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Development, maintenance and implementation of the United Nations Framework Classification for Resources:
Minerals

Draft United Nations Framework Classification for Resources Supplemental Specifications for Minerals Projects

Prepared by the Expert Group on Resource Management Minerals Working Group

Summary

This draft document outlines the United Nations Framework Classification for Resources (UNFC) Supplemental Specifications for Minerals Projects. The objective is to promote the use of UNFC as a system for the sustainable management of all minerals sources. These minerals specifications are intended to support the attainment of the Sustainable Development Goals as relevant to the minerals industry. Through their application, the collective industry will be directed towards the shared global goals. The development of this document will take into consideration comments received from the Technical Advisory Group and feedback from the twelfth session of the Expert Group on Resource Management. This document incorporates the changes introduced by the recent update of UNFC (2019).

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Acronyms and Abbreviations

Acronyms and Abbreviations	*Meaning*
CPD	Continuous Professional Development
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
ECE	United Nations Economic Commission for Europe
EGRM	Expert Group on Resource Management
ESG	Environmental, Social, and Governance
GT	Grade x Thickness
ISL	In-situ Leaching
ISR	In-situ Recovery
MWG	Minerals Working Group
SDG	Sustainable Development Goal
TAG	Technical Advisory Group of the ECE Expert Group on Resource Management
UNDP	United Nations Development Programme
UNFC	United Nations Framework Classification for Resources

I. Introduction

1. The purpose of this document is to specify the use of UNFC to classify mineral projects, including metal ores, technical minerals, evaporites, aggregates and solid energy minerals such as coal and others. Its main focus area is to adapt the classification system to the projects in an environment of innovative technologies and advanced resource management tools.

2. This document is intended for a broad audience including (i) policymakers, and (ii) those responsible for government resource management. It may also be of interest to (iii) those responsible for company internal resource management, and (iv) financial reporting, in particular in relation to the mineral potential that falls outside existing classification and reporting standards (e.g. the CRIRSCO Template), especially for users that wish to ensure realisation of the Sustainable Development Goals (SDGs).

II. Scope

3. This document specifies functional requirements to classify mineral projects including:

(a) Project plan and definition;

(b) Project evaluation;

(c) Project classification;

(d) Project reporting.

III. Application of key instructions in UNFC

4. UNFC (Update 2019) Part II Annex III Guidelines on the use of project maturity to Sub-classify projects using UNFC shall apply to the mineral specifications (ECE Energy Series No. 61 and ECE/ENERGY/125).

IV. Normative references

5. The following referenced document is indispensable for the application of this document:

- United Nations Framework Classification for Resources – Update 2019.[1]

6. The following referenced documents provide guidance for selected aspects of project classification. The latest edition of the referenced document (including any amendments) applies:

- UNFC Guideline: Project definition[2]
- Guidance for Social and Environmental Considerations for UNFC (ECE/ENERGY/GE.3/2021/6)
- Guidance Note on Competent Person Requirements and Options for Resources Reporting.[3]

[1] See United Nations Framework Classification for Resources – Update 2019 https://unece.org/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf

[2] See UNFC Project definition https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC-Guidance-Notes/UNFC.Project.Guidance.Note_15.07.2016.pdf

[3] See Guidance Note on Competent Person Requirements and Options for Resources Reporting https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC-Guidance-Notes/Guidance_Note_on_Competent_Person_Requirements_and_Options_for_Resource_Reporting.pdf

V. Terms and definitions

7. [Note: Any key terms that are missing will be included in the next revision.]

A. Overview

8. All common terms and definitions, and minerals-specific terms and definitions, are provided in the glossary. This section includes some commonly used minerals-specific terms as well as terms with particular meaning in UNFC.

1. Mineral sources

9. The term "source" as used in UNFC is, for minerals projects, equivalent to the term deposit. The Glossary of Geology defines minerals as "a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.". Within the scope of this document, organic carbon minerals like peat, lignite and hard coal and their sources are explicitly included. Mineral sources are a potentially economically recoverable accumulation of a specific or a group of minerals.

2. Mineral products

10. Products of a mineral project may be bought, sold or used, and may include:

- Mined or produced ores
- Beneficiated ores
- Processed ore concentrates
- Co-products
- By-products.

3. Mining project

11. A mining project produces mineral products from a mineral source with defined frame conditions, which provide the basis for environmental-socio-economic evaluation and decision-making. A mineral project comprises of a defined activity or set of activities, which provide the basis for estimating environmental-socio-economic viability including costs and potential revenues associated with its implementation.

4. Minerals life cycle

12. The minerals life cycle starts with the exploration and subsequent primary mineral production, such as beneficiation, processing and value-addition in a mineral project(s). Mineral products reflect the primary entrance of raw materials into the stock available for economic value chains. During the length of stay within value-added chains, the mineral products and compositions might be altered in linear and cyclic processes. Regardless of any sharp definition boundaries, there is an overlapping field with the Specifications for the Application of UNFC to Anthropogenic Resources.[4] Secondary minerals (including recycled material) might be used to blend primary minerals in order to optimize the combined value, exploration methods used to define primary mineral sources might be utilized to classify secondary sources like mine dumps and so on. In overlapping project frame conditions, the choice which document to prefer should be based on common sense, a combination of documents onto different project parts might lead to target as well.

[4] https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/Anthropogenic_Resources/UNFC_Antropogenic_Resource_Specifications.pdf

5. Minerals reference point

13. The minerals reference point is a defined location within a mineral project at which the reported estimate is made. The minerals reference point may be the sales, transfer or use point from the projector it may be an intermediate stage, in which case the reported quantities account for losses prior to but not subsequent to the delivery point.

6. Mining methods

14. There are numerous conventional and unconventional mining methods, which could be utilised to produce minerals from sources. Each has its pros and cons depending on situation-specific characteristics like deposit type, ore morphology, mineralisation style, mineralisation depth, rock mechanics, safety, geopolitical factors, infrastructure, economics etc. The following mining methods are considered as conventional mining technologies:

- Surface Mining (Open Pit Mining, Quarrying)
- Subsurface Mining (Room & Pillar, Longwall, Slope Mining and others)
- Placer Mining (Trenching)
- In-situ Recovery (ISR) (or In-situ Leaching (ISL) or Borehole Mining)
- Solution Mining/Brine mining
- Seafloor Mining.

15. Quantity estimates vary significantly depending on the deployed mining method. The most significant differences in quantity estimates become evident when comparing conventional open pit to underground production methods. Underground mining is more commonly applied to high-grade, low tonnage deposits whereas open-pit mining provide an economically feasible approach for rather a homogenous low- to medium-grade high tonnage deposits with limitations based on the depths and strip ratio. Key parameters defining the quantity estimates for both methods vary significantly since the overburden or strip ratio is crucial for an open-pit operation making it amenable only to shallow deposits while underground operations do not consider any overburden thickness and instead require a precise understanding of the ore morphology and have much higher unit costs.

16. Some deposit types like low-grade copper or sources of rare earth elements (REEs) (also uranium) considered to be uneconomic using conventional mining methods may be economically viable if suitable for ISR. The quantity estimate incorporates additional physical and chemical parameters that are not relevant to open pit and underground mining. These include permeability and hydrologic confinement of the mineralised horizon, the solubility of the uranium minerals by weak alkaline or acidic solutions, and the ability to return groundwater within the mined area to its original baseline quality.

17. It is common practice in quantity estimates for ISR projects to use a grade x thickness (GT) contour method. A minimum GT cut-off, used in much the same way that a grade cut-off is established for conventional mining operations, should be reported.

18. Mineral sources for ISR production methods should be reported regarding quantity, quality and anticipated recovery. This can be achieved by reporting, in addition to the contained uranium and anticipated recovery, either: (i) deposit area, average thickness and average GT; or (ii) tonnage, average grade and average GT. Recovery may be reported either as the quantity of recoverable uranium or a percentage of the estimated contained uranium.

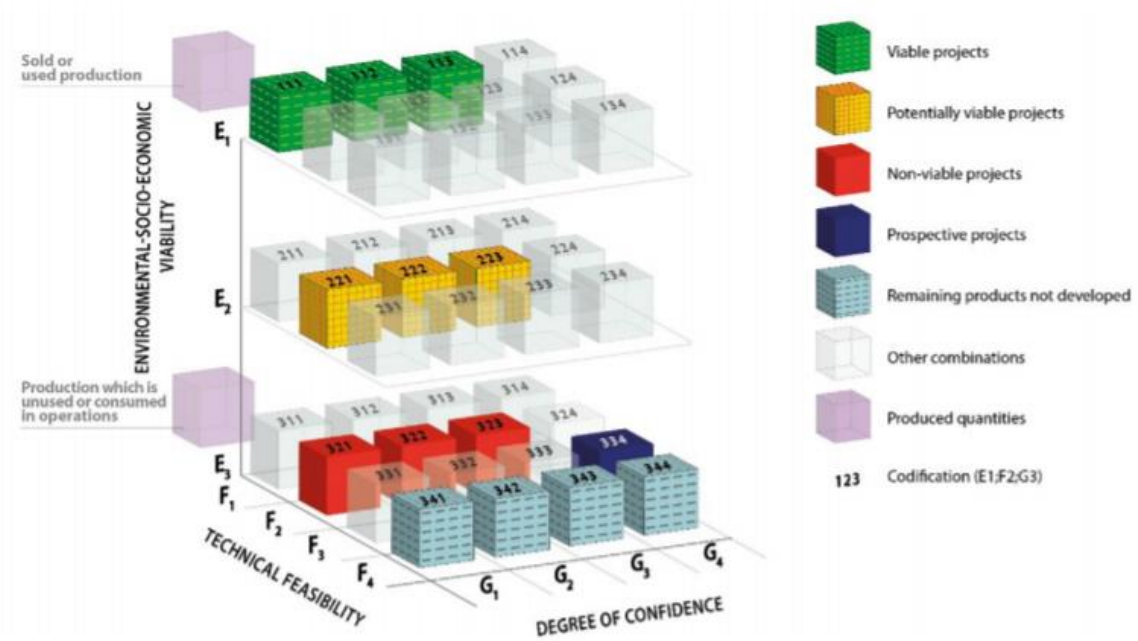
7. Categories and Sub-categories

19. *UNFC is a principles-based system in which the products of a resource project are classified using a numerical coding system on the basis of the three fundamental criteria: (i) environmental-socio-economic viability (E), (ii) technical feasibility (F), and (iii) degree of confidence in the estimate (G). Combinations of these criteria create a three-dimensional system (Figure II). Categories (e.g. E1, E2, E3) and, in some cases, Sub-categories (e.g. E1.1) are defined for each of the three criteria, as set out and defined in section B.*

20. *The first set of Categories (E Axis) designates the degree of favourability of environmental-socio-economic conditions in establishing the viability of the project, including consideration of market prices and relevant legal, regulatory, social, environmental, and contractual conditions. The second category (F Axis) designates the maturity of technology, studies, and commitments necessary to implement the project. These projects range from early conceptual studies advancing through to a fully developed project that is producing, while reflecting standard value chain management principles. The third category (G Axis) designates the degree of confidence in the estimate of the quantities of products from the project.*

21. *The Categories and Sub-categories are the building blocks of the system and are combined in the form of "Classes". UNFC can be visualised in three dimensions, as shown in Figure 2.*

Figure
UNFC Categories and Example of Classes



22. Some terms with particular meanings are used in the Category definitions in Tables 3-7. These terms are explained here:

Foreseeable Future: The period of time that a Project can make a reasonable projection of the occurrence of future conditions, events or other factors that determine the environmental-socio-economic viability or technical feasibility of a Project.

Reasonable Expectations: High level of confidence. This term is used within the E1 classification and concerns the likelihood that all necessary conditions will be met. It is also used in the F1.3 Sub-category and concerns the likelihood that all necessary approvals/contracts for the project to proceed to development will be forthcoming.

Reasonable Prospects: Moderate level of confidence. This term is used within the E2 and E3 classification and concerns the likelihood that all necessary conditions will be met.

Reasonable Time Frame: The time frame within which all approvals, permits and contracts necessary to implement the project are to be obtained. This should be the time generally accepted as the typical period required to complete the task or activity under normal or typical circumstances.

Table 1
Abbreviated version of UNFC, showing Primary Classes
(footnotes a through h are provided below the table)

Total Products	*Produced*	*Sold or used in production*			
		Production which is unused or consumed in operations[a]			
		Class	**Minimum Categories**		
			E	F	G[b]
	The project's environmental-socio-economic viability and technical feasibility has been confirmed	Viable Projects[c]	1	1	1, 2, (3)[h]
	The project's environmental-socio-economic viability and/or technical feasibility has yet to be confirmed	Potentially Viable Project[d]	2[e]	2	1, 2, 3
		Non-Viable Projects[f]	3	2	1, 2, 3
	Remaining products not developed from identified projects[g]		3	4	1, 2, 3
	There is insufficient information on the source to assess the project's environmental-socio-economic viability and technical feasibility	Prospective Projects	3	3	4
	Remaining products not developed from prospective projects[g]		3	4	4

a. Future production that is either unused or consumed in the project operations is categorized as E3.1. These can exist for all classes of recoverable quantities.

b. G categories may be used discretely, or in cumulative scenario form (e.g. G1+G2).

c. Estimates associated with Viable Projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within different industries and hence the term is not used here.

d. Not all Potentially Viable Projects will be developed.

e. Potentially Viable Projects may satisfy the requirements for E1.

f. Non-Viable Projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become viable developments within the foreseeable future.

g. Remaining products not developed from identified projects or prospective projects may become developable in the future as technological or environmental-socio-economic conditions change. Some or all of these estimates may never be developed due to physical and/or environmental-socio-economic constraints.

h In minerals projects the parallel categorisation of G3 together with E1 and F1 categories usually is **not** realised due to lack of direct evidence.

Table 2
UNFC Classes and Sub-classes defined by Sub-categories[a]
(footnotes are provided below)

UNFC Classes Defined by Categories and Sub-categories						
Total Products	**Produced**	Sold or used production				
		Production which is unused or consumed in operations				
	Class		**Sub-Class**	**Categories**		
				E	F	G
	Known Sources	Viable Projects	On Production	1	1.1	1, 2, (3)[c]
			Approved for Development	1	1.2	1, 2, (3)[c]
			Justified for Development	1	1.3	1, 2, (3)[c]
		Potentially Viable Projects	Development Pending	2[b]	2.1	1, 2, 3
			Development On Hold	2	2.2	1, 2, 3
		Non-Viable Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development Not Viable	3.3	2.3	1, 2, 3
		Remaining products not developed from identified projects		3.3	4	1, 2, 3
	Potential Sources	Prospective Projects	[No Sub-classes defined]	3.2	3	4
		Remaining products not developed from prospective projects		3.3	4	4

[a] Refer also to the notes for Table 1**Error! Reference source not found.**

[b] Development Pending Projects may satisfy the requirements for E1.

[c] In minerals projects the parallel categorisation of G3 together with E1 and F1 Categories usually is **not** realised due to the lack of direct evidence.

8. Classes and Sub-classes

23. *A Class is uniquely defined by selecting from each of the three criteria a particular combination of a Category or a Sub-category (or groups of Categories/Sub-categories). Since the codes are always quoted in the same sequence (i.e. E; F; G), the letters may be dropped and just the numbers retained. The numerical code defining a Class is then identical in all languages using Hindu-Arabic numerals.*

24. *While there are no explicit restrictions on the possible combinations of E, F and G Categories or Sub-categories, some may be more useful than others. For the more important combinations (Classes and Sub-classes), specific labels are provided as a support to the numerical code, as illustrated in Figure 2*[5].

25. For further clarity in global communications, additional UNFC Sub-classes are defined based on the full granularity provided by the Sub-categories included in Annex III of UNFC (2019). These are illustrated in Table 2.

[5] Figure 2 is equivalent to Table 1 in this document.

B. Definitions of Categories and Sub-Categories

26. Tables 3 to 7 provide the definitions of Categories and Sub-categories.

Table 3
E-Axis categories (UNFC (2019) text *in italics*)

Category	*Definition*	*Supporting explanation for minerals*
E1	*Development and operation are confirmed to be environmentally-socially- economically viable.*	*Development and operation* (prospection, exploration, mine production, processing, sales-access to market, rehabilitation) *are environmentally-socially-economically viable on the basis of current conditions and realistic assumptions of future conditions. All necessary conditions have been met (including relevant permitting and contracts) or there are reasonable expectations that all necessary conditions will be met within a reasonable timeframe and there are no impediments to the delivery of the product to the user or market. Environmental-socio-economic viability is not affected by short-term adverse conditions provided that longer-term forecasts remain positive.*
E2	*Development and operation are expected to become environmentally-socially-economically viable in the foreseeable future.*	*Development and operation* (prospection, exploration, mine production, processing, sales-access to market, rehabilitation) *are not yet confirmed to be environmentally-socially-economically viable but, on the basis of realistic assumptions of future conditions, there are reasonable prospects for environmental-socio-economic viability in the foreseeable future.*
E3	*Development and operation are not expected to become environmentally-socially-economically viable in the foreseeable future or evaluation is at too early a stage to determine environmental-socioeconomic viability.*	*On the basis of realistic assumptions of future conditions, it is currently considered that there are not reasonable prospects for environmental-socio-economic viability* of mining *in the foreseeable future; or, environmental-socio-economic viability cannot yet be determined due to insufficient information* (e.g. during prospection and exploration). *Also included are estimates associated with projects that are forecast to be developed, but which will be unused or consumed in operations* (sub-economic ore, waste).

Table 4
E-Axis Sub-categories (UNFC (2019) text in *italics*)

Category	*Sub-Category*	*Sub-Category Definition*
E1	E1.1	*Development and operation is environmentally-socially-economically viable on the basis of current conditions and realistic assumptions of future conditions.*
	E1.2	*Development and operation is not environmentally-socially-economically viable on the basis of current conditions and realistic assumptions of future conditions, but is made viable through government subsidies and/or other considerations.*
E2	No Sub-categories defined	
E3	E3.1	*Estimate of* mineral *product that is forecast to be developed, but which will be unused or consumed in operations.*
	E3.2	*Environmental-socio-economic viability cannot yet be determined due to insufficient information.*
	E3.3	*On the basis of realistic assumptions of future conditions, it is currently considered that there are not reasonable prospects for environmental-socio-economic viability in the foreseeable future.*

Table 5
F-Axis Categories (UNFC (2019) text *in italics*)

Category	*Definition*	*Supporting explanation for minerals*
F1	*Technical feasibility of a development project has been confirmed.*	*Development or operation is currently taking place or, sufficiently detailed studies have been completed to demonstrate the technical feasibility of development and operation. A commitment to develop should have been or will be forthcoming from all parties associated with the project, including governments.*
F2	*Technical feasibility of a development project is subject to further evaluation.*	*Preliminary studies of a defined project provide sufficient evidence of the potential for the development and that further study is warranted. Further data acquisition and/or studies maybe required to confirm the feasibility of development.*
F3	*Technical feasibility of a development project cannot be evaluated due to limited data.*	*Very preliminary studies of a project indicate the need for further data acquisition or study in order to evaluate the potential feasibility or development.* Additional exploration and investigation are required to confirm or to assess the technical feasibility of the project.
F4	No development project *or mining operation* has been identified.	*Remaining quantities of product not developed by any project* (not recoverable ore, at least not with available technology, too deep, groundwater issues etc.).

Table 6
F-Axis Sub-categories (UNFC (2019) text in *italics*)

Category	*Sub-Category*	*Sub-Category Definition*
F1	F1.1	*Production or operation is currently taking place.*
	F1.2	*Capital funds have been committed and implementation of the development is underway.*
	F1.3	*Studies have been completed to demonstrate the technical feasibility of development and operation. There shall be a reasonable expectation that all necessary approvals/contracts for the project to proceed to development will be forthcoming*
F2	F2.1	*Project activities are ongoing to justify development in the foreseeable future.*
	F2.2	*Project activities are on hold and/or where justification as a development may be subject to significant delay.*
	F2.3	*There are no plans to develop or to acquire additional data at the current time due to limited potential.*
F3	F3.1	*Site-specific studies have identified a potential development with sufficient confidence to warrant further testing.*
	F3.2	*Local studies indicate the potential for development in a specific area but requires more data acquisition and/or evaluation in order to have sufficient confidence to warrant further testing.*
	F3.3	*At the earliest stage of studies, where favourable conditions for the potential development in an area may be inferred from regional studies.*
F4	F4.1	*The technology necessary is under active development, following successful pilot studies, but has yet to be demonstrated to be technically feasible for this project.*
	F4.2	*The technology necessary is being researched, but no successful pilot studies have yet been completed.*
	F4.3	*The technology is not currently under research or development.*

Table 7
G-Axis Categories (UNFC (2019) text in *italics*)

Category	*Definition*	*Supporting explanation for minerals*
G1	*Product quantity associated with a project that can be estimated with a high level of confidence.*	*Product quantity estimates may be categorised discretely as G1, G2 and/or G3 (along with the appropriate E and F Categories), based on the degree of confidence in the estimates (high, moderate and low confidence, respectively) based on direct evidence. Alternatively, product quantity estimates may be categorized as a range of uncertainty as reflected by either (i) three specific deterministic scenarios (low, best and high cases) or (ii) a probabilistic analysis from which three outcomes (P90, P50 and P10) are selected. In both methodologies (the "scenario" and "probabilistic" approaches), estimates are then classified on the G Axis as G1, G1+G2 and G1+G2+G3 respectively. In all cases, the product quantity estimates are those associated with a project.*
G2	*Product quantity associated with a project that can be estimated with a moderate level of confidence.*	
G3	*Product quantity associated with a project that can be estimated with a low level of confidence.*	*The G axis Categories are intended to reflect all significant uncertainties (e.g. source uncertainty, geologic uncertainty, facility efficiency uncertainty, etc.) impacting the estimate forecast for the project. Uncertainties include variability, intermittency and the efficiency of the development and operation (where relevant). Typically, the various uncertainties will combine to provide a full range of outcomes. In such cases, categorization should reflect three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.* Additional Comments: The G axis in minerals and mining conditions primarily reflect geologic uncertainty impacting the estimate forecast for the project. Uncertainties include availability and resolution of direct data such as drill hole density in relation to the mineralisation and or deposit type. In addition, indirect data such as geophysical data might be included measured against redundancy of methods (e.g. geophysical measurements calibrated against drill core evaluation – drill hole logs – count higher than e.g. seismic data with no direct data calibration. The accuracy of measurements controls the level of the category (lab assay, rock mechanics, mineralogical phase assessment).
G4	*Product quantity associated with a Prospective Project, estimated or postulated primarily on indirect evidence.*	*A Prospective Project is one where the existence of a developable product is based primarily on indirect evidence and has not yet been confirmed. Further data acquisition and evaluation would be required for confirmation.* *Where a single estimate is provided, it should be the expected outcome but, where possible, a full range of uncertainty should be calculated for the prospective project.* Based on the lack of direct evidence an estimation of qualities and quantities is not suitable and / or potentially misleading in mineral exploration. *In addition, it is recommended that the chance of success (probability) that the prospective project will progress to a Viable Project is assessed and documented.*

Note: Further sub-categorisation of Class G4 is not applicable for minerals projects.

VI. Supplemental Specifications

27. In these supplemental specifications, the following words have specific meanings:

- "Shall" is used where a provision is mandatory;
- "Should" is used where a provision is preferred; and,
- "May" is used where alternatives are equally acceptable.

28. Where a specification is defined or referenced below, this sets a minimum standard for reporting under UNFC. Where text from UNFC (2019) is quoted in verbatim, it is shown *in italics.*

A. Minerals project plan and definition

29. A minerals project is a defined development or operation which provides the basis for environmental, social, economic and technical evaluation and decision-making. Minerals projects may include all stages of the mineral life cycle including:

- Prospecting/Exploration
- Mining
- Beneficiation
- Processing
- Decommissioning
- Remediation.

30. The minerals project plan may be detailed or conceptual (in the case of long-term national resource planning). The minerals project plan should be sufficiently detailed to allow an appropriate assessment for the stakeholder needs at the defined level of maturity.

B. Minerals project lifetime

31. *Project Lifetime is the remaining period of time that a project is expected to operate, constrained by technical, economic, regulatory or other permit/license cut-offs*. Minerals project lifetime is normally constrained by the period for which prospecting, exploration or mining license may apply for the project. Mining license may include beneficiation, processing, decommissioning and remediation stages of the mineral lifecycle.

C. Minerals project evaluation

32. Minerals projects may adopt various methodologies in the various stages of the mineral lifecycle including in the estimation of quantities as appropriate to the project. The basis for any estimations shall be appropriately referenced in the evaluation. This includes not only third-party data but also methodologies or procedures that have been used by the evaluating entity to generate in-house data.

1. Environmental-Socio-Economic Viability

33. Environmental-socio-economic viability shall reflect both the economic assessment of the project as well as the environmental or social aspects within a project's life cycle balanced against the SDGs. Minerals provides the basic raw materials that contributes to several SDGs. Alignment to the SDGs to the mineral industry is essential for the future especially in order to operate a sustainable mining (and exploration) with environmental, health and work protection standards and geoethics. When mineral projects are assessed using UNFC, attention should be paid to understand the impacts on the SDGs such as:

- Direct, indirect and induced high skilled and well-paying jobs (SDG 1)

- Support to sustainable food production (SDG 2)
- Support to the health infrastructure and improving public health by reducing the pollution levels (SDG 3)
- Support to science and technology education (SDG 4)
- Energy access to enhance labour emancipation and reduce jobs involving drudgery, which disproportionately affects women (SDG 5)
- Clean water and sanitation, including support to desalination (SDG 6)
- Support to the green energy transition (SDG 7)
- Support to a diverse range of jobs, including various engineers, technicians, and other specialists (SDG 8)
- Enabling mining and processing facilities to operate at greater safety and performance levels (SDG 9)
- Engaging stakeholders including indigenous and marginalised groups (SDG 10)
- Support to urban development and improving e-mobility (SDG 11)
- Improving resource efficiency (SDG 12)
- Support to decarbonization of mining life-cycle (SDG 13)
- Preventing ocean acidification or other chemical emissions (SDG 14)
- Enhancing biodiversity (SDG 15)
- Supporting the development of strong national institutions committed to human rights (SDG 16)
- Partnerships with governments, industry, non-governmental organizations (NGOs), and educational institutes (SDG 17).

34. The E-axis expresses the favourability of environmental, social, and economic conditions for establishing the commercial viability of the Project including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions. With respect to the current version of UNFC (2019), Tables 3 and 4 in this document define the E-axis Categories and Sub-Categories.

35. UNFC defines E1, E2 and E3 based on the environmental-socio-economic viability of the Project. It may be noted that this encompasses environmental, social and economic factors, including relevant 'market conditions', and consideration of prices, costs, legal/fiscal framework, and all other non-technical aspects that could directly impact the viability of a development project. In classifying estimated quantities that may be produced in the future from a development project or mining operation, the E- axis Categories are explicitly defined to include both environmental and social issues that may be relevant to the commercial viability of such a venture, in addition to economic, legal and other non-technical factors. In particular, the identification and consideration at the time of the estimate of all known environmental or social impacts of the project during its entire life cycle are recognised as an integral part of the project assessment. The presence of environmental or social impediments can prevent a project from proceeding, or it can lead to the suspension or termination of activities in an existing operation.

2. Technical Feasibility

36. The F Axis designates the maturity of studies and commitments necessary to implement mining projects. These extend from early exploration efforts before a deposit or accumulation has been confirmed to exist and extends through to a project that is producing and selling a commodity and reflect standard value chain management principles.

37. The F Axis represents the stage of Project Feasibility (F Axis in the Figure). It may be noted that the phrase 'project feasibility' encompasses technical conditions that could directly impact the feasibility of a development project. In classifying estimated quantities that may be produced in the future from a development project or mining operation, the

F-Axis Categories are explicitly defined to include technical issues that may be relevant to the feasibility of such a venture.

38. Some relevant technical parameters which influence the technical feasibility of a mining project include the following:

- Mining method (e.g. underground, open pit) and mining technique (e.g. drill and blast, continuous mining)
- Rock mechanical conditions of the site
- Volume - masses relation of volume streams, density of relevant rock types
- Processing method (incl. required grain size for process)
- Metallurgical features (thin sections)
- Infrastructure (access to power supply and to market, transport distances and means)
- Technical aspects of legal and governmental obligations (licence to operate, prospecting, exploration, mining)
- Technical practicability of safety requirements
- Available technology for site closure, decomissioning and site remediation
- Climatic, temperature aspects esp. in projects with seasonally variable frost conditions on site or in infrastructure axes.

3. Estimate of product quantity

39. *The G Axis designates the degree of confidence in the estimate.* Translated into minerals and mining relevant conditions the G Axis usually reflects the degree of geological knowledge regarding quantities and qualities.

D. Project Classification

1. Classification of projects based on the level of maturity

40. *Where it is considered appropriate or helpful to sub-classify* mineral projects *to reflect different levels of project maturity, based on the current status of the project, the optional Sub-classes shown in Figure IV may be adopted. Additional guidance on the distinction between the Sub-classes of UNFC is provided in Annex III of UNFC (2019).*

41. The levels of maturity in mineral projects may be determined by the results of prospection, exploration, feasibility studies as well as the production operations.

2. Distinction between [E1 E2 E3]

42. *The distinction between quantities that are classified on the environmental-socio-economic axis as E1, E2 or E3 is based on the phrase "reasonable prospects for environmental-socio-economic viable development in the foreseeable future". The definition of "foreseeable future" can vary depending on the development* but the generic definition is provided in Section V.A.7.

43. *The Environmental-socio-economic Axis Categories encompass the non-technical issues that directly impact the viability of a project, including product prices, costs, legal/fiscal framework, environmental regulations and known environmental or social impediments, barriers or benefits. Any one of these issues could prevent anew project from proceeding (and hence quantities would be classified as E2 or E3, as appropriate), or it could lead to the suspension or termination of production activities in an existing operation. Where development or operation activities are suspended, but there are "reasonable prospects for environmentally, socially and economically viable production in the foreseeable future", the project shall be reclassified from E1 to E2. Where "reasonable prospects for environmentally, socially and economically viable production in the foreseeable future" cannot be demonstrated, the project shall be reclassified from E1 to E3.*

44. *In some cases, the presence of positive social or environmental externalities may be a key driver for starting a project. The classification will record the maturity of the social or environmental aspects and their impact on the project.*

3. Environmental-socio-economic assumptions

45. *In accordance with the definitions of E1, E2 and E3, environmental-socio-economic assumptions shall be based on current conditions and realistic assumptions of future conditions. Except where constrained by regulation, assumptions of future market conditions should reflect the view of either:*

(a) The organization responsible for the evaluation;

(b) The view of a competent person or independent evaluator; or,

(c) An externally published independent view, which is considered to be a reasonable forecast of future conditions.

46. *The basis for the assumptions (as opposed to the actual forecast) shall be disclosed. Where alternative assumptions are used, the alternative estimates shall be identified, and accompanied by an explanation of the assumptions used.*

4. Distinction between potentially produced quantities and undeveloped quantities

47. *Quantities of products associated with projects are categorized as F1 to F3 as potentially developable using existing technology or technology currently under development or operation. There may be remaining quantities with no development project. The product quantity associated with these are categorized as F4. These are quantities which, if produced, could be bought, sold or used.*

48. In minerals projects these products may be currently unused by-products such as specific minerals or metals or mine waste (host rock) which could be used as aggregate material.

E. Project reporting

1. Basis for the estimate

49. *Estimates may be attributable to the project as a whole, or may reflect the proportion of those estimates that is attributable to the reporting entity's environmental-socio-economic interest in the project.*[6] *The reporting basis shall be clearly stated in conjunction with the estimate. Government royalty obligations are often treated as a tax to be paid in cash and are therefore generally classified as a cost of operations. In such cases, the reported estimate may include the proportion attributable to the royalty obligation. Where the reported estimate excludes the proportion attributable to the royalty obligation, this shall be disclosed*

2. Effective date

50. *Reported estimates of mineral product quantities are as at the Effective Date of the evaluation. The Effective Date shall be clearly stated in conjunction with the estimate. The evaluation should take into account all data and information available to the evaluator prior to the Effective Date. If information becomes available subsequent to the Effective Date, but prior to reporting, that could have significantly changed the estimate as at the Effective Date, the likely effect of this information shall be included in the report.*

51. Classified minerals quantities are estimates of remaining quantities as at the Effective Date of the evaluation.

[6] The proportion of gross quantities attributable to a company will depend on the specific contractual arrangements governing mineral development and operations, and may be defined by regulation. For corporate reporting, the general principles used to determine net quantities shall be documented.

3. Minerals product

52. *Estimates should be classified separately for each* minerals product *that will be sold, transferred, used, unused or consumed in operations. Where estimates for different products have been aggregated for classification, and separate estimates are not provided, the aggregated estimates shall be accompanied by a statement clarifying which products have been aggregated and the conversion factor(s) used to render them equivalent for the purposes of aggregation.*

53. Product types could include metallic minerals, non-metallic minerals and/or industrial minerals, including aggregates, coal, diamond, etc.

54. In minerals projects the reported quantity of the product usually depends on the reported qualities. This is reflected via the so-called grade-tonnage relationship (different cut-off values in quality / grade of the minerals derive different quantities). The choice of different cut-off values usually covers different scenarios in technical and financial frame conditions (e.g. beneficiation techniques, market prices). Frequently mineral equivalents are calculated for the estimation and used in cut-off considerations (e.g. Au (gold)-Ag (silver)-Cu (copper)-values combined by a constant equation as Cu-equivalent). All utilised values and equations shall be disclosed within the report.

4. Reference point

55. *The Reference Point is a defined location within a development at which the reported estimate or measurement is made. The Reference Point may be the sales, transfer or use point from the development or it may be an intermediate stage, in which case the reported quantities account for losses prior to but not subsequent to the delivery point. The Reference Point shall be disclosed in conjunction with the classification. Where the Reference Point is not the point of sale to third parties (or where custody is transferred to the entity's other operations), and such quantities are classified as E1, the information necessary to derive estimated sales shall also be provided.*

56. The Reference Point in a minerals project can depend on the development stage of the project, the end of a drilling campaign in exploration or during a running operation the mine head production or the concentrate production at the processing plant.

5. Aggregation of quantities

57. *Estimates associated with projects that are classified in different Categories on the Environmental-Socio-Economic or Technical Feasibility Axes shall not be aggregated with each other without proper justification and disclosure of the methodology adopted. In all cases, the specific Classes that have been aggregated shall be disclosed in conjunction with the classified quantity (e.g. 111+112+221+222) and a footnote added. The footnote shall state how projects with different E and F Categories have been aggregated to account for the likelihood that not all will mature to Viable Projects. It shall also state, if relevant, how quantities with different G Categories have been aggregated (arithmetically or stochastically, and if stochastic aggregation is used, how).*

58. *Where estimates have been aggregated from multiple projects, consideration should be given to sub-dividing the aggregated totals by product type and by location.*

59. Estimated minerals categories have therefore to be disclosed exclusively in their classes or aggregated together in the lower classes and categories. In all cases the aggregated classes and categories and the processes of aggregation shall be exactly described.

6. Use of Numerical Codes

60. *While the defined Classes and Sub-classes may be used as supplementary terminology, the relevant Numerical Code(s) shall always be reported in conjunction with the estimated mineral quantity. For example, these may be documented in the form 111, 111+112, or 1.1;1.2;1, as appropriate.*

61. *Note that some Sub-categories that are defined in the text are in addition to those provided in Annex II of UNFC. These optional Sub-categories have been identified as*

potentially useful in certain situations and have been defined herein in order to ensure consistency in their application. Nothing in this document shall preclude the possible use of additional Sub-classes in the future that may be deemed to be useful in particular cases especially where such sub-classes facilitate the linkage to other systems and which may be defined in Bridging Documents.

7. Units and Conversion Factors

62. *In order to facilitate global comparability of product estimates, it is recommended that the Système International d'Unités (SI units) is used for reporting of resource quantities. However, it is recognised that there are traditional measurement units that are widely used and accepted for certain product types; where such units are used, conversion factors to SI units shall be provided. Similarly, where quantities are converted from volume or mass to energy equivalents, or other conversions are applied, the conversion factors shall be disclosed.*

63. Reporting shall use the same units and should not combine different measurement systems (e.g. metric *versus* imperial, grams *versus* ounces). This might especially the case by re-evaluating projects from different geographical or historical backgrounds. The conversion equations, where applied, shall be disclosed.

8. Documentation

64. *Estimates shall be documented in sufficient detail that would allow an independent evaluator or auditor to clearly understand the basis of the estimate and their classification. Note that this is an obligation for ensuring that appropriate internal documentation is generated and kept and is not an obligation for external disclosure of such information.*

65. Such documentation might be especially valid for e.g. sample data and laboratory validation and the process of deposit modelling and classification.

9. Avoidance of double counting

66. Reporting of estimates shall be exclusive for each class or sub-class. When different products are reported care should be taken to avoid double counting.

10. National reporting

67. *At a government level, national product estimates may be based on an aggregation of reported or published corporate estimates for individual projects. However, such estimates may not cover all known or potential development options. Further, where government organizations have a responsibility for developing estimates at a regional or national level, the estimates may be different from corporate estimates on an individual project basis, regardless of the classification system being used. In such cases, regional or national estimates using UNFC shall be derived using an appropriate methodology based on the nature and extent of available data. In accordance with Generic Specification on aggregation methodology shall be disclosed.*

68. *When reporting aggregated estimates using UNFC, it is mandatory that the relevant Numerical Codes for the individual Classes are disclosed. For example, it may be useful at a national level to determine the sum of estimated quantities for Viable Projects and Potentially Viable Projects at a "best estimate" level, though it is preferred that the breakdown by Class is also provided.*

VII. Quality assurance and quality control

A. Evaluator qualifications

69. *Evaluators must possess an appropriate level of expertise and relevant experience in the estimation of resource project under evaluation.*

70. The evaluator will always be accountable for the correct use of the classification, and the correctness of the estimates reported irrespective of who has prepared them.

71. The following should be read in conjunction with the Guidance Note on Competent Person Requirements and Options for Resources Reporting.[7] A Competent Person is essential for certain types of reporting functions, especially in the disclosures required by financial institutions. In this case, the following definitions and requirements may apply.

72. A Competent Person is one who has the ability to put skills, knowledge and experience into practice in order to perform activities or a job in an effective and efficient manner for resource classification, management and reporting.

73. Classification, management and reporting of mineral sources may be a team effort involving several technical disciplines. In the case of a team effort, it is recommended that there is a clear division of responsibility in a team where each Competent Person and his or her contribution should be identified and explain the responsibility for their particular contribution. If a single Competent Person accepts responsibility for the whole of the documentation, he or she should be satisfied that the supporting work prepared in whole or part by others is acceptable.

74. Core values:

75. Principles that should influence a competent person's actions and choices in connection with resource reporting are:

- Sustainable development values: Should demonstrate in-depth knowledge and commitment to the 2030 Agenda for Sustainable Development (and SDGs)
- Integrity: Should demonstrate the values of impartiality, fairness, honesty and truthfulness, in daily activities and behaviours. Takes prompt action in cases of unprofessional or unethical behaviour
- Professionalism: Should demonstrate skill, good judgment and mastery of the subject matter
- Care for the Environment: Should have a commitment to protect the environment and preserve the earth's natural resources, both for today and for generations into the future
- Respect for Diversity: Should have the commitment to respect for gender justice and diversity, such as race/ethnicity, culture, language, gender, age, sexual orientation or expression, religion and disability.

76. The following requirements may be applied for the Competent Person:

(a) Single Person or Group: Competent Person may be a single person or a team of experts with different backgrounds performing mineral resource management functions. For complex projects where knowledge in different areas are required, reporting should be performed by a team of Competent Persons, each having appropriate education, experience and continuous training in relevant areas;

(b) Disclosure: The full name, affiliation, education and experience of the Competent Person providing the estimation should be disclosed. If a group is performing the actions, each member of the group should satisfy all the generic requirements and the specific requirements of the mineralisation style, mineral deposit type, or mineral value-chain process for which the person is responsible. All members of the group should disclose their full name, affiliation, education and experience and indicate which specific part of the reporting they are responsible for;

(c) Responsibility: The responsibility of the reporting should in all cases rest on the organization or entity reporting the mineral quantities or volumes;

[7] https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC-Guidance-Notes/Guidance_Note_on_Competent_Person_Requirements_and_Options_for_Resource_Reporting.pdf

(d) Education: A Competent Person should have undergone a managed process of individual learning at a university or academic institution that provides basic knowledge that underpins the science, technology and socio-economics of the mineral value chain management. At a minimum, a Competent Person should have a relevant tertiary degree;

(e) Experience: A Competent Person should have a minimum of five years of relevant experience in mineral resource management functions;

(f) Continuous Training: A Competent Person should undergo Continuous Professional Development (CPD). This is a managed process that is focused on the continuous development of specialised knowledge needed to meet mineral resource management;

(g) Licences: A Competent Person should hold appropriate licences issued by a competent authority if required in the jurisdiction in which he or she is reporting;

(h) Affiliation: For the purpose of public reporting, a Competent Person should be affiliated with a government-designated statutory body or a professional body or association with an enforceable code of ethics and performance expectations. The regulator/authority may specify the acceptable statutory or professional bodies or associations acceptable for the purpose;

(i) General guidance: Persons being called upon to act as a Competent Person should be clearly satisfied in their minds that they could face their peers and demonstrate competence in the particular activity and sector under consideration. Should doubt exist, the person should seek opinions from appropriately experienced colleagues or should decline to act as a Competent Person.

B. Ethical standards

77. Ethical standards: Resource estimation and reporting, as well as project evaluation, can be the subject of unintentional or motivational bias. To ensure mineral sources are evaluated in an unbiased manner, certain ethical standards should be observed, including compliance with the highest standards of professionalism and personal conduct in the performance of required duties.

78. These ethical standards include:

1. Independence

- Declare any conflict of interest
- Disclosure of any outcome-related compensation plan
- Maintain the freedom to report any irregularities to an independent governance body.

2. Objectivity

- Consider all available data (including poor or unexpected results)
- Use realistic and supportable commercial assumptions
- Maintain compliance with appropriate resource evaluation definitions and guidelines
- Utilize adequate technical, commercial and ethical training opportunities for personnel involved in resource estimation
- Avoid manipulation of data to support a pre-conceived idea
- Document all assumptions and results
- Peer review work and discuss differences of opinion
- Present results fully and openly.

3. Confidentiality

- Maintain confidentiality of data and analyses
- Comply with any confidential agreements such as non-disclosure agreements.

4. Additional guidelines

- Maintain records of all data and analyses in a secure place for an appropriate period as required by internal controls and compliance with regulatory authorities
- Conduct all work within health and safety guidelines in place.

VIII. Bridging document

79. *UNFC may be aligned with other classification systems. A Bridging Document explains the relationship between UNFC and another classification system, including instructions on how to classify estimates generated by the application of that system using UNFC Numerical Codes. The Bridging Document that was used as the basis for the evaluation shall be disclosed in conjunction with the reported quantities.*

80. The bridging documents are continuously developed and updated, therefore the most recent version available shall be used. A list of official bridging documents is published on the UNECE website. When quantities are transferred from UNFC to an aligned classification system, all requirements of the aligned system shall apply. For example, transferring volumes from UNFC to the CRIRSCO Template, the requirements of Competent Person as referred to in Section VII.A on Evaluator qualifications shall apply.

IX. Glossary of Terms

[This section will be updated when a common UNFC glossary is issued.]

Term	*Definition*
Aligned System	A classification system that has been aligned with UNFC as demonstrated by the existence of a Bridging Document that has been endorsed by the Expert Group on Resource Management.
Bridging Document	A document that explains the relationship between UNFC and another classification system, including instructions and guidelines on how to classify estimates generated by application of that system using UNFC Numerical Codes.
Category	Primary basis for classification using each of the three fundamental Criteria of environmental-socio-economic viability (related Categories being E1, E2, and E3), field project status and feasibility (related Categories being F1, F2, F3 and F4), and level of knowledge and/or confidence in estimates of quantities (related Categories being G1, G2, G3 and G4). Definitions of Categories are provided in UNFC Part I.
Class(es)	Primary level of resource classification resulting from the combination of a Category from each of the three Criteria (axes).
Classify (according to UNFC)	To assign estimated quantities to a specific Class (or Sub-class) of UNFC by reference to the definitions of Categories or Sub-categories for each of the three Criteria and taking into account both the Generic Specifications and the Sectoral Specifications or requirements that are included in the Aligned System, as set out in the relevant Bridging Document.
Competent Person	Competent Person is one who has the accredited ability to put skills, knowledge and experience into practice in order to perform activities or a job in resource documentation, classification, management and reporting.

Term	*Definition*
Criteria	UNFC utilises three fundamental Criteria for resource classification: favourability of environmental-socio-economic conditions in establishing the viability of the project (E axis); maturity of technology, studies and commitments necessary to implement the project (F axis); and, degree of confidence in the estimate of quantities of products from the project (G axis). These Criteria are each subdivided into Categories and Sub-categories, which are then combined in the form of Classes or Sub-classes.
Effective Date	The date for which the assessment is made.
Evaluator	Person, or persons, performing resource estimation and/or classification (compare competent person).
Foreseeable Future	The period of time that a Project can make a reasonable projection of the occurrence of future conditions, events or other factors that determine the environmental-socio-economic viability or technical feasibility of a Project.
Generic Specifications	Specifications that apply to the classification of products of any resource project using UNFC.
Guidelines	Additional instruction on how UNFC should be applied in specific circumstances.
Harmonisation of Classification Systems	To identify significant differences between systems, if any, by mapping and then, if necessary, to adjust definitions and/or specifications of one system so that they lead to comparable results. A system that is harmonized with UNFC can become an Aligned System through the development and endorsement (by the Expert Group on Resource Management) of a Bridging Document.
Known Minerals Source	A Minerals Source that has been demonstrated to exist by direct evidence, usually derived through exploration or ongoing production.
Mapping Document	The output of a comparison between another resource classification system and UNFC, which highlights the similarities and differences between the systems. A Mapping Document can provide the basis for assessing the potential for the other system to become an Aligned System through the development of a Bridging Document.
Minerals Source	A Minerals Source is a concentration or occurrence of material quantity of intrinsic commercial or Political interest, in such form, quality and quantity from which a benefit is produced.
Minerals Life Cycle	The Minerals Life Cycle usually starts with the exploration and subsequent primary mineral production in the course of a mining operation., and decommissioning and site remediation. This step reflects the primary entrance of raw materials into the stock available for economic value chains. During the length of stay within value-added chains, the mineral nature and compositions might be multiply altered in linear and cyclic processes (recycling).
Numerical Code	Numerical designation of each Class or Sub-class of resource quantity as defined by UNFC. Numerical Codes are always quoted in the same sequence (i.e. E;F;G).
Potential Source	A Minerals Source that has not yet been demonstrated to exist by direct evidence, but is assessed as potentially existing based primarily on indirect evidence or evidence with limited density of exploration data.
Product	Products of the project may be bought, sold or used. In some cases the product and the source are similar and might be utilised directly (e.g., aggregates); in other cases the product is indirectly utilised i.e. derived from the source by industrial processes like beneficiation (steel / iron from iron ore).

Term	*Definition*
Project	A Project is a defined development or operation which provides the basis for environmental, social, economic and technical evaluation and decision-making. In the early stages of evaluation, including verification, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail. Where no development or operation can currently be defined for all or part of a source, based on existing technology or technology currently under development, all quantities associated with that source (or part thereof) are classified in Category F4. These are quantities which, if produced, could be bought, sold or used.
Prospective Project	A Project that is associated with one or more Potential Minerals Source (See Potential Source). The results of a prospective project might potentially provide the necessary direct evidence for a Known Minerals Resource.
Remediation (or Reclamation)	The restoration of a project site conditions that are required by regulatory or other provisions.
Reasonable Expectations	High level of confidence. This term is used within the E1 classification and concerns the likelihood that all necessary conditions will be met. It is also used in the F1.3 Sub-category and concerns the likelihood that all necessary approvals/contracts for the project to proceed to development will be forthcoming.
Reasonable Prospects	Moderate level of confidence. This term is used within the E2 and E3 classification and concerns the likelihood that all necessary conditions will be met.
Reasonable Time Frame	The time frame within which all approvals, permits and contracts necessary to implement the project are to be obtained. This should be the time generally accepted as the typical period required to complete the task or activity under normal or typical circumstances.
Specifications	Additional details (mandatory rules) as to how a resource classification system is to be applied, supplementing the framework definitions of that system. Generic Specifications provided for UNFC ensure clarity and comparability and are complementary to the sectoral requirements, including in Aligned Systems, as set out in the relevant Bridging Document.
Sub-categories	Criteria of environmental, social and economic viability, technical feasibility, and degree of confidence.
Sub-classes	Optional subdivision of resource classification based on project maturity principles resulting from the combination of Sub- categories. Project maturity Sub-classes are discussed further in UNFC (2019) Part III Section III.
Système International d'Unités	Internationally recognized system of measurement and the modern form of the metric system. Prefixes and units are created and unit definitions are modified through international agreement as the technology of measurement progresses, and as the precision of measurements improves. Abbreviated to SI.
UNFC	United Nations Framework Classification for Resources.
Viable	A project is viable when it has been confirmed to be economically, socially, technically and environmentally feasible and satisfies all the relevant criteria of the E, F, and G axes that are required for it to proceed.

X. References

UNFC (Update 2019) (current version)

https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf