Commissariat à l'énergie atomique et aux énergies alternatives
Atomic Energy and Alternative Energies Commission

Answer to the European Consultation

EU Methane Strategy

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Summary

The French Atomic Energy and Alternative Energies Commission (CEA) welcomes the European Commission's will to establish a methane strategy designed to reduce methane – a gas having a potent greenhouse effect – emissions.

1. **This will require a strategy considering trade-offs and co-benefits** based on the following criteria in each sector and across sectors:

C1 – Is the magnitude of emissions in a given sector such that it can be prioritized as a target for achieving a large emission mitigation?

C2 – Are technologies and solutions available or can they be developed to mitigate these emissions?

C3 – Are the costs of the solutions in this sector effective with respect to mitigation in other sectors and for other gases?

2. When methane leaks are considered within the full lifecycle emission assessment, fossil gas often presents no clear or low climate benefits compared to other fossil fuels (coal for electricity, oil for mobility…). GHG emissions should be assessed with precision over the entire lifecycle before considering fossil gas as a substitute. In any case, the climate benefits brought by fossil gas in favourable situations are small and in no way compatible with carbon neutrality. Fossil gas should NOT be considered as a sustainable energy source.

3. Methane emissions measurements remain underdeveloped in many sectors. A better continuous monitoring of methane leaks at potential emission sites appears necessary to reduce the current uncertainties of the global methane balance, in particular regarding the impact of the energy and waste disposal sectors.

The French Atomic Energy and Alternative Energies Commission (CEA) welcomes the European Commission's will to establish a methane strategy designed to reduce methane – a gas having a potent greenhouse effect – emissions. This paper aims at:

- recalling basic facts and figures regarding the role of methane in greenhouse gas emissions;
- underlining the need for comprehensive lifecycle assessment of methane emissions before considering fossil gas as an alternative to other fossil fuels for energy supply and applications;
- discuss possible strategy for methane emissions monitoring and mitigation in the three main areas subject to the consultation.

I. Role of methane in the global warming

Methane (CH_4) is the 2nd greenhouse gas contributing to global warming behind carbon dioxide (CO_2). It is responsible for almost one quarter of the cumulated radiative forcing of the three main contributors to global warming (namely CO_2, CH_4 and N_2O) since 1750[1]. Radiative forcing corresponds to the difference between the radiative energy received and emitted by the climate system. The higher the radiative forcing, the more the system warms. Conversely, a negative radiative forcing leads to a cooling of the system. In that respect, **almost a quarter of the energy trapped by the greenhouse effect of these three gases since 1750 comes from methane.**

For a given mass of gas, methane's radiative forcing is much higher than that of carbon dioxide, but its residence time (half-life) in the atmosphere is much shorter. The Global Warming Potential (GWP) is the conversion factor indexed on CO_2 that enables to compare the climate footprint of different gases for a given duration. Methane GWP is significantly higher than 1. The exact value depends on the time horizon that is considered, as the methane lifetime in the atmosphere is shorter than that of CO_2. For a time horizon of 20 years, 1 kg of methane (kgCH_4) will heat the atmosphere as much as 84 kg of CO_2 (kgCO_2), that is a GWP20 of 84. This value comes down to 28 for a time horizon of 100 years (GWP100 = 28)[2].

In 2017, we can estimate from a top-down approach (measurements of atmospheric methane) that 596 MtCH_4 were emitted and 571 MtCH_4 absorbed by the sinks. Among the 596 MtCH_4, 363 MtCH_4 are from anthropic sources (108 from fossil fuel production and use, 227 from agriculture and waste and 28 from biomass and biofuel burning) and 233 MtCH_4 are from natural sources (194 from wetlands and 39 from other sources)[3].

II. Methane emissions on the lifecycle

Several Member States are inclined to replace coal by fossil gas in order to reduce greenhouse gas emissions. Indeed, the combustion of methane emits less CO_2 than the combustion of coal, for the same energy output. But the climate footprint of a switch from coal to gas (or from oil to gas for mobility) has to be approached through lifecycle analyses considering both CO_2 and CH_4. In that respect, several studies have shown that methane leakage emissions are much higher than reported. **When these leaked emissions are accounted for, the carbon footprint of fossil gas increases and makes the benefit of switching from coal to gas often uncertain.**

The following section discusses the potential benefit of methane, with respect to other energy sources, depending on the leakage rate, for various energy uses.

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[1] M. Etminan et al. Radiative forcing of carbon dioxide, methane, and nitrous oxide: a significant revision of the methane radiative forcing, *Geophys. Res. Lett.*, 2016, 43, 12614-23

[2] G. Myhre et al., 2013: Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Chapter 8, Page 714

[3] R. B. Jackson et al., Increasing anthropogenic methane emissions arise equally from agricultural and fossil fuel sources, *Environ. Res. Lett* 15 (2020) 071002

1. Methane leaks from fossil gas supply

Fossil gas extraction leads to leaks comprised between 0.2 and 2.4% for conventional gas and from 0.6 to 9% for unconventional "shale" gas[4].

Then, gas transport and distribution also lead to methane leakage. For onshore gas transportation and distribution, these are mostly due to the ageing, the nature and the length of pipelines. These leaks can reach between 0.07% and 3.6%[4][5] of transported and distributed gas. For Liquefied Natural Gas (LNG) transported by boat, the International Council for Clean Transportation estimates that methane leaks can reach between 2.7 and 5.4 %[6]. These leakage rates vary greatly from one source to the other.

2. Methane leaks by sector (end use)

<u>Electricity sector, comparison with coal</u>

Methane emission rate from gas power plants are poorly documented but potentially significant. T. N. Lavoie et al. evaluate them at a range between 0.1 and 0.42 %.

The scientific literature indicates that total methane leaks (extraction, transport and usage) have to be kept under 3.7% to expect a climate benefit after 20 years, compared to coal use[7]. **The addition of methane emission all along the lifecycle makes therefore unclear the climate benefit of switching electricity production from coal to gas.** It depends on many parameters affecting methane leakage on the lifecycle. In any case, methane cannot be considered as "sustainable" or low-carbon. In the best configuration, it is slightly better than coal but far from being compatible with carbon neutrality.

<u>Mobility, comparison with oil products</u>

For heavy mobility, a study carried out by the Imperial College[8] showed that fossil gas could reduce greenhouse gas emissions in trucks and ships by circa. 16% and 10% respectively. Large uncertainties encompass these values, and the Imperial College recognizes that "natural gas fueled trucks and ships may have lifecycle emissions exceeding current incumbent diesel trucks and heavy fuel oil ships."

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[4] Robert W. Howarth, « A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas », *Energy Sci. Eng.*, vol. 2, nº 2, p. 47-60, 2014, doi: 10.1002/ese3.35.
[5] « Délibération de la Commission de régulation de l'énergie du 10 mars 2016 portant décision sur le tarif péréqué d'utilisation des réseaux publics de distribution de gaz naturel de GRDF ». Commission de régulation de l'énergie - CRE, mars 10, 2016, [Online]. Available on: https://www.grdf.fr/documents/10184/1291504/Doc+1+D%C3%A9lib+ATRD5+juillet+2016.pdf/6d350ac0-8877-40da-a104-a606bb85c64c
[6] Dana Lowell, Haifeng Wang, et Nic Lutsey, « Assessment of the fuel cycle impact of liquefied natural gas as used in international shipping ». ICCT, mai 2013, [Online]. Available on: https://www.theicct.org/sites/default/files/publications/ICCTwhitepaper_MarineLNG_130513.pdf
[7] Ramón A. Alvareza, Stephen W. Pacalab, James J. Winebrake, William L. Chameides, et Steven P. Hamburg, « Greater focus needed on methane leakage from natural gas infrastructure ». *PNAS*, 2012. https://www.pnas.org/content/pnas/109/17/6435.full.pdf
[8] J. Speirs et al., « Can Natural Gas Reduce Emissions from Transport ? Heavy Goods Vehicles and Shipping ». Imperial College, January 2019, https://safety4sea.com/wp-content/uploads/2019/01/Imperial-College-London-Can-natural-gas-reduce-emissions-from-transport-2019_01.pdf

Residential heating

For residential heating, Howarth et al.[4] show that compared to heat pumps fuelled with coal-based electricity, gas heating has a stronger 20-years climate impact if total methane leaks are higher than 0.7%. Considering upstream leaks, the probability is high for fossil gas to have a stronger climate impact than heat pumps, irrespective of the power mix.

Conclusion

When methane leaks are considered within the full lifecycle emissions assessment, fossil gas often present no clear or low climate benefits compared to other fossil-fuels (coal for electricity, oil for mobility…). GHG emissions should therefore be assessed with precision on the lifecycle before considering fossil gas as a substitution. **In any case, the climate benefits brought by fossil gas in favourable situations is small and therefore in no way compatible with carbon neutrality. It should not be considered as a sustainable energy source.**

For current fossil gas uses, the reduction of methane leaks would help improve its climate impact. To that end, it is necessary to invest in equipment to measure and quantify methane leaks, as well as in the improvement of gas transportation infrastructures.

Regarding the metrics to compare CH_4 reductions to CO_2 reductions, CEA recommends pursuing research on the most cost effective metrics including Global Temperature Potentials, and least cost metrics derived from integrated assessment models, to inform policy on the best choices for considering CH_4 in the portfolio of mitigation options given low warming targets.

III. Sectoral strategy to quantify and reduce methane emissions

Focusing on an effective reduction of methane emissions at EU scale would require a strategy considering tradeoffs and co-benefits for the following criteria in each sector and across sectors.

C1 – Is the magnitude of an emission in a sector such that it can be prioritized as a target for achieving a large emission mitigation?

C2 – Are technologies and solutions available or can they be developed to mitigate these emissions?

C3 – Are the costs of the solutions in this sector effective with respect to mitigation in other sectors and for other gases?

The three sectors of anthropogenic emissions considered in the consultation (energy, agriculture and waste) are those for which countries are responsible for to the UNFCCC, as reported in their national inventories. However, we should note that there are significant additional emissions from natural wetlands that are sensitive to climate change and which could be considered in a global EU GHG neutrality strategy as all sources matter for curving down the atmospheric growth rate of CH_4.

Methane will become increasingly important in the future to reach the EU carbon neutrality objectives if CO_2 emissions can be abated**. CEA therefore strongly recommends that clear sectorial and national targets are set both in the short term and for a long-term neutrality trajectory at the EU level**, to have quantitative temporal mitigation objectives upon which progress and effectiveness of actions can be measured.

1. Energy emissions

Most of methane emissions from the energy sector are typically isolated or local clusters of point sources (e.g. coal mines, refineries and LNG terminals, leaks from gas extraction and transport infrastructures) with temporal intermittence, e.g. compressors may emit more during specific maintenance steps. Emissions are currently estimated based on emission factors and activity data in national inventories.

Regarding C1: CEA recommends coordinating a comprehensive mapping of potential sources and their activity within the EU. This mapping could be achieved using e.g. high-resolution remote sensing images. We also recommend performing, as much as possible, systematic measurements of emission factors using robust and recently developed scalable approaches, including but not limited to UAV[9] regular *in situ* measurements, arrays of low-cost *in situ* sensors and airborne surveys using e.g. hyperspectral imagery as performed for thousands of sources in the USA. These data could be collected and processed for emission detection and quantification, based on atmospheric and statistical models by a consortium of site owners, research communities, and private operators. The information should be reported and archived on an appropriate data infrastructure, on an open-disclosure basis with full documentation of methods, calibrations and measurement conditions. Data could be reported to independent authority to perform Quality Assurance / Quality Control and data distribution. Work on new European and international standards for emission determination is recommended, including the promotion of mandatory *in situ* reporting of energy providers' emissions, as it is done for air quality for instance.

At a larger spatial scale and for the most intense CH_4 sources, Earth Observation (EO) from the Copernicus programme could be used to monitor the largest sources and establish the capabilities for detecting smaller sources with a future generation of spaceborne / airborne instruments. CEA recommends cooperation between the EU and ESA to promote R&D and demonstration studies with industry partners regarding microsatellites that could detect and quantify CH_4 emissions with a lower detection threshold than with current EO data.

Additional remark: since a large share of gas used in the EU is imported from other countries with variable GHG emission footprints, CEA recommends developing a global traceability approach using e.g. global EO data to assess the carbon intensity on the life-cycle of gas imports, as done for instance for oil-palm and soybean in deforestation sensitive areas. This system coupled with price schemes or regulations favouring "clean" imports will leverage the EU role as a global player to enable emission reduction from the energy sector in exporting countries.

Regarding C2: Mitigation solutions could be developed with the private sector to improve standards and develop a technological roadmap for reducing fugitive emissions from all energy sub-sectors, coupled with stronger regulations (e.g. an ETS-based scheme for CH_4 emissions by the coal, oil and gas upstream and downstream sectors).

Regarding C3: Socioeconomic modelling studies & technology benchmark should be performed on the marginal costs and opportunities of emission reductions, that should help meeting sectorial targets along GHG neutrality pathways. We also recommend to foster fast implementation of mitigation technologies to lower their cost with time, including the development of R&D programs,

[9] Unmanned Aerial Vehicle

demonstration studies and regulations / market based tools to facilitate the systematic reduction of fugitive emissions.

2. Agriculture emissions

Most of CH_4 sources in the agricultural sector are from livestock production (ruminants) and waste (manure). These sources can be locally intense but also diffuse.

Regarding C1: CEA recommends coordinating a comprehensive mapping of potential sources within the EU and their activity. We also recommend that the control of emission at the source be continuously be monitored in farms. Biogas units should include detection systems. For the most intense sources (e.g. intensive livestock farms) atmospheric detection is possible. For diffuse sources like grazing animals, detailed measurement of emission factors (EF) at animal level for different genotypes and diet schemes will be necessary in representative farms to determine emission coefficients applicable elsewhere. Since the CH_4 emission intensity primarily depends on the quality and quantity of ingested herbage, we propose to take advantage of recent advances in remote sensing to better study and understand the links between cattle food and CH_4 emissions. A clear accounting framework will have to be developed for setting reduction objectives, e.g. reducing the CH_4 emissions per unit animal products, per unit of intake or per capita. Unfortunately, less intensive grazing systems which are better for animal well-being are also much more intensive regarding CH_4 emissions and trade-offs will need to be considered between food quality and climate objectives.

Regarding C2: CEA recommends developing with the private sector new technologies for feed additives reducing CH_4 emissions and optimizing livestock production systems. For manure processing, technologies exist to develop biogas generation and manure collection at farm level that could be favoured to prevent EF of biogas digesters and avoid the risk of inadvertent leaks of CH_4.

Regarding C3: Similarly to the energy sector, regulation for imported meat and animal products could include CH_4 emission intensity.

3. Waste emissions

In this part, we consider organic waste and exclude manure.

Regarding C1: CEA recommends coordinating a comprehensive mapping of landfills and wastewater treatment sources within the EU and their activity (same tools as for the energy sector). For the most intense sources, atmospheric detection may be possible. We recommend focussing on abandoned landfills whose emissions have no clear responsible entity, and to perform emission factors measurement on these overlooked emitting facilities. The use of UAV regular *in situ* measurements, arrays of low-cost *in situ* sensors is appealing to monitor how wastewater treatment and landfills emissions change with time. As they are sensitive to climate, site feedstock and operations, a single emission factor measurement is likely to be insufficient.

Regarding C2: CEA recommends developing with the private sector new technologies to systematically capture and use CH_4 from landfills and wastewater. Industrial processes related to better waste management exist and have a large potential for being deployed for the two types of waste facilities.

Regarding C3: Here, one question is the one of tradeoffs between waste incineration and dumping in landfills, incineration being more efficient for CH_4 reduction but comes with emissions of carcinogenic compounds into the atmosphere. Otherwise, same remark as for the energy sector.

4. Other remarks

CEA recommends coordinating with inventory agencies, DG-CLIMA and the scientific community including Copernicus services to produce a regular synthesis of EU and Members States CH_4 emissions per sector, inclusive of uncertainties and trend analyses. It could serve as a reference information for assessing progress towards agreed upon targets.