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Development, maintenance and implementation of the United Nations Framework Classification for Resources and the United Nations Resource Management System: Commercial aspects and financial reporting

The United Nations Framework Classification for Resources Applied to Commercial Assessments - Update

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

Summary

This report complements and updates the report of the Commercial[1] Applications Working Group of 2019 (1), taking full account of the United Nations Framework Classification for Resources (UNFC) Update 2019 (ECE/ENERGY/125 and ECE Energy Series 61) that was issued in December 2019. **It is intended as a document for discussion of further work. It is not a guideline for commercial applications of UNFC, respecting that individual stakeholders may wish to tailor applications to their specific needs.** The report distinguishes between commercial products and commercial assets, both of which are bought and sold. Commercial assets are the legal rights that stakeholders (including governments through the fiscal system and otherwise) hold in the projects that are classified in UNFC. Application of UNFC in conventional commercial assessments of both products and assets is described in section III. Valuation is particularly important in making commercial assessments. This often requires information beyond the quantities to be produced, such as time series of costs, revenues, emissions, labour, material and other inputs. The projects carry this information and the legal rights define how they get included in the assets. Section IV is about conventional valuation. The potentially far more important issue of the consequences on valuation of the reforms required to reach the SDGs is addressed in section V. It is concluded that these two issues require further substantial work, to be related to decision analyses. Section VI clarifies the well-established truth that efficient development requires standards, in this case IT standards for *inter alia* commercial applications of UNFC. This issue is introduced in section VI and requires major follow-up. Finally, section VII presents the conclusions and recommendations. The report contains an Annex on accounting for UNFC that combines the technique of input-output tables used in national statistics with the design structure matrix techniques used in project management. Both techniques have proven powerful, and their proposed combination is expected to be useful in commercial applications of UNFC.

[1] The report uses the term commercial as "ready for buying and selling at scale". For this, economics is important, but is not in itself sufficient for commercial transactions to take place. Many other conditions need to be satisfied as well, including the will to act.

Contents

I. Acknowledgements

1. This report is produced by the Commercial Applications Working Group of the United Nations Economic Commission for Europe (ECE) Expert Group on Resource Management.

2. The Petroleum Working Group has supported the Technical Advisory Group in reviewing the draft report. The Petroleum Working Group and the Technical Advisory Group are both sub-groups of the Expert Group on Resource Management. They recommended that the issue of valuation should presented more extensively, beyond what has been possible within the limitations of this report, which covers the entire spectrum of commercial applications in a few pages, and has been developed on the basis of the United Nations Framework Classification for Resources (UNFC[2]) Update 2019 only days after it was published at the end of December 2019. Numerous good and detailed constructive comments have been provided by Barbara Pribyl of Santos, Claudio Virues of the Alberta Energy Regulator, Canada, and Satinder Purewal, Chairperson of the Petroleum Working Group and Imperial College London. Although not all comments could be included, all were appreciated, as always is the case when such devoted and serious reviews are provided from readers outside the project group. In the comment period, the Commercial Applications Working Group on its own initiative also reviewed and matured the text.

3. The Technical Advisory Group has through its Chairperson, Alistair Jones, completed the Technical Advisory Group assessment of the report and in the process contributed significantly to its quality and consistency with other UNFC documents.

4. The Bureau of the Expert Group on Resource Management supported the recommendation of the Technical Advisory Group that the report be issued as a parliamentary document for the eleventh session of the Expert Group.

5. Members of the Commercial Applications Working Group have shown exemplary cooperation in shaping this report which deals with exceptionally complex issues. The members are:

Ms. Kathryn Campbell (Attorney)

Ms. Carolina Coll (CGG)

Mr. David Elliott, (Consultant)

Mr. Steve Griffiths (ERCE)

Mr. Matthias Hartung, Target Energy Solutions

Mr. Sigurd Heiberg, (Chairperson), Petronavit a.s. and Petrad

Mr. Julian Hilton (Aleff Group)

Mr. Donald Roy Lessard (Professor Emeritus, Massachusetts Institute of Technology)

Mr. Michal Lynch-Bell (KAZ Minerals)

Mr. Nick Stansbury (Legal & General Investment Management)

Mr. Danny Trotman (EY).

6. This report is issued with the consent of all members of the Working Group.

II. Introduction

7. Commercial assessments are important in judging paths for providing the vast amounts of energy and raw material services required for reaching the Sustainable

[2] All references to UNFC in this document refer to the UNFC Update 2019 (ECE/ENERGY/125 and ECE Energy Series 61).

Development Goals (SDGs) while at the same time meeting the ambitions for climate change mitigation in ways that the capital market can finance.

8. Following adoption of the 2030 Agenda for Sustainable Development in 2015 (3) a number of standards and governing documents have been updated to facilitate attainment of these goals (4) (5) (6) (7) (8) (9). This includes documents issued by the Expert Group on Resource Management, including: UNFC Update 2019 (2), Principles of Resource Classification (ECE/ENERGY/GE.3/2020/3 (10)), and United Nations Resource Management System (UNRMS) Concept Note: Objectives, requirements, outline and way forward (ECE/ENERGY/GE.3/2020/4).

9. This document does not intend to provide rules of any sort for commercial applications of UNFC but rather it highlights the underlying issues of such application for discussion and planning of further work.

10. A list of abbreviations and definitions has been omitted in this update, and instead it is proposed that a unified set of abbreviations and definitions be produced for all UNFC documents.

III. Application of UNFC in making commercial assessments

11. Commercial assessments are about the availability and value of future production under likely future conditions set by government framework conditions, industry capabilities and capital market structures. Commercial assessments may vary between stakeholders depending *inter alia* on whether costs and revenues are shared equally or not. Acknowledging the difference between commercial assessments of projects and of the assets defining stakeholder interests in projects is important and a key to understanding this report.

12. UNFC is about products to be delivered in the future and not just about the source of the products using projects as the basic building block and categorising its acceptability (E axis) and technical feasibility (F axis).

A. Impact of resource management, including fiscal design.

1. Resource management applications

13. This document uses the term resource management to mean the shaping of the framework conditions under which project appraisal, development, operation and production takes place, i.e. the shaping of the industrial system and the development project. Both public and private sectors play important roles in this shaping - see references (11; 12; 13; 14; 15; 16; 17; 18). In the face of the climate crisis, assessments of future framework conditions include taxes and other measures intended to limit greenhouse gas (GHG) emissions.

2. Fiscal and contractual designs

14. It may be unexpected to see fiscal designs discussed in a document on commercial applications of a resource classification. Industry and financiers may have limited opportunity to influence them and therefore take them for granted. This is not the case for governments who may choose to use fiscal design as an instrument to shape efficient public private partnerships driving reforms while benefitting both sectors by improving the commercial status of assets.

15. Fiscal and contractual designs determine, together with market values and costs, the perceived producer’s share and value of the produced quantity at the point of valuation (reference point), typically the point of sale or the point where a netback price may be assessed. The value, together with the costs of bringing quantities to the reference point, govern the recovery decisions. The lower the value at source, the lower the commercially recoverable quantities normally will be. Many recovery processes, and especially in extractive activities are physically irreversible processes, i.e. the recovery efficiency depends on the history of recovery. For these, failure of initial decisions to design for the recovery of economically marginal quantities (that can be very large) cannot be repaired by later efforts,

at least not without additional cost and effort. A prerequisite for efficient recovery is therefore a perceived sufficiently high value at source, facilitated by predictable fiscal and contractual regimes that do not harvest economic rent downstream or introduce other measures acting as costs in reducing the value at source.

16. Fiscal and contractual frameworks cause the value, opportunities and risks of the project[3] to differ among asset holders, including governments.

17. Misalignment of interest may be an impediment for reaching balanced decisions. This might in itself affect the environmental and socio-economic viability (E axis) category assigned to projects and thus also the commercial value of assets.

18. In their endeavours to improve national benefits and facilitate required reforms, governments may examine how the fiscal system can be effective in creating framework conditions that allow industries to deploy their best capabilities in ways that the capital market can finance while increasing their own benefit. The outcome normally falls somewhere in between two extreme designs:

- Collecting revenues through gross taxes such as royalty or environmental fees. This will be a cost to the producer, reduce the value at source and eliminate economically marginal resources from being developed.
- Collecting revenues through equity participation (19) (20). This will be incentive neutral except for differences arising from the effects on the risk contribution to the very different public and private portfolios and the assessment of the time value of money (discount rate). Incentive neutral tax does not act as a cost and therefore does less to prevent economically marginal quantities to be produced, enhances commerciality and does not limit government take to the extent that gross taxes do.

19. There are many reasons why neither of these systems can be practised in pure form, explaining why fiscal designs are found to be somewhere in between the extremes.

B. The recognition of commercial product quantities

20. UNFC inventories must show commercial product quantities as a subset of quantities produced by viable projects. These are quantities of production that are expected to be available for purchase and sale from projects that will be executed, i.e. Category E1[4] and F1[5]. Although there will be no contingencies blocking these projects, quantitative commercial assessments will still need to consider opportunities and risks arising from uncertainties in estimated future production, market conditions, changes in framework conditions, carbon taxes or other emissions charges, operational changes etc.

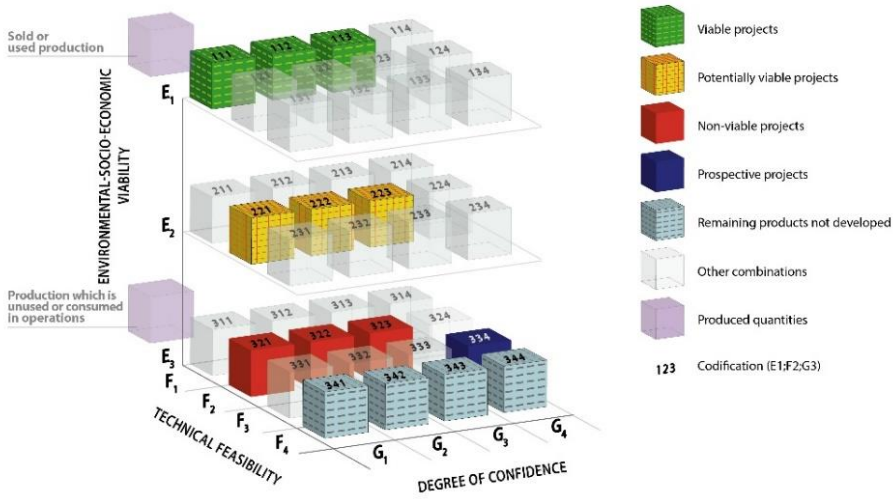
21. Commercial quantities to be produced by viable projects are shown as green classes (boxes) in Figure I. These are the quantities addressed in this sub-section.

[3] The concepts of uncertainty, opportunity and risk are often understood differently by different people. In this document opportunity and risk refer to the consequences of an uncertain event happening, discounted (multiplied) by the probability that it will happen. A simple example is the case where it is uncertainty whether it will rain. This will not represent a risk for a person who remains indoors, as there will not be consequences for that person.

[4] E1: Development and operation are confirmed to be environmentally-socially-economically viable.

[5] F1: Technical feasibility of a development project has been confirmed.

Figure I
UNFC Categories and Examples of Classes



22. The non-commercial (non-sales) delivered products for direct use need to be recognised separately from the commercial quantities in the inventories.

23. In UNFC, the non-sales quantities for use are split, depending on whether the products are delivered out of the project or consumed by the project. Quantities delivered out of the project for direct use without commercial transactions are classified together with commercial quantities. With the introduction of renewable energy into UNFC, they become more important. In practice the commercial products and the non-commercial products for direct use need to be accounted for as separate products. However, the accounting for multiple products recurs often. Projects regularly produce multiple products such as oil and gas, heat and electricity, lead and zinc etc. and now commercial products and non-commercial products for direct use.

24. Undelivered products used in operation or not used, remain as category E3.1[6] and the F Category of the projects intended to produce them. Importantly, to the extent that products used in operations result in GHG or other emissions, they also will be subject to GHG taxes and/or other charges that apply and must be accounted for, even if the products are not sold commercially. Separate accounting of products consumed in operations and products not used is required for management purposes, and for complying with the System of National Accounts (SNA) which in some cases recognise products consumed in operations. Neither of these details change UNFC relative to what it was prior to the update at the end of 2019. They lead to the recognition that the term "economic project" does not need to be a project delivering products that are sold and obtain positive monetary value, but more generally a project where the (value of the) benefits exceed the efforts (or cost) of getting the benefits. By contrast, commercial products do need to generate monetary value.

25. UNFC classifies commercial products based on their E, F and G Categories as seen at the date of assessment. Products categorised as E1,F1.1[7] are expected to be produced by projects "on production". For these the main project-related commercial uncertainties are the production performance and the cost and performance of operations, maintenance, modification and abandonment as well as changes in framework and market conditions. To the extent that production rates over time are affected, these uncertainties may affect commercial assessments made by the buyers of the products. In addition, the uncertainties will all affect the commercial assessments made by the producers. Quantities categorised by

[6] E3.1: Estimate of product that is forecast to be developed, but which will be unused or consumed in operations.

[7] F1.1: Production is currently taking place.

F1.2[8] will in addition be exposed to the project development risks. There is literature on the success, failure and strategic management of large engineering projects that may be consulted for direction with respect to development risks and opportunities (21).

26. For projects classified using Category F1.3[9], the entire development phase remains with all its opportunities and risks. In addition, while there may be uncertainty about when a given project development will start although there is no underlying uncertainty that the project will at some point be initiated. That makes it a viable commercial project even though a final investment decision has not yet been made.

27. The quantities will be categorised using the G Categories[10], providing users with indication of the range of uncertainty within which the quantities lie, on the condition that the project will be executed.

28. While the quantities to be produced can be read in the UNFC inventories, it will, as mentioned above be necessary to go to the underlying individual project information to make complete commercial assessments.

29. Some security regulators may impose their own restrictions with respect to how estimates of different commodities should be made and/or disclosed (22) (23) (24) (7) (25) (26; 23) (27). Others, like the European Securities Market Authority (ESMA), allow preparers to choose between a set of classifications (28). Some of these restrictions apply in some jurisdictions and not in others, and different restrictions apply to different commodities. Some restrictions will distort a balanced probabilistic estimate by truncating the probability distribution. They tend to be proscriptive, mainly to remove the upside.

1. Quantification of commercial products

30. In principle, the quantities of products should be expressed as probability-weighted expected values. Often, however, the quoted quantities do not align precisely with expected values. In such cases, the quantities categorised as G2 will, when added to the G1 estimates represent "proved + probable reserves" as defined by the United States Securities and Exchange Commission (US SEC), the Petroleum Resources Management System (PRMS)[11] and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) Template systems for petroleum and mining projects. While G1 + G2 is often viewed as the "best estimate" of commercially viable products, its commercial value will in general be less than the expected (mean) commercial value of production. It is common to see the estimated sum of G1+G2 to be near the median, i.e. a 50% probability (P50) in the cumulative density function. This value will, especially for extractive activities, often differ from the expected (mean) value as the probability density functions for quantities in three dimensional bodies will seldom be symmetrical. In most cases it is not possible to measure probabilities. The difference between the mean and the median is therefore often ignored, making accurate aggregation difficult.

31. Individual commercial assessment of a viable project is typically conducted on the G1+G2 (best) estimate. For viable projects, this estimate must be economic to demonstrate economic viability. Moreover, most entities test the economic viability of the G1 quantity prior to project sanction. The expected (mean) commercial value of a project is valuable when making commercial assessments of a group of projects, as the expected value for the total is equal to the sum of the expected values of the individual projects. The law of large numbers

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

[9] 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.

[10] G1: Low estimate of the quantities.
G2: Incremental amount to G1 such that G1+G2 equates to a best estimate of the quantities.
G3: Incremental amount to G1+G2 such that G1+G2+G3 equates to a high estimate of the quantities.

[11] The Petroleum Resources Management System of 2018 that has been endorsed by the Society of Petroleum Engineers, World Petroleum Council, American Association of Petroleum Geologists, Society of Petroleum Evaluation Engineers, Society of Exploration Geophysicists, European Association of Geoscientists and Engineers and Society of Petrophysicists and Well Log Analysts.

may then reduce the relative range of uncertainty as the number of projects increases, depending on dependencies and correlations between the projects. Uncertainties caused by common systematic variables such as price and climate induced tax/costs will however not be reduced through diversification and remain as critical uncertainties even for large well-diversified investment portfolios.

32. When assessing a large number of projects, it is common in regulatory reporting to add the physical product quantities arithmetically. While this may be reasonable to do for the G1+G2 numbers that are close to the expected values, the sums of G1 estimates and of G1+G2+G3 estimates may lie outside the practical range of uncertainty for the aggregate and in that sense can be irrelevant. The probability that all outcomes are low or that all are high is much less than that one of them are. In the case where uncertainties are dominated by common variables, more of the uncertainty range will be preserved.

33. The upsides are also individually important for commercial assessments. Although the probability that they will be realised is low, their economic value can be quite high, particularly in extractive activities where the probability distribution of the quantities tends to have many outcomes near and below the average and few, but quite high outcomes on the upside (a log-normal probability distribution). The high case may benefit from economies of scale for the project and hold a higher economic value per unit of production than the lower outcomes. The legal rights may contain clauses that in turn redistribute excess profits among stakeholders. The economies of scale and the redistribution of profits will need to be taken into account in commercial assessments when considering the value of various uncertain outcomes. These relationships will in general cause the probability density function (pdf) of commercial values to be distorted relative to the pdf of commercial product quantities. The expected commercial value of a project will, as alluded to above, in general differ from the value of the expected physical outcome of the project.

34. The low cases are important for assessing the risk, particularly to stakeholders who do not participate equally in the upside or who have limited risk management capacities. These cases are particularly important to the investor for assessing the risk of their investment in a particular project.

C. Commercial assessments of assets

35. In addition to selling and buying commercial products, it is common to sell, buy or trade the rights to produce these quantities. These rights are defined here as assets and are distinguished from the projects that UNFC classifies.

36. The rights may be defined in terms of quantities, as is the case when only fixed royalties are imposed. They will typically be defined in terms of the cash flow that the projects may produce. Assessment of the commerciality of the assets will therefore in general require consideration of framework and market conditions, the project information that defines the flows of cash i.e. quantities to be produced, revenues, investments, operating costs, taxes, fees, tariffs, physical and human inputs, emissions and other project information. The rules embedded in the legal rights define the corresponding distributions over time for the asset components and how the opportunities and risks involved are distributed to asset holders, including government. This information is not generally publicly available today.

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

(a) In resource management considerations;

(b) In fiscal and contractual design;

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

(d) In asset transactions;

(e) In portfolio optimization;

(f) In public and financial reporting.

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

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

39. As was the case with fiscal and contractual design, analysis under these three headings requires access to the project information allowing assessment of both project and asset perspectives. Both may affect the appropriate project and asset decisions and thereby the appropriate E and F categories of the projects and the assets.

1. Capital allocation

40. Allocation of capital will generally depend on outlooks for framework (e.g. legal, fiscal, contractual etc.) and market conditions, the technical shaping of the project or development process and on the position of the stakeholders. The F Categories reflect the technical project maturity decisions in this respect. Allocation of capital will also depend on the availability and cost of capital. Project finance will depend on the business model of the project, while asset finance may in addition depend on the financial position of the asset holder. If capital is not available at satisfactory conditions, the project cannot be categorised as E1 and will therefore not be a viable commercial project for one or all asset holders in the project.

2. Asset transactions

41. Different views of the future drive capital allocation as well as asset transactions that are described next.

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

(i) Asset trades and swaps;

(ii) Mergers of assets including agreements for joint development of multiple assets and unitization;

(iii) Asset acquisition and divestment.

43. These transactions are affected by value in one form of another.

Asset trades and swaps

44. Asset trades and swaps may involve resource quantities of all classes. Here, commercial assessments of trades may be based on estimated product quantities from identified projects or remaining products where no project has yet been identified, adjusted for obvious differences in value. Trades may be guided by other similar transactions observed in the market. Detailed cash flow analyses are often not available for some of these assets due to lack of sufficient project definition.

45. Resource quantities with Categories E3, F3 and F4 fall into this category.

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

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

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

Asset acquisition and divestment

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

49. Companies that prefer to specialize in capabilities required for one part of the value chain may wish to enter and exit assets to leverage their capabilities. Others may have other motivations for entering or exiting assets.

50. In the context of UNFC, the project information and the terms and conditions governing the assets are again key for determining the values, risks and opportunities for sellers and buyers. If the partners to the transaction agree on making a cash transfer, then it is necessary to aggregate the asset values of the projects involved in the transaction to assess what a reasonable price will be. This also requires valuing and aggregating assets in immature projects. It is sometimes quite difficult to do this, as the maturation or not of a non-viable to a viable project may be both a chance, with an estimated probability of success that can be estimated, but also a decision that may need to be negotiated. Whether it is a chance, or a decision depends on the role of the evaluator.

51. Aggregation[12] of resource quantities for projects or assets with an equivalent chance of being realised (indicated by them having the same E and F Categories) is possible. It will depend on whether the uncertainties indicated through the G Categories are discrete estimates, scenario estimates or probability density functions with information on dependencies and correlations between assets. As should happen with all simulations/estimates, assumptions need to be presented so that the outcome can be tested.

52. Aggregation of uncertain time distributions of production and sales, costs, cash flows etc. is complex. For instance, production may be impacted by delays in start-up but realise high production later, resulting in a low forecast in early years but higher in later years. A forecast whether high, or low or both cannot be made without taking time into account. A way to work around this is to describe the forecasts by using scalar quantities such as start-up dates, build up rates, production capacity, production rates at various levels of cumulative production, recoverable quantities etc. where the range of uncertainty of each of these scalars can be described using probability density functions. They are then used together in Monte Carlo type simulations to produce alternative production profiles. Such profiles may be applied to generate a range of probability density functions of scalar project information of interest such as net present value, cumulative sales, non-sales production over a given time period, etc. These latter probability density functions can in turn be aggregated whether through modelling a derivative Monte Carlo simulation or as data points in more sophisticated analytical methodologies such as Global Optimization, which take into account the dependencies and correlations of the key uncertainties.

D. Portfolio optimisation

53. Projects classified and categorised using UNFC can be included on a consistent basis in comparative portfolio analysis of assets either within or between resource types. This analysis can be used by asset holders including governments to assess the incremental value, risk and opportunity that an asset brings to the portfolio and thus to the public and private stakeholders concerned.

54. The value of a portfolio depends on the nature, size, number and characteristics of its elements and their interrelations.

55. In portfolio optimisation, the optimiser can, within the limits that agreements with others allow, include or exclude elements from the portfolio, change their magnitude and timing, shape their dependencies and influence their uncertainties, opportunities and risks in

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

search for an optimal portfolio. What an optimal portfolio is depends on the interests and constraints of the optimiser. It may be a portfolio that maximises value for a certain level of risk, or one where the opportunities and risks are manageable, or one that has a fair chance of meeting commitments, respecting financial constraints, providing full employment of people and equipment, filling infrastructure capacities, minimising waste, etc.

56. UNFC may be used as a template for portfolio optimisation, while the underlying project information provides the basis for the optimisation. Portfolio optimisation may in turn impact the commercial value that the portfolio holds for the owner of the portfolio or for a buyer of it.

E. Public reporting, including corporate and financial reporting

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

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

59. Corporate reporting relates to the public reporting by an entity on an annual or periodic (e.g. quarterly) basis for instance for value reporting (Annual reports, quarterly financial reports) as well as other information provided to the market (for instance through prospectuses, press releases or investor presentations).

60. Product quantities and their classifications are relevant to such reporting both where quantities at a defined date are disclosed and discussed and where quantities are used in the estimates and calculations underpinning financial reporting (for instance in estimating product quantities for impairment testing or the calculation of depletion, depreciation and amortisation).

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

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

63. Reporting of resource quantities in annual corporate reports has traditionally been used in extractive activities as a proxy for future revenues, but less in renewable energy, anthropogenic or storage activities. The mining sector commonly applies variants of the CRIRSCO Template (29) (25) (23) while the petroleum industry often uses variants of PRMS (4). However, there are modified local regulatory requirements in jurisdictions including in the United States and Canada.

64. When UNFC is used in one jurisdiction, it is possible to relate it to the requirements in that jurisdiction. This has been done by developing bridging documents (30) (31) (32) and guidance (33).

65. Users of corporate reporting often operate in global capital markets and across traditional commodity boundaries. There are clear benefits of having a classification system that is global and sufficiently general to apply equally to all relevant commodities. UNFC meets these requirements. It also facilitates the generation, for example of CRIRSCO (29) and PRMS (4) reports when these are required or desired.

66. To achieve a coherent reporting of resource activities requires a practice that adheres to the project-based application used in UNFC. This is in place for PRMS. It is easily achieved when using the CRIRSCO Template provided that Resources, including those designated as “Measured Resources”, are understood to mean estimates of production from future projects that have not yet been sanctioned. While this may sound like a difficult step

to take, many industries solve this by reporting recovery factors when they report CRIRSCO Resources.

67. Adopting UNFC for corporate reporting has two compelling additional advantages:

(a) The distinction between environmental and socio-economic contingencies on the one hand and the operational contingencies on the other allows the analysis of the project characteristics in two-dimensions (F and E) improving the communication of the nature of opportunities and risks associated with projects. This is important for making necessary judgements about the effectiveness of framework conditions in governing future operations, and most importantly in mitigating climate change and accommodating other requirements for meeting the SDGs;

(b) UNFC allows reporting in a single framework for an entity that owns multiple commodities, for example entities that own diverse energy and mineral resources;

(c) Production that will not be used or used in operations are categorised and can be reported. This represents resources for non-commercial use and resources that that may have future commercial value if handled differently.

IV. Conventional Valuation

68. The commercial application of UNFC described previously relies on valuation, where the valuation process may seek to be objective in attempting a dispassionate prediction of what the future may hold, or it may be based on applying generic standards to facilitate like-for-like comparison of asset values.

69. As was the case in the 2019 report (1), this update does not contain a full treatment of valuation. It points to some references and principles that may guide the reader to understand what to expect in other standards and to study them. To produce a valuation standard for the Expert Group on Resource Management to accompany UNFC and UNRMS will require work beyond what has been possible for this update.

70. Some references are:

- System of National Accounts (SNA) (34)
- System of Environmental-Economic Accounting Central Framework (SEEA Central Framework) (35). This is an elaboration of SNA based on UNFC
- System of Environmental-Economic Accounting for Energy (SEEA Energy) (8)
- International Valuation Standards (IVS)[13]; and
- International Mineral Property Valuation Standards Template (IMVAL Template) that includes petroleum (5).

71. The IMVAL Template is in turn related to product specific standards such as:

- Australasian Code for Public Reporting of Technical Assessments and Valuations of Mineral Assets (36)
- CIMVal Standards and Guidelines for Valuation of Mineral Properties[14]
- SME Standards and Guidelines for Valuation of Mineral Properties (including Petroleum) (6)
- The South African Code for Reporting of Mineral Asset Valuation (The SAMVAL Code), 2016/2018 Edition.[15]

[13] https://www.ivsc.org

[14] http://www.cimmes.org/cimval-standards-guidelines/

[15] https://www.samcode.co.za/samcode-ssc/samval

72. Guidance may also be found in:

- The Canadian Oil and Gas Evaluation Handbook (COGEH).[16]

73. Additional references can be found on the websites of the standards mentioned above.

74. The standards under the SNA detail methods of valuation, while the standards building on the IVS are less specific in this regard but detail the qualification of valuators and valuation processes in line with what is found in classifications conceived in regions governed by Common Law.

75. The Expert Group on Resource Management relates to both. Requirements with respect to qualification are to a large extent common for both classification and valuation and will be dealt with jointly by this Commercial Applications Working Group and the Competent Persons Task Force of the Expert Group. They are not elaborated in this report.

76. The IMVAL Standard names three valuation processes:

(a) Market Approach (IVS 105 Valuation Approaches and Methods, Section 20);

(b) Income Approach (IVS 105 Valuation Approaches and Methods, Section 40);

(c) Cost Approach (IVS 105 Valuation Approaches and Methods, Section 60).

77. Further guidance on the Valuation Approaches is provided in the IVSs.

78. Of these, the Income Approach and Market Approach are directly reflective of value, while the Cost Approach relies on past costs being reflective of future income and is of less relevance for assessing the consequences of meeting the SDGs.

79. The SNA and SEEA standards detail the valuation of current production. In addition, they address valuation of viable commercial projects, identifying these with respect to the UNFC classification. The standards recognise implicitly the difficulty in obtaining reliable data for potentially viable and non-viable projects as well as the remaining potentials not developed by projects. Since assets holding projects in all these broad classes are being traded commercially, it is necessary to address commercial assessments for all of them.

A. Valuing current production

80. The SEEA Central Framework distinguishes between Basic prices (project prices not yet allocated to stakeholders), Producers' prices and Purchasers' prices. The relationship between them is as follows:

Basic prices *plus*

Taxes on products excluding invoiced value added tax *less*

Subsidies on products *equal*

Producers' prices *plus*

Value added tax not deductible by the purchaser *plus*

Separately invoiced transport charges *plus*

Wholesalers' and retailers' margins *equal*

Purchasers' prices

[16] https://speecanada.org/coge-handbook-subscription/cogeh-individual-subscription/

81. The value of current production will be the value accruing to the producer under the framework governing the asset, less:

- The costs of production
- Depreciation of investments made
- The depletion in value of the source and products remaining to be produced as a result of current production, plus:
    - The enhancement of remaining sources and products when that is relevant as is the case for many renewable energy, anthropogenic and storage projects where there is both inflow and outflow of material or energy over time.

82. For non-renewable resources, physical depletion will equal current production. Monetary depletion may differ depending on the production performance of the project, the view and time of introducing future framework conditions and the method of valuing future income.

B. Valuing viable projects

83. Viable commercial projects will in most cases carry sufficiently reliable information to be valued using the income approach, i.e. the net present value (NPV) that may be received by the producer of the discounted net cash flow of the project (the NPV method).

C. Valuing potentially viable, nonviable and prospective projects

84. Potentially viable projects may or may not carry sufficiently reliable information to be valued using the income (NPV) approach. If they can be valued this way the value will also need to reflect the likelihood (probability) that the project will become viable at some point.

85. The IMVAL standard recommends using and comparing several valuation methods. That is particularly useful for valuing less mature projects. Provided market transactions can be found for projects or assets that are analogous to the project being valued, then the market value may be used after making appropriate adjustments for differences between the projects or assets. A comparison between the NPV and this market value may reveal the probability assessed by the market of the project becoming a viable project.

86. The cost approach uses the written-down replacement cost. The value of an asset will decline over time as the value at the time of acquisition, the acquisition price, is reduced by consumption of fixed capital (more commonly referred to as depreciation) over the asset's life. Furthermore, the acquisition prices of equivalent new assets will change. In theory, the value of an asset at any given time is equal to the current acquisition price of an equivalent new asset less the accumulated consumption of fixed capital over its life. When reliable directly observed prices for used assets are not available, this procedure appears to give a reasonable approximation of what the market price would be were the asset to be offered for sale (35) (8).

87. Project valuation is typically required internally by entities for future investment, financing and operation. It is also required for selling or buying an asset. Asset valuation could be a complex process that requires a careful consideration of the assumptions and methodologies applied. Depending on the type of asset and available information, different methods can be used and the results compared for better valuation. An aspect to consider in NPV based valuation beyond the cash flows is what discount rate to use for a project or an asset. It will always reflect the time value of money. In addition, it is generally designed to compensate for systematic and non-diversifiable risk. This can be assessed differently by company management and investors. Investors may choose to be much better diversified than companies with respect to unsystematic risk and to some extent also systematic risk when invested in markets with different and independent systematic risks. Company management is in theory there to serve the interests of investors who hold the capital they manage. The discount rate may also be used as a blunt instrument to account for the risk of projects

underperforming, recognising that the different components of the cash flow are exposed to different uncertainties, opportunities and risks. Alternatively, the risks and opportunities may be accounted for as real options associated with the cash flow (37).

88. It is extremely important to assess the uncertainties as well as the opportunities and risks that flow from them. The G Categories of UNFC hold important information for assessing confidence in estimated quantities. The extent to which their uncertainties represent opportunities or risks will depend on the exposure stakeholders have to the consequences that may arise from uncertain events materialising or not. In addition, the E and the F Categories reflect environmental-socio-economic (E Categories) and technical feasibility (F Categories) conditionalities, both associated with uncertainty about whether a project as such will be executed or an asset will remain valuable.

89. In short, commercial assessments may require an assessment of:

(a) Time distributed future costs and revenues, and the associated produced quantities;

(b) Uncertainties in these costs and revenues;

(c) Future framework conditions distributing costs and revenues to stakeholders (assets) including government;

(d) Uncertainties with respect to future frameworks.

90. The aggregate value of a set of projects or assets in different commodities will sometimes need to be assessed. UNFC is constructed to allow such valuations of complex portfolios allowing comparative analyses of different commodities. This is more difficult when different projects use different standards.

V. Consequences on valuation of reforms required to reach the SDGs

91. The critical role of efficient and responsible management of natural resources in achieving almost all the SDGs is clearly recognised in the text of the 2030 Agenda (3).

92. In this context, efficient and responsible means a process which is “integrated and indivisible and balances the three dimensions of sustainable development: the economic, social and environmental”.

93. In applications of UNFC it may occasionally be important to view the interrelations of projects in order to assess their full commercial potential. In simple form, this can encompass polymetallic deposits such as those containing copper, gold, silver and uranium. UNFC may also serve as a foundation for integrated analyses of energy and raw material basins where projects interact (38). An integrated approach, based fully on UNFC and SEEA/SNA (35) (8) enhances the likelihood that a project will achieve an appropriate environmental-socio-economic maturity based on balanced considerations.

94. As mentioned, UNFC covers renewable energy and underground storage projects for which classification is not used extensively. Application to water resources is being formulated.

95. Furthermore, UNFC is applicable to anthropogenic (secondary) resources. As policies for the circular economy are formulated, this ability to cover the whole lifecycle of a resource becomes an essential management instrument for material flow analyses in the physical economy. This strengthens the applicability of UNFC to SEEA (35).

96. This ability of UNFC to classify projects handling multiple commodities in the same manner facilitates the task of preparers and users in transferring skills and routines from one type of project to another. It provides efficiency in preparation and use over a situation where individual classifications are used for the different types of projects. As UNFC is international and designed to serve policy formulators, governments, management and financiers it avoids today’s situation where different stories need to be told to these different users and to users in different jurisdictions. It is an essential aid in judging realistic

commercial paths that the capital markets can finance for reaching the SDGs, all of which are resource demanding and environmentally challenging. In summary it serves the UN intention behind the SDGs of facilitating a balance of the three dimensions of sustainable development: the economic, social and environmental through modern and science-based resource management to attain the 17 integrated and indivisible goals shown in Figure II.

Figure II
The UN Sustainable Development Goals

97. The reforms required to meet the SDGs require a view of the availability of products as classified in UNFC, analyses of the cost of current, proposed and required reforms, changes in the market structures and assessment of the dynamics of change. This has profound consequences for the valuation of projects.

98. The complexity of the analyses can be illustrated by examining the energy situation, which will drive the physical reforms. Analysis performed by the ECE Committee on Sustainable Energy, the Expert Group on Resource Management's parent body, in its project Pathways to Sustainable Energy (39) shows that the climate ambitions cannot be reached without curtailing GHG emissions produced when burning fossil fuels.[17] Others reach similar conclusions and assess the costs and Gross Domestic Product (GDP) effects (40). Several methods are in use or being proposed with the motivation to curtail GHG emissions, and they have different commercial consequences:

- A schedule on allowable emissions forcing users to incur the cost of carbon capture use and storage
- A carbon tax imposed and collected by producing countries
- A carbon tax imposed and collected by consuming countries.

99. These measures will have the effect of reducing the value at the source of production of fossil energy products, in particular the carbon rich hydrocarbon products such as coal and heavy oil and to a lesser extent the hydrogen rich ones, such as natural gas and natural gas

[17] Fossil fuel production is sometimes equated to CO_2 emissions. Fossil fuels contain very small quantities of CO_2 if any at all. It is the use of them by conventional burning that causes the carbon in fossil fuels to combine with oxygen in the air to produce CO_2, i.e. it is not the production of fossil fuels that generates CO_2, but the common use of them. That is what creates the commercial value today.

liquids (NGLs). The extent to which this impacts production and thereby also the consumption and emissions depends on the relation between costs and quantities of production, and how this impacts prices. This can possibly be informed through broad implementation of UNFC. Producers who have chosen to hold back low-cost production for market or other reasons, may choose to increase production in order to maintain revenue, and thereby increase consumption and emissions above what was intended by introducing the GHG costs. When it comes to gas and light oils, the production from source rocks has substantially increased the quantities to a point where resource limits are not in sight. The extent to which low cost quantities will be produced depends on the framework conditions set. To assess the quantitative effects of meeting the SDGs on the energy markets and therefore also on commercial value of future production requires information about these conditions as well as about the relation between costs and quantities of alternative energy products.

100. In the absence of uniform global measures to avoid GHG emissions, commercially, environmentally and socially acceptable future product quantities should be assessed with two levels of carbon pricing in addition to the cost of producing energy free from GHG emissions:

(a) The specific carbon taxes/prices that are currently applicable in each national jurisdiction, and;

(b) A normative set of carbon prices in line with a 1.5 °C scenario (40) (39).

101. A comparison of (a) and (b) provides a first estimate of the proportion of products of any given project that is "at risk" to GHG taxation/pricing. A second estimate is also required of the effect of this on the market prices of the products.

102. Just as commercial valuation will change through time with adjustments to market prices, so too will commercial valuation be adjusted for GHG emission costs. A UNFC database must be organized so as to facilitate incorporation of different market price and GHG emissions price vectors over time for users who wish to consider a variety of market and GHG emission price scenarios.

VI. Commercial project management, accounting and potential IT facilitation

103. In order to move from theory to practice in facilitating the resource management efforts required to reach the SDGs it is critically important to provide global standards for UNFC IT systems for handling the information flows required for commercial assessments.

104. Project management requires coordination of the tasks to be performed and information to be collected in order to reach a decision to move a project from one position in the E-F matrix to another. There are many ways to keep an overview of how this can be and is done, such as the Design Structure Matrix (DSM) approach (41). The DSM structure can be applied when accounting for changes made in a portfolio of projects. An example is shown in the Annex. This system is a relative of the Input-Output Tables applied in national statistics (42).

105. An IT system is required to make this operational, starting by designing a minimum viable project (MVP) as shown in the Box.

Box
Solution Functionality - The Minimum Viable Product

Solution Functionality - The MVP

1. **Project Ingest:**
   (a) Capture of project assessments, new upload or updates, by Competent Persons
   (b) Based on questionnaires as referred to in the quoted literature, compliant with applicable legislation and industry standards
   (c) Ideally with direct access to the relevant information repositories for evidence, like spatial/GIS, reference documents, etc.
2. **Project Store**
   (a) The trusted data & information base of projects with assessments and audit trails.
3. **Project Portfolio Management**
   (a) Dashboarding, auto-reporting of UNFC/UNRMS and sector reports (PRMS, CRIRSCO Template), further management information self-services
   (b) Analyse and review portfolios at corporate, at country, sector, geographic or at individual project level along the UNFC axes
   (c) Support decision makers with scenario-testing/impact on their triple bottom-line (including socio-economic and sustainability)
   (d) Make available relevant information for investors, regulators and for social inclusion & engagement (e.g., DSM, PRMS, Corporate Social Responsibility (CSR)).
4. **Consistent version adapted to meet needs of different stakeholder groups**
   (a) Primary – decision makers/executives in operating companies, regulators and investors
   (b) Secondary – influential stakeholders like policymakers, political parties, trade organisations and stock exchanges
   (c) Tertiary – effected communities, interest groups, NGOs and the public at large.
5. **Solution modular and customizable by design**
   (a) UNFC E, F, G-Sub-categories to be incorporated in approval stage (maturation) and in UNRMS operations reporting (realization)
   (b) To reflect different requirements per resource type and legislation.

VII. Conclusions and recommendations

106. UNFC has a range of features which make it uniquely suited for transparent commercial evaluation such as:

(a) Global acceptance;

(b) Matching the increasing scope of capital markets;

(c) Applicability to single- or multi-resource projects, including anthropogenic (secondary) resources as managed in a circular economy;

(d) Flexibility, matching current and emerging needs for transformation of energy and raw material services;

(e) Reflecting the SDGs stated requirements for balanced, integrated management of resources taking full account of environmental, social and economic considerations for classification and resource progression;

(f) Accommodating technical and industrial considerations;

(g) Factoring in considerations of the relative confidence in estimated quantities in categorising whether projects can or even should be executed.

107. UNFC therefore facilitates making realistic commercial assessments both of commercial quantities and assets to be sold and bought.

108. The Commercial Applications Working Group recommends:

(a) That efforts are made to produce realistic UNFC inventories of resources in the markets where they are traded. This will need to include information on the cost of supplies in order to assess the relative merit of alternative sources and likely reactions of producers to changes in framework conditions and notably to the introduction of carbon costs;

(b) That the Expert Group on Resource Management further facilitates commercial assessments including the development of standards for international data structures;

(c) That the Commercial Applications Working Group be encouraged to develop the topic of valuation in greater detail, elaborating on the estimation of mean values and relate it to decisions analyses. This work should include considering the impacts on valuation of reforms to meet the SDGs;

(d) That UNRMS be built on UNFC, with full consideration of the information carried by the projects, also beyond the bare resource quantities. Notably, this includes estimated time series of inputs and outputs, checked against performance and the corresponding cash flows;

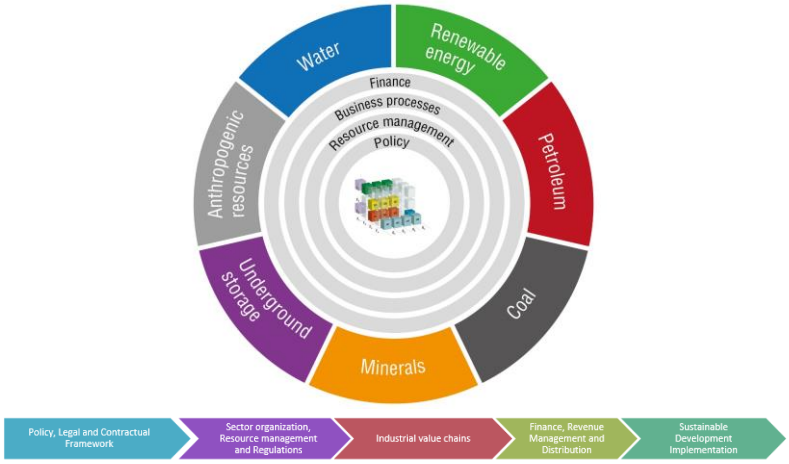
(e) That the Expert Group examines the convenience of shifting the Category E3.1 of UNFC (Estimate of product that is forecast to be developed, but which will be unused or consumed in operations) from the E to the F axis in future revisions of UNFC.

Annex

Structured Integrative Resource Analyses for Improved Commercial Assessments

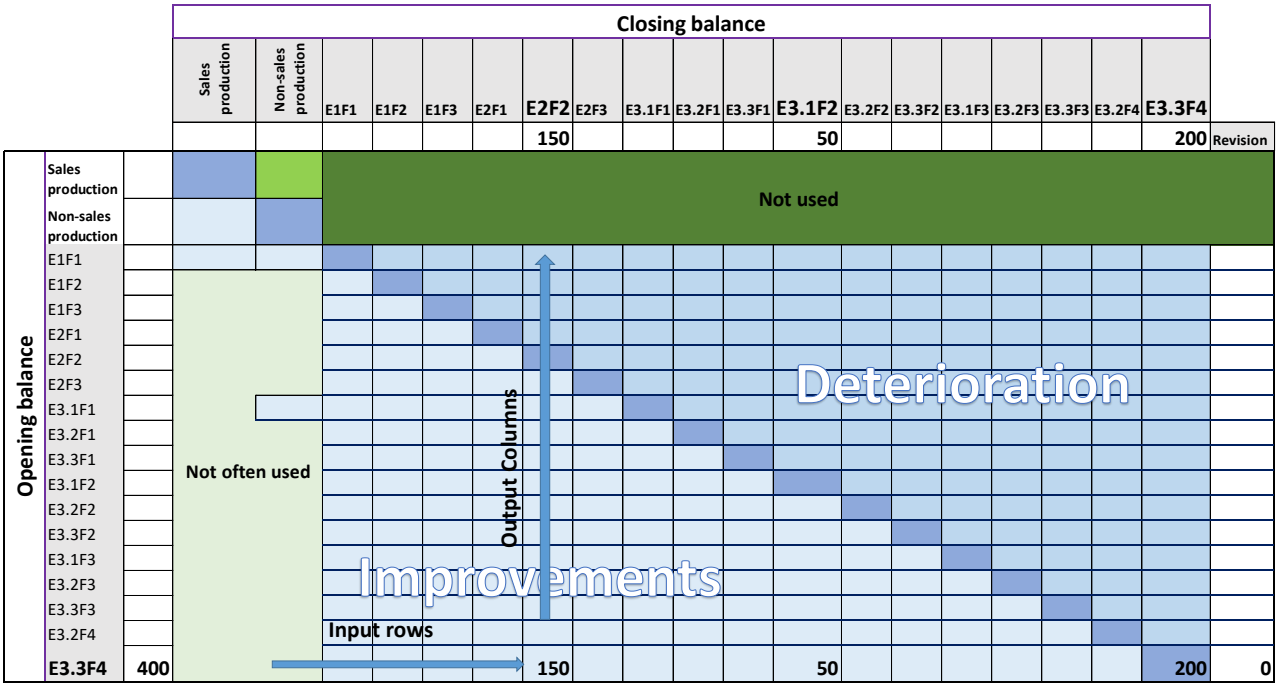
1. UNFC can be presented as shown in Figure I and its application in Figure III.

Figure III
Applications of UNFC[18]



2. As an example, a UNFC product account showing the maturation of projects may be displayed in 2D form shown in Figure IV. Carbon prices and other taxes/penalties related to GHG and/or charges/penalties for water usage and other externalities are important elements of the environmental-social-and economic viability. Projects that are commercial after taking these prices/penalties into account can be highlighted.

Figure IV
Resource account, first period



[18] Nuclear fuels are included here under minerals but do require special attention and are handled by a separate working group of the Expert Group on Resource Management.

3. There is a third dimension (G axis – not shown) for each cell in Figure IV reflecting the confidence in estimates. All classes of UNFC[19] are plotted identically on the horizontal and vertical axes, the "best" being at the top and left. In this illustration, at time zero there is a source of product of 400 units in place (E3.3F4) representing an opening balance. In the first period a project is identified that will recover 150 units of product from this (E2F2). It will also produce 50 units of product consumed in operations or not used (E3.1F2) and leave 200 units in the ground (E3.3F4). The closing balance is shown in the top row.

4. By the end of next period (e.g. after a year) what is recorded is shown in Figure V.

Figure V
Resource account, second period

			Closing balance																		
			Sales production	Non-sales production	E1F1	E1F2	E1F3	E2F1	E2F2	E2F3	E3.1F1	E3.2F1	E3.3F1	E3.1F2	E3.2F2	E3.3F2	E3.1F3	E3.2F3	E3.3F3	E3.2F4	E3.3F4	
					200								10								190	Revision
Opening balance	Sales production				Not used																	
	Non-sales production																					
	E1F1																					
	E1F2		Not often used																			
	E1F3																					
	E2F1																					
	E2F2	150			150																	
	E2F3																					
	E3.1F1																					
	E3.2F1																					
	E3.3F1																					
	E3.1F2																					
	E3.2F2																					
	E3.3F2	50			40								10									
	E3.1F3																					
	E3.2F3																					
	E3.3F3																					
	E3.2F4																					
	E3.3F4	200			10																190	0

5. In the second period, the opening balance is the closing balance of the previous period and repeated on the vertical axis.

6. A final investment decision has been made regarding a project and the 150 units in E2F2 accordingly have moved to E1F1. At the same time, a solution is found to produce for sale or use 40 of the 50 units that were produced and either used in operations or not used. These move to E1F1 from E3.1F2. 10 units remain, but now in E3.1F1. Recovery of the quantities in place have increased by 10 units that move to E1F1, leaving 190 in place. In this example material balance is preserved so there are no revisions. The new outgoing balance is again found in the top row.

7. By plotting the best classes at the top and left, any numbers below the diagonal represent a change to a higher commercial maturity, improvements, while those above represent the opposite.

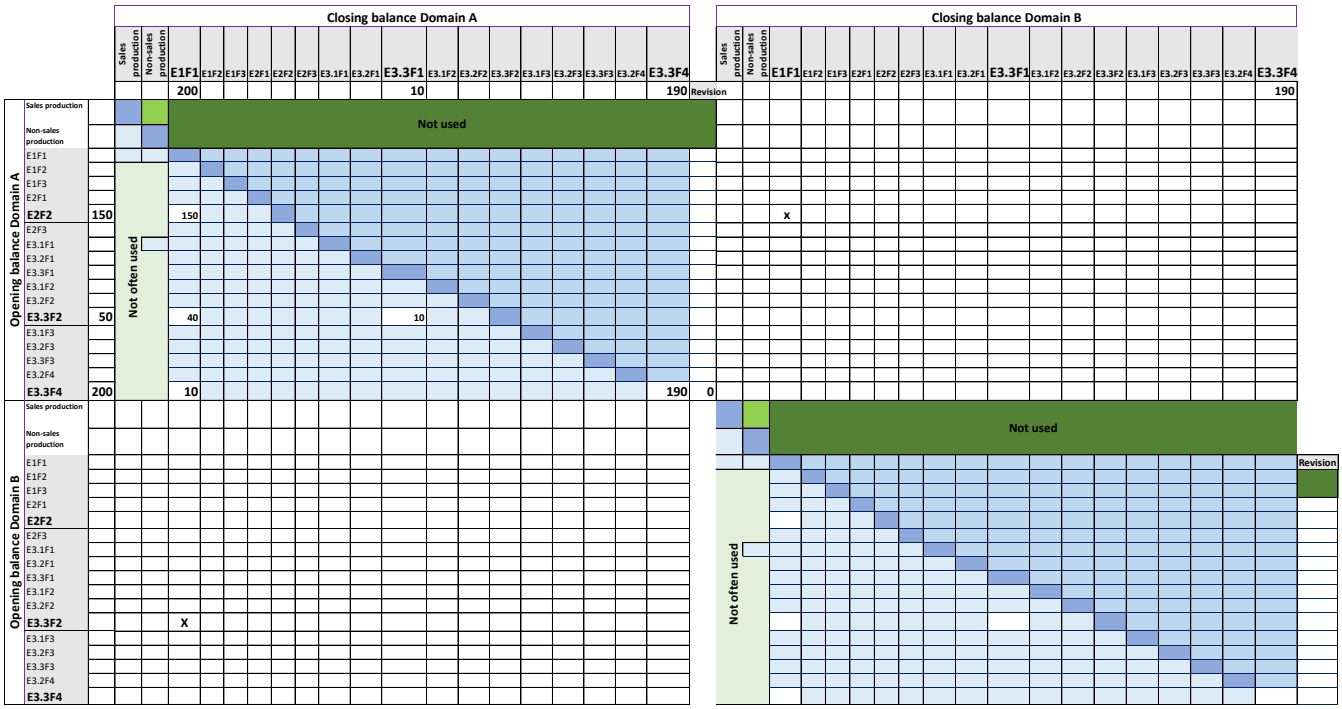
8. The example is relatively straight forward for the user and can be represented in a simple application like excel or in a more complete IT system as described in section VI.

9. At the outset, Units may be thought of as representing quantities of material. They need not be. They can be any information carried by the projects such as commercial value, cost, revenue, emissions, staff and conceivably even forecasts of these. Several matrices that are relevant to the commercial evaluation of the projects may be superimposed on one another, revealing the relation between say commercial value, product quantities, emissions or staff. Projects may be interlinked through their respective matrices to reveal the extent to which the projects play their part in integrated systems.

[19] Only a subset is shown here for graphical reasons.

10. Integrating the accounts of several types of projects and portfolios such as natural gas and electricity projects may improve commercial assessments as described in section IV. Multi-portfolio type matrices may be constructed as shown in Figure VI. The account for type A is placed in the upper left and the account of type B in the lower right.

Figure VI
Sketch of a multi-portfolio type resource account



11. The set of methods built on this platform will, if implemented, facilitate the development of integrative dynamic capabilities in government, industry and finance by applying the same intellectual substance in different applications.

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