs should be discounted at a rate appropriate to that cash stream.

The basis of the reporter's view of commercial conditions and the related assumptions used in calculating the commercial value shall accompany the statement of his view.

1.8. Qualified person

The studies referred to in the UNFC must be undertaken by a person(s) with the appropriate qualifications to assess resources/reserves of the type of commodity in question. The qualifications and experience required will vary from country to country. In certain circumstances licensing may be required.

2. The UNFC applied to coal, uranium and other solid minerals

2.1. Categories

Figure 5 represents an expanded three-dimensional layout showing the codified classes, categories that are applicable in practice for coal, uranium and other solid minerals.

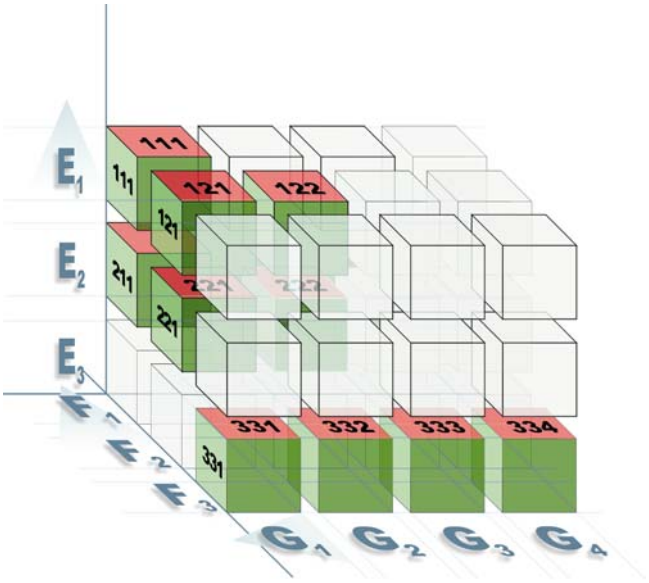

Figure 5. UNFC as applied to coal, uranium and other solid minerals

The following categories of the three sets of criteria shall be used for coal, uranium and other solid minerals:

Table 3. Categories for coal, uranium and other solid minerals

Categories and subcategories		
E1		**Economic**
	E1.1	Normal Economic
	E1.2	Exceptional Economic
E2		**Potentially Economic**
	E2.1	Marginal Economic
	E2.2	Sub-Marginal Economic
E3		**Intrinsically Economic**
F1		**Mining Report and/or Feasibility Study**
	F1.1	Mining Report
	F1.3	Feasibility Study
F2		**Pre-feasibility Study**
F3		**Geological Study**
G1		**Detailed Exploration**
G2		**General Exploration**
G3		**Prospecting**
G4		**Reconnaissance Study**

Categories and sub-categories are further defined in chapter 4.

The purpose of the Feasibility Study is to assess the technical and economic viability of the project and to support a decision regarding project development.

A Feasibility Study must fulfil the following essential functions:

- Provide a comprehensive framework of established and detailed facts concerning the mineral project.
- Present an appropriate scheme of exploitation complete with plans, designs, equipment lists, etc., in sufficient detail for accurate cost estimation and associated economic results.
- Indicate the most likely profitability on investment in the project, assuming the project is equipped and operated as specified in the report.
- Provide an assessment of pertinent legal factors, financing alternatives, fiscal regimes, environmental regulations, and risk and sensitivity analyses on important technical, economic, political, and financial variables affecting the project.

2.2. Classes of remaining recoverable quantities

The following classes of recoverable coal, uranium and other solid mineral quantities are defined, though in practice not all will used in every case:

1. Mineral Reserves including:
   - Proved Mineral Reserves: code 111
   - Probable Mineral Reserves: codes 121 + 122
2. Mineral Resources (Additional or Remaining Resources) including:
   - Feasibility Mineral Resources: code 211
   - Pre-Feasibility Mineral Resources: codes 221+222
   - Measured Mineral Resources: code 331
   - Indicated Mineral Resources: code 332
   - Inferred Mineral Resources: code 333
   - Reconnaissance Mineral Resources: code 334

2.3. Additional classes for uranium resources

The above categories may be applied to uranium resources. Historically, however, the following four categories are used for uranium:

1. Reasonably Assured Resources (RAR): code 111 + 211
2. Estimated Additional Resources – Category I (EAR I): code 121+122+221+222
3. Estimated Additional Resources – Category II (EAR II): code 333
4. Speculative Resources: code 334

The known uranium resources RAR and EAR I may be defined as shown. These two categories may be expressed in terms of recoverable tonnes of uranium, i.e. quantities of uranium recoverable from mineable ore, taking into account mining and milling losses.

Undiscovered uranium resources (EAR II and Speculative Resources) are reported as in-place resources, not taking into account mining and milling losses.

2.4. Proved mineral reserves

Proved mineral reserves are the quantities defined by code 111.

A proved mineral reserve is the economically mineable part of a recoverable quantity assessed by a feasibility study or actual mining activity usually undertaken in areas of detailed exploration (measured recoverable quantity). It includes diluting materials and allowances for losses which may occur when material is mined and milled. Appropriate assessments, which include feasibility studies, have been carried out, and include consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate, with a high degree of confidence at the time of reporting, that extraction is justified.

A feasibility study or actual mining activity, usually undertaken at the detailed exploration stage, may demonstrate a proved mineral reserve to be economically mineable.

3. The UNFC applied to petroleum

3.1. Categories

Figure 6 represents an expanded three-dimensional layout showing the codified classes that are applicable in practice for petroleum.

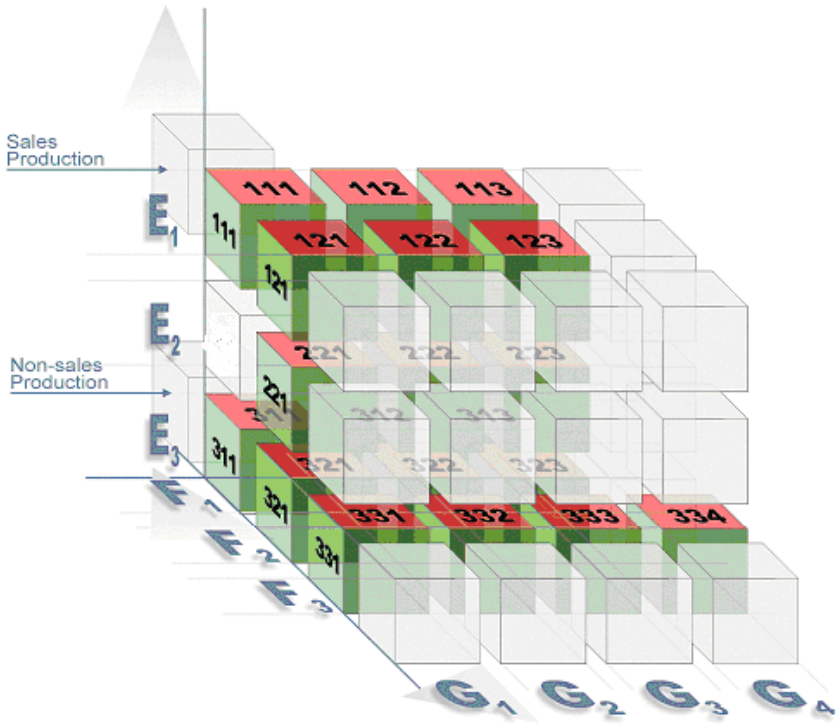

Figure 6. UNFC as applied to petroleum

The following categories of the three sets of criteria shall be used for petroleum:

Table 4. Categories and subcategories for Petroleum

Categories and sub-categories		
E1		**Economic**
	E1.1	Normal Economic
	E1.2	Exceptional Economic
E2		**Potentially economic**
	E2.1	Marginal Economic
	E2.2	Sub-Marginal Economic
E3		**Intrinsically Economic**
	E3.1	Non-sales
	E3.2	Undetermined
	E3.3	Unrecoverable
F1		**Justified Development and/or Production Project**
	F1.1	Project in Production
	F1.2	Committed Development Project
	F1.3	Uncommitted Development Project
F2		**Contingent development project**
	F2.1	Under Justification
	F2.2	Unclarified or On hold
	F2.3	Not Viable
F3		**Project Undefined**
G1		**Reasonably Assured Geological Conditions**
G2		**Estimated Geological Conditions**
G3		**Inferred Geological Conditions**
G4		**Potential Geological Conditions**

The categories are further defined in Chapter 4.

3.2. Classes of remaining petroleum quantities

Classes of remaining recoverable quantities of petroleum may be defined by using combinations of E, F and G categories. Four such classes are:

1. Reserves: code 111,112,113
2. Contingent Resources: code 121,122,123,221,222,223,321,322,323,331,332,333.

Prospective Resources: code 334.Committed Reserves are subset of reserves restricted to F1.1 and F1.2.

Unrecoverable quantities are estimated to remain in-place after the completion of all relevant development and production projects. It is therefore not practical to categorize them by field project status and technical feasibility. Classes of unrecoverable quantities are defined with respect to geological assessment G. Their economic viability is categorized as E3.3. They may be visualised to be contained in the front row of the unnumbered colourless boxes in Figure 6.

As an example, a class of unrecoverable quantities in an accumulation where the geology is Reasonably Assured will be defined by categories E3.2, all of F1 and F2 and F3, G1, or in numerical codes: 3.3;1;1 and 3.3;2;1 and 33;3;1.

3.3. Proved, probable and possible petroleum reserves

Proved petroleum reserves are specifically defined below. The terms probable and possible petroleum reserves are broad terms that are widely used in the petroleum industry. The meaning assigned to them varies. The SPE/WPC definitions, seen in the context of the SPE/WPC/AAPG resource classification, relates proved + probable (2P) reserves directly to the best estimate of committed reserves as defined above. Likewise, proved + probable + possible (3P) reserves relate directly to the high estimate of committed reserves.

In order to make full use of the precision offered by the UNFC, it is recommended not to use the broader, and somewhat ambiguous, terms probable and possible reserves. Instead, the terms low, best and high estimates may be used stating precisely the classes of interest.

In the context of geological knowledge, which includes considerations of reservoir production characteristics, it is intended that category G1 would generally correspond to the level of technical confidence required for proved reserves. Similarly, categories G2 and G3 correspond to the levels of confidence associated with probable and possible reserves respectively. A particular assessment must however also include appropriate consideration of the level of confidence resulting from uncertainties with respect to economic and commercial viability and with respect to field project status and feasibility.

Proved petroleum reserves

Proved reserves are a specifically defined subset of Committed Reserves. Proved reserves are those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known accumulations and under current economic conditions, operating methods, and government regulations. Proved reserves can be categorized as developed or undeveloped.

If deterministic methods are used, the term reasonable certainty is intended to express a high degree of confidence that the quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability that the quantities actually recovered will equal or exceed the estimate.

Proved developed reserves are a particularly important subset of proved reserves. They allow the recognition of reserves for which the investments have been made and are accounted for.

They are defined as follows:

Proved developed reserves are quantities of proved reserves that are estimated to be recovered from existing wells and which will be processed and transported to market using facilities and infrastructure that exist at the date of the estimate.

4. Categories

Cat.	2004 Coal, uranium and other solid minerals		2004 Petroleum	
	Label	Definition	Label	Definition
E1	**Economic**	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a pre-feasibility study, feasibility study or mining report, in order of increasing accuracy, that justify extraction under the technological, economic, environmental and other relevant commercial conditions, realistically assumed at the time of the determination.	**Economic**	Production is justified under the technological, economic, environmental and other relevant commercial conditions, realistically assumed or specified at the time of the estimation
E1.1	Normal Economic	Extraction is justified under competitive market conditions. Thus, the average value of the commodity mined per year must be such as to satisfy the required return on investment.	Normal Economic	Production is justified under normal economic conditions. Assumptions regarding future economic conditions may be constrained by regulation.
E1.2	Exceptional Economic	Exceptional (conditional) economic quantities are at present not economic to extract under normal economic conditions. Their extraction is made possible through government subsidies and/or other considerations.	Exceptional Economic	Exceptional economic quantities are at present not economic to produce under normal economic conditions. Their production is made possible through government subsidies and/or other considerations.
E2	**Potentially Economic**	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a pre-feasibility study, feasibility study or mining Report, in order of increasing accuracy, not justifying extraction under the technological, economic, environmental and other relevant commercial conditions, realistically assumed at the time of the determination, but possibly so in the future.	**Potentially Economic**	Production is not justified under the technological, economic, environmental and other relevant commercial conditions, realistically assumed at the time of the estimation, but which may become justified in the future.
E2.1	Marginal Economic	Marginal economic quantities are quantities that at the time of determination are not economic, but border on being so. They may become economic in the foreseeable future as a result of changes in technological, economic, environmental and/or other relevant commercial conditions.	Marginal Economic	Marginal economic quantities are quantities that at the time of determination are not economic, but border on being so. They may become economic in the foreseeable future as a result of changes in technological, economic, environmental and/or other relevant commercial conditions.
E2.2	Sub-Marginal Economic	Sub-marginal economic quantities are quantities that would require a substantially higher commodity price or a major cost-reducing advance in technology to render them economic.	Sub-Marginal Economic	Sub-marginal economic quantities are quantities that would require a substantially higher commodity price or a major cost-reducing advance in technology to render them economic.
E3	**Intrinsically Economic**	Quantities, reported in tonnes/volume with grade/quality, estimated by means of a geological study to be of intrinsic economic interest. Since the geological study includes only a preliminary evaluation of economic viability, no distinction can be made between economic and potentially economic. These resources are therefore said to lie in the range of economic to potentially economic. Generally only in-situ quantity figures are reported.	**Intrinsically Economic**	Quantities that are of undetermined economic viability or are of no economic interest (unrecoverable).
E3.1	Not used		Non-sales	Quantities that will be produced but not sold
E3.2	Not used	.	Undetermined	Economic viability undetermined.
E3.3	Not used		Unrecoverable	Additional quantities remaining in-place, i.e. the quantities initially in-place less the produced and remaining recoverable quantities.

	2004 Coal, uranium and other solid minerals		2004 Petroleum	
F1	**Mining Report and/or Feasibility Study**	Mining Report and/or Feasibility Study has demonstrated extraction of the reported quantities to be justified. Cost data must be reasonably accurate, and no further investigations should be necessary to make the investment decision. The information basis associated with this level of accuracy comprises the reserve figures based on the results of detailed exploration, technological pilot tests and capital and operating cost calculations such as quotations of equipment suppliers.	**Justified Development and/or Production Project**	Development and/or production plans have demonstrated production of the reported quantities to be justified.
F1.1	Mining Report	A Mining Report is understood as the current documentation of the state of development and exploitation of a deposit during its economic life including current mining plans. The operator of the mine generally makes it. The study takes into consideration the quantity and quality of the minerals extracted during the reporting time, changes in categories of economic viability due to changes in prices and costs, development of relevant technology, newly imposed environmental or other regulations, and data on exploration conducted concurrently with mining. It presents the current status of the deposit, providing a detailed and accurate, up-to-date statement on the reserves and the remaining resources.	Project in Production	The development project is completed and the facilities are producing.
F1.2	Not used		Committed Development Project	Development projects for recovery of a commodity are committed when firm commitments have been made for the expenditures and activities needed to bring a discovered accumulation to the production stage. Undeveloped projects are committed only when it can be clearly demonstrated that there is intent to develop them and bring them to production. Intent may be demonstrated with funding / financial plans, declarations of commerciality, regulatory approvals and satisfaction of other conditions that would otherwise prevent the project from being developed and brought to production. These commitments should be unconditional, except for timing that may be dependent on the development of prior committed projects. An example of this would be where production is dedicated to a long-term sales contract and will only be developed as and when the capacity is required to satisfy the contract.
F1.3	Feasibility Study	A Feasibility Study assesses in detail the technical soundness and economic viability of a mining project, and serves as the basis for the investment decision and as a bankable document for project financing. The study constitutes an audit of all geological, engineering, environmental, legal and economic information accumulated on the project. Generally, a separate environmental impact study is required.	Uncommitted Development Project	Development plans have demonstrated production of the reported quantities to be justified, but commitments to carry out the development works have not yet been made.

	2004 Coal, uranium and other solid minerals		2004 Petroleum	
F2	**Pre-feasibility Study**	A Pre-feasibility Study provides a preliminary assessment of the economic viability of a deposit and forms the basis for justifying further investigations (detailed exploration and feasibility study). It usually follows a successful exploration campaign, and summarizes all geological, engineering, environmental, legal and economic information accumulated to date on the project. The pre-feasibility study addresses the items listed under the feasibility study, although not in as much detail.	**Contingent Development Project**	Development and production of recoverable quantities has not been justified, due to conditions that may or may not be fulfilled.
F2.1	Not used		Under Investigation	Activities are ongoing to justify development and production in the foreseeable future.
F2.2	Not used		Unclarified or On hold	Activities to justify development and production are unclarified or temporarily suspended.
F2.3	Not used		Not Viable	Investigations have indicated that development and production will not be technically justified.
F3	**Geological Study**	A Geological Study is an initial evaluation of economic viability. This is obtained by applying meaningful cut-off values for grade, thickness, depth, and costs estimated from comparable mining operations. Economic viability categories, however, cannot in general be defined from the Geological Study because of the lack of detail necessary for an Economic viability evaluation. The resource quantities estimated may indicate that the deposit is of intrinsic economic interest, i.e. in the range of economic to potentially economic. A Geological Study is generally carried out in the following four main stages: reconnaissance, prospecting, general exploration and detailed exploration (as defined below). The purpose of the geological study is to identify mineralization, to establish continuity, quantity, and quality of a mineral deposit, and thereby define an investment opportunity.	**Project Undefined**	Project evaluation is incomplete or lacks sufficient definition to establish feasibility. This includes projects aiming to identify the presence of petroleum accumulation(s) or projects to improve recovery.
G1	**Detailed Exploration**	Detailed exploration involves the detailed three-dimensional delineation of a known deposit achieved through sampling, such as from outcrops, trenches, boreholes, shafts and tunnels. Sampling grids are closely spaced such that size, shape, structure, grade, and other relevant characteristics of the deposit are established with a high degree of accuracy. Processing tests involving bulk sampling may be required. A decision on whether to conduct a feasibility study can be made from the information provided by detailed exploration.	**Reasonably Assured Geological Conditions**	Quantities that are estimated to be recoverable from a known (drilled) accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a high level of confidence. Quantities in this category that are associated with a development project (i.e. F1) may be subdivided to reflect their development and producing status.

	2004 Coal, uranium and other solid minerals		2004 Petroleum	
G2	**General Exploration**	General Exploration involves the initial delineation of an identified deposit. Methods used include surface mapping, widely spaced sampling, trenching and drilling for preliminary evaluation of mineral quantity and quality (including mineralogical tests on laboratory scale if required), and limited interpolation based on indirect methods of investigation. The objective is to establish the main geological features of a deposit, giving a reasonable indication of continuity and providing an initial estimate of size, shape, structure and grade. The degree of accuracy should be sufficient for deciding whether a Pre-feasibility Study and detailed exploration are warranted.	**Estimated Geological Conditions**	Quantities that are estimated to be recoverable from a known (drilled) accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a reasonable level of confidence.
G3	**Prospecting**	Prospecting is the systematic process of searching for a mineral deposit by narrowing down areas of promising enhanced mineral potential. The methods utilized are outcrop identification, geological mapping, and indirect methods such as geophysical and geochemical studies. Limited trenching, drilling, and sampling may be carried out. The objective is to identify a deposit that will be the target for further exploration. Estimates of quantities are inferred, based on interpretation of geological, geophysical and geochemical results.	**Inferred Geological Conditions**	Quantities that are estimated to be recoverable from a known (drilled) accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a low level of confidence.
G4	**Recon-naissance Study**	A Reconnaissance study identifies areas of enhanced mineral potential on a regional scale based primarily on results of regional geological studies, regional geological mapping, airborne and indirect methods, preliminary field inspection, as well as geological inference and extrapolation. The objective is to identify mineralized areas worthy of further investigation towards deposit identification. Estimates of quantities should only be made if sufficient data are available and when an analogy with known deposits of similar geological character is possible, and then only within an order of magnitude. In the case of uranium, reconnaissance studies identify speculative resources, defined as in-situ resources. This is uranium that is thought to exist, mostly on the basis of indirect evidence and geological extrapolations, in deposits discoverable with existing exploration techniques. The location of deposits envisaged in this category could generally be specified only as being somewhere within a given region or geological trend.	**Potential Geological Conditions**	Quantities that are estimated to be recoverable from an un-drilled accumulation, on the basis of inferred geological and reservoir production performance characteristics.

5. Definitions

5.1. General definitions

Term	Definition
Category	A category is a main subdivision in a set of criteria.
Class	A class is defined by a set of E, F and G categories. A quantity of a commodity is always associated with a class.

Commercial	When a quantity is commercial, this implies that the essential social, environmental and economic conditions are met, including political, legal, regulatory and contractual conditions.
Criteria	Standards for judging commodities. Three sets of criteria (E, F and G) are used.
Deposit	A concentration of a solid commodity in the subsoil. The equivalent term for petroleum is accumulation.
Field project status	Field project status refers to the status of a project to recover the commodity. It ranges from early exploration and research projects, to development, production and abandonment projects. The status of a project is normally defined in terms of a decision moving it from one status to another, such as a commitment to develop.
Initial time	A reference time marking the beginning of the record of produced quantities. Normally this is the time of production start. In instances where the records of historical recovery are not available, a different convenient time may be chosen, provided that the other information relating to the initial state of the deposit or accumulation relates to that time.
Mineral occurrence	An indication of mineralization, that is worthy of further investigation. The term mineral occurrence does not imply any measure of volume or tonnage, grade or quality and is thus not part of a mineral resource.
Non-sales quantities	Those quantities that have been, or are expected to be produced but not sold. This may include quantities that either have been or are expected to be used during the production process, such as for fuel gas, plus those quantities that are removed or lost during the production process (losses).
Sales quantities	Those quantities that have been sold to third parties or that are expected to be available for sale to third parties in the future.

5.2. Definition of uranium terms

Term	**Definition**
Reasonably Assured Uranium Resources	Reasonably Assured Uranium Resources are defined by having the coordinates E1 or E2, F1 and G1, in number code 111 + 211.These resources can also be referred as Proved Mineral Reserve (111) and Feasibility Mineral Resource (211). If the Economic and Feasibility parameters are not available or are not taken into account, uranium resources shall be defined by having the coordinates E3, F3 and G1, in number code 331. These resources are also referred as Measured Mineral Resource (331). Reasonably Assured Uranium Resources refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities that could be recovered within the given production cost ranges with

currently proven mining and processing technology, can be specified. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of project characteristics. Reasonably Assured Resources at prevailing market prices are commonly defined as "Reserves".

Estimated Additional Uranium Resources – Category I

Estimated Additional Uranium Resources – Category I are defined by having the coordinates E1 or E2, F2, and either G1 or G2, in number code 121 + 122 + 221 + 222. These resources can also be referred as Probable Mineral Reserve (121) and (122) and Pre-feasibility Mineral Resource (221) and (222).

If the Economic and Feasibility parameters are not available or are not taken into account, uranium resources shall be defined by having the coordinates E3, F3 and G2, in number code 332. These resources are also referred as Indicated Mineral Resource (332).

Estimated Additional Uranium Resources – Category I refers to uranium, in addition to Reasonably Assured Resources, that is inferred to occur based on direct geological evidence, in extensions of well-explored deposits, or in deposits in which geological continuity has been established but where specific data, including measurements of the deposits, and knowledge of the project's characteristics are considered to be inadequate to classify the resources as Reasonably Assured Resources.

Estimated Additional Uranium Resources – Category II

Estimated Additional Uranium Resources – Category II are defined as a remaining quantity in-place in Category G3 and refers to uranium that is expected to occur in deposits for which the evidence is mainly indirect and which are believed to exist in well-defined geological trends or areas of mineralization with known deposits. Estimates of tonnage, grade, recovery and costs are based primarily on knowledge of characteristics in known deposits within the respective trends or areas and on such sampling, geological, geophysical or geochemical evidence as may be available.

Uranium Production cost

When estimating the cost of production for assigning resources within the cost categories, account has been taken of the following costs:

- The direct costs of mining, transporting and processing of the ore.
- The costs of associated environmental and waste management during and after mining.
- The costs of maintaining non-operating production units where applicable.
- In the case of ongoing projects, those capital costs that remain non-amortised.
- The capital cost of providing new production units, including the cost of financing.
- Indirect costs such as office overheads, taxes and royalties where applicable.
- Future exploration and development costs wherever required for further ore delineation to the stage where it is ready to be mined.

5.3. Definition of petroleum terms

Term	Definition
Accumulation	An individual and separate natural accumulation of petroleum that is confined by impermeable rock or by water barriers and is characterized by a single pressure system. Accumulations may be related to a localized geological structural feature and/or stratigraphic condition, or pervasive throughout a large area (e.g. basin centre gas). The equivalent term for a solid mineral is deposit.
Petroleum	Petroleum is a naturally occurring mixture consisting predominantly of hydrocarbons in the gaseous, liquid or solid phase.
Petroleum in-place	Quantities of petroleum, which have been mapped according to geological methods, and which according to geological and reservoir engineering methods have been estimated to be present in an accumulation.
Reference point	The reference point is a convenient point in the production chain where the produced quantities are measured or assessed. The produced quantities are the sum of the quantities that are brought to cross this point over the period of interest. For quantities that are, or are expected to become commercial, the reference point will typically be the point of sale. This allows the commodity accounts to match the financial accounts. It also ensures that the quantities and qualities of the commodity are uniquely defined. Non-commercial quantities may typically have their reference point at the point of delivery or consumption in the case of usages and consumption in natural economies, and at the point of loss in the case of losses.