FRAMEWORK CLASSIFICATION FOR WORLD ENERGY RESOURCES SURVEY COAL, PETROLEUM[1] AND URANIUM

Draft Explanatory Note and Questionnaire Supplement

The UN/ECE Committee on Sustainable Energy has created an Ad Hoc Group of Experts having the objective to seek to harmonize the reserve/resources terminologies currently applied to different energy commodities (coal, petroleum and uranium). One of the purposes is to serve the World Energy Council's (WEC) tri-annual World Energy Survey (WES).

The harmonization effort of the Ad Hoc Group of Experts is based on the major international energy resources classifications which have recently been elaborated and by which almost all fossil energy resources world wide are classified, namely the UN/CMMI for coal, the SPE/WPC/AAPG for petroleum and the IAEA/NEA for uranium.

Each of these major classifications use a number of individual reserves/resources classes to serve their different specific needs at national and institutional levels. The on-going harmonization effort aims to correlate the different classes by means of codification as introduced by UN Framework Classification (UNFC).

In the UNFC, three independent axes are established to harmonise the characterisation of the petroleum resources. They are:

The economic axis (E or Codes 1xx[2].)
The field/feasibility project axis (F or Codes x2x)
The geologic axis (G or Codes xx3)

The WES aims to provide an overall picture of energy resources availability to guide international resource management. The versatility that UNFC offers permits this to be done in several ways; two of which are pointed out:

Economic emphasis (preference in coal and uranium classification)

The main classes on the economic axis are emphasised. Reserves/Resources are presented in terms of:

- Economically extractable quantities appropriately assessed (Codes 1xx)
- Potentially economically extractable quantities appropriately assessed, which are currently not economic but may be so in the future (Codes 2xx)
- Intrinsically economically extractable quantities with future economic prospects pending appropriate assessment (Codes 3xx)

The emphasis is on the economic potential of the resources with a view to the maturity of the assessments.

Field development emphasis (preference in petroleum classification)

The field development axis is emphasised and resources are discussed in terms of:

- Committed development (Reserves) (Codes x1x)
- Contingent development (Contingent resources) (Codes x2x)
- Prospective resources (Codes x3x)

Emphasis is on the industrial projects aimed at recovering them. In this way, they are tied to time and relate directly to financial and strategic needs.

[1] All liquid and gaseous hydrocarbons, including gas hydrates and bitumen which exist in their natural state in the subsoil, as well as other substances produced in association with such hydrocarbons

[2] x = the sum of the individual classes in question

The two approaches are combined for the purpose of the WES as follows:

Joint class	Codes		
	Coal	**Petroleum**	**Uranium**
Reserves/Economically extractable quantities	111,121,122	111,112,	111,121,122
Contingent Resources /Potentially economically extractable quantities	211,222	121,122,221,222,223,224, 322,	211, 221, 222,311,321,322
Prospective resources and Intrinsically economic extractable quantities	331,332,333,334	234,321,322,323,334	331,332,333, 334

Table 1 The codes of categories included in each joint class (see appendix A for their explanation)

In the last 5 years, since the UNFC was first established, the petroleum sector has improved its basis for resource management by allowing the classification to reflect some of the uncertainty that is attached to exploration and exploitation projects. Emphasising the projects rather than the resources forces consideration of alteration of projects, or in other words, of the real options that are so crucial for ensuring the success of large industrial efforts.

This has created a difference between the way petroleum on one hand and coal and uranium on the other is classified as shown above. Their harmonization is possible by means of the UN codification. This allows at the same time each sector to retain its individual terms in use. This is of importance as they have long standing traditions. The codification allows furthermore the content of the three major groups of terms for use by WEC to be joined as shown below.

Reserves respectively Economically Extractable Quantities (Code 1xx)
Quantities of petroleum, coal and uranium that are commercially recoverable from a given date forward as result of development and production commitments. Geological, technical and economic viability have been resolved including all relevant legal environmental and other relevant aspects of commercialisation.
The following individual classes are grouped together:

Coal (UN/CMMI)
- Proved Mineral Reserve (Code 111)
- Probable Mineral Reserve (Code 121 + 122)

Uranium (IAEA/NEA)
- RAR (<US $ 40/kg U) (Code 111)
- EAR-I (<US $ 40/kg U) (Code 121 + 122)

Petroleum
Reserves (Proved reserves, Code 111 + Unproved reserves, Code 112)

Contingent Resources respectively Potentially Economically Extractable Quantities (Code 2xx)
Quantities of petroleum, coal and uranium which are not currently considered being commercially recoverable but estimated to be potentially so in the future. Geological, technical and economic viability have been assessed but not resolved, including all relevant legal environmental and other relevant aspects of commercialisation. They may include, for example, accumulations for which there is currently no viable market or where commercial recovery is dependent on the development of new technology. Quantities of petroleum where evaluation of the accumulation is still at an early stage are included.
The following individual classes are grouped together:

Coal (UN)

Feasibility Mineral Resource (Code 211)

Prefeasibility Mineral Resource (Code 221 + 222)

Uranium

RAR (US $ 40–80/kg U) (Code 211)

EAR-I (US & 40-80/kg U) (Code 211 + 222)

RAR (US $ 80-130/kgU) (Code 311)

EAR-I (US $ 80-130/kgU) (Code 321+322)

Petroleum

Contingent resources that are commercial on economic grounds, with all degrees of discovered geologic definition (Proved, explored and delineated or just discovered) Codes 121, 122, 123.

Contingent resources that are contingent also on economic grounds, with all degrees of geologic definition. Codes 221, 222, 223.

Contingent resources that are non-commercial on economic grounds, and that are explored and delineated or just discovered. Codes 322 and 323.

Prospective Resources respectively Intrinsically Economic Quantities (Code 3xx)
Quantities of petroleum that are postulated from geological information and theory to be potentially recoverable from outside of known oil and gas fields. In the case of coal and uranium, quantities of geologically assessed deposits that have not yet been subject to extraction and economic assessment, are covered, and (for uranium) quantities that are 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 (Speculative Resources).. The common aspect is that these quantities warrant further assessment.
The following individual classes are grouped together:

Coal (UN/CMMI)

Measured Mineral Resource (Code 331)

Indicated Mineral Resource (Code 332)

Inferred Mineral Resource (Code 333)

Reconnaissance Mineral Resource (Code 334 UN only)

Uranium

RAR in-situ (Code 331)

EAR-I in-situ (Code 332)

EAR-II (Code 333)

Speculative (Code 334)

Petroleum

Prospective resources with contingent commerciality on economic grounds (Code 234)
Contingent resources that are non-commercial on economic grounds from accumulations with all degrees of geologic definition (proved), explored and delineated, or just discovered geology (Code 321, Code 322 and 323) Prospective resources that are non-commercial on economic grounds (Code 334)

The natural reference point at which commercial energy carriers are quantified is the point of sale.

Quantities of petroleum present in the subsoil are in this context referred to as in-place quantities. It is considered to be supplemental and not primary information.

The quantity of petroleum recoverable through industrial production projects is uncertain in two distinct ways. One is related to quantities, the other to whether a recovery project will be carried out or not:

The quantity to be produced through the execution of any one project will have some uncertainty associated with it, normally expressed by use of a continuous probability distribution function or some other form reflecting such a function. For the purpose of aggregating the world energy resources it is not justified to take account of the non-correlated elements of this uncertainty, as the deviations (positive and negative) are expected to cancel out and be negligible in the aggregate, relative to the expected value (the law of large numbers due to diversification). The correlated elements, and in particular those that relate to world economic framework conditions including prices and costs, global technological development, geopolitical conditions etc… will impact the uncertainty of the aggregate in full, and must be of concern.

Whether a given project, or a required series of projects, will be executed may be uncertain. For projects designated to produce reserves, this uncertainty will have been eliminated for all practical purposes. Projects to discover prospective resources and projects to mature contingent resources to reserves will all normally have a discrete risk of failure associated with them. This may be expressed qualitatively through the classification, or quantitatively as a probability, depending on the application. For the purpose of aggregating world resources of petroleum it will be necessary to discount the contingent and prospective resources taking into account the risk that the projects required to produce them will not be carried out.

Appendix A Terms and definitions of individual codes

Coal

The below given terms and definitions, and with those of Appendix B are taken from the document: UNITED NATIONS INTERNATIONAL FRAMEWORK CLASSIFICATION FOR RESERVES/RESOURCES – Solid Fuels and Mineral Commodities- Final Version. ENERGY/WP.1/R.70; 17 February 1997 (page 15 to 17).
The definitions of the UN Framework Classification are abbreviated. All terms used like "economic", "Feasibility Study" etc. is defined in the above-mentioned UN document on page 14 to 17 and is attached below. CMMI (Council of Mining and Metallurgy Institutions) agreed in November 1999 to join its definitions with the UN definitions. The content of both definitions is identical even though the wording is different.
The codification as introduced by the UN classification on page 8 of the above mentioned document is attached.

Terms and Code	UN Framework Classification	CMMI
Proved Mineral Reserve (111)	Demonstrated to be economically mineable by a Feasibility Study or actual mining activity usually undertaken in areas of Detailed Exploration.	A 'Proved Mineral Reserve' is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, and include consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal,

Terms and Code	UN Framework Classification	CMMI
		metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate, with a high level of confidence at the time of repor ting, that extraction is justified.
Probable Mineral Reserve (121+122)	Demonstrated to be economically mineable by a Prefeasibility Study usually carried out in areas of Detailed Exploration and General Exploration.	A 'Probable Mineral Reserve' is the economically mineable part of an Indicated and, in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments, which may 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 at the time of reporting that extraction is justified.
Feasibility Mineral Resource (211)	Demonstrated to be potentially economic by a Feasibility Study or prior mining activity usually carried out in areas of Detailed Exploration.	Not available
Prefeasibility Mineral Resource (221 + 222)	Demonstrated to be potentially economic by a Prefeasibility Study usually carried out in areas of Detailed Exploration and General Exploration.	Not available
Measured Mineral Resource (331)	Estimated to be of intrinsic economic interest based on Detailed Exploration establishing all relevant characteristics of a deposit with a high degree of accuracy.	A 'Measured Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and/or grade continuity.
Indicated Mineral Resource (332)	Estimated to be of intrinsic economic interest based on General Exploration establishing the main geological features of a deposit providing an initial estimate of size, shape, structure and grade	An 'Indicated Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm

Terms and Code	UN Framework Classification	CMMI
	grade.	geological and/or grade continuity but are spaced closely enough for continuity to be assumed. An Indicated Mineral Resource has a lower level of confidence than that applying to a Measured Mineral Resource, but has a higher level of confidence than that applying to an Inferred Mineral Resource.
Inferred Mineral Resource (333)	Estimated to be of intrinsic economic interest based on Prospecting having the objective to identify a deposit. Estimates of quantities are inferred, based on outcrop identification, geological mapping, indirect methods and limited sampling.	An 'Inferred Mineral Resource' is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which is limited, or of uncertain quality and reliability. An Inferred Mineral Resource has a lower level of confidence than that applying to an Indicated Mineral Resource.
Reconnaissance Mineral Resource (334)	Based on Reconnais-sance, having the objective to identify areas of enhanced mineral potential. 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.	Not available

Petrole um

Code:111: Proved reserves (SPE/WPC definition)

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 reservoirs 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.

Establishment of current economic conditions should include relevant historical petroleum prices and associated costs and may involve an averaging period that is consistent with the purpose of the reserve estimate, appropriate contract obligations, corporate procedures, and government regulations involved in reporting these reserves.

In general, reserves are considered proved if the commercial producibility of the reservoir is supported by actual production or formation tests. In this context, the term proved refers to the actual quantities of petroleum reserves and not just the productivity of the well or reservoir. In certain cases, proved reserves may be assigned on the basis of well logs and/or core analysis that indicate the subject reservoir is hydrocarbon bearing and is analogous to reservoirs in the same area that are producing or have demonstrated the ability to produce on formation tests.

The area of the reservoir considered as proved includes (1) the area delineated by drilling and defined by fluid contacts, if any, and (2) the undrilled portions of the reservoir that can reasonably be judged as commercially productive on the basis of available geological and engineering data. In the absence of data on fluid contacts, the lowest known occurrence of hydrocarbons controls the proved limit unless otherwise indicated by definitive geological, engineering or performance data.

Reserves may be classified as proved if facilities to process and transport those reserves to market are operational at the time of the estimate or there is a reasonable expectation that such facilities will be installed. Reserves in undeveloped locations may be classified as proved undeveloped provided (1) the locations are direct offsets to wells that have indicated commercial production in the objective formation, (2) it is reasonably certain such locations are within the known proved productive limits of the objective formation, (3) the locations conform to existing well spacing regulations where applicable, and (4) it is reasonably certain the locations will be developed. Reserves from other locations are categorized as proved undeveloped only where interpretations of geological and engineering data from wells indicate with reasonable certainty that the objective formation is laterally continuous and contains commercially recoverable petroleum at locations beyond direct offsets.

Reserves which are to be produced through the application of established improved recovery methods are included in the proved classification when (1) successful testing by a pilot project or favorable response of an installed program in the same or an analogous reservoir with similar rock and fluid properties provides support for the analysis on which the project was based, and, (2) it is reasonably certain that the project will proceed. Reserves to be recovered by improved recovery methods that have yet to be established through commercially successful applications are included in the proved classification only (1) after a favourable production response from the subject reservoir from either (a) a representative pilot or (b) an installed program where the response provides support for the analysis on which the project is based and (2) it is reasonably certain the project will proceed.

Code 111+112: Reserves (proved and unproved): Quantities of petroleum that are anticipated to be commercially recovered from known accumulations with proved geological conditions and from explored and delineated accumulations from a given date forward as a result of development and production commitments.

Code 121: Quantities of petroleum anticipated to be commercially recovered from known accumulations with proved geological conditions from a given date forward as a result of

development and production commitments contingent upon project conditions that may or may not be fulfilled.

Code 122: Quantities of petroleum anticipated to be commercially recovered from explored and delineated accumulations from a given date forward as a result of development and production commitments contingent upon project conditions that may or may not be fulfilled.

Code 221: Quantities of petroleum from known accumulations with proved geological conditions anticipated to be commercially recovered from a given date forward contingent upon commercial and project conditions that may or may not be fulfilled.

Code 222: Quantities of petroleum from explored and delineated accumulations anticipated to be commercially recovered from a given date forward contingent upon commercial and project conditions that may or may not be fulfilled.

Code 223: Quantities of petroleum from discovered accumulations anticipated to be commercially recovered from a given date forward contingent upon commercial and project conditions that may or may not be fulfilled.

Code 224: Quantities of petroleum from prospective accumulations (not yet discovered) anticipated to be commercially recovered from a given date forward contingent upon commercial and project conditions that may or may not be fulfilled (the prospective discovery must be confirmed).

Code 322: Quantities of petroleum from explored and delineated accumulations that for the time being are not regarded as commercial on economic grounds and that also are contingent on project conditions that may or may not be fulfilled.

Code 323: Quantities of petroleum from discovered accumulations that for the time being are not regarded as commercial on economic grounds and that also are contingent on project conditions that may or may not be fulfilled

Code 234: Quantities of petroleum from prospective accumulations (not yet discovered) anticipated to be commercially recovered from a given date forward contingent upon conditions that may or may not be fulfilled (the prospective discovery must be confirmed).

Code 334: Quantities of petroleum from prospective accumulations (not yet discovered) that for the time being are not regarded as commercial on economic grounds, anticipated to be commercially recovered from a given date forward (the prospective discovery must be confirmed).

Code 321: Quantities of petroleum from known accumulations with proved geological conditions, that for the time being are not regarded as commercial on economic grounds, and that also are contingent upon project conditions that may or may not be fulfilled.

Code 322: Quantities of petroleum from explored and delineated accumulations that for the time being is not regarded as commercial on economic grounds, and that also are contingent upon project conditions that may or may not be fulfilled.

Uranium

Code: 111 Term: Reasonably Assured Resources (RAR) (<US $ 40/kg U)

(Proved Mineral Resources)

Definition: Refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities which could be recovered at a cost below $ 40/kg U, 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 deposit characteristics.

Code: 121, 122:Term: Estimated additional Resources-Category 1 (EAR-1) (< $ 40/kg U)

(Probable Mineral Resources)

Definition: Refers to uranium, in addition to RAR, 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 deposit's characteristics are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit's characteristics as determined in the best known parts of the deposits or in similar deposits. Uranium could be recovered at a cost below $ 40/kg U, with currently proven mining and processing technology.

Code: 211: Term: Reasonably Assured Resources (RAR) ($ 40-$ 80/kg U)

(Feasibility Mineral Resources)

Definition: Refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities that could be recovered at a cost comprised between $ 40/kg U and $ 80/kg U, 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 deposit characteristics.

Code: 221, 222:Term: Estimated additional Resources-Category 1 (EAR-1) ($40/kg U-$80/kgU)

(Pre-feasibility Mineral Resources)

Definition: Refers to uranium, in addition to RAR, 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 deposits' characteristics are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best known parts of the deposits or in similar deposits. Uranium could be recovered at a cost comprised between $ 40/kg U and $ 80/kg, with currently proven mining and processing technology.

Code: 311: Term: Reasonably Assured Resources (RAR) ($ 80-$ 130/kg U)

(Potentially Economic Feasibility Mineral Resources)

Definition: Refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities that could be recovered at a cost comprised between $ 80/kg U and $ 130/kg U, with currently proven mining and processing technology, can be specified (these deposits may have been economic or potentially economic at a certain period of time). Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics.

Code: 321, 322:Term: Estimated additional Resources-Category 1 (EAR-1) ($80/kg U-$130/kgU)

(Potentially Economic Pre-Feasibility Mineral Resources)

Definition: Refers to uranium, in addition to RAR, 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 deposits' characteristics are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best known parts of the deposits or in similar deposits.

Uranium could be recovered at a cost comprised between $ 80/kg U and $ 130/kg, with currently proven mining and processing technology. (These deposits may have been economic or potentially economic at a certain period of time).

Code: 331: Term: Reasonably Assured Resources (RAR) (< $ 130/kg U)

(Measured Mineral Resources)

Definition: Refers to uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities that could be recovered at a cost comprised below $ 130/kg U, 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 deposit characteristics. No feasibility study has been made on these deposits.

Code: 332:Term: Estimated additional Resources-Category 1 (EAR-1) (< $130/kgU)

(Indicated Mineral Resources)

Definition: Refers to uranium, in addition to RAR, 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 deposits' characteristics are considered to be inadequate to classify the resource as RAR. Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best known parts of the deposits or in similar deposits. Uranium could be recovered at a cost below $ 130/kg, with currently proven mining and processing technology. . No feasibility study has been made on these deposits.

Code: 333:Term: Estimated additional Resources-Category 2 (EAR-2) (< $130/kgU)

(Inferred Mineral Resources)

Definition: Refers to uranium, in addition to EAR-1, 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 and cost of discovery, delineation and recovery are based primarily on knowledge of deposit characteristics in known deposits within the respective trends or areas and on such sampling, geological, geophysical or geochemical evidence as may be available.

Code: 334:Term: Speculative Resources(< $130/kgU)

(Reconnaissance Mineral Resources)

Definition: Refers to uranium, in addition to EAR-2, 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. As the term implies, the existence and size of such resources are speculative.

Appendix B

Definitions of Terms to be used in the English Language Version of the United Nations International Framework Classification for Reserves/Resources - Solid Fuels and Mineral Commodities -[3]

Definitions of Stages of Feasibility Assessment

Mining Report	A **Mining Report** is understood as the current documentation of the state of development and exploitation of a deposit during its economic

[3] Quoted from UN ECOSOC Document Energy/wp.1/R.70 of 3rd February, 1997

	life including current mining plans. It is generally made by the operator of the mine. The study takes into consideration the quantity and quality of the minerals extracted during the reporting time, changes in Economic Viability categories 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.
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. Cost data must be reasonably accurate (usually within ± 10 %), 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. A detailed list of the items addressed in a Feasibility Study is given in Appendix III.

Definitions of Stages of Feasibility Assessment (Cont.)

Prefeasibility Study	A **Prefeasibility 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. In projects that have reached a relatively advanced stage, the Prefeasibility Study should have error limits of ± 25 %. In less advanced projects higher errors are to be expected. Various terms are in use internationally for Prefeasibility Studies reflecting the actual accuracy level. The data required to achieve this level of accuracy are reserves/resources figures based on Detailed and General Exploration, technological tests at laboratory scale and cost estimates e.g. from catalogues or based on comparable mining operations. The Prefeasibility Study addresses the items listed under the Feasibility Study, although not in as much detail.
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 (for definition of each stage see 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.

Definitions of Stages of Geological Study

(cont.)

Reconnais-sance	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.
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 which will be the target for further exploration. Estimates of quantities are inferred, based on interpretation of geological, geophysical and geochemical results.
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 Prefeasibility Study and Detailed Exploration are warranted.
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 whether to conduct a Feasibility Study can be made from the information provided by Detailed Exploration.

Definitions of Economic Viability Categories

(cont.)

Economic	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a Prefeasibility Study, Feasibility Study or Mining Report, in order of increasing accuracy, that justify extraction under the technological, economic, environmental and other relevant conditions, realistically assumed at the time of the determination. The term economic comprises both normal economic and exceptional economic as defined below. These two subcategories are for optional use on a national level.
Normal Economic	Normal economic reserves are reserves that justify extraction 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.
Exceptional Economic (conditional economic)	Exceptional (conditional) economic reserves are reserves which at present are not economic under competitive market conditions. Their exploitation is made possible through government subsidies and/or other supportive measures.
Potentially Economic	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a Prefeasibility Study, Feasibility Study or Mining Report, in order of increasing accuracy, not justifying extraction under the technological, economic, environmental and other relevant conditions, realistically assumed at the time of the determination, but possibly so in the future. The term potentially economic comprises both marginal and submarginal as defined below. These two subcategories are for optional use on a national level.
Marginal Economic	Marginal economic resources are resources which at the time of determination are not economic, but border on being so. They may become economic in the near future as a result of changes in technological, economic, environmental and/or other relevant conditions.
Submarginal Economic	Submarginal economic resources are resources that would require a substantially higher commodity price or a major cost-reducing advance in technology to render them economic.
Economic to Potentially Economic (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[1] . These Resources are therefore said to lie in the range of economic to potentially economic.

[1] Except in the case of low investment mineral commodities like sand, gravel and common clay, where a distinction between economic and potentially economic can be made.

6. Codification

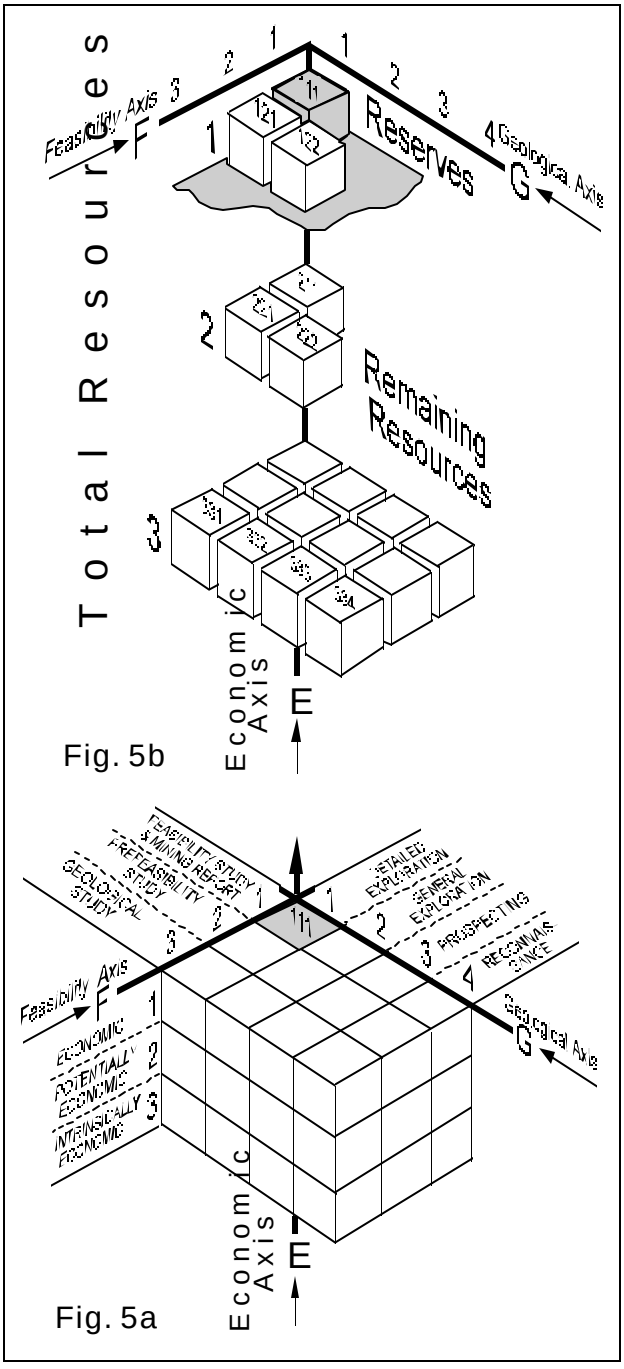
The incorporation of existing classification systems into the UN Framework Classification and their comparison will be further simplified by means of codification acting as interface. Codification has the further advantage of providing a short, unambiguous identification of the reserve/resource categories[1] which facilitates computer processing of data and exchange of information. During the Workshop in Hanover, the codification systems in use were discussed in detail; finally it was agreed that numerical codification of the UN Framework Classification would be most advantageous [50].

[1] Geostatistics have been proposed for this purpose. However, so far currently they are only used in the case of a Feasibility Study and occasionally in a Prefeasibility Study.

Figure 5a shows the principle behind the proposed codification of the UN Framework Classification, the three dimensions of categorization represented by the edges of a cube, the E (Economic) axis for Economic Viability, the F (Feasibility) axis for Feasibility Assessment, and the G (Geology) axis for Geological Study. The digits are quoted in the order EFG firstly because alphabetical order is easy to memorise, and secondly because the first digit refers to the Economic Viability, which is of decisive interest to both mining company and investor.

Numbers are used to designate the different classes; the lowest number, in accordance with the usual perception that the 1st is the best, referring to the highest degree of Economic Viability on the E axis, and the highest degree of assurance on the F axis and G axis. Figure 5b represents an "exploded" three dimensional layout of Figure 5a showing the codified classes which are applicable in practice.

The class coded 111, which is shaded in Figure 5a and 5b, is of prime interest to an investor: it refers to quantities that are economically mineable (number 1 as the first digit), have been proved by means of a Feasibility study or actual mining (number 1 as the second digit), and are based on Detailed Exploration (number 1 as the third



Draft comments for discussion

There should be a list of the questions that need to be reviewed and resolved before finalising the draft. An initial list is provided below:

In place and recoverable quantities

Petroleum resources will be recovered from natural occurrences of petroleum in the subsoil through industrial projects. Recoverable quantities are related primarily to the industrial projects. Their classification reflects the economics, the field development and production status as well as the degree of geological definition of the projects, and as a consequence, their activities, costs, production and emissions.

The industrial projects are in turn related to the quantities in place. There will always be an initial project, that first recovers petroleum from an in place quantity. Normally, this is followed by additional projects for improved recovery that draws on the same in-place quantities. In the classification, the in place quantities are part of the administrative information defining the projects. The in-place quantities may be categorised using the categories that reflect geologic definition (the G-axis). Accounts of in-place quantities are always kept separate from the accounts of recoverable quantities.

Suggested advice: In place quantities should be accounted for separately from the recoverable quantities and included with the administrative data defining the recovery projects. The subdivision of the Geology axis should be used to further subdivide the in place quantities.

Reserves and resources reference point:

For purposes of reporting quantities of commercial energy, it is natural to use the point of sale into the market as the reference point at which reserves and resources are quantified.

Quantities recovered, but lost, upstream of this point are neither reserves nor resources. If they are used upstream of the reference point, in for instance the production process, then they may be counted as reserves or resources, provided that they are included in the production cost. Quantities that are used in the recovery and production processes upstream of the reference point are in practice often not taken into account as reserves or resources.

For uranium, point of sale would mean uranium as yellow-cake, or recoverable resources, mining and milling losses deducted. However, prospective resources (Code 33x) are reported as in-situ resources, as there is no Economy/Feasibility study.

If the resources are not introduced into a market, but used by the producer, as is the case for companies that have integrated up-and -downstream activities, an equivalent sales point is normally defined, at which market prices are known, or can be estimated through netback procedures or otherwise.

In barter economies, it may not be meaningful to use the concept of sale. Coal may in certain regions be used as a non-commercial energy resource, like firewood is in other regions.

Suggested advice: It should be clarified whether bartered is a concern for the WES. If this is of concern, agree a practical point at which quantification should take place.

Treatment of systematic uncertainty caused by "global" factors

The UNECE is actively addressing how to improve global factors, whose uncertainty may threaten or improve the availability of energy resources. It is therefore natural to ask whether the WES should be built to support these activities by allowing information on sensitivity to changes in global factors to be displayed. At the outset, this may seem too complex a task to undertake, but not to discuss.

Suggested advice: Discuss the issue with the UNECE. As a minimum, propose that these uncertainties continue to be managed outside the WES. If this is agreed, discuss the use of standardised global conditions with the WEC. These are the political, legal and administrative frameworks, the technical and operational conditions, the environmental constraints and the market conditions amongst others. A starting point for discussion may be to consider the relevance of existing conditions.

Treatment of uncertainty with respect to whether development and production projects will be carried out

At the meeting of the Petroleum Group in September 2002, it was found necessary to introduce a way of discounting contingent and prospective resources for the risk that the projects required to produce them will not be carried out. For prospective resources there is a well-established practise for doing so. This can be adapted easily. However, it has not been widely done for contingent resource. The need to do so is often not present as it will be sufficient to subdivide the contingent resources into sub-categories and manage them form there. The UNFC is particularly well suited for this practise as it allows distinction between projects that are contingent on economic conditions, field development conditions (both with respect to technology and maturity), conditions of geologic definition or a combination of these.

It is recognised that for the purpose of aggregating world reserves and resources in WES, it will be necessary to discount the contingent resources taking into account the risk that they may not be produced. As a very practical measure, it was evaluated to use the categorisation, and to disregard certain subcategories completely, while others where accounted for in full, to arrive at an expected value of future production from contingent resources. Locally, this may be a satisfactory procedure, provided that there is sufficient insight into the detail to ascertain that the result is relevant. In the general case, and for WES in particular, greater rigor is required as the large size of resource base prevents access to the details.

Suggested advice: Request that contingent and prospective resources be discounted for the risk that they may not be produced. Each reporter will then have to evaluate how to do this, taking into account the nature of the information available locally.

Conversion factors

Conversion factors between energy carriers will need to be established. This can be finalised late in the discussions, but principles may be discussed early. The natural choices are:

1. Conversion to energy units

2. Use of conventions to convert to one energy carrier. Oil seems to be taking over from coal as the preferred energy carrier to convert to, the unit being oil equivalent. Mass and volume are both in use. Conversions in use take account of energy content, mass, volume and to some extent also value. The consideration of value creates a preference for the use of volume equivalents over mass equivalents as the lighter oils normally fetch a higher price than the heavier ones.

Suggested advice: Propose to the WEC that reports to the WES be made in units of energy, and refine the procedures for doing so. Allow the database to be structured in such a way that reporters may present results in units of energy or in units of an equivalent energy carrier of their choice.

Uranium : Conversion factors to energy depend on type of NPP, enrichment factor, burnup, …. Report should be made as tonnes of uranium, then converted by WEC to units of energy.