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Overview of Benefits and Challenges for Governments applying the United Nations Framework Classification for Resources to Renewable Energy Projects and Resources

Note by the Group of Experts on Renewable Energy and the Expert Group on Resource Management

Summary

This note summarizes the key parts of the Joint Study of the Group of Experts on Renewable Energy (GERE) and Expert Group on Resource Management (EGRM) "Overview of Benefits and Challenges for Governments applying the United Nations Framework Classification for Resources to Renewable Energy Projects and Resources", which is the result of a series of workshops and reviews. The Concept Note for the Joint Study was based on discussions during the Joint Session of the Group of Experts on Renewable Energy (GERE) and Expert Group on Resource Management (EGRM) held on 23 September 202. The Concept Note was also discussed at the twelfth session of EGRM, Geneva, 26-30 April 2021. The Joint Study undertaken by GERE and EGRM explores the potential benefits and challenges for governments applying UNFC to renewable energy projects and resources. The Joint Study is available at: https://unece.org/publications/renewable-energy.

The United Nations Framework Classification for Resources (UNFC) is a unified classification scheme for energy and other resources, making it possible to compare multiple types of energy projects, monitor portfolios, and assess energy-related risks and opportunities for investment using a single framework. Potential users of UNFC include governments, regulators, financiers, and investors that need to be able to compare projects across resources, as well as project developers that typically have a focus on specific project or resource types. The Joint Study explores the benefits of resource classification including the classification of renewable energy projects, related opportunities and risks, highlighting how UNFC can be used to succinctly summarise the environmental, social and economic aspects of projects.

I. Introduction

1. Given the critical importance of renewable energy to the world and society, it is important to have consistent and reliable information on renewable energy projects. This includes environmental and socio-economic viability, technological feasibility, and the degree of confidence of the resources expected to be utilised. The United Nations Framework Classification for Resources (UNFC) addresses this need. It provides a project-based resource classification system allowing project developers to monitor their own progress, investors and financiers to understand levels of risk they are engaging in, and energy companies and governments to monitor energy portfolios, matching resources with a changing demand profile. Importantly, UNFC builds on over 100 years of resource classification experience, providing a classification scheme for renewable and non-renewable energy resources alike.

2. This note describes how renewable energy resources are classified under the UNFC system. Its advantages are described, including commercial applications, policy making and government planning, and understanding climate risk. Benefits for renewable energy resources are then discussed, including renewable energy project development; banking and investment; applications by energy and utility companies; regulation and accounting including climate related financial disclosures; government policy and planning applications; as well as international cooperation towards the Sustainable Development Goals (SDGs). Lastly, conclusions and recommendations are made. Other potential users include academia and research institutions.

II. Resource classification and the development of UNFC

3. Early resource classification systems were developed to meet two types of need:

- Reliable information to the market for investors in companies or projects
- Reliable information to governments for resource and economic planning.

4. A knowledge of what resources will be produced is fundamental to planning the development of resources and commitment of investments in resource production. What a classification standard does is provide a route to consistent, reliable information on:

- The maturity of planned and potential developments, i.e. whether the project is viable and will go ahead, or has potential for the future
- The anticipated quantities associated with the projects, including but not limited to products (e.g. energy), costs, revenues and expected value (e.g. income).

5. After 100 years of resource classification, a range of systems existed, so it was important to develop a standard enhancing consistency and understanding of projects regardless of resource. UNFC makes it possible to compare projects and related resources, classifying them according to environmental-socio-economic viability (E Axis), technical feasibility (F Axis) and degree of confidence (G Axis) (see Annex III). UNFC is unique in providing a common classification framework for a wide range of energy, mineral and other resources (e.g. anthropogenic resources, carbon dioxide storage, and water), using not only technical and economic criteria, but also social, environmental and sustainability considerations.[1]

[1] For more information on the history and origins of resource classification, see Annex II of the Concept Note titled "Application of UNFC to Renewable Energy". The Concept Note including annexes, is available online: https://unece.org/sites/default/files/2021-04/ECE_ENERGY_GE.3_2021_13_UNFC-RE_ConceptNote_2021.pdf

III. Renewable energy resource classification

6. Renewable energy resource classification is not new (see Annex IV) but has lacked widespread adoption and consistency in definitions. This situation has made comparisons between projects and their underlying resources difficult and unreliable. UNFC addresses this problem. Its application to renewable energy ensures consistency in the assessment of project risks and in reporting of resource estimates. As such there are Specifications documents for Applying UNFC to Geothermal,[2] Bioenergy (i.e. biomass), Wind, and Solar Energy. Each of these Specifications documents provide guidance on how UNFC can be applied consistently to related projects, portfolios, and resources with a focus on resource product types. This can easily be expanded to include other information that projects carry as well as the interrelations between projects. Note: Specifications are also being prepared showing how to apply UNFC to marine energy and hydro energy projects and resources.

7. UNFC classifies projects into viable, potentially viable and non-viable project classes for known and potential sources. This classification indicates the stage of development of a project and the confidence of the resources attached to it. It provides valuable information for all stakeholders, investors, financiers, and developers included. It is essential for governments and utilities exploring energy development paths and designing energy systems (see Annex I and Annex III). Such development can benefit from cross-sectoral synergies with e.g. land and water management as well as agro-forestry.[3]

IV. Advantages of classifying renewable energy projects with UNFC

8. Given that UNFC is designed to collect and organise natural resources and project information, all the while harmonising communication between stakeholders; potential uses of UNFC for renewable energy include:

(a) Government policy and planning:

(i) Government/Regional departments seeking input on viability and quantities for resource planning and policymaking, including managing energy transition and implementation of SDGs (see section V);

(ii) Long term planning, for example, looking at probable renewable energy resources and the extent to which these renewable energy resources might become projects in the future and utilised for economic and social development, including in remote areas or areas that have previously lacked energy. Other examples include infrastructure development as well as cost and revenue management.

(b) Regulation and accounting:

(i) Financial regulators, such as independent stock exchange regulators or governments, can use UNFC as a basis for developing financially relevant reporting requirements at the enterprise level, including resources as assets, climate related financial disclosures, and reporting on SDGs;

(ii) Accounting standards bodies, such as the International Financial Reporting Standards Foundation (IFRS Foundation) and the U.S. Securities and Exchange Commission (SEC) in bringing transparency, accountability and efficiency to financial markets.

[2] Technically, geothermal energy can be depleted if there is excessive exploitation, but with appropriate management, geothermal resources are renewable. Geothermal resource exploitation can also include fugitive carbon dioxide emissions.

[3] These opportunities are highlighted by a complementary "tool-kit" publication on sustainable renewable energy deployment, available at: https://unece.org/info/publications/pub/21768.

(iii) Other regulators such as energy agencies and local government can use UNFC classification to understand projects and underlying resources, imposing tariffs or other measures.

(c) Project development:

(i) UNFC will help renewable energy project developers monitor their projects, including achievement of milestones, manage stages of project development, and report standardised information when seeking finance.

(d) Banking and investment:

(i) UNFC will help potential investors who need reliable information on the renewable energy projects they are considering, and their expected value;

(ii) Some financiers have become highly sophisticated in many markets as to renewable energy evaluation and appraisal[4] – they already use technical resource assessments, i.e. energy yield assessment (lenders usually apply a probability of exceedance of 90%, i.e. P90, while equity investors often apply P50);[5]

(iii) For investors, including banks, fund managers, and others, who are less experienced with evaluating renewable energy projects, UNFC will be useful in obtaining reliable, standardised information on renewable energy assets held. Investors increasingly see renewable energy projects as an asset class they want to invest in. In many cases, banks or fund managers lack expertise in renewable energy but require information that can help them make investment choices.

(e) Energy and utilities:

(i) Utilities, oil and gas companies, and other energy companies with renewable energy portfolios, can integrate information on projects regardless of energy source, and as such harmonise decision-making and management processes;

(ii) Electricity utilities and Transmission System Operators in their integrated resource planning and their capacity expansion models.

V. Exploring possible applications in much more detail

9. The list in section IV provides a quick introduction to possible applications of UNFC to renewable energy. The text that follows explores these applications in much more detail.

A. Government policy and planning

10. The purpose of UNFC is to allow the accounting of projects from different energy types and assess them in their socio-economic and environmental viability. Such like-for-like comparison of competing or complementing energy resources might, in turn, influence policymakers in reviewing or extending their existing regulations and accounting practices in economic, social and environmental aspects.

11. Governments are faced with a complex set of requirements and aspirations when it comes to energy policies, in terms of energy access security and affordability as well as the socio-economic and sustainability impact such policies may have on the governed nation, region or community. Energy solutions are manifold and rapidly evolving, all coming with

[4] For these financiers, a benefit of UNFC would be its use in describing the richness of the resource (in the case of solar: irradiation and other factors, e.g. grid access and matching to peak demand). For example, lenders would be interested in a uniform statement of comparative Levelised Cost Of Energy (LCOE) versus other national sources of electricity, so that they can assess where their project sits in the technical merit order (even if they have priority of despatch) and thus be clear on the extent to which their project stands on its merits as opposed to being subsidy or fixed tariff dependent

[5] P values refer to probability of exceedance, e.g. P90 means there is 90% probability of exceeding production or resource estimates.

their own benefits and limitations. On one hand, energy projects need to comply with existing rules and regulations and on the other demonstrate needs for changes to accommodate the energy transition. They must protect social rights and expectations, respect cultural heritage and protected sites, natural reserves and endangered species, support commitments made to minimise pollution such as greenhouse gas (GHG) emission reductions and commitments to the Paris Agreement as well as the 2030 Agenda for Sustainable Development, for example.

12. Providing the right policies, incentives, and plans requires consistent and transparent information across all energy-related projects. Only when governments can compare and rank energy projects in terms of economic, social and environmental viability (i.e. triple bottom line or Environmental, Social, and Governance (ESG) terms), will they be able to provide well-informed and balanced policies as well as plans that can be communicated and accepted by their respective stakeholders. Past examples of renewable resource classification include the United States Department of Energy in 1989 (see Annex IV). Meanwhile, every 5 or 6 years Geoscience Australia prepares a publication entitled "Australian Energy Resource Assessment". The assessment for 2014 used 2012/2013 data and mentions the possibility of applying the UNFC classification to renewable energy (see p342, which is p358 of the PDF).[6] The assessment was updated in 2018 and UNFC was mentioned again, although briefly. Geothermal resource classification exercises have also been conducted in Canada and the United States, using classification codes related to UNFC.

B. Regulation, accounting and climate related financial disclosures

13. Policies, rules and regulations for resource management are determined by authorities within their area of sovereignty or jurisdiction. The United Nations plays a decisive role in establishing transnational rules, e.g. on air and waterborne emissions, trade etc. In addition, some industries have their own resource management systems for the consistent and transparent reporting of resource projects in terms of their economic viability and maturity, technical feasibility and confidence of quantities, revenues and asset values associated with a project. Bridging guidance documents exist between industry-specific resource management systems and UNFC (e.g., the Petroleum Resource Management System (PRMS), the Committee for Mineral Reserves Reporting Standards (CRIRSCO) Template for minerals, etc.). For many renewable energy resources, none of this exists.

14. Investment risks arising from climate change and regulatory uncertainty is a key consideration for regulators informing investors on assets and enterprise values by the use of disclosure standards, including issues of transparency, reporting and accounting. In response to the Task Force on Climate Related Financial Disclosures (TCFD) and its recommendations (see Annex V), the World Business Council for Sustainable Development (WBCSD) together with Eni, Equinor, Shell, and TotalEnergies, prepared a report on climate-related financial disclosures by oil and gas companies. From the report, five topics were identified about which climate-related financial disclosures were suggested. These topics consisted of GHG emissions, research and development, low-carbon investments, portfolio resilience, and water. While neither the TCFD nor the WBCSD have mandates to regulate reporting, they may be influencing the IFRS Foundation, which currently is considering revising its constitution to establish an International Sustainability Reporting Standards Board, and the US SEC in their endeavours. These efforts may provide information on the aggregate of those parts of the projects held by listed companies. Similar government sustainability reporting systems will be required to ensure transparency in the complete energy systems within a jurisdiction, and thus also a better view of the sustainability risks faced by investors in assets and enterprises within the jurisdiction. Energy portfolios reported according to UNFC could have a special role to play when it comes to disclosing low-carbon investments and portfolio resilience (see Annex II and Annex V). For example, when it comes to investments in renewable energy, renewable energy resource estimates classified using UNFC would give a sense of currently viable resources as well as other renewable energy projects likely to be developed and come online in the future.

[6] Australian Energy Resource Assessment: https://arena.gov.au/assets/2018/08/australian-energy-resource-assessment.pdf

15. Regarding portfolio resilience, renewable energy resource estimates can be compared and reported together with non-renewable energy resources (see Annex III). Importantly, a portfolio of projects classified using UNFC will also indicate the extent to which a company, other entities of communities, rely on renewable or non-renewable energy projects, including the extent to which the project pipeline is renewable or non-renewable.

C. Renewable energy project development

16. Renewable energy has been successfully developed without the use of global resource classification standards, including billions of dollars of investment, but not at the industrial scale required to replace fossil fuels. Now, standardisation of information is required, creates opportunities, increases transparency, reduces risks arising from misunderstandings or miscommunications, and can reduce transaction costs. Standardisation of information starts at the level of projects.

17. UNFC can help renewable energy project developers monitor project development relative to classification and investment milestones (e.g. crossing from ‘approved for development’ to ‘on production’) while at the same ensuring projects are classified and presented with the information needed for financiers and investors to make assessments of risks and returns.

18. There may be a number of reasons for the lack of standardised project information to date, for example: existing renewable energy project evaluation and reporting practices have been “fit for purpose” given the scale of investments even though they lack consistency between projects; a standardised system has not been available until now; and, the scale of renewable energy projects has been relatively small (but growing rapidly) compared to the fossil sources of energy. By contrast, resource estimation and classification has become central to the extractive industries and to governments managing petroleum and minerals resources, in part due to the large investments being made as well as the close relationship between estimated energy production and expected profits.

D. Banking and investment

19. For utility-scale projects, there is a large pool of expertise in financial institutions with experience in investment and credit policies to evaluate the projects, particularly in existing financial centres or hubs. UNFC can assist these institutions through the generic classification of projects in a particular market or region – which can then be extended to framing credit or investment products for sub-utility scale projects, e.g. off-grid wind, rooftop solar or distributed energy systems. Outside of existing financial centres and hubs, there are many other financial institutions, banks and investors that want to invest in renewable energy as asset classes but lack the necessary experience or expertise.

20. UNFC is well suited to provide standardised information on renewable energy projects that can be used by experts and novices alike. UNFC addresses P50-P90 probability of exceedance estimates required of investors to make decisions on projects. Importantly, UNFC provides a consistent framework for presenting this information, make it easier for financiers and investors with limited expertise to understand renewable energy projects, their maturity, or portfolios of renewable energy projects being invested in, including the level of risk involved. Even more importantly, UNFC requires quality estimates (i.e. from experts and regular industrial quality management processes) to assess projects and their classification, to ensure the quality of information. In many ways, this follows existing practices where financial institutions already hire the services of technical consultants to provide due diligence on-site and design specific P50 and P90 annual yields and system performance ratios. The main difference is the standardisation of reporting in relation to other investment considerations. UNFC helps classify information quality so that investors can better understand the basic dynamics of a market and benchmark specific opportunities to that.

21. It is worth noting that application of UNFC to renewable energy is analogous to oil and gas, and mineral classification and reporting. For example, PRMS was developed so

lenders could differentiate oil and gas estimates, (e.g. possible, probable or proven estimates) which was important when it comes to understanding risk and determining the conditions around project finance and profitability. Likewise, the CRIRSCO Template differentiates mineral reserve and resource estimates. Interestingly, by applying UNFC to renewable energy resources, financiers or investors with experience in oil, gas, or minerals projects will be able to better understand renewable energy projects.

22. It is also worth noting that many countries around the world (e.g. countries in Europe, Latin America and Africa) have effective renewable energy auction processes or regimes, where project data are presented regarding resources, as well as any electricity sectoral impediments and fiscal, governance, and macroeconomic, financial capacity constraints. UNFC could play a role in standardising the information shared in these auctions.

E. Multilateral Development Banks

23. For Multilateral Development Banks (MDBs), UNFC and renewable energy-related specifications offer a method and associated metrics for evaluating and comparing their interventions in the energy sector – whether at strategic or policy levels or at project assistance and funding levels. Moreover, by using UNFC in categorizing and reporting on their interventions, ready comparisons can be made across time and geography, as well as between institutions and investment platforms/facilities.

24. When assisting governments in developing national frameworks and policies for renewable energy generation,[7] baseline resources and end objectives can be categorised using UNFC and renewable energy-related specifications, and targets can be expressed by the quantum of resource to be upgraded from less developed categories to the viable and developed categories. Examples could include:

(a) “Support the feasibility of not less than X Gigawatt hours per annum (GWh/a) of potential generation in Country Y by selected investments in grid expansion and strengthening, i.e. shift X GWh/a currently in category F3.2 (local studies indicate potential) to F2.1 (actual projects to be implemented in the foreseeable future)”;

(b) “Enable not less than Z GWh/a to be economically viable by designing and launching an appropriate procurement programme or tariff regime such that, in each of the next 5 years, not less than W% of the national solar resource currently categorised as E3.2 (conditions for viability are not yet in place) becomes economically and commercially viable (i.e. E1.1 or (if subsidy required) E1.2 resource)”.

25. By their nature, MDB’s technical assistance facilities (TAFs) at project level[8] seek to support project developers from the identification stage (category E3/F3/G1+2+3) to the near-commercial stage (category E2/F2/G1+2). As part of their aggregate goals, such facilities could be set targets such as the quantum of renewable energy resource that they succeeded in advancing to category E2/F2/G1+2, and the amount of funding expended or to be deployed at each intervening stage. Donors to such facilities would then have ready comparators by which to assess the relative efficacy of the TAFs seeking their support.

26. MDB’s financing activities can also be categorized using UNFC and related specifications, noting that financing inherently facilitates the transition of projects to construction and operations stages (categories E1/F1/G1 (or a full spread of uncertainty) from E2/F2/G1+2). The principal benefit would be in performance evaluation and reporting on financing activities, for example, by setting targets for GWh/a per USD million invested and

[7] Successful programmes to date, such as Scaling Solar or the Global Energy Transfer Feed-in Tariff (GET-FiT) programmes implemented in several African countries, have been characterised by having specific a priori targets and delivery plans. Such targets are readily capable of being articulated and categorised using UNFC, to aid comparability.

[8] Several such facilities provide support to private developers of specific projects, as well as to public bodies to assist institutional capacity building and programme development. Examples include the Technical Assistance Facility of the Private infrastructure Development Group (PIDG), which provides grant funding for project feasibility and technical studies and viability gap funding where justified.

associated avoided carbon and other emissions. Such metrics can then feed into climate sustainability reporting that financial institutions (whether MDBs, national/regional or private/commercial) are increasingly seeking to adopt.[9]

F. Energy and utilities

1. Utilities

27. Electricity, heating, or cooling utilities may have an interest in renewable energy and UNFC. As governments and regulators adopt more aggressive carbon-reduction targets, electric utilities must retire fossil fuel generation and add renewable energy generation along with energy storage and power electronics. UNFC could provide a complete and consistent methodology to allow utilities to plan for those changes and then to study the impact of these new resources on their transmission grids.

28. Examples, where a change in the source of energy generation will have end-use impacts, is in the heating and cooling sectors. Currently, in many countries heating and water heating in the residential and commercial sectors are predominantly supplied by direct use of natural gas and oil. The UNFC methodology has the potential to be used to determine benefits of renewable led grid electrification aimed at providing higher efficiencies, lower emission outputs and lower costs. The methodology can also determine the benefits of incorporating renewable thermal systems for water and space heating. Technologies used in this renewables-led transition will include heat pumps for heating, cooling and water heating with high coefficients of performance, much higher than can be provided by the point of use combustion of oil and gas. Furthermore, in cases where renewable energy technologies were traditionally used for water and space heating, the reduced cost of the renewable energy system has meant that water heating is now being considered as a “sponge” to take up excess energy generated during the day. This is often combined with a “sponge” incentive tariff to help minimize the “duck curve” when it comes to solar energy.[10]

29. For industrial process heat where mainly gas and coal are used, again high-temperature process heat derived from renewable thermal systems, or renewable electrification together with green hydrogen are being looked at as replacements and used in combination with thermal storage.

30. In addition, consideration should always be given to energy efficiency improvements, including waste heat recovery in commercial and industrial processes. The UNFC methodology can be developed to include these. Meanwhile, renewable energy intermittency remains a challenge that is increasingly being addressed through the deployment of energy storage. While storage does not influence energy source, it does help match intermittent renewable energy generation with variable demand. As such, the deployment of storage can also reduce curtailment and increase quantity of energy able to be sold.

2. Oil and gas companies becoming integrated energy companies

31. In a business environment where renewable energy is becoming cheaper, road transport is being electrified, and fund managers are considering divestment of oil and gas

[9] Financial institutions worldwide are increasingly citing the lack of consistency in terminology as a significant obstacle to their deploying more capital in climate change investment and in sustainable investment more generally. See “The Case for Simplifying Sustainable Investment Terminology”, the October 2019 survey by the Sustainable Finance Working Group of the Institute of International Finance. The survey proposed three categories of investment – “exclusion investments”, “inclusion investments”, and “impactful investments”. Investments to increase solar power generation and access generally would fall into the latter two categories and could be readily classified by reference to the UNFC Solar Specifications. See https://www.iif.com/Portals/0/Files/content/IIF%20SFWG%20-%20Growing%20Sustainable%20Finance.pdf

[10] The “duck curve” is “the difference in electricity demand and the amount of available solar energy throughout the day” (DOE 2017), which when plotted looks a bit like a duck. For more information see: https://www.energy.gov/eere/articles/confronting-duck-curve-how-address-over-generation-solar-energy.

stocks, it is important for oil and gas companies to have the flexibility to match their "reserves" (i.e. viable projects) with a changing demand profile and be able to limit transition risks related to climate change concerns. As such, it would be useful if oil and gas companies could include information on renewable reserves (i.e. viable renewable energy resources) to stock exchanges and shareholders.

32. Currently, oil and gas companies are only able to replace oil and gas extracted with new oil and gas reserves due to accounting rules, creating an accounting lock-in. Importantly, a reserve replacement ratio of less than 1 is considered problematic by shareholders as it indicates the company is depleting its asset base (i.e. energy reserves upon which the company makes its income). To facilitate a transition, it is important that renewable energy reserves (i.e. viable resources) can be included in reserves and reserve replacement ratios. Inclusion of solar energy in the oil and gas company's reserve replacement ratio for 2016 made an appreciable difference, raising the ratio from 93.1% to 94.9% even using conservative assumptions (see Annex VI).

33. Furthermore, the inclusion of viable renewable reserves in reported reserves of oil and gas companies could also be an important form of climate-related financial disclosures for oil and gas companies (see section G below) highlighting investments in low carbon energy and portfolio resilience. Alternatively, this could be achieved by giving the financial investments made in USD and the status and plans of renewable energy projects – classified using UNFC.

G. International cooperation towards the Sustainable Development Goals

34. Renewable energy would significantly benefit from consistent adoption of UNFC by governments and policymakers as it has significant advantages in terms of environmental sustainability (e.g., total GHG emissions per energy unit provided) and in many cases comes with higher social acceptance compared to other energy types.

35. Within the 2030 Agenda for Sustainable Development, SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all. This includes targets for universal energy access, increasing the share of renewable energy in the global energy mix and improving energy efficiency by 2030. Energy is also linked with the attainment of other SDGs.

36. UNFC seamlessly informs a shift in investments into renewable energy. In addition to UNFC and related specifications on how to apply UNFC to renewable energy sources, further guidance for application of UNFC could be developed on how to aggregate project data and use portfolio data, along with guidance for investors, banks, and other institutions using this information.

37. There are early indications of the adoption of UNFC, e.g. development of the UNFC-African Minerals Resources Classification and Management System (UNFC-AMREC) and initiation of UNFC-Europe, ongoing discussions with the IFRS Foundation and U.S. SEC, active participation of many nations, regions, international bodies and companies in the development and testing of UNFC. With rapidly increasing investments in renewable energy and the growing emphasis on managing the energy transition and meeting SDGs, stakeholders may well increasingly see the benefits and opportunities that UNFC provides.

H. Use cases

38. There are two broad categories of UNFC use cases needed. The first category is the classification of renewable energy projects, and the second category is the use of the project data for the purposes UNFC is constructed to serve, i.e. policy formulation and advice, government resource management, business process management and capital allocation. Case studies help ensure resource classification and applications are informed and driven by, experience and feedback – each of which is important for continuous improvement of UNFC. Furthermore, case studies can demonstrate value to potential UNFC users and foster adoption.

39. Various UNFC use cases already exist[11] – all of them are resource-type specific and demonstrate that project resource volumes can be classified according to UNFC. Many of them demonstrate that the bridging between an industry-specific resource management classification system and UNFC can be achieved. However, there was no attempt made yet to compare projects of different energy types (petroleum, renewables, coal, nuclear etc). To the best knowledge of the authors, no decision has yet been taken on energy projects using UNFC, although similar systems have been used extensively, demonstrating the natural application of the proposed system, provided that information carried by projects is included. In many respects, the UNFC process is not new. It is just more convenient than current systems.

40. Economic energy quantities are one aspect UNFC can deliver consistently across energy types. The other two are social and environmental aspects. Any of those can be reported in a progressive level of detail, capturing the various requirements in the respective jurisdiction and expectation of society. For instance, protecting endangered species varies geographically, and so does social acceptance. To start simple, it is proposed to report on aspects that are most commonly applicable, like total project GHG emissions and in-country employment figures for environmental and social impact assessments, respectively. Thus, by reporting on total project economic energy quantities in exajoules (EJ), GHG emissions in tonnes CO_2-equivalent and in-country value in employee staff years, a minimum viable report following UNFC could be delivered to compare projects at the most basic level. Likewise, UNFC opens up possibilities for wider integration of physical and economic data under the System of Environmental Economic Accounting (SEEA). The SEEA already uses UNFC as a basis for natural resource accounts involving non-renewable energy and mineral resources.

41. This minimum report can and will certainly have to be detailed further, allowing for local/national or regional requirements to be captured. UNFC allows for adaptation and additions of further reporting requirements to fit user needs.

42. For the renewable energy industry, further use cases are sought to demonstrate the value of renewable energy in direct comparison with other energy resources. One simple case could be the replacement of a steam-generator using fossil fuels with a non-photovoltaic solar device, such as a concentrating solar thermal collector: How much is the total cost per energy (steam) generated, what is the total CO_2/EJ and how many staff were employed per energy unit or during the lifetime of the project. This approach offers a simple like-for-like comparison that the decision makers can use to showcase the socio-economic and environmental aspects of their decision to their stakeholders.

43. More case studies are needed regarding the application of UNFC to renewable energy projects, including the classification of projects using UNFC as well as the use of this classified data, for example, by investors.

VI. Next steps

44. This note highlights the range of possible UNFC applications with a focus on government applications and other applications that might need oversight or even regulation in the future.

45. There is a need to explore and test UNFC applications further including case studies. To date, specifications have been prepared showing how UNFC can be applied to geothermal, biomass (i.e. bioenergy), wind and solar energy projects and progress is being made to develop hydro-marine specifications.[12] These specifications are especially useful for developers with projects utilising these resource types. Going forwards, it may be useful to engage new communities of users and prepare specifications for the application of UNFC to: governance and regulation; accounting and reporting; finance; energy planning; portfolio management; as well as climate related financial disclosures. For those interested to learn

[11] See a collection of use cases for various energy and other resource types at https://www.unece.org/energywelcome/areas-of-work/unfc-and-sustainable-resource-management/case-studies.html.

[12] Hydro-marine specifications will address hydro energy resources, as well as marine energy resources.

more about how UNFC might be applied in each of these areas, see the online video "Renewable Energy Milestones for Business and Government".[13]

46. Lastly, for more information on application of UNFC to renewable energy and overcoming barriers to scaling renewable energy, GERE and EGRM organized a joint event on "Overcoming barriers to scaling up Renewable Energy" on 23 September 2020.[14] Valuable information is also provided in the session "Renewable Energy Workshop with focus on integrated water and energy management" organized during the twelfth session of EGRM.[15]

[13] https://www.youtube.com/watch?v=Y2GVQreX3oc&feature=youtu.be
[14] https://unece.org/sustainable-energy/events/overcoming-barriers-scaling-renewable-energy
[15] https://www.youtube.com/watch?v=XPprz5XPNho

Annex I

Table 1
UNFC Classes and Sub-classes

	Class	*Sub-class*	*Resource confidence - High, Moderate, Low* (*General definition of project/resource)*
Known source	Viable Projects	On production Approved for development Justified for development	The project's environmental-socio-economic viability and technical feasibility has been confirmed
	Potentially Viable Projects	Development pending Development on hold	The project's environmental-socio-economic viability or technical feasibility has yet to be confirmed
	Non-Viable Projects	Development unclarified Development not viable	
	Remaining products not developed from identified projects		May become developable in the future, but this depends on technological change or environmental-socio-economic change.
Potential source	Prospective Projects		There is insufficient information on the source to assess the project's environmental-socioeconomic viability and technical feasibility
	Remaining products not developed from prospective projects		May become a project in the future, but this depends on technological change or environmental-socio-economic change.

Note: For definitions of the terms in this table, see UNFC 2019 on the UNECE website (https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf).

Annex II

Table 2
Examples of topics and suggested disclosures for oil and gas companies with renewable energy in their portfolios, from the WBCSD report published in 2018

Topic	*Unit*	*Suggested disclosure*	*Comments*
Low-carbon investments	Currency (if applicable)	Investment (Capex) in low-carbon alternatives, or indicative breakdown of capital investments into main categories. Specify definitions of “low-carbon” and “investments.”	Flexible definition of “low-carbon” needed to allow for practical implementation.
Portfolio resilience	Not applicable	Describe portfolio flexibility over time based on capital investment plans. Supporting disclosures could include future Capex flexibility overview (committed vs non-committed Capex), capital payback periods or return on capital employed.	Relevant timeframes and metrics will differ from company to company. Some elements may be considered commercially sensitive by some companies. Flexibility needed so that companies can choose relevant and non-sensitive indicators.

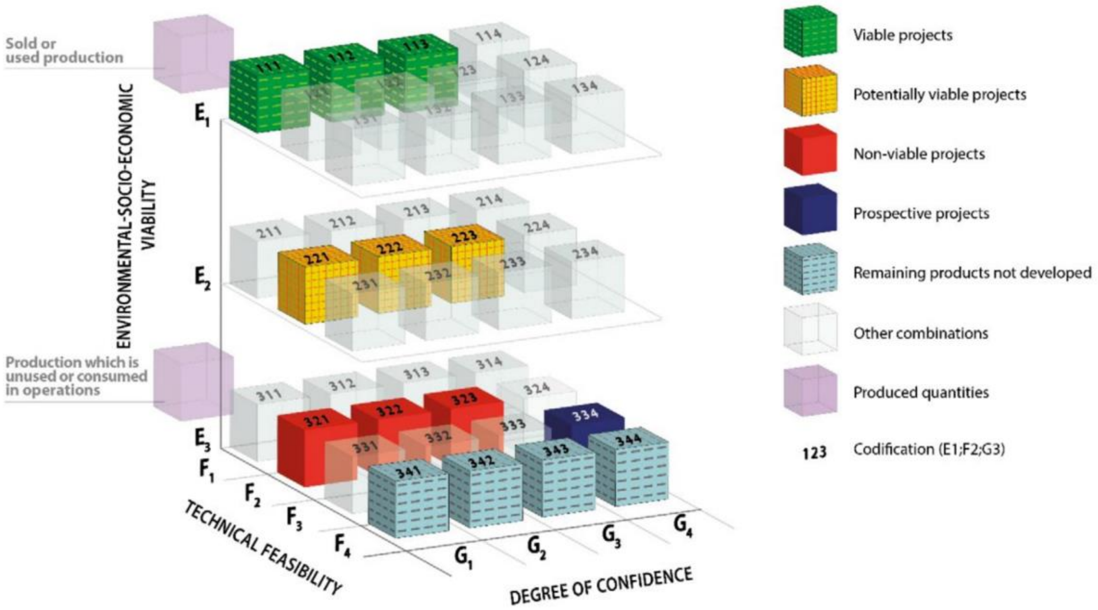
Note: To see the full list of topics and suggested disclosures, see Annex III in the Joint Study.

Annex III

The United Nations Framework Classification for Resources (UNFC)

1. UNFC is a principles-based system in which the products of a resource project are classified on the basis of the three fundamental criteria of environmental-socio-economic viability (E), technical feasibility (F), and degree of confidence in the estimate (G), using a numerical coding system. Combinations of these criteria create a three-dimensional system (Figure I).

Figure I
UNFC Categories and Examples of Classes



Note: For more information see UNFC 2019: https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf

Annex IV

Historical example - United States energy resource classification

1. United States energy resources (Table 3) were classified using three simplified categories drawing from the McKelvey Diagram (Figure II). The McKelvey Diagram provides a two-dimensional framework for classifying energy sources according to the degree of physical assurance (i.e. geological assurance for energy minerals and petroleum) on the horizontal axis, and the degree of economic feasibility on the vertical axis. The three simplified categories drawn from the McKelvey Diagram consisted of: reserves, accessible resources, and total resource base.

Table 3
Energy sources assessed in the characterisation of United States energy resources and reserves

Renewable energy sources	*Non-renewable energy sources*
Geothermal	Coal
Hydropower	Natural gas
Photoconversion (consisting of solar and biomass)	Peat
Wind	Petroleum
	Shale oil
	Uranium

Note: Source United States Department of Energy (DOE) 1989.

2. Reserves had the greatest physical assurance and economic feasibility and were defined as “a subset of the accessible resource which is identified and can be economically and legally extracted using the current technology to yield useful solar energy.” (page 1, US Department of Energy (DOE) 1989).[16] Accessible resources were defined as “The portion of the total resource base, without regard to current economics, that can be captured, mined, or extracted using current technology or technology that will soon be available or economically extracted.” (page 1, DOE, 1989). Accessible resources were the portion of the total resource base that had been identified (see Figure III in this Annex). The total resource base was defined as the “Total physically available energy that encompasses both identified and undiscovered resources, regardless of whether or not they can be practically or economically extracted.” (page 1, DOE, 1989). The total resource base included both identified and undiscovered energy sources.

3. DOE made estimates of the reserves, accessible resources and total resource base for the energy sources in Table 3 and presented the results graphically (see Figures III and IV in this Annex). Figure III presents the total energy reserves and illustrated the relative proportions. Figure IV presents the results for each type of energy source.

[16] US DOE, 1989. Characterization of U.S. Energy Resources and Reserves. United States Department of Energy. Online 31/01/2021: https://www.osti.gov/scitech/servlets/purl/5128243

Figure II
Modified McKelvey Diagram

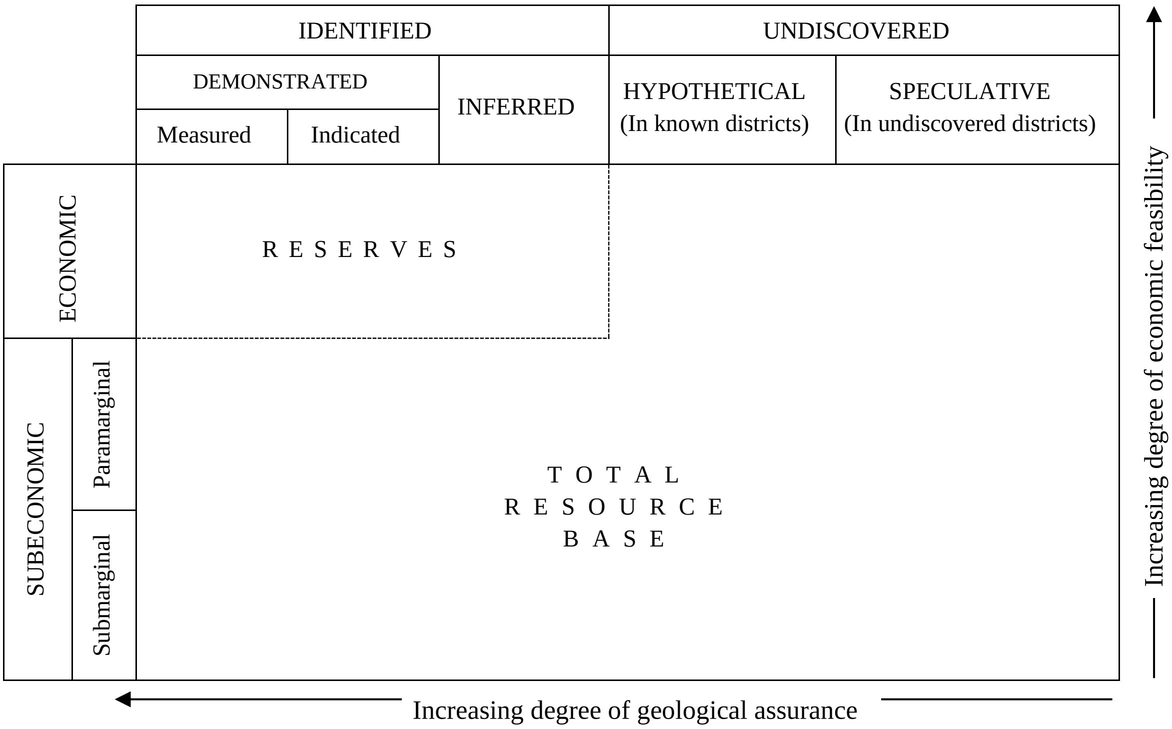
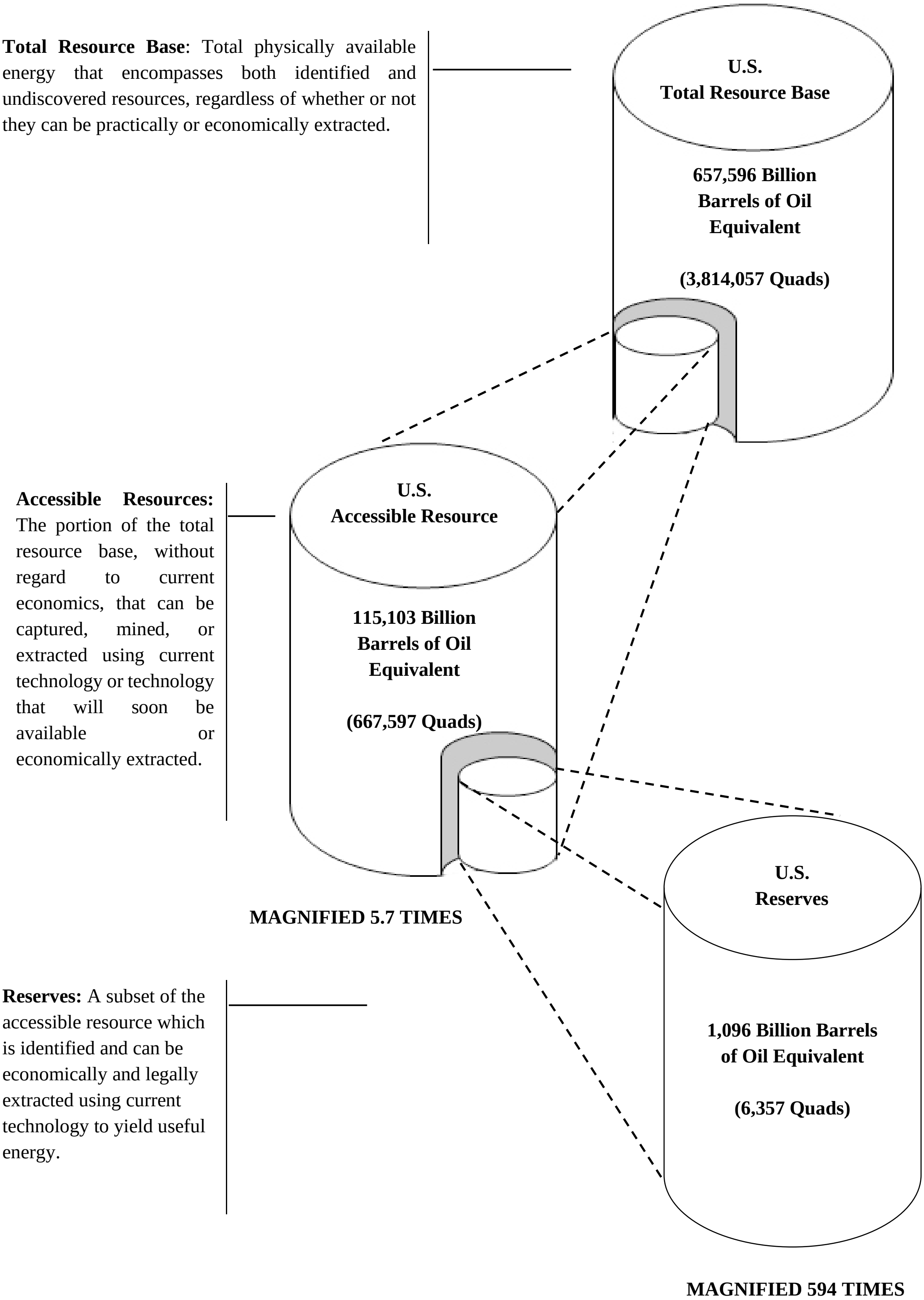


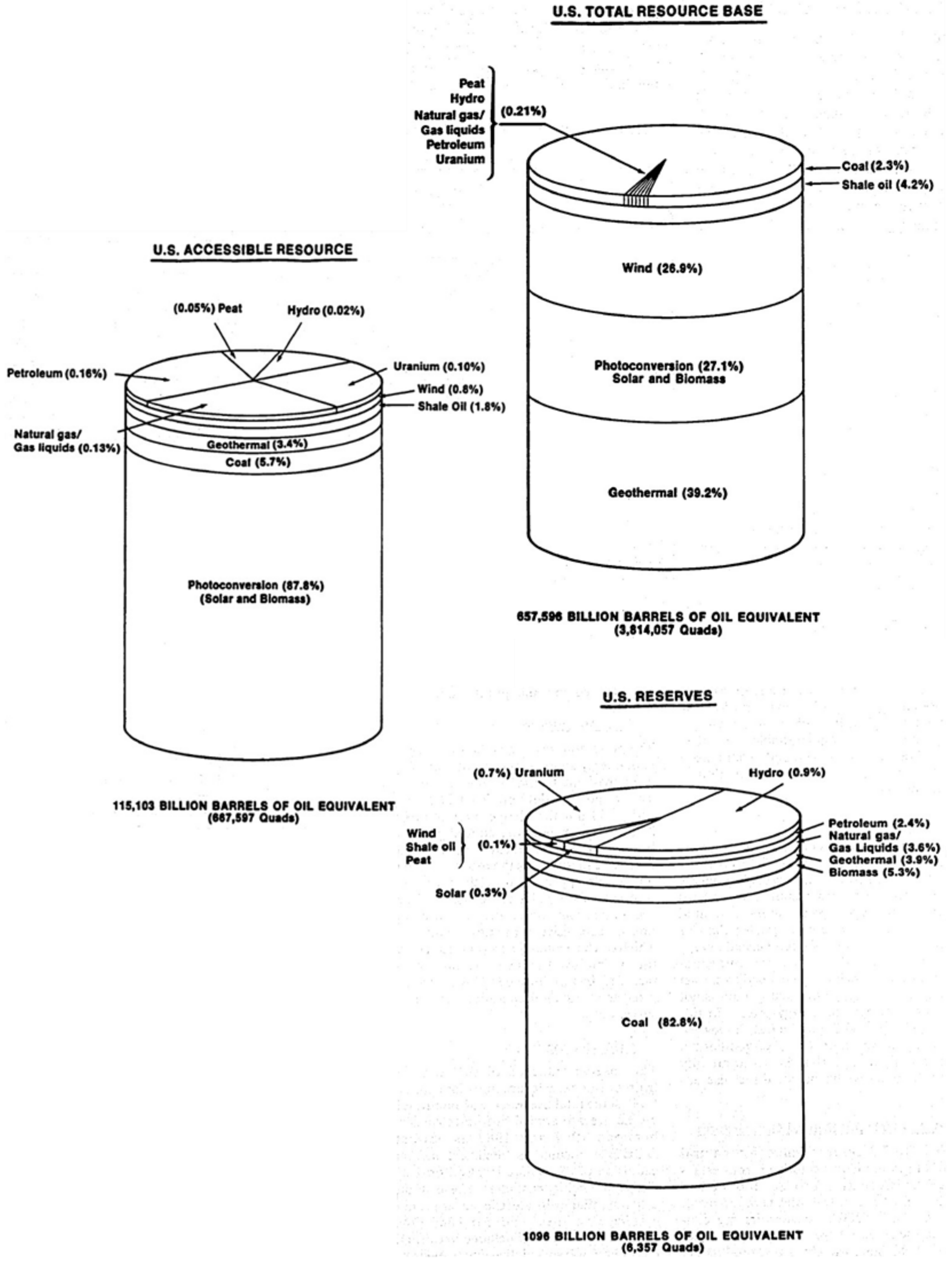
Figure III
Total energy resources estimated by the United States Department of Energy



Source: Modified from DOE 1989.

Figure IV

Solar and other energy resources classified by the United States Department of Energy



Source: DOE 1989

Annex V

World Business Council for Sustainable Development oil and gas climate-related financial disclosures

Table 4
Topics and suggested climate-related financial disclosures for oil and gas companies

TOPIC	*UNIT*	*SUGGESTED DISCLOSURE*	*COMMENTS*
GHG emissions	Tons CO_2e	Amount of GHG scope 1 emissions in the reporting year. Specify scope and boundary (equity/operator).	Operational boundary is the industry norm - not aligned with financial reporting boundary (equity).
GHG emissions	Tons CO_2e	Amount of GHG scope 2 emissions in reporting yea. Specify scope and boundary (equity/operator).	Operational boundary is the industry norm - not aligned with financial reporting boundary (equity).
GHG emissions	Tons CO_2e	Amount of GHG scope 3 emissions in reporting year. Specify scope and boundary.	Operational boundary is the industry norm - not aligned with financial reporting boundary (equity).
GHG emissions	CO_2e/BOE; CO_2e/MwH or similar	Industry specific GHG efficiency ratios. Specify scope and boundary (equity/operator).	Allow for company-specific KPIs and targets.
R&D	Currency and/ or % of Total	Expenditures (Opex) to low-carbon R&D (amount and/or share of total R&D expenditure). Specify the definition of "low-carbon" and "expenditures."	Flexible definition of "low-carbon" needed to allow for practical implementation.
Low-carbon investments	Currency (if applicable)	Investment (Capex) in low-carbon alternatives, or indicative breakdown of capital investments into main categories. Specify definitions of "low-carbon" and "investments."	Flexible definition of "low-carbon" needed to allow for practical implementation.
Low-carbon investments	Currency	Revenues from investments in low-carbon alternatives. Specify the definition of "low-carbon" and "investments."	May not be practical if this is not aligned with business reporting segments. Allow for flexible definition of "low-carbon" and "revenues," e.g. with respect to revenue from equity accounted companies. Recommendations suggest a clear divide between low-carbon and traditional business, which may not be the case.
Portfolio resilience	Not applicable	Describe portfolio flexibility over time based on capital investment plans. Supporting disclosures could include future Capex flexibility overview (committed vs non-committed Capex), capital payback periods or return on capital employed.	Relevant timeframes and metrics will differ from company to company. Some elements may be considered commercially sensitive by some companies. Flexibility needed so that

TOPIC	*UNIT*	*SUGGESTED DISCLOSURE*	*COMMENTS*
			companies can choose relevant and non-sensitive indicators.
Portfolio resilience	Currency	Describe the current carbon price or range of prices used in investment analysis. Specify scope.	
Portfolio resilience	Not applicable	Describe resilience to a 2ºC or lower scenario and other relevant scenarios (optional). Describe key assumptions of scenarios used. Supporting disclosures could be, e.g. carbon price sensitivity and/or oil and gas price sensitivity.	Companies can refer to externally recognised scenarios, e.g. IEA scenarios, or use own scenarios. This information may be better suited in other reports than financial reports due to high uncertainty and long-time horizons.
Water	% of BOE	Share of production in areas that have high or extremely high baseline water stress.	Specify scope and boundary (equity/operated).
Water	%	Share of water withdrawn in regions with high or extremely high baseline water stress.	Depending on materiality.

Note: WBCSD, 2018.

Annex VI

Reserve replacement ratio including solar reserves for an oil and gas company

1. These are back of the envelope calculations, using publicly reported data from an oil and gas company coupled with estimates where indicated. The calculations include a number of assumptions which may or may not be accurate. As such, the estimated Reserve Replacement Ratio (RRR) is indicative of how solar energy might be included in RRR estimates. Any comments or suggestions on the methodology, assumptions or the RRR are welcome.

Table 5
Change in solar energy reserves (i.e. viable solar energy resources)

Formulas	*Data item*	*Value*	*Units*	*Notes*
a	Installed capacity 2016	6	GW	
b	Capacity factor	0.2	Ratio	Estimate (between 10% and 30%)
c	Days in a year	365	Days	
d	Hours in a day	24	Hours	
e = a*b*c*d	Annual solar production estimate	10512	GWh	
f	Conversion factor GWh to BOE	588.24	Ratio	
g = e*f	Solar production guestimate	6,183,579	BOE	
h = g / 1,000,000	Annual solar production estimate	6.2	MBOE	
i	Lifespan of solar project (before replacement of capital)	20	Years	
j = h*i	Solar energy reserves in 2016	123.7	MBOE	
k	Annual growth in installed capacity	15	Percent	Estimate
l = j / (1 + (k/100))	Solar energy reserves in 2015	107.5	MBOE	Estimate*
m = j - l	**Change in solar energy reserves**	**16.1**	**MBOE**	

Note: It would be ideal to have estimates based on installed capacity in 2015 rather than a guessed change in capacity. However, annual figures on the total installed solar capacity are not publicly available.

Table 6.
Change in petroleum reserves (i.e. viable hydrocarbon reserves)

Formulas	*Data item*	*Value*	*Units*	*Notes*
n	Hydrocarbon reserves 2016	11,518	MBOE	
o	Hydrocarbon reserves 2015	11,580	MBOE	
p = n-o	Change in reserves	-62	MBOE	
q	Daily production 2016	2,452	KBOE/day	
r = q*c	Annual production 2016	894,980	KBOE	
s = r / 1,000	Annual production 2016	895.0	MBOE	
t = s+p	**Calculated discoveries and extensions of petroleum reserves**	**833.0**	MBOE	

Table 7
Reserve replacement ratio with and without solar energy reserves (i.e. viable solar energy resources)

	Data item	*Value*	*Units*	*Notes*
u = t / s	RRR (just hydrocarbon)	93.1%	Percentage	
v = (t+m) / s	RRR (hydrocarbon and solar electricity)	94.9%	Percentage	