Public Comment to

UNFC Petroleum Resources Specifications and Guidelines (PRSG)

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The Expert Group on Resources Management of the UN Economic Commission for Europe (UNECE) has elaborated and presented the draft of Petroleum Resources Specifications and Guidelines (PRSG) to the global resources management system of the United Nations Framework Classification for Resources (UNFC).

UNFC is a three-dimensional classification system combining the criteria of the Degree of Confidence (G-Axis), Technical Feasibility (F-Axis) and Environmental-Socio-Economics (E-Axis). The well-known illustration of UNFC is inserted below as Figure 1.
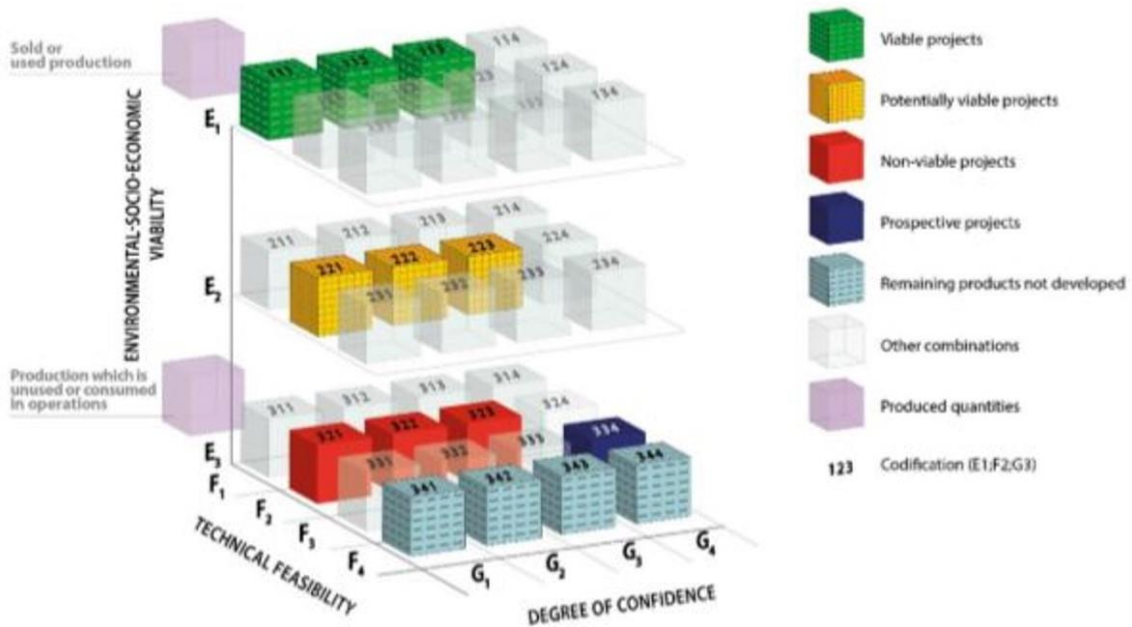

Fig. 1 UN Framework Classification system

The PRSG, with its robustness and integrity, is significantly contributing to the adequate classification and categorization of oil and gas resources. The draft specification and guideline document however contains several ambiguities.

In my comment I will focus on these ambiguities. The attempt to provide solutions for the arising problems will also be made. My study will discuss the ambiguities assignable to each classification criteria and finally I will address the risk assessment methodology.

G-Axis

Compared to other petroleum resources management systems it is probably the most remarkable feature of PRSG that it does not support the much debated "deterministic incremental" method any more. Formerly, the method were primarily recommended for the

classification along Axis G where the evaluation criterion is the Degree of Confidence. Under *Chapter 6.4.* of PRSG the scenario based (Low, Best, High) is mentioned as the only available deterministic estimation methodology. As a consequence, and in line with the observations of many petroleum resource experts (including myself: See [Challenging the viability of P2 and P3 Reserves, LinkedIn, 2017](#) and [Update to PRMS's classification and categorization concept: Ambiguities removed and remained, LinkedIn, 2018](#)) PRSG confirms that standalone estimations for G2 and G3 quantities in any reasonable F and E combinations (e.g. volumes of 222 and 223) cannot be given. For the first look it seems strange that a class of a resource management system involve volumes which cannot not occur, not even as a viable scenario of production forecasts…

PRSG however clarifies that G2 volumes are the mathematical differences of the Best and Low Estimate scenarios while G3 are computable as High minus Best Estimates. The approach undoubtedly meets the classification criterion "*confidence in estimates of the potential recoverability of the quantities*" (G-Axis), however raises several concerns as follows:

1. It is clear that the degree of confidence (in having the estimated project resource volume in hand) is gradually decreasing from G1 to G3 where G1 is the Low Estimate scenario and G1+G2+G3 equals the High – for a recovery project of discovered volumes. It seems illogical however that G4, representing the Best Estimates for undiscovered volumes, is defined as the G-Axis class of the lowermost degree of confidence. As it is correctly discussed in PRSG, the discovered and undiscovered volumes are separated by the assignment of the Geological Probability (for discovered resources it equals 1, while for the undiscovered $0 < Pg < 1$). It is easy to admit that the consideration of Pg as a factor in the degree of confidence criterion is very different from the approach to the classification literally also based on the degree of confidence applied for discovered volumes (High Confidence = Low Estimate; Moderate Confidence = Best minus Low Estimates; Low Confidence = High minus Best Estimates). The discrepancy is challenging the consistency and the granularity of UNFC classification – at least in the case of the G-Axis.

2. Furthermore, but also connected to the discussion point 1 above, it seems illogical that the High-Moderate-Low Confidence (G1, G2, G3) type distinction is not applied to Prospective Resources (G4), albeit Low, Best and High Estimates are normally estimated in this resource class, too. Why are High, Moderate and Low confidence volumes not demonstrated at the G-Axis for the undiscovered resources, similarly to the discovered?

3. If G2 and G3 quantities (in any reasonable F and E combinations) are mathematical differences of two viable scenarios we may conclude that volumes in the G2 and G3 classes are not assignable to recovery projects. I think it conflicts the statement that "*UNFC is a project based classification and management system*" which may suggest for the users that volumes in any E-F-G combination – for instance 2.2.1. - are standalone recovery project resources. As of this, they cannot be differences of two project scenarios (e.g. 1.1.2. & 1.1.3. or 2.2.2. & 2.2.3. or 3.2.2. & 3.2.3., see Fig. 1).

   In fact, volumes of 1.1.1., 1.1.2., 1.1.3.; and 2.2.1., 2.2.1., 2.2.2., 2.2.3.; and 3.2.1., 3.2.2., 3.2.3. are together assigned to separate (viable, potentially viable and non-viable, respectively) recovery projects for discovered resources, plus 3.3.4. for undiscovered (as demonstrated in Fig. 2).

FIGURE 1
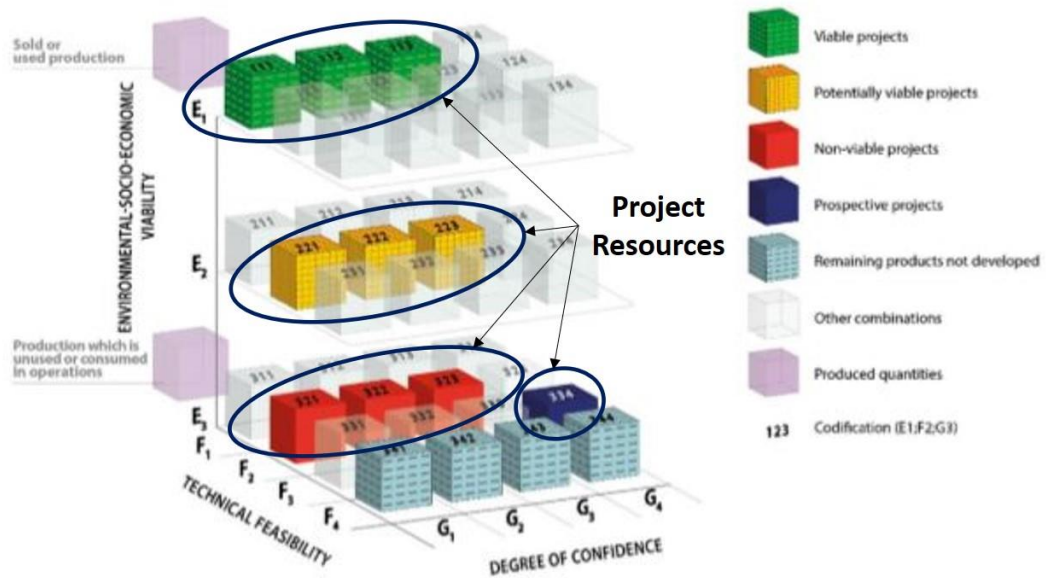**UNFC Categories and Examples of Classes**

Fig. 2. Project resources in UNFC

4. Provided but not allowed that G2 and G3 resource volumes (in any reasonable F and E combinations) are assessable it remains still ambiguous whether how PRSG suggests to apply the Technical Feasibility and the Environmental-Socio-Economic criteria for resource volumes which are not assigned to a recovery project – but assigned to two differences of viable project scenarios. Alternatively, PRSG should make it clear if the criteria set is recommended to apply for a recovery project represented by the triplets (as per the observation under Point 3).

For the sake of completeness, following the logic above I note that nor the P50 minus P90, neither the P10 minus P50 probabilistic volumes should reasonably be considered as G2 and G3 class standalone volumes (in any F and E combinations), respectively.

Furthermore, I note here that the application of the probabilistic resource assessment method (*Chapter 6.4.2. of PRSG*) to a (potential) *project* recovery is challengeable. (For the Volume Initially In-Place and for the Estimated Ultimate Recovery of a *deposit* it is not.) Project recovery scenarios (Low, Best, High Estimates) by definition are cumulative production forecasts of wells assigned to the project (Fig. 3), and as such, they are deterministic. True however, that each deterministic scenario-based estimate can be considered as a reasonable realization of sampled values of the resource estimation parameters with stochastic outcome distributions.
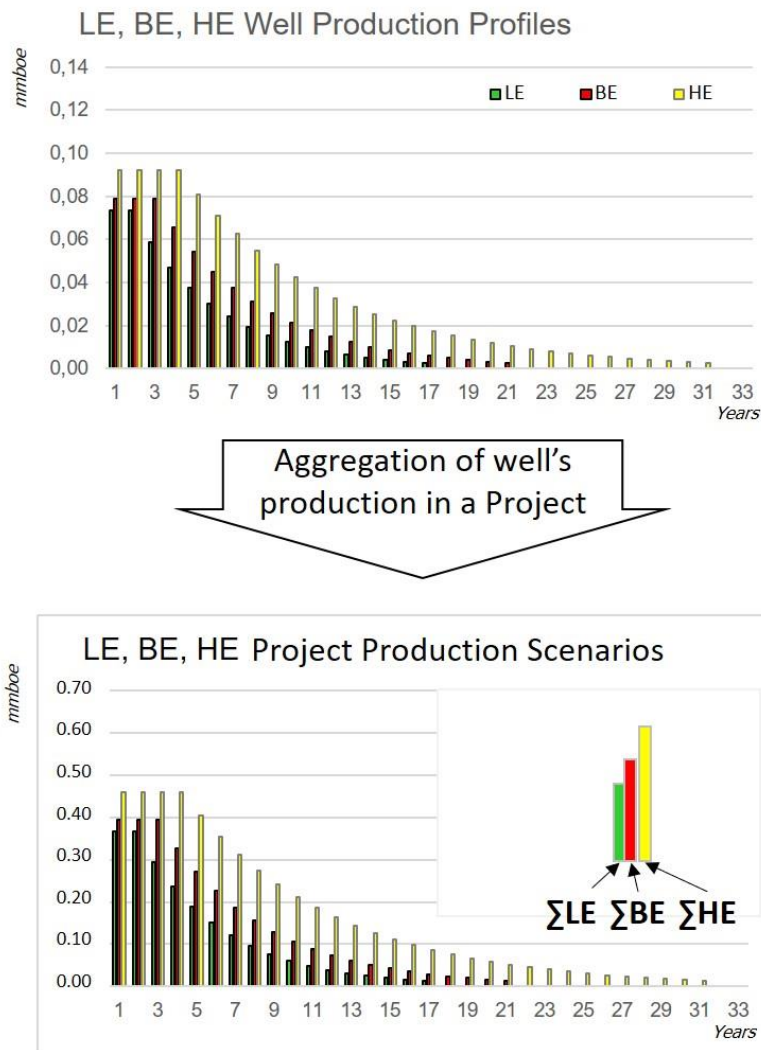
Fig. 3. Deterministic project recovery scenarios

Finally, I note that the preterition of the deterministic incremental method shall raises questions about the viability of the alignment (mapping, bridging) of UNFC with PRMS and RF2013 (the oil and gas resources assessment system of the Russian Federation). Remember: PRMS still includes the deterministic incremental method, while RF2013 applies a special "version" of the same.

The Petroleum Working Committee of UNECE may consider the revision of the interpretation of the Degree of Confidence, the classification criterion of the G-Axis. I see two alternative versions for moving ahead, as follows:

   A. Alignment of the Degree of Confidence criterion with the Range of the Uncertainty in recovery project volume's estimations: let it assume that the less uncertainty is perceived (the narrower the range is) the more confident one can be about having the resource in hand. Well-known that the order of magnitude in the range of the uncertainty gradually decreases with the resource (non-commercial) maturation, i.e. the order of magnitude of the range is the highest at Prospective (undiscovered) Resources in the exploration phase, while (normally) it is less after the discovery and prior to the appraisal, even less after the appraisal and before development, finally it is the lowest for the production forecast of the developed volumes. The assumption lays on the fact that the consecutive maturation projects

(exploration > appraisal > field development > production) are gradually increasing the geo-engineering knowledge which enables to perform "more precise" estimations to the parameters controlling the estimations. Conclusively, G4, G3, G2 and G1 UNFC-volumes may correspond the Best Estimates of prospective (undiscovered) resources, the discovered unappried resources, the undeveloped resources, and the resources of the producing projects (see Fig. 4).

*Best Estimates assigned to exploration projects

** Best Estimates assigned to appraisal projects

***Best Estimates assigned to potential and viable development projects

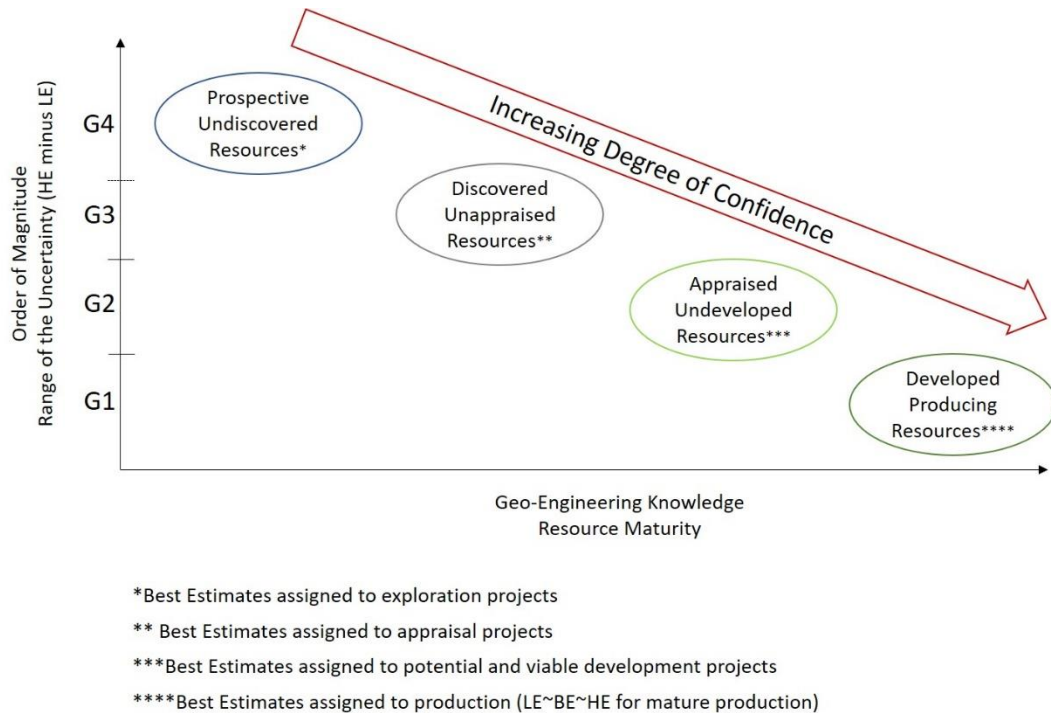****Best Estimates assigned to production (LE~BE~HE for mature production)

Fig. 4. Re-interpretation of the Degree of Confidence

The revision of the G-axis, as discussed above, would affect the classifications along with the F-Axis (Technical Feasibility) because category (F1, F2, F3, F4) descriptions consider the maturity of the development project which corresponds with the resource maturation concept above. The elimination of the redundancy shall be attempted at the discussion of the F-Axis below.

B. The interpretation of the Degree of Confidence criterion remains as it is saved the inclusion of volumes assigned to prospective projects (G4). The suggestion for the removal of category G4 is justifiable by the observation that the characteristics of Prospective Resources simply do not comply with the concept of decreasing confidence in incremental resource volumes from G1 to G3 where G2 and G3 volumes are mathematical differences of quantities of viable recovery scenarios. If the suggestion were accepted PRGS should explicitly clarify that G1, G2 and G3 (in any reasonable F and E combinations) are volumes assigned to a single recovery project (currently it is ambiguous in the Project definition of PRSG).

The High, Moderate and Low Confidence categorization scheme can be applied to Prospective Resources because the scenario-based estimations for the Low, Best, High is normally completed – exactly the same way as it is done for discovered resources. Once the elimination of the G4 category is accepted the Prospective Resources may be recorded at the F-Axis (see discussion below).

Note that Version B leaves recoverable volumes in the UNFC system that do not exist in nature, not even as a viable scenario.

F-Axis

The revision of the Degree of Confidence criterion and the associated modification of the G-Axis affect the F-Axis which is based on the classification criterion of Technical Feasibility.

In case the suggestion of Version A is accepted for the revision to the Degree of Confidence criterion, the F-Axis description in PRSG should be revised as well. It is because the current discussion relates the resource maturity (mentioned as "development maturity") to the Technical Feasibility criterion. I do want to argue the reasonability of this relation but I point out the redundancy with the optionally revised interpretation of the Degree of Confidence (See version A). If the redundancy were removed by the exclusion of the development maturity (*Chapter 5.5. of PRSG*), understood as resource maturity, from the F-Axis specification, the Technical Viability criterion could primarily focus on the viability of the production technology. Without going into details, my suggestion is outlined as follows:

➢ F1 may categorize project resources that are recovered by justified and routinely applied subsurface and surface technologies (no technology development is needed).

➢ F2 classes may involve resources to be recovered by the implementation of minor technology developments.

➢ Volumes that need innovative technologies (R&D) to be recovered might be assigned to F3.

➢ Finally, remaining volumes, for what no recovery technology exists at the moment should be in F4.

In case the suggestion of Version B is confirmed for the revision of the Degree of Confidence criterion, the F-Axis specification could remain as it is. The only change to be implemented is the re-location of recoverable Prospective Resources to F3 with full range of the degree of confidence (F3G1, F3G2, F3G3).

Independently of which version of the above two (or none of them) is followed, I argue that development viability assessment (*Chapter 5.3. of PRSG*) should discuss project economics or other commerciality aspects in the specification of Axis F. The Environmental-Socio-Economic Viability criterion serves for that (E-Axis).

E-Axis

The criterion of Environmental, Societal and Economic conditions (E-Axis) is said to be most elaborated and robust feature of UNFC-2009 that distinguishes the resource management system from others. Also known that UNFC-2009 has already been and is being introduced by several government agencies and institutions (ministries, geological surveys, mining bureaus, etc.) and National Oil Companies.

In the light of this it may be a surprise that the PRSG discusses the criterion above exclusively from the perspectives of the Independent Oil Companies which are primarily accountable for transparent resource disclosures in the defense of the interest of their private investors. I do not argue that the environmental and societal risks should jointly evaluated with other stakeholders, such as the government, local communities, environmentalists, nature

conservationists (authorities, NGO-s, other) but in accordance with PRSG I want to highlight that the "project owner" is the oil and gas company, and as such, solely bears the accountability of resource assessments, including the evaluations against the E-Axis criteria.

The discussion of project economics also unambiguously affirms that UNFC-2019 – similarly to others - is a resource management system for oil and gas companies which follow investors' interest, even if they are formally NOCs where the government is the investor. Other stakeholders, such as government authorities, cannot influence components of the cash-flow e.g. product prices forecasts, capital expenditures and costs and the discount rate (WACC), because they are company specific. Moreover, it is hardly conceivable, that companies share details of the economic analyses and the NPV with "outside" stakeholders, unless regulations oblige them.

In summary, we may conclude that the evaluation of the Environmental, Societal and Economic criterion as per the E-Axis is the sole discretion of the oil and gas companies' Resource Boards. In this respect, companies are in fact in charge of the E-Axis classifications, i.e. whether the project is in the E1 or in the E2 or in the E3 classes.

Consequently, if government agencies wish to use UNFC-2019 for the classification of petroleum resources of a country or of any other political-administrative entity, the project resource reports of oil and gas companies must be supplied. Regulations should have been elaborated accordingly.

Few further comments to the E-Axis:

➤ At the discussion of economics (*Chapter 4.2.*) PRSG suggests the usage of analogues for prospective projects. The wording is unambiguous. In fact, analogues are used for the volumetric assessment but not for economic analyses. The cash-flow evaluation (similarly to non-prospective projects) is based on assumption of revenues, capital expenditures and costs, and the discount rate. Also noted here, that economic analyses are done for the deterministic Low, Best and High Estimates (G1, G1+G2 and G1+G2+G3 in UNFC, respectively) of production forecasts that are based on the probabilistic estimations of the Volume Originally In-Place and the Estimated Ultimate Recovery.

➤ At the discussion of the Economic Limit (*Chapter 4.4.*) PRSG suggests that "*…future production may be tested at an undiscounted rate…*" to determine the economic limit of a project. It is ambiguous whether PRGS wants to refer to undiscounted cash-flows or undiscounted production. If the former, the specification is redundant because the economic limit – i.e. when revenue no longer exceeds operating costs – is reached at the same time at the cumulative of the discounted and undiscounted cash-flows (see Fig. 5).
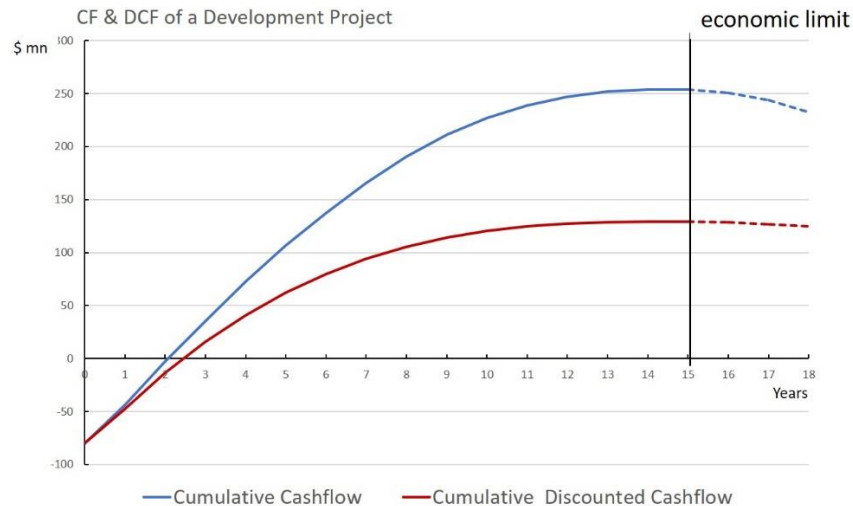
Fig. 5.The economic limit on cumulative undiscounted and discounted cash-flow curves

If the word "*undiscounted*" relates to production rates further explanation should be provided on its meaning (how to discount production rates?)

Risk Analyses

If geological probability is understood as the geological probability (Pg) of project success we may have to consider that projects may fail in the appraisal phase due to geological reasons, too. The assessment (qualification) of the geological risk in the appraisal however should be very different than that of the Pg (POS) in the exploration phase.

PRSG defines Pc as the multiplication product of Pg and the development probability, Pd. *Chapter 5.2.* discussing the consideration of risks is unambiguous about the understanding of Pd. The last sentence of the first paragraph, "*the Pd includes the demonstration of a viable recovery technology*" suggests that Pd is the chance for the implementation of a viable technology. The third phrase of the second paragraph however mentions the social-environmental-economic factors that are also needed to be evaluated at the assessment of Pd. I believe that risks of the technological viability and social-environmental-economic risks are different by nature and therefore should be separately assessed.

My suggestion is to assign Pc (probability of commercial success) to the Environmental-Social-Economic criteria (E-Axis) because these are in fact the criteria of commerciality. Pd (probability of the development's technical success) should belong in this scheme to the Technical Feasibility (F) axis, while Pg (probability of geological success) is to be assigned to the Degree of Confidence criterion (G-Axis) if G-Axis classification follows the Version A approach to the Degree of Confidence discussed above. In case Version B is implemented at the G-Axis Pg should be assigned to the F-Axis – simultaneously with but independently of Pd (Fig. 6). Taken that Pg, Pd and Pc are probabilities for independent events the overall probability of recovery project success (let Pr to be introduced) shall be the multiplication product of Pg, Pd and Pg.
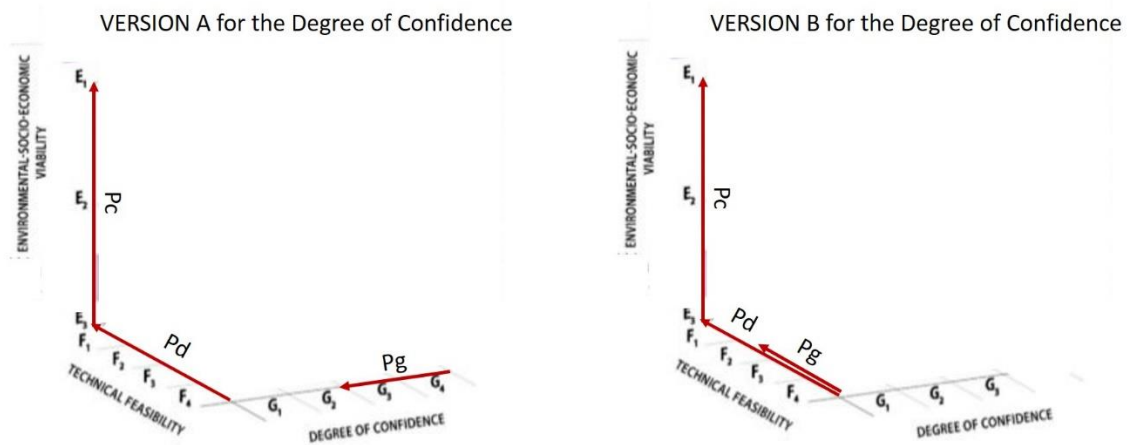
Fig. 6 Proposed assignments of Pg, Pd and Pc to UNFC classification criteria

Version A: Degree of Confidence aligned with project resource maturation

Version B: Degree of Confidence aligned with incremental confidences in volumes of a project

Summary

As the most important conclusion, due to several ambiguities and inconsistencies observed, I suggest the revision of the classification criterion Degree of Confidence. Two versions might be considered:

- Version A: The Degree of Confidence could be aligned with the Resource Maturity (Fig. 4.). Under this scheme the Best Estimate volumes of exploration, appraisal, field development and production projects are assigned to G4, G3, G2 and G1 classes, respectively. At the same time aspects of resource maturity are removed from the criterion of Technical Feasibility. The modification will deliver the result that each "cube" of any reasonable G-F-E combination represents a viably assessable recovery project volume.

- Version B: The interpretation of the Degree of Confidence does not change, i.e. G1, G2 and G3 classes continue representing the High Confidence (Low Estimate), Moderate Confidence (mathematical difference of the Best and Low Estimates) and Low Confidence (High Estimate minus Best Estimate) resource volumes, respectively. Class G4, being available for Prospective Resources however is ceased and moved to F-Axis (Technical Feasibility) which – besides the feasibility of the development technology – evaluates the resource maturity. A project resource volume under this scheme includes the triplet of G1, G2, G3 "cubes" of any F-E combination, where G2 and G3 are not "real" project volume scenarios.

Version A seems to be a more consistent solution.

The analyses of the Environmental-Socio-Economic criteria set (E-Axis) concludes that UNFC is primarily prepared for and useable by the oil and gas companies of the public domain.

Regarding risk (actually success probability) evaluation I suggest the refinement of Pg (geological probability) by its extension to appraisal project volumes, the limitation of Pd

(development probability) to the technological success, and the assignment of Pc (commercial probability) to the environmental, societal and economic factors. The introduction of the overall probability of recovery project success (Pp) is recommended as the multiplication product of the reinterpreted Pg, Pd and Pc.

I firmly believe that my recommendations and suggestions above to PRSG shall significantly improve the consistency, clarity and integrity of UNFC.

Respectfully submitted,

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