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Geneva, 29 April – 3 May 2019
Item 9 (i) of the provisional agenda
Development, maintenance and implementation of the United Nations Framework Classification for Resources and the United Nations Resource Management System: Commercial aspects and financial reporting

The United Nations Framework Classification for Resources Applied to Commercial Assessments – draft considerations

Prepared by the Commercial Working Group of the Expert Group on Resource Management

• *Summary*

- *This report serves as background for the further work of the Working Group on Commercial Applications of the United Nations Framework Classification for Resources (Commercial Working Group) and as a basis for the discussions on this topic at the tenth session of the Expert Group on Resource Management.*
- *It recognises the need to distinguish between quantities that are ready for buying and selling in a market and are defined as commercial quantities, from those quantities that are produced for direct use without going through a market.*
- *The United Nations Framework Classification for Resources (UNFC) is well suited to classify both. No substantial change is required in its structure. However, the term commercial displayed in UNFC needs to be replaced by a term covering both types of quantities. Furthermore, "economic" needs to be defined in a way that is relevant to both. The term is taken to mean that the benefits derived from the quantities exceed the efforts of obtaining them. This is often expressed in monetary terms that will require a revenue, which is not necessarily relevant for quantities that will be used without being sold.*
- *The above conclusion is communicated now since it may impact the ongoing update of UNFC.*
- *Further conclusive work from the Commercial Working Group will await the outcome of the update in order to ensure that the official communication from the Expert Group on Resource Management over the longer term is internally consistent.*

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I. Acknowledgements

1. The Commercial Working Group is grateful for the attention and support extended to it by the Technical Advisory Group through its Chairperson, Alistair Jones and members of the group. In particular, we wish to thank Satinder Purewal, Chairperson of the Petroleum Working Group and members of that Group Andrew Barrett, Barbara Pribyl and Claudio Virues for their diligent and constructive review. We also wish to thank Ulrich Kral, Chairperson of the Anthropogenic Working Group for his always very clear guidance. Our thanks also go to the Bureau of the Expert Group on Resource Management, and in particular its members Bernard Seiller, Bradley van Gosen and Roger Dixon for their review, judgement and support.

We thank the firms Legal & General Investment Management and Sullivan & Cromwell LLP for hosting meetings of the Working Group in London.

II. Terms of Reference and Members of the Commercial Working Group

2. At its ninth session, the United Nations Economic Commission for Europe Expert Group on Resource Classification (now Expert Group on Resource Management, effective as of December 2018) took the following decision:

> "**(g) Commercial aspects and financial reporting**
>
> 13. The Expert Group recommended the Commercial Working Group to review developments related to commercial aspects and assess how they are reflected in UNFC to support commercial assessments of projects. The Expert Group further recommended the Working Group to prepare guidelines to facilitate commercial assessments, including guidance on the use of categories of UNFC and submit it to the tenth session."

3. Members of the Commercial Working Group are:

- Carolina Coll, International Finance Corporation
- Daniel Trotman, EY
- David Elliott, Expert
- Julian Hilton, Aleff Group
- Kathryn A. Campbell, Attorney
- Michal Lynch-Bell, Independent Director
- Nick Stansbury, Legal and General Investment Management
- Sigurd Heiberg, Petronavit a.s. and PETRAD (Chairperson)
- Steve Griffiths, ERC Equipoise Ltd.

III. Introduction

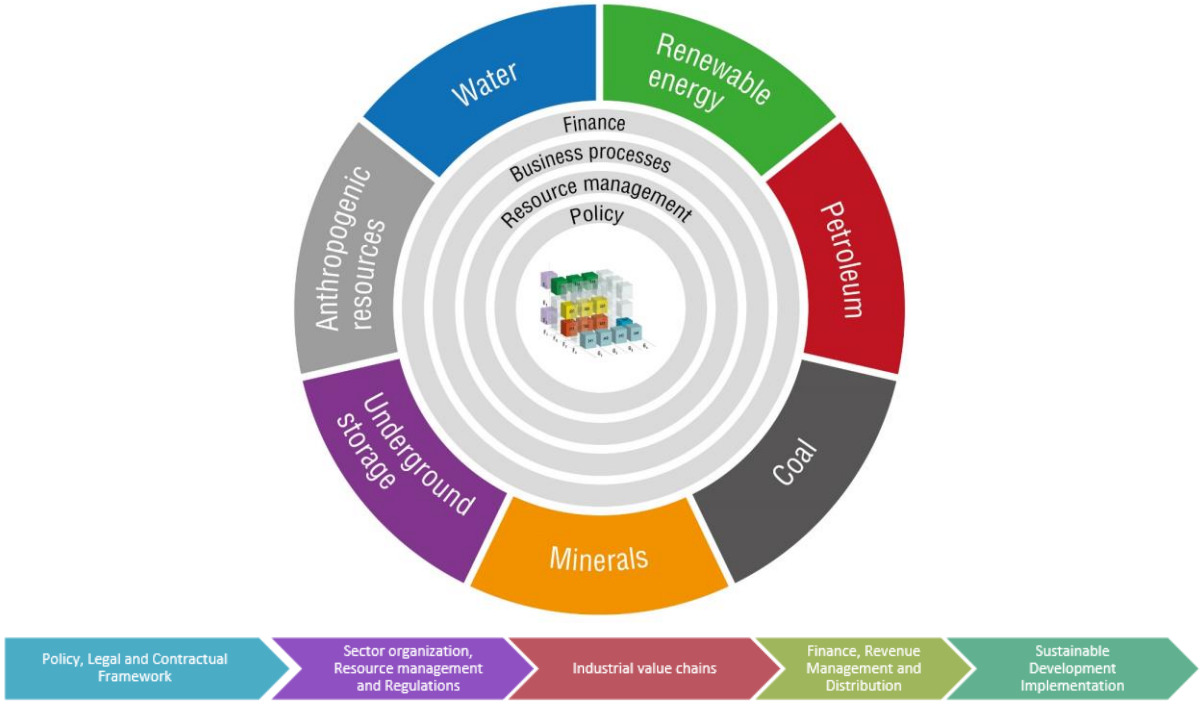
4. Commercial assessments are important in judging paths for providing the vast amounts of energy and raw material services required for reaching the United Nations Sustainable Development Goals (SDGs) and at the same time meeting the ambitions for climate change mitigation in ways that the capital market can finance.

5. This report is written as background for a discussion by the Expert Group on Resource Management at its tenth session (Geneva, 29 April – 3 May 2019). The intention is to produce a guidance based on this document at a later stage, taking into account inter alia the revisions of the United Nations Framework Classification for Resources (UNFC) that are underway.

6. The report contains:

- An introduction to how UNFC can be used in assessments of commercial quantities produced by the projects. These are defined as quantities ready for selling and buying in in a market, i.e. by a project that will be executed unconditionally. While these assessments are made by both sellers and buyers, they are of particular importance for buyers who aim to commit to long term purchase of the products.
- A description of asset transactions, i.e. the selling and buying of legal rights to participate in projects.
- An introduction to portfolio optimisation.
- A view on public and financial reporting.
- A view on the handling of complex portfolios.

Figure I
Applications of UNFC (UNECE, 2013)



Note: Nuclear fuels are included here in minerals but do require special attention and are handled by a separate working group of the Expert Group on Resource Management

7. The factors to consider when applying UNFC in helping make commercial assessments are reviewed. The assessments are generally focused on value in one form or another.

8. Finally, the report identifies issues to consider from the point of view of facilitating commercial assessments when updating UNFC before concluding and recommending the next steps to consider.

9. The report uses the definitions given at the end of the report. The defined terms, such as commercial are identified in blue colour in the text where they occur.

IV. Valuation

10. Valuation is identified as a subject to be further elaborated in future guidance. It is not the intention to cover this important subject exhaustibly here. Some key concepts are highlighted for completeness of this document.

11. Commercial assessments are strongly linked to valuation. Project valuation is typically required internally by entities for future investment and operation. It is also required for selling or buying an asset. Asset valuation could be a complex process that requires a

careful consideration of the assumptions and methodologies applied. Depending on the type of asset and available information, different methods can be used for valuation. Analysis of net present value of a discounted cash flow (DCF) is typically one of them. All future cash flows are estimated and discounted using a discount rate to give their net present value. Aspects to consider in valuation beyond the cash flows are what discount rate to use for a project or an asset. It will always reflect the time value of money. It may also be used as a blunt instrument to account for the risk of projects underperforming. Alternatively, the risks and opportunities may be accounted for as real options associated with the cash flow (Laughton, Guerrero, & Lessard, 2008).

12. Commercial assessments may require an assessment of:

- Time distributed future costs and revenues, and thereby of produced quantities
- Uncertainties in these costs and revenues
- Future framework conditions distributing costs and revenues to stakeholders (assets) including government
- Uncertainties in future frameworks, including but not limited to policy measures enforced to reach the SDGs and climate ambitions. In particular, the effects of imposing a sufficient greenhouse gas cost to limit emissions to tolerable levels may need to be considered.

13. UNFC is often displayed as a three-dimensional system with 3 axes describing the different classes of projects and quantities (see Figures III and V). Other classification systems are usually two dimensional in nature (see Figure II). Each class (box) in the 3-D system can have assigned a different risk by the valuator. A strength of UNFC is that it facilitates separate assessments of the risk of project feasibility and of economic, social and environmental acceptability. This allows different weights to be assigned to each.

14. The aggregate value of a set of projects or assets in different commodities will sometimes need to be assessed. UNFC is uniquely positioned to perform valuation of complex portfolios and comparative analyses of different commodities. It avoids the normalization that is required when using separate classification systems for each commodity (see Figure IV).

Figure II
Two dimensional classifications

CRIRSCO Template		UNFC-2009 "minimum" Categories			UNFC-2009 Class
Mineral Reserve	Proved	E1	F1	G1	Commercial Projects
	Probable			G2	
Mineral Resource	Measured	E2	F2	G1	Potentially Commercial Projects
	Indicated			G2	
	Inferred			G3	
Exploration Target		E3	F3	G4	Exploration Projects

2-D systems
CRIRSCO For valuation
Project risk = risk G axis x risk E&F axes

Code	Class	Sub-class
1	Commercial Projects	On Production
2		Approved for Development
3		Justified for Development
4	Potentially Commercial Projects	Development Pending
5		Development on Hold
6	Non-Sales / Non-Utilized Production	
7	Non-Commercial Projects	Development Unclarified
8		Development Not Viable
9	Exploration Projects	[Prospect], [Target Outline]
10		[Lead], [Early Exploration]
11		[Play], [Grassroots]
12	Additional Quantities in Place	

2-D systems
SPE PRMS
G vs E&F combined

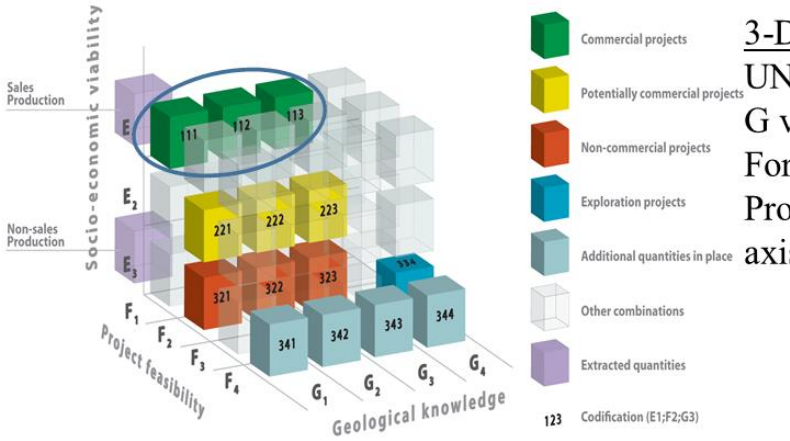
For valuation
Project risk =risk G axis x risk E&F axes

Figure III
Three independent categories facilitate assessments of project realisation

	E3.3	E3.2	E3.1	E2	E1
F1.1					1
F1.2					2
F1.3					3
F2.1				4	
F2.2		7		5	
F2.3	8		6		
F3.1		9			
F3.2		10			
F3.3		11			
F4	12				

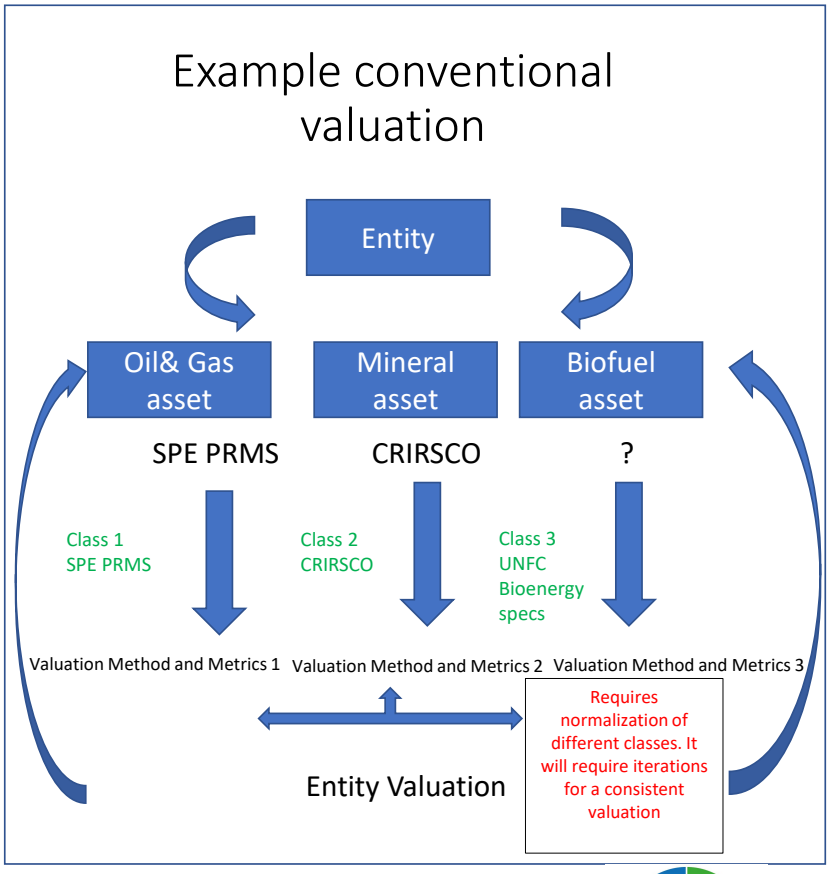
Risk analysis

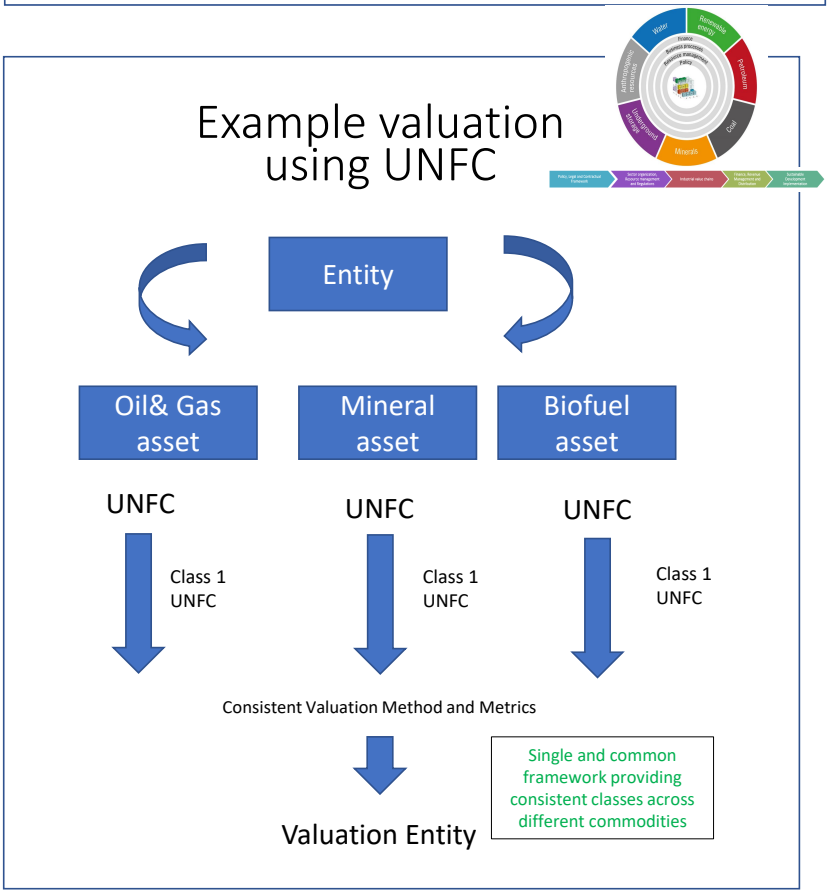
- 3D space of risk options vs a 2D surface from other guidelines which allows better modelling of the total project risk
- Allows de-coupling Environmental aspects from Project Technical feasibility issues and therefore allows assigning different weighting



3-D systems
UNFC
G vs E vs F
For valuation
Project risk =risk G axis x risk E axis x risk F axis

Figure IV
Applying UNFC to complex portfolios





V. Application of UNFC in making commercial assessments

15. Commercial assessments are about the likely availability and value of future production. This may vary between stakeholders depending on whether costs and revenues are shared equally or not. The difference between commercial assessments of projects and of the assets defining stakeholder interests in projects will be explained in more detail in the section on commercial assessments of assets.

16. Uncertainty is inherent in the assessments even where terms like "proved reserves" and "measured resources" are used in extractive activities, corresponding to a high degree of certainty. In the present contexts of both UNFC and other classifications the meaning of these words are migrating from estimates of quantities in place to quantities of future production. This move makes it possible for UNFC to be a classification not just for extractive activities but also for activities in renewable energy production, underground storage and anthropogenic resources and others. By focusing on "what we get" rather than on "what we found", we experience a disconnect between the meaning of terms in the UNFC and the terms used in classifications rooted in the traditions of portraying "what we found". Future production is certainly not measurable (yet) nor provable.

17. Uncertainties can be estimated using deterministic or probabilistic methods.

18. UNFC supports commercial assessments based on an uncertainty evaluated using either deterministic or probabilistic methods (or combination thereof). The choice will depend on:

(a) The application of the commercial assessment;

(b) The need, preference and/or capability of the user;

(c) The information available to the preparer.

19. Assuming that projects have been classified according to project maturity, estimation of associated recoverable quantities under a defined project and assignment to uncertainty categories may be based on one or a combination of analytical procedures. Such procedures may be applied using an incremental and/or scenario approach; moreover, the method of assessing relative uncertainty in these estimates of recoverable quantities may employ both deterministic and probabilistic methods.

A. The assessments of commercial supplies

20. UNFC inventories show the commercial product quantities. These are quantities of production that will be available for purchase and sale from projects that will be carried out. In other words, their projects have no contingencies in the economic, social and environmental domain (category E1)[1] and no contingencies with respect to technical execution (F1)[2] that will stop them from proceeding. Although there will be no blocking contingencies in these domains, commercial assessments will still need to consider uncertainties arising from market conditions, changes in the framework conditions, operational changes, etc.

21. The quantities to be produced are categorised according to the level with which they have been defined in categories G1, G2 and G3, alternatively as G1 quantities, G1+G2 quantities and G1+G2+G3 quantities[3]. For petroleum and when probabilistic estimation is done, G1 represents a high level of confidence as having at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the estimate. G1+G2 represents a

[1] E1: Extraction and sale has been confirmed to be economically viable. The phrase "economically viable" encompasses economic (in the narrow sense) plus other relevant "market conditions", and includes consideration of prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that could directly impact the viability of a development project.

[2] F1: Feasibility of extraction by a defined development project or mining operation has been confirmed.

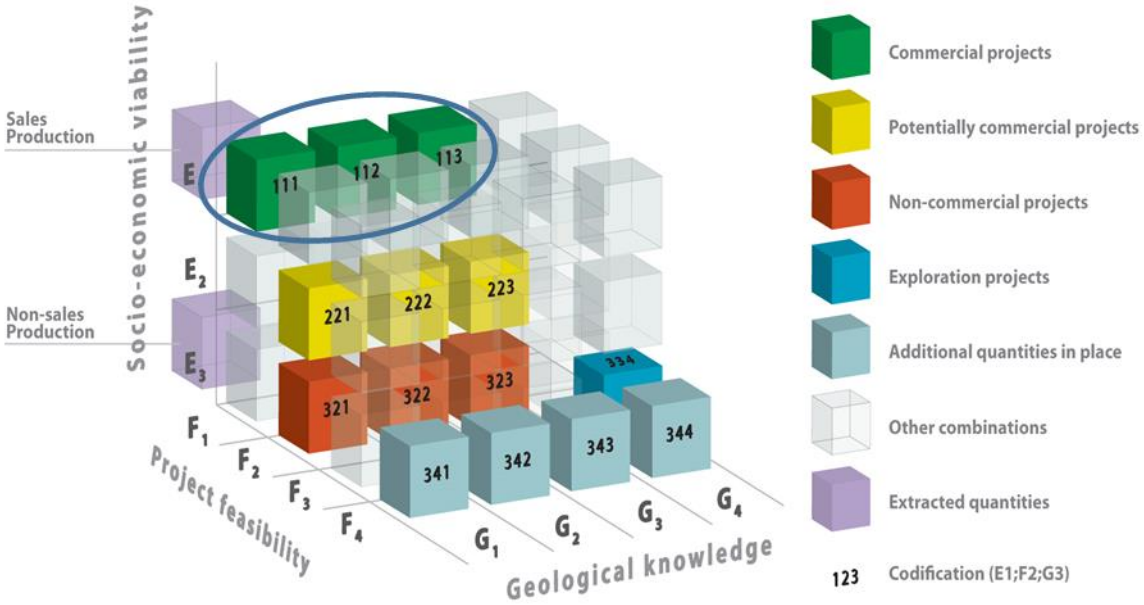
[3] G1: Quantities associated with a known deposit that can be estimated with a high level of confidence.

moderate level of confidence near the expected (mean) value with at least a 50% probability (P50) that the actual quantities recovered will equal or exceed the estimate. For the high estimate of G1+G2+G3 this probability should be equal or greater than 10% (P10). Deterministic estimates will strive to have the same levels of confidence as is defined for probabilistic estimates.

22. Commercial quantities to be produced are shown in green in Figure IV. These are the quantities we address in this sub-section.

23. Not all quantities produced for use are sold in a market and therefore commercial. Some are produced for direct use without being sold or purchased. Examples are fuel used in operations in energy recovery projects, biofuel collected by users and burned, hydropower, solar and wind energy and electricity produced and used directly with no commercial transaction, earth materials, clay, sand, gravel, wood etc. collected locally and used in earth and other structures, water, coal, salt and minerals collected for direct use, other artisanal mining, etc.

Figure V.
Commercial quantities are produced by commercial projects



24. These non-commercial (non-sales) quantities produced for direct use need to be recognised separately from the commercial quantities in the inventories. Combining them with the commercial quantities will make it impossible to support commercial assessments. Although their price will be zero, this does not mean that they do not have value. Non-commercial production of fuel may replace fuel purchases and appear in the accounts as a reduced cost. They will be economic in the sense that the benefits they produce are worth the efforts or cost of producing them. The quantities are however not comparable to commercial quantities with respect to price or with respect to exposure to market and other risk that characterises commercial quantities.

25. In UNFC, these non-sales quantities for use are grouped together with other non-used, non-sales quantities including flared gas, mine waste etc. and categorised as E3.1[4]. With the introduction of renewable energy into UNFC, they become more important. It is advisable therefore to separate them from other non-sales quantities and name them as products of projects that produce non-commercial quantities for use, and alternatively when they are produced jointly with commercial quantities as is the case for fuel used in oil and gas operations, to consider them as a co-produced commodity in line with other co-produced

[4] E3.1: Quantities that are forecast to be extracted, but which will not be available for sale.

commodities, as for instance oil and gas, but clearly labelled as non-commercial quantities. Neither of these approaches changes UNFC in other ways than forcing a different nomenclature for the projects named in Figures II and IV, and by understanding the term "economic project" not as a project with positive net present monetary value, but more generally as a project where the (value of the) benefits exceed the efforts (or cost) of getting the benefits.

26. UNFC classifies commercial quantities based on their E, F and G categories. Quantities categorised by F1.1[5] are expected to be produced by projects "on production". For these the main project related uncertainties are the production performance and the cost and performance of operations, maintenance modification and abandonment. To the extent that production rates over time are affected, these uncertainties may affect commercial assessments of the buyers of the products. The uncertainties will all affect the commercial assessments of the producers. Quantities categorised by F1.2[6] will in addition be exposed to the project development risks. There is a large literature on the success, failure and strategic management of large engineering projects that may be consulted for direction with respect to development risks and opportunities (Lessard & Miller, 2013).

27. For projects classified using category F1.3[7], the entire development phase remains with all its opportunities and risks. In addition, there may be uncertainty about when project development will start, but there is no uncertainty that the project will be initiated. That makes it a commercial project even though a final investment decision is not required before it is time to take it. While the quantities to be produced can be read in the UNFC inventories, it will be necessary to go to the underlying individual project information to make complete commercial assessments.

28. Once the assessments related to the project development and production are made, the quantities will be categorised as G1, G2 or G3[8], or alternatively as G1, G1+G2 and G1+G2+G3, informing users of the range of uncertainty within which the quantities lie.

29. The G1 quantities correspond to the low estimates "proved" in the SPE PRMS (SPE, WPC, AAPG, SPEE, SEG, SPWLA, EAGE, 2018) and the CRIRSCO (Committee for Mineral Reserves International Reporting Standards, 2013) family of codes. These estimates are important for stakeholders who are exposed more heavily to the downside risks than the upside opportunities such as lenders and some shareholders. Security regulators will impose their own restriction with respect to how estimates should be made (Australian Stock exchange ASX, 2014) (Ontario Securities Commission, 2015) (Ontarion Securities Commission, 2018) (Australian Institute of Geoscientists, The Minerals Institute and Minerals Council of Australia, 2012) (US Securities and Exchange Commission, 14 January 2009; Australian Stock exchange ASX, 2014) (US Securities and Exchange Commission, 2018). Others, like the European Securities Market Authority (ESMA) allows preparers to choose between a set of classifications (European Securities and Market Authority, 2013).

30. Some of these restrictions apply in some jurisdictions and not in others, and different restrictions apply to different commodities. Some restrictions will distort a balanced probabilistic estimate by truncating the probability distribution. They tend to be prescriptive, mainly to remove the upside.

31. The quantities categorised as G2 will, when added to the G1 estimates represent "proved + probable reserves" as defined by the US Securities and Exchange Commission (SEC) and in the SPE PRMS and the CRIRSCO family of codes. The most useful estimate for commercial applications would be this "best estimate". It is common to see this estimate

[5] F1.1: Extraction is currently taking place.

[6] F1.2: Capital funds have been committed and implementation of the development project or mining operation is underway.

[7] F1.3: Sufficiently detailed studies have been completed to demonstrate the feasibility of extraction by implementing a defined development project or mining operation.

[8] G1: Quantities associated with a known deposit that can be estimated with a high level of confidence.
G2: Quantities associated with a known deposit that can be estimated with a moderate level of confidence.
G3: Quantities associated with a known deposit that can be estimated with a low level of confidence.

being near a 50 per cent probability (P50) in the cumulative density function (pdf), therefore, as explained above in the case of petroleum, a 50 per cent probability should exist that the resources actually recovered will equal or exceed the best estimate. The estimate with a 50 per cent probability of being exceeded will generally differ from the expected (mean) value as the probability density functions for quantities in three dimensional bodies will seldom be symmetrical. In practice it is often difficult to ascertain probabilities accurately. This difference is therefore often ignored.

32. The expected value of a project is valuable when making commercial assessments of a group of projects, as the expected value for the sum is equal to the sum of the expected values of the individual projects. The law of large numbers may then reduce the relative range of uncertainty as the number of projects increases, depending on dependencies and correlations between the projects.

33. The sum of the G1+G2+G3 represents a high estimate of commercial quantities. In the SPE PRMS family of classifications, this corresponds to proved plus probable plus possible reserves (3P). The CRIRSCO family of codes explicitly exclude these estimates from being quoted as reserves in public reports and does therefore not have a category for them. They are included as inferred resources without the application of modifying factors that convert them to recoverable sales quantities.

34. When assessing a large number of projects, it is common in regulatory reporting to add the quantities arithmetically. While this may be reasonable to do for the G1+G2 numbers that are close to the expected values, the sums of G1 estimates and of G1+G2+G3 estimates risk lying outside the practical range of uncertainty for the aggregate and in that sense can be irrelevant. The probability that all outcomes are low or that all are high is much less than that one of them are.

35. The high numbers are individually important also for commercial assessments. Although the probability that they will be realised is low, their economic value can be quite high, particularly in extractive activities where the probability distribution of the quantities tends to have many outcomes near and below the average and few, but quite high outcomes on the upside (a log-normal probability distribution). The high case may benefit from economies of scale for the project and hold a higher economic value per unit of production than the lower outcomes. These values can only be realised if the project design has the flexibility to produce additional quantities should they be proven to be recoverable. This flexibility (real options) may or may not come at a cost and affect the commercial assessments. The legal rights may contain clauses that in turn redistribute excessive profits among stakeholders. The economies of scale and the redistribution of profits will need to be taken into account in commercial considerations when considering the value of various uncertain outcomes.

36. Likewise, the low cases are important for assessing the risk, particularly to stakeholders who do not participate equally in the upside or who have limited risk management capacities

B. Commercial assessments of assets

37. In addition to selling and buying commercial quantities, it is common to sell, buy or trade the rights to produce these quantities. These rights are defined here as assets and are distinguished from the projects that UNFC classifies. The relationship between the asset and the project is defined by the legal, regulatory, fiscal and contractual conditions contained in the definition of the rights. The values attached to these rights are not limited to the value of the commercial production that is referred to above, but relates to the entire resource base, i.e. in all UNFC classes.

38. The rights may be defined in terms of quantities as is the case when fixed royalties are imposed. They will more often than not be defined in terms of the cash flow that the projects may produce. Assessment of the commerciality of the assets will therefore in general require consideration of the project information that defines the cash flows including quantities to be produced, time series of revenue, investment, operating costs, taxes, fees,

tariffs, physical and human inputs, emissions and other information carried by the projects. Then the rules embedded in the rights define the corresponding time series for the assets, i.e. how they and the risks involved are distributed to stakeholders, including government. This information is not generally publicly available. Some users may have access to it while other sophisticated users may be able to understand the general nature and quantification from available information in the UNFC inventories of quantities and other related observations available to them. Depending on the nature of the rules defining an asset, the asset holder may find that the class of hers or his asset may differ from the class of the project i.e. a project that is acceptable to government may not necessarily be acceptable to all licensees.

39. Below is a non-exhaustive list of where commercial assessments of assets are used:

(a) in resource management considerations;

(b) in fiscal and contractual design;

(c) in capital allocation, project development and commodity transaction, including valuation;

(d) in asset transactions;

(e) in portfolio optimization;

(f) in public and financial reporting.

Resource management applications

40. Commercial assessments affect resource management beyond the fiscal and contractual designs described below.

41. This document uses the term resource management to mean the shaping of the framework conditions under which development, operation and production takes place, i.e. the shaping of the industrial system. Both public and private sectors play important roles in shaping this. (Al Kasim, 2015; Al-Kasim, 2006; Garcia, Lessard, & Singh, 2014; Heiberg & Lessard, 2014; Åm & Heiberg, 2014; Heiberg, et al., 2018; Lund, 2014; Zamora, 2014).

42. The consequence of inefficient industrial systems will be identified, among other ways through commercial assessments and show up in the UNFC in categories on the E- axis below E1 and in the form of quantities produced but not sold and quantities remaining in place.

Fiscal and contractual designs

43. Fiscal and contractual designs determine, together with market values and costs, the perceived value of the produced commodity at the point of valuation (reference point), typically the point of sale or the point where a netback price may be assessed. This is the value, that together with the costs of bringing quantities to the reference point, govern the value at the source of production and thereby the recovery decisions. The lower the value at source, the lower the commercial recoverable quantities will be. Many recovery processes are physically irreversible processes, i.e. the total outcome depends on the history of recovery. Failures of initial recovery decisions to design for the recovery of economically marginal quantities (that can be very large) cannot be repaired by later efforts, at least not without additional cost and effort relative to what could be achieved if the quantities were targeted for recovery from the start. A prerequisite for efficient recovery is therefore a high perceived value at source, facilitated by time stable fiscal and contractual designs that do not harvest economic rent downstream or act as costs in reducing the value at source.

44. Fiscal and contractual designs might cause the value of the commodity produced not to be the same for all stakeholders, including governments.

45. This causes misalignment of interest that may be an impediment for reaching balanced decisions for the recovery of the commodity seen from a project perspective.

46. The fiscal design to produce a given value to government may in itself affect the quantities that the producer can afford to extract and have an effect on the way quantities are classified. One extreme is a situation where only gross taxes are applied (royalty, production

fees, etc.) that will cause the value at the source of production, and the potentially recoverable quantities to differ seen by the payer and receiver of gross taxes. The other extreme is where the taxes have been designed not to distort incentives and where the public and private sector interests in pursuing recovery will be aligned and equal to what they would be for a project with only one stakeholder. (Hannu, 2006; Brown, 1948).

47. When there is full alignment of interests, and ignoring portfolio effects, the stakeholders may categorise their assets on the E-axis in the same way. When there is not full alignment this may not be the case.

Capital allocation, project development and commodity transactions

48. There are at least three parts to project and asset economics involving commercial transactions:

- Allocation of capital to development and production activities
- Selling of the commodity produced including valuation
- Managing the opportunities and risks associated with the above.

49. As was the case with fiscal and contractual design, the analyses require access to the project information. This allows one to see the project and asset perspectives. Both may affect the appropriate project and asset decisions and thereby the appropriate E and F categories of the projects and the assets.

50. Allocation of capital may take place at the project or asset level or as a combination of the two. It will generally depend on the technical shaping of the project or development process and on the position of the stakeholders. The F-categories reflect the project maturity decisions in this respect. Allocation of capital will also depend on the availability and cost of capital. Project finance will depend on the business model of the project, while asset finance may in addition depend on the financial position of the asset holder. If capital is not available at satisfactory conditions, the project cannot be categorised as E1 and will therefore not be a commercial project for one or all asset holders in the project.

51. Future produced quantities, project development and commercial value are all associated with uncertainty. Risks and opportunities represent the consequences of uncertainty, often quantified as the probability that an uncertain outcome will occur times the consequence this will have. The consequence is always to someone and therefore inherently subjective.

52. Uncertainties may be combined probabilistically to help in capital allocation by determining the ranges of resources or values.

53. Different views of the future are some of the factors driving capital allocation as well as asset transactions that are described next.

54. Opportunities and risks for the project, the asset or the asset holders may play a role in shaping the decisions. The asset holders may not have, or wish to, develop the capabilities required to proceed. The asset holder may see higher value in selling the asset or may wish to hold on to it without developing it for strategic reasons or no reason at all as discussed in the chapter on portfolio optimisation below. The appropriate category to use in the classification is always dependent on what is done, not what should be done. Firstly, this reflects the physical realities, and is therefore valuable for users. Secondly, it separates classification from decision making, making classification easier relative to the much more difficult task of decision making.

Asset transaction

55. There are at least three types of asset transactions in which the UNFC may be applied:

- Asset trades and swaps
- Mergers of projects and/or assets including agreements for joint development of multiple assets and unitization

- Asset acquisition and divestment.

56. These transactions refer to value in one form of another.

Asset trades and swaps

57. Asset trades and swaps may involve resource quantities of all classes. Here, commercial assessments of trades may be based on estimated recoverable resource quantities or quantities in place adjusted for obvious differences in value. Trades may be guided by other similar transactions observed in the market. Detailed cash flow analyses are often not available for some of these assets due to lack of sufficient project definition.

58. Resource quantities with categories E3, F3 and F4 fall in this category.

59. Trades and swaps of assets with sufficiently mature projects to define cash flows are guided by the estimated cash flows.

Mergers of assets including agreements for joint development of multiple assets and unitization.

60. Mergers (or the joining) of two or more assets to form a new asset is quite natural when the value of the new asset is higher than the sum of the values of the merged assets. It is also natural to merge assets when misalignment of interests in individual assets represents an impediment to efficient and fair asset development.

61. Several assets may, for instance be combined to utilise a joint infrastructure where the new asset takes full advantage of this and exploits the combined asset as a unit.

62. Combining several assets is common when they have overlapping legal rights that cause misalignment of interests (unitisation). This is the case for oil and gas fields that cover two or more licenses and where the quantities in one can be produced from another.

63. To achieve an efficient resource management, it is important that the allocation of value from the new asset to the initial asset holders is done through mechanisms that are not affected by the way development and production takes place. An example is the use of initial quantities in place to allocate value. Allocation of value between the initial asset holders may be based on information that becomes better defined as development and production proceeds. This causes the agreement governing the new asset to contain clauses on the redistribution of asset ownership, including future production, cost and reallocation of past costs as new information becomes available. The UNFC holds the relevant resource quantities used for redetermination of future production, and the project information holds the cash flow information required for cash adjustments and distribution of future costs. Past costs are found in the accounts.

Asset acquisition and divestment

64. Asset and company transactions involve asset trades as described above as well as commercial transactions involving cash, shares, etc.

65. Examples are companies who prefer to specialize in capabilities required for one part of the value chain. This can be exploration, development, production operations, tail end production or abandonment. These companies seek opportunities in their segment where they can do better than the seller or seek to exit their segment when they have done what they are best at and have improved the asset value accordingly.

66. In the context of UNFC, the project information and the terms and conditions governing the assets are again key for determining the values, risks and opportunities for seller and buyers. If the partners to the transaction agree on making a cash transfer, then it is necessary to aggregate the asset values of the projects involved in the transaction to assess what a reasonable price will be. This requires valuing and aggregating assets in immature projects. It is sometimes not possible to do this, as movement from one category to another may be both a chance, with an estimated probability of occurrence that can be estimated, but also a decision that may need to be negotiated. Whether it is a chance, or a decision depends

on the role of the evaluator. Aggregation[9] of resource quantities for projects or assets with an equivalent chance of being realised, indicated by them having the same E and F categories is possible depending on whether the uncertainties indicated through the G-categories are discrete estimates, scenario estimates or probability density functions with information on dependencies and correlations between assets. As should happen with all simulations/estimates, all assumptions need to be exposed so that the outcome can be tested.

67. Aggregation of uncertain time series for production and sales, costs, cash flows etc. is complex. For instance, a production forecast can reflect delays in start-up but high production later. It will be a low forecast in early years and high one in later years and cannot be described as a high or low forecast without taking time into account[10]. A way to work around this is to describe the forecasts by using scalar quantities such as start-up dates, build up rates, production capacity, production rates at various levels of cumulative production, recoverable quantities etc. where the range of uncertainty of each of these scalars can be described using probability density functions. They are then used together through mathematical equations using a Monte Carlo type simulation to produce alternative production profiles. Both simple closed form solutions and/or elaborated numerical simulations of the development and production processes can be used. From this it is possible to generate a field of forecasts (a swarm) that can be used to generate a probability density functions for scalar project information of interest such as net present value, cumulative sales, non-sales production over a given time period, etc. These probability density functions can in turn be aggregated using a second Monte Carlo simulation or more sophisticated methods like Global Optimization, taking into account the dependencies and correlations of the key uncertainties.

Portfolio optimisation

68. As described above, the value of a portfolio depends on the nature, size, number and characteristics of its elements.

69. In portfolio optimisation, the optimiser can, within the limits that agreements with others allow include or exclude elements from the portfolio, change their magnitude and timing, shape their dependencies and influence their uncertainties, in search for an optimal portfolio. What an optimal portfolio is depends on the interests and constraints of the optimiser. It may be a portfolio that maximises value for a certain amount of risk, but also one that produces manageable opportunities and risks, that can meet commitments, respect financial constraints, provide full employment of people and equipment, fill infrastructure capacities, minimise waste, etc.

70. Again, UNFC with the underlying project information may be used as a key instrument in portfolio optimisation. Portfolio optimisation may in turn impact the commercial value it holds for the owner of the portfolio or for a buyer of it.

Public reporting, including corporate and financial reporting

71. Public reporting can be on a supranational, national, regional, project, company or asset level. It invariably requires a high professional quality of estimates at a frequency and an aggregation level where numbers are reasonably stable over time and estimated in a transparent and auditable manner for the public to use.

72. Reporting resource quantities at the project level and at the level of aggregated projects does not necessarily require going into project information. The UNFC inventories display the quantities directly.

73. Corporate reporting relates to the public reporting by an entity on an annual or periodic (e.g. quarterly) basis for instance for value reporting (Annual reports, quarterly financial

[9] Aggregation might involve dependency factors. Simple arithmetic addition can be misleading and although Monte Carlo could theoretically handle it, it is hard to see how dependencies and correlations could be determined. There may not be awareness of any substantial guidance on this topic. The professional societies of the EGRM should be challenged to address this?

[10] Probability density functions cannot be assigned to vectors, only to scalars.

reports) as well as other information provided to the market (for instance through press releases or strategy presentations).

74. Resource quantities are relevant to such reporting both where quantities at a defined date are disclosed and discussed and when quantities are used in the estimates and calculations underpinning financial reporting (for instance in estimating recoverable amounts for impairment testing or the calculation of depletion, depreciation and amortisation).

75. Such reporting reflects the net quantities associated with the legal rights of the entity, directly or indirectly, which often differs from the project value.

76. The basis for, and content of, such corporate reporting varies across different jurisdictions, from one commodity to another, and in extent of classification categories reported publicly.

77. Reporting of resource quantities in annual corporate reporting has traditionally been used in extractive activities but less for activities in renewable energy, anthropogenic or storage activities. For example, the mining sector commonly applies variants of the CRIRSCO Template (Australian Institute of Geoscientists, The Minerals Institute and Minerals Council of Australia, 2012) (Australian Stock exchange ASX, 2014) while the petroleum industry often uses variants of the SPE PRMS (SPE, WPC, AAPG, SPEE, SEG, SPWLA, EAGE, 2018). However, there are modified local regulatory requirements in jurisdictions including in the United States and Canada.

78. When UNFC is used in one jurisdiction, it is convenient to relate it to the needs created by the framework conditions in that jurisdiction. This has been done by developing bridging documents (UNECE, 2018) (UNECE, 2018) (UNECE, 2016) and guidance (UNECE, 2017).

79. Users of corporate reporting often operate in a global capital markets and across traditional commodity boundaries. There are clear benefits of a classification system that is global and sufficiently general to apply equally to all relevant commodities. UNFC meets these requirements. For instance, the bridging of CRIRSCO and SPE PRMS classifications to the UNFC facilitates a coherent reporting of extractive activities (UNECE, 2013).

80. To achieve a coherent reporting of extractive activities requires a practice that adheres strictly to the project-based application used in UNFC. This is in place for the PRMS. It is easily achieved when using the CRIRSCO Template provided that Resources, including those designated as “Measured Resources”, are understood to mean estimates of future production from future projects that have not yet been sanctioned. While this may sound to be a difficult step to take, many industries solve this by reporting recovery factors when they report CRIRSCO Resources.

81. Adopting UNFC for corporate reporting has two additional advantages:

(a) Non-sales production may be reported. This represents resources for non-commercial use and resources that that may have future commercial value if handled differently. Future gas to be flared and mined rocks to be wasted according to the project plans are examples;

(b) The distinction between economic, social and environmental contingencies on one hand and the operational contingencies on the other allows an improved judgement of the nature of opportunities and risks associated with the projects. This might become important during the fundamental reforms required to reach the Sustainable Development Goals. The risk associated with a possible introduction of an effective carbon cost may have profound consequences on investment decisions.

VI. Complex portfolios of more than one commodity

82. The critical role of efficient management of natural resources in achieving almost all SDGs is clearly recognised in the Agenda 2030 text. In this context efficient means a process which is “integrated and indivisible and balance[s] the three dimensions of sustainable development: the economic, social and environmental”. It is natural in aligning itself to this purpose for UNFC to make the “bold and transformative” step to classifying multiple

combinations of resources as well as single items, but also secondary as well as primary resources. It can encompass polymetallic deposits such as those containing copper, gold, silver and uranium, but also whole energetic basins containing solids, fluids and gases, fully and uniformly. It is already clear that taking such an integrated approach considerably enhances the likelihood that a project will establish a social licence to operate. This is also a technical advantage in cases where petroleum is mined as a solid and where a mineral is recovered as or by a fluid. Here the CRIRSCO family of codes are designed to classify solids, while the SPE PRMS is designed to classify fluids. UNFC is bridged to both. It draws on the strength of these classifications. In addition, it can be used as a stand-alone system, which allows classification of projects for which the other two families are not traditionally developed.

83. UNFC also covers renewable energy and underground storage projects for which classification has not been used extensively. This comprehensive and global approach facilitates the comparison and consistent management of projects in extractive activities, renewable energy and for permanent or temporary underground storage of CO_2, natural gas other commodities and waste.

84. Furthermore, it is applicable to anthropogenic (secondary) resources - as well as resources from primary production. As policies for the circular economy are formulated, this ability to cover the whole life-cycle of a resource becomes an essential management instrument for material flow analyses in the physical economy. This strengthens the support of UNFC to the UN System of Economic and Environmental Accounting (UN, EU, FAO, IMF, OECD, WB, 2012).

85. Applications to water resources have not yet been formulated but are on the active agenda of the Expert Group Resource Management.

86. This ability of UNFC to classify projects handling multiple commodities in the same manner facilitates the task of preparers in transferring skills and routines from one type of project to another. It provides efficiency in preparation and use over a situation where individual classifications are used for the different types of projects. The UNFC may serve as a foundation for integrated analyses of energy and raw material basins where projects interact (Jaireth, McKay, & Lambert, 2008) It is thus an essential aid to users in judging realistic commercial paths that the capital markets can finance for reaching the Sustainable Development Goals and the climate change mitigation ambitions, all of which are resource demanding and environmentally challenging. In summary it serves the UN intention behind the Sustainable Development Goals of facilitating a balance of the three dimensions of sustainable development: the economic, social and environmental through modern and science-based resource management to be achieved to reach the 17 integrated and indivisible goals.

Figure VI.
The UN Sustainable Development Goals

VII. Facilitating commercial assessments when updating the United Nations Framework Classification for Resources

87. When updating UNFC, the following issues related to commercial assessments should be considered:

(a) treat future sales quantities and non-sales quantities for use as separate projects. When they are produced together with commercial quantities, they may be treated in the manner that oil and gas produced by one project is treated or in the manner that different mineral commodities produced by one project are treated in mining. There is no need to change the basic structure of UNFC to achieve this. The nomenclature needs to change, since the words "commercial projects" and "potentially commercial projects" do not reflect that some of them produce quantities for non-commercial use. In no circumstance should the commercial and non-commercial quantities be reported together as this will prevent commercial assessments and also misinform investors who expect reported quantities to be exposed to similar risks. Non-commercial quantities are not exposed to market risks (the price is zero) and their use is often assured. This recommendation also has consequences for the definition of "economic" on the E-axis, since the non-sales quantities will not attract monetary revenues. They will instead be valued on whether or not they produce sufficient benefits to justify the efforts of getting those benefits, and thus favour a definition of "economic" that reflect this while at the same time reflecting the meaning given to it in commercial assessments;

(b) consider a subdivision of category E2 as proposed by the Social and Environmental Task Force and consented to by the Expert Group on Resource Management in 2018, but now with criteria related to commerciality (economics, decision patterns, alignment of interests etc.) added to the social and environmental ones;

(c) consider options to reflect recoverable quantities with and without internalising externalities[11] that are likely to be internalised in the future, and in particular greenhouse gas (carbon) costs;

(d) review the commodity specific input to UNFC from SPE and CRIRSCO with an aim to produce updated two-way bridging documents conforming to the updated UNFC, the updated SPE PRMS 2018 and the updated CRIRSCO Template 2013;

(e) introduce commercial assessments as a key topic when developing the UN Resource Management System (UNRMS), wherein project information, including time series and legal rights/contracts.

VIII. Conclusions and recommendations

88. To meet the Sustainable Development Goals and the climate change mitigation ambitions requires strong dynamic and integrative capabilities in both the public and the private sectors and in the public-private partnership. Government sets framework conditions that allow industry to deploy its best capabilities in ways that the capital markets can afford to finance. Strong and rapid reforms are required to meet the current ambitions. They may need to be carried out stepwise where one step builds on the previous. Each step may require new capabilities both in the public and private domain and in the public-private partnership. In this process, the availability of energy and raw materials as reflected through UNFC inventories is crucial. So are commercial assessments of production, projects and assets in determining whether the chosen paths are commercially possible.

89. UNFC is unique in three aspects:

(a) it is global, matching the increasing scope of capital market;

[11] Internalising externalities means the act of making a change in a company's private costs or benefits in order to make them equal to the company's social costs or benefits.
Source: http://www.businessdictionary.com/definition/internalizing-an-externality.html

(b) it applies to multiple commodities matching the needs for transformation of energy and raw material services going forward;

(c) it takes explicitly into account economic, social and environmental considerations separately from the technical and industrial considerations in executing the projects.

90. This makes it an ideal basis for an international corporate public reporting standard going beyond financial reporting.

91. It is recommended that an update of UNFC ensures that commercial assessments are facilitated. No needs for substantial changes have been identified, but a need to change certain nomenclatures are necessary.

92. It is further recommended that establishment of UNRMS be built on UNFC, but with full consideration of the information carried by the projects, also beyond the bare resource quantities. Notably, this includes estimated time series of inputs and outputs, checked against performance and the corresponding cash flows.

Annex I

Abbreviations and definitions

Abbreviations

	Abbreviation
AAPG	American Association of Petroleum Geologists
CO_2	Carbon Dioxide
COGEH	Canadian Oil and Gas Evaluation Handbook
CRIRSCO	Committee for Mineral Reserves International Reporting Standard
CSE	The Intergovernmental Committee on Sustainable Energy
EAGE	European Association of Geoscientists and Engineers
ECE	Economic Commission for Europe - See UNECE
EGRM	Expert Group on Resource Management of the UNECE CSE
ESMA	European Securities and Markets Authority
PRMS	Petroleum Resource Management System of the SPE
SDGs	UN Sustainable Development Goals
SEC	US Securities and Exchange Commission
SEEA	UN System of Environmental Economic Accounting
SEG	Society of Economic Geologists
SPE	Society of Petroleum Engineers
SPEE	Society of Petroleum Evaluation Engineers
SPWLA	Society of Petrophysicists and Well Log Analysts
UN	United National
UNECE	UN Economic Commission for Europe. See ECE
UNFC	United Nations Framework Classification for Resources
UNFC 2009	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.
WPC	World Petroleum Council

Definitions from UNFC 2009

	The following definitions of the UNFC apply in this document
Asset	A legal right to which value is attached.
Bridging document	A document that explains the relationship between UNFC-2009 and another classification system, including instructions and guidelines on how to classify estimates generated by application of that system using the UNFC-2009 Numerical Codes.
Category	Primary basis for classification using each of the three fundamental Criteria of economic and social viability (related Categories being E1, E2, and E3), field project status and feasibility (related Categories being F1, F2, F3 and F4), and geological knowledge (related Categories being G1, G2, G3 and G4). Definitions of Categories are provided in Annex I to UNFC-2009.
Project	A Project is a defined development or mining operation which provides the basis for economic evaluation and decision-making. In the early stages of evaluation, including exploration, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail. Where no development or mining operation can currently be defined for all or part of a deposit, based on existing technology or technology currently under development, all quantities associated with that deposit (or part thereof) are classified in Category F4.
Reference point	The Reference Point is a defined location within an extraction and processing operation at which the reported quantities are measured or estimated. The Reference Point may be the commodity sales point from the extraction and processing operation or it may be an intermediate stage, such as pre-processing (if required), in which case the reported quantities would not take into account processing losses. The Reference Point shall be disclosed in conjunction with the reported quantities. Where the Reference Point is not the point of sale to third parties (or where custody is transferred to the entity's downstream operations), and such quantities are classified as E1, the information necessary to derive estimated sales quantities shall also be provided.

Other Definitions

	Definition
Best estimate	Best Estimate is considered to be the best estimate of the quantity that will actually be recovered. It is equally likely that the actual remaining quantities recovered will be greater or less than the best estimate. If probabilistic methods are used, there should be a 50 percent probability (P50) that the quantities recovered will equal or exceed the best estimate.[12]
Commercial	Ready for buying and selling in a market[13]. In this document it is used separately for physical quantities or capacities (in the case of storage), and for assets.
Commercial Assessment	Assessment of the commercial potential.
Commercial project	A project is commercial when it can be categorised by categories E1 and F1 of the UNFC.
Commercial quantities	The quantities produced for buying and selling in a market by a commercial project.
Correlation	A statistical measure that indicates the extent to which two or more variables fluctuate together.
Dependency	When two variables fluctuate together.
Deterministic	Where no randomness is involved in the development of future states. In the deterministic method, quantities are estimated by taking a discrete value or array of values for each input parameter to produce a discrete result.
Dynamic capability	Dynamic capability is a firm's or a government's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments[14].
Expected value	The expected value (EV) is an anticipated value for a given investment at some point in the future. In statistics and probability analysis, the expected value is calculated by multiplying each of the possible outcomes by the likelihood each outcome will occur, and summing all of those values. By calculating expected values, investors can choose the scenario most likely to give them their desired outcome[15].
Framework conditions	Framework conditions are a shorthand for the legal, fiscal, regulatory, contractual and other similar conditions that form the frameworks within which the project is shaped.
Gross tax	Gross tax is here used for tax on gross production not considering the cost of production. Examples are royalty, certain emission fees, etc.
Inferred Resources	This refers to resources defined in the CRIRSCO Template as Inferred Resources.
Integrative dynamic capability	Integrative dynamic capabilities (IDCs) occur when dynamic capabilities involve system-level orchestration of different elements in order to sustain competitive advantage[16].

[12] https://definedterm.com/best_estimate

[13] Commercial is an adjective derived from commerce which comes from the Latin word commercium (com=together, mercium=merchandise). In English it means pertaining to trade, while in American it is also used to designate pertaining to large scale trade, often of lower quality goods i.e. commercial quantities as opposed to small quantities of pure material.

[14] Adopted from: https://www.davidjteece.com/dynamic-capabilities

[15] https://www.investopedia.com/terms/e/expected-value.asp

[16] Adopted from (Garcia, Lessard, & Singh, 2014)

	Definition
Law of large numbers	The law of large numbers (LLN) is a theorem that describes the result of performing the same experiment a large number of times. According to the law, the average of the results obtained from a large number of trials should be close to the expected value, and will tend to become closer as more trials are performed[17].
Measured Resources	This refers to resources defined in the CRIRSCO Template as Measured Resources.
Modifying factors	This refers to factors defined in the CRIRSCO Template to convert resources to reserves.
Netback price	The value of a unit of crude oil or natural gas calculated as the sales price of the products refined from it minus the cost of producing those products.[18]
Non-commercial use	Non-commercial use refers to quantities used in operations or consumed directly without being sold or bought in a market.
Numerical simulation	A numerical simulation is a calculation this is run on a computer following a program that implements a mathematical model for a physical system. Numerical simulations are required to study the behaviour of systems whose mathematical models are too complex to provide analytical solutions, as in most nonlinear systems[19].
Opportunity	Additional benefit arising from uncertainties if they were to occur.
Probability density function	Probability density function (PDF) is a statistical expression that defines a probability distribution for a continuous random variable as opposed to a discrete random variable[20].
Portfolio	A portfolio is a grouping of assets
Probabilistic	Situation or model where there are multiple possible outcomes, each having varying degrees of certainty or uncertainty of its occurrence[21]. In the probabilistic method, the evaluator defines a probability density distribution representing the full range of possible values for each input parameter.
Project asset	The legal rights to participate in a project.
Project information	Information carried by a project, including produced quantities, investments operating costs, other quantities and the time series of each.
Real option	A real option is a choice made available with respect to business investment opportunities. It is referred to as “real” because it typically references projects involving a tangible asset instead of a financial instrument.
Risk	Loss or damage arising from uncertainties should they occur.
Scalar	A physical quantity that is completely described by its magnitude[22].
Stakeholder	A person, group or organization that has interest or concern in a project. A primary stakeholder is a person with formal competence to influence or take a decision affecting a project.
Swap	To exchange or give an asset in an exchange for another asset.
Unitization	The combining of assets of various project into assets of a single project.

[17] Source: https://en.wikipedia.org/wiki/Law_of_large_numbers
[18] Source: https://www.thefreedictionary.com/netback
[19] Source: https://www.nature.com/subjects/numerical-simulations
[20] Source: https://www.investopedia.com/terms/p/pdf.asp
[21] Source: http://www.businessdictionary.com/definition/probabilistic.html
[22] Source: https://www.britannica.com/science/scalar

	Definition
Value chain	A set of activities that a firm operating in a specific industry performs in order to deliver a valuable product or service for the market, in this case to create a commercial project and the production from it.

Annex II

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