Specifications

for the application

of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009

to Renewable Energy Resources

Done in Geneva, 30 September 2016

Specifications for the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 to Renewable Energy Resources

Prepared by the Task Force on Application of UNFC-2009 to Renewable Energy Resources

Summary

This document provides the Specifications that enable the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) incorporating Specifications for its Application (as set out in United Nations Economic Commission for Europe (UNECE) Energy Series No. 42 and ECE/ENERGY/94) to Renewable Energy Resources. The intended use of this document is in conjunction with UNFC-2009 incorporating Specifications for its Application and with the aligned commodity-specific specifications (currently under development) for specific types of Renewable Energy Resources.

The Specifications were endorsed by the UNECE Committee on Sustainable Energy at its twenty-fifth session, Geneva, 30 September 2016.

Preface

At its fourth session in April 2013, the Expert Group on Resource Classification of the United Nations Economic Commission for Europe (ECE) recommended that a Task Force on Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to Renewable Energy Resources be established.

Following its formation in June 2013, the Task Force worked on the development of generic Specifications that would allow application of UNFC-2009 to renewable energy resources. The first draft of the Specifications was presented to the Expert Group at its fifth session in April 2014, following which the document was issued for public comment from 12 June until 12 September 2014. The document was revised following careful consideration of all the comments received and submitted to the sixth session of the Expert Group in April 2015 (ECE/ENERGY/GE.3/2015/3). The Expert Group recommended that the draft generic Specifications be accepted and made available on the ECE website as a draft document. The Expert Group also requested the Task Force to propose any updates to the generic Specifications that may be needed as a result of the development of the commodity-specific specifications. Subsequent revisions were hence made, including as result of feedback from the sub-groups of the Task Force: Geothermal Working Group, Bioenergy Working Group and G axis Sub-group. The revised generic Specifications were submitted to the Expert Group on Resource Classification for review at its seventh session in April 2016 (ECE/ENERGY/GE.3/2016/5). The Expert Group accepted the revised draft generic Specifications for the application of UNFC-2009 to Renewable Energy Resources and recommended they be submitted to the twenty-fifth session of the Committee on Sustainable Energy for endorsement.

The intended use of this document is in conjunction with UNFC-2009 incorporating Specifications for its Application (ECE Energy Series No. 42) and with the aligned commodity-specific specifications (currently under development) for specific types of Renewable Energy Resources.

Growing interest in renewable energy has highlighted a need to harmonize the way in which renewable energy potential is reported. Investors, regulators, governments and consumers need a common comparison framework for both renewable and non-renewable energy resources to assess energy sustainability scenarios at project, company, country, regional or global levels. The application of UNFC-2009 to renewable energy resources could not only improve the view of energy sustainability but also greatly facilitate the economic evaluation of renewable energy projects and the raising of finance.

Acknowledgements

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Contents

I. Introduction

1. The purpose of this document is to enable the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) incorporating Specifications for its Application (as set out in ECE Energy Series No. 42 and ECE/ENERGY/94) to Renewable Energy Resources. The Specifications are presented in Part IV of this document for reference. Additional context for their application to Renewable Energy Resources is provided where deemed necessary. This document is intended for use in conjunction with UNFC-2009 incorporating Specifications for its Application and with the commodity-specific specifications that are under development for specific types of Renewable Energy Resources.

2. These Specifications represent 'rules of application' of UNFC-2009 for Renewable Energy Resources. The commodity-specific specifications under development represent 'rules of application' of UNFC-2009 to specific types of Renewable Energy Resources via these Specifications. Hence, this document is to be used only in conjunction with the two documents listed above, and not as a stand-alone document.

3. The United Nations Sustainable Energy for All (SE4All) definition of renewable energy is adopted in this document:

> *"Renewable energy is energy that is derived from natural processes (e.g. sunlight and wind) that are replenished at a higher rate than they are consumed. Solar, wind, geothermal, hydro*[1]*, and biomass are common sources of renewable energy."*

4. The SE4All definition uses "replenished at a higher rate than consumed". It is noted that alternative definitions describe renewable energy as being replenished at an equal or higher rate than consumed or that the replenishment rate may vary seasonally or depending on the type of project (i.e., the replenishment rate may vary with the extraction rate). The specifics of the replenishment and sustainability of different types of Renewable Energy Resources are addressed in the commodity-specific specifications.

5. Because renewable energy sources are by definition renewable and replenished, the estimation of the resource quantity is in theory infinite. However, such an estimate does not consider parameters such as economics, siting, project development and the like that delimit and define the amount of useful energy that can be extracted from a renewable energy resource, which is the amount that is relevant for governments, companies, and society at large. This presentational challenge is addressed in UNFC-2009 because the its central concept is the Project. The resources that are classified in UNFC-2009 are the (finite) quantities that are estimated to be extracted during the lifetime of the Project, and are classified according to the status of the Project. The identification and definition of the Project therefore remains the fundamental starting point for the application of UNFC-2009 to Renewable Energy Resources.

II. Renewable Energy definitions

A. Renewable Energy Source, Products and Resources

6. **Renewable Energy Source** is the equivalent of the terms "deposit" or "accumulation" used for petroleum and solid mineral resources. Renewable Energy Source is the primary energy (e.g., earth thermal energy, energy from sun, wind, biomass, river

[1] In this definition the term "hydro" includes energy generated from waves, currents and tides.

flow, tides, waves) available for extraction of (and conversion into) Renewable Energy Products. The main difference with fossil fuels or solid minerals is that, during the lifetime of the project, the Renewable Energy Source is being replenished.

7. A **Renewable Energy Product** is directly linked to (or a direct replacement of) a fungible energy commodity and is saleable[2] in an established market. Examples of energy products are electricity, heat and biofuels. Other products extractable from the Renewable Energy Source in the same extraction process may not qualify as a Renewable Energy Product; nevertheless, they may contribute to the economic viability of the Project.

8. **Renewable Energy Resources** are the cumulative quantities of extractable[3] Renewable Energy Products from the Renewable Energy Source, measured at the Reference Point.

B. Defining the Project

9. The Renewable Energy Resource classification process consists of identifying a Project, or Projects, associated with a Renewable Energy Source, estimating the quantity of Renewable Energy Products that can be extracted from a Renewable Energy Source, with associated level of confidence, and classifying the Project(s) based on Project status (or maturity) and socio-economic viability.

10. The Project is the link between the Renewable Energy Source and the quantities of Renewable Energy Products and provides the basis for economic evaluation and decision-making. There is a clear recognition of risk versus reward for the investor, linked to uncertainties and/or variability in the Renewable Energy Source (including the sustainability of extraction versus replenishment), the efficiency of the extraction and conversion process, Renewable Energy Product prices and market conditions (including policy support mechanisms) and social acceptance. In the early stages of evaluation, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail.

11. The cumulative quantity of Renewable Energy Products taken to the Project's economic, contractual or other time limit defines the Renewable Energy Resource quantity.

C. Project lifetime

12. The forecasted Renewable Energy Resources associated with a Project are constrained by the Economic Limit on Project lifetime.

13. The Economic Limit is defined as the extraction date beyond which the remaining cumulative net operating cash flows from the Project are negative, a point in time that defines the Project's economic life. A significant difference from non-renewable energy Projects is that the economic limit will often not be an appropriate basis for the resource assessment because renewable energy is often replenished at an equal or higher rate than

[2] This does not prescribe that the Renewable Energy Product must be sold. For example, own-use quantities (within the defined Project) can be included and classified under UNFC-2009, even though they are not being sold. This is similar to the concept of "Consumed in Operations" (CiO) for fossil energy.

[3] The term "extraction" is used in these specifications. This term is equivalent to "production" or "recovery", which are commonly used for petroleum projects. It implies the process of converting a Renewable Energy Source into Renewable Energy Product(s). Where necessary, the meaning of "extraction" in the context of different types of Renewable Energy Resources is clarified in the aligned commodity-specific specifications.

consumed[4] and other Project limitations may become relevant before the Economic Limit is reached.

14. Generally, it will be necessary to limit the quantification of Renewable Energy Resources to a defined Project lifetime of a number of years. This Project lifetime can be determined from the design basis of the facilities or key components of those facilities, or based on industry practice or benchmarks for similar Projects. Routine maintenance requirements do not constrain the Project lifetime, but a need for significant capital re-investment, requiring a new Project investment decision and/or regulatory approval, would have to be captured, from a resource assessment perspective, as a separate Project of lower maturity.

15. The reporting entity's Entitlement (see Section D) to the Renewable Energy Resources may also be limited in time and, if of lesser duration than the design life of the facilities and the economic limit, will be the constraining factor for the entity's resource reporting.

D. Entitlement

16. Entitlement defines the quantities of Renewable Energy Resource that accrue to Project participants.

17. A reporting entity's Entitlement to Renewable Energy Resources is governed by applicable contracts. Key elements that provide the basis for the ability of the entity to recognize and report resources are: (i) access to the Renewable Energy Source; (ii) exposure to risks in the extraction process; and (iii) the opportunity for reward through the subsequent sales of the Renewable Energy Product(s).

E. Development plan

18. In order to assign Renewable Energy Resources to any class, except for category F4, a development plan needs to be defined consisting of one or more Projects. The level of detail appropriate for such a plan may vary according to the maturity of the Project and may also be specified by regulation.

III. Definition of categories and supporting explanations

19. The following text (noted in italics) is from the publication UNFC-2009 *incorporating* Specifications for its Application (ECE Energy Series No. 42 and ECE/ENERGY/94):

> *"UNFC-2009 is a generic principle-based system in which quantities are classified on the basis of the three fundamental criteria of economic and social viability (E), field Project status and feasibility (F), and geological knowledge (G), using a numerical coding system. Combinations of these criteria create a three-dimensional system. 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 Annexes I and II of the Generic Specifications.*

[4] While the output from a renewable energy Project might decrease over time (e.g. due to reduced efficiency in the extraction and conversion process) it can nonetheless remain cash flow positive for a very long time (e.g. hydroelectric projects).

The first set of categories (the E axis) designates the degree of favourability of social and economic conditions in establishing the commercial viability of the Project, including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions. The second set (the F axis) designates the maturity of studies and commitments necessary to implement mining plans or development Projects. These extend from early exploration efforts before a deposit or accumulation has been confirmed to exist through to a Project that is extracting and selling a commodity, and reflect standard value chain management principles. The third set of categories (the G axis) designates the level of confidence in the geological knowledge and potential recoverability of the quantities. The categories and sub-categories are the building blocks of the system, and are combined in the form of "classes"."

20. In UNFC-2009, the G axis *designates the level of confidence in the geological knowledge and potential recoverability of the quantities*. This definition reflects the fact that, at the time of its publication, UNFC-2009 was designed to be applied to fossil energy and mineral reserves and resources. It is recognized that the reference to "geological knowledge" is not generally applicable to Renewable Energy Resources. Therefore, when applied to Renewable Energy Resources, the G axis should be understood to reflect the "level of confidence in the potential recoverability of the quantities". Thus, the G axis categories are intended to reflect all significant uncertainties impacting the estimated Renewable Energy Resources quantities that are forecast to be extracted by the Project and typically would include (but not be limited to) areas such as meteorology, climatology, topography and other branches of geography, ecology and, for geothermal Projects, geology. Uncertainties include both variability in the Renewable Energy Source and the efficiency of the extraction and conversion methodology (where relevant).

21. There are three established approaches to determining appropriate estimates for G1, G2 and G3, two of which are based on the assessment of a range of uncertainty for quantities associated with a Project, with the other reflecting different levels of confidence. The terms used within these specifications are as follows:

(a) The "incremental" approach, which is based on estimates for discrete portions of the Renewable Energy Source and/or the Project, where each estimate is assigned on the basis of its level of confidence (high, moderate and low)[5] reflecting available knowledge regarding potential recoverability;

(b) The "scenario" approach, which is based on three discrete scenarios that are designed to reflect the range of uncertainty in the possible outcomes (low, best and high estimates)[6] of the Project extracting energy from the Renewable Energy Source as a whole;

(c) The "probabilistic" approach, where multiple possible scenarios are generated (e.g. by Monte Carlo analysis) from input distributions of parameter uncertainty associated with the Project extracting energy from the Renewable Energy Source as a whole. Three specific outcomes are then selected from the output probability distribution as representative of the range of uncertainty (P90, P50 and P10 values are equated to low, best and high estimates respectively, where P90 means there is 90% probability of exceeding that quantity).

[5] In the petroleum sector, for example, incremental reserves with high, moderate and low confidence would be documented as proved, probable and possible reserves respectively and would correspond to E1F1G1, E1F1G2 and E1F1G3 in UNFC-2009.

[6] In the petroleum sector, for example, both the scenario and probabilistic approaches would equate low, best and high estimates for reserves with proved (1P), proved plus probable (2P) and proved plus probable plus possible (3P) reserves, which would correspond to E1F1G1, E1F1G1+E1F1G2 and E1F1G1+E1F1G2+E1F1G3 in UNFC-2009.

22. In order to maintain alignment between different Renewable Energy Resources, as well as with non-renewable fossil energy and mineral reserves and resources, specifications for application of the G axis categories to Renewable Energy Resources are provided in Part IV, Specification I of this document.

23. Additional context is added to Annex I "Definition of Categories and Supporting Explanations" of Part I of UNFC-2009 *incorporating* Specifications for its Application (ECE Energy Series No. 42 and ECE/ENERGY/94) where deemed necessary for the application of UNFC-2009 to Renewable Energy Resources. The original text from UNFC-2009 *incorporating* Specifications for its Application is shown in italics in the Table and the additional context for the application of UNFC-2009 to Renewable Energy Resources is shown in normal font.

Table
Definition of categories and supporting explanations

Category	*Definition*	*Supporting Explanation (UNFC-2009, Part I, Annex I)*	*Additional Renewable Energy Context*
E1	*Extraction and sale has been confirmed to be economically viable*[a]	*Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/ contracts have been confirmed or there are reasonable expectations that all such approvals/contracts will be obtained within a reasonable timeframe. Economic viability is not affected by short-term adverse market conditions provided that longer-term forecasts remain positive.*	Extraction is the process of converting a Renewable Energy Source into Renewable Energy Product(s).
E2	*Extraction and sale is expected to become economically viable in the foreseeable future.*	*Extraction and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction and sale in the foreseeable future.*	
E3	*Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability*	*On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future; or, economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the assessment phase). Also included are quantities that are forecast to be converted, but which will not be available for sale.*	

[a] *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.*

Category	*Definition*	*Supporting Explanation (UNFC-2009, Part I, Annex I)*	*Additional Renewable Energy Context*
F1	*Feasibility of extraction by a defined development project or mining operation has been confirmed.*	*Extraction is currently taking place; or, implementation of the development project is underway; or, sufficiently detailed studies have been completed to demonstrate the feasibility of extraction by implementing a development project or mining operation.*	The term *development project* is the renewable energy Project as described in Part II.
F2	*Feasibility of extraction by a defined development project or mining operation is subject to further evaluation.*	*Preliminary studies demonstrate the existence of a project in such form, quality and quantity that the feasibility of extraction by a defined (at least in broad terms) development Project or mining operation can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of extraction.*	
F3	*Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data.*	*Very preliminary studies (e.g. during the assessment phase), which may be based on a defined (at least in conceptual terms) development project or mining operation, indicate the need for further data acquisition in order to confirm the existence of a project in such form, quality and quantity that the feasibility of production can be evaluated.*	
F4	*No development project or mining operation has been identified.*	*In situ (in-place) quantities that will not be produced by any currently development project or mining operation.*	Category F4 can be used to classify the currently non-extractable quantities at the geographical location of the defined Project due to, for example, site/area constraints, technology limitations and/or other constraints
G1	*Quantities associated with a known deposit that can be estimated with a high level of confidence.*	*For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorized discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorized as G1, G2 and/or G3 as appropriate.* *For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities*	The G axis reflects the level of confidence in the potential recoverability of the quantities. Thus, the G axis categories are intended to reflect all significant uncertainties impacting the estimated Renewable Energy Resources quantities that are forecast to be extracted by the Project and typically would include (but not be limited to) areas such as meteorology, climatology, topography and
G2	*Quantities associated with a known deposit that can be estimated with a moderate level of confidence.*		

Category	*Definition*	*Supporting Explanation (UNFC-2009, Part I, Annex I)*	*Additional Renewable Energy Context*
G3	*Quantities associated with a known deposit that can be estimated with a low level of confidence.*	*to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.*	other branches of geography, ecology and, for geothermal Projects, geology. Uncertainties include both variability in the Renewable Energy Source and the efficiency of the extraction and conversion methodology (where relevant). Typically, the various uncertainties will combine to provide a full range of possible outcomes, comparable to the extraction of fluids in the petroleum sector. In such cases, categorization should reflect three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G4	*Estimated quantities associated with a potential deposit, based primarily on indirect evidence.*	*Quantities that are estimated during the initial assessment phase are subject to a substantial range of uncertainty as well as a major risk that no development project or mining operation may subsequently be implemented to extract the estimated quantities. Where a single estimate is provided, it should be the expected outcome but, where possible, a full range of uncertainty in the size of the potential deposit should be documented (e.g. in the form of a probability distribution). In addition, it is recommended that the chance (probability) that the potential deposit will become a deposit of any commercial significance is also documented.*	Category G4 is equally applicable to renewable energy, for "Estimated quantities associated with a potential Renewable Energy Source, based primarily on indirect evidence" (e.g. mapping studies).

IV. Generic specifications for the Application of UNFC-2009 in the context of Renewable Energy

24. This section presents the Generic Specifications for the Application of UNFC-2009 as contained in Part II of UNFC-2009 *incorporating* Specifications for its Application (ECE Energy Series No. 42 and ECE/ENERGY/94) with additional guidance and clarification provided with respect to application in the context of renewable energy, where required. The original text from UNFC-2009 *incorporating* Specifications for its Application is noted in italics and additional guidance with respect to application in the context of renewable energy is noted in normal font:

"*In these generic 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.*

Where a generic specification is defined below, this sets a minimum standard for reporting under UNFC-2009. However, where a specification for the same issue exists in the Aligned System, and it fully meets the requirements of the generic specification defined below, that specification may be adopted."

A. Use of numerical codes

25. *While the defined Classes and Sub-classes shown in Figures 2 and 3 of UNFC-2009 may be used as supplementary terminology, the relevant Numerical Code(s) shall always be reported in conjunction with the estimated quantity. For example, these may be documented in the form 111, 111+112, or 1.1;1.2;1, as appropriate.*

26. *Note that some Sub-categories are defined below that are in addition to those provided in Annex II of UNFC-2009. 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 Subclasses 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.*

B. Bridging Document

27. *Application of UNFC-2009 requires reference to a Bridging Document for the relevant commodity-specific specifications. The Bridging Document that was used as the basis for the evaluation shall be disclosed in conjunction with the reported quantities.*

Renewable energy – additional guidance:

The application of UNFC-2009 to Renewable Energy Resources will be supported by a set of commodity-specific specifications for bioenergy, geothermal, hydro, solar and wind energies.

C. Effective date

28. *Reported quantities are estimates of remaining quantities as at the Effective Date of the evaluation. The Effective Date shall be clearly stated in conjunction with the reported quantities. 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 estimated quantities as at the Effective Date, the likely effect of this information shall be disclosed.*

D. Commodity or product type

29. *Estimated quantities should be reported separately for each commodity or significant product type that will be sold, used, transferred or disposed of separately. Where estimates for different commodities or product types have been aggregated for reporting purposes, and separate estimates are not provided, the aggregated estimates should be accompanied by a statement clarifying which commodities or product types have been aggregated and the conversion factor(s) used to render them equivalent for the purposes of aggregation*[7].

Renewable energy – additional guidance:

For renewable energy Projects producing multiple saleable products, the non-energy commodity output shall be excluded from the Renewable Energy Resource quantity. For example, the sugar produced from a sugarcane ethanol mill and the inorganic materials, such as silica, lithium, manganese, zinc and sulphur, that can be extracted from geothermal fluids represent a value to the project (and the revenue generated by their sale may be included in the economic evaluation of the Project), but would not be classified as Renewable Energy Resources. On the other hand, own-use quantities of Renewable Energy Products extracted via the defined Project shall be included in the estimate of quantities of Renewable Energy Resources associated to that Project (see also guidance relating to the use of sub-category E3.1, quantities that may be forecast to be extracted, but will not be available for sale in Specification T "Extracted Quantities that may be Saleable in the Future").

E. Basis for estimate

30. *Reported quantities may be those quantities attributable to the mine/development Project as a whole, or may reflect the proportion of those quantities that is attributable to the reporting entity's economic interest in the mining operation or development Project*[8]. *The reporting basis shall be clearly stated in conjunction with the reported quantities. 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 quantities may include the proportion attributable to the royalty obligation. Where the reported quantities exclude the proportion attributable to the royalty obligation, this shall be disclosed.*

F. Reference Point

31. *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*

[7] *For example, crude oil volumes may be reported inclusive of condensate and natural gas liquids, in which case this fact shall be disclosed. Further, if gas volumes are converted to "oil equivalent" volumes and aggregated with crude oil estimates, this shall be disclosed. In addition, where resource estimates (e.g. oil, gas, coal and uranium) are converted into a measure of energy equivalency, the relevant conversion factors shall be disclosed.*

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

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.

Renewable energy – additional guidance:

In the case of renewable energy, the default for the Reference Point shall be the location in the extraction and conversion process at which the reported quantities of Renewable Energy Products are measured or estimated. Any deviation from this location shall be clearly justified. In all cases, the additional obligations for disclosure contained in the Specifications for the Application of UNFC-2009 as in Part II of UNFC-2009 *incorporating* Specifications for its Application (ECE Energy Series No. 42 and ECE/ENERGY/94) shall still apply.

G. Classification of Projects based on level of maturity

32. *Where it is considered appropriate or helpful to sub-classify Projects to reflect different levels of Project maturity, based on the current status of the Project, the optional Sub-classes shown in Figure 3 of UNFC-2009 may be adopted for reporting purposes. Additional guidance on the distinction between the Sub-classes of UNFC-2009 is provided in Annex V of Part II of UNFC-2009 incorporating Specifications for its Application, ECE Energy Series No. 42 (ECE/ENERGY/94).*

H. Distinction between E1, E2 and E3

33. *The distinction between quantities that are classified on the Economic axis as E1, E2 or E3 is based on the phrase "reasonable prospects for economic extraction and sale in the foreseeable future". The definition of "foreseeable future" can vary depending on the commodity and hence more detailed specifications can be found in relevant commodity-specific systems that have been aligned with UNFC-2009.*

34. *The Economic axis Categories encompass all non-technical issues that could directly impact the viability of a Project, including commodity prices, operating costs, legal/fiscal framework, environmental regulations and known environmental or social impediments or barriers. Any one of these issues could prevent a new 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 extractive activities in an existing operation. Where extractive activities are suspended, but there are "reasonable prospects for economic extraction and sale in the foreseeable future", remaining technically recoverable quantities shall be reclassified from E1 to E2. Where "reasonable prospects for economic extraction and sale in the foreseeable future" cannot be demonstrated, remaining quantities shall be reclassified from E1 to E3.*

I. Confidence levels for G1, G2 and G3

35. *The level of confidence for quantities that are classified on the Geological axis as G1, G2 and G3 is defined as "high", "medium" and "low", respectively. These are not*

specified more precisely at a generic level because there are fundamental differences between the approaches that are appropriate for commodities extracted as solids and those extracted as fluids, as discussed in the Supporting Explanation to the definitions of these Categories in UNFC-2009. More detailed specifications can therefore be found in relevant commodity specific systems that have been aligned with UNFC-2009.

Renewable energy – additional guidance:

It is recognized that the reference to "geological knowledge" is not generally applicable to Renewable Energy Resources. Therefore, when applied to Renewable Energy Resources, the G axis should be understood to reflect the "level of confidence in the potential recoverability of the quantities". Thus, the G axis categories are intended to reflect all significant uncertainties impacting the estimated Renewable Energy Resources quantities that are forecast to be extracted by the Project and typically would include (but not be limited to) areas such as meteorology, climatology, topography and other branches of geography, ecology and, for geothermal Projects, geology. Uncertainties include both variability in the Renewable Energy Source and the efficiency of the extraction and conversion methodology (where relevant).

The level of confidence for quantities that are classified on the G axis as G1, G2 and G3 is defined as "high", "moderate" and "low", respectively.

In order to maintain alignment between different Renewable Energy Resources, as well as with non-renewable fossil energy and mineral reserves and resources, specifications for application of the G-axis categories to Renewable Energy Resources are provided below.

Where the "probabilistic" approach is used, the cumulative probability levels associated with G1, G1+G2 and G1+G2+G3 shall be 90%, 50% and 10% respectively, where each probability level reflects the probability of exceeding the estimated Renewable Energy Resource quantities for that level.

Where the "scenario" approach is used, the low, best and high estimates shall reflect the same principles, and approximately the same probabilities, as would be associated with estimates derived from a probability analysis as described above for the "probabilistic" approach.

Where the "incremental" approach is used for non-renewables, there are no generally-accepted numerical levels of confidence. However, where all three approaches are permitted, the same logic that is applied for the "scenario" approach is also adopted for the "incremental" approach. Thus, for G1, the high confidence estimate shall be equivalent to the low case scenario. The aggregate of the high and moderate confidence estimates (G1+G2) shall be equivalent to the best estimate scenario, and the aggregate of the high, moderate and low confidence estimates (G1+G2+G3) shall be equivalent to the high case scenario.

Where the "scenario" or "probabilistic" approaches are used, the low (or P90) estimate is classified as G1, the best (or P50) estimate is classified as G1+G2 and the high (or P10) estimate is classified as G1+G2+G3. In principle, regardless of the analytical procedure used, resource estimates may be prepared using the "incremental", "scenario" or "probabilistic" approach. However, for some Renewable Energy Resources, it is likely that the three approaches will not all be applicable and further guidance is contained in the commodity-specific specifications.

In all cases, due consideration must be given to possible dependencies between input parameters. Further, whichever approach is used, all three categories (G1, G2 and G3) should be reported to provide an indication of the range of uncertainty in the estimate.

The above specifications and considerations for confidence levels for G1, G2 and G3 shall also apply to G4.1, G4.2 and G4.3 respectively.

J. Distinction between recoverable quantities and in situ (in-place) quantities

36. *Other than quantities that are classified on the Feasibility axis as F4, all reported quantities shall be limited to those quantities that are potentially recoverable on the basis of existing technology or technology currently under development, and are associated with actual or possible future exploration/development Projects or mining operations. For solid minerals Projects where the ultimate extraction methodology has yet to be confirmed (E2F2), in situ quantities may be reported, provided that there are "reasonable prospects for economic extraction and sale" of all such quantities in the foreseeable future. If in situ quantities are reported and it is expected that the extraction methodology will lead to significant losses and/or grade dilution, this shall be disclosed, e.g. in a footnote. In the absence of any consideration of potential economic recoverability, all reported quantities shall be classified as F4. For commodities extracted as fluids, the recovery factor is usually a major uncertainty and hence this should always be taken into account for such Projects (F2 and F3) and shall be accommodated using the G axis Categories*[9].

Renewable energy – additional guidance:

Category F4, i.e. in situ (in place) quantities, can be used to classify currently non-extractable quantities at the geographical location of the defined Project (e.g. the area of the land lease) due to, for example, site/area constraints, technology limitations and/or other constraints. Examples are water over the spillways for hydroelectric projects, or only partial availability of the leased land for a solar project due to heavy vegetation, or national parks/restricted areas within the lease/ concession area of a geothermal project. Or when the planned extraction and conversion technology has not been demonstrated to be technically viable in analogous Renewable Energy Sources.

K. Aggregation of quantities

37. *Estimated quantities associated with mining operations or development Projects that are classified in different Categories on the Economic or Feasibility axis shall not be aggregated with each other without proper justification and disclosure of the methodology adopted*[10]*. In all cases, the specific Classes that have been aggregated shall be disclosed in conjunction with the reported quantity (e.g. 111+112+221+222) and a footnote added to highlight the fact that there is a risk that Projects that are not classified as E1F1 (Commercial Projects) may not eventually achieve commercial operation.*

38. *Where estimated quantities have been aggregated from multiple Projects, consideration should be given to sub-dividing the aggregated totals by deposit type and by location (e.g. offshore vs. onshore).*

L. Economic assumptions

39. *In accordance with the definitions of E1, E2 and E3, economic assumptions shall be based on current market conditions and realistic assumptions of future market conditions.*

[9] *As discussed in Annex I of UNFC-2009 (G1/G2/G3 Supporting Explanation).*

[10] *Note that regulatory bodies may explicitly preclude such aggregation in corporate reporting under any circumstances.*

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[11] or independent evaluator; or,

(c) An externally published independent view, which is considered to be a reasonable forecast of future market conditions. The basis for the assumptions (as opposed to the actual forecast) shall be disclosed.

Renewable energy – additional guidance:

Current market conditions and realistic assumptions of future market conditions should include policy support mechanisms for renewable energy, but shall not assume that such mechanisms will become more beneficial in the future unless already specified in the regulation.

M. Evaluator qualifications

40. *Evaluators must possess an appropriate level of expertise and relevant experience in the estimation of quantities associated with the type of deposit under evaluation. More detailed specifications can be found in relevant commodity-specific systems that have been aligned with UNFC-2009.*

N. Units and conversion factors

41. *In order to facilitate global comparability of resource estimates, it is recommended that the Système International d'Unités (SI units) is used for reporting of resource quantities. However, it is recognized that there are traditional measurement units that are widely used and accepted for certain commodities; where such units are used for reporting purposes, 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.*

O. Documentation

42. *Estimates of resource quantities shall be documented in sufficient detail that would allow an independent evaluator or auditor to clearly understand the basis for estimation of the reported quantities and their classification.[12]*

P. Expansion of G4 to account for uncertainty

43. *In some situations, it may be helpful to express a range of uncertainty for quantities that are classified on the Geological axis as G4, e.g. Exploration Projects. In such cases, the following specification shall apply:*

[11] *Note that "competent person" may be defined by regulation.*

[12] *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.*

(a) G4.1: low estimate of the quantities;

(b) G4.2: incremental amount to G4.1 such that G4.1+G4.2 equates to a best estimate of the quantities;

(c) G4.3: incremental amount to G4.1+G4.2 such that G4.1+G4.2+G4.3 equates to a high estimate of the quantities.

44. *Category G4, when used alone, shall reflect the best estimate and is equal to G4.1+G4.2.*

Renewable energy – additional guidance:

See Specification I, Confidence levels for G1, G2 and G3 – the specifications and considerations for confidence levels for G1, G2 and G3 shall also apply to G4.1, G4.2 and G4.3 respectively.

Q. Optional labels for estimates

45. *Where it is considered appropriate or helpful to use labels in addition to the numerical codes for a range of estimates for a specific development Project or mining operation, the terms "Low Estimate", "Best Estimate" and "High Estimate" may be used to correspond to quantities that are classified on the Geological axis as G1, G1+G2 and G1+G2+G3 respectively.*

R. Classification of quantities associated with Exploration Projects

46. *In some situations, it may be helpful to sub-classify Exploration Projects on the basis of their level of maturity. In such cases, the following specification shall apply:*

(a) F3.1: where site-specific geological studies and exploration activities have identified the potential for an individual deposit with sufficient confidence to warrant drilling or testing that is designed to confirm the existence of that deposit in such form, quality and quantity that the feasibility of extraction can be evaluated;

(b) F3.2: where local geological studies and exploration activities indicate the potential for one or more deposits in a specific part of a geological province, but requires more data acquisition and/or evaluation in order to have sufficient confidence to warrant drilling or testing that is designed to confirm the existence of a deposit in such form, quality and quantity that the feasibility of extraction can be evaluated;

(c) F3.3: at the earliest stage of exploration activities, where favourable conditions for the potential discovery of deposits in a geological province may be inferred from regional geological studies.

Renewables – additional guidance:

Instead of terms such as "site-specific geological studies", "exploration activities", "drilling" and "testing" use "site-specific studies" or "data acquisition activities" that are relevant to corresponding renewable energy Projects. The term "geological province" remains applicable to geothermal Projects, but can be replaced by "geographic area" for other types of renewable energy.

S. Classification of Additional Quantities in Place

47. *In some situations, it may be helpful to sub-classify Additional Quantities in Place on the basis of the current state of technological developments. In such cases, the following specification shall apply:*

(a) F4.1: the technology necessary to recover some or all of the these quantities is currently under active development, following successful pilot studies on other deposits, but has yet to be demonstrated to be technically feasible for the style and nature of deposit in which that commodity or product type is located;

(b) F4.2: the technology necessary to recover some or all of the these quantities is currently being researched, but no successful pilot studies have yet been completed;

(c) F4.3: the technology necessary to recover some or all of these quantities is not currently under research or development.

T. Extracted quantities that may be saleable in the future

48. *The Sub-categories of E3 permit a distinction to be made between those quantities that may be forecast to be extracted, but which will not be available for sale (E3.1) and those for which there are currently no reasonable prospects for economic extraction and sale in the foreseeable future (E3.3). In the former case, the quantities are those that will be used, lost, destroyed or otherwise disposed of during the extraction process, and hence will not be made available for sale, such as natural gas that is produced in association with oil and is then flared into the atmosphere or used on-site for operational purposes.*

49. *In some situations, however, quantities may be extracted to the surface and then stored in some way for possible economic sale in the future and these may be assigned to E3.3 (and subsequently moved to E2 and E1 as appropriate[13]).*

[13] *One example is natural gas that has been produced to surface, but then injected back underground into the same or a different rock formation in such a way that it remains available for possible extraction and sale in the future. Another example would be thorium that has been extracted along with other, commercially saleable, commodities, but where there is no current market for the commodity. Provided that it is then stored in a manner in which it remains available for future commercial sale, it may be assigned to E3.3.*

Annex

Glossary of Terms[14]

Term	***Definition***
Aligned System	*A classification system that has been aligned with UNFC-2009 as demonstrated by the existence of a Bridging Document that has been endorsed by the Expert Group on Resource Classification.*
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.*
Class(es)	*Primary level of resource classification resulting from the combination of a Category from each of the three Criteria (axes).*
Complementary texts	*Additional texts to provide mandatory requirements (i.e. Specifications) and further guidance regarding the application of UNFC-2009. (This Specifications Document is an example of a complementary text.)*
CRIRSCO Template	*The CRIRSCO Template of 2013 is the system developed by the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) for solid minerals and, for the purposes of this Specifications Document, includes the reporting codes and standards that are aligned with it.*
Criteria	*UNFC-2009 utilizes three fundamental Criteria for reserve and resource classification: economic and social viability; field Project status and feasibility; and, geological knowledge. These Criteria are each subdivided into Categories and Sub-categories, which are then combined in the form of Classes or Sub-classes.*
Economic Limit	The extraction rate beyond which the remaining cumulative net operating cash flows from the Project are negative, a point in time that defines the Project's economic life. A significant difference with non-renewable energy Projects is that the economic limit will often not be an appropriate basis for the resource assessment because renewable energy is often replenished at an equal or higher rate than consumed and other Project limitations may become relevant before the Economic Limit is reached.

[14] Additional terms are added to the Glossary of Terms included in Annex I of Part II of "UNFC-2009 incorporating Specifications for its Application" (ECE Energy Series No. 42 and ECE/ENERGY/94) where deemed necessary for the application of UNFC-2009 to Renewable Energy Resources. The original text is shown in italics and the additional terms for the application of UNFC-2009 to Renewable Energy Resources are shown in normal font.

Term	***Definition***
Entitlement	The quantity of Renewable Energy Resource that accrues to a Project's participant.
Evaluator	*Person, or persons, performing resource estimation and/or Classification*
Exploration Project	*A Project that is associated with one or more Potential Deposits (as defined below).*
Generic Specifications	*Specifications (as documented in this Specifications Document) that apply to the classification of quantities of any commodity using UNFC-2009.*
Known Deposit	*A deposit that has been demonstrated to exist by direct evidence. More detailed specifications can be found in relevant commodity-specific Aligned Systems.*
Mapping Document	*The output of a comparison between another resource classification system and UNFC-2009, or between that system and existing Aligned Systems, 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.*
Numerical Code	*Numerical designation of each Class or Sub-class of resource quantity as defined by UNFC-2009. Numerical Codes are always quoted in the same sequence (i.e. E;F;G).*
Potential Deposit	*A deposit that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g. surface or airborne geophysical measurements). More detailed specifications can be found in relevant commodity-specific Aligned Systems.*
PRMS	*Petroleum Resources Management System of 2007 (PRMS), which was approved by the Society of Petroleum Engineers (SPE) Board in March 2007 and endorsed by the World Petroleum Council (WPC), the American Association of Petroleum Geologists (AAPG), the Society of Petroleum Evaluation Engineers (SPEE) and the Society of Exploration Geophysicists (SEG).*
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.*
Renewable Energy Product	Output from a Renewable Energy Project that is directly linked to (or a direct replacement of) a fungible energy commodity and is saleable in an established market.
Renewable Energy Resources	The cumulative quantities of extractable Renewable Energy Products from the Renewable Energy Source, measured at the Reference

Term	*Definition*
	Point.
Renewable Energy Source	The primary energy (e.g. sun, wind, biomass, earth thermal energy, river flow, tides, waves) available for extraction of (and conversion into) Renewable Energy Products. The equivalent of the terms "deposit" or "accumulation" used for fossil fuels and solid mineral resources.
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 the UNFC-2009 in this Specifications Document ensure clarity and comparability and are complementary to the commodity-specific requirements included in Aligned Systems, as set out in the relevant Bridging Document.*
Specifications Document	*Specifications for the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).*
Sub-categories	*Optional subdivision of Categories for each of the fundamental Criteria of economic and social viability, field Project status and feasibility, and geological knowledge. Definitions of Subcategories are provided in Annex II to UNFC-2009.*
Sub-classes	*Optional subdivision of resource classification based on Project maturity principles resulting from the combination of Subcategories. Project maturity sub-classes are discussed further in Annex V of the Specifications Document.*
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-2009	*United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (ECE Energy series No. 39).*