Recommendations of the Scientific and Expert Committee on unconventional hydrocarbons and alignment strategies

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Policy Statement

The Scientific and Expert Committee welcomes the creation of the Sustainable Finance Observatory, an initiative that will be all the more useful as it will respect five major principles that are reflected in many of our recommendations:

- Transparency
- Readibility
- Consistency
- Reliability
- Relevance

These five main principles must be the pillars of each indicator published in the Sustainable Finance Observatory.

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I. Recommendations on unconventional hydrocarbons

INTRODUCTORY REMARKS AND METHODOLOGY ADOPTED BY THE COMMITTEE

- The Scientific and Expert Committee believes that **the credibility of the greening of the Paris financial center depends on the exit from coal financing by 2030 in the European Union and OECD countries, and by 2040 in the rest of the world (as recommended by the February 25, 2021 recommendations), as well as on the effective support of the fossil fuel industry in its decarbonization process, by integrating the issues related to a just transition**. It is in this regard that the Scientific and Expert Committee emphasized in its above-mentioned opinion that the principle-based approach (i.e. comparability, replicability, completeness and reliability) adopted for coal could be more broadly applied to all the sectoral policies of financial market participants, in particular for oil and gas. **In the perspective to align with the scientific imperative to halt all new fossil fuel projects and substantially reduce oil and gas production, the Scientific and Expert Committee is publishing its first recommendations on unconventional oil and gas.**

1. The necessary transition of the oil and gas industry: literature review

- **The scientific literature is unambiguous on the transition of the oil and gas industry, and it is within this framework that the Scientific and Expert Committee has conducted its work**. In particular:

  - The special report released by the Intergovernmental Panel on Climate Change (IPCC) in 2018 on the impacts of global warming of 1.5°C[1] highlights that between 2020 and 2050, **primary energy supplied by oil must decrease in most scenarios, in the range of -39 to -77%** (interquartile range), **while natural gas is projected to decrease in the range of -13 to -62%** (interquartile range), with overall deployment of carbon capture and storage (CCS) technologies varying considerably across the scenarios (from zero to 300 GtCO2eq stored in 2050). In addition, in the four mitigation strategies supported by the IPCC to reduce net emissions to achieve a pathway limiting warming to 1.5°C (with no or minimal overshoot), the share of fossil fuels is greatly reduced. In the P1 scenario (with energy demand reduction until 2050, where fossil fuels are not used with CCS), the P2 scenario (with increasing energy intensity and technological innovation) and the P3 scenario (with demand reduction and usual societal and technological development patterns), the share of oil decreases by 87%, 50% and 81% respectively compared to 2010, and that of natural gas decreases by 74% and 53% respectively (P1 and P2 scenarios) and increases by 21% compared to 2010 (P3 scenario).

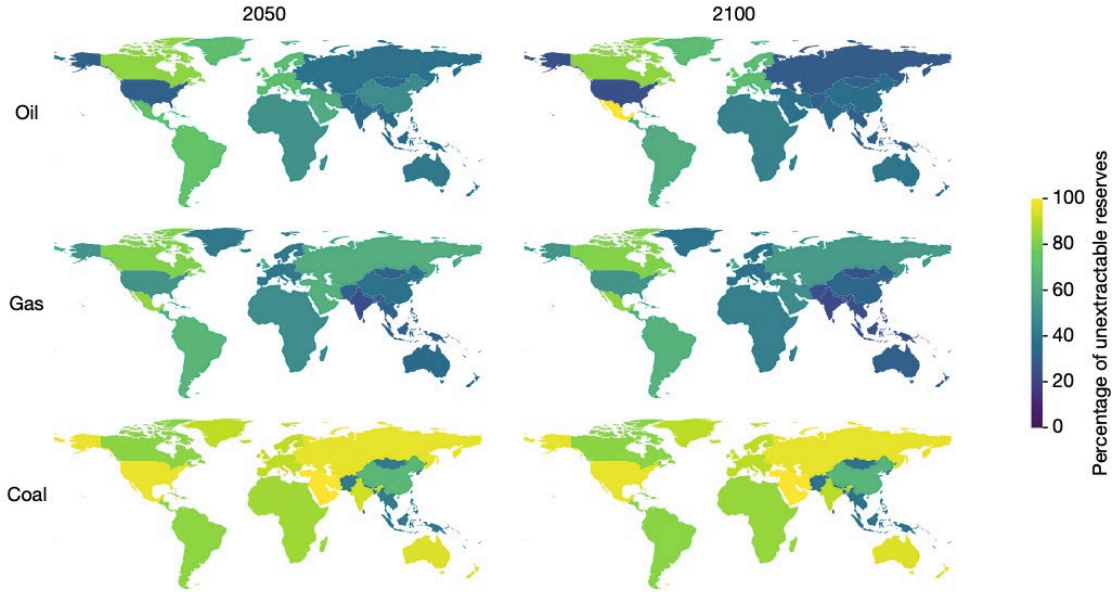
  - The United Nations' *Production Gap Report* (2020) [2] stresses that **a decrease in fossil fuel production of about 6% per year between 2020 and 2030 is necessary in order not to exceed a global warming of 1.5°C.** This gradual reduction in global fossil fuel production that would be consistent with remaining below 1.5°C or 2°C could be achieved, according to the United Nations, through a different combination of decline rates for coal, oil and gas, under different assumptions of costs and CCS dependencies.

[1] Rogelj, J., D. Shindell, K. Jiang, S. Fifita, P. Forster, V. Ginzburg, C. Handa, H. Kheshgi, S. Kobayashi, E. Kriegler, L. Mundaca, R. Séférian, and M.V.Vilariño, 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Disponible en ligne : SR15_Chapter2_Low_Res.pdf (ipcc.ch)

[2] SEI, IISD, ODI, E3G, and UNEP. (2020). The Production Gap Report: 2020 Special Report. http://productiongap.org/2020report

- The report "*Net Zero by 2050 A Roadmap for the Global Energy Sector*" published by the International Energy Agency (IEA) in May 2021 - which develops a "*net zero*" scenario (hereafter "NZE") - insists on the issues of financing and investment. It emphasizes the need to reduce annual investment in fossil fuel-based electricity supply (from an average of $575 billion/year over the last five years to $110 billion/year in 2050). **According to the IEA, investment should be limited to maintaining the production of existing oil and natural gas fields** (i.e. use in combination with CCS, for petrochemical production or in sectors where the reduction of greenhouse gas emissions is more laborious - with a 55% decrease in gas demand and 75% for oil). In addition, **beyond the projects already committed from 2021 onwards, no new oil and gas fields are approved by the IEA in this scenario** - as well as no new coal mines (or mine expansions), with a 90% decrease in coal demand by 2050 (representing then 1% of total energy consumption). Specifically, the IEA points out that "the unwavering policy focus on climate change in the net zero pathway results in a sharp decline in fossil fuel demand, meaning that the focus for oil and gas producers switches entirely to output - and emissions reductions - from the operation of existing assets." The IEA also states that "many liquefied natural gas liquefaction facilities currently under construction or in the planning stage" are incompatible with achieving carbon neutrality.

- A paper published by Welsby et al. on September 8, 2021 in the science journal Nature[3], and duplicating the work initially carried out by McGlade and Ekins (2015[4]) estimates (based on a model to assess the amount of fossil fuels to be kept in the ground at regional and global scales in order to stay within the 1.5°C warming target) that by 2050, **nearly 60% of fossil oil and gas reserves** (and 90% of coal reserves) **should be unextractable**. These results are thus higher than the available estimates of unextractability. Furthermore, the paper shows that oil and gas production is expected to decrease by 3% per year until 2050 (reaching a peak in 2021/2022 and even more so in the next decade).



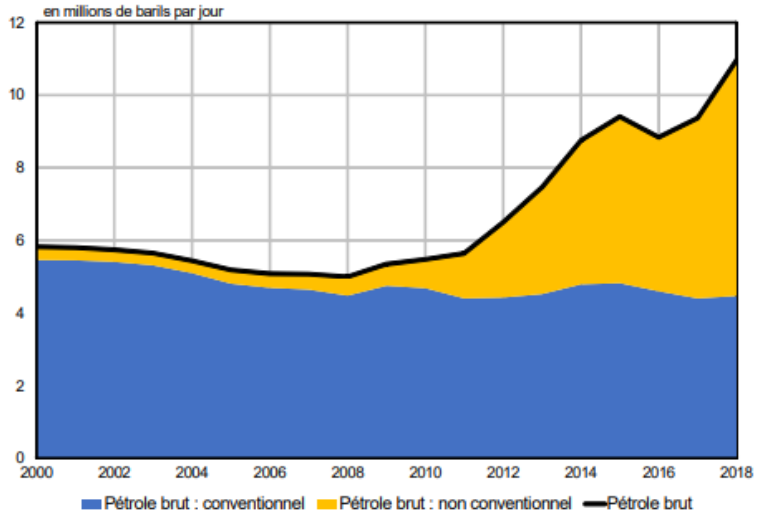
Regional distribution and percentage of non-extractable oil, gas and coal reserves (Welsby et al. 2021)

[3] Welsby, D., Price, J., Pye, S. *et al.* Unextractable fossil fuels in a 1.5 °C world. *Nature* **597,** 230–234 (2021). https://doi.org/10.1038/s41586-021-03821-8. Disponible ici : https://www.nature.com/articles/s41586-021-03821-8.pdf

[4] McGlade, Christopher, and Paul Ekins. 2015. The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2°. Nature 517 : 187–190.

The Scientific and Expert Committee focused on unconventional hydrocarbons for two main reasons:

- First, because of the **growth of the unconventional sector** in recent years[i] (although it was relatively marginal in the early 2000s), as noted by the IEA, and in particular given the supply of shale oil from the United States[ii]. Such a level of growth jeopardizes the achievement of the temperature objectives of the Paris Agreement. Out of 186.2 billion *boe* (barrel of oil equivalent) related to projects under development or under evaluation (i.e. expected to come on stream within six years at the latest), 87.4 billion - or 46.9% - come from unconventional sectors (Rystad UCube Database, May 2020).



Source : US Energy Information Administration (EIA).

Composition of US crude oil production (2000-2018) [iii]

- In his speech given on October 29, 2020 on the occasion of the Climate Finance Day, the French Minister of the Economy, Finance and Recovery stressed: "*The commitment made to stop financing the coal sector must be implemented more quickly and in a more uniform and ambitious way by all players, according to common and shared criteria.* ***This commitment must be replicated in the so-called unconventional hydrocarbons sector"***. [5]

Given the broader issues related to the growth of the oil and gas sector and the guidelines issued by organizations such as the IPCC and the IEA, the Scientific and Expert Committee will develop recommendations for the entire oil and gas sector[iv] at a later date.

2. Unconventional hydrocarbons: rationale from a climate, environmental and financial point of view

Disengagement from fossil fuels has great potential to mitigate climate change and preserve the environment. Beyond the above-mentioned energy-climate trajectories, the Scientific and Expert Committee insists on the following four elements:

▪ The carbon lock-in effect of continued investment in fossil fuel infrastructure

As a reminder, *carbon lock-in* is a particular case of path dependency which, as a "*rigid trajectory*" (Gürsan and Gooyert, 2020), favors carbon-intensive technologies and excludes other emerging technologies. Such an

[5] Finance For Tomorrow, Climate Finance Day 2020, Press release. Available online : CP-CFD-2020_VFINALE.pdf (financefortomorrow.com) ; Ministère de l'Economie, des Finances et de la Relance, Dossier de presse, Climate Finance Day. Disponible en ligne : Download (augure.com)

effect is particularly likely to take root due to high investment costs, long infrastructure lifetimes, and interrelationships between the socioeconomic and technical systems involved when it comes to fossil fuels: yet, due to the climate emergency, recalled by the IPCC Working Group I report "Climate Change 2021: The Scientific Evidence," published on August 9, 2021, the responsibility of "lock-in" is exacerbated, and characterized by both infrastructure and technological, institutional, and behavioral blockages (Seto et al. 2016[6]). A series of research papers[7] have thus highlighted the lock-in effect due to unconventional resources (particularly on the role of shale gas and shale oil), especially given the capital-intensive nature of new unconventional and offshore gas and oil developments (Erickson and Lazarus, 2015[8]).

Furthermore, in the October 2020 *World Energy Outlook*, the IEA points out that all of today's power plants, industrial facilities, buildings and vehicles will produce some level of greenhouse gas emissions in the future if they continue to rely on the ongoing combustion of fossil fuels: thus, if all of these assets (and power plants currently under construction) were operated for a similar lifetime and in a similar manner as in the past, they would continue to emit about 10 Gt CO2eq in 2050. The IEA points out that if energy infrastructures continue to operate under a "*business as usual*" scenario, they would lead to a definite temperature increase of about 1.65°C (*lock-in temperature*) by 2100.

Finally, in their paper "*Greater committed warming after accounting for the pattern effect*", Zhou et al. (2021) [9], point out that, in the absence of short-term fossil fuel emissions, short-lived aerosols and climate forcings would decline rapidly. In contrast, under a "business-as-usual" emissions trajectory, and taking into account the model effect, the best estimate of committed global warming under current forcing ranges from 1.31 K to more than 2 K (degree of climate feedback amplitude), and committed warming in 2100 with long-lived constant forcing ranges from 1.32 K to more than 1.5 K - returning to at least 2.3°C warming relative to pre-industrial levels by 2100.

- **The CO2eq content of unconventional fossil fuels (especially methane)**

The scientific literature on the CO2eq content of unconventional energies - in particular in relation to conventional energies - includes a number of papers with varying results, due to the diversity of extraction techniques and geological structures involved around the world. Nevertheless, these papers highlight - especially concerning oil and gas production by hydraulic fracturing - the greater impact of these hydrocarbons in terms of greenhouse gas emissions (and methane in particular[10]), compared to their conventional counterparts[11]. For example, greenhouse gas emissions from shale gas are about 11% higher than those from

[6] Seto Karen C., Steven J. Davis, Ronald B. Mitchell, Eleanor C. Stokes, Gregory Unruh, and Diana Urge-Vorsatz, Carbon Lock-In: Types, Causes, and Policy Implications, Annu. Rev. Environ. Resour. 2016. 41:425–52; G.C. Unruh Understanding carbon lock-in, vol. 28 (2000); D. Arent, J. Logan, J. Macknick, W. Boyd, K. Medlock, F. O'Sullivan, **et al.** A review of water and greenhouse gas impacts of unconventional natural gas development in the United States**,** MRS Energy Sustain, 2 (2015)

[7] C. Gürsan, V. de Gooyert, The systemic impact of a transition fuel: Does natural gas help or hinder the energy transition? Renewable and Sustainable Energy Reviews, Volume 138, 2021; Smith, C.J., Forster, P.M., Allen, M. et al. Current fossil fuel infrastructure does not yet commit us to 1.5 °C warming. Nat Commun 10, 101 (2019); Jérôme Hilaire, Nico Bauer, Elmar Kriegler, Lavinia Baumstark, Achieving the 2°C target will not be facilitated by relying on a global abundance of natural gas, Potsdam Institute for Climate Impact Research Bertram C. et al (2014) "Carbon lock-in through capital stock inertia associated with weak near-term climate policies". Technological Forecasting and Social Change 90, Part A:62–72. doi: 10.1016/j.techfore.2013.10.001
Jacoby H. et al (2012) "The Influence of Shale Gas on U.S. Energy and Environmental Policy" Economics of Energy and Environmental Policy, 1, 1. doi:10.5547/2160-5890.1.1.5; Shearer C. et al (2014). The effect of natural gas supply on US renewable energy and CO_2 emissions, Environmental Research Letters 9, (2014)

[8] Erickson P. and Lazarus M., Carbon lock-in from fossil fuel supply infrastructure, Stockholm Environment Institute, Discussion Brief, October 2015.

[9] Zhou, C., Zelinka, M.D., Dessler, A.E. et al. Greater committed warming after accounting for the pattern effect. Nat. Clim. Change. (2021). The paper focuses on the "pattern effect" and recalls the key role of the lack of spatial homogeneity of sea surface temperature and sea ice changes in climate projections..

[10] Lassey, Keith & Etheridge, David & Lowe, D. & Smith, A. & Ferretti, D.. (2006). Centennial evolution of the atmospheric methane budget: What do the carbon isotopes tell us? Atmospheric Chemistry and Physics Discussions. 7. 10.5194/acp-7-2119-2007.

[11] Howarth R., Santoro R., Ingraffea A., Methane and the greenhouse-gas footprint of natural gas from shale formations, Climatic Change, June 2011, DOI: 10.1007/s10584-011-0061-5.

conventional gas[12]. Also, the literature shows that this impact is mainly due to extraction techniques, and not to the initial CO2eq content - and methane in particular - of these hydrocarbons[13] (see pp. 13-14 of this report for more information).

- **The health and environmental effects of unconventional energy**

Unconventional hydrocarbons also pose various risks to public health (Kaden and Rose, 2015[14]) as well as to the achievement of environmental goals, particularly in terms of protecting biodiversity and reducing the land footprint of energy activities (Popescu et al. 2020)[15].

- **A transition risk management issue for financial market participants**

The Scientific and Expert Committee emphasizes the **key role of the financial sector in the transition of the oil and gas industry**, as recalled by the IEA in its *World Energy Outlook* of October 2020: "*The finance sector will need to facilitate a dramatic scale up of clean technologies, aid the transitions of fossil fuel companies and energy-intensive businesses, and bring low-cost capital to the countries and communities that need it most*" and by recent literature[16]. Plantinga and Scholtens (2020)[v] have also shown that divestment from fossil fuels would not significantly harm the financial performance of the industry, and therefore would not conflict with the fiduciary duty of investors.

Above all, the Scientific and Expert Committee insists on the issue of **risk management for financial market participants that constitutes the effective financing of the industry's transition**, as recalled by the abundant literature on *stranded assets*, including on the stock of assets (McGlade and Ekisn, 2015[17]; OECD, 2021[18]).

3. Challenges and difficulties in developing recommendations on unconventional hydrocarbon sectoral policies and associated indicators

[12] Nathan Hultman, Dylan Rebois, Michael Scholten and Christopher Ramig, The greenhouse impact of unconventional gas for electricity generation, 2011 Environ. Res. Lett. 6 044008; Carnegie Endowement for International Peace, The Carbon Content in Global Oils, 18 December 2012.

[13] Marshall N., Maddox R., Rojey A. Natural gas: production, processing, transport, Paris, 1997; Azis Yudhowijoyo, Roozbeh Rafati, Amin Sharifi Haddad, Moiz Shahid Raja, Hossein Hamidi, Subsurface methane leakage in unconventional shale gas reservoirs: A review of leakage pathways and current sealing techniques, Journal of Natural Gas Science and Engineering, Volume 54, 2018, pages 309-319, ISSN 1875-5100; Alvarez, R. A., S. W. Pacala, J. J. Winebrake, W. L. Chameides, and S. P. Hamburg. 'Greater Focus Needed on Methane Leakage from Natural Gas Infrastructure'. Proceedings of the National Academy of Sciences 109, no. 17 (9 April 2012); MacKay, D. J. C. & Stone, T. J. Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use. (2013). Voir aussi: Stephen Leahy, Fracking boom tied to methane spike in Earth's atmosphere, National Geographic, 15 August 2019; Benjamin Storrow, Methane Leaks Erase Some of the Climate Benefits of Natural Gas, Scientific American, 5 May 2020.

[14] Kaden, Debra & Rose, T. (2015). Environmental and Health Issues in Unconventional Oil and Gas Development. Voir aussi: Srebotnjak T., Human Health Risks of Unconventional Oil and Gas Development Using Hydraulic Fracturing, *Open access peer-reviewed chapter*, 2018, DOI: 10.5772/intechopen.82479; Alan J. Krupnick and Isabel Echarte, Health Impacts of Unconventional Oil and Gas Development, *Resources for the Future*, June 2017; Lelieveld J. et al., Effects of fossil fuel and total anthropogenic emission removal on public health and climate, Proceedings of the National Academy of Sciences Apr 2019, 116 (15) 7192-7197; DOI: 10.1073/pnas.1819989116

[15] Popescu, V.D., Munshaw, R.G., Shackelford, N. *et al.* Quantifying biodiversity trade-offs in the face of widespread renewable and unconventional energy development. *Sci Rep* 10, 7603 (2020). Voir aussi: Dirzo, R. *et al.* Defaunation in the Anthropocene. *Sci.* 345, 401–406 (2014); Jones, N. F., Pejchar, L. & Kiesecker, J. M. The Energy Footprint: How Oil, Natural Gas, and Wind Energy Affect Land for Biodiversity and the Flow of Ecosystem Services. *Bioscience* 65, 290–301 (2015); Souther, S. *et al.* Biotic impacts of energy development from shale: research priorities and knowledge gaps. *Front. Ecol. Environ.* 12, 330–338 (2014) ; Harfoot M. et al., Present and future biodiversity risks from fossil fuel exploitation, Conservation Letters, Society for Conservation Biology, Volume 11, Issue 4, July/August 2018, e12448

[16] Cojoianu, Theodor and Ascui, Francisco and Clark, Gordon L. and Hoepner, Andreas G. F. and Wojcik, Dariusz, Does the Fossil Fuel Divestment Movement Impact New Oil & Gas Fundraising? (April 22, 2019). Forthcoming in Journal of Economic Geography, Available at SSRN: https://ssrn.com/abstract=3376183 or http://dx.doi.org/10.2139/ssrn.3376183; Zhou X. et al., The energy transition and changing financing costs, Oxford Sustainable Finance Program, April 2021.

[17] Ibid.

[18] OCDE, Transition finance: Investigating the state of play: A stocktake of emerging approaches and financial instruments, *OECD Environment Working Papers* No. 179, July 2021.

This topic nevertheless raises key difficulties, which the Scientific and Expert Committee has taken fully into account in its work, and which play a critical role in the nature of the recommendations detailed below:

- Without providing a precise *ad hoc* overview of the industry in this report, the Committee recalls the difficulties associated with the organization of the industry, both in terms of players (including, regarding the upstream segment for example, small independent operators coexisting with large traditional producers (*the majors*), whose projects are more capital-intensive) and in geographical terms.

  A distinction can be made between the majors[vi] (sometimes referred to as "*international oil companies*"), which are integrated companies (most often listed) whose *upstream* division accounts for the majority of their financial value[vii] (IEA, 2017[19]); and the independents ("juniors"), which are integrated companies similar to the majors but smaller in size, or independent *upstream* operators, who generally focus on assets that are less attractive to the majors (e.g. medium-sized fields in decline or border areas[viii]). Other types of players play a key role, such as engineering services companies specializing in drilling, reservoir management and infrastructure construction; midstream and *downstream*[ix] companies operating refineries and distribution networks; and trading companies[x].

  The highly fragmented nature of the oil and gas industry, combined with the heterogeneity of the technologies and types of non-conventional energies involved, as well as the end uses of these energies (i.e., the economy's dependence on fossil fuels, including non-coal (IEA, 2020)), require a different analysis than that used for the coal industry in the Committee's above-mentioned February recommendations.

  The Scientific and Expert Committee has therefore based its work on the energy-climate trajectories detailed above, while giving substantial weight to ambitious support for the industry's transition, particularly in its *upstream* segment (especially for the majors, where unconventional energies sometimes play a key role in financing the transition).

- The Scientific and Expert Committee also points out the difficulties associated with the **availability of data on the distinction between conventional and unconventional energies**, due to the lack of distinction from an accounting point of view (for example, in view of IFRS 8), which does not necessarily allow for the monitoring of financial results by geological type of production.

- Finally, the Scientific and Expert Committee notes **the challenges of identifying and acting beyond the perimeter of the value chain of companies** (particularly as far as the majors are concerned), leading to methodological difficulties in calculating the tax base.

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In addition to an extensive review of the literature and internal exchanges, the Scientific and Expert Committee's methodological approach consisted of conducting a series of hearings in the spring of 2021 with the oil and gas industry (Total, in particular), the banking and financial industry in the Paris marketplace, the International Energy Agency, the French Environment and Energy Management Agency, the French Central Bank, Kayrros, the European Commission, the banking and financial industry in Paris, the NGO Oil & Change International, the NGO Urgewald, Trucost-S&P and counsel Olivier Laffitte.

[19] AIE, The Oil and Gas Industry in Energy Transition, 2017. Disponible en ligne: The Oil and Gas Industry in Energy Transitions (windows.net)

Following an approach based on the methodological principles of comparability, replicability, exhaustiveness and reliability, the Scientific and Expert Committee issues a series of four recommendations to the professional federations in the context of the publication of harmonized data relating to the exit of unconventional hydrocarbons[xi] (which it will ensure to specify as much as necessary, particularly on the methodological level, in its subsequent discussions with the federations). It should be noted that the nature of the recommendations is twofold, addressed to (i) the financial industry *via* the federations of the Paris financial center; and (ii) the Sustainable Finance Observatory (see the "indicators" box for each recommendation).

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PART 1 - DEFINITION OF UNCONVENTIONAL HYDROCARBONS

The Scientific and Expert Committee, based on the revised literature and internal discussions, insists on the need to adopt a homogeneous definition for unconventional hydrocarbons, particularly in view of the significant divergences noted within existing policies.

In this sense, the Scientific and Expert Committee recommends, first, to rely on the geological characteristics of hydrocarbon reservoirs (i.e., viscosity and permeability of the reservoirs), retaining as "unconventional" the following hydrocarbons: [20xii]

- Coal bed methane (CBM) ;
- Tight oil and gas ;
- Oil shale/shale oil ;
- Shale gas and oil ;
- Oil from tar sands (oil sand);
- Extra heavy oil[xiii].

Methane hydrates (gas hydrates) can also be included in this classification (Rajput and Thakur, 2016[21]).

By extension, and taking into account criteria often found in the literature, relating to the additional investments required to extract these hydrocarbons (Soliman and Yassin, 2015[22] ; Chew, 2013[23]) as well as the consequences they have on the preservation of ecosystem services[24], including climate (Wookey, 2007[25] ; Palosaari, 2020[26]), the Scientific and Expert Committee recommends that two additional categories be retained in this definition:

- Ultra-deepwater offshore oil and gas[xiv] ;
- Fossil oil and gas resources in the Arctic.

[20] Wang H., Ma F., Tong X ., Liu Z., Zhang X., Wu Z., Li D., Wang B., Xie Y., Yang L., Assessment of global unconventional oil and gas resources, Petroleum Exploration and Development, Volume 43, Issue 6, 2016, Pages 925-940. Available online : Assessment of global unconventional oil and gas resources - ScienceDirect
Zou C., Chapter 2 - Meaning of Unconventional Petroleum Geology, Unconventional Petroleum Geology (Second Edition), 2017, Pages 49-95. Disponible en ligne : Meaning of Unconventional Petroleum Geology - ScienceDirect
[21] Rajput S., Thakur N. K., Geological Controls for Gas Hydrate Formations and Unconventionals, 2016. . Available online : Geological Controls for Gas Hydrates and Unconventionals | ScienceDirect
[22] Soliman A. and Yassin M., Unconventional Reservoir: Definitions, Types and Egypt's Potential, Technical Report · December 2015
[23] Chew KJ. The future of oil: unconventional fossil fuels. Philos Trans A Math Phys Eng Sci. 2013 Dec 2
[24] Froger G. *et al*., Regards croisés de l'économie sur les services écosystémiques et environnementaux, Vertigo, Volume 12, Issue 3. Décembre 2012
[25] Wookey P., Climate change and biodiversity in the Arctic—Nordic perspectives, Polar Research, Volume 26, Issue 2, pages 96-103, September 2007. Voir aussi: Johnson, C. J. *et al*. Cumulative effects of human developments on Arctic wildlife. *Wildl. Monogr.* 1–36 (2005)
[26] Palosaari T., "Climate Change Ethics in the Arctic", *in* L. Heininen and H. Exner-Pirot (eds.), Climate Change and Arctic Security, July 2019 (. Available online : https://doi.org/10.1007/978-3-030-20230-9_4)

However, a certain precaution must be taken, insofar as, according to the U.S. Energy Information Administration, the scope of the definition of unconventional hydrocarbons is *de facto* subject to change :

"What has qualified as "unconventional" at any particular time is a complex interactive function of resource characteristics, the available exploration and production technologies, the current economic environment, and the scale, frequency, and duration of production from the resource. Perceptions of these factors inevitably change over time and they often differ among users of the term "[27].

Regarding the definition of the Arctic, the Scientific and Expert Committee adopts that of the Arctic Monitoring and Assessment Program:

"Land and sea areas north of the Arctic Circle (66°32'N), as well as north of [parallel] 62°N in Asia and north of [parallel] 60°N in North America, modified to include the maritime space north of the Aleutian chain, Hudson Bay, and parts of the North Atlantic Ocean including the Labrador Sea. "[28].

Source: AMAP, *Geographical Coverage*, 1998 Assessment Report

[27] US Energy Information Administration, Glossary. Disponible en ligne : Glossary - U.S. Energy Information Administration (EIA)
[28] Arctic Monitoring and Assessment, 1998 Assessment report, Chapter 2 "Physical/Geographical Characteristics of the Arctic". . Available online : Geographical Coverage | AMAP

Recommendation No. 1

- The Scientific and Expert Committee recommends that the Paris financial center adopt a **homogeneous definition of unconventional hydrocarbons based on geological and ecosystem service preservation characteristics**, including layer gas or coal gas; tight oil and gas; shale and shale oil; oil sand gas and oil ; extra-heavy oil; methane hydrates; ultra-deepwater[xv] offshore oil and gas[xv] and Arctic oil and gas fossil resources.

  More broadly, the Scientific and Expert Committee recommends expanding the scope of recommendations to include extraction in areas of very high biodiversity impact, including at a minimum ultra-deepwater offshore oil and gas, and Arctic oil and gas.

  The Scientific and Expert Committee proposes to further detail this recommendation in the coming months - these very high-impact areas may potentially go beyond the two categories mentioned above.

- The Scientific and Expert Committee recommends applying the definition of the Arctic retained by the Arctic Monitoring and Assessment Program.

Proposed "Observatory" indicators

- In the short-term (2021-2022): Aggregate measure of the share of the entity's assets under management or balance sheet associated with unconventional hydrocarbons, over a minimum two-year history, as well as the associated absolute amount.

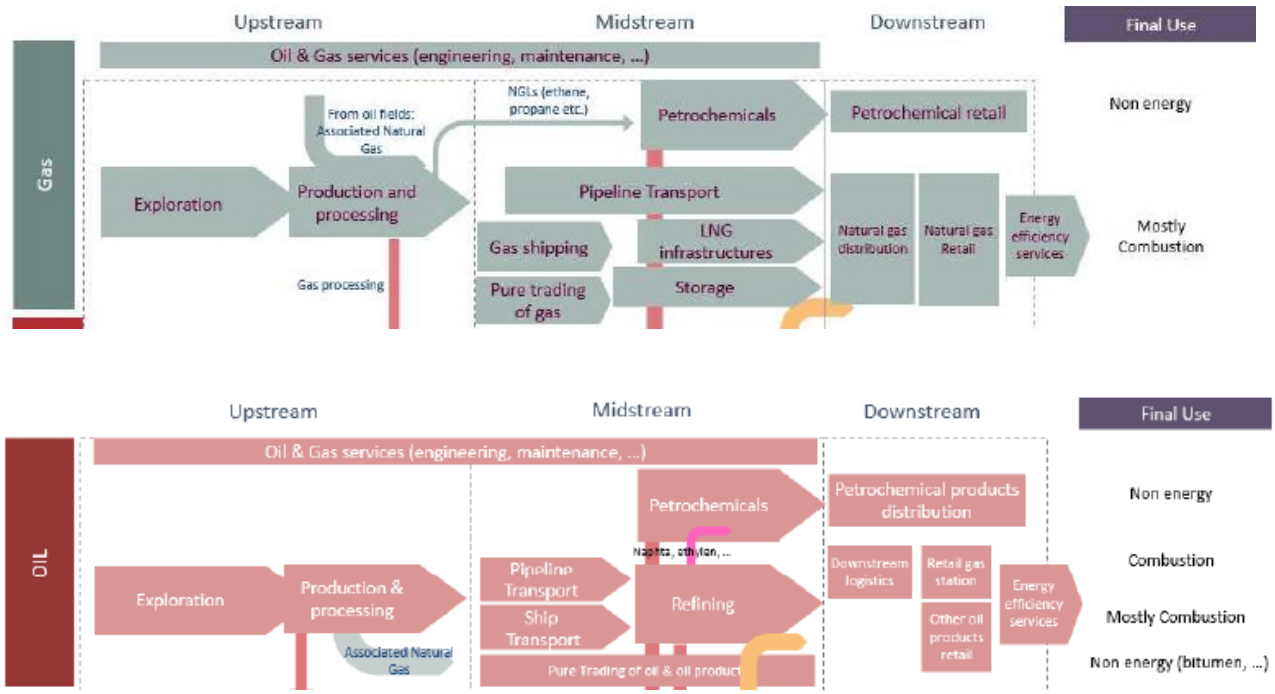
- In the medium term (from 2023-2024), and consistent with publicly available data (in particular the *Global Oil & Gas Exit List* published by Urgewald by end of 2021): Measurement of estimated exposure by type of unconventional hydrocarbon (at a minimum shale gas and oil; tar sands; methane hydrates; ultra-deep offshore oil and gas; Arctic oil and gas resources).

  This estimate should be made on flows and stocks, differentiating between dedicated and corporate financial services for credit institutions, and highlighting development exposure (and, to the extent possible, the distinction between greenfield and brownfield). The methodology underlying the exposure estimate must be explained, as well as the assumptions used (e.g. distribution keys, etc.).

  The Scientific and Expert Committee recommends that the financial community harmonize its reporting based on these indicators and a common database.

PART 2 - SCOPE OF THE VALUE CHAIN

The Scientific and Expert Committee underlines the fundamental nature of a common understanding of the Oil & Gas industry value chain by the market. Oil & Gas activities can be divided into three main segments of the value chain: upstream, midstream and downstream. Although the Oil & Gas value chains include similar upstream activities, their midstream and downstream activities are significantly different: therefore, the types of activities in the downstream segments must be analyzed separately for Oil & Gas.



Source : ADEME, Assessing the Low-Carbon Transition – Oil & Gas, Version 2.0, February 2021.

Recommendation No. 2

- The Scientific and Expert Committee recommends adopting a homogeneous definition of the unconventional oil and gas value chain, based on the definition adopted by ADEME in the methodology "Assessing the Low-Carbon Transition" (2021) [29].

- The Scientific and Expert Committee recommends defining the "significant" character of the attribution of a link in the chain to unconventional hydrocarbons according to its place in said chain:
  - For the *upstream* segment, as a percentage of reserves and production ;
  - For the *midstream* and *downstream* segments, as a percentage of revenues (this indicator is retained for reasons of data availability and given industrial practices that do not necessarily allow for a clear distinction between conventional and unconventional in the volumes of hydrocarbons involved).

PART 3 - SUPPORTING THE TRANSITION

The Scientific and Expert Committee recognizes the fundamental role of the financial sector in supporting the transition for players in the Oil & Gas sector for which the sectoral exclusion policies are not directly relevant (in particular because of their diversification).

[29] ADEME, Oil & Gas Methodology, 2021. .Available online : https://actinitiative.org/publications/

Recommendation No. 3

In addition to the good industrial practices usually encouraged by financial market participants at this stage (i.e. encouraging the implementation of good practices through the support of international initiatives, such as the Extractive Industries Transparency Initiative), the Scientific and Expert Committee recommends the rapid implementation of a market consensus on a common standard of good industrial practices to be required from their counterparts within the framework of a dedicated sectoral policy.

This set of good industrial practices could be structured around three axes:

3.1. STOPPING DEVELOPMENT IN NON-CONVENTIONAL SECTORS

In order to align with the scientific imperative to stop all new fossil fuel projects and to support the transformation and decarbonization of the entire fossil fuel industry, the Scientific and Expert Committee recommends as part of the implementation of the sectoral policy, the immediate adoption of specific requests and guidelines for companies active in oil and gas production, aimed at divesting their *(i)* holdings in specialized players active in the development of unconventional energies; *(ii)* interests in the development of blocks[xvi] and hydrocarbon fields; and *(iii)* interests in the development of production licenses. Such requirements should be accompanied by robust and regular monitoring, at the risk of being subject to an exclusionary mechanism.

In terms of reporting, such policies would be fully consistent with the provisions of Decree no. 2021-663 of May 27, 2021 issued in application of Article L. 533-22-1 of the French Monetary and Financial Code, in particular those relating to the publication of the "fossil" portion of portfolios, the establishment of a strategy for alignment with the Paris Agreement[xvii], the assessment of the voting policy (in particular in terms of sectoral disengagement) and the publication of a continuous improvement plan.

3.2. MEASURING AND REDUCING THE SECTOR'S GREENHOUSE GAS EMISSIONS (CO2 EQUIVALENT)

The Scientific and Expert Committee recommends the adoption by the Paris financial center of a common standard for the monitoring, measurement and reduction of $CO2_{eq}$ emissions from the Oil & Gas sector, in line with a goal of carbon neutrality for all activities by 2050. This standard should include a role for capture, storage and utilization (CCS/CCU[30]) technologies, distinguishing them from nature-based and offset solutions.

More specifically, the Scientific and Expert Committee recommends that financial market participants:

- To require in their policies that their clients systematically measure (and not estimate) CO2 emissions over the entire value chain (not just covering the upstream segment) and over all of their assets (not just covering operated assets[xviii]), based on the absolute $CO2_{eq}$ emissions on scopes 1, 2 and 3 (tons of CO2 eq.);
- To detail in their policy the application of possible financial penalties and/or a progressive exclusion scheme for industry players not meeting the following criteria:
    - A quantified commitment to an annual reduction in absolute $CO2_{eq}$ emissions on scopes 1, 2 and 3 (with priority given to scope 1 and downstream scope 3), aligned with a goal of carbon neutrality by 2050[xix] - i.e., a reduction of about 40% between 2020 and 2030[xx] ;

[30] IEA, Special Report on Carbon Capture Utilisation and Storage, Septembre 2020. Disponible en ligne : https://www.iea.org/reports/ccus-in-clean-energy-transitions/a-new-era-for-ccus#abstract

- A commitment to an annual reduction in CO2 emissions intensity on scopes 1 and 2 (ton of CO2 per barrel of oil equivalent). [xxi]

3.3. MEASUREMENT AND REDUCTION OF METHANE EMISSIONS AND TORCHING FROM THE SECTOR

The Committee recommends the adoption by the Paris financial center of a common standard regarding the monitoring, measurement and reduction of methane emissions from the Oil & Gas sector.

It should be noted that methane emissions are included, for the most part, in the measurement of $CO2_{eq}$ scope 1 emissions, as mentioned above. However, in view of their critical nature, the Scientific and Expert Committee recommends that the Paris financial center adopt a series of specific commitments on the subject.

Given the availability of remote sensing measurement technology and the technical capacity to rapidly reduce a majority of these emissions, the Scientific and Expert Committee recommends that the Paris financial center be eminently ambitious on this issue.

The reduction of methane emissions by the sector concerns in particular :

⇨ Prevention of fugitive emissions, i.e. (i) systematic early maintenance of production sites to prevent methane leaks; and (ii) replacement and repair of obsolete equipment (including, but not limited to, pneumatic controllers and storage tanks);

⇨ Prohibition of deleterious industrial practices, i.e. (i) methane venting; and (ii) routine flaring (or recurrent flaring).

More specifically, the Scientific and Expert Committee recommends that financial market participants:

⇨ To require in their policy the implementation by their Oil & Gas clients of the systematic measurement by an independent remote sensing system[xxii] of methane and flaring emissions over the entire value chain (not covering only the upstream) and over all their assets (not covering only operated assets), based on the following indicators:

- Identification of "super-emitters" (*emissions volume greater than 1T CH4/hr*);
- Flaring volume by area (*millions of cubic meters per year);*
- Flaring intensity by area (*cubic meters per barrel of oil equivalent*), to be compared with an average intensity by area in order to take into account the diversity of geological characteristics of the basins;
- Methane volume by area (*tons of methane*);
- Methane intensity by area (*kg of methane emitted per barrel of oil equivalent*) to be compared with an average intensity by area to account for the diversity of geological characteristics of basins.

⇨ To require in their policy the implementation by their customers, on all of their assets (not just covering operated assets), of systematic early maintenance of production sites - in order to prevent methane leaks - and of systematic replacement and repair of equipment throughout the value chain;

⇨ To detail in their policy the application of possible financial penalties and/or a progressive exclusion scheme for industry players who do not comply with the following criteria:

- Removal of "super-emitters" in the short, or even very short, term;
- Reduction of methane emissions in the order of 75% between 2020 and 2030[xxiii];
- Annual flaring emissions reduction targets;
- Methane and flaring intensity by area systematically below the regional (or extraction basin) average methane and flaring intensity.

Recommendations 3.1 and 3.2 apply to the unconventional sector but can be applied to the entire Oil & Gas sector without being limited to the unconventional energy perimeter (as defined by recommendation n°1).

Proposed "Observatory" indicators

This proposal is part of a more general approach to transparency for market participants of the sector on the list required to check in their policies.

The indicators are the essential elements of such a checklist, based on the following four elements: (i) the application of good industrial practices (beyond encouraging and joining *ad hoc* initiatives) and in line with recommendation n°3); (ii) an investment plan on upgrading the company's activities within a period of five to ten years (in line with the delegated act under article 8 of the EU/2020/852 EU Regulation known as "Taxonomy") ; (iii) the regular revision of the policy in line with developments - particularly technological developments - in the sector; and (iv) the effective application of the accompanying measures detailed in the policy (i. (i.e. application of financial penalties; progressive exclusion mechanism; etc.).

In particular, the key indicators to be published are:

- Implementation of an obligation to measure CO_2 emissions by an independent body for players in the Oil & Gas sector;
- Implementation of an annual quantified obligation to achieve absolute reductions in CO_2 emissions on scopes 1, 2 and 3;
- Implementation of an obligation to measure methane and flaring emissions by an independent remote sensing system for players in the Oil & Gas sector;
- Implementation of an obligation for systematic early maintenance of production sites to prevent methane leaks, and for systematic replacement and repair of obsolete equipment throughout the value chain;
- Implementation of an annual quantified obligation in line with a reduction in methane emissions of around 75% between 2020 and 2030 ;
- Implementation of an annual quantified obligation to reduce flaring emissions;
- Implementation of an obligation to maintain flaring and methane intensity by area below regional average intensities (or by extraction basin).

Role of methane emissions in radiative forcing - and therefore on global warming[xxiv]

- Methane (CH_4) is one of six greenhouse gases[xxv], whose emissions must be reduced under the Kyoto Protocol.
- Methane emissions contribute, along with nitrous oxide, aerosol, soot carbon, and other anthropogenic forcing factors, to the net radiative forcing other than that due to CO_2[xxvi]. Yet it is the changes in atmospheric CO_2 concentration and other radiative forcing factors that determine changes in global average surface temperature. [31]

[31] IPCC, IPCC Special Report on the Implications of Global Warming of 1.5°C above Preindustrial Levels and Associated Global Greenhouse Gas Emission Trajectories in the Context of Strengthening the Global Response to Climate Change, Sustainable Development and Poverty Alleviation, 2019 Available online : IPCC-Special-Report-1.5-SPM_fr.pdf (eelv.fr)

- Thus, although CO_2 is central to long-term temperature rise, decreasing short-lived climate forcing factors that induce warming (including methane) is of major importance in containing warming to 1.5°C relative to pre-industrial levels[32].
- Moreover, as a gas with a very high energy absorption capacity, the global warming potential (GWP in CO_{2eq}[xxvii]) of methane is between 84 and 87 over a twenty-year period, and between 28 and 36 over a 100-year period[33]. This is equivalent to considering that methane has a global warming potential about 84 times that of CO_2 on a 20-year scale. In addition to its effects on climate, methane also affects air quality - as it participates in the formation of ground-level ozone, a dangerous air pollutant.

Methane's multiplier effect on the climate impact of hydrocarbons

- The Global Methane Budget's multi-sectoral estimate, estimates that annual global methane emissions between 2008 and 2017 were 576 $TgCH_4$/year (million tons per year), comprising both natural (38%) and anthropogenic (62%) emissions. The main source of anthropogenic emissions is agriculture (25%), followed by the energy sector (43.1 $TgCH_4$/year for emissions from natural gas, 40.5 $TgCH_4$/year for coal, 29 TgCH4/year for oil, and 10 $TgCH_4$/year for biofuels) [xxviii].
- Methane emissions from the Oil & Gas sector come from the entire conventional and unconventional hydrocarbon value chain. They depend on the geology of the sites where they are located and the industrial practices of the operators.
- These emissions can be accidental, due to maintenance defects or obsolete equipment, or deliberate, due to operational flaring[xxix] or release[xxx34]. practices. The Oil & Gas Methane Partnership (OGMP) identifies nine key sources of emissions among its members, placing obsolescent pneumatic controllers as the number one source. [xxxi] A study in the United States[35] further demonstrated that leaks associated with pneumatic controllers and storage tanks are responsible for almost half of the methane emissions associated with hydrocarbon production.
- The main constituent of natural gas, methane is present in all hydrocarbon fuels. Methane emissions thus add to CO_2 emissions when hydrocarbons are burned and can increase the climate impact by up to 45% in the case of oil, and up to 100% for gas.[xxxii]
- The IEA estimates that it is technically feasible to remove 75% of the sector's methane emissions, with the profitability to industry of these emission reductions dependent on fluctuating methane prices (given that methane has a commercial value) [36].

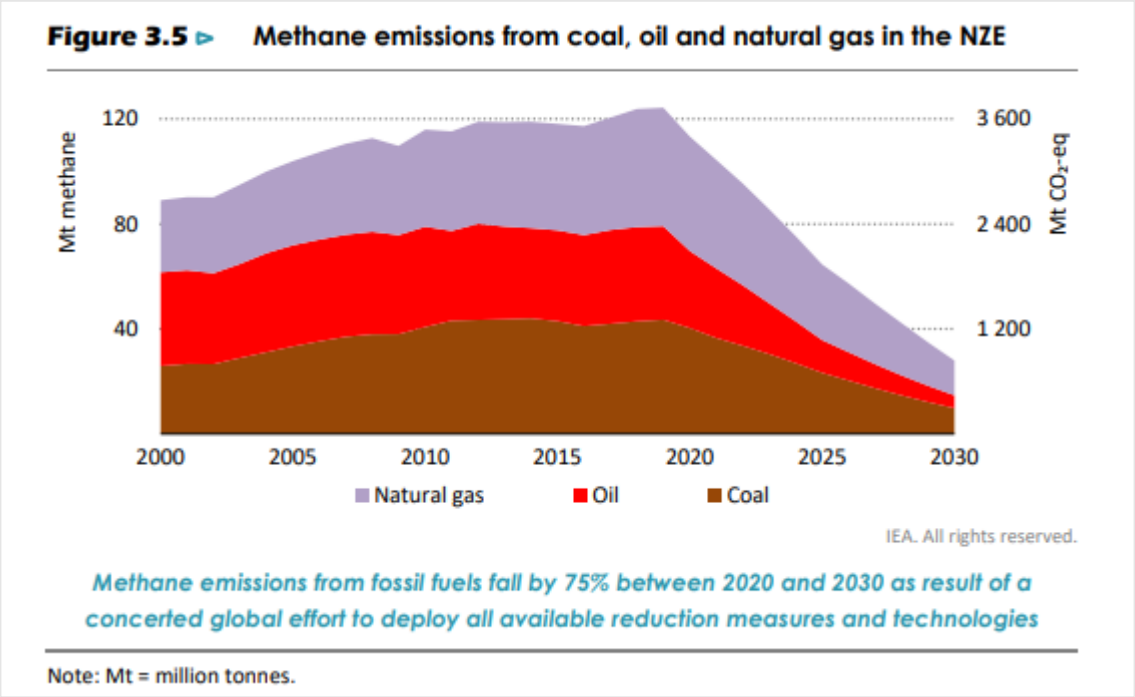
[32] GIEC, Rapport spécial du GIEC sur les conséquences d'un réchauffement planétaire de 1,5 °C par rapport aux niveaux préindustriels et les trajectoires associées d'émissions mondiales de gaz à effet de serre dans le contexte du renforcement de la parade mondiale au changement climatique, du développement durable et de la lutte contre la pauvreté, 2019. . Available online : IPCC-Special-Report-1.5-SPM_fr.pdf (eelv.fr)

[33] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang., Anthropogenic and Natural Radiative Forcing, 2013, p174. . Available online : WG1AR5_Chapter08_FINAL.pdf (ipcc.ch)

[34] EA, Methane Tracker 2021. . Available online : Methane and climate change – Methane Tracker 2021 – Analysis - IEA

[35] J. S. Rutherford, E. D Sherwin, A. P Ravikumar, G. A Heath, J. Englander, D. Cooley , David Lyon , Mark Omara , Quinn Langfitt , Adam R Brandt, Closing the gap: Explaining persistent underestimation by US oil and natural gas production-segment methane inventories, 2020. . Available online : https://eartharxiv.org/repository/view/1793/

[36] IEA, Methane Emissions from Oil and Gas, 2020. Disponible en ligne: Methane Emissions from Oil and Gas – Analysis - IEA



Source: IEA, *Net Zero by 2050 – A roadmap for the global energy sector*, Flagship report, May 2021

- The IEA ranks methane emission reductions from the oil and gas industry as one of the most cost-effective measures to combat climate change (average mitigation cost of $3/mmBtu (*million British thermal unit)* of methane removed) [37]

The evolution of good industry practices and regulations

- As part of the EU Methane Strategy adopted in October 2020, the European Commission is developing a legislative proposal (regulation) to prevent methane leakage in the energy sector, which is expected to be adopted in the course of 2021[38]. It will include binding rules on monitoring, reporting, verification, detection and repair of leaks in the energy sector and will consider rules on venting and routine flaring. The European Commission distinguishes between prescriptive standards (Measurement and Monitoring, Reporting and Verification (MRV), Leak Detection and Repair (LDAR), restriction on venting and flaring) and performance standards (mandatory performance standard for regulated entities, e.g., targets set at the individual company level for a specific piece of equipment or facility or flaring efficiency, but do not dictate how the target is to be achieved). [39]

- While prescriptive methane reduction measures adopted over the past decade have so far failed to significantly reduce methane emissions from the oil and gas sector as a whole due to a lack of adequate detection and measurement technology. Remote sensing technologies are now the basis for effective regulation (technical advances in the detection, measurement and attribution of methane emissions, particularly measurement technologies based on the Sentinel satellites of ESA's Copernicus program)

[37] IEA, Driving Down Methane Leaks from the Oil and Gas Industry: A Regulatory Roadmap and Toolkit, January 2021. Disponible en ligne : https://www.iea.org/reports/driving-down-methane-leaks-from-the-oil-and-gas-industry

[38] Commission Européenne, Communication de la commission au parlement européen, au Conseil, au comité économique et social européen et au comité des régions sur une stratégie de l'UE pour réduire les émissions de méthane, 2020. Disponible en ligne : https://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:52020DC0663&from=EN

[39] Commission européenne, Public consultation on future EU rules for reducing methane emissions in the energy sector, 2021. Disponible en ligne: Public consultation on future EU rules for reducing methane emissions in the energy sector | European Commission (europa.eu)

and will make it possible to improve the relevance of prescriptive measures and performance standards.

PART 4 - PLACE OF EXCLUSION IN SECTORAL POLICIES

Recommendation No. 4

The Scientific and Expert Committee focused initially on banking institutions - the remainder of the recommendation concerns the portfolio management business. The Committee proposes to further detail this recommendation in the coming months for the insurance sector (liability side).

The Scientific and Expert Committee adopts a two-pronged approach in its recommendations on the exclusion policy for financial services and products dedicated to unconventional hydrocarbons, depending on the type of financial services concerned.

A. EXCLUSION OF PROJECT-DEDICATED FINANCIAL SERVICES

The Scientific and Expert Committee recommends that sectoral policies provide for the exclusion of:

- Exploration and production of unconventional oil and gas resources (*upstream*);
- Transportation infrastructure significantly dedicated to the transportation of unconventional oil or gas; and infrastructure primarily dedicated to the storage of unconventional oil and gas (*midstream*) ;
- Liquefied natural gas export terminals supplied by a significant volume of unconventional gas (*midstream*);
- Expansion projects (*brownfield* or *greenfield*) of unconventional hydrocarbons, in line with the IEA's NZE scenario, which emphasizes the need to halt the expansion of new oil and gas fields.

Given the characteristics of the unconventional oil and gas value chain, which make it difficult to identify the midstream and downstream segments, the Scientific and Expert Committee recommends focusing policies, in a first phase, on the upstream segment.

The Scientific and Expert Committee considers that a more detailed knowledge and visibility on the state of the market is necessary ("primary data") before determining exclusion thresholds. In this sense, recommendation 4.1 is accompanied by a requirement for better quality primary data on the exploration/production sector as a priority, according to a region-country-asset triptych. In the absence of data from independent suppliers, the Scientific and Expert Committee recommends that market participants require their clients to transmit such data in the short term.

It should be noted in particular that this recommendation includes reserve-based lending, as well as project financing by investment companies.

B. EXCLUSION OF GENERAL AND CORPORATE FINANCIAL SERVICES

Note that this recommendation includes in particular credit, bond issuances, insurance coverage, investment and consulting services. The Scientific and Expert Committee recognizes the need to make a distinction between specialized players, large groups significantly involved in unconventional hydrocarbons or contributing to their development, and large diversified groups marginally involved, given the specific structure of the oil and gas industry. In this sense, the Scientific and Expert Committee recommends that sectoral policies provide for the exclusion of:

- Players active in upstream whose owned and/or operated exploration and production assets (including in development) are significantly comprised of unconventional hydrocarbons; and

specialized midstream players with a significant part of their activity related to the transportation and storage of unconventional hydrocarbons;
- Trading companies for which unconventional hydrocarbons constitute a significant part of the business portfolio (*downstream*);
- Companies active in oil and gas production that would not rapidly divest from their (i) interests in specialized players active in the development of unconventional energy; (ii) interests in the development of blocks [xxxiii] and hydrocarbon fields; and (iii) interests held in the development of production permits (cf. recommendation 3.1 above).

This recommendation may also apply to off-balance sheet and financial services provision (e.g. advisory, liquidity lines, structuring of bond issues, equity issues; provision of insurance coverage products...).

* *
*

Application to third-party portfolio managers

The Scientific and Expert Committee recommends:
- The application of the exclusions detailed in recommendation 4.2;
- With regard to index management, in addition to the necessary compliance with the provisions of Delegated Regulation EU/2020/1817 on environmental, social and governance quality transparency of index administrators, the adoption within the investment practices of the methodology underlying the "Paris-Aligned" benchmark, as defined by Regulation EU/2019/2089
  It should be noted that the adoption of such criteria appears to be a minimum, given the relatively high exclusion thresholds of the "Paris-Aligned" benchmark (e.g. 10% of revenues for oil exploration, extraction and distribution; 50% of revenues for natural gas; and 50% for electricity production whose carbon intensity is greater than the threshold of 100gCO2/kWh).

More generally, the Scientific and Expert Committee recommends in this sense the use of the following indicators in the development of exclusion policies:
- As soon as public data is available, in particular for production and expansion, the % production indicator (in million barrels of oil equivalent) and the short-term developing resources indicator (in million barrels of oil equivalent) (approximately 1 to 6 years, which is the average life of fields operated by private players) - taking into account that a longer-term indicator would be more relevant to scenario analysis (cf. Global Oil & Gas Exit List published by Urgewald by the end of 2021);
- Where public data is of low quality, the Committee recommends the use of geographic proxies (by basin and by region).

Proposed "Observatory" indicators

- Percentage decrease in dedicated external financing flow related to exposure to actors affected by the exclusion policy, on an annual basis.
- Percentage decrease in the flow of external corporate financing related to exposure to actors affected by the exclusion policy, on an annual basis.
- These indicators should be read in perspective with the "Observatory" indicators in Recommendation 1, in order to have a more dynamic view of the Paris financial center's exposure to Oil & Gas industry players.

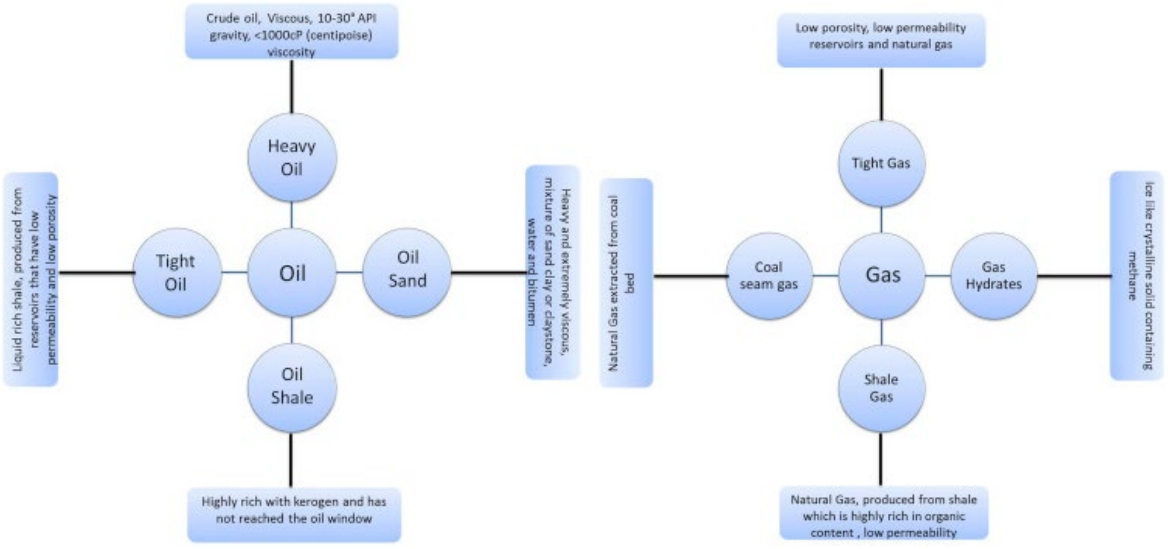
APPENDIX

APPENDIX 1: GEOLOGICAL CHARACTERISTICS OF "UNCONVENTIONAL" HYDROCARBON RESERVOIRS

Table 1. Definitions and classification criteria of unconventional oil and gas resources

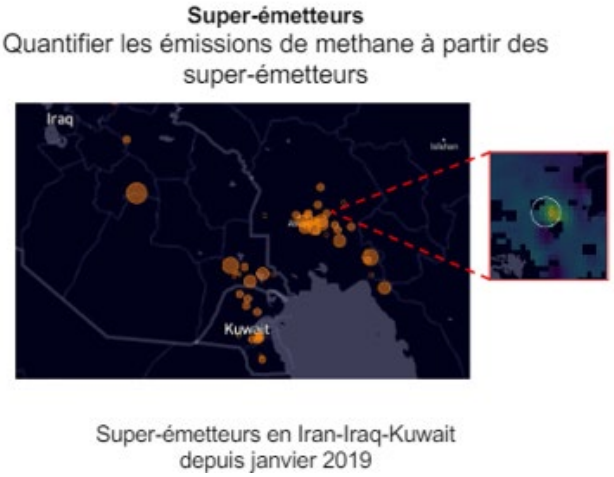
Resource type	Definition	Criteria				
		Viscosity/ (mPa·s)	Overburden pressure matrix permeability/10^{-3} μm^2	Oil content/%	Calorific value/ (MJ·kg^{-1})	Methane content/%
Heavy oil	Refers to the crude oil that is difficult to or cannot flow at reservoir temperature.	50–10 000				
Oil sand	Or called tar sand, specially refers to sandstone or other rocks containing natural asphalt, which is composed of asphalt, sand, water, clay, and other minerals.	>10 000				
Tight oil	Refers to a kind of oil accumulating in tight sandstone, tight carbonatite, and other reservoirs; tight oil wells generally have no natural production capacity, but can obtain industrial oil production by taking some technical measures under certain economic conditions.		≤0.200			
Oil shale	Refers to combustible shale with high ash content and high organic matter content;shale oil can be obtained through low temperature carbonization.			>3.5	>4.18	
Shale gas	Refers to natural gas occurring in rich organic shale reservoir in free and absorbed states; shale gas wells generally have no natural production capacity, but can obtain industrial oil production with some technical measures under certain economic conditions.		≤0.001			
Tight gas	Refers to natural gas accumulating in tight sandstone and other reservoirs; tight gas wells generally have no natural production capacity, but can obtain industrial oil production under certain economic conditions and technical measures.		≤0.100			>85
Coalbed methane	Refers to hydrocarbon gas occurring in coal seam, which mainly absorbs on the surface of coal matrix grains, but part of which exists in free state in coal pores or dissolves in coalbed water.					

Assessment of global unconventional oil and gas resources, Petroleum Exploration and Development, Volume 43, Issue 6, 2016

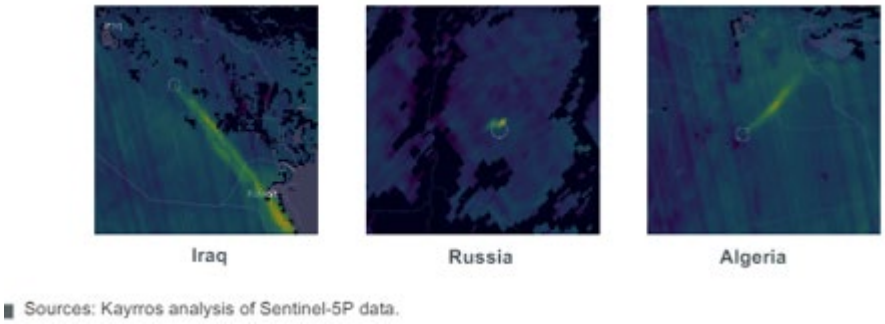


Geological Controls for Gas Hydrate Formations and Unconventionals, 2016.

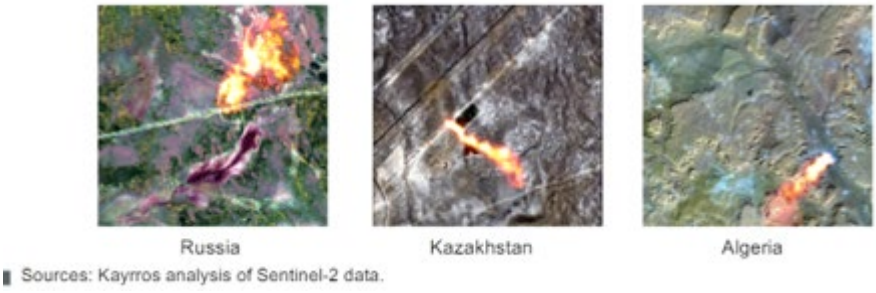
APPENDIX 2: EXAMPLES OF DATA COLLECTED BY KAYRROS USING REMOTE SENSING TECHNOLOGY



Identification of super-emitters, Kayrros



Identification of methane emissions, as part of a global coverage (5-7 km resolution), Kayrros



Identification of methane emissions in a site-specific coverage (30-meter resolution), Kayrros

Identification of flaring emissions, Kayrros

II. Recommendations on alignment strategies

Introduction

The Scientific and Expert Committee believes that it is necessary to address the initial lack of guidance on the Paris marketplace's July 2019 commitment to publish and monitor alignment strategies. This lack of clear direction has led to the emergence of differentiated strategies by Paris marketplace participants, both in terms of their level of ambition and their technical characteristics.

In this context, and taking into account the request of the Minister of the Economy, Finance and Economic Recovery made in its above-mentioned October 29, 2020 speech, for a common basis of commitments shared by all, the Scientific and Expert Committee recalls the following elements:

- It is necessary to **clarify, within the commitments made, the notions of "alignment" and "impact".** An alignment strategy can indeed include the notion of impact in the broadest sense, i.e. a positive impact expected from the dynamics to which the aligned funding contributes. However, the conditions required to quantify and prove the impact of the strategy, i.e. an additional reduction in greenhouse gas (GHG) emissions, are generally not met. **The Scientific and Expert Committee, based in particular on the work of the Paris Stock Exchange's "impact" task force, which will end in the fall of 2021, plans to continue its reflections on the link between alignment commitment and impact, and the characteristics that derive from it.**

- In order to make these recommendations, the Scientific and Expert Committee has relied on :
  - The analysis of various previous works, including the so-called "Katowice" report, the work of the *Net Zero Asset Owner Alliance* (Unep-Fi), *the Aligned Investment Initiative* (PAII) of the *Institutional Investors Group on Climate Change*, the *Measuring Portfolio Alignment initiative* of the TCFD Group COP26 Private Finance Hub, the work "*Aligning finance for the net-zero economy: Thought Leadership Series*," the Net Zero Asset Manager Commitment work of the *Net Zero Asset Managers Initiative* (NZAMI), and, finally, the Alignment Cookbook report;
  - A series of interviews with external organizations, including representatives from the Louis Bachelier Institute and the Institute for Climate Economics, Carbon 4 Finance and the International Energy Agency (IEA).

- It is essential to distinguish between alignment with the Paris Agreement - which requires commitments on climate change mitigation and adaptation, but also on other sustainable development goals - and alignment with a transition scenario that limits temperature increase to 2°C by the end of the 21st century. This alignment approach consists of verifying the compatibility of a financial participants' activities with the reference scenario: in the vast majority of cases, this is the notion currently used by financial participants.

- The use of certain indicators requires particular attention.
  - Thus, carbon intensity is a **relative** measure of CO_{2eq} emissions, as it is a ratio of absolute CO2eq emissions to another metric, such as: kg of CO_{2eq} per kilowatt-hour, per m_2 or per million euros of sales. While this measure allows us to distinguish between two companies within the same sector according to their energy efficiency and to correct for volume effects, there is no guarantee that managing a portfolio using carbon intensity will achieve the desired mitigation objective (insofar as mitigation requires an **absolute** reduction in greenhouse gas (GHG) emissions): a carbon intensity indicator is based on the assumption that turnover would

necessarily reflect the relevance of the rate of change of GHG emissions, and retains the assumption of homogeneity of turnover. Consequently, one or more absolute GHG emissions reduction indicators will necessarily be used, if necessary in addition to an intensity indicator.
    - Another methodology may be used as an alternative. Thus an indicator such as the **Implied Temperature Rise** (ITR), expresses the amount of warming caused by a given portfolio, isolated from exogenous variables. The ITR is calculated on the basis of a large number of methodological choices that make it not very transparent and not very comparable, although it has the advantage of consolidating a large amount of information into a relatively accessible and easily communicated numerical indicator.

- The notion of alignment with a transition scenario can be used to put a financial market participant's activities on a carbon neutral path, as long as the reference scenario used allows carbon neutrality to be achieved within the set timeframe.

- **These recommendations set out a number of principles that financial institutions must follow in their individual commitments to an alignment strategy**. In addition, such criteria pursue the **objective of comparability** of individual commitments within the framework of the Sustainable Finance Observatory. On this basis, **the Scientific and Expert Committee plans to propose a definition of the key characteristics of an "alignment" label for financial products (particularly investment products) in the coming months.**

Following an approach based on the methodological principles of comparability, replicability, completeness and reliability, the Scientific and Expert Committee recommends the following elements to financial actors:

Recommendation No.1

The Scientific and Expert Committee recommends that financial actors clarify the **notion of alignment** they use, and provide themselves with indicators to measure alignment in relation to a reference low-carbon transition scenario, with **objectives and milestones in their alignment strategy**, as well as with **clearly identified steering tools.**

- A **long-term goal** must be set (necessarily by 2050, and before 2050 if possible);
- **Intermediate targets** must be set (at least every five years) to monitor the achievement of the long-term target;
- The **steering instruments** must make it possible to verify whether a financial actor is actually implementing the instruments to meet its roadmap.
    - *For example: engagement with clients, changing the composition of the client portfolio, implementing impact products, financing sustainable activities, financing decarbonization of activities, etc.*
- The reference scenario should be based on **convergence-based benchmarks**, based on the scenario used (and not on a warming function, which describes the central trend of a sectoral emissions trajectory based on a wide range of different climate scenarios).

Recommendation No.2

The Scientific and Expert Committee recommends that financial actors use recent scenarios adapted to the methodologies applied and aiming at a temperature warming below 2°C by the end of the century and at

1.5°C as much as possible. They must be published with an explanation of the key points (notably: exceeding the target temperature, assumption of the use of carbon sequestration techniques).

The alignment scenario must be consistent with: the low-carbon strategy of the country or countries where the main activities financed are located; the investment strategy pursued and the different scenarios used within the same institution.

- The baseline scenario must allow only a **small amount of target temperature overshoot** and only industrial-scale use of **mature technologies**;
- The **sectoral segmentation of the scenario** used (or the sectoral variation of the central scenario) **must be consistent with the structure of the activities financed;**
- The reference scenario must be based on **convergence-based benchmarks**, based on the scenario used (and not on a warming function, which describes the central trend of a sectoral emissions trajectory based on a wide range of different climate scenarios), as portfolio companies must converge to average performance levels required for each industry sector (as opposed to reduction rate criteria, where all companies must improve their performance at the same rate as the sector average, including those that have made above-average decarbonization efforts).
- The scenario must be robust, i.e., not very sensitive to assumptions whose validity is difficult to verify in the current state of knowledge and to socio-economic uncertainties.
- The scenario must be recent
- The scenario must be adapted to the characteristics of the portfolios analyzed as well as to the methodologies :
    - *For example: the use of an IEA scenario is not adapted to an investment in the tertiary sector*
    - *For example: the PACTA methodology is very demanding on the data required, and few scenarios provide it for a large number of economic sectors*

Recommendation No.3

The Scientific and Expert Committee recommends that the **strategy adopted by the financial sector make explicit the steering instruments identified (i.e. engagement with clients, modification of the composition of the client portfolio, implementation of impact products, financing of sustainable activities, financing of the decarbonization of activities, etc.), the policies followed for all activities and the specific policies adopted for each segment of the activity, in particular through a detailed roadmap.**

The strategy must contain a **section on fossil fuels** and **specific objectives** to achieve the decarbonization of the energy production financed, within the carbon neutrality horizon set by the European Union.

These **targets** must be **explained and made consistent with the institution's theory of change**. In order to incorporate recent relevant developments, the alignment strategy and targets should be **revised regularly** by updating the information presented on the Observatory annually.

- At the general meeting, the financial market participants communicate information on the adopted strategy;
- The strategy must be reviewed at the occurrence of any major event (with respect to the company or methodological advances) and in all cases at least every three years;

- The strategy adopted must be **consistent with public policies**, in particular with the French National Low-Carbon Strategy and the French Multi-Year Energy Plan;
- Eventually, the strategy should aim to use **granular benchmarks**, in order to capture existing differences in decarbonization feasibility between industries or geographical areas - taking into account the difference in investment strategy for sectors (i.e. technological constraints) and geographical areas (i.e. existing energy infrastructure) that are more difficult to decarbonize. This allows the financial actor to distinguish between companies that are ahead or behind the curve within a comparable set of companies, based on shared climate scenarios.
  These benchmarks can be absolute emissions (preferred by the Scientific Committee), production capacity benchmarks or emissions intensity benchmarks (convergence rate approach, which must be updated according to the evolution of the scenarios): in any case, the choice of these benchmarks must be justified, either by the need for absolute emissions reductions, or because an intensity benchmark provides an incentive for the transition.

- **The financial market participant must rely on both historical data and emissions targets to inform future emissions projections**. As such, the weighting between data sources should be based on an assessment of the credibility of short- and long-term targets (where they exist), including investment plans.
- The adopted strategy should include an escalation policy. If the objectives of the strategy are not met through coaching and engagement with their clients, financial actors will gradually increase their divestment from the companies concerned;
  - The roadmap should answer the following questions:
  - How has the strategy changed?
  - To what extent are the commitments made material?
  - How are these policies actually implemented?

  An explicit strategy includes, for example, compatibility with a reference trajectory, a carbon neutrality objective, an impact objective, etc.

Recommendation No.4

The Scientific and Expert Committee recommends that financial market participants choose a **relevant scope of application for the alignment strategy.** The scope covered by the alignment strategy and indicators should be **precisely explained** and include at least **80% of the financial institution's activities and the main financial instruments.**

- The percentage of activities covered must be assessed by a relevant indicator (e.g. net banking income for credit institutions)
- Financial actors have a duty of care concerning all their activities. However, given the difficulty of accessing data, an obligation of result is expected, at a minimum, for 80% of activities. Financial market participants should specify the 20% of activities that are not covered and the reason for this lack of coverage in light of the difficulty of accessing information.

Recommendation No.5

The Scientific and Expert Committee recommends to financial actors that the **methodologies** used be **robust** and correspond to best market practices. These methodologies must be **usable with the available data**. They must allow for the monitoring of the **degree of alignment of the financial institution over time** by

making it possible to identify the factors that explain the variation in performance. The choice of methodologies used and their assumptions must be made explicit.

- The methodologies used must allow the objectives mentioned in recommendation 1 to be met.
- Financial actors should make explicit the methodology or methodologies used.
- Financial actors must be transparent about the aggregation method used. They must also justify the choice of the aggregation method.
- The best practices identified in the marketplace come, for example, from the publications of the TCFD Cop 26 Group and ADEME's Climate Transparency Hub.

Recommendation No.6

The Scientific and Expert Committee recommends to financial actors that the alignment indicators used be **forward-looking**. The choice of indicators should be **explained**, as well as their respective strengths and weaknesses, as identified by the stakeholders
Since the carbon footprint of financial market participants is almost exclusively a footprint induced by their financing and investment portfolios, the indicators used to monitor these portfolios must take into account companies' scope 1 and 2 and scope 3 - unless this is technically impossible and justified.

All greenhouse gases - CO_{2eq} - must be included in the analysis. Insofar as emissions from production inputs (scope 3, known as "upstream") and those from outputs (scope 3, known as "downstream") are very rarely published by companies at this stage, the methods for taking into account scope 3 (i.e. physical or statistical data, extrapolations, estimates, averages, etc.) must be clearly specified, particularly in light of the difficulties encountered sector by sector and company by company.

At a minimum, the Committee recommends including scope 3 emissions for the fossil fuel, mining and automotive sectors - for which sectoral benchmarks are available.

In this regard, it should be noted that **instead of a "scope" view, which simply reflects the ownership of emissions sources, a "challenge" view - which provides a strategic, physical and operational analysis of the emissions of the sectors of activity according to their reduction potential - can be preferred**, in particular in order to reduce the dilemma of allocation to the producer or the consumer. The "stake" for an economic agent is the quantity of GHG emissions that this agent is likely to reduce or avoid, and not to compensate.

- According to the principle of legal autonomy, each company is only fully responsible for its own emissions. Nevertheless, **a financial market participants can encourage client/supplier companies to quantify their emissions so that they can set reduction targets and strategies**. It can also propose to share best practices with them;
- The **sources** of the data used to calculate the indicators must be **published**;
- **Data quality assurance** processes should be **described**;
- Indicators related to implied temperature rise (ITR) will be reported within a temperature range;
- Within this framework, financial actors are encouraged to distinguish their fossil carbon footprint from their living carbon footprint, i.e., relating to what is not fossil (*for example: agriculture, methane*).

Recommendation No.7

The Scientific and Expert Committee recommends that financial actors **be able to measure**, on an **annual basis, the alignment of a portfolio or of all the activities of an institution through one or more indicators.** In order to ensure comparability of performance over time, the choice of and reason for a change in indicator and/or methodology should be specified. The methodologies and indicators used must be published and documented for analysis and replication. These should be **consistent** with the purpose of the alignment strategy. **Uncertainties in the data and methodologies used should be explained** and their impact on the results explained.

- This measurement must be performed **in relation to a reference low-carbon transition scenario**;
- The aggregation methods used to move from the company level to the portfolio level must be specified and explained;
- The **choice** of setting targets in terms of **carbon intensity** or **absolute emissions reductions must be specified and explained;**
- The **indicators** and **methodologies** used can be **revised** to incorporate improvements.

III. Presentation of the Scientific and Expert Committee

The Committee is composed of a chairman, a secretary, and several colleges: two members from NGOs or think tanks, four academic members, two members representing public authorities, and two experts with knowledge of the banking and investment business.

Members are appointed "*intuitu personae*" by the Finance Clim'Act Steering Committee. They therefore speak on their own behalf and not on behalf of their institutions, apart from the representatives of the French Treasury and the Ministry for the Ecological Transition, even though they bring the expertise and knowledge of their respective organizations.

They may also act as internal rapporteurs and communicators within their respective organizations.

The Secretary of the Scientific and Expert Committee assists the Chairman and ensures the smooth functioning of the Committee.

President : Pierre-Louis Lions - Fields Medal winner in 1994, Professor at the *Collège de France*, Chairman of the International Scientific Committee of the Louis Bachelier Institute and of the "Green & Sustainable Finance Transversal Program".

Secretary: Stéphane Voisin

College of NGOs and Think Tanks :

Lucie Pinson

Michel Cardona

Academic College :

Anna Creti

Delphine Lautier

Augustin Landier

Peter Tankov

Emmanuel Hache

College of experts :

Jérôme Courcier

Carlonie Delerable

College of public authorities :

Elise Calais – Ministry for the Ecological Transition

Charlottes Gardes – French Treasury

[i] Connaissance des Energies, « L'évolution des marchés pétroliers d'ici à 2024 vue par l'AIE », 11 March 2019. Available online: https://www.connaissancedesenergies.org/levolution-des-marches-petroliers-dici-2024-vue-par-laie-190311 ; Is the oil industry able to support a world that consumes 105 million barrels of oil per day in 2025?, Pierre Hacquard, Marine Simoën and Emmanuel Hache, Oil Gas Sci. Technol. – Rev. IFP Energies nouvelles, 74 (2019) 88 ; Global prospects of unconventional oil in the turbulent market: a long term outlook to 2040, Nikita O. Kapustin and Dmitry A. Grushevenko, Oil Gas Sci. Technol. – Rev. IFP Energies nouvelles, 73 (2018) 67 ; World Energy Council, Unconventional gas, a global phenomenon, 2016.
[ii] Lettre Trésor Eco, n°257, "Effets du prix du pétrole sur l'économie américaine", mars 2020.
[iii] Ibid.
[iv] It should be noted that the work on measuring the exposure of the French financial sector, carried out by the Autorité des marchés financiers and the Autorité de contrôle prudentiel et de résolution since 2021, will provide input to the work of the Scientific and Expert Committee in this regard.
[v] Extract: "*Beyond divestment, there are alternatives for investors to show their concern over climate change: they can engage and use their shareholder rights to convince management to change course in the direction of non-fossil fuel resources or they can invest in renewable and more sustainable energy technologies (Scholtens, 2014). However, the assessment of the most beneficial strategy from a climate change perspective is outside the scope of this paper. Further, divesting from fossil fuel stocks does not guarantee that global warming will not go above the 2°C threshold and/or that dramatic and irreversible changes to ecosystems will not occur (Steffen et al., 2018). But divestment will help change the mindset in the required direction of reducing the use of fossil fuels,and does not financially hurt investors and their beneficiaries*".
[vi] BP, Chevron, ExxonMobil, Shell, Total, ConocoPhillips et Eni.
[vii] Although in physical terms, most of these companies are net buyers of oil for their refining operations, where throughputs are higher than in other sectors. The decoupling of the marketing of their upstream production and the supply of their refineries makes them active players in the international oil market. Historically, they have focused on large, capital-intensive projects (often in partnership with national oil companies), taking both market and project management risks, although many are increasingly investing in shorter-cycle investments (IEA, 2017).
[viii] Independents most often outsource drilling, well completion and logistics operations. They include a wide range, such as Lukoil and Repsol in Europe, a large number of North American players such as Marathon, Apache and Hess, and diversified conglomerates like Mitsubishi Corp. Also included in this group are the North American shale independents, a relatively new group of companies focused almost exclusively on developing shale gas and tight oil resources. These companies have a heavy reliance on debt financing and leverage (IEA, 2017).
[ix] Examples include Marathon Petroleum and Phillips. These are companies that operate refineries and distribution networks, knowing that their capitalization and balance sheets are generally considerably smaller than those of the majors (IEA, 2017).
[x] (e.g. Vitol and Glencore). These are companies that are active in the physical trading of oil products and LNG. They sometimes invest in transportation, refining, distribution and storage assets, but their business model is generally based on owning transportation assets, allowing them to optimize their market position. They play a major role in ensuring the smooth functioning of markets (IEA, 2017).
[xi] The recommendations cover the supply of electricity and heat from coal (thermal coal value chain), but do not cover coal outlets in industry (as provided for in the Taxonomy resulting from EU Regulation No. 2020/852 of 18 June 2020), in particular coking coal (known as "steelmaking" or "metallurgical" coal), notably because of the lack of alternative solutions to the use of coke for the transformation of iron ore into cast iron and steel, as well as the abatement costs involved in the reorientation of steel production from recovered steel.
[xii] A description of the geological characteristics of these different hydrocarbons is attached
[xiii] Defined by an API (American Petroleum Institute) degree less than or equal to 14°C
[xiv] Depth exceeding 1500 meterss. Cf. Muehlenbachs L. et al., The impact of water depth on safety and environmental performance in offshore oil and gas production, Energy Policy, Volume 55, Pages 699-705, Avril 2013
[xv] Depth exceeding 1500 meters. Cf. Muehlenbachs L. et al., The impact of water depth on safety and environmental performance in offshore oil and gas production, Energy Policy, Volume 55, Pages 699-705, Avril 2013
[xvi] A petroleum block is the area that a country delimits in its territorial waters and grants, if necessary, to an oil company for exploration or exploitation of the continental shelf.
[xvii] In particular: "Changes in the investment strategy in line with the strategy of alignment with the Paris Agreement, and in particular the policies implemented with a view to phasing out coal and non-conventional hydrocarbons, specifying the timetable for exit and the proportion of total assets managed or held by the entity covered by these policies.

[xviii] The Scientific and Expert Panel adopts the definition adopted by the Environmental Defense Fund (as written on p.5 of the report entitled "A Shareholder Engagement Guide to Uncovering Climate Risks from Non Operated Assets in the Oil and Gas Industry", published on October 20, 2020 and available online (Emission Omission_ A Shareholder Engagement Guide.pdf (edf.org)), namely: Operated assets (*actif opéré*): An asset where a company's employees and directly managed contractors are on the ground using the company's standards for processes, tools, and system. Non-operated assets (*actif non opéré*): An asset at which another oil and gas company assumes the role of asset operator, overseeing all decision-making and standards.

[xix] In this sense, the recommendation is in line with Article D. 533-16-1. III, 6° which - for investors - requires the publication of a strategy for alignment with the long-term objectives of Articles 2 and 4 of the Paris Agreement relating to the mitigation of greenhouse gas emissions, accompanied in particular by the setting of a quantitative target for 2030, reviewed every five years until 2050, which includes direct and indirect greenhouse gas emissions in absolute value or intensity value in relation to a reference scenario and a reference year. The literature supporting the IPCC's 1.5°C global warming report (2019, p. 15) confirms that the goal of limiting warming to well below 2°C defined in the Paris Agreement requires reducing greenhouse gas emissions by about 25% by 2030 (in most scenarios) and reaching zero net emissions between 2050 and 2070 - which corresponds to the carbon neutrality goal. The latter directly allows us to not exceed the temperature objective of the Paris Agreement.

[xx] In the report "Net Zero by 2050, A Roadmap for the Global Energy Sector", published on May 17, 2021 by the International Energy Agency (IEA) (available under this link), CO2 emissions from industry and the energy sector are reduced by 40% between 2020 and 2030, until reaching neutrality in 2050. Thus, an average reduction rate of 40% of CO2 emissions between 2020 and 2030 corresponds to an annual rate of about -5% (assuming that such a reduction rate has been applied since 2020).

[xxi] In view of the importance of Scope 3 in measuring the sector's CO2eq emissions *Oil & Gas* (« *Regarding the downstream activities of O&G companies, Scope 1+2 GHG emissions are relatively low compared to the total GHG emissions of the value chain. Combustion of O&G products sold (Scope 3 downstream) is by far the largest source of emissions, representing more than 80% of total GHG emissions of the oil value chain [6]. As the different energy products (coal, gas, oil products) have different carbon intensity per energy supplied, the mix of products sold is crucial to analyze the climate impact of companies in the sector. The development of an offer of energy efficiency services to the final client is also a key lever to reduce the GHG emissions related to the use of products sold* », IEA, The Oil and Gas Industry in Energy Transitions (windows.net), 2020), and the lower relative carbon intensity of gas (US Energy Information Administration, Frequently Asked Questions), taking into account the carbon intensity of all of the scopes 1, 2 and 3 would be tantamount to giving excessive priority to the nature of the energy mix chosen by the companies concerned, to the detriment of possible improvements in scope 1 and 2 (e.g. good operational practices).

[xxii] The Scientific and Expert Committee believes that the manufacturers' estimates of their emissions are inadequate. For example, the average methane intensity declared by the main oil and gas operators is 12.9 kg/TJ, which is much lower than the IEA's figure of 194 kg/TJ.

[xxiii] In the report "Net Zero by 2050, A Roadmap for the Global Energy Sector", published on May 17, 2021 by the International Energy Agency (IEA) (available under this link), methane emissions from fossil fuels decrease by 75% from 2020 to 2030. This reduction corresponds to a decrease of 2.5 gigatons of CO2 equivalent in GHG emissions and is attributed (i) to an overall reduction in fossil fuel consumption for one third and (ii) for two thirds to a considerable increase in the deployment of emission reduction measures, allowing the elimination of all technically avoidable methane emissions by 2030. Thus, an average 75% reduction rate in methane emissions between 2020 and 2030 corresponds to an annual rate of about -13% (assuming that such a reduction rate was applied as early as 2020).

[xxiv]Additionnal data available online : Methane emissions | Energy (europa.eu) / Methane Tracker 2021 – Analysis - IEA / Methane and climate change – Methane Tracker 2021 – Analysis - IEA / IPCC-Special-Report-1.5-SPM_fr.pdf (eelv.fr) / WG1AR5_Chapter08_FINAL.pdf (ipcc.ch)

[xxv] Greenhouse gases are defined by the IPCC as "gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths of the terrestrial radiation spectrum emitted by the Earth's surface, atmosphere and clouds. It is this property that causes the greenhouse effect."

[xxvi] Radiative forcing is defined by the IPCC as "the change in net radiation (difference between the radiative flux received and the radiative flux emitted, expressed in W m-2) at the tropopause or top of the atmosphere due to a change in a climate change factor, such as a change in carbon dioxide concentration or solar radiation. Non-CO2 radiative forcing refers to "all anthropogenic emissions of gases, excluding CO2, that result in radiative forcing. These include short-lived climate forcers such as methane, some fluorinated gases, ozone precursors, aerosols and their precursors such as soot carbon and sulfur dioxide, and long-lived greenhouse gases such as nitrous oxide or other fluorinated gases."

[xxvii] The Global Warming Potential is a measure that combines two essential characteristics of greenhouse gases in measuring their impact on the climate: the length of time they remain in the atmosphere and their capacity to absorb energy.
[xxviii] Sources additionnelles disponibles en ligne : ESSD - The Global Methane Budget 2000–2017 (copernicus.org) / Sources of methane emissions – Charts – Data & Statistics - IEA
[xxix] Flaring is deleterious because the gas is never completely burned, and a non-negligible percentage of the gas, up to 10%, escapes without burning (when the flame goes out, 100% of the gas is released). The alternative to flaring is simply to use the gas locally (e.g. by powering a gas turbine to generate electricity) or to channel it into a pipeline network.
[xxx] The release of gas in transport networks represents 5.5 million tons of CH4 per year, i.e. 8% of methane emissions in the hydrocarbon sector (IEA).
[xxxi] The nine key emission sources in question are: “Natural gas driven pneumatic controllers and pumps, Fugitive component and equipment leaks, Centrifugal compressors with wet (oil) seals, reciprocating compressor rod seal, packing vents, Glycol dehydrators, Unstabilised hydrocarbon liquid storage tanks, Well venting for liquids unloading, Well venting/flaring during well completion for hydraulically fractured gas wells, Casinghead gas venting." (United Nations Environment Programme, Climate and Clean Air Coalition, Oil and Gas Methane Partnership: Third year Report, 2018. Disponible en ligne : Oil and Gas Methane Partnership (OGMP): Third-Year Report | Climate & Clean Air Coalition (ccacoalition.org))
[xxxii] Data provided by Kayrros during dedicated interviews with the Scientific and Expert Committee (May to July 2021).
[xxxiii] A petroleum block is the area that a country delimits in its territorial waters and grants, if necessary, to an oil company for exploration or exploitation of the continental shelf.