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IMPACT ASSESSMENT REPORT

Accompanying the

Proposal for a Regulation of the European Parliament and of the Council

on methane emissions reduction in the energy sector and amending Regulation (EU) 2019/942

{COM(2021) 805 final} - {SEC(2021) 432 final} - {SWD(2021) 460 final}

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Glossary

Term or acronym	***Meaning or definition***
AMM	Abandoned mine methane
BAU	Business as usual
CCAC	Climate and Clean Air Coalition
CEER	Council of European Energy Regulators
CH4	Methane
CMM	Coalmine methane
CTP	Climate Target Plan
DSO	Distribution System Operator
E-PRTR	European Pollutant Release and Transfer Register
ESR	Effort Sharing Regulation
EU	European Union
GAINS	Greenhouse Gas - Air Pollution Interactions and Synergies model
GHG	Greenhouse gases
IA	Impact assessment
IEA	International Energy Agency
IED	Industrial Emissions Directive
IMEO	International Methane Emissions Observatory
IPCC	Intergovernmental Panel on Climate Change
IPIECA	International Petroleum Industry Environmental Conservation Association
KT	Kiloton
LDAR	Leak Detection and Repair
LNG	Liquefied Natural Gas
MRV	Measurement, Reporting, and Verification
MSI	Methane Supply Index
OPC	Open Public Consultation
UNEP	United Nations Environmental Programme
VAM	Ventilation air methane
WTO	World Trade Organization

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

The European Green Deal puts the EU on a path to climate neutrality by 2050 through the deep decarbonisation of all sectors of the economy, in line with the Paris Agreement goal of keeping global temperature increases well below 2°C and pursuing efforts to limit the increase to 1.5°C. The Regulation establishing the framework for achieving climate neutrality ('European Climate Law') made the EU's climate neutrality target by 2050 legally binding, and raised the 2030 ambition, requiring a domestic reduction of net greenhouse gas emissions (emissions after deduction of removals) by at least 55% compared to 1990 levels by 2030[1]. To this end, the Commission is focusing on overhauling the relevant climate and energy legislation to align with the target set out in the Climate Target Plan[2] to reduce greenhouse gas (GHG) emissions by at least 55% by 2030 compared to 1990 levels. While much of the focus of the public discussion has so far been on carbon dioxide emissions, short-lived GHGs such as methane contribute significantly to overall GHG emissions. This contribution is receiving increasing attention, as recognised in the Sixth Physical Science Basis Report of the Intergovernmental Panel on Climate Change, which finds that global warming could be limited by "strong, rapid and sustained reductions in CH4 emissions"[3].

The 2030 Climate Target Plan (CTP) has highlighted methane emissions abatement as a cost-effective way of cutting GHG emissions in the EU. All 2030 CTP and Fit for 55 mitigation scenarios achieving at least 55% GHG reductions[4] include abatement potential for EU methane emissions at low costs. The CTP IA further indicates that a significant part of such reductions stems from the energy system, and this is also further recognised by stakeholders and by international studies[5,6].

The European Green Deal Communication[7] indicates that the decarbonisation of the gas sector will be facilitated, including by addressing the issue of energy-related methane emissions. It also calls on the EU to engage with third countries on cross-cutting climate and environment issues, including via action to reduce methane emissions. In addition, and in response to the request expressed in Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action (the Governance Regulation)[8], the

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[1] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (OJ L 243, 9.7.2021, p. 1).

[2] See EU 2030 Climate Target Plan Impact Assessment, https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en

[3] IPCC (2021) Sixth Assessment Report - Climate Change 2021: The Physical Science Basis, p.21. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf

[4] REG, MIX, CPRICE

[5] IEA (2021) Methane Emissions from Oil and Gas, https://www.iea.org/reports/methane-emissions-from-oil-and-gas

[6] Climate and Clean Air Coalition & United Nations Environment Programme (2021) Global Methane Assessment, https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions

[7] COM(2019) 640 final.

[8] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, http://data.europa.eu/eli/reg/2018/1999/oj

Commission adopted an EU strategy to reduce methane emissions ('the Methane Strategy') in October 2020[9].

The Methane Strategy announces a list of 17 actions across the agriculture, waste and wastewater, and energy sectors, as well as seven international actions[10]. See Box 1 for those most relevant to this initiative.

Box 1. Relevant actions in the methane strategy

- The Commission will deliver legislative proposals in 2021 on:
    - Compulsory measurement, reporting, and verification (MRV) for all energy-related methane emissions, building on the Oil and Gas Methane Partnership (OGMP 2.0) methodology[11].
    - Obligation to improve leak detection and repair (LDAR) of leaks on all fossil gas infrastructure, as well as any other infrastructure that produces, transports or uses fossil gas, including as a feedstock.
- The Commission will consider legislation on eliminating routine venting and flaring in the energy sector covering the full supply chain, up to the point of production.
- As part of the EU's diplomatic and external relations action, the Commission will address methane emission reductions in all relevant sectors with partner countries and promote global coordination of efforts to address energy-sector methane emissions.
- The Commission will support the establishment of a detection-and-alert process for methane super-emitters using EU satellite capability, and share this information internationally through the foreseen international methane emissions observatory[12].

The current context as regards information on methane emissions in the energy sector globally is one of insufficiently precise data in terms of the origin as well as magnitude and nature of these emissions. Detailed explanations are provided in the next section why that is the case. As a result, a key objective of any targeted action to further reduce methane emissions and to assess the effectiveness of such actions is to start by improving the quality of data and information on the sources of methane emissions. This means that currently available data and the projections these are based on, must be treated with caution. Improved availability and robustness of data and information can then serve as a reliable basis for additional targeted measures to further abate methane in the future. At the same time, there are actions that can be taken to curb emissions cost-efficiently that do not require precise data, as there are a number of best practice methane mitigation measures in the energy sector which can lead to effective and rapid reductions in

[9] COM(2020) 663 final

[10] See Annex 3 for a list of all actions contained in the Methane Strategy

[11] The Oil and Gas Methane Partnership 2.0 (OGMP 2.0) is a voluntary methane measurement and reporting standard, which was launched in November 2020. It commits participating companies to undertake source-level methane emission measurements and to report them according to specific criteria tailored to the realities of oil and gas companies across the supply chain. See further Section 2.3.2. http://ogmpartnership.com/

[12] Action 2 of the Methane Strategy: The Commission will support the establishment of an independent international methane emissions observatory anchored in the United Nations framework, in cooperation with international partners. The observatory would be tasked with collecting, reconciling, verifying and publishing anthropogenic methane emissions data at a global level.

methane emissions and which do not rely on accurate quantification of methane emissions from the outset, such as fixing leaks once they are discovered.

In this context, this impact assessment analyses the key issues and legislative options to address methane emissions in the energy sector. This initiative is included in the Commission work programme for 2021 (COM(2020) 690 final) under point g) 'Reducing methane emissions in the energy sector' of the European Green Deal 'Fit For 55 Package'.[13]

2. Problem definition

2.1. What are the problems?

Methane is a powerful greenhouse gas, second only to carbon dioxide in its overall contribution to climate change and responsible for about one third of current climate warming[14]. Although it remains in the atmosphere for a shorter period of time than CO2 (10-12 years compared to hundreds of years), on a molecular level, methane is a far more powerful climate forcer (with a GWP of 28 times that of CO2 over 100 years and a GWP of 86 over 20 years). In addition to the significant short-term effect on the climate, methane contributes to ozone formation, which is a potent local air pollutant that causes serious health problems, before oxidizing into carbon dioxide that continues to trap heat and affect the climate for a much longer time-frame. During their 10-12-year atmospheric lifetime, methane emissions originating from one country disperse and affect others, causing - in addition to their global warming effect illnesses, premature deaths, and losses in agricultural harvests not only at the point of origin but on a much wider geographical scope[15,16].

The global mean methane concentration in the atmosphere has risen sharply over the last decade. In 2019, concentrations of methane were higher than at any time in at least 800,000 years[17], and 2020 exhibited the fastest growth rate in the 37-year record maintained by the National Oceanic and Atmospheric Administration (NOAA)[18].

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[13] Interlinkages with other relevant EU initiatives are described in Annex 6.

[14] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[15] Van Dingenen, R., Crippa, M., Janssens-Maenhout, G., Guizzardi, D. and Dentener, F., Global trends of methane emissions and their impacts on ozone concentrations, EUR 29394 EN, Publications Office of the European Union, Luxembourg, 2018, doi:10.2760/820175, JRC113210.

[16] European Commission COM(2020) 381 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381

[17] IPCC AR6, (2021). IPCC, 2021: WGI Climate Change 2021The Physical Science Basis. WGI Climate Change 2021The Physical Science Basis Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, p.4110, https://www.ipcc.ch/report/ar6/wg1/

[18] Climate and Clean Air Coalition & United Nations Environment Programme (2021) Global Methane Assessment, https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions

Correspondingly, reductions in methane emissions can have positive near-term effects in reducing the rate of global warming as well as air quality benefits. According to recent estimates, global methane emission reductions of 45% by 2030, based on available targeted measures and additional measures in line with UN priority development goals, could avoid 0.3°C of global warming by the 2040s[19].

Relevance of the energy sector

Approximately 40% of global methane emissions are thought to come from natural sources (biogenic), like wetlands or wildfires[20]. The remaining 60% are anthropogenic, of which the largest sources, based on estimations, are agriculture (around half of total anthropogenic methane emissions) – in particular linked to intensive production – fossil fuel production and use (between a fourth and a third), and waste (around a quarter)[21].

In the EU, around half of anthropogenic methane emissions are estimated to come from agriculture, a quarter from waste and a fifth from energy[22]. This distribution across sectors only takes into account domestic emissions, and given that the EU currently imports more than 90% of the fossil fuels consumed in the EU[23], would change drastically if emissions occurring outside of EU borders, but associated with EU fossil energy consumption were to be taken into account. A large portion of the methane emissions linked to EU fossil energy consumption is deemed to occur during the production phase of that energy, as well as along its transmission phase (especially in the context of fossil gas) to the EU. Some estimations have been carried out of the magnitude of such methane emissions (specifically linked to EU consumption but occurring outside the EU). One such estimation is for fossil gas and it concludes that, depending on the methodology employed, results can vary widely – from an order of magnitude of between 3 to 8 times the level of methane emissions from the fossil gas value chain occurring within the EU borders[24,25]. The IEA estimates that in 2020, methane emissions associated with imported oil and gas to the EU represented around 9,000 kilotonnes of

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[19] Ibid

[20] International Energy Agency (IEA), World Energy Outlook, (2018), https://edgar.jrc.ec.europa.eu/overview.php?v=50_GHG.

[21] Note that, while the overall concentration of methane in the atmosphere is a reliable figure, estimates of the distribution of emissions across sectors and sources are currently subject to considerable uncertainty and should be treated with caution, as further discussed below.

[22] European Environment Agency (EEA), (2018). EEA greenhouse gas - data viewer. https://www.eea.europa.eu/ds_resolveuid/f4269fac-662f-4ba0-a416-c25373823292.

[23] European Commission (2021) EU energy in figures, statistical pocketbook and country datasheets (June 2021) https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en

[24] Carbon Limits. Value chain methane emissions from natural gas imports in Europe. https://www.carbonlimits.no/wp-content/uploads/2020/10/Methane_Value-Chain_Carbon-Limits.pdf

[25] Note that a similar issue is receiving attention through the development of the Imported Flare Gas Index by the World Bank, which identifies the exposure of oil importing countries to flaring activities in the source countries. However, the index is specific to primarily the carbon-intensity of imported oil linked to flaring rather than methane emissions. World Bank (2021) Global Gas Flaring Tracker Report. https://thedocs.worldbank.org/en/doc/1f7221545bf1b7c89b850dd85cb409b0-0400072021/original/WB-GGFR-Report-Design-05a.pdf

methane[26]. This compares to 1,033 kilotonnes of methane emissions from oil and gas estimated to have occurred in 2019 in the EU[27]. While the share of total global man-made methane emissions emitted in Europe is estimated to be around 6%[28], the consumption of, and import dependency for, fossil fuels produced outside the EU hence adds significant levels of methane emissions that are incurred because of consumption within the EU.

Emissions from the waste sector are covered by existing and upcoming planned reviews of environmental legislation. For the agriculture sector, a number of challenges are addressed in the 'Farm to Fork' strategy[29]. The energy sector currently offers the most cost-effective methane emissions savings potential[30].

Emission estimates

As party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, the Union is required to provide annually an inventory report of anthropogenic greenhouse gas emissions constituting an aggregate of the member States national greenhouse gas inventories, prepared using good practice methodologies accepted by the Intergovernmental Panel on Climate Change (IPCC).. The EU emissions data used in this report are taken from that EU inventory report, which represents a compilation of national inventories, based on the emissions reported by EU Member States under the EU Climate Monitoring Mechanism Regulation[31], followed by the integrated reporting system of the Governance Regulation. The Governance Regulation requires Member States to establish national inventory systems to estimate anthropogenic emissions of GHGs and to report their national projections. This reporting is done using IPCC guidelines, and is often based on default emission factors rather than direct source-level measurements, implying uncertainties regarding the precise origin, frequency and magnitude of emissions and was deemed to be significantly underestimated by certain studies[32], see further section 2.2.1.

[26] Curtailing methane emisisons from fossil fuel operations (2021), IEA: https://iea.blob.core.windows.net/assets/585b901a-e7d2-4bca-b477-e1baa14dde5c/CurtailingMethaneEmissionsfromFossilFuelOperations.pdf

[27] EU 2021 GHG inventory (2019 data).

[28] Van Dingenen, R., Crippa, M., Janssens-Maenhout, G., Guizzardi, D. and Dentener, F., Global trends of methane emissions and their impacts on ozone concentrations, EUR 29394 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96550-0, doi:10.2760/820175, JRC113210.

[29] European Commission COM(2020) 381 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381

[30] Climate Target Plan Impact Assessment

[31] Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R0525

[32] As the Clean Air Task Force outlines in its Report on Benchmarking Methane and Other GHG Emissions of Oil & Natural Gas Production in the United State (2021, p.8): "Default emission factors do not represent actual emissions. The use of emission factors to estimate total emissions relies on the emissions factor being representative of average emissions for a given activity. This approach can be effective where there is robust data on emissions per unit of activity. For example, automobile emissions are routinely and reliably estimated using emission factors despite the fact that emissions from a single vehicle may be different than predicted by an emission factor. With a diversity of emission sources and the

In the most recent EU GHG inventory submission to UNFCCC[33], methane emissions in the EU energy sector are estimated at 3.1 million tonnes (see Annex 7 for more detailed data)[34].

Table 1: Split of energy-related methane emissions per sub-sector in the EU as reported to the UNFCCC in the April 2021 GHG Inventory Submissions (2019 data)

EU energy-related CH4 emissions		
Category	**Kt CH4**	**Share**
Incomplete combustion of fuels	974	31%
Coal	1002	32%
Leaks from oil	44	1%
Leaks from fossil gas	847	27%
Venting and flaring from oil	118	4%
Venting and flaring from fossil gas	24	1%
Biogas	75	2%
Other	32	1%
Total	**3116**	**100%**

A distinction is made throughout this document between direct emissions, which are caused directly by an organisation's activity, and indirect emissions from incomplete combustion (see Figure 1). Direct emissions can be either fugitive/unintentional, e.g. from leaks, or intentional. The latter are either from venting, flaring (which always releases an amount of unburnt gas in form of methane slip), or from the normal operation of machinery. Indirect methane emissions occur when oil, fossil gas or coal are used or processed in the production of other products or used as fuels and incomplete combustion occurs. Incomplete combustion represents almost a third of estimated energy sector related methane emissions in the EU.

presence of low frequency, high emission events, the use of emission factors is significantly less reliable in the oil and gas sector, and typically underestimates actual emissions […].”

[33] As party to the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), the EU is required to provide annually an inventory report of anthropogenic greenhouse gas emissions within its territory.

[34] April 2021 EU GHG Inventory Submission to UNFCCC (2019 data)

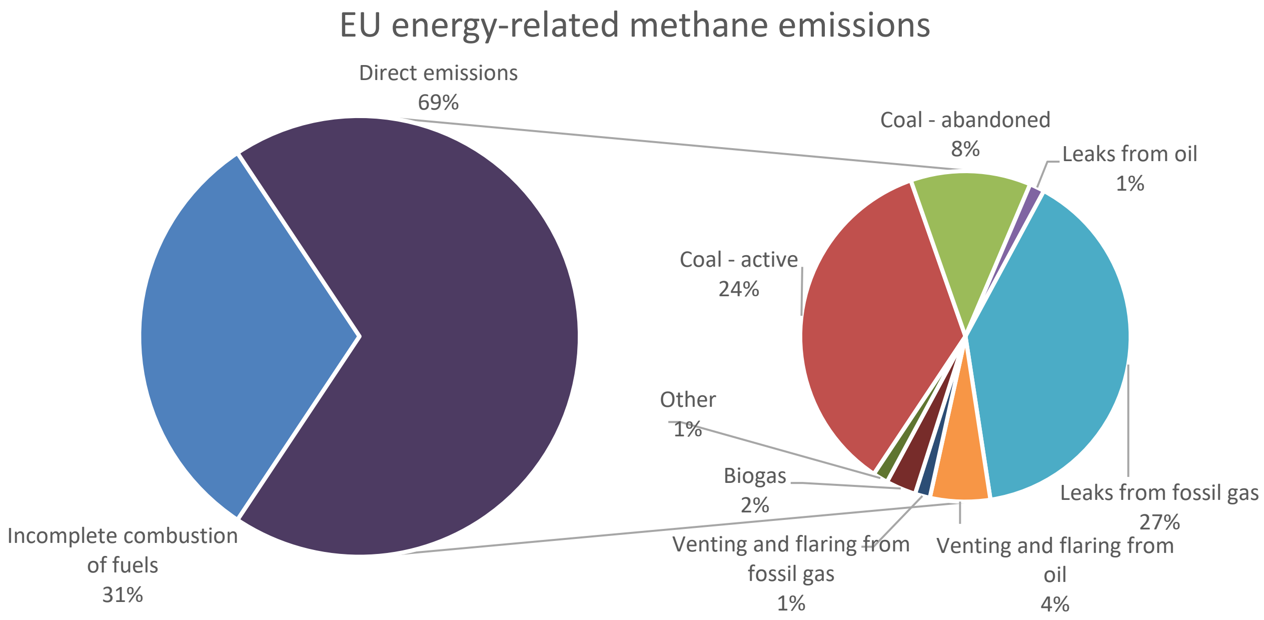

Figure 1: Split of energy-related methane emissions in the EU as reported to the UNFCCC in the April 2021 GHG Inventory Submissions (2019 data)

Based on the estimates contained in the 2021 GHG Inventory Submissions and keeping the limitations of this data in mind, more than half of the around 70% of all direct energy sector emissions within the EU is estimated to come from unintentional releases[35]. Coal mining is estimated to be responsible for 32% of EU energy sector methane emissions, composed of 24 percentage points (pp) from ongoing mining activities (which are intentional emissions) and 8pp from abandoned mines. Fossil gas represents 28% of the methane emissions, of which 27pp are estimated to be from leaks and 1pp from intentional emissions of methane into the atmosphere. For oil, leaks represent 1% of overall estimated energy emissions, and intentional releases another 1%. A split of reported fugitive emissions by Member States and reporting category per fuel is available in Appendix 6. The data further highlights the generally high share of fugitive methane emissions among total reported energy sector emissions across most Member States (see Figure 2).

[35] 70% of total methane emissions in the energy sector are estimated to stem from direct emissions. 27 percentage points (pp) come from leaks from fossil gas, 1pp from leaks from fossil oil, and 8pp from abandoned coal mines, providing a total of 38pp of total methane emissions, and just over half of direct emissions (see Table 1 and Section 2.1 E*mission estimates*).

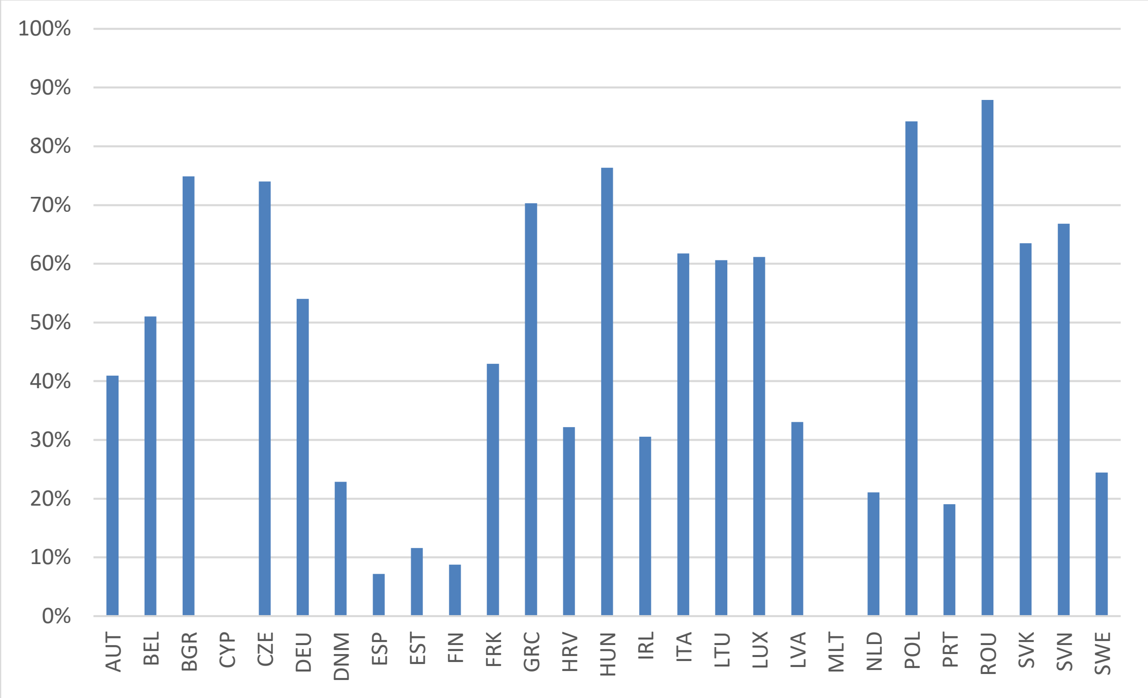

Figure 2: Share of fugitive methane emissions in total energy sector methane emissions as reported in the 2021 GHG inventories submitted to UNFCCC (2019 data)
Note: Includes fugitive emissions from coal, oil, natural gas, venting and flaring, and other emissions from energy production

2.2. What are the problem drivers?

Reductions of methane emissions in the energy sector are hindered by the following challenges and problem drivers, which will be discussed below:

1) A lack of precise information on emission sources and quantities.
2) Lack of sufficient incentives to mitigate planned and unplanned methane emissions.
3) Lack of information on and mitigation of methane emissions occurring outside the EU but linked to consumption of fossil energy in the EU.

The first two problem drivers specifically address the situation with respect to methane emissions within the EU, while the third driver describes the mechanisms hindering the reduction of emissions linked to EU imports.

2.2.1. No precise information on emission sources and quantities

Whereas CO2 emissions typically occur during the combustion of fuels or during industrial processes at well-identified points - thus with clear emission sources and comparably straight forward measurement options - methane emissions are often diffuse, can occur along the entire supply chain, and are as a result more difficult to measure and accurately quantify, leading to substantial uncertainty about current emissions levels.

The lack of availability of precise data and identification of the magnitude of the various sources of emissions is the key challenge to the abatement of those emissions. Current means of methane emission quantification are primarily based on estimation rather than direct measurement and are fragmented across sectors and Member States. When operators do not have precise knowledge on their emissions, e.g. in the case of unintentional fugitive emissions through leaks, action to mitigate such emissions is commonly driven principally by safety considerations. The lack of an accurate data basis hinders the development and implementation of measures for the mitigation of methane emissions in the energy sector. This is widely recognised among experts, and it is a key premise of the voluntary Oil and Gas Methane Partnership on measuring and reporting of methane emissions by companies (see further Section 2.3.2).

A lack of information also implies limited possibilities for competent authorities and civil society to engage with the issue. Especially in the case of intentional releases of methane emissions, a lack of data accessibility adds a problem of information asymmetry between polluters and society. With technological improvements over recent years, such as increasing satellite observation capacities and availability of specialised cameras, recent international studies by commercial companies, NGOs and academia have identified and brought to public attention significant emission events and super-emitters around the globe[36], as well as highlighted substantial discrepancies between reported and observed emissions[37].

Country data reported pursuant to UNFCCC Reporting Guidelines is submitted to the UNFCCC secretariat according to different tiers of reporting, and it is recommended to use higher tier levels of accuracy for estimating emission sources that have a large contribution to total emissions in a country (e.g. those sources falling within 95% of total emissions). A tier represents a level of methodological complexity. Three tiers are

[36] For EU infrastructure, recent observations made by the Clean Air Task Force using optical gas imaging cameras identified a number of leaks at sites across multiple Member States, see https://cutmethane.eu/ and related news coverage, e.g.: Reuters (24 June 2021) Gas infrastructure across Europe leaking planet-warming methane, https://www.reuters.com/business/environment/exclusive-gas-infrastructure-across-europe-leaking-planet-warming-methane-video-2021-06-24/; Der Standard (26 August 2021) OMV remains under attack over methane leaks in Romania / OMV bleibt wegen Methanlecks in Rumänien unter Beschuss. https://www.derstandard.at/story/2000129170336/omv-bleibt-wegen-methanlecks-in-rumaenien-weiter-unter-beschuss

For a recent analysis of super-emitting events see: Lauvaux, T., Giron, C., Mazzolini, M., d'Aspremont, A., Duren, R., Cusworth, D., Shindell, D. and Ciais, P., 2021. Global Assessment of Oil and Gas Methane Ultra-Emitters; T.. arXiv preprint arXiv:2105.06387, https://arxiv.org/abs/2105.06387..

For recent press-coverage of leaks identified by satellites see, e.g., Bloomberg/Clark, A. & Khrennikova, D. (18 June 2021) Huge Methane Leak Spotted by Satellite Came From Gazprom Pipeline, https://www.bloomberg.com/news/articles/2021-06-18/gazprom-admits-to-massive-methane-leaks; Reuters/Nasralla, S. (26 June 2020) Satellites reveal major new gas industry methane leaks, https://www.reuters.com/article/us-climatechange-methane-satellites-insi/satellites-reveal-major-new-gas-industry-methane-leaks-idINKBN23W3K4.https://www.reuters.com/article/us-climatechange-methane-satellites-insi/satellites-reveal-major-new-gas-industry-methane-leaks-idINKBN23W3K4.

[37] Research carried out on behalf of the Environmental Defence Fund between 2012 and 2018 shows actual emissions in the US oil and gas supply chain to be around 60% higher than those reported to the US EPA, see Alvarez et al. (2021) Assessment of methane emissions from the U.S. oil and gas supply chain. Science, 13 Jul 2018: Vol. 361, Issue 6398, pp. 186-188.

available (see box). Progressing from tier 1 to tier 3 represents an increase in the certainty of methane estimates[38].

Box 2. UNFCCC GHG emissions reporting tiers (UNFCCC Resource Guide)[39]

Different methods can be used to estimate emissions or removals from most source and sink categories. The selection of a particular method will depend on the desired degree of estimation detail, the availability of activity data and emission factors, and the financial and human resources available to complete the inventory. In IPCC terminology, the lowest ranking or simplest method is "Tier 1", while more elaborate methods are "Tier 2" and "Tier 3."

Tier 1 methods typically utilise IPCC default emission factors and require the most basic, and least disaggregated, activity data. Higher tiers usually utilise more elaborate methods and source-specific, technology-specific, region-specific and/or country-specific emission factors, which are often based on measurements, and normally require more highly disaggregated activity data. Tier 2 and 3 methods require more detailed data and/or measurements for their application. Specifically, tier 2 requires country-specific, instead of default, emission factors to be used while tier 3 requires plant-by-plant data or measurements and comprises the application of a rigorous bottom-up assessment by source type at the individual facility level. In cases where a national methodology exists, which is consistent with the IPCC Guidelines, it is highly advisable to use the national methodology. This methodology should be fully documented in order to allow the reader to understand why this particular method is better than the default one proposed by the IPCC.

There are however no mandatory requirements to report direct source-level measurements as part of the national inventories reporting requirements. The UNFCCC does not require their submission, as reporting at tier 2 level for large emission sources is in line with IPCC guidelines as tier 2 is considered a higher tier method. Estimation methodologies and reporting of methane emissions hence varies across Member States, and a significant share of methane emissions in the EU energy sector, i.e. those estimated using default methods, are arguably less accurate than other emission categories estimated using higher tier methods[40]. The use of default emission factors means that the estimated emissions are less representative of national circumstances, and therefore less accurate, and may for each specific case underestimate or overestimate actual emissions for those categories. Note that the uncertainty about the size and direction of bias in the

[38] IPCC (2019) 2019 Refinement to the 2006 IPCC guidelines for national greenhouse gas inventories, https://www.ipcc.ch/site/assets/uploads/2019/12/19R_V0_01_Overview.pdf

[39] UNFCCC (2009) Resource Guide for preparing the National Communications of Non-Annex I Parties – Module 3 National Greenhouse Gas Inventories, https://unfccc.int/resource/docs/publications/09_resource_guide3.pdf

[40] The Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER) submitted a survey among their members as informal contribution to the open public consultation, expressing the view that "NRAs broadly support an EU-level harmonised approach to methane emissions monitoring and detection, based in particular on mandatory monitoring of methane emissions."

estimation of emissions from specific sources using emission factors makes any correlation between the use of methodology and accuracy of reported emissions difficult.

- For coal mining, most Member States report their methane emissions at tier 1 or tier 2 levels. While a few Member States' reporting for operating mines is also done at level 3, this is not the case for emissions from non-operating or abandoned mines, all emissions for which are either estimated using tier 1 or tier 2 methodologies.
- For fugitive emissions from the gas sector, the large majority comes from gas transmission, distribution or storage, and methane emissions estimation approaches in those sub-sectors vary greatly among Member States. For transmission and storage, a few Member States use very detailed tier 2 or 3 approaches (Belgium, Germany, Finland, Latvia, the Netherlands, Austria, and Sweden) and others (eleven Member States) use only a tier 1 approach. For distribution, almost half of Member States use a tier 1 approach or do not report methane emissions from this source. Other Member States use approaches that are more detailed, although the most commonly used is the tier 2 approach.
- For oil emissions, the largest source of which is from production and processing, the majority of EU countries apply a tier 1 method for estimating methane emissions[41].

For methane emissions occurring outside of the EU but specifically linked to fossil energy consumed in the EU, not all countries exporting fossil fuels to the EU submit inventories to the UNFCCC (see further Section 2.2.3), and for those that do, data quality is dependent on the methodologies used. Data is also not disaggregated according to domestic use and exports in the greenhouse gas inventories submitted to UNFCCC. The consequence is that there is no precise knowledge, nor any robust estimations, of either the magnitude, origin or nature of methane emissions resulting from EU consumption but occurring outside the EU territory.

2.2.2. Lack of sufficient incentives to mitigate planned and unplanned methane emissions.

The lack of accurate information on the extent and the sources of emissions are a significant barrier to public and private business awareness of the origin and effects of methane emissions and to tackling them. Furthermore, there is a substantial market failure in the form of negative externalities associated with methane emissions not being fully internalised by polluters, but costs accruing to societies at large in coping with climate warming effects as well as direct health and economic impacts. Section 6 will provide further details on the significant difference between the relatively low costs of a large share of methane emission abatement possible via specific measures in the sub-sectors included in the scope of this report and the costs to society of methane emissions. The resulting lack of information may equally imply a lack of awareness by polluters themselves, leading to inefficient allocation of resources from the point of view of GHG emission abatement.

[41] See national greenhouse gas inventories submitted to UNFCCC

Even in cases when operators have good awareness of their emissions, the market failure of a lack of internalisation of the costs of the environmental externalities impedes incentives for operators to address the issues.

Operators have two principal incentives to curb methane emissions: first, methane has heating and energetic, and therefore economic, value; second, methane is extremely flammable and may explode if it comes into contact with a heat source. These characteristics explain why, traditionally, the choice of abatement of methane emissions in the energy sector has been the result of net cost/risk trade-offs[42], without taking much else into consideration. As long as environmental considerations are not given sufficient relevance in this trade-off due to a lack of internalisation of the costs of the externalities of methane emissions, even cost-effective abatement measures may not be undertaken if other investments are prioritised for private returns.

However, even if economic considerations are a key factor in the decisions taken by operators to abate their methane emissions, there may be reasons why they do not undertake all the abatement that is cost effective from their perspective, even if they have that information. Operators may choose to abate only the emissions that are necessary to avoid for safety considerations, allowing other methane emissions to continue even if they would be cost effective to abate. This might be due to the fact that even cost effective abatement will require upfront investment, while returns will accrue at a later stage. Operators may consider that if risk to safety is low, such investments should be expanded elsewhere, on other projects which are also cost effective. In such cases, operators will typically base their abatement decisions, taking into account risk to safety, on the size of methane losses. Small losses, such as from small leaks, might not be repaired even if this could be done at low cost. This might well be sub-optimal from an environmental perspective, as small losses might amount to large losses over a certain period of time. Indeed, as long as environmental considerations are not given sufficient relevance in the above trade-off due to a lack of internalisation of the costs of the externalities of methane emissions, even cost-effective abatement measures are not undertaken if other investments are prioritised instead. As projections of methane emission reductions in the EU energy sector reveal (more details in section 6.2), a business as usual scenario will not achieve all possible economically or socially/environmentally cost effective abatement, and large amounts of additional methane emission abatement (on top of the baseline) are possible in the sectors included in the scope of this report, a significant share of which can be achieved at negative to zero net costs[43].

[42] This trade-off only incentivises emission mitigation where it poses a safety risk or creates sufficient direct economic benefit to the operator, i.e. when the value of the saved saleable gas clearly outweighs the costs of intervention. However, such benefits are subject to the perceptions and focus of the operator, as for instance seen in the venting or flaring of associated gas in oil production, where it may be considered a waste product rather than a valuable commodity.

[43] See Section 6.2.1 for further details and definitions of cost-effectiveness. Note that measures that are cost-effective from a societal point of view may not be cost-effective for a company, in line with the market failure caused by the externalities of methane emissions. However, even measures that would be cost-effective from a company perspective may not be undertaken due to a lack of awareness of emissions and their associated costs, or due to the allocation of scarce resources to potentially more profitable investments.

In addition, operators have different approaches to assessing safety risk, especially in the case of inexistent or non-prescriptive national regulations[44]. Safety risk needs to be properly considered in any measures to be adopted with the aim to further reduce methane emissions in the energy sector, not only to ensure a homogenous approach among operators but also to ensure that such measures do not lead to unintended consequences with regards to safety. This is something which is considered in further detail in section 5.2.3 where the approach taken in the options which include measures on leak detection and repair and on venting and flaring are described in detail.

Independent of the continued consumption of fossil energy carriers in the coming decades (see Section 5.1), the need for methane emission monitoring and abatement is also required once production has halted. For the coal sector in particular, methane emissions remain an important issue once mining operations are terminated, as mines can continue to emit methane for decades after operations have stopped[45]. Similar concerns surround non-operating oil and gas production sites, e.g. in the case of abandoned boreholes and well-heads[46].

Methane emissions are included in the scope of the union greenhouse gas reduction targets for 2030 set out in the European Climate Law[47] and the binding national emission reduction targets under Regulation (EU) 2018/842[48]. However, there is currently no Union level legal framework setting out specific measures for the reduction of methane emissions occurring at the level of upstream oil and fossil gas exploration and production, fossil gas gathering and processing, transmission, distribution, underground storage and liquid fossil gas (LNG) terminals, operating underground and surface coalmines, closed and abandoned underground coal mines. More specifically (see also Table 2):

- The EU Emissions Trading System (EU ETS) does not presently regulate methane-emitting activities due to their diffuse nature and the associated challenges of monitoring and reporting of leakage at individual installation level.

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44 For more details on national regulations, see sections 2.2.2.1 and 2.2.2.2 below. As regards different approaches taken on safety risk, the GIE MARCOGAZ survey referenced in section 2.2.2.1 revealed for instance that among the national requirements in place in the EU, the frequency of LDAR surveys and of leak quantification varied significantly, and that the approach taken in terms of required time to repair leaks aslo varies significantly. In addition, annex V of the GIE MARCOGAZ report to the June 2019 Madrid Forum (Potential ways the gas industry can contribute to the reduction of methane emissions, June 2019), on the LDAR practices of gas operators in the EU reveals that the frequency of monitoring leaks in ditribution systems varies significantly in the EU depending on leak factors, which are also different from one EU Member State to another.

45 N. Kholod et al (2020) Global methane emissions from coal mining to continue growing even with declining coal production, Journal of Cleaner Production, Volume 256, 120489

46 UNEP & CCAC (2021) Global Methane Assessment, p.20&p.91. See also press reporting about emissions from abandoned sites, e.g. in the US: https://www.reuters.com/article/us-usa-drilling-abandoned-specialreport-idUSKBN23N1NL

47 Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (OJ L 243, 9.7.2021).

48 Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (OJ L 156, 19.6.2018).

This is a necessary requirement before methane-emitting activities could be included in the EU ETS.

- Methane is included in the current Effort Sharing Regulation (ESR)[49] and maintained in the proposal for revision adopted on 14 July 2021[50], which contains binding annual greenhouse gas emission targets at country level for Member States from 2021 to 2030 for sectors including transport (without aviation), buildings, agriculture, non-EU ETS industry, waste and parts of the energy sector. The ESR does not include sectoral measures or targets and Member States have the flexibility to decide how to achieve the required mitigation across sectors and different greenhouse gases. As such, it does not contain any general or sector-specific requirements or tools for its implementation, and thus does not provide specific incentives for companies in the sectors within the scope of this present proposal (coal, oil upstream, gas upstream, midstream and downstream - LNG, gas storage, transmission and distribution) to cut down their methane emissions. Taking this into account, further action will be complementary to the ESR and will facilitate achieving the targets set out under the ESR. Specific action in the energy sector is warranted for a number of reasons (further detailed and explained in this section and in section 6):
    - The persistence of large amounts of methane emissions in the energy sector within the EU;
    - The projection of large amounts of additional methane emission abatement on top of the baseline that are possible in the sectors included in the scope of this report, a significant share of which can be achieved at negative to zero net costs;
    - The absence of such specific measures in a large number of EU Member States and the fact that EU action via specific measures to curb methane emissions in the energy sector will help Member States to achieve their ESR targets and can also contribute to increasing the cost-effectiveness of achieving those targets due to the trading potential in the ESR between Member States;
    - Other than specific EU measures to further mitigate methane emissions, this report assesses options to achieve better and more accurate information on the origin, magnitude and nature of methane emissions in those sectors. This will incentivise operators to have a better understanding of their methane emissions, thereby allowing them to achieve further effective abatement of their emissions and in so doing, will further help EU Member States fulfil their ESR targets.
- Methane is included in the Industrial Emissions Directive (IED)[51] which regulates pollutant emissions from industrial installations. It requires installations

[49] https://ec.europa.eu/clima/policies/effort/regulation_en
[50]https://ec.europa.eu/clima/policies/effort/regulation_en
https://ec.europa.eu/info/sites/default/files/proposal-amendment-effort-sharing-regulation-with-annexes_en.pdf
[51] https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

undertaking certain industrial activities to operate in accordance with a permit and conditions which include emission limit values based on best available techniques. The scope of the IED however excludes all fossil gas upstream, mid and downstream (LNG, underground gas storage, transmission, distribution), oil upstream as well as coal mining/extraction. The scope of the IED covers only methane emissions from the refining of mineral oil and gas, which are not covered by this initiative. Thus every sub-sector within the scope of this report (oil and gas production, LNG, underground gas storage, transmission, distribution and coal mining) is not covered by the IED. The ongoing revision of the IED will take into account the sub-sectors included in this proposal with a view to avoid double regulation and to ensure that this proposal is complementary to the IED.

- Methane emissions occurring in space heating and cooling appliances (included in inventories as part of what we term indirect emissions) are covered in several Ecodesign and Energy Labelling regulations[52], which provide rules for improving the environmental performance of products, such as household appliances, information and communication technologies or engineering. The Ecodesign Directive sets out minimum mandatory requirements for the energy efficiency of these products. The Energy Labelling Regulation complements ecodesign requirements with mandatory labelling requirements for the information of consumers.

- The European Pollutant Release and Transfer Register (E-PRTR) contains data reported by individual industrial facilities above a certain size threshold to their national authority on the quantities of pollutants released into the air, water and land within the EU territory[53].While it includes methane among the pollutants covered, its limitation to individual facilities and certain activities does not provide the necessary scope along the full energy supply chain; it does not cover all fossil gas upstream, mid and downstream (LNG, underground gas storage, transmission, distribution) as well as coal mining/extraction.

The above clearly demonstrates a lack of appropriate incentives and regulatory framework for the mitigation of methane emissions in key methane emitting energy sub-sectors (see also Annex 6 for more details).

There are a number of voluntary initiatives covering the oil and gas sectors, among which:

- The Oil and Gas Methane Partnership (OGMP) voluntary initiative on measuring and reporting of methane emissions[54].

- The Oil and Gas Climate Initiative (OGCI)[55] partner companies have committed to reducing the collective average methane intensity of their aggregated upstream

[52] https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign_en

[53] https://ec.europa.eu/environment/industry/stationary/eper/legislation.htm

[54] https://globalmethane.org/challenge/ogmp.html#:~:text=The%20Oil%20and%20Gas%20Methane,in%20the%20oil%20and%20gas

[55] https://www.ogci.com/

oil & gas operations to below 0.25 % by 2025 (from a baseline of 0.32 % in 2017), with an ambition to achieve a level of 0.2 %.

- The Methane Guiding Principles[56], which is focused on areas of action to reduce methane emissions in the oil and gas sector, notably via its best practice guides[57], designed to help oil and gas companies develop methane management plans.
- The Global Methane Alliance[58], with the aim to significantly reduce methane emissions in the oil and gas sector by 2030.
- GIE/MARCOGAZ have published a number of reports and guides advising the fossil gas industry on measures to reduce its methane emission reductions[59].

A number of oil and gas companies have also voluntarily committed to methane emission reduction targets[60].

In and of themselves voluntary initiatives are, however, unlikely to provide sufficient sectoral coverage, transparency, and enforceability (see further Section 2.3.2). For instance, even the currently most ambitious voluntary initiative on MRV of the Oil and Gas Methane Partnership (OGMP) only covers around 30% of the world's oil and gas production.

In April 2021, Member States were requested through the Council Working Party on Energy to provide information on the regulatory framework on methane emission monitoring and mitigation in their respective jurisdictions. Unfortunately, no direct feedback to this request was received by September 2021. A few submissions by Member States containing information on national rules were received for the open public consultation[61]. With this basis, constraints of capacity and time prevent a complete overview of rules in place in Member States. Surveys conducted by GIE-MARCOGAZ among their members on the Commission's request on LDAR and venting & flaring, respectively, portray a picture of often non-existing or insufficient rules in place, and substantial divergence in scope and granularity of rules across Member States. The results of the surveys are further discussed in the relevant Sections 2.2.2.i and 2.2.2.ii below.

Whilst the overall market failure of a lack of internalisation of externalities is relevant regardless of origin, precise scope for mitigation, and current regulatory treatment across Member States, the lack of incentives to mitigate methane emissions needs to be considered differentially for unintentional and intentional releases of methane and across sectors.

[56] https://methaneguidingprinciples.org/about/
[57] https://methaneguidingprinciples.org/best-practice-guides/
[58] https://www.ccacoalition.org/en/activity/global-methane-alliance
[59] These include the following: https://www.gie.eu/publications/methane-emission/methane-emissions-report/; https://www.gie.eu/wp-content/uploads/2021/05/Guidelines-for-methane-target-setting_Final.pdf; https://www.marcogaz.org/publications/recommendations-on-ldar-campaigns/; https://www.marcogaz.org/publications/recommentations-on-venting-and-flaring/
[60] See in IOGP/GIE/MARCOGAS report on guidelines for methane emissions target setting, April 2020
[61] Denmark, Hungary, Netherlands, Latvia, and Spain

Table 2: Overview of existing EU legislation and voluntary initiatives covering methane emissions

	Methane in scope	Emission reporting requirement/ Level of emission reporting	Mitigation requirement/ Description of type of requirement	Directly applicable provisions on specific mitigation measures			Sectoral coverage				Industry coverage
				LDAR	Venting	Flaring	Oil or gas production, gas transmission, oil or gas storage, LNG, gas distribution.			End-use	
							Oil	Gas	Coal		
EU legislation											
ETS	No	None	None	No	No	No	No	No	No	No	
ESR	Yes	Yes/ Member State level**	Overall GHG reduction target but no specific CH4 targets ***	No	No	No	Yes	Yes	Yes	Yes	
IED	Yes	Yes/ Installation level	Permits and BATs, applies to large industrial installations	No	No	No	No †	No †	No	Yes	
Eco design	Yes	None	Emission limits by design	No	No	No	No	No	No	Yes††	
E-PRTR	Yes	Yes/ Facility level	None	No	No	No	No	No*	Yes	Yes	

Voluntary initiatives											
Oil & Gas Methane Partnership	Yes	Yes/ up to facility level	None	No	No	No	Yes	Yes	No	No	30% of global oil and gas production[62]
Global Gas Flaring Reduction Partnership[63]	Yes	None	Ban	No	No	Yes	Yes	No	No	No	40%[64]
Zero Routine Flaring by 2030 Initiative[65]	Yes	Yes/ Member State or	Ban	No	No	Yes	Yes	No	No	No	60% of global gas flared[66]
Oil and Gas Climate Initiative[67]	Yes	Company (asset based)	Intensity target	No	No	No	Yes †††	Yes †††	No	No	32% of global oil and gas production[68]

* includes LNG terminals
** through Reg 525/2013: monitoring and reporting greenhouse gas emissions
*** the ESR emissions target is for GHG overall, no specific sub-target for methane is set.
† Note that the IED includes the category of refining of mineral oil and gas
†† specifically applicable for specific end-use product categories, e.g. solid fuel local space heaters
††† Upstream operations only

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[62] http://ogmpartnership.com/
[63] https://www.worldbank.org/en/programs/gasflaringreduction
[64] DG ENER correspondence with the World Bank
[65] https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030
[66] Ibid
[67] https://www.ogci.com/
[68] https://www.ogci.com/wp-content/uploads/2019/10/OGCI-Annual-Report-2019.pdf

2.2.2.1. Unintentional release of methane

More than half of all direct energy sector methane emissions is estimated to come from unintentional release of emissions into the atmosphere (see Section 2.1 *Emission estimates*). The countries reporting the highest methane emission estimates in the energy sector are Poland, Germany, Romania, Italy, Czech Republic, and Hungary[69], all of which have a ratio of fugitive emissions above 50% of total reported energy sector methane emissions (see Figure 2).

In the case of oil and gas, the largest proportion of methane emissions in the EU is estimated to come from leaks from various points along the supply chain[70]. Leaks can occur during drilling, extraction as well as processing, storage, transmission and distribution to end-use consumers[71]. Some emissions can result from imperfections in, or ordinary wear and tear of, technical components such as joints, flanges and valves, among others, or damaged components, e.g. in case of accidents. Corrosion or damage can also cause leaks from the walls of pressurised equipment[72]. Methane emissions from leaks are most commonly reduced by periodic Leak Detection and Repair (LDAR) surveys/programs that comprise inspections to identify leaks followed by repair[73]. LDAR programmes are traditionally driven by safety considerations[74]. However, leak detection practices, frequencies, type and granularity of assets covered and hence effectiveness of LDAR as well as efforts to quantify fugitive emissions vary widely across Member States. Lack of detection and quantification of emissions from leaks further contributes to the uncertainty surrounding estimates of methane emissions in the fossil fuel supply chain discussed under section 2.2.1[75]. A lack of mitigation of emissions from leaks contributes to continued and increasing emissions where small leaks are left to develop into large leaks[76].

In the EU, legislation on LDAR exists only at the national level in a few Member States. A survey conducted among mid and downstream gas companies by GIE-MARCOGAZ on request of the Commission returned responses from companies operating in 18 Member States. Of those 18, 13 were identified as having some form of rules on leak detection in place, and five as not having any binding rules. Among the 13 countries indicated to have rules in place, respondents described the legal nature of the rules to differ. Some Member States adopted specific regulations (e.g. Belgium, France, Greece), and in others rules are stipulated by the National Regulatory Authority (e.g. Italy, Romania). The scope of the rules varies, with responses indicating divergence in coverage from distribution networks only, to including transmission networks as well as storage facilities. Asked whether respondents to the survey quantified emissions from leaks, six out of eleven DSOs and ten out of 29 TSOs indicated that they do not. For

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[69] See also Annex 7, Table A.7.1.. Methane emissions for the energy sector in Kt, per Member States, as reported to UNFCCC in April 2021 for 2019.
[70] https://www.iea.org/reports/methane-tracker-2020/methane-from-oil-gas
[71] https://www.wri.org/insights/close-look-fugitive-methane-emissions-natural-gas
[72] GIE-MARCOGAZ, February 2021, Facts finding journey in survey answers on LDAR. Presentation to DG ENER.
[73] A methane emissions reduction equivalence framework for alternative leak detection and repair programs, Fox, TA, et al. 2019.
[74] IOGP response to the open public consultation, available at https://www.oilandgaseurope.org/documents/response-legislation-to-measure-and-mitigate-methane-emissions/
[75] See also the research efforts by EDF on leakage, online, https://www.edf.org/climate/methane-studies
[76] The Sniffers (2020) Benchmark Results: Analysis of 400 Gas Asset Emission Monitoring Campaigns.

those having indicated that quantification of leaks takes place, this does not necessarily mean that all leaks are quantified[77].

At the global level, some voluntary initiatives and best practices have emerged, notably the United Nations Economic Commission for Europe (UNECE) best practice guidance for effective methane management in the oil and gas sector[78] and the Methane Guiding Principles LDAR guide[79]. While the private sector has developed voluntary initiatives to measure and reduce emissions from fugitive methane leaks in the gas industry, they remain fragmented along the value chain and lack harmonisation[80]. According to the IEA, while a number of companies already undertake LDAR, the frequency, practices and rigour of programmes still vary widely within the industry[81].

2.2.2.2.Intentional release of methane

Aside from fugitive emissions and incomplete combustion, all other emissions in the EU energy sector stem from intentional releases of methane, including from venting, flaring, and the use of equipment that emits ('bleeds') as part of its normal operation. Flaring is the process of burning associated, unwanted or excess gases and liquids released during normal or unplanned processes. Venting is the process of directly releasing gasses into the atmosphere, often for the same reasons, or as part of equipment design. Excess gasses in oil, gas and coal production can be a safety hazard and must therefore be processed, either by trapping, utilisation, or by flaring or venting.

While vented and flared gas implies the destruction of a valuable commodity, depending on the sector and part of the supply chain, operators may not have the right incentives to avoid emitting methane in those ways. As discussed above, methane abatement decisions by energy companies are often undertaken on the basis principally of cost effectiveness and safety risk considerations, not for social or environmental reasons. Other missing incentives may include the lack of attribution of responsibility for emissions to specific operators, the lack of available infrastructure to bring associated gas to market, or the lack of awareness or incentives in using the available mitigation measures – as indicated by the availability of cost effective measures that are not being implemented (for further details see section 6.2)[82]. Further downstream, emissions are often linked to venting events with typically smaller emission quantities from individual sources. Avoidance or recovery per unit can be more difficult and costly under such circumstances.

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[77] GIE-MARCOGAZ, February 2021, Facts finding journey in survey answers on LDAR. Presentation to DG ENER.
[78] https://unece.org/sustainable-energymethane-management/best-practice-guidance-effective-methane-management-oil-and
[79] Methane Guiding principles: Reducing Methane Emissions: Best Practice Guide on equipment leaks, November 2019. https://methaneguidingprinciples.org/best-practice-guides/equipment-leaks/
[80] Potential ways the gas industry can contribute to the reduction of methane emissions (2019) Report to the Madrid Forum, https://ec.europa.eu/info/sites/default/files/gie-marcogaz_-_report_-_reduction_of_methane_emissions.pdf
[81] https://www.iea.org/reports/methane-tracker-2020/methane-abatement-options
[82] See IEA (2021) Methane Tracker: Methane abatement and regulation https://www.iea.org/reports/methane-tracker-2021/methane-abatement-and-regulation

a) Venting and flaring in the oil and gas sectors

Of the total 3.1 million tonnes of methane emissions within the EU reported in the April 2021 EU GHG Inventory Submissions to the UNFCCC, venting in the oil and fossil gas sectors accounted for respectively 57 kilotonnes (kt) and 15 kt of methane. Flaring in the oil sector contributed 61 kt and flaring of fossil gas 9 kt of methane emissions. On a global level, and in relation to energy imported and consumed in the EU, venting and flaring are a much larger issue. The World Bank estimates that 140 bcm (118 Mtoe) of gas – equivalent to about a third of the EU's gas consumption – are flared each year[83], and recently developed the Imported Flare Gas Index highlighting the exposure of oil importing countries to gas flaring[84].

The motivation behind flaring and venting activities can differ depending on whether they occur as part of routine operations, in exceptional circumstances, or for safety reasons with substantial uncertainty surrounding the classification of specific instances within such categories. For flaring in the oil sector, the World Bank's Global Gas Flaring Reduction Partnership (GGFRP) has devised a set of definitions in close consultation with stakeholders, which provides a widely held understanding specifically for flaring at oil production facilities considering the categories of routine flaring, safety flaring, and non-routine flaring[85]. The GGFRP definitions address only the upstream however. Fossil gas production does not typically incur flaring as operations are focused on capturing and bringing the gas to market. For venting, there are no comparable definitions.

Flaring can also provide an alternative to venting where no other options for the disposal of excess gases are available. Flaring is generally the safer approach for disposal relative to venting. However it remains a second-best option compared to full emission mitigation.

In the EU gas mid- and downstream , industry argues that there is no reason to vent or flare to balance production and demand[86]. However, some operational activities (including maintenance and start/stop operations) and the use of pneumatic equipment entail emissions. It is unclear from available reports how much of the total methane emissions in this part of the supply chain derive from venting and flaring across the EU[87]. Recent examples by the Clean Air Task Force campaign 'CutMethane' of recorded venting activities from infrastructure across Europe signal a larger-scale issue.[88]

[83] World Bank (2021) Zero Routine Flaring by 2030. https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030

[84] World Bank (2021) A new index highlights the need for shared responsibility to end gas flaring. https://blogs.worldbank.org/opendata/new-index-highlights-need-shared-responsibility-end-gas-flaring

[85] World Bank (2016) Global Gas Flaring Reduction Partnership Gas Flaring Definitions. https://documents1.worldbank.org/curated/en/755071467695306362/pdf/Global-gas-flaring-reduction-partnership-gas-flaring-definitions.pdf

[86] Marcogaz (2021) Venting and flaring on mid and downstream gas infrastructure

[87] Note that in this part of the supply chain it is predominantly an issue of venting. An industry quantification of venting within the European gas network for selected segments shows venting to represent 6% of methane emissions from LNG terminals, 17% from underground storage, and 40% from transmission in 2016. Marcogaz (2016)

[88] https://cutmethane.eu/

Further emission reductions are technically achievable by application of best available practices, which, however, remains fragmented. Emission reductions in transmission and distribution, for example, are subject to awareness and to considerations of operators' costs against environmental benefit, impact of asset (un)availability, and security of supply[89]. Current frameworks do not seem sufficient to appropriately tackle the issue.

On basis of a survey conducted on request of the Commission, GIE-MARCOGAZ comes to the conclusion that "the reduction of venting and flaring is neither regulated nor incentivised in most European countries"[90]. As far as national provisions exist, they commonly emphasize licensing requirements from the relevant competent authority to conduct activities releasing methane emissions into the air.

b) Venting and flaring in the coal sector

For the coal sector, methane emissions are primarily linked to hard coal underground mining activities, both in operating and abandoned mines. Methane is produced during the coal formation and is released into the atmosphere during mining activities though ventilation and degasification systems and from cracks in the coal seams post mining operations. Emissions from lignite mines are more difficult to identify, as according to IPCC Guidelines, it is not yet feasible to collect mine-specific higher tier measurement data for surface mines[91].

In underground mines, methane is an important health and safety issue as it can, in certain concentrations, lead to explosions. Production releases methane trapped in coal seams, called coalmine methane (CMM). Methane can be captured before, during and after mining by pre- and post-mining drainage techniques, respectively. In active underground mines, atmospheric methane concentration is continuously controlled. Methane drainage can be used to lower the percentage of methane in the air by capturing the gas to prevent it from entering mine airways. In the EU, recovered CMM is, if at all, most commonly used for power generation on site[92]. Current practices differ by Member State and mine. Ventilation air from underground mines contains diluted concentrations of methane, referred to as ventilation air methane (VAM). VAM can be mitigated with or without energy recovery[93], though solutions remain comparably expensive[94].

Today, incentives are often insufficient to ensure recovery of such methane emissions. At present, there are no EU-wide specific regulations limiting CMM or VAM. In some Member States, national legislation is in place to reduce the fugitive methane losses from

[89] GIE-MARCOGAZ, April 2021, MARCOGAZ technical recommendation On Venting & Flaring - Gas mid and downstream segment, Presentation to DG ENER

[90] GIE- MARCOGAZ, April 2021, Recommendations on Venting and Flaring, https://www.marcogaz.org/publications/recommentations-on-venting-and-flaring/

[91] Lignite mines in the EU are predominantly opencast surface mines, with the exception of one lignite underground mine in Slovenia.

[92] JRC (2015) Environmental and Sustainability Assessment of Current and Prospective Status of Coal Mine Methane Production and Use in the European Union

[93] Ventilation Air Methane (VAM) Utilization Technologies, EPA, July 2019 https://www.epa.gov/sites/production/files/2017-01/documents/vam_technologies-1-2017.pdf.pdf

[94] JRC (2015) Environmental and Sustainability Assessment of Current and Prospective Status of Coal Mine Methane Production and Use in the European Union

coal production[95,96]. In Germany, while there is no direct requirement for mining companies to capture those gases[97], coal mine methane and abandoned mine methane are eligible for feed-in-tariffs when used to generate electricity. In its 2014 State Aid Decision on the relevant German Renewable Energy Law (EEG), the Commission finds the measure to be an effective and proportionate incentive[98], which was reaffirmed in the 2021 decision on the amended EEG[99]. A similar approach is taken in France for coalmine methane[100] for environmental protection and safety purposes, where legislation aims to ensure a tariff that reasonably covers the exploitation costs of this resource while limiting the revenues.

Since 1990, certain EU countries have drastically reduced methane emissions from coal mining, such as Germany and the Czech Republic. In comparison, since that time, no changes have been recorded in Romania, while in Poland, methane emissions from coal have been reduced by only around 17%[101]. Some projections consider that the decrease in coal production will lead to a decrease in coal-related methane emissions[102]. However, recent studies have shown that these emissions might be currently underestimated, and that emissions of mines with continued production are likely to increase in the future because of exploitation of deeper and gassier deposits due to the exhaustion of shallow coal reserves[103].

Once production is halted and a mine is abandoned, it continues to release methane, referred to as abandoned mine methane (AMM), over a long period of time[104]. Attribution of responsibility for those emissions and their abatement can pose a problem depending on ownership and exploitation rights, and treatment of AMM remains fragmented with significant quantities escaping into the atmosphere and emissions projected to increase as more mines close[105].

[95] Global Methane Initiative (2013). European Commission Global Methane Reduction Actions, Ref. Ares (2013)2843722-06/08/2013.

[96] Also in the UK, legislation has provided tax breaks for CMM projects, for further details see N. Kholod et al., Legal and Regulatory Status of Abandoned Mine Methane in Selected Countries: Considerations for Decision Makers, 2018

[97] European Commission C(2014) 5081 final, recital (274), State aid SA.38632 (2014/N) – Germany EEG 2014 – Reform of the Renewable Energy Law,
https://ec.europa.eu/competition/state_aid/cases/252523/252523_1589754_142_2.pdf

[98] Ibid, section 3.3.3.3

[99] European Commission C(2021) 2960 final, State Aid SA.57779 (2020/N) – Germany EEG 2021,
https://ec.europa.eu/competition/state_aid/cases1/202124/288710_2283746_342_2.pdf

[100] Loi n° 2006-1537 du 7 décembre 2006 relative au secteur de l'énergie

[101] UNFCCC 2017 reported data on greenhouse gas emissions: EEA Report No 6/2019, Annual European Union greenhouse gas inventory 1990–2017 and inventory report 2019, Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, 27 May 2019

[102] Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation Potential: 2015-2050, EPA, 2019

[103] N. Kholod et al (2020) Global methane emissions from coal mining to continue growing even with declining coal production, , Journal of Cleaner Production, Volume 256, 120489

[104] Ibid

[105] Ibid

2.2.3. Lack of information on and mitigation of methane emissions occurring outside the EU but linked to consumption of fossil energy in the EU.

EU import dependence is 95.7% for oil[106] and 89.7% for fossil gas[107]. As discussed above, neither precise knowledge nor official estimations exist on the magnitude, origin or nature of methane emissions occurring outside of the EU and specifically linked to fossil energy consumed in the EU.

The same market failures occurring within the EU also apply to operators in countries exporting energy to the EU. Lack of information is a particularly strong driver for market failures across borders as internalisation of externalities is further impeded. Exporters lack incentives to act on methane emissions as long as importers do not have access to reliable emission information that could inform their buying decisions (e.g. to fulfil company or demand-driven environmental considerations) or internationally occurring externalities are priced in through (domestic) regulation[108]. Whereas for instance local air pollution would primarily be a domestic concern, global warming effects are externalities that affect exporters, importers as well as third parties. Some exporting countries are beginning to act domestically on methane emissions from the energy sector. For many exporters operating under conditions without domestic regulation of methane emissions the only reliable incentive, however, would be clear market signals. For such signals to emerge, relevant information needs to become available and visible.

In the absence of obligations to submit comprehensive GHG inventories to the UNFCCC, uncertainties about emissions related to imported fossil energy are aggravated by many exporting countries yet having to submit any data, making estimates of actual emissions dependent on incomplete top-down observational data (e.g. from satellites) and extrapolation. A number of key exporting countries of fossil energy to the EU are parties to the Paris Agreement, and are as such committed to its greenhouse gas reduction objectives. These include Algeria, Australia, Colombia, Iraq, Nigeria, Norway, Qatar, Russia, Saudi Arabia, South Africa, the United Kingdom, and the United States, which are all major exporters of either coal, fossil gas or oil to the EU. While parties to the Paris agreement are normally expected to submit national GHG inventories data to the UNFCCC, to date, of those major exporters, only five have submitted full inventories: Australia, Norway, Russia, the United Kingdom and the United States. Even for those countries that have submitted national GHG inventories, the quality of the data is only as good as the levels of tier of reporting employed. As stated in the case of the EU, there is no obligation to report direct source-level measurements of emissions (Tier 3 reporting, according to the IPCC guidelines) in the GHG inventories delivered to the UNFCCC.

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[106] The statistical category comprises crude oil and natural gas liquid

[107] European Commission (2021) EU energy in figures, statistical pocketbook and country datasheets (June 2021) https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en

[108] The Flaring Intensity Index recently developed by the World Bank for instance attempts to make such information visible by highlighting the exposure of crude oil importing countries to the flaring practices linked to its production. See https://blogs.worldbank.org/opendata/new-index-highlights-need-shared-responsibility-end-gas-flaring

The nine largest exporters of fossil fuels to the EU are considered to be responsible for half of the world's methane emissions[109]. Russia and the United States alone, which are the largest exporters of fossil fuels to the EU, are estimated to be responsible for one-third of methane emissions in the energy sector worldwide[110]. According to the IEA[111], Russia was estimated to have emitted almost 14 million tonnes of methane in the energy sector for oil and gas in 2020, followed by the United States, which emitted 11.8 million tonnes of methane that same year. Iraq and Algeria were estimated to have emitted respectively 3.4 million tonnes and 2.6 million tonnes of methane. As a point of comparison, the EU's entire energy sector was estimated to have emitted 3.1 million tonnes of methane in 2019 within the EU.

Moreover, according to a series of scientific studies coordinated by environmental organisations, not only have emissions from oil and gas production activities increased globally from 65 to 80 Mt/year in the last 20 years, but such emissions from national inventories have been widely underestimated and industries are likely to be underreporting methane emissions in the energy sector[112]. Case studies for specific production areas or parts of the supply chain in the US, Canada[113], Russia[114], and Iraq[115] all show significant underreporting with actual emissions up to 15 times higher. In addition, the number of large methane leaks around the world, each associated with an ultra-emitter, was found to amount to more than 1,800 single observed anomalies over two years (2019-2020), a large fraction of them located over Russia, Turkmenistan, the United States, the Middle East and Algeria[116].

Currently, voluntary industry-led initiatives remain the principal course of action for methane emission mitigation in many countries but are not sufficient for addressing the global oil and natural gas value chain. Existing regulatory instruments often remain either ineffective, incomplete or non-existent among a number of countries exporting fossil energy to the EU. For instance, approaches to regulations on venting and flaring across oil and gas producer countries vary widely. Major exporting countries to the EU such as Russia, Saudi Arabia, Iran, Iraq and United Arab Emirates do not have any regulations restricting venting and flaring; the US has restrictions, performance standards and taxes/fees on venting and flaring but not at federal level, and Russia applies a fee for flared gas but allows deductions for investment in associated gas infrastructure[117].

[109] https://www.iea.org/articles/methane-tracker-database
[110] ibid
[111] ibid
[112] https://www.edf.org/media/new-oil-and-gas-study-shows-once-again-industry-severely-underreporting-methane-emissions
[113] https://drillordrop.com/2016/06/11/uk-link-to-alleged-under-reporting-of-fracking-methane-emissions/
[114] TJ Cinq-Mars, 1Leak Detection and Repair in the Russian Federation and the United States: Possibilities for Convergence
[115] https://jpt.spe.org/gas-capture-and-storage-program-iraq-slashes-emissions
[116] Global Assessment of Oil and Gas Methane 1 Ultra-Emitters; T. Lauvaux, C. Giron, M. Mazzolini, A. d'Aspremont, R. Duren, D. Cusworth, D. Shindell, P. Ciais; April 2021.
[117] IEA (2021) Driving down methane leaks from the oil and gas industry, see Table 2

Among the same set of countries, only the United States have prescriptive regulations on leak detection and repair[118].

For exporters, especially in the absence of effective domestic regulation, clear market signals would be a strong incentive, but remain absent.

2.3. How will the problem evolve?

2.3.1. Contribution of methane emissions to temperature change

The Intergovernmental Panel on Climate Change (IPCC) notes that deep reductions in methane emissions must be achieved by 2030 for the world to stay below 1.5°C (and similarly 2°C) temperature change[119]. Figure 3 highlights the projected temperature developments in relation to the mitigation of methane emissions. Recent estimations show that at a global level, reducing methane emissions associated with anthropogenic activity by 45% by 2030 would avoid 0.3°C of global warming by the 2040s.[120]

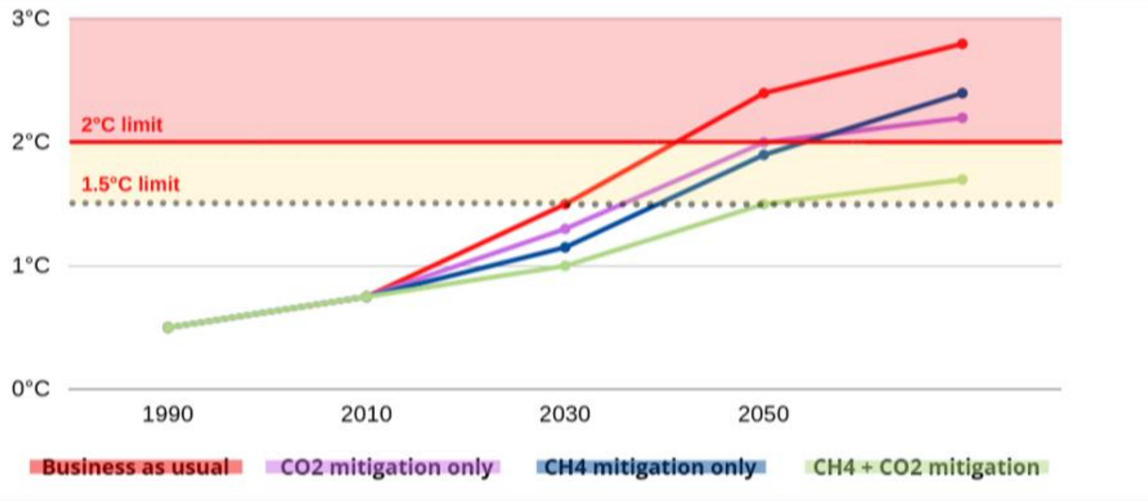

Figure 3: Temperature pathways to 2050

The strong effect of methane on climate change requires accelerated action. Without regulatory intervention, internalisation of the externalities caused by methane emissions is unlikely, and the market failure will persist. With respect to all three identified problem drivers, increasingly ambitious commitments to global climate objectives set a positive frame for action. While voluntary industry initiatives exist, economic incentives for operators, however, often remain insufficient without regulatory action.

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[118] Ibid

[119] IPCC Special report: Global warming of 1.5°C, available at https://www.ipcc.ch/sr15/chapter/spm /

[120] Climate and Clean Air Coalition & United Nations Environment Programme (2021) Global Methane Assessment, https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions

As discussed in Section 2.2.2., relevant existing EU regulation does not provide sufficient measurement, reporting and verification obligations for accurate information on the full extent of methane emissions in the energy supply chain. It also leaves mitigation of a large part of methane emissions outside of its scope with current provisions focused predominantly on specific sub-sectors in end-use (see Table 2)

2.3.2. *Why methane emissions will still be relevant in a decarbonised future*

Methane emission mitigation is important to lessen fossil energy's impacts on climate change and the environment while clean fuels progressively replace fossil fuels. The regulatory framework being put in place in the context of the European Green deal is supportive of the progressive replacement of fossil fuels with renewable and decarbonised energy carriers, towards which the Commission's July 2021 Green Deal proposals contribute, including among others the revision of the Renewable Energy Directive, as well as the Hydrogen and Gas Market Decarbonisation Package[121].

Presently, fossil fuels still dominate the energy mix[122] and fossil gas is often seen as a transition fuel for the coming decade, warranting appropriate emission reductions to enable such a role and ensure sufficient security of supply during the transition.

The impact assessment of the 2030 Climate Target Plan[123] discusses the evolution of the energy system in line with the climate neutrality objective by 2050, and provides elements on the possible sources of future methane emissions in a progressively decarbonised energy system[124].

The analysis contained in the impact assessment reveals that while overall consumption of fossil gas is expected to progressively reduce over time, by 2030 it is projected to be only around 13% lower than in 2015, eventually reducing by around 70% in 2050 compared to 2015, which still represents a consumption of around 100 Mtoe.

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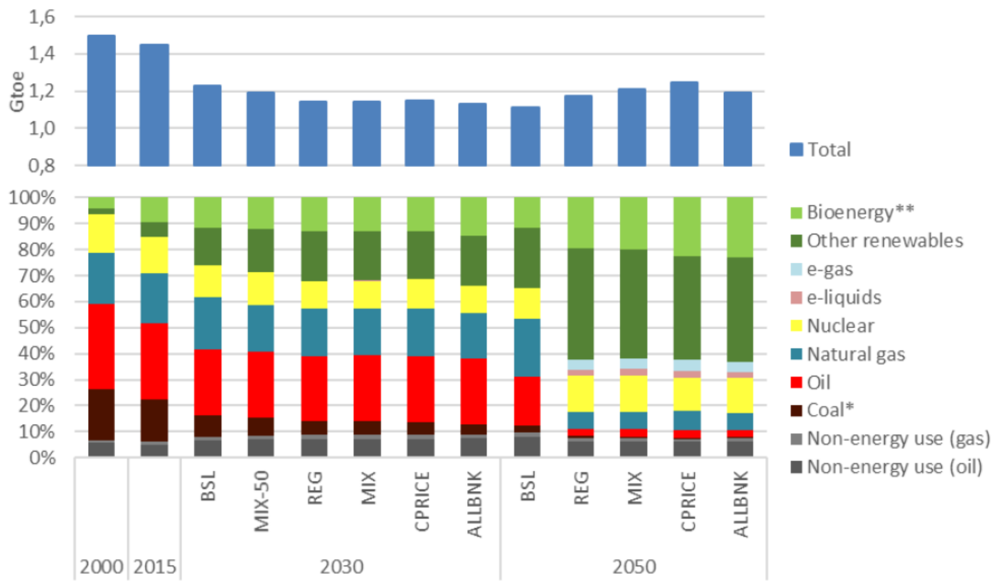
[121] See Annex 6 on linkages

[122] Natural gas provided 17.2% of the EU energy mix in 2020, solid fossil fuels 26.4%, and oil and petroleum products 37.7%,

[123] SWD(2020) 176 final

[124] Ibid., section 9.4.2.4, Figure 49



*Note: * includes peat, oil shale, ** includes waste*

Source: 2000, 2015: Eurostat, 2030-2050: PRIMES model

Figure 4: Energy gross inland consumption (Climate Target Plan impact assessment)

Fossil gas consumption still increases from current levels by 2030 in some Member States and will remain a major source of heating for buildings until 2030. Especially in urban areas, the health impacts from methane emissions' contribution to ozone formation will therefore continue to remain an important factor[125].

It is also important to highlight that other forms of methane-based fuels will develop in the EU energy system throughout this transition. While biomethane and low-carbon synthetic methane are expected to play a limited role by 2030, they are expected to be increasingly deployed afterwards. In 2030, their consumption amounts to close to 20 Mtoe and is projected to keep increasing afterwards to reach around 60 Mtoe of biogas and 50 Mtoe of synthetic methane by 2050, for uses in various sectors of the economy.

As a consequence, methane-based fuels, which will continue to be transported through the existing gas network, will continue to represent an important element of the EU decarbonised energy system by 2050, amounting in total to 60%-70% of the consumption of gaseous fuels observed in 2015. This consumption is a potential source of methane leaks along the entire supply chain for both fossil and renewable gas, both with the EU as well as outside the EU when these fuels are imported.

[125] Plant, G., Kort, E.A., Floerchinger, C., Gvakharia, A., Vimont, I. and Sweeney, C., 2019. Large fugitive methane emissions from urban centers along the US East Coast. Geophysical research letters, 46(14), pp.8500-8507, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019GL082635
Euroneaws (13 September 2021) Scientists sniff for hidden methane leaks to combat global warming https://www.euronews.com/green/2021/09/13/scientists-in-utrecht-sniff-out-methane-to-help-protect-the-environment

Also for hydrogen, the issue of methane emissions remains if it is produced from fossil gas[126]. Fugitive and intentional releases of methane remain relevant in the production and transmission of fossil gas to the point of transformation into hydrogen, potentially impeding or eliminating any greenhouse gas emissions advantage of such hydrogen[127].

Furthermore, while coal is projected to virtually disappear from the EU energy system by 2050, some limited consumption of oil is expected to remain by 2050 notably for non-energy purposes. This refining, transport, distribution and consumption of oil can also be a source of venting and leakage of methane.

Finally, and in addition to possible methane emissions from actively operated assets, emissions from closed and abandoned sites (coalmines, oil and gas boreholes and wellheads, etc.) represent a long-term issue independent of future consumption that also needs to be addressed.

As a consequence, a fully decarbonised EU energy sector will still be associated with risks of methane emissions along the active supply chains of liquid and gaseous fuels (be it within the EU or externally through the imports of fuels), as well as from closed fossil fuel production sites. Specific actions to abate these emissions is thus required to ensure that such an energy sector fully contributes to the EU climate neutrality objective.

2.3.3. *Availability of data*

The current reporting requirements and recommendations for use of the different tiers under UNFCCC reporting can be improved (see 2.2.1), and substantial improvement of data availability and accuracy for methane emissions is unlikely to be forthcoming under present conditions.

However, parts of the oil and gas industry have recognised the issue and the setting up of the Oil and Gas Methane Partnership (OGMP) voluntary initiative on measuring and reporting of methane emissions by companies[128] is based on the premise that by establishing best-practices in both emissions quantification and management, the OGMP equips partner companies with the tools to systematically survey their operations to identify equipment and processes with high potential to emit methane, and to utilize proven methods to minimize these emissions[129]. Indeed, the objectives of OGMP are to improve the availability of global information on where partner companies can reduce methane emissions and driving mitigation actions to achieve methane emission

[126] For instance by Steam methane Reformation including with CCS/U or pyrolysis.
[127] Howarth, R.W., and Jacobson, M.Z. (2021) How green is blue hydrogen? Energy Science & Engineering, https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956
[128] https://globalmethane.org/challenge/ogmp.html#:~:text=The%20Oil%20and%20Gas%20Methane,in%20the%20oil%20and%20gas
[129] Oil and Gas Methane Partnership, online, accessed 31/08/2021 - http://ogmpartnership.com/

reductions[130]. This approach is in fact considered best practice, on the basis that while measurement and reporting on the one hand, and mitigation on the other, are distinct activities, they are also strongly related because mitigation can be most effective and cost-efficient when based on sound measuring, reporting and verification (MRV) practices[131]. To date, 62 companies have signed up to OGMP, covering 30% of global oil and gas production and assets on five continents[132].

Nevertheless, the OGMP is a voluntary initiative and does not provide full coverage of EU methane emissions or emissions linked to EU fossil fuel consumption. For further development of data availability through the OGMP, it is unfortunately not possible to predict the further uptake by industry or how many companies will sign up to the OGMP going forward. It is also limited to the oil and gas sectors and does not address methane emissions from coal. Once operational, reporting is limited to aggregate numbers on an annual basis, imposing limitations on transparency. While providing a positive impetus, the voluntary nature and incomplete coverage of OGMP make it an unsuitable stand-alone basis for regulatory action on mitigation.

Without a solid MRV framework, and in continued absence of verified source-level data as basis for evidence-based measures and reliable metrics for the evaluation of their success, regulatory action on methane emission mitigation remains constrained in its options.

As regards methane emissions occurring outside of the EU, unless measures to specifically address them are put in place, it can be expected that the critical situation clearly detailed in Section 2.2.3 will continue in the future.

2.3.4. *Mitigation of methane emissions within the EU and outside the EU in relation to fossil fuels consumed in the EU*

While voluntary initiatives for the mitigation of fugitive and intentional methane emissions from the oil and gas sector exist, their focus often remains limited to specific sub-sectors and instances. For example, the World Bank's Zero Routine Flaring by 2030 initiative has brought together governments and industry stakeholders to commit to end the practice at the production stage for oil. It does not address other sectors, parts of the supply chain, or non-routine and safety flaring. For venting, no comparable initiative exists. In the coal sector, positive developments across Member States have primarily been driven by regulation and subsidies, not by industry action.

As long as non-abated fossil energy is produced and consumed in the EU, emissions relating to their production and transport occurring also outside the EU will continue to be emitted. The import of energy into the EU remains relevant also within the context of achieving the 2050 climate neutrality objective as: i) according to PRIMES modelling,

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130 Ibid

131 Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector: Monitoring, Reporting and Verification (MRV) and Mitigation, Report sponsored by the United Nations Economic Commission for Europe and the Global Methane Initiative, August 2019.

132 Oil & Gas Methane Partnership 2.0 (2021) http://ogmpartnership.com/

even in 2050 the import of fossil fuels does not decline to zero (see Figure 4 with part of the remaining use as feedstock for other purposes than energy consumption), ii) the decline is gradual and emissions linked to imports in the upcoming decades could threaten the global achievement of the Paris Agreement climate goals if left unabated, and iii) existing import infrastructure is projected to be used for the import of renewable and decarbonised gases. For methane-based gases, e.g. in the case of biomethane, the same problem and problem drivers as for methane emissions from fossil gas are relevant. In the case of other renewable or decarbonised gases, e.g hydrogen[133], relevant concerns remain according to their environmental and climate impact in the case of leaks or intentional release.

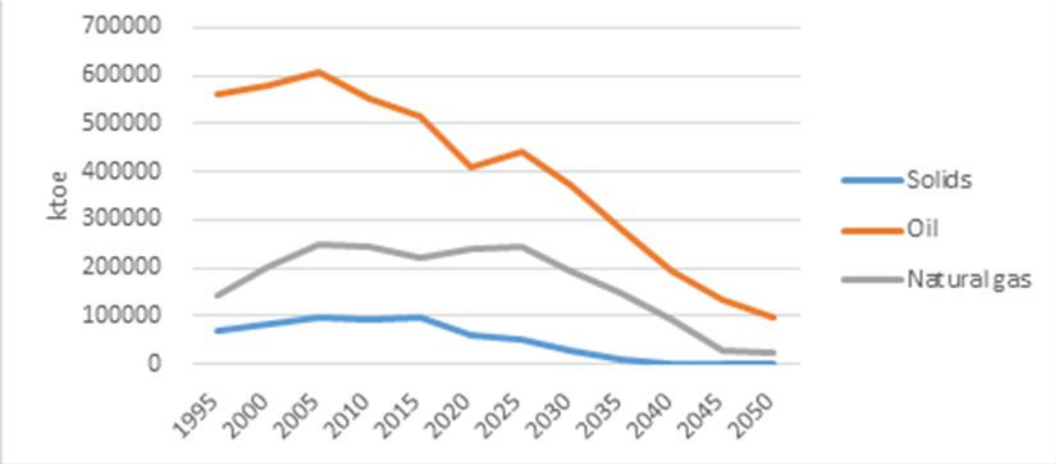

Figure 5: Net imports of fossil fuels (Source: PRIMES)

Without EU action, the external costs of methane emissions would risk not being sufficiently addressed and no new incentives would be set for international market players to address methane emissions. Voluntary industry-led initiatives remain the principal action in addressing methane emissions across the oil and natural gas value chain outside of the EU. Lack of information and adequate mitigating measures persist, and existing regulatory instruments remain either ineffective, incomplete or non-existent among a number of countries exporting fossil energy to the EU.

In conclusion, under a scenario of continuation of the current situation and on-going initiatives, the availability and quality of information would improve only to a limited extent and more importantly, the overall problems and underlying problem drivers will remain.

[133] As indirect greenhouse gas, hydrogen has a Global Warming Potential of 5.8 over 100 years. See Derwent et al. (2006) Global environmental impacts of the hydrogen economy. Int. J. of Nuclear Hydrogen Production and Applications. DOI: 10.1504/IJNHPA.2006.009869

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

The legal basis of this initiative is Article 194 of the Treaty on the Functioning of the European Union, which empowers the EU to establish the measures necessary to achieve the objectives of the Union with regard to policy on energy, in the context of the internal market and with regard for the need to preserve and improve the environment.

Methane is a greenhouse gas and an ozone-precursor that knows no borders. When emitted in one country, it will have a climate and air quality impact in others. The proposal aims to create a new policy framework facilitating the reduction of methane emissions, which is key to achieving the EU's climate objectives and the zero pollution ambition, building on and complementing existing EU law already partially regulating methane emissions from the energy system.

3.2. Subsidiarity: Necessity of EU action

Methane emissions in the energy sector are a transboundary problem and vary across national and regional levels of the EU. They are relevant in all Member States but to a varying degree, depending on their energy mix and natural endowments, e.g. how many underground coalmines are operated or sealed, how much fossil gas is produced or transported. The scale of EU gas infrastructure demonstrates the Union wide aspect, with roughly 190,000 km of transmission pipelines across all Member States[134].

As highlighted above, the level of reporting of emissions differs by Member State and sector, with some Member States opting for the least effort approach, limiting the development of an accurate measurement basis for further action. While some Member States have already addressed methane emissions mitigation in specific sub-sectors, others do not have provisions in place or only private sector initiatives are addressing the issue. Private initiatives are however insufficient as main instruments to address methane emissions due to limitations in scope, participation, and incentivisation in case of non-adherence.

Diverse national approaches may lead to inconsistencies in regulatory treatment across Member States, increasing the administrative burden on companies operating in more than one Member State, potentially impeding the functioning of the internal market through the creation of barriers to operators, as well as complicating the collection of comparable data across the EU.

While methane emissions are included under the Effort Sharing Regulation, they are one of a number of greenhouse gases, including CO2, nitrous oxide and F-gases for which a collective reduction target is defined. The persistence of methane emissions in the energy sector within the EU over the last decade, along with the absence of concrete measures in

[134] In addition, the length of the distribution grid has been estimated at around 1.4 million kilometres of pipes across the EU; see Navigant (2019) Gas for Climate. The optimal role for gas in a net zero emissions energy system.

a substantial number of Member States, even if cost efficient, demonstrates that specific EU action can contribute to further and more rapid reductions. Conversely, such EU action to curb methane emissions in the energy sector will help Member States to achieve their Effort Sharing targets.

As the majority of methane emissions linked to fossil energy consumed within the EU occur outside the EU, joint action by Member States would be more likely to deliver results for those parts of the supply chain outside of EU borders and preserve the integrity of the internal energy market. The challenges in reducing methane emissions hence require a harmonised and coordinated approach and cannot be addressed efficiently by individual Member States. EU action is thus justified on grounds of subsidiarity in line with Article 194 of the Treaty on the Functioning of the European Union.

3.3. Subsidiarity: Added value of EU action

The reduction of methane emissions across the European Union would benefit from a homogeneous policy approach at the EU level given the strong interlinkage between Member States through cross-border infrastructure – in this context particularly gas infrastructure – and the integrated EU energy market. The impacts of measures aimed at methane measurement and mitigation and related effects on innovation, cost-effectiveness, and a level-playing field in maintenance of a well-functioning internal market warrant coordination across Member State borders. Coordinated EU policies have a much higher chance of leading to further reductions in methane emissions in the energy sector. Coordinated action at the EU level furthermore facilitates the full consideration of the different capabilities to act among Member States and private entities. It also affords operators the benefits of a single regulatory regime, facilitating adherence and reducing administrative burden relative to the application of fragmented rules across Member States.

The EU and its Member States are part of a global oil market in which collective action carries more weight vis-à-vis exporters than individual national measures. The EU is also the biggest gas import market in the world and can thus influence global methane emissions through its purchasing power, provided a harmonised approach towards such imports. The EU gas market allows for flexible and short-term (spot) trading of gas. While long-term contracts with specific suppliers still exist, the ‘hydrogen and gas market decarbonisation package’, which is part of the Fit-for-55 package, addresses such contracts and seeks to limit their duration to avoid locking-in fossil gas use and to send a signal to decarbonise the gas sector in line with the European Green Deal. Hence, an increasing part of imports may become subject to methane emission considerations in purchasing decisions.

EU-level methane policy adds significant value for international climate action. By working to develop a legislation to minimize methane emissions in the energy sector, the EU is sending a strong political signal to external actors, increasing the awareness of the harmful effects of methane emissions on the climate. This signal will not only encourage EU partners to address the problem of methane emissions in the energy sector, but also lead to the creation of an international partnership and thus give the EU a leadership role in addressing methane emissions.

The initiative is fully in line with Article 37 of the Charter of Fundamental Rights of the European Union, which requires that a high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives

The general objective of the initiative is, in the context of the functioning of the internal market for energy and while ensuring security of supply in the Union, to preserve and improve the environment by reducing methane emissions from fossil energy produced or consumed in the EU. This objective contributes to the 'Fit for 55' package[135], specifically to the greenhouse gas emissions reduction targets of at least 55% by 2030 compared to 1990 as set out by the European Climate Law Regulation and to the EU's objective of achieving climate neutrality by 2050.

4.2. Specific objectives

To achieve the general objective, three specific objectives are addressed by this initiative:

i. Improve the accuracy of information on the main sources of methane emissions associated with energy produced and consumed within the EU. The goal is to ensure the availability of source-level data and robust quantification of emissions, and thereby increase the reliability of reporting – including the reporting of GHG inventories data to the UNFCCC – as well as the scope for appropriate measures for mitigation. This specific objective creates the basis for future improvements on specific objective ii).

ii. Ensure further effective mitigation of methane emissions across the energy supply chain in the EU. This specific objective addresses the market failure leading to insufficient mitigation of methane emissions by companies.

iii. Reduce methane emissions related to fossil energy imported to the EU. As the majority of methane emissions linked to fossil energy consumed within the EU occur outside the EU, this specific objective seeks to tackle methane emissions in cooperation with partner countries and international organisations, taking into account the security of supply aspects of the EU's high import dependency for fossil fuels, a large share of methane emissions linked specifically to EU consumption occurring outside EU borders, and the

[135] See Annex 5 for interlinkages with other initiatives

market failures rooted in the absence of information on emissions for importers and of market signals for exporters.

5. What are the available policy options?

5.1. What is the baseline from which options are assessed?

In the baseline, only current EU legislation addressing methane emissions linked to the energy sector remain in force (see Section 2.2.2 and Table 2), thereby leaving a large part of those emissions outside the scope of EU regulation.

As regards measurement, reporting and verification of methane emissions within the EU, existing legislation does not provide sufficient obligations for accurate information on the full extent of methane emissions in the energy supply chain. The reporting of methane emissions is part of the greenhouse gas emission reporting under the EU Climate Monitoring Mechanism, followed by integrated reporting system of the Governance Regulation[136], and the European Pollutant Release and Transfer Register (E-PRTR).[137] Reporting continues to be based on the methodologies of the UNFCCC Reporting Guidelines (see Section 2.2.1 and Box 2), including the use of default emission factors and the lack of source-level measurement. As outlined above, this reporting likely underestimates methane emissions along the fossil energy supply chain, as the data cannot be considered complete or sufficiently reliable and there are no specific higher tier reporting obligations at the EU level.

As also discussed in more detail in Section 2.3.2, Voluntary industry initiatives to improve reporting and commit to mitigation of methane emissions are a positive step, but by their voluntary nature are unlikely to become exhaustive sources of transparency and abatement for all emissions in the fossil energy supply chain.

Overall, in the baseline, information on methane emissions from the energy sector remains inaccurate in national reporting, as well as incomplete in industry reporting. Such lack of (accurate) information creates barriers for adequate mitigation of emissions, with implied economic and social costs if their unabated contribution to global warming continues.

Current EU regulations, as would continue to apply in the baseline, exclude concrete mitigation of methane emissions among substantial, methane-emitting, parts of the energy supply chain and national regulations remain isolated and limited to specific (sub-) sectors, leading to continued unabated emissions, additional barriers for private sector

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[136] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (OJ L 328, 21.12.2018, p. 1)

[137] Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC (OJ L 33, 4.2.2006, p. 1)

providers of mitigation solutions, as well as long-term adverse health outcomes for citizens.

As described in Sections 2.2.3 and 2.3.3, for methane emissions occurring outside of the EU but specifically linked to fossil energy consumed in the EU, at best partial and likely incomparable information would be available in the baseline as regards imports depending on domestic measures taken by exporting countries and their submission of greenhouse gas inventories to the UNFCCC.

In partnership with the United Nations Environmental Programme (UNEP), the Climate and Clean Air Coalition (CCAC) and the International Energy Agency, the Commission is supporting the establishment of an independent international methane emissions observatory anchored in a United Nations framework, tasked with collecting, reconciling, verifying and publishing anthropogenic methane emissions data at a global level. Support for setting up the IMEO was subsequently provided by the Council in its January 2021 conclusions on Climate and Energy Diplomacy[138]. While the IMEO is in the process of being set up, it has yet to be formally endorsed by energy partner countries to the EU, its financing has not been fully secured and the exact scope of its operations need to be defined and agreed.

The supporting function of the International Methane Emissions Observatory depends on further commitments and contributions from partners outside the EU, and implementation of appropriate measures such as the Methane Supply Index. As regards the costs of the IMEO, it has benefitted from 10 Million Euros committed from the EU budget. Further funding is still being sought from voluntary donations from governments and independent organisations willing to support such a project.

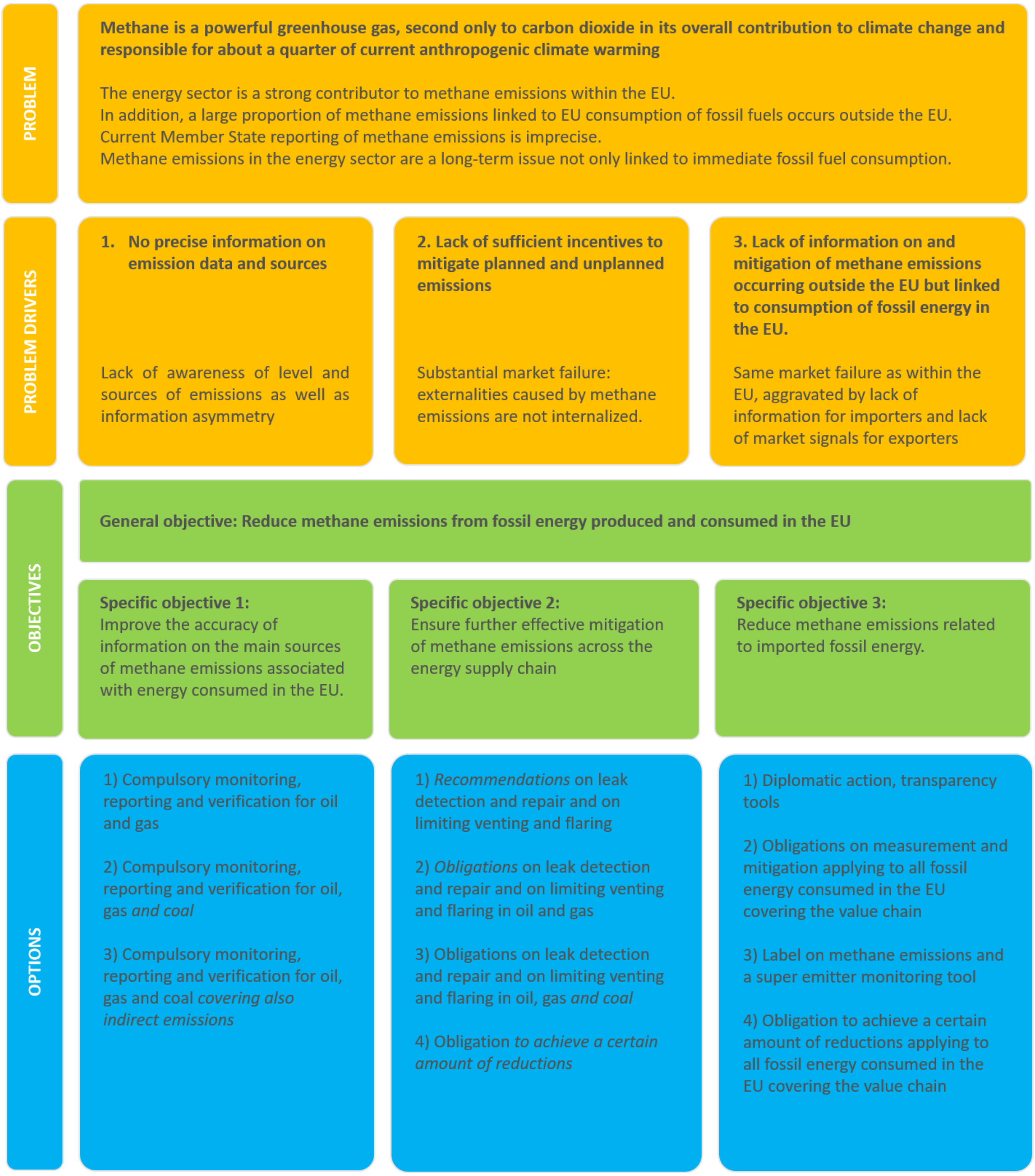
While the continued implementation of the Paris Agreement may lead to some improvements in reporting and mitigation of emissions, the current level of methane emissions and scientific projections do not suggest sufficient progress. While additional public awareness may result from improved data becoming available from satellite detection technology, for many exporting countries incentives may remain insufficient to (further) reduce methane emission levels linked to fossil energy destined for consumption within the EU.

5.2. Description of the policy options

The policy options are structured along the following three policy areas building on the problem drivers and the intervention logic diagram:

- **Policy area 1**: Improving measuring and reporting of methane emissions in the EU
- **Policy area 2**: Mitigation of methane emissions in the EU

- **Policy area 3**: Measuring, reporting and mitigation of methane emissions linked to EU fossil fuel consumption but occurring outside the EU

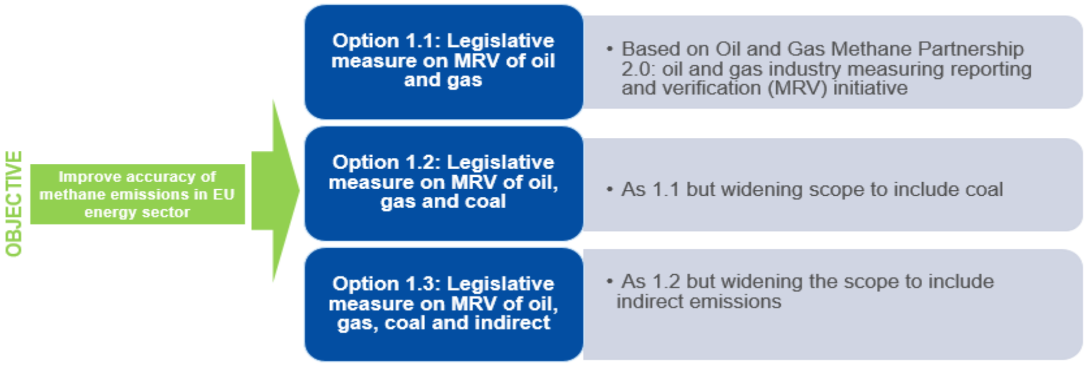


5.2.1. *Targeted entities*

One element which is common to all of the options assessed below across all three policy areas is that the targeted entities are companies in the energy sector. These include all companies involved at some point in the energy value chain in the relevant energy sub-sectors (depending on the option, this includes either oil and gas or coal or sectors explicitly mentioned as being included under the term ‘indirect emissions’) which are responsible for an activity which is known to or has the potential to leak, vent or flare methane. Where an option includes an obligation, this means that the obligation would fall on such a company. When ownership of the asset in question cannot be attributed to any one company, for instance in the case of an abandoned mine or well, the obligation would fall on the country in whose jurisdiction the asset is located.

5.2.2. <u>Policy area 1: Improving measuring and reporting of methane emissions in the EU</u>

This policy area considers measures to improve measuring and reporting of methane emissions in the energy sector. In the context of greenhouse gas emission measuring and reporting, the term ‘MRV’ is used. MRV typically covers three categories of activities: i) monitoring, which encompasses direct measurements and other methods for quantifying emissions; ii) reporting, which covers compilation of estimated emissions in specific formats for internal use or external circulation; and iii) verification of emissions and/or emission reductions, often by a third party, for internal purposes or as required by public regulations[139].



Option 1.0: Business as usual scenario

In the baseline, no additional policies are developed. Refer to sections 2.2.2 and 5.1 for a description of how measuring and reporting of methane emissions is currently being regulated in the EU through the EU Climate Monitoring Mechanism and the integrated reporting of the Governance Regulation, the E-PRTR and for a description of the OGMP voluntary initiative by the oil and gas industry.

Option 1.1: Mandatory measuring and reporting of oil and fossil gas companies. Obligation on oil and fossil gas companies to carry-out direct source-level measurements and reporting of direct emissions of methane by making relevant parts of the OGMP standard legally binding to economic activities in the EU territory.

[139] Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector: Monitoring, Reporting and Verification (MRV) and Mitigation, Report sponsored by the United Nations Economic Commission for Europe and the Global Methane Initiative, August 2019.

The OGMP 2.0 framework has five levels of reporting. Source-level reporting begins at level 3, which is considered comparable with UNFCCC tier 3. It allows generic emission factors to be used. OGMP 2.0 level 4 reporting requires direct measurements of source-level methane emissions. It allows the use of specific emission factors. OGMP 2.0 level 5 reporting requires the addition of complementary site-level measurements. In addition, the OGMP 2.0 framework requires companies to report direct measurements of methane emissions within three years of joining OGMP 2.0 for operated assets and within five years for non-operated assets. Building on the approach taken in OGMP 2.0 with regard to source-level reporting and taking into account that a large number of Union companies had already signed up to OGMP 2.0 in 2021, Union operators would be required to deliver direct source-level measurements of their emissions within 24 months for operated assets and within 36 months for non-operating assets.

A site-level measurement is a top-down measurement (as opposed to source-level measurement, considered a bottom-up measurement), and typically involves the use of sensors mounted on a mobile platform (such as on vehicles, drones, aircrafts or boats), satellites, or other means to capture a complete overview of emissions across an entire site. This quantification of site-wide emissions, which is independent from source level quantification, allows assessment and verification and reconciliation of source-level estimates aggregated by site, thereby providing improved confidence in reported emissions.

The approach taken in OGMP 2.0, of requiring site-level measurements to reconcile source-level measurements, is the approach taken here as well.

Option 1.2: **Mandatory measuring and reporting of oil, fossil gas and coal companies.** As per 1.1 but widening the scope to include coal methane emissions. OGMP does not cover coal emissions.

Option 1.3: **Mandatory measuring and reporting of direct and indirect emissions.** As option 1.2 but widening the scope further to include indirect emissions, which occur from final end use/consumption of oil, fossil gas or coal. Such emissions are not covered by the OGMP.

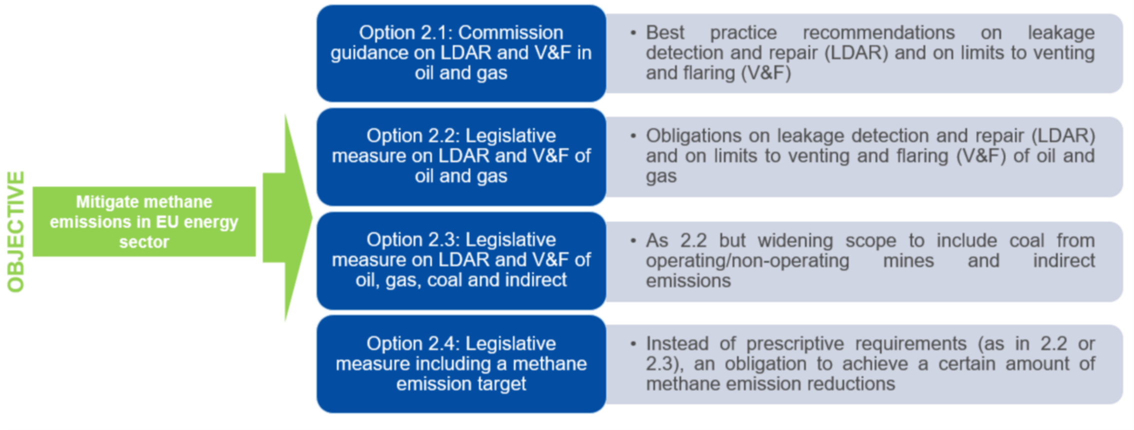
Some oil and gas companies are already voluntarily reporting such indirect emissions, and IPIECA (the global oil and gas industry association for advancing environmental and social performance) recommends that oil and gas companies undertake reporting on the basis of an existing international standard – the GHG Protocol scope 3 (scope 3 refers to indirect emissions) reporting standard[140][141]. This option proposes to set binding rules on companies to report their indirect emissions based on that standard.

5.2.3. <u>Policy area 2 - Mitigation of methane emissions in the EU</u>

[140] IPIECA Sustainability reporting guidance for the oil and gas industry, March 2020.

[141] GHG Protocol establishes global standardized frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions. https://ghgprotocol.org/standards/scope-3-standard

Options 2.1 to 2.3 below contain best practice methane abatement measures covering key aspects of the main prescriptive measures typically used to mitigate methane emissions in the oil and fossil gas sectors, which includes methane leakage detection and repair, and limits on venting and flaring.



Option 2.0: BAU scenario

In the baseline, no additional policies are developed. Refer to sections 2.2.2 and 5.1 for a description of how methane emission abatement is currently being regulated in the EU though the ESR, the IED, Ecodesign and Energy labelling regulations and individual Member States regulations.

Option 2.1: **Commission guidance on mitigation of methane emissions in the oil and fossil gas sectors.** As explained previously, several voluntary initiatives to abate methane emissions exist in the oil and gas sectors (see section 2.2.2 for a detailed list of oil and fossil gas sector initiatives). These are based on best practice methane abatement measures covering key aspects of the main prescriptive measures typically used to mitigate methane emissions in the oil and fossil gas sectors, which includes methane leakage detection and repair (LDAR) surveys and limits on venting and flaring. In contrast to the oil and gas sectors, there are no industry-wide voluntary schemes to abate methane emissions in the coal sector on which Commission guidance could be based. This option therefore only covers the oil and gas sectors.

This option includes Commission guidance based on a combination of best practices contained in such voluntary initiatives as well as from existing methane regulations considered state of the art, together with detailed technical input received from various stakeholders in response to the Public Consultation for this initiative.

Key aspects of such guidelines would be as follows:

Periodic Leak Detection and Repair Surveys:

Methane emissions from leaks are most commonly reduced LDAR surveys, carried out to identify leaks and followed by repair of such leaks. Operators should therefore conduct periodic LDAR surveys and these should also cover surveying of components that vent methane, to survey for unintentional venting of methane.

Guidance would include minimum requirements for LDAR surveys, while leaving an adequate degree of flexibility to Member States and operators. New technologies and detection methods continue to emerge and Member States should encourage innovation in this sector, so that the most accurate and cost-effective methods can be adopted.

LDAR surveys should reflect a number of good practices. LDAR surveys should be primarily aimed at finding and fixing leaks, rather than quantifying them, and those areas with a higher risk of leaks should be checked more frequently; the frequency of surveys should be guided not only by the need to repair components from which methane is escaping above the methane emission threshold but also by operational considerations, taking into account risks to safety. Thus, where a higher risk to safety or higher risk of methane losses is identified, the competent authorities should be allowed to recommend a higher frequency of surveys for the relevant components; all leaks irrespective of size should be recorded and monitored, as small leaks can develop into larger ones; leak repairs should be followed by confirmation that they have been effective; in order to allow for future, more advanced methane emissions detecting technologies to be used, the size of methane loss at or above which a repair is warranted should be specified, while allowing operators the choice of detection device.

Limiting venting and flaring

Best practice regulatory approaches to limit venting consist of prohibiting it except in the case of emergencies, malfunction or during certain specific events where some venting is unavoidable. With regards to flaring, when carried out during the normal production of oil or fossil gas and as a result of insufficient facilities or amenable geology to re-inject methane, utilise it on-site, or dispatch it to a market, it is considered routine flaring. In this option, flaring would be recommended when it is the only alternative to venting and where venting is not prohibited[142]. Re-injection, utilisation on-site or dispatch of the methane to a market should always be preferable to flaring - and therefore venting - of methane.

Exceptions where venting could be allowed (such as emergencies, malfunction or during certain events where some venting is unavoidable) are necessary to ensure that measures prohibiting venting do not contribute to increases in risk to safety. Thus measures must allow venting to occur in the case of temporary, unexpected, infrequent situations in which methane emissions are unavoidable and necessary to prevent an immediate and substantial adverse impact on human safety, public health or the environment. Also venting should be allowed in the case of malfunctions, that is to say in the case of a sudden, unavoidable failure or breakdown of equipment beyond the reasonable control of the operator that substantially disrupts operations.

Option 2.2: **Mandatory measures on mitigation of methane emissions in the oil and fossil gas sectors.** As per option 2.1 but instead of issuing guidance, all of the measures listed above would be mandatory.

[142] Venting is more harmful to the environment than flaring as the released gas typically contains high-levels of methane, whereas flaring oxidises methane into carbon dioxide.

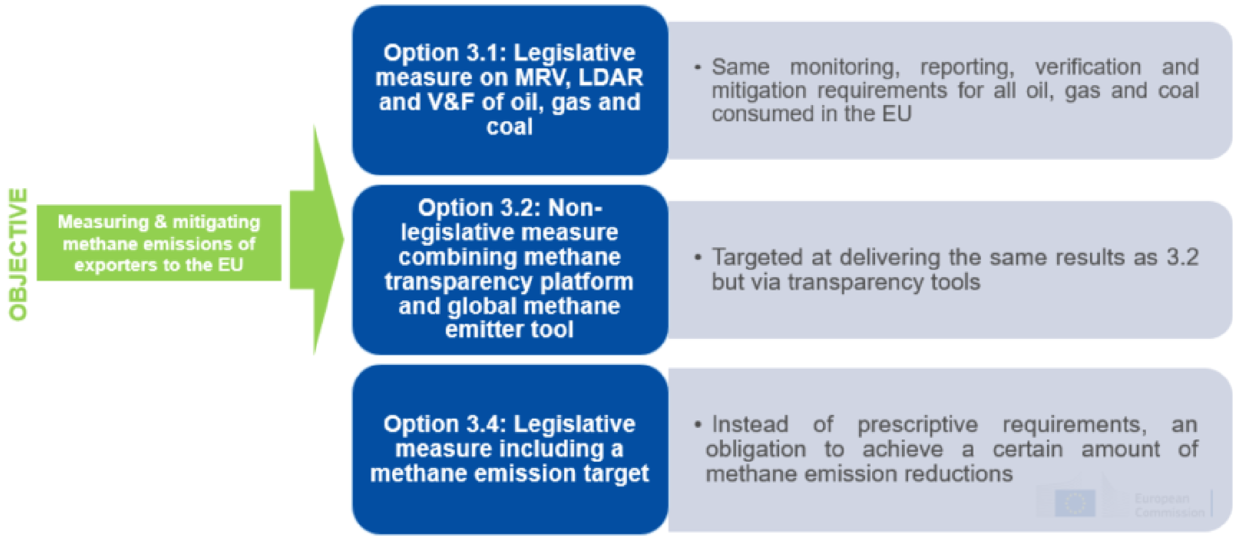
Option 2.3: **Mandatory measures on mitigation of methane emissions in the oil, fossil gas and coal sectors as well as indirect emissions**. As per option 2.2 but with an increased scope of emissions, covering a) coal from both operating and non-operating mines, and b) indirect emissions from the oil, fossil gas and coal value chains.

Although unlike the oil and gas sectors, there are no industry-wide voluntary schemes to abate methane emissions in the coal sector on which to base either Commission guidance or mandatory measures, this option assesses the merits of including coal in its scope of mandatory measures. On top of the oil and gas measures included in option 2.2, this option therefore includes specific coal sector methane abatement measures. These measures include the requirement to capture methane and to use it on-site or dispatch it to market rather than vent it. It however makes an exception in the case of very low concentrations of methane emanating from ventilation shafts, allowing methane in such instances to be oxidated. As regards non-operating mines, it requires sealing of mines to prevent methane from escaping.

Option 2.4: **Legislative measure to achieve a certain reduction in methane emissions**. Instead of specific measures prescribing how to reduce methane emissions in the energy sector (as per options 2.2 and 2.3), another approach to mitigate methane emissions is via outcome-based requirements which require obligated entities to meet a specific emissions target or standard, but without specifying how to meet it.

5.2.4. Policy area 3 – Measuring, reporting and mitigation of methane emissions linked to EU fossil fuel consumption but occurring outside the EU

While under policy areas 1 and 2 only methane emissions linked to the energy sector and occurring within the EU are considered, policy area 3 sets out various policy options which could be used to include all methane emissions linked to the consumption of fossil fuels in the EU. These options therefore envisage measures on non-EU actors exporting fossil energy to the EU market.



Option 3.0: BAU scenario

The situation in the baseline in this policy area is described in detail in sections 2.2.3 and 5.1. which highlights the low level of accuracy, as well as high levels of methane emissions from countries that are key exporters of fossil energy to the EU.

Option 3.1: **Mandatory measuring, reporting and mitigation of fossil energy sector emissions**. Mirrors options 1.2 and 2.3 from policy areas 1 and 2, but applying them also to all methane emitting fossil energy consumed in the EU, including imported energy. It therefore consists of an obligation on coal, oil and fossil gas companies to carry-out source-level measurements and reporting of direct emissions of methane as well as obligations covering key aspects of the main prescriptive measures typically used to mitigate methane emissions in the coal, oil and fossil gas sectors, which includes obligations on methane leakage detection and repair and limits on venting and flaring.

Option 3.2: **Transparency measure on MRV and mitigation of methane emissions of fossil fuels consumed in the EU.** With the aim of achieving the same results as 3.1 but based on influencing sourcing decisions through greater transparency on emissions and including the development of an EU initiative to develop a global super emitter monitoring tool as an incentive for compliance. It is composed of two complementary parts:

1. Creation of a transparency database for fossil energy imports into the EU, containing the following, cumulative, requirements:

    - Information provided by operators as regards efforts to measure and report as well as reduce their methane emissions. Indication of regulatory equivalence with EU legislation, including secondary legislation, on measurement, reporting and mitigation of methane emissions (via leakage detection and repair programmes and limits to venting and flaring) in the country of origin supplying the oil/fossil gas/coal to the EU.

- Until regulatory equivalence is ensured, indication that the fossil energy is being purchased from a company that has signed up to the OGMP for oil and/or fossil gas companies, and for coal, at a later date, according to agreement on MRV methodology developed under tertiary EU legislation

2. Setting-up of methane emitter global methane monitoring tool

Creation of global methane monitoring tool based on inputs from Copernicus as well as other satellites and services which will regularly publish the results of aerial monitoring of high methane emitters from around the world and which will provide continuous updates on the magnitude, recurrence of high methane-emitting sources and their exact location.

Option 3.3: **Legislative measure to achieve a certain reduction in methane emissions.** Mirrors option 2.4 but applying it also to oil, fossil gas and coal imported to the EU; it would therefore impose outcome-based requirements which require obligated entities to meet a specific emissions target or standard, but without specifying how to meet it.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

The analysis of the impacts of the options is carried out in two principle ways:

Environmental and social impacts

As methane emissions have a direct impact on climate change, any mitigation of methane emissions has a direct positive environmental impact both in terms of climate change, as well as in terms of air pollution (as methane is a precursor to ozone). Methane is also an air pollutant, therefore the social impacts are interpreted as the indirect impacts on human health. Less methane emissions lead to reduced air pollution and less health issues and to slower climate change. Based on these considerations, the environmental and social impacts are closely related and are assessed together.

Under policy areas 2 and 3, for which quantitative estimations are available, 'environmental and social impacts' include the amount of methane emission reductions that result from the measures associated to the level of abatement costs (at 'negative or zero' costs, at equal or less than 'low costs' or at less than the sum of 'social and environmental costs of methane' – see section 6.2.1 for full definitions and further explanation) that will result, or are most likely to result, from choosing that option. Estimations of the various environmental and social benefits associated with those amount of methane emission reductions are also provided.

Economic impacts and administrative burden

For policy area 1, the assessment of the economic impacts and the administrative burden is based essentially on information received from representatives from the sectors included in the scope assessed in the options. However, the information obtained was only partial and mostly qualitative.

Under policy areas 2 and 3, for which quantitative estimations are available, the sections on 'economic costs and administrative burden' assess which shares of reductions are achievable at different levels of cost-effectiveness (cost-effective to the company vs. cost-effective to society – factoring in the external benefits) and identifies the associated list of measures through which those reductions can be achieved.

In the case of both GAINS projections (policy area 2) and IEA estimations (policy area 3), abatement cost estimations for each individual measures are in terms of net costs. These abatement costs consider the cost-savings of utilising recovered gas after deducting revenues from investment and operational costs. This includes the sum of fixed investment costs, labour costs, non-labour related operation and maintenance costs, and energy-related cost savings (methane sold on the market as natural gas).

6.1. Policy area 1: Improving measuring and reporting of methane emissions in the EU

6.1.1. General considerations for policy area 1

Environmental and social impacts

More precise data and accurate measurements, monitoring, reporting and verification (MRV) of methane emissions, do not per se have a direct effect on the amount of emissions, however they provide the data necessary to accurately determine the causes and magnitude of methane emissions and to monitor the impact of the mitigation actions and the basis for possible additional future policy action if deemed necessary. Achieving robust MRV is therefore an essential part of the emission abatement process, and consequently its benefits as well as costs should be considered also in terms of the more effective abatement of methane emissions that it contributes towards, including the associated environmental and social benefits of that abatement.

Economic impacts

The main distinguishing feature under policy area 1 are the economic impacts on operators, which is analysed below in more detail. As observed above for environmental impacts, the costs of achieving robust MRV should be considered also in terms of the more effective abatement of methane emissions that it contributes towards. This is especially important to recognise given that, irrespective of the exact levels of costs to companies and administrations of achieving robust MRV, these would be more than adequately covered by the level of net benefits (in money terms) of abatement of those emissions that robust MRV would bring to light. Indeed, as revealed later in the case of both EU or non-EU emissions (in policy areas 2 and 3), the net benefits of methane abatement measures available even at zero or negative costs to companies are substantial when taking into account also the costs to society of methane emissions.

6.1.2. Option 1.0: Business as usual

Environmental and social impacts

Continuing with a business as usual scenario (option 1.0) implies continued reliance on national inventories data for information on methane emissions in the EU energy sector which does not provide accurate enough information (in the form of direct source-level measurements) for effective mitigation. Direct source-level measurement data will become available via OGMP, but for now it only covers 30% of the (global) oil and gas industry.

Emissions from coal would not be covered as OGMP covers only direct emissions from oil and gas.

Environmental monitoring with satellites will continue, it would however not be sufficiently granular in the near future to provide reliable and sufficiently precise MRV information.

Therefore from an *environmental and social impacts* perspective, the availability of information would remain limited and could not provide an accurate basis for further policy action.

Economic impacts

In terms of *economic impacts and administrative burden*, EU oil, gas and coal companies would continue incurring current reporting costs and administrative burden as part of their reporting of emissions data (for all greenhouse gases, not just methane) to national authorities in the context of national inventories greenhouse gas data reporting.

National authorities already play a data collection and verification role in the context of national greenhouse gas inventory reports as well as the European Pollutants Transfer Registry. Inventory reports cover all greenhouse gases (not just methane) and all emitting sectors (not just parts of the energy sector).

In the case of oil and fossil gas companies, many such EU companies have signed up to OGMP, meaning that they will already be incurring the costs of OGMP reporting[143].

In conclusion, under a business as usual scenario, while there are no significant economic/administrative costs, the envisaged action would not allow to meet specific objective 1, in terms of accuracy of information on the quantities and main sources of methane emissions associated with energy produced and consumed within the EU.

6.1.3. Option 1.1: Mandatory measuring and reporting of oil and fossil gas companies

Environmental and social impacts

[143] http://ogmpartnership.com/partners

Such a measure could meet the specific objective of improving the accuracy of information to a large extent, provided that: (i) it is designed to require energy companies to measure and report methane emissions by individual source, (ii) it includes effective verification by a competent authority/third party of those reported emissions and (iii) it makes aggregated data available to Member States to improve the accuracy of their inventories reporting to UNFCCC.

The OGMP 2.0 framework meets the above criteria. It is specifically designed for the oil and gas sector and applies to all segments of the oil and gas sector where material quantities of methane are considered to come from. It is a global standard, with 66 member companies with assets in five continents representing 30% of the world's oil and gas production[144]. Transposing relevant parts of OGMP 2.0 into EU law would oblige companies to undertake source-level measurements of methane emissions and to report them according to specific criteria tailored to the realities of oil and gas companies across the supply chain, and it is UNFCCC tier 3 compliant. It would hence yield reliable and robust data that would form sufficient basis for monitoring methane emissions and if necessary to build additional action to curb emissions.

Economic impacts

As regards the *economic impacts*, no public figures exist on the additional costs and administrative burden of putting in place a methane MRV and no such assessment was undertaken by UNEP or the CCAC in the context of setting up the OGMP.

For the OGMP signatory companies there would be no additional cost compared to the baseline. In order to try to estimate the cost to companies that are not already members of OGMP, the Commission approached the industry directly to try to obtain information via a survey to OGMP member companies, which was transmitted via the main oil and gas associations (the International Oil and Gas Production Association (IOGP), Eurogas, GIE-Marcogaz-ENTSOG) in May 2021 (the results of the survey are included in Annex 2).

Of the 36 companies that responded to the questionnaire, only five reported having estimated how much signing up to the OGMP would add to their regulatory implementation costs and only three companies provided estimations, but those replies were only partial, thus preventing an assessment of the 'extra' cost or burden for those companies. Views were split as regards the estimated or perceived additional costs and administrative burden, however IOGP considers that while the additional costs are not negligible, they are also not significant (this was further emphasised in an exchange with the organisation, which confirmed that industry is in full support of the OGMP 2.0 MRV standard and that the additional costs and administrative burden linked to its implementation would be manageable for the industry). In addition, 10 respondents consider that the overall benefits outweigh the extra cost and administrative burden at the level of the company. A number of the responses also commented that even if they do not

[144] Ibid.

consider that the benefits will outweigh the costs at the level of the company, they still consider that there are significant benefits to society.

In their response, regulated companies indicated that if the MRV costs are not recognised in the regulated tariffs, the benefits would not outweigh the costs. For regulated companies, the Council of European Energy Regulators (CEER) has expressed the view that TSOs, storage operators and LNG operators, as well as DSOs above a size threshold, should be obliged to measure and report their methane emissions according to a standard methodology, and that national regulatory authorities are willing to recognize efficiently incurred costs for regulated entities[145].

As regards national authorities, as described under the business as usual scenario, they already play a data collection and verification role. For this reason, the incremental costs and administrative burden to national authorities of verification in the context of the MRV part of these proposals should be minimal.

Responses from stakeholder consultations and European Parliament

In the public feedback on the Roadmap to the Communication on Methane, not only was there widespread support expressed by all categories of stakeholders for developing a robust MRV standard for methane emissions in the energy sector[146] but in the oil and gas industry joint responses the OGMP framework was recommended as the basis on which such a standard should be developed[147]. This widespread support was mirrored in the more recent open public consultation on the methane legislative proposals, with 78% of responses in support of basing the oil and gas part of the MRV proposal on the methodology of the OGMP[148], which is also backed by all the EU oil and gas trade associations. Furthermore, the European Parliament offers explicit support for ambitious MRV requirements in its resolution of 21 October 2021 on an EU strategy to reduce methane emissions[149]. The resolution “underlines the importance of adopting mandatory MRV for all methane-emitting sectors, including through the adoption of rules, standards and methodologies” and provides specific support for basing it on OGMP, as it “calls on the Commission to propose legislation for the energy sector with binding rules on MRV, building on the methodology of the Oil and Gas Methane Partnership”.

[145] Presentation by CEER at the 16th of March EC workshop on a regulatory approach on leak detection and repair.

[146] Explictly supported by the following NGOs: Environmental Defense Fund, Climate Action Network, an NGO coalition covering 170 member organisations, and industry: Shell, IOGP (the international upstream oil and gas federation), Eurogas (the EU federation representing the European gas wholesale, retail and distribution sectors)

[147] Recommended by IOGP (the international upstream oil and gas federation) and Eurogas (the EU federation representing the European gas wholesale, retail and distribution sectors).

[148] Even some NGOs (Climate Action Network and Climate Action Task Force) that responded no to the question stated in their answers that OGMP should be enshrined into EU law, though had some reservations on certain elements of the framework.

[149] 2021/2006(INI)

A number of stakeholders have however expressed the opinion that the OGMP framework lacks certainty and clarity regarding verification/compliance. The OGMP framework gives the role of verification only to the International Methane Emissions Observatory (IMEO). This would however be overcome by following the example of existing EU MRV legislation such as the Monitoring Mechanism Regulation (repealed by the Governance Regulation) or the European Pollutant Release and Transfer Register, and add an intermediary role for competent authorities before final check by the IMEO[150]. The OGMP aggregates all data and only publishes a summary of the data on an annual basis. To still ensure verification, the proposal would require access to direct source-level data, while ensuring respect for confidential company data and data protection requirements[151]. In addition, Member States would be required to lay down rules on penalties applicable to infringements of the provisions and take all measures necessary to ensure that they are implemented. The penalties provided for would have to be effective, proportionate and dissuasive and may include fines.

In conclusion, mandatory measuring and reporting of methane emissions by oil and fossil gas companies within the EU territory would achieve objective 1, thereby improving the accuracy of information on the main sources of methane emissions associated with energy produced and consumed within the EU. This would be achieved at moderate economic impacts.

6.1.4. Option 1.2: Mandatory measuring and reporting of oil, fossil gas and coal companies

Environmental and social impacts

This option builds on option 1.1, as it would include extending and adapting the reporting framework already developed for oil and fossil gas to coal. Such an extension is highly advisable, as on the basis of GHG inventories data, coal mine methane emissions are the biggest single source of methane emissions in the EU energy sector. In 2019, direct emissions from the coal sector represented 31% of emissions, almost equal to direct methane emissions from fossil gas and oil combined (33%).

Economic impacts

[150] Regulation no 166/2006 establishing the European Pollutant Release and Transfer Register requires operators to report emissions annually to competent authorities in the Member States.

[151] In line with article 11 of Regulation no 166/2006 establishing the European Pollutant Release and Transfer Register which states that whenever information is kept confidential by a Member State in accordance with Article 4 of Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information, the Member State shall, in its report under Article 7(2) of this Regulation for the reporting year concerned, indicate separately for each facility claiming confidentiality the type of information that has been withheld and the reason for which it has been withheld.

As no international standard aiming for highest tier reporting such as OGMP exists for the coal industry, it was not possible to obtain estimates for the coal industry to find out the costs of putting in place an MRV standard. Nevertheless, it is important to highlight the willingness of the coal industry for including coal into an MRV regulation (see further below).

The imperative of acting quickly to improve methane emissions from all key sources in the EU energy sector, as well as the wide support – including from the coal industry – to do so by including coal in the scope of an MRV regulation mean that even if no international coal-related international MRV standard exist to base such requirements on, sufficient best practice knowledge is available to already include coal in the scope of the proposals on MRV.

It however requires a tailored approach which recognises the specificities of coal-mine methane emissions, which includes taking the following into account:

- For underground coal mines, mine operators should perform continuous ventilation air methane emissions measurement and quantification on all exhaust ventilation shafts used by the mine operator. Furthermore, continuous measurements of volumes of vented and flared methane from drainage stations, should also be undertaken.
- Measurement of surface coal mine methane emissions is challenging due to their diffuse nature over a wide area. Therefore, and despite available technology[152], emissions from surface mines are rarely measured. Methane emissions from surface mines can be derived using basin-specific coal emission factors[153] and, with greater precision, using mine- or deposit-specific emission factors, since coal basins have deposits with different methane-bearing capacity[154]. Emission factors can be derived from measuring gas content of the seams sampled from exploration borehole cores[155]. Mine operators should thus perform measurements of methane emissions in surface coal mines using such emission factors. Therefore, mine operators should perform continuous measurement and quantification of methane emissions from ventilation shafts in underground coal mines, continuous measurement of vented and flared methane in drainage stations and use specific emission factors as regards surface coal mines.

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[152] Best Practice Guidance for Effective Management of Coal Mine Methane at National Level: Monitoring, Reporting, Verification and Mitigation, ECE Energy Series No. 71, UNECE 2021 (Forthcoming)

[153] 2006 IPCC guidelines for national greenhouse gas inventories.

[154] Bilans Zasobow Zloz Kopalin, stan na 31.12.2020', State Geological Surowce mineralne (pgi.gov.pl)

[155] Best Practice Guidance for Effective Management of Coal Mine Methane at National Level: Monitoring, Reporting, Verification and Mitigation, ECE Energy Series No. 71, UNECE 2021 (Forthcoming)

Responses from stakeholder consultations and European Parliament

There is very high and widespread support for including coal into an MRV regulation (96% of responses to the OPC), including by the coal industry. Moreover, the European Parliament expresses its strong support for mandatory MRV for coal mine methane emissions as well as to adopt the same MRV measures for closed or abandoned mines as for operating mines in its resolution of 21 October 2021 on an EU strategy to reduce methane emissions[156].

In conclusion, mandatory measuring and reporting of methane emissions by oil, fossil gas as well as coal companies within the EU territory would contribute towards meeting objective 1, thereby improving the accuracy of information on the main sources of methane emissions associated with energy produced and consumed within the EU. This would be achieved at moderate economic impacts.

6.1.5. *Option 1.3: Mandatory measuring and reporting of direct and indirect emissions*

Environmental and social impacts

This option would include also indirect emissions beyond direct emissions from coal, oil and fossil gas.

Including all indirect emissions occurring in the energy sector would significantly increase the scope of potential methane emissions into an MRV regulation.

Nevertheless, making the case for including obligations on indirect emissions in legislative proposals at this stage would be difficult to do or, as regards some of these emissions, not necessary, for the following reasons:

- Less than half of responses to the open public consultation were in support of the inclusion of indirect emissions;
- Methane emissions from industrial installations such as oil refining, chemicals and plastics (specific sectors which certain stakeholders asked to include in the methane legislative proposals) are not only relatively small according to GHG inventories data but they are already covered in the European Pollutant Release and Transfer Register, which requires plant-specific data to be reported. Including those indirect emissions in this proposal would therefore amount to double regulation.

[156] 2021/2006(INI)

- There is no consensus on any existing international standards on indirect emissions among stakeholders. For instance, the recommendation by IPIECA (the global oil and gas industry association for advancing environmental and social performance) that oil and gas companies undertake reporting on the basis of an existing international standard – the GHG Protocol scope 3 (scope 3 covers indirect emissions) reporting standard – was supported in only half of the responses, and no other existing standard was proposed in place of it.

Economic impacts

The *economic impacts* of including indirect emissions are difficult to estimate as indirect emissions are particularly diffuse. In addition, including indirect emissions in the scope would unnecessarily add to the administrative burden of operators that are already fulfilling requirements from existing EU regulations.

Taking the above into account, it is not proposed to retain such an option.

6.2 Policy area 2 - Mitigation of methane emissions in the EU

6.2.1 General considerations for policy area 2

The assessment of impacts under this policy area was not done on the basis of modelling specifically developed for this report. Instead, it was carried out essentially on the basis of available figures specifically developed and used for the impact assessment for the 2030 Climate Target Plan[157]. The numbers come from the GAINS (Greenhouse gas and Air Pollution Information and Simulation) model, described in more detail in annex 4. GAINS projections do not mirror exactly, nor comprehensively cover, all the measures being assessed under this policy area. However, they provide a useful approximation and indication on the economic benefits of methane emission reductions to society.

GAINS modelling projects methane emissions as well as methane emission reductions for all methane-emitting sectors of the economy and their associated costs of abatement according to the different types of measures available in those sub-sectors. These abatement costs consider the cost-savings of utilising recovered gas after deducting revenues from investment and operation costs. This includes the sum of fixed investment costs, labour costs, non-labour related operation and maintenance costs, and energy-related cost savings (methane sold on the market as natural gas). Therefore, they represent net costs. In this report, only GAINS methane emission and methane emission reduction projections available for the sub-sectors of the energy sector which are within its scope are employed. Specifically this covers oil and fossil gas production, fossil gas transmission and distribution as well as coal production and abandoned mines. Tables A.5.1, A.5.2, A.5.3 and A.5.4 show the results of GAINS modelling projections for these sub-sectors.

[157] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0176

Specifically, the oil and gas related measures which are available in GAINS projections at all levels of costs effectiveness discussed and included in this report are as follows:

- Oil and gas production: maximum recovery and utilisation of associated gas; addressing all major leaks using LDAR;
- Gas transmission: series of measures (including new controller and dry seals) to remedy typical leakages emanating from long-distance gas pipelines, which include leaky compressor seals and valves;
- Gas distribution: doubling control of frequency of leaks using LDAR.

In addition, the coal sector specific measures which are available in GAINS projections at all levels of costs effectiveness discussed and included below are as follows:

- Operating mines: pre-mining degasification, oxidation of ventilation air methane (VAM) and VAM oxidation with improved ventilation;
- Abandoned coal mines: good-practice flooding.

As specified, all those measures which are available in GAINS projections are relevant at all levels of abatement costs assessed in this report. What changes is that with each higher level of abatement costs, more methane emissions can be abated across the EU with each of the above-cited measures.

Note in addition that GAINS projects methane emission reductions that are available at different levels of abatement costs. Each level of cost represents different measures and their associated methane emission reductions and all require a policy action to trigger them. While the baseline (business as usual) scenario includes mitigation that corresponds to current EU legislation, the mitigation potential explored in this impact assessment is over and above what is included in the GAINS baseline emissions projections.

An important caveat as regards the modelling data used in this report concerns the fact that emission reduction projections are based on historical data established often as a result of default values and which contain some degree of uncertainty as regards the origin and nature of methane emissions (as we have described in section 2 of this report). While model projections are useful to give a sense of what can be expected under different circumstances, caution is advisable as to the extent to which the projections themselves can be deemed to accurately reflect what will be the situation as regards the future origin, magnitude and nature of methane emissions in the sub-sectors being analysed in this report.

Tables A.5.1 and A.5.2 highlight the share of cost-effective methane abatement measures available in the coal, gas and oil sub-sectors by comparing the projected reductions in additional methane emission reductions over and above the baseline in different years available at different levels of abatement costs, as follows:

1 *Share of emissions that can be abated at negative or zero costs*: a sum of all the projected emission on top of baseline emission reductions which are possible to abate at no net cost to the commercial entity, from which operators can either expect a net positive return (negative costs) or not net loss (zero costs). The methane abatement

captured at that level of cost would include measures that companies could theoretically be expected to implement of their own accord but are unlikely to do so in practice due for instance to lack of information;

2 *Share of emissions that can be abated at costs less or equal to 'low' costs*: a sum of all the projected emission on top of baseline emission reductions which are possible at negative or zero costs and at 'low costs'. 'Low costs' is a threshold which takes into account all the emissions that can be abated at less than 18.2 Euros per ton of CO2 equivalent of methane. The methane abatement captured at that level of costs would include measures that companies could theoretically be expected to implement of their own accord but are unlikely to do so in practice due to lack of information and/or a different perception on what they consider as 'low' costs;

3 *Share of emissions that can be abated at costs less than the sum of social and environmental costs of methane:* a sum of all the projected emission on top of baseline emission reductions which are possible at negative, zero costs, 'low costs' and at less than the sum of 'social and environmental costs'. It is a threshold which takes into account all the emissions that can be abated at less than 130 Euros per ton of CO2 equivalent of methane. This level of costs takes into account an estimation of the combined environmental, social and health-related costs of methane emissions. The methane abatement captured at that level of costs would include regulatory measures that address the externality (benefits of emission reductions accruing to society while the costs are borne by the operators). The level of abatement of emissions which is possible at less than that level of costs can thus be considered the optimal level of abatement from the point of view of society.

Both 'low cost' and 'social and environmental cost' thresholds are based on the assessments undertaken by the United Nations Environment Programme/Climate and Clean air Coalition in their recently published 'Global Methane Assessment: benefits and costs of mitigating methane emissions'[158].

More details on the cost effective measures relevant for the EU are included in annex 5 as well as the emission reductions which they are projected to deliver if put in place. These measures are listed under the relevant options below. More details on what constitutes social and environmental costs are also available in Annex 5. The benefits shown in table A.5.4 provide estimations for each of these individual benefits for 2030 which would result under each different option. Estimations for 2040 and 2050 are not included, but would similarly reveal large net benefits in terms of the comparison between the total costs of abatement measures and the total social and environmental benefits of those measures.

All the major oil and gas industry associations which responded to the open public consultation agreed with the statement that the overall benefits – including economic, social, environmental and other relevant benefits - of putting in place legislative

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[158] https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions. More information on those cost levels are contained in annex 5 in this impact assessment.

measures to ensure robust and effective measurement, reporting and mitigation of methane emissions in the energy sector generally outweigh the costs to industry[159]. The cost/benefit results presented below support this view.

Given that GAINS projections (as well as IEA estimations used in policy area 3) take into account the market price of recoverable methane in their estimations of net costs of various abatement measures, it means that the cost effectiveness of measures varies depending on the prevailing market prices for fossil gas. Thus, any estimations which would be based on the current situation (at the time of writing) of unprecedentedly high prices for fossil gas would further and significantly improve cost effectiveness, which in terms of projections would result in a larger share of emission abatement available at zero or low costs. The GAINS projections results (as well as IEA estimations) used in this report can therefore be considered as underestimating cost effectiveness in the context of the current reality of very high fossil gas prices.

As explained above, GAINS projections take into account the costs of abatement to the companies. GAINS projections do not, however, take into account other costs, such as costs to competent authorities to verify that measures are adequately implemented or other costs of ensuring compliance and enforcement, and no estimations of those costs are readily available. For a full calculation of the net benefits (in monetary terms) of abatement measures available at all levels of abatement costs, such costs would have to be estimated and deducted from the net socio-economic benefits reported below under the various options. However, as table A.5.5 clearly demonstrates, and as will be highlighted in further detail in this section when assessing different options, the levels of benefits of methane abatement are many times higher than the total net costs of abatement measures. This is true for all levels of cost abatement included in this report, as can clearly be seen in table A.5.4 which shows that for all options, net benefits amount to between 866 and 2,446 million Euros (including looking at coal measures separately). These would undoubtedly cover all those additional costs which would accrue to competent authorities as a result of these measures.

A similar point can be made as regards the likely impact of such measures on energy prices. When looking at the range of total net costs of measures included in table A.5.4, it can be seen that they are between 0 to 127 million Euros. Even taking into account the likely costs to other parties, the total net costs of measures for the highest level of cost abatement is negligible compared to what the EU 27 spent on the consumption of oil, fossil gas or coal. In 2020, the EU 27 spent 184 billion Euros on oil, coal and fossil gas combined (140 billion Euros on oil, 40 billion Euros on fossil gas and 4.5 billion Euros

[159] Both Eurogas and IOGP (International Oil and gas Association) supported that statement. The industry body representing the gas mid and downstream segment (GIE-Marcogaz ENTSOG) opted neither for a ‘yes’ nor a ‘no’ answer, but explained that the vast majority of the mid and downstream fossil gas companies are regulated entities and that the investments on MRV, LDAR and mitigation measures undertaken by infrastructure operators should be recognised within the scope of regulated activities by the national regulatory authorities. At the workshop on LDAR organised by the Commission on the 16th of March 2021, the representative of the Council of European Energy Regulators stated that National Regulatory Authorities generally expressed support to include such costs in the scope of regulated activities.

on coal), while in previous years the total level of EU purchases of oil, fossil gas and coal was much higher (287 billion Euros in 2019, 345 billion Euros in 2018). It can therefore be said that the total costs of the most ambitious level of methane abatement is unlikely to have any material impact on the prices of energy, even more so in 2021 with the very high level of energy prices recorded over the year. For instance, the IEA, which estimates that more than 70% of current emissions from oil and gas operations globally are technically feasible to prevent and around 45% could typically be avoided at no net cost because the value of the captured gas is higher than the cost of the abatement measure, states that "this share would be much higher at the moment, given the record highs in natural gas prices"[160].

No comprehensive projections are available for indirect emissions[161], and therefore a comparison of option 2.3b with other options was not possible. In addition, none of the available projections of methane emission reductions specifically model performance requirements such as option 2.4. This is because projections of methane emissions model specific abatement measures, not the instruments to be employed in order to achieve the projected reductions. Deciding on the level of emission reductions that would be included in a performance requirement would entail making a choice on a point along the marginal cost curve of all possible measures and setting the target reduction requirement on the basis of the amount of emission reductions represented by that point. In the case of prescriptive mitigation requirements, the measures would be chosen first, but regard for cost-effectiveness would also require to choose a point along the marginal cost curve beyond which no further measures are included. The end result is therefore the same for both instruments, hence the reason why there is no distinction in the results between option 2.4 and the other options covering the same scope of emissions.

All the numbers reported below can be found in one or more of the following tables contained in annex 5.

6.2.2 Option 2.0: Business as usual

Environmental and social impacts

In terms of *environmental and social impacts*, a business as usual scenario would lead to the following reductions in total direct methane emission:

- From a level of methane emissions for coal, oil and fossil gas of 1,797 kilotonnes in 2020 to levels of emissions of 1,080, 538 and 461 kilotonnes , respectively, in 2030, 2040 and 2050. Thus, methane emissions from coal, oil and fossil gas would fall by 40%, 70% and 74% under the baseline respectively in 2030, 2040 and 2050, compared to 2020.
- From a level of methane emissions for oil and fossil gas of 838 kilotonnes in 2020 to levels of emissions of 713, 412, and 355 kilotonnes, respectively in 2030,

[160] https://www.iea.org/news/tackling-methane-emissions-from-fossil-fuel-operations-is-essential-to-combat-near-term-global-warming.
[161] GAINS only projects emissions from transport and oil refining as part of indirect emissions.

2040 and 2050 Thus, methane emissions from oil and fossil gas would fall by 15%, 51% and 58% under the baseline respectively in 2030, 2040 and 2050, compared to 2020.

- From a level of methane emissions for coal of 959 kilotonnes in 2020 to levels of emissions of 367, 126 and 106 kilotonnes, respectively in 2030, 2040 and 2050. Thus, methane emissions from coal would fall by 62%, 87% and 89% under the baseline respectively in 2030, 2040 and 2050, compared to 2020.

In terms of the methane emission reductions that could be expected under a business as usual scenario, much of the past reductions in methane emissions in the energy sector were driven by declines in fossil fuel production. All things being equal therefore, it could be realistic to expect that energy sector methane emissions in the EU will at least continue to fall in line with expected reductions in fossil fuel production.

However, there would be no automatic reductions in methane emissions from operators active in non-production parts of the energy supply chain (such as in LNG terminals, gas storage, transmissions and distribution).

It is also unlikely that coal, oil and gas companies would of their own accord undertake sufficient abatement of methane emissions under a business as usual scenario. As the projections included in tables A.5.3 demonstrate, there is significant further abatement of methane emissions that the EU energy sector could undertake in future years over and above baseline emission reductions, much of which is cost effective from the point of view of companies (available at negative, zero or low costs). And there is further abatement, on top of that, which can also be achieved which is environmentally and socially cost-effective. Thus, in table A.5.3 it can for instance be seen for the oil, fossil gas and coal sectors combined that between 43% and 67% (depending on the year of projection) of total projected reductions in methane emissions over and above the baseline can be achieved at zero costs. This share rises with each higher level of abatement cost, but even at less than low costs, between 63% and 72% of extra reductions can be achieved. For the coal sector specifically, the results are even more significant: between 88% and 100% of total projected reductions in methane emissions that are available over and above the baseline can already be achieved at less than low costs.

Tables A.5.1 and A.5.2 contain the methane emissions data on which table A.5.3 is based. Both tables show the extra amount of methane emission reductions which could be abated over and above the baseline at different levels of abatement costs separately for the coal and for the oil and gas sectors. It reveals for instance for coal that putting in place measures at less than low cost could trigger an extra 218 kilotonnes of methane emission reductions on top of 593 kilotonnes of baseline methane emission reductions projected to occur between 2020 and 2030. This rises to 247 kilotonnes of extra emission reductions in 2030 with measures at less than the social and environmental costs of methane, which is the level of abatement which would be optimal to reach from the point of view of society. For the oil and gas sectors, putting in place measures at zero costs could already trigger a substantial amount of extra methane emission reductions, amounting to 292 kilotonnes of methane, on top of 125 kilotonnes of baseline methane emission reductions projected between 2020 and 2030. This rises to 458 kilotonnes of extra emission reductions in 2030 with measures at less than the social and environmental costs of methane.

In summary, those projections highlight not only that without specific requirements, operators would likely not undertake all of the abatement that is theoretically in their commercial interest to do (i.e: abatement at negative or zero net costs), but in addition, that large amounts of extra methane emission reductions could be achieved at low or even zero costs, depending on the sector.

In addition, as reflected in more detail below on the responses to the open public consultation under options 2.1 and 2.2, there was widespread support for legislative measures to mitigate emissions in the oil, fossil gas and coal sectors.

Economic impacts

GAINS projections for the baseline do not provide associated cost data. In terms of the economic impacts on companies, under a baseline whereby much of the methane emission reductions could be expected to occur naturally from further falls in the production of fossil energy in the EU, these could be expected to be minimal, as fossil production companies would not actively abate methane emissions. For other operators active in non-production parts of the energy supply chain (such as in LNG terminals, gas storage, transmissions and distribution), there could be no expectations that they would undertake any further abatement of methane emissions under a baseline scenario, and therefore that they would incur much additional impacts in terms of costs of abatement.

Given the high short term climate change impact of methane emissions and the uncertainty linked to the pace of further reductions in EU fossil production, allowing methane emissions reductions to occur as and when further reductions in fossil energy production also occur in the EU would be contrary to the imperative for expediently tackling energy related methane emissions which form the political basis of this assessment.

In conclusion, while a business as usual option would not have significant economic costs, its outcome in terms of environmental and social impacts are too uncertain and would unlikely lead to an environmentally and socially optimal outcome required to meet specific objective 2.

6.2.3 Option 2.1: Commission guidance on mitigation of methane emissions in the oil and fossil gas sectors

Environmental and social impacts

Commission guidance on mitigation of methane emissions in the oil and fossil gas sectors would contain the same measures as included in mandatory option 2.2, but these would not be legally binding. Thus, companies would be at the liberty to decide whether to implement these measures or not.

In light of the growing focus and attention on the climate changing effects of methane, some companies could likely undertake methane emission abatement as a result of the guidance, but if so only up to the extent that is cost-efficient to them (i.e: up to the level of cost-effectiveness that is qualified above as at 'negative or zero cost', but certainly not up to the levels that are considered cost effective from an environmental/social perspective) and only to the extent that information on what measures are available at negative to zero costs is available to them.

Explicitly, the environmental and social impacts of option 2.1 (covering oil and fossil gas) associated with that level of abatement costs would be as follows (see tables A.5.2 and A.5.3):

- Additional methane emission reductions (on top of baseline emission reductions) of, respectively, 292, 191 and 198 kilotonnes of methane respectively in 2030, 2040 and 2050.
- The environmental and social benefits associated with 292 kilotonnes of methane emission reductionsinclude (see table A.5.3):

  a. 418 annual premature deaths due to ozone prevented;

  b. 1,168 annual asthma-related accident and emergency department visits avoided;

  c. 26 annual hospitalizations avoided;

  d. 42,340 tons of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided;

  e. 117 million hours per year of work loss due to extreme heat avoided.

While the above *environmental and social impacts* of this option are an improvement on the baseline both in terms of the extra methane emission reductions that could be expected from it and the associated benefits, they would be unlikely to lead to the extra emission reductions and associated benefits of measures available at higher than zero costs. In the case of the oil and gas sector, as table A.5.2 shows, while not much additional methane emission reductions can be achieved at low cost compared to zero costs, at socially optimal levels of abatement costs, 56% more methane emission could be abated in 2030 (458 kilotonnes) compared to a zero cost scenario (292 kilotonnes).

In addition, the uncertain outcome of this option make it insufficient in response to the political imperative for expedient and decisive action to tackle methane emissions in the EU energy sector.

Finally, choosing this option would not adequately meet the widespread support for mandatory measures to mitigate emissions in these sectors, as highlighted in more detail below on the responses to the open public consultation under option 2.2. .

Economic impacts

In terms of the *economic impacts and administrative burden* of Commission guidance on mitigation of methane emissions in the oil and fossil gas sectors, these would be as follows (see table A.9.1 and A.5.3):

1. The share of total projected reductions in methane emissions above the baseline that can be abated cost effectively at negative or zero costs - range from between 44% to 64% for the years 2030, 2040 and 2050;

2. As table A.5.3 shows, abatement of methane emissions at zero costs means there would be no net impacts on companies. In comparison, the total social and environmental benefits of avoiding 292 kilotonnes of methane emissions is 1,064 million Euros. The net socio-economic benefits of option 2.1 therefore amount to 1,064 million Euros.

By virtue of the fact that Commission guidance would only likely lead to levels of methane emissions abatement associated with measures that are cost effective to companies, the economic impacts and administrative burden would be less than for measures that are available at (higher) social/environmental cost abatement levels, but as can be seen in options 2.2 and 2.3, the total costs of measures associated with this higher level of abatement is negligible in comparison to the total social and environmental benefits of methane emissions abatement.

In conclusion, while Commission guidance on mitigation of methane emissions would have less economic impacts than a mandatory measure covering the same scope of emissions, it would not lead to an environmentally and socially optimal outcome required to reach specific objective 2.

6.2.4 Option 2.2: Mandatory measures on mitigation of methane emissions in the oil and fossil gas sectors

Setting mandatory measures on mitigation of methane emissions in the oil and fossil gas sectors would equate to including all the methane abatement measures which are available at costs less than the sum of social and environmental costs of methane in the expectation that they would lead to the level of abatement of methane emissions associated with these measures. However, as explained earlier on, all of the measures modelled in GAINS which are listed in section 6.2.1 are common to all levels of abatement costs included in this analysis. What changes is only the amount of emission reductions achievable via such measures which increases with higher levels of abatement costs. This could be translated into policy measures by taking an ambitious approach as regards mandatory measures on mitigation of methane emissions in the oil and fossil gas sectors, meaning one that is likely to lead to the highest possible abatement of methane emissions, yet taking care to ensure that such mandatory measures are realistic and feasible. The measures described in section 5.2.3 represent such an approach. As explained in that section, they are the result of taking into account a combination of best practice methane abatement measures covering key aspects of the main prescriptive measures typically used to mitigate methane emissions in the oil and fossil gas sectors, as well as from existing methane regulations considered state of the art, together with detailed technical input received from various stakeholders in response to the Open Public Consultation for this initiative.

In addition, and as highlighted in section 6.2.3, taking an ambitious approach is important in the case of methane emissions in the oil and gas sector because, as table A.5.1 shows, while not much additional methane emission reductions can be achieved at low cost compared to zero costs, at socially optimal levels of abatement costs, 56% more methane emission could be abated in 2030 (458 kilotonnes) compared to a zero cost scenario (292 kilotonnes).

Environmental and social impacts

Explicitly, assuming that an ambitious set of measures would lead to the environmental and social impacts associated with a socially optimal cost of abatement, option 2.2 (covering oil and fossil gas) could be expected to deliver the following (see tables A.5.2 and A.5.3):

- Additional methane emission reductions (on top of baseline emission reductions) of, respectively, 458, 270 and 225 kilotonnes of methane respectively in 2030, 2040 and 2050.
- The environmental and social benefits associated with 458 kilotonnes of methane emission reductions include (see table A.5.3):
    a. 655 annual premature deaths due to ozone prevented;
    b. 1,832 annual asthma-related accident and emergency department visits avoided;
    c. 41 annual hospitalizations avoided;
    d. 66,410 tons of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided;
    e. 183 million hours per year of work loss due to extreme heat avoided.

Economic impacts

In terms of the *economic impacts and administrative burden* of option 2.2, according to the main findings of tables A.5.2, A.5.3 and A.5.4:

1. The share of projected oil and fossil gas methane emissions over and above the baseline that can be abated cost effectively from a social and environmental perspective (which, as indicated below table A.5.2, is considered in the UNEP/CCAC assessment to amount to less than 130 Euros per tonne of CO2 equivalent) range from between 65% and 68% for the years 2030, 2040 and 2050.
2. The total costs of measures to achieve socially and environmentally cost effective methane emission reductions under option 2.2 in 2030 of 458 kilotonnes of methane amounts to 93 million Euros. In comparison, the total social and environmental benefits of avoiding the same amount of methane emissions is 1,669 Million Euros. The net socio-economic benefits of option 2.2 for that year therefore amount to 1,576 million Euros. The total costs of abatement to operators are therefore negligible compared to the total benefits of that level of abatement to society.

Responses from stakeholder consultations and European Parliament

In responses to the open public consultation, all oil and gas industry associations expressed support for putting into EU legislation an obligation on leak detection and repair (LDAR), and NGOs are also widely supportive of such an obligation. It is also widely supported by National Regulatory Authorities.

As regards a ban on routine venting and flaring, all NGOs and industry respondents to the open public consultation believe that it is feasible to phase out routine venting and flaring associated with energy produced and consumed in the EU. Such an obligation is also widely supported by National Regulatory Authorities. The industry responses are more nuanced than those of NGOs, but it is clear from the detailed responses of industry to the Public Consultation questions on what a ban on routine venting and flaring should contain that they conditionally support such an obligation.

In addition, many oil companies (a number of which are also fossil gas companies) have committed to achieving zero routine flaring by 2030, as signatories to the World Bank zero routine flaring by 2030 initiative[162], so it could be argued, especially if we ensure a sufficiently comparable approach to that of the World Bank's in our proposals, that they could not reasonably oppose it.

Furthermore, the European Parliament offers explicit support for ambitious mandatory requirements on LDAR and on venting and flaring in its resolution of 21 October 2021 on an EU strategy to reduce methane emissions[163]. In the resolution, it "underlines the importance, [moreover], of adopting mandatory leak detection and repair (LDAR) programmes…" and expresses the view that "… leak detection should be followed by sound recordkeeping and a requirement to repair potential leaks within a clear timeframe; it states that "improving leakage detection and repair and strict rules on routine venting and flaring are essential measures to reduce methane emissions from the energy sector"; it "welcomes the consideration of rules covering the whole supply chain to ban routine venting and flaring in the energy sector up until the point of production, except in exceptional cases necessary for safety reasons…".

On both obligations on LDAR and restrictions on venting and flaring, the oil and gas industry as well as NGOs have provided very detailed replies of what should be contained in them, which can be considered conditions for putting in place such obligations. The emerging commonalities from those responses as well as useful guidance, which are taken into account in the measures proposed and further detailed for oil and gas in section 5.2.3 which form part of options 2.1, 2.2 and 2.3 are as follows.

On LDAR, the policy proposal should take the following into account:

1. Accuracy and quantifying of leaks is less important than finding and fixing them.
2. A risk-based approach should be taken, meaning that those areas with a higher risk of leaks should be checked more frequently. All leaks irrespective of size need to be recorded as small leaks can develop into larger ones, and these have to be monitored.
3. There should be verification and confirmation that leak repairs have been effective soon after the repair.

[162] Company endorsers of the initiative include BP, Chevron, ConocoPhillips, Eni, Equinor, Entreprise Tunisienne d'Activités Pétrolières, Galp Energia, Kuwait Oil Company, Nigerian National Petroleum Corporation (NNPC), Total, Sonatrach, Shell, Socar, Repsol, Wintershall Dea, to name but a few, the rest can be found here: https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030#4

[163] 2021/2006(INI)

4. Harmonized definitions of certain key terms should be included.
5. The obligation should have a certain amount of flexibility, for instance by not being prescriptive on the types of device to be used for detecting leaks, and allowing for new, advanced LDAR technologies. It should however specify the sensitivity threshold.

In addition, notable recommendations which are also reflected in the measures detailed in section 5.2.3 for oil and gas include the following:

1. Unlike industry, NGOs are especially keen on setting the frequency of LDAR campaigns in legislation.
2. Both NGOs and industry are divided on the question of the requirement to repair all detected leaks and on the question of allowed time taken for leaks to be repaired after detection. It seems that a middle way would be to include some exceptions.

As regards the approach to be taken on limiting venting and flaring, the following emerging commonalities from stakeholder input in response to the Open Public Consultation are also taken into account in set of measures proposed on oil and gas and detailed in sections 5.2.3:

1. A common set of definitions and parameters for venting and flaring is necessary (unanimous among responding NGOs and industry).
2. The EU should establish a list of clearly defined circumstances under which venting and flaring is allowed (unanimous among responding NGOs and industry, although industry advise that only guidance should be issued, and that it should avoid being overly prescriptive).
3. For routine flaring, there is wide support among both NGOs and industry to base the proposal on, and use the definitions of, the World Bank's zero routine flaring initiative by 2030.
4. On venting, several NGOs are proposing an outright ban, with exemptions for a discrete set of clearly defined activities and situations.
5. Both NGOs (with one exception) and industry agree that there should be a phase out of routine venting and flaring, though they are divided on the length of it (0 to 5 years according to NGOs, more than 5 years according to industry).

As regards compliance, the approach should closely follow existing EU legislation which already requires operators to deliver proof of compliance at plant-level with methane emission limits, such as for instance in the case of the Industrial Emissions Directive (IED). Under the IED, verification of compliance is based on Member State systems and plans of environmental inspections at national, regional and local level. This requires national competent authorities to draw up programmes for routine environmental inspections, including the frequency of site visits for different types of installations. Such inspections must include site visits, monitoring of emissions and checks of internal reports and follow-up documents, verification of self-monitoring, checking of the techniques used and adequacy of the environment management of the installation, undertaken by or on behalf of the competent authority to check and promote compliance of installations[164].

In addition, Member States would be required to lay down rules on penalties applicable to infringements of the provisions and take all measures necessary to ensure that they are implemented. The penalties provided for would have to be effective, proportionate and dissuasive and should include fines.

In summary, option 2.2 would lead to achieving a socially and environmentally optimal outcome for that scope of methane emissions (covering oil and gas), and while the economic costs would be higher than in the case of non-mandatory measures, the net economic impacts linked to an environmentally and socially cost effective abatement level is significantly positive. In conclusion, option 2.2 would meet objective 2.

6.2.5 Option 2.3: Mandatory measures on mitigation of methane emissions in the oil, fossil gas and coal sectors as well as indirect emissions

In keeping with the approach taken under option 2.2, setting mandatory measures on mitigation of methane emissions in the oil, fossil gas and coal sectors would equate to including all the methane abatement measures which are available at costs less than the sum of social and environmental costs of methane in the expectation that they would lead to the level of abatement of methane emissions associated with these measures. As explained under option 2.2, this could be translated into policy measures by taking an ambitious approach as regards mandatory measures on mitigation of methane emissions in the oil, fossil gas and, in this case also, coal sectors, meaning one that is likely to lead to the highest possible abatement of methane emissions, yet taking care to ensure that such mandatory measures are realistic and feasible.

On the inclusion of indirect emissions, following the reasoning under policy area 1, it is not possible currently to know what, if any, additional mitigation measures would be necessary.

In addition, and as highlighted under the BAU scenario, EU regulations already exist which include obligations to mitigate energy related methane emissions such as emissions from all industrial installations from several sectors via the Industrial emissions Directive (such as chemical, oil refining and plastic production plants), and emissions from space heating and cooling installations, via the Ecodesign and Energy Labelling regulations.

It is however important to note that the scope of the IED excludes all fossil gas upstream, mid and downstream (LNG, underground gas storage, transmission, distribution) as well as coal mining/extraction, which itself provides an additional justification for covering all these sectors in the present proposal.

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[164] Article 23 on environmental inspections of Directive 2010/75/EU of 24 November 2010 on industrial emissions,

Environmental and social impacts

Explicitly, assuming that an ambitious set of mandatory measures would lead to the environmental and social impacts associated with a socially optimal cost of abatement, option 2.3a (covering oil, fossil gas and coal but not indirect emissions) could be expected to deliver the following (see tables A.5.1, A.5.2 and A.5.3 for detailed numbers):

- Additional methane emission reductions (on top of baseline emission reductions) of, respectively, 706, 377 and 317 kilotonnes of methane respectively in 2030, 2040 and 2050.
- The environmental and social benefits associated with 706 kilotonnes of methane emission reductions include (see table A.5.4): 1,010 annual premature deaths due to ozone prevented;
    a. 2,824 annual asthma-related accident and emergency department visits avoided;
    b. 64 annual hospitalizations avoided;
    c. 102,370 tonnes of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided;
    d. 282 million hours per year of work loss due to extreme heat avoided.

By virtue of including a larger scope of emissions, option 2.3a results in larger environmental and social benefits, in terms of methane emission reductions, and thus also in terms of environmental and social benefits, than option 2.2.

Economic impacts

In terms of the *economic impacts and administrative burden* of option 2.3a, according to the main findings of tables A.5.3 and A.5.4:

1. The share of total projected methane emissions over and above the baseline under option 2.3a that can be abated cost effectively from a social and environmental perspective range from between 73% to 77% for the years 2030, 2040 and 2050.
2. The total costs of measures to achieve socially and environmentally cost effective methane emission reductions under option 2.3a in 2030 amounts to 127 million Euros. In comparison, the total social and environmental benefits of avoiding the same amount of methane emissions is 2,573 Million Euros. The net socio-economic benefits of option 2.3a for that year therefore amount to 2,446 million Euros.

On the inclusion of coal

Honing in specifically on the economic impacts and administrative burden of the coal-related measures in option 2.3a, according to the main findings of tables A.5.1 and A.5.3:

1. All of the projected coal-related methane emissions over and above the baseline can be abated cost effectively from a social and environmental perspective for the years

2030, 2040 and 2050. Already at low cost of abatement, between 88% and 100% of total coal-related methane emissions over and above the baseline can be abated. Thus, taken as a whole, a large number of methane emissions in the coal sector can be abated at relatively low costs. This however merits further qualification. As table A.5.1 which provides further details clearly shows:

- The measure modelled for abandoned mines (where possible, good-practice flooding, as highlighted in section 6.2.1) is very cost effective with 100% of measures, for all years, being available already at negative or zero costs.
- Due to the sizeable share of overall projected methane emissions and methane emission reductions emanating from abandoned mines – especially in later years as a growing number of coal mines will stop operation – the overall cost effectiveness of coal-mine methane emission measures is influenced to some extent by the high cost effectiveness of measures related to abandoned mines.

2. The total costs of coal-related methane abatement measures at low cost of abatement amounts to 15 million Euros for 218 kilotonnes of abatement by 2030. The total social and environmental benefits of avoiding the same amount of methane emissions amounts to 794 million Euros, resulting in net socio-economic benefits of 780 million Euros. The level of net socio-economic benefits increases to 866 million Euros for coal-related methane emission abatement measures that are socially optimal. Thus, coal-related methane emissions abatement is very worthwhile taking into account the cost of methane emissions to society at low cost and at social cost abatement levels.

There are other projections that arrive at very similar conclusions as these GAINS model projections in terms of the types of cost-effective methane abatement measures available in the coal sector. For instance, the Climate Clean Air Coalition/United Nations Environment Programme May 2021 report 'Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions'. states that 55% to 98% of targeted measures in the coal sector have low mitigation costs (of less than 18.1 euros per ton of CO2 equivalent), and that these include the same measures included in GAINS modelling, namely pre-mining degasification and recovery and oxidation of ventilation air methane as well as flooding of abandoned coal mines (see also further details in annex 5).

Other recent analysis of methane mitigation measures in the energy sector[165] also supports the cost effectiveness of such coal-related mitigation measures, and concludes from an assessment of a number of different estimations of marginal abatement cost curves and maximum technical abatement potentials that prominent methane mitigation measures in the coal sector include pre-mining degasification, flooding abandoned mine, ventilation air methane with improved ventilation, open flaring, and that the first three measures can sometimes be achieved at no net cost.

Responses from stakeholder consultations and European Parliament

[165] Ocko et al: Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming, 25 January 2021.

In responses to the open public consultation, as regards the inclusion of mitigation measures of coal mine methane in the proposal, the public consultation yielded high and widespread support (80% of responses). Note that although the European coal federation, Euracoal, did not respond positively, Polska Grupa Górnicza, which is Poland's largest mining group, did.

Furthermore, the European Parliament offers explicit support for ambitious mandatory requirements to reduce methane emissions from coal mines in its resolution of 21 October 2021 on an EU strategy to reduce methane emissions[166]: it "expresses strong support for mandatory MRV and LDAR for coal mine methane emissions, including the requirement for companies that own closed sites or Member States (for abandoned mines where no existing owner is liable) to effectively close and seal all abandoned sites in the EU as soon as possible and to adopt the same MRV and LDAR measures as for operating sites; appeals to the Commission to take appropriate action to ensure that Member States address the ownership of abandoned sites and support coal mine methane mitigation". There are in addition many arguments in favour of including coal in the mitigation measures of the proposal, in addition to the wide support expressed in the public consultation and the high share of coal-related methane emissions in the EU sector according to inventory data, as follows:

1. The existence of proven and effective regulations in the EU (such as France, Germany) and in the UK which have led to significant reductions in direct emissions of methane in these countries (from operating and/or non-operating mines). In Germany specifically, in the case of methane emissions from abandoned mines, it has led to 99% of recovery and utilisation of coal mine methane.
2. In Poland (close to 70% of total methane emissions from coal mining in the EU) and Romania (second biggest emitter, around 18% of emissions), methane emissions from coal mines have fallen by only 17% for Poland, and have stayed the same for Romania, since 1990. EU level action is therefore clearly warranted.
3. Global coal mine methane emissions are likely to continue growing in the future, even with declining coal production because of continued increases in abandoned mine methane emissions, and exploitation of deeper and gassier deposits due to the exhaustion of shallow coal reserves[167].
4. The measures to effectively reduce methane emissions from coal mines are well known and widely recognised:
    - In the case of operating mines,
        - In active underground mines, methane drainage can be used to lower the percentage of methane in the air: capturing the gas to prevent it from entering mine airways. Methane can be captured before, during and after

[166] 2021/2006(INI)
[167] Global methane emissions from coal mining to continue growing even with declining coal production; Journal of Cleaner Production, February 2020.

mining by pre- and post-mining drainage techniques, respectively. The recovered methane can be used (most commonly for power generation, direct thermal, and pipeline injection) or flared when utilisation is not possible.

    - Ventilation air from underground mines contains diluted concentrations of methane and is referred to as ventilation air methane (VAM). It can be mitigated by oxidation, with or without energy recovery or used as a supplementary fuel (i.e: combustion air for boilers or turbines).

- In the case of closed or abandoned mines, methane emissions can be abated via flaring of excess drained gas, exploitation of drained gas for power generation, pipeline gas, chemical feedstock and others, and use or abatement by oxidation of ventilation air methane. Alternatively, flooding can prevent methane emissions.

However, mitigating coalmine methane in operating mines can be challenging as methane concentration of emissions is very low and can fluctuate in quality and quantity. The lower the concentration of methane, the more technically difficult and costly it is to abate[168]. Taking into account also the profitability of coal mining compared to other fossil fuels, the economic case for the mitigation of methane emissions from coal mines is therefore not as strong as for oil and gas operations. Indeed, the schemes which have been put in place in Europe all have in common that specific support mechanisms have been put in place to recover and use methane from operating and/or closed/abandoned mines for power generation which function with a dedicated feed-in tariff.

The European Commission has on two occasions provided extensions of the German state aid scheme[169] (to 2021 and to 2026), on the basis that supporting mine gas utilisation contributes to the efforts to reduce the release of greenhouse gases and also recognising that besides climate protection effects, using mine gas to produce electricity leads to primary energy savings, as this gas would otherwise simply be released into the atmosphere and instead another primary resource would be used to produce electricity, with associated impacts in terms of greenhouse gas emissions which such production would lead to.

It is not within the legal scope of this proposal to address the issue of attribution of state aid to incentivise recovery and use of coal mine methane or abandoned mine methane, which is within the remit of the Energy and Environmental State Aid Guidelines[170], which at the moment of writing, the Commission is in the process of reviewing as well as consulting the public on[171].

[168] IEA, World Energy Outlook 2019
[169] Decisions SA.38632 C(2014) and SA.57779, EEG 2021
[170] COMMUNICATION FROM THE COMMISSION Guidelines on State aid for environmental protection and energy 2014-2020, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN
[171] https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2784

In summary, option 2.3a would lead to achieving a socially and environmentally optimal outcome for that scope of methane emissions (including the oil, gas and coal sectors), and the net economic impacts linked to an environmentally and socially cost effective abatement level is significantly positive. In conclusion, option 2.3a would meet objective 2.

6.2.6 *Option 2.4: Mandatory measure to achieve a certain reduction in methane emissions*

As explained under section 6.2.1, the modelling of methane emission abatement that is used in policy area 2 does not allow for a distinction to be made between target-based or non-target based (prescriptive) instruments. Both would equally require choosing a level of abatement cost and including all the associated abatement measures included within it in the expectation that they would lead to the associated reductions in methane emissions that the model projects. From this, a target could be derived for a target-based instrument and included in policy, while for a prescriptive instrument it is the measures themselves which would be included in policy. This explains why the environmental and social impacts as well as the economic impacts of a target-based instrument can be considered to be the same as the equivalent impacts for prescriptive requirements such as in option 2.2 or 2.3 (depending on the scope of emissions).

Thus, there are no distinctions both in terms of efficiency of measures between the two types of instruments or in terms of administrative burden and compliance costs for companies and/or administrations. Note that this assumes that verification costs are equivalent for both instruments, although this is a less important point given that there are other, more important reasons, for choosing not to put forward option 2.4 as a preferred option.

There are two main ways that such target-based requirements could be set:

1. Absolute targets: which represents an absolute target reduction in methane emissions of an activity or sector;
2. Intensity target: which represents a relative target reduction in methane emissions of an activity, usually expressed as a share of total production/energy sold.

The latter is the type that all stakeholders (NGOs and industry included) in favour of such an instrument refer to in their policy recommendations to mitigate methane emissions in the energy sector. The advantage of such an approach is that it allows straightforward comparisons between entities with different production levels.

The problem common to all these types of requirements is that without accurate information on the levels and magnitude of methane emissions on which they are based, it is difficult to set adequate levels of targets and to properly assess their effectiveness. This was also widely recognised by respondents to the open public consultation: 94% of responses consider that such target-based requirements first need a robust measurement and reporting regime and that they require an accurate baseline understanding of the level of emissions before they can be implemented.

The only way, for instance, that one could gauge whether the OGCI initiative mentioned in the baseline (or any target on methane emission reductions by any entity, whether company or country) is achieving the methane emission reductions it aims or claims to be achieving is if accurate, representative and independently verified methane emissions data based on direct source-level measurements for those companies was readily available, which is not the case today. This is the reason why the IEA advises, in its recently published report providing recommendations on how to regulate energy sector methane emissions[172], that prescriptive requirements typically used to mitigate methane emissions in the oil and fossil gas sector (which includes MRV, LDAR and restrictions on venting and flaring) can serve as a useful first step on the path to more flexible and economically efficient regulations like target-based requirements. The IEA also explains that in contrast to such requirements, prescriptive requirements are relatively simple to administer for both the regulator and the operators, as it is clear what must be done to comply and it is relatively easy for regulators to determine if the standard has been met. The IEA also adds that such requirements have the potential for a significant impact on overall emissions but that, unlike target-based requirements, they do not require an accurate baseline understanding of the level of emissions or a robust measurement and estimation regime.

This means that success in proposing EU legislation which includes the preferred option in policy area 1 would, in due course, provide the opportunity to consider such requirements. Indeed, one of the key justifications for developing robust MRV that leads to direct source-level methane emission measurements, reporting and verification is that it is the necessary basis for being able to consider a much broader methane emission mitigation toolkit than we are currently able to do. And it is something that many respondents clearly feel strongly about, as only 32% of responses consider that prescriptive mitigation requirements, (such as MRV, LDAR and venting and flaring), in and of themselves, can be sufficient to drive further decreases in methane emissions, though 64% of responses consider that target-based requirements are necessary to achieve significant methane emissions reductions in the energy sector.

In summary, while option 2.4 would target the same levels as options 2.2 or 2.3a (depending on the scope of emissions) in terms of both environmental/social and economic impacts/administrative burden, its successful implementation (i.e. accurate calibration of a target) is conditional on the availability of robust MRV of energy-related methane emissions which is not yet in place in the EU, and which is the objective of policy area 1.

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

6.3 Policy area 3 – Measuring, reporting and mitigating methane emissions linked to EU fossil fuel consumption but occurring outside the EU

6.3.1 General considerations for policy area 3

The assessment of impacts under this policy area was not done on the basis of modelling specifically developed for this report. And as full GAINS methane emissions projections are not available for non-EU countries, the analysis of the environmental, social and economic impacts in this section is based on estimations from the International Energy Agency[173] of methane emissions in 2019 and reductions that could be achieved under various different cost considerations (assessed using the same definitions and levels of abatement costs as for policy area 2, as included in sections 6.1 and 6.2.1) in a sample composed of the largest exporting countries of oil and fossil gas to the EU:

- Oil: Russia, Saudi Arabia, US, Iraq, Norway;
- Fossil gas: Russia, Norway, Algeria, Qatar, Nigeria, US.

The detailed results are included in the tables A.5.5 and A.5.6 in Annex 5. The IEA did not carry out similar analysis for the coal sector, and no such estimations are available for the coal sector from other sources.

Those estimations are not specifically linked to EU consumption, as they cover all oil and fossil gas related methane emissions occurring in those countries. No equivalent estimations are available from the IEA, or from any other organisation, focusing only on methane emissions linked to EU consumption of fossil energy but occurring in third countries. They therefore cannot be used to make quantitative distinctions between one proposed option or the other. Another reason why those numbers cannot be used to make such distinctions is because all policy options are the same in terms of targeted scope of emissions and have the same objective in common, which is to improve information on, and incentivise mitigation of, methane emissions sources taking place outside of the EU but related to EU fossil fuel consumption. They therefore primarily serve to highlight the magnitude of the methane emissions estimated to originate from key exporters of fossil energy to the EU in comparison to methane emissions occurring in these same sectors in the EU, as well as to highlight – in the same way as was done using GAINS projections in policy area 2 – the share of those methane emissions that can be abated at different levels of abatement costs.

Thus, rather than distinguish the different policy options assessed under this policy area by attempting to estimate and attribute different level of emission reduction abatement to each, the assessment of impacts of options under this policy area focuses instead on qualitatively evaluating whether the options could realistically be implemented in order to incentivise such reductions in methane emissions in exporting countries in the EU via the use of cost-effective measures as highlighted by the IEA, and achieve the associated benefits, and therefore fulfil specific objective 3.

[173] IEA Methane Tracker 2020 (https://www.iea.org/reports/methane-tracker-2020)

Those estimations are not provided according to any time-scale, and as such represent the sum of all methane emissions which the IEA considers technically feasible to achieve by those countries in the foreseeable future. And the IEA did not attempt to project what amount of those emission reductions are already likely to take place under a baseline (business as usual scenario).

While these estimations focus on a sample of main exporting countries to the EU, all options under this policy area would equally aim to achieve methane emission reductions in all exporting countries to the EU, not just in those listed above.

As regards the specific abatement measures available in the oil and gas sectors of these countries which the IEA considers in its estimations, and which are relevant at all levels of abatement costs, these are very comparable to the measures included in GAINS, and include upstream and downstream LDAR, replacement of existing methane-emitting devices via retrofitting or replacing them with lower-emitting versions and installing new emission control devices that can reduce or avoid large sources of vented emissions.

There was high and widespread support expressed via responses to the public consultation on the notion of covering all emissions linked to EU fossil energy consumption, including those occurring outside the EU. These responses are conveyed in more detail below, under the relevant options.

Environmental and social impacts

In terms of the *environmental and social impacts* implied by these estimations in the above tables, the following represent a number of key findings, in comparison to options 2.1/2.2, which cover the same sub-sectors, oil and fossil gas, (see table A.5.5):

1. The amount of methane emission reductions that can be abated at negative or zero costs in those key countries represents a total of 8,504 kilotonnes of methane, compared to 292 kilotonnes of methane for the EU (in 2030): which is 29 times greater for those key exporting countries than for the EU;
2. The amount of methane emission reductions that can be abated at low costs or less in these key countries represents a total of 25,255 kilotonnes of methane, compared to 361 kilotonnes of methane for the EU (in 2030): which is 69 times greater for those key exporting countries than for the EU;
3. The amount of methane emission reductions that can be abated at environmental/social level of abatement costs in those key countries represents a total of 25,513 kilotonnes of methane, compared to 458 kilotonnes of methane for the EU (in 2030): which is 56 times greater for those key exporting countries than for the EU.
4. The environmental and social benefits associated with the socially and environmentally cost effective methane emission reductions achievable in those key exporting countries (comparable figures for EU in brackets) are as follows:
    - 36,656 (653) annual premature deaths due to ozone prevented;
    - 102,535 (1,825) annual asthma-related accident and emergency department visits avoided;

- 2,307 (41) annual hospitalizations avoided;
- 3,716,883 (66,062) tons of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided;
- 10,253 (182) million hours per year of work loss due to extreme heat avoided.

Economic impacts

In terms of the *economic impacts and administrative burden* implied by these estimations in the above tables, the following represent a number of key findings, in comparison to options 2.1/2.2 (see table A.5.6):

1. 33% of the share of total 2019 emissions in these key countries can be abated cost effectively at zero or negative costs. For comparison, the equivalent proportion for the EU (options 2.1/2.2) is between 44% and 64%, depending on the year;
2. 98% of the share of total 2019 emissions in these key countries can be abated cost effectively at low costs or less. For comparison, the equivalent proportion for the EU (options 2.1/2.2) is between 54% and 66%, depending on the year;
3. 99% of the share of total 2019 emissions in these key exporting countries can be abated cost effectively from an environmental/social perspective, at costs less than social and environmental costs of methane emissions. For comparison, the equivalent proportion for the EU (options 2.1/2.2) is between 65% and 68%, depending on the year. The total costs of measures to achieve socially and environmentally cost effective methane emission reductions in those key exporting countries amounts to 2,607 million USD (or 2,216 million Euros). In comparison, the total environmental/social benefits of avoiding the same amount of methane emissions is 110,225 million USD (or 93,691 million Euros), yielding net social and environmental benefits of 107,618 million USD (or 91,475 million euros). For the EU, the comparable net social and environmental benefits (option 2.1/2.2) are 1,576 million Euros.

In conclusion, though the proportion of methane emissions that can be abated in those key exporting countries at negative or zero costs is less than for the EU, a much greater share of emissions can be abated at low costs or less in those export countries than in the EU. And as per the EU, the costs of abating those methane emissions are significantly less than the total social benefits. Taking into account that abatement which is cost effective from the point of view of companies could already lead to as much as 25,255 kilotonnes of methane being abated in those countries, compared to only 361 kilotonnes of methane in the EU, the case for action to achieve further abatement of methane emissions in countries exporting to the EU – as well as in the EU - is clear from a social and environmental perspective.

It should be noted that, as with GAINS projections, while IEA estimations take into account the costs of abatement to the companies, they do not take into account other costs, such as costs to competent authorities to verify that measures are adequately implemented and other costs of ensuring compliance and enforcement, and no estimations of those costs are readily available. For a full calculation of the net benefits (in monetary terms) of abatement measures available at all levels of abatement costs, such costs would have to be estimated and deducted from the net socio-economic benefits reported below under the various options. However, as table A.5.6 clearly demonstrates, the levels of benefits of methane abatement are many times higher than the total net costs of abatement measures. This is true for all levels of cost abatement, for which the net benefits would more than adequately cover all those additional costs which would accrue to parties other than operators as a result of these measures.

A similar point can also be made as regards the likely impact of such measures on energy prices as was made with GAINS projections, which are likely to be small given the small amount of total costs of those measures at all level of abatement costs compared to the vastly greater amounts spent on energy. This would be even more the case in the current context of very high energy prices. The IEA, which estimates that more than 70% of current emissions from oil and gas operations globally are technically feasible to prevent and around 45% could typically be avoided at no net cost because the value of the captured gas is higher than the cost of the abatement measure, states that "this share would be much higher at the moment, given the record highs in natural gas prices" [174].

6.3.2 Option 3.0: Business as usual

Environmental and social impacts

With the successful launch of the IMEO (see section 5.1 for more details), there is the expectation that in the next few years, it will fulfil its remit of collecting, reconciling, verifying and publishing anthropogenic methane emissions data at a global level, thereby providing much needed transparency on global methane emissions.

The Commission is fully committed to working in cooperation with the EU's energy partner countries to the EU for their endorsement of and commitment to the IMEO, and towards ensuring that its financing is fully secured.

The Commission will also work with the IMEO towards the delivery of a market transparency tool such as the Methane Supply Index, as mentioned in the EU Methane Strategy. It would provide methane emission information from different sources of fossil energy from around the globe, thereby empowering buyers of fossil energy for consumption in the EU or elsewhere to voluntarily make informed purchasing decisions on the basis of the methane emissions of fossil energy sources. This would complement well the primary objective of the IMEO to become a global information provider on methane emissions by using the information which it will gather to incentivise also the reduction of methane emissions which such a tool would promote.

The widespread publication and recognition of such data could help operators to address the awareness gap and provide information about cost-effective measures available to

[174] https://www.iea.org/news/tackling-methane-emissions-from-fossil-fuel-operations-is-essential-to-combat-near-term-global-warming.

them. However, the external environmental and social benefits of methane emissions abatement would remain unaddressed..

In the responses to the open public consultation, 96% of responses are supportive of the setting up of an International Methane Emissions Observatory (IMEO) and the development of a methane supply index (MSI) at EU and international level, composed using existing and reported data from countries' emissions inventories as well as satellite data and, in time, global data processed and published by the IMEO.

However, respondents also conveyed the following opinions:

1. Only 12% of responses consider that such a market transparency tool should play a central role, and be the key instrument to provide the energy sector the incentives to reduce their methane emissions;

2. 70% of responses consider that such a market transparency tool should play a role alongside and together with obligations on MRV, LDAR and limits on venting and flaring on exporters of fossil energy into the EU;

3. 5% of responses consider that such a market transparency tool should play a role together with methane intensity standards on exporters of fossil energy into the EU.

For these reasons, while it is considered that the described diplomatic actions should be pursued in any case and can contribute towards achieving the objectives under policy area 3, they are unlikely to be sufficient.

Economic impacts

In terms of economic impacts, if it were to successfully incentivise abatement measures equivalent to social/environmentally optimal levels of methane emissions reductions, the impacts would be equivalent to those described in 6.3.1. at comparable level of abatement costs. While the costs on companies would be higher than at commercial levels of cost effectiveness (zero/negative or low costs), it would also result in much higher social/environmental benefits.

In conclusion, the outcome of a business as usual option in terms of environmental and social impacts are too uncertain and insufficient and would therefore unlikely lead to an environmentally and socially optimal outcome required to meet specific objective 3.

6.3.3 Option 3.1: Mandatory measures on measuring, reporting and mitigation of fossil energy sector emissions

Environmental and social impacts

Option 3.1 mirrors two options that are assessed in the previous policy areas, in the context of methane emissions occurring in the EU territory: the mandatory measures included in options 1.2 and 2.3. The appeal of such an option is that it is based on a proportionality rationale that if mandatory requirements on methane emissions should be imposed on companies based in the EU which produce or transport energy which is consumed in the EU, then these same types of measures should equally be imposed on companies that produce or transport energy outside of the EU but which is destined for final consumption in the EU.

In terms of environmental and social impacts, it could therefore at least theoretically be considered that, as per the mandatory measures under policy areas 1 and 2, such an option could similarly lead to a level of methane emissions abatement, and associated benefits, equivalent to a social/environmental outcome for those countries in question (as highlighted in section 6.3.1).

Economic impact and administrative burden

In terms of economic and social impacts, it could equally be considered that, as per the mandatory measures under policy areas 1 and 2, if it were to successfully incentivise abatement measures equivalent to social/environmentally optimal levels of methane emissions reductions, the impacts would be equivalent to those described in 6.3.1. for that level of abatement costs. While the costs on companies would be higher than at commercial levels of abatement costs (zero/negative or low costs), it would also result in much higher social/environmental benefits.

But extending obligations to non-EU actors would imply also the need to ensure compliance and verification outside of the EU. Though this would represent extra costs, as already explained, the net benefits of abating methane emissions would adequately cover those costs. The issue is rather about how to effectively ensure that detailed EU requirements on monitoring, measuring and reporting of methane emissions, repair of leaks and limits to venting and flaring along a complex supply chain are properly implemented and verified in countries beyond the EU's jurisdictions. It is vastly more complicated than verifying whether a product which has been exported to the EU has been made according to EU standards, and certified as such. With further technology improvements, such as increasingly accurate satellite data, such verifications may become possible and reliable in the future.

The additional question is what penalties to issue for non-compliance. Stakeholders that are supportive of extending all the requirements on operators based in the EU to non-EU operators are unanimous in asking to condition EU market entry of fossil energy on full compliance with the future EU requirements. In practice, this would mean not allowing imports of oil, fossil gas or coal from countries that do not comply with the same or comparable requirements to monitor, measure and report methane emissions, repair methane leaks or limit venting or flaring of methane that are imposed on EU operators.

Stakeholders defending such an approach consider that such an approach would be WTO compliant on the basis that under WTO jurisprudence, the EU may condition market access upon compliance with certain measures so long as well-defined conditions are met. These conditions are, among others, that the measures are equally applicable to EU domestic actors, that they are necessary to achieve the level of protection set out by the EU, that they are not applied in a discriminatory manner and afford third country exporters to the EU the ability to comply with alternative measures that are comparable in effectiveness.

And indeed, in terms of WTO implications, this option would not: (i) envisage more stringent requirements for imported goods; (ii) result in a more stringent application of the rules for imported compared to domestic goods, in line with WTO rules. By virtue of the mandatory aspect of this option, it would be considered a "technical regulation" and would therefore require notification to the WTO. There are however two major issues with the proposal to condition market entry on compliance with regulations on methane emissions of fossil energy:

1. In the context of the policy options in policy areas 1 and 2 on MRV, LDAR and on venting and flaring, covering EU operators only, the intention is not to condition market entry upon compliance with EU methane legislation, and none of the existing relevant EU regulations which either regulate MRV or mitigation of methane emissions (such as the Monitoring Mechanism Regulation, the European Pollutant Registry or the Industrial Emissions Directive) have such an approach, so doing it for exports into the EU cannot be envisaged;
2. Given that coal, oil and fossil gas together make up 70% of the EU's energy consumption and given that the EU is dependent on imports for 70% of its hard coal consumption, 97% of its oil consumption, and 90% of its fossil gas consumption[175], such a measure could put EU energy security at risk. Note that EU regulations that cover methane emissions in their scope such as the Effort Sharing Regulation, the Industrial Emissions Directive or the European Pollutant Release and Transfer Register, do not include exporters of fossil energy in their scope.

Responses from stakeholder consultations and the European Parliament

Such an option did however receive wide support in the open public consultation: 72% of responses consider that EU legislation on methane emissions in the energy sector should extend obligations to companies importing fossil energy into the EU/companies exporting fossil energy to the EU. In addition, 65% of responses consider that it is feasible to impose the same obligations on MRV, LDAR and venting and flaring equally on all actors of the oil and gas value chain for oil and gas consumed in the EU, including actors from outside of the EU.

It is also supported by the European Parliament. In its resolution of 21 October 2021 on an EU strategy to reduce methane emissions[176], it "calls on the Commission to make all fossil fuel imports into the Union conditional on their compliance with EU regulations on MRV and LDAR and the rules on venting and flaring, applicable to the entire fossil fuel supply chain, up to and including production; believes that a credible system has to be put in place to ensure that imports are compliant with EU requirements and that the Commission should therefore develop a robust independent methodology to assess the

[175] On the basis of 2019 Eurostat data.
[176] 2021/2006(INI)

compliance of imports with EU requirements; stresses that these rules should enter into force as soon as possible, while paying due regard to energy security”.

While this option could have the potential to meet specific objective 3, based on the above, it is considered that its environmental and social benefits are uncertain, as the enforcement and the verification of emission reductions outside the EU would be challenging. Furthermore, beyond the costs of compliance occurring outside the EU, this option could entail security of supply risks for the EU with potential direct economic impacts.

6.3.4 Option 3.2: Transparency measure on MRV and mitigation of methane emissions of fossil fuels consumed in the EU

Environmental and social impacts

This option represents an alternative approach to option 3.1.

Compliance would require proof of the following requirements:

1. Equivalent (comparable or more stringent) methane regulations in place in the country of origin supplying the fossil fuels to the EU.
2. Until such a time when regulatory equivalence is ensured, proof that the fossil energy is being purchased from a company that has signed up to the OGMP for oil and/or fossil gas companies, and for coal, at a later date, according to agreement on MRV methodology developed under tertiary EU legislation.

Information is already being published in different independent publications and updates provided by methane regulatory experts on the energy sector methane regulations in place across the globe[177], and on the basis of membership information from OGMP[178] and could facilitate verification of the information in the list.

Compliance with the requirements of this measure would be relatively simple to assess. It would require to establish a list of all exporting countries of fossil energy to the EU which would also contain a list of all exporting companies from those countries, and for each, respectively, indications of whether the countries comply with point 1, and companies with point 2, above, would be provided which would inform importers of fossil energy to the EU (or elsewhere for that matter) who would be free to choose whether to base their purchasing decision on such a list or not.

The second part of this option – the setting-up of a super emitter global methane monitoring tool - represents an additional incentive, as it would further encourage real and demonstrable results from implementation of equivalent methane regulations and/or effective mitigation actions by companies supplying fossil energy to the EU. It would

[177] The most recent such publication which provides a very detailed update on energy sector methane regulations across the globe is the IEA’s Driving Down Methane Leaks from the Oil and Gas Industry: A Regulatory Roadmap and Toolkit, January 2021. https://www.iea.org /reports/driving-down-methane-leaks-from-the-oil-and-gas-industry.

[178] http://ogmpartnership.com/partners.

achieve that by setting up the first official high emitter global methane monitoring tool, analysing and regularly publishing the results from global airborne imagery surveys from the EU's Copernicus satellites, confirming the location of large, intermittent, methane emissions caused by oil, gas or coal plants.

This option would not duplicate what the IMEO is aiming to do (baseline 3.0), as IMEO does not plan to produce a high emitter monitoring tool.

This option would thus enhance transparency and improve the possibility of wider uptake of methane mitigation across the globe. In addition, this option would further incentivise international companies to sign up to OGMP or to adopt similar measurement, reporting and mitigation measures as per EU legislation.

In terms of environmental and social impacts, it is considered that this option has a realistic chance of effectively leading to a level of methane emissions abatement, and associated benefits, equivalent to a social/environmental outcome for those countries in question (as highlighted in section 6.3.1).

Economic impacts and administrative burden

In terms of economic impacts, if it were to successfully incentivise abatement measures equivalent to social/environmentally optimal levels of methane emissions reductions, the impacts would be equivalent to those described in 6.3.1. at comparable level of abatement costs. While the costs on companies would be higher than at commercial levels of abatement costs (zero/negative or low costs), it would also result in much higher social/environmental benefits.

Such an option would not incur the additional economic costs which are discussed in the case of option 3.1:

- Market access to the EU would not be conditioned upon compliance with regulatory equivalence or OGMP membership. It could not therefore result in any risks to security of energy supplies.
- In terms of WTO implications, the transparency list would still have to comply with WTO rules, and in particular that it would not result in a more stringent application of the rules for imported goods compared to EU goods and also not create unnecessary obstacles to international trade. But by virtue of the non-mandatory aspect of this option, it would not require notification to the WTO, unlike option 3.1.
- By requiring regulatory equivalence, rather than an obligation to comply with EU law, it does away with all the main enforcement and compliance challenges mentioned under option 3.1.

As regards the costs of verifying the information requirements for the transparency list, we consider that these should be limited within the scope of current available resources of the Commission. As regards the costs of setting up the methane monitoring tool, the satellite information is already publically available for analysis and there are a number of existing private or independently funded initiatives which are undertaking the analysis and publishing the results. The costs of providing a regularly updated platform which would bring together in one place all the results to ensure such monitoring would also be limited.

In summary, option 3.2 would lead to achieving a socially and environmentally adequate outcome and the net economic impacts linked to an environmentally and socially cost effective abatement level is significantly positive. In conclusion, option 3.3 is deemed to meet objective 3 and is considered the most proportionate option in Policy area 3.

6.3.5 Option 3.3: Legislative measure to achieve a certain reduction in methane emissions

In the open public consultation, 86% of responses are supportive of EU legislation imposing emission reduction requirements on companies exporting fossil energy to the EU.

In spite of the high support as regards the possibility to impose such a requirement also on companies exporting fossil energy to the EU, the same considerations apply (as regards the effectiveness of specific measures and the uncertainties of setting targets while lacking accurate data) as under policy area 2. Before being in a position to consider the possible added value of such a requirement, accurate, direct source-level methane emission measurements from other parts of the world which supply the EU with fossil energy would be necessary. Furthermore, in order to ensure compliance with WTO rules, such a requirement would first have to be put in place in the EU. Only then could it be considered also for all imports of fossil energy into the EU.

7. HOW DO THE OPTIONS COMPARE?

Building on the assessment of the impacts of the different options in the previous section, this section compares the options against the following criteria, using the business as usual scenario as the reference:

- **Effectiveness**: the extent to which they would achieve the objectives set out in Section 4, with the overall aim to reduce methane emissions linked to the consumption of fossil energy in the EU. The ranking of options is therefore in terms of the level of methane emissions abatement, and associated social and environmental benefits, achieved (see tables A.5.3 and A.5.4 for policy area 2 and tables A..5 and A.5.6 for policy area 3). In the case of policy area 1, the ranking is in terms of the scope of emissions covered by MRV;
- **Coherence**: provides an assessment of the coherence of each option with other relevant EU policies as well as with the legislative package proposed in July 2021 delivering the Green Deal, which is to make the EU’s policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels;
- **Efficiency**: provides a ranking of the options according to level of socio-economic benefits, including also the consideration of administrative burden (see table A.5.3 for policy area 2 and table A.5.6 for policy area 3).

The tables provide a summary of the assessment of the policy options against these criteria. Each policy option is rated between "---" (very negative), 0 (neutral) and "+++" (very positive). NP is applied when no estimation was possible.

Policy area 1: Improving measuring and reporting of methane emissions in the EU

Criteria → / Options ↓	Effectiveness	Coherence	Efficiency
Option 1.0: BAU scenario	0	0	0
Option 1.1: (Legislative measure on measuring and reporting of oil and fossil gas companies)	+	++	++
Option 1.2: (Legislative measure on measuring and reporting of oil, fossil gas and coal companies)	++	+++	+++
Option 1.3: (Legislative measure on measuring and reporting of direct and indirect emissions)	+++	-	NP

Explanations for the table above:

- Option 1.2 will be more effective than option 1.1 given the higher scope of emissions, and associated environmental and social benefits, that it entails while option 1.3 will have the highest level of effectiveness;
- Coherence is considered to be high for all options other than the option which includes indirect emissions due to the risk of double regulation. Coherence for the option that includes coal is considered to be higher than for the option that includes only oil and gas as excluding methane emissions from the coal sector, a major fossil source, would not be in line with the overall aim of existing EU climate and renewable legislation as well as the overall objectives of the legislative package proposed in July 2021 delivering the Green Deal, which is to make the EU's policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels;
- In the absence of quantitative data on costs and benefits of MRV, but assuming on the basis of the results of the survey of the oil and gas industry that they are unlikely to be significant, and further assuming this to hold true also for coal, we consider that efficiency is likely to be highest for option 1.2 given the expectation that better MRV will lead to better and more targeted methane emissions abatement, which would allow greater socio-economic benefits to be achieved under option 2.3a (see next table below as well as table A.5.3).
- Option 1.3 scores the highest in terms of effectiveness due to the higher level of emissions that would be captured by inclusion of indirect emissions but scores a negative in terms of coherence as it would amount to double regulation. No information is available, qualitative or otherwise, on the costs or benefits of MRV of indirect emissions, making it impossible to assess the efficiency of option 1.3.

Policy area 2 - Mitigation of methane emissions in the EU

Criteria → / Options ↓	Effectiveness	Coherence	Efficiency
Option 2.0: BAU scenario	0	0	0
Option 2.1: (Commission guidance on mitigation of methane emissions in the oil and fossil gas sectors)	-	++	+
Option 2.2: (Legislative measure on mitigation of methane emissions in the oil and fossil gas sectors)	+	++	++
Option 2.3a: (Legislative measure on mitigation of methane emissions in the oil, fossil gas and coal sectors)	++	+++	+++
Option 2.3b: (Legislative measure on mitigation of methane emissions in the oil, fossil gas and coal sectors as well as indirect emissions)	+++	-	NP
Option 2.4: (Legislative measure to achieve a certain reduction in methane emissions via a performance requirement)	++	+++	+++

Explanations for table above:

- Options 2.1 is ineffective as its outcome is too uncertain. Option 2.3a will be more effective than option 2.2 given the higher scope of emissions, and associated social and environmental benefits, that it entails. Option 2.3b scores the highest in terms of effectiveness due to the higher level of emissions that would be captured by inclusion of indirect emissions.
- Coherence with other policy objectives are considered to be high for all options other than the option which includes indirect emissions due to the risk of double regulation. Coherence for the option that includes coal is considered to be higher than for the options that include only oil and gas as excluding methane emissions from the coal sector, a major fossil source, would not be in line with the overall aim of existing EU climate and renewable legislation as well as the overall aim of the legislative package proposed in July 2021 delivering the Green Deal, which is to make the EU's policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels;
- Efficiency is highest for option 2.3a as setting mandatory measures on mitigation of methane emissions in the oil, fossil gas and coal sectors would lead to the highest socio-economic benefits. Option 2.2 achieves the second highest level of socio-economic benefits. (see table A.5.4). Option 2.1 only achieves abatement at a level of cost-effectiveness which is optimal from a company perspective and therefore achieves the lowest socio-economic benefits of the three options. No information is available, qualitative or otherwise, on the costs or benefits of abatement of indirect emissions, making it impossible to assess those characteristics for option 1.3.
- For reasons explained in the section on the impacts of options, there are no differences shown here between prescriptive requirements and performance

requirements for the same scope of emissions, which explains why option 2.4 is considered to be equivalent to option 2.3a, even if it isn't an option that would make sense to implement this point in time

Policy area 3 – Measuring, reporting and mitigating methane emissions linked to EU fossil fuel consumption but occurring outside the EU

Criteria → **Options ↓**	**Effectiveness**	**Coherence**	**Efficiency**
Option 3.0: BAU scenario	0	0	0
Option 3.1: (Legislative measure on measuring, reporting and mitigation of fossil energy sector emissions)	+	+++	+++
Option 3.2: (Non-legislative measure on measuring, reporting and mitigation of fossil energy sector emissions)	+++	+++	+++
Option 3.3: (Legislative measure to achieve a certain reduction in methane emissions via a performance requirement)	+++	+++	+++

Explanations for table above:

- Differences in effectiveness are explained in more detail in the section on the impacts of the various options. In summary, the preferred option (option 3.2) is considered more effective than option 3.1 as it is deemed most likely to succeed in reducing the methane emissions linked to fossil energy consumption in the EU but occurring outside the EU territory;
- Coherence with other policy objectives are considered to be equally high for all options. This is because all options assessed are considered to be equally coherent with either existing EU climate or renewable energy legislation as well as the overall aim of the legislative package proposed in July 2021 delivering the Green Deal, which is to make the EU's policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels;
- As regards a relative assessment of the various options on the basis of efficiency, this is not possible given that the estimated costs and benefits under policy area 3 are equally relevant for all options, and given that there is no distinction in the targeted scope of emissions between options. Thus, the efficiency of the various options are considered to be equivalent;

8. PREFERRED OPTION

The preferred policy option is the combination of the preferred options under each policy area. This includes legislative measures prescribing compulsory MRV, leak detection and repair and rules on venting and faring covering the oil, gas and coal sectors, both for operating and closed mines (**options 1.2 and 2.3**), and a transparency list plus a high methane emitter monitoring tool (**option 3.2**) to increase transparency and thereby provide incentives to reduce methane emissions in relation to fossil energy consumed in the EU, including that which is imported from global suppliers.

For the reasons explained earlier, it is not recommend to propose an emission reduction/target or standard at this stage while accurate data is not available. However, such an instrument could be considered a later date, when the receipt of more detailed direct source-level methane emissions data - as a result of implementing the preferred option of policy area 1 into EU law - would allow it. The same considerations are valid also in relation to fossil energy consumed but not produced in the EU. In this case, the requirements on which information needs to be included in the transparency list could evolve over time based on additional data becoming available.

Choice of instrument

With respect to the choice of instrument, a Regulation appears the most appropriate legal instrument for this legislative proposal as it imposes clear and detailed rules that do not give room for divergent transposition by Member States. A Regulation ensures that legal requirements are applicable at the same time throughout the Union, therefore avoiding any inefficiencies and regulatory costs/burdens related to an inconsistent implementation of methane emission reduction provisions across the EU.

In addition, a Regulation is the adequate instrument to impose direct obligations on economic operators and national authorities. This would be required in order to have clear obligations to quantify report and verify data, as well as to employ measures to mitigate methane emissions, including the phasing out of harmful industry practices such as venting and flaring.

In more detail, with respect to option 1.2 (compulsory MRV rules covering the oil, gas and coal sectors), in order to have consistent and comparable data, it is crucial to have harmonised measurement and reporting requirements. This can be best done via a Regulation, as shown by related EU legal acts[179]. On this subject, the level of discretion left to Member States in a Directive would risk discrepancies and lack of comparability of data[180].

[179] E.g. Regulation (EU) 2015/757 on the MRV of carbon dioxide emissions from maritime transport; Regulation (EC) 166/2006 on the European Pollutant Release and Transfer Register; Implementing Regulation (EU) 2020/1208 of 7 August 2020 on structure, format, submission processes and review of information reported by Member States pursuant to the Governance Regulation; Commission Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to ETS Directive; Implementing Regulation (EU) 2018/2067 on the verification of data and on the accreditation of verifiers pursuant to the ETS Directive.

[180] See, for example, the justification in the Explanatory Memorandum of the European Pollutant Register Regulation: '*Another policy option for implementation would be a Directive. The major disadvantage of this option is its incompatibility with the need for comparable and therefore harmonised data to be delivered to the European PRTR central database. Comparability of data is a priority because the UN-ECE PRTR Protocol sets forth a number of technical options and approaches, which could – if not stringently harmonised – lead to totally different national systems and the impossibility to collect and disseminate meaningful data on European level. The level of discretion, left open for Member States in a*

Furthermore, with respect to option 2.3 (compulsory leak detection and repair and rules on venting and flaring covering the oil, gas and coal sectors), a Regulation would be the adequate instrument to ensure that provisions target companies directly and limit their business practices in this respect.

Moreover, in what concerns option 3.1 (diplomatic action) and option 3.3. (transparency list and a super-emitter monitoring tool), in light of the international character of the measures and the need to set out Commission obligations to set up the transparency tools, a Regulation is the most suitable instrument.

Finally, a Regulation allows to address in a more direct and conducive manner the urgency of dealing with methane emissions, in the context of the climate emergency and the Union's climate neutrality target. Most recently, the sixth IPCC Assessment Report[181] underlines the role of methane as one of the main gases responsible for climate change The report outlines that methane levels are at an all-time high and well above emission levels compatible with limiting warming to 1.5°C. There is thus a need for a sharp and rapid reduction in methane emissions to slow down global warming and improve air quality. It is important to note that the report concludes that the increase of methane in the atmosphere is the result of human activity and that fossil fuels have been a large contributor to the growth in methane emissions at least since 2007, alongside agriculture (livestock) and wastewater.

The choice of a Regulation ensures that the identified problems and objectives are addressed in the most effective, efficient and proportionate way. It ensures a careful balance between, on the one hand, the regulatory autonomy Member States have for national corrective actions, setting incentives for technological innovation, or deciding on the level of dedicated resources and, on the other hand, the need to address the problems concerning methane emissions that have to be tackled centrally. The preferred options do not extend beyond what is necessary to solve the identified problems and to achieve the objectives set.

9. How will actual impacts be monitored and evaluated?

EU climate and energy legislation provides for a comprehensive framework to track progress towards EU targets, to which this proposal will contribute. The overarching framework is provided by the Climate Law and a detailed integrated monitoring and reporting framework is provided by the Regulation on the Governance of the Energy Union and Climate Action. Data collected in the context of the Governance Regulation is

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Directive would risk discrepancies and incomparability of data. Moreover, risk of delays in transposition by the MS could frustrate the objective of a speedy conclusion and implementation of the PRTR Protocol.'

[181] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

being made publicly accessible on an e-platform, including indicators for monitoring progress towards Energy Union objectives[182].

As regards monitoring and evaluation of the MRV parts of the legislative proposals, the Commission annually evaluates Member States' progress in reducing GHG emissions, taking into account progress in Union policies and measures and information from Member States. Member States report their GHG emissions every year in form of greenhouse gas emissions inventories for the previous year in accordance with the 2006 IPCC guidelines for national GHG inventories. These submissions are subject to quality assurance and control that includes checks of the transparency, accuracy, consistency, comparability and completeness of the submitted inventories. The IPCC guidelines require the inventory compiler to attribute one of the three tier methods of UNFCCC reporting of emissions for each source category and greenhouse gas. This process enables verification of compliance with requirements for source-level reporting.

Every two years, Member States are obliged to report on national policies and measures and national systems of policies and measures implemented in order to achieve their targets under the Effort Sharing Regulation and on their emission projections. Under article 9 of the ESR, the control of Member States' compliance with their annual targets is carried out every 5 years. To ensure that the five yearly compliance check foreseen by the Effort Sharing Regulation is based on accurate and verified data, the GHG emissions inventories submitted by Member States for the relevant years are subject to a comprehensive Union review co-ordinated by the European Environment Agency on behalf of the Commission. The provisions contained in the proposal help to improve the accuracy of methane emission monitoring, which will be reflected in the national submissions and the data basis available to assess the target achievement under the ESR. The established control mechanisms for the quality of national submissions also allow an evaluation of the effectiveness of the provisions of this proposal in achieving improvements in data quality.

As concerns monitoring and reporting of emissions by regulated entities, the Agency for the Cooperation of Energy Regulators (ACER) has called for access of National Regulatory Authorities to at least all methane emissions data of entities operating in their legal domain of responsibility. Such access by national regulatory allows for scrutiny of the implementation of obligations locally.

Finally, the International Methane Emission Observatory will provide additional scrutiny of submitted methane emissions data, including the possibility to cross-reference them with other sources such as satellite imaging.

As regards monitoring and evaluation of the mitigation parts of the legislative proposals, the main responsibility in ensuring application of the provisions will lie with the national competent authorities. Additional monitoring mechanisms could be integrated as per the Industrial emissions Directive, which require periodic reports from Member States

[182] https://ec.europa.eu/energy/data-analysis/energy-union-indicators/scoreboard_en?redir=1

established on the basis of the findings of the implementation of Member State systems and plans of environmental inspections which requires national competent authorities to draw up programmes for routine environmental inspections, including the frequency of site visits for different types of installations. Such inspections should include site visits, monitoring of emissions and checks of internal reports and follow-up documents, verification of self-monitoring, checking of the techniques used and adequacy of the environment management of the installation, undertaken by or on behalf of the competent authority to check and promote compliance of installations.

Methane emissions are increasingly subject to public attention as demonstrated by their increased visibility in the 6th IPCC Assessment Report[183] and scientific and stakeholder campaigns to detect and quantify emissions[184]. Supported by better satellite becoming available, such public scrutiny is a valuable resource in monitoring the impact of the proposal and identifying shortcomings in implementation.

In addition, annual sector fora organised by the Commission, e.g. the European Gas Regulatory Forum ('Madrid Forum') and the Energy Infrastructure Forum ('Copenhagen Forum) provide opportunities for exchange and stocktaking with stakeholders including national authorities, energy regulators, industry, and civil society.

The Commission will monitor the implementation of the regulation by checking the correct application of the measures by the obligated parties. Furthermore, it is proposed that the Commission will regularly evaluate the measures included in the regulation in the form of reports to be submitted to the European Parliament and the Council. If necessary, the Commission will take enforcement action, including infringement procedures.

[183] IPCC (2021) Sixth Assessment Report - Climate Change 2021: The Physical Science Basis, p.21. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf

[184] See, e.g., recent observations made by the Clean Air Task Force using optical gas imaging cameras that identified a number of leaks at sites across multiple Member States, https://cutmethane.eu/, and research efforts by EDF on leakage, https://www.edf.org/climate/methane-studies

ANNEX 1: PROCEDURAL INFORMATION

Lead DG, Decide Planning/CWP references

DG ENER, PLAN/2020/7536, 2021 Commission Work programme (under the "European Green Deal" headline ambition and as part of the "Fit for 55" package).

Organisation and timing

Under the umbrella of the European Green Deal and as called for by Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action , the Commission adopted an EU strategy to reduce methane emissions ('the Methane Strategy') on 14 October 20202, announcing that the Commission will propose legislation to reduce methane emissions in the energy sector through provisions on measuring, reporting and verification (MRV) as well as leakage detection and repair (LDAR), while considering legislation on venting and flaring.

An Inter Service Steering Group was established which involved the following DGs: AGRI, CLIMA, DEFIS, DEVCO, EEAS, ENV, GROW, INTPA, JRC, LS, MOVE, NEAR, REGIO, TRADE, SANTE, and the Secretariat General. A total of four meetings were held, on Monday 7 December 2020, Thursday 20 May 2021, Wednesday 16 June 2021 and Friday 12 November 2021.

Consultation of the Regulatory Scrutiny Board (RSB)

An "upstream" meeting with the RSB in advance of the submission of the Impact Assessment took place on 26 April 2021, with DG ENER, the JRC and the Secretariat General represented.

The Impact Assessment was submitted to the RSB on 23 June 2021.

The meeting with the RSB to discuss the Impact Assessment took place on 22 July 2021.

The RSB's negative opinion was received on 26 July 2021.

The revised impact assessment was submitted on 20 September 2021.

The RSB's positive opinion with reservations on the revised impact assessment was received on 18 October 2021.

Evidence, sources and quality

Much of the analysis carried out in this impact assessment is based on data and projections from the GAINS model[185] underpinning also the Climate Target Plan (CTP) Impact Assessment[186], impact estimates by the United Nations Environment Program and the Climate and Clean Air Coalition, as well as emissions and abatement costs data compiled by the International Energy Agency (IEA).

In addition, the following material from Commission Services fed into this impact assessment:

[185] Greenhouse gas and Air Pollution Information and Simulation Model, see Annex 3
[186] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0176

- Environmental and Sustainability Assessment of Current and Prospective Status of Coal Mine Methane Production and Use in the European Union (JRC, 2015)[187]
- EU energy statistical pocketbook and country datasheets (European Commission, June 2021)[188]

All sources are referenced in footnotes throughout the document.

RSB first opinion of 26 July 2021

RSB comments what to improve:	How they were addressed
(1) The narrative of the report needs to be improved starting with the problem definition. Even with the missing data, the report should be more explicit about the problem, its scale and what exactly would be addressed and could realistically be achieved by this specific initiative. The discussion should incorporate the specific economic and safety features of methane. The report should present more clearly, with figures and projections, where available, the relative importance of EU energy related methane emissions as compared to EU methane emissions from other sectors. The problem description should clarify what market failures the initiative would address and why and where there is a need for harmonisation of legislation. It should present more clearly how the situation differs across Member States and justify the need for EU action accordingly.	In line with the opinion of the Board, the narrative has been reworked to become more explicit upfront about the problem and its context (Section 2.1). The problem description was also expanded and now includes the relevant market failures to be addressed (see particularly Sections 2.2.2 and 2.2.3) and provides a clear and comprehensive overview of relevant legislation highlighting the scope for intervention and harmonisation (see Table 2). The problem drivers have been restructured and clarified to enable the reader to more easily identify the possible contribution of this initiative in resolving them (Section 2.2), along with a clarified baseline (Section 5.1). The specific economic and safety features of methane have been integrated into the discussion (in particular Section 2.2.2.). To address the important comment from the Board, a description of the relevance of energy related methane emissions has been added to Section 2.1 and more details provided on current relative emissions across sectors. The available information on differences across Member States was clarified (particularly in Sections 2.2.2.1 and 2.2.2.2). Based on available examples of national legislation, the report highlights

[187] https://publications.jrc.ec.europa.eu/repository/handle/JRC100875
[188] https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en

	divergences and inconsistencies with the risk of an uneven playing field within the internal market. It also highlights that existing national legislation will be insufficient to tackle the problem. Time constraints prevent the examination and elaboration of a comprehensive overview of each Member States' national legislation.
(2) The report should take full account of coherence with EU rules (in particular but not limited to the Effort Sharing Regulation and the Industrial Emissions Directive), national legislation, international commitments and voluntary industry initiatives that all affect the same emissions. The report should explain the scope of this initiative compared to those other initiatives and be clearer about the rationale for this proposal, how it fits with other initiatives, and exactly which gaps it fills.	A new overview has been added in Section 2.2.2 to address the identified need to provide a clear representation of interlinkages with EU acquis. Such an overview now situates the methane initiative within the broader context of other relevant EU instruments and identifying their shortcomings in addressing the identified problems adequately (either due to lack of scope, specific rules, or incentives). The same overview includes also international commitments and voluntary initiatives. The clarified partial overview of national legislation highlights already that national action is not sufficiently addressing the issue and differences across Member States risk creating regulatory uncertainty and barriers for companies.
(3) The report should provide a more developed and better explained baseline. It needs to fully reflect the result of the phase out of fossil fuels and account for existing and upcoming EU legislation, voluntary industry initiatives and the initiatives at global level specific for methane monitoring and mitigation. The report should clarify why methane emissions remain high in 2050, even when the use of fossil fuels should be largely eliminated. It should assess the evolution of EU imports of fossil fuels and its effect on the EU's influence on third countries.	The baseline section was redrafted and cross-references to the problem definition were added in order to better explain the expected regulatory environment in the absence of this initiative, including the role of voluntary initiatives, and to avoid duplication of text. Further details on the anticipated development and effects of a fossil fuel phase-out and changes in imports are reflected in Section 2.3. Relevant data on expected future methane emissions and explanations about their origins in the energy sector were added in Section 2.3.1. Section 2.3.3 now provides projections for

	the evolution of EU fossil fuel imports and discusses the relevance of EU measures in the upcoming decades and beyond.
(4) The description of options should become more complete. The structure of the options should reflect the policy choices to be made. It should allow to distinguish the effects of key measures, such as venting and flaring, and leak detection and repair.	The description of options has been revised throughout Section 6. Further details have been added to provide a better overview. The assessment of impacts has been expanded and restructured to better reflect the environmental, social, and economic effects of options as well as the administrative burden they may imply. Specific considerations for the policy proposal on leak detection and repair as well as for venting and flaring have been integrated in Section 6.2.4.
(5) The report should present a consistent narrative as regards imports from third countries and the options considered to mitigate methane emissions outside the EU. It should be clearer about the incentives or lack thereof for third countries and economic actors to reduce methane emissions. The report should better explain why it considers that the environmental and social impacts of all options considered for the international dimension of the initiative would be the same. It should justify better the impacts expected from the label for fossil energy imports.	The report was revised throughout to address the relevant comment from the Board and clarify the importance and future role of imports from third countries (see Section 2.3.3), as well as the relevance of emissions specifically linked to EU consumption of fossil fuels but occurring outside of EU borders and the options to address them. The market failure surrounding those emissions, incentives for economic operators, and options to address them have been clarified (see Section 2.2.3 and Section 6.3). The underlying problems and related lack of incentives are the same for actors within and outside the EU (now clarified in the problem definition in Section 2.1). However, the EU's options to act (to regulate, enforce and verify) are different and this was reflected in the options. The discussion on the environmental and social impacts of the policy options in the international dimension (Section 6.3.1) was expanded. It now better reflects that all options seek to achieve the same goal in terms of scope and methane emission mitigation by external partners through different means. Hence, the estimates of

	economic and social impacts are equally valid across them as they are based on assumed identical outcomes. The choice of a preferred option is thus dependent on considerations of likely success in implementation, verification, and enforceability.
(6) The report needs to provide information on the methodologies used or referred to. It should clearly set out the modelling assumptions, limitations and uncertainties. It should also provide an indication of the robustness and credibility of the underlying methodologies.	Annex 4 was expanded to include comprehensive information on the methodologies, assumptions, and, where relevant, limitations and uncertainties about the different modelling results that have been used in the impact assessment.

RSB second opinion of 18 october 2021

RSB 2nd opinion comments on what to improve:	How they are addressed in the IA
(1) The report should describe in detail the origin and causes of intentional and unintentional releases of methane and how these can be avoided without jeopardising efficient industrial processes and safety. It should clearly identify the scale of the problem originating from the EU compared to the global total and break this down by sector to give an accurate and unambiguous overview which can then inform the options and their selection. It should discuss, with concrete evidence rather than assertion, what prevents companies, Member States and third countries from mitigating methane emissions. The suggested problem driver of ‘lack of awareness and information’ needs to be backed up by solid evidence, given that much of the emissions can be avoided at relatively low cost.	Additional clarifications and evidence were added in section 2.2.2, explaining that operators have different approaches to assessing safety risk, especially in the case of inexistent or non-prescriptive national regulations, and that safety risk needs to be properly considered in any measures to be adopted with the aim to further reduce methane emissions in the energy sector, not only to ensure a homogenous approach among operators but also to ensure that such measures do not lead to unintended consequences with regards to safety. Additional text was also inserted in section 5.2, making it clear that exceptions such as safety reasons are included in the options being assessed. Additional text was added in the introduction making it clear that the current context as regards information on methane emissions in the energy sector globally is one of insufficiently precise data in terms of the origin as well as magnitude and

	nature of these emissions, and as a result, a key objective of any targeted action to further reduce methane emissions and to assess the effectiveness of such actions is to start by improving the quality of data and information on the sources of methane emissions Additional text was included in section 2.2.2 explaining why, even if economic considerations are a key factor in the decisions taken by operators to abate their methane emissions, there may be reasons why they do not undertake all the abatement that is cost effective from their perspective, even if they have that information. Additional text was also added in that section highlighting the results from section 6, which demonstrate that large amounts of additional methane emission abatement (on top of the baseline) are possible in the sectors included in the scope of this report, a significant share of which can be achieved at negative to zero net costs.
(2) The report should justify the need for additional EU action taking into account the existing requirements stemming from EU legislation, international agreements binding Member States and industry voluntary commitments. It should identify which gap the proposal will fill and where precisely it will act, being explicit on which emissions and reporting obligations are already covered by other measures. It should be fully coherent with other legislation which covers these emissions such as, but not limited to, the Effort Sharing Regulation, the Industrial Emissions Directive and national measures. In the case of the Effort Sharing Regulation	Additional text was included in section 2.2.2 explaining that while methane emissions are included in the scope of the union greenhouse gas reduction targets for 2030 set out in the European Climate Law and the binding national emission reduction targets under Regulation (EU) 2018/842, there is currently no Union level legal framework setting out specific measures for the reduction of methane emissions occurring at the level of upstream oil and fossil gas exploration and production, fossil gas gathering and processing, transmission, distribution, underground storage and liquid fossil gas (LNG) terminals, operating underground and surface coalmines, closed and abandoned underground coal mines. As regards existing legislation, in particular

it should assess how setting binding requirements on methane reduction would limit the freedom of choice given to Member States to decide on the areas in which to deliver their GHG emissions linked to their national energy mixes.	the Effort Sharing Regulation, additional text was also included in section 2.2.2 explaining that further action will be complementary to the ESR and will facilitate achieving the targets set out under the ESR, and listing how that will be the case. Further clarifications were also added to make it clear that the scope of emissions assessed in the report are outside the scope of the current IED and that the review of the IED will take into account the scope of emissions covered in this proposal.
(3) The report should analyse how methane emissions would evolve without additional intervention. It should incorporate the planned phasing out of fossil fuels and the existing initiatives at EU level, internationally and on a voluntary basis. This should be reflected in a quantified baseline.	Additional clarifications were added throughout section 6 clarifying the amount of methane emissions that are possible to abate in the sectors included in the scope of this report over and above the baseline scenario. Furthermore, section 2.3.2 explaining why methane emissions will still be relevant in a decarbonised future was significantly expanded with information from the projections from the impact assessment of the 2030 Climate Target Plan.
(4) The report should be precise in presenting options instead of addressing full sectors at once. The options should reflect the main sources of EU energy sector methane emissions starting from the largest (coal) to the smallest (oil). The options should contain measures that are specific, targeted and proportionate. It should provide in-depth analysis of specific measures to avoid methane emissions, describe their feasibility and possible uptake and assess their costs and benefits. It should describe which part of the full abatement potential will be tackled by the measures proposed. It should justify why in some options the coal sector is left out while it accounts for the largest part of the	Additional details on the policy options and the specific measures which they contain as well as justifications for those policy options, were added to section 5.2. Section 6 was also revised, including clearer and more detailed explanations as well as more in-depth analysis of the specific abatement measures available in the various sub-sectors included in the scope of this report as well as the associated costs and benefits of those measures.

emissions.	
(5) The report should assess the feasibility of options to avoid methane emissions in third countries together with the impact on security of supply and possible price increases for EU consumers. It should further explain why it considers that the environmental and social impacts of all (voluntary and mandatory) options considered for the international dimension of the initiative would be the same, even if their likely success in implementation, verification, and enforceability would be different.	Additional text was provided in sections 6.2 and 6.3 on the likely impacts of the measures assessed in the report on energy prices. Additional text was also included in section 6.3, principally under option 3.2, on the feasibility of such an option, in particular in terms of the difficulties of verifying compliance with the requirements on the measures included in this report in third countries. Additional clarifications were also provided in section 6.3.1 on the usefulness of IEA estimations used in policy area 3 (assessing options on measuring, reporting and mitigating methane emissions linked to EU fossil fuel consumption but occurring outside the EU) which are not specifically linked to EU consumption, as they cover all oil and fossil gas related methane emissions occurring in the sample of countries included in the analysis. This included explaining that they cannot be used to make quantitative distinctions between one proposed option or the other, and that they therefore primarily serve to highlight the magnitude of the methane emissions estimated to originate from key exporters of fossil energy to the EU in comparison to methane emissions occurring in these same sectors in the EU, as well as to highlight – in the same way as was done using GAINS projections in policy area 2 – the share of those methane emissions that can be abated at different levels of abatement costs. Thus, rather than distinguish the different policy options assessed under this policy area by attempting to estimate and attribute different level of emission reduction abatement to each, the assessment of impacts of options under this policy area focuses instead on qualitatively evaluating

	whether the options could realistically be implemented in order to incentivise such reductions in methane emissions in exporting countries in the EU via the use of cost-effective measures as highlighted by the IEA, and achieve the associated benefits, and therefore fulfil specific objective 3.
(6) The report should include the required standard annex on the estimated costs and benefits of the preferred option.	This annex was included in annex 5.

ANNEX 2: STAKEHOLDER CONSULTATION

Stakeholder events for the EU methane strategy

As part of the development of the EU strategy to reduce methane emissions, the Commission held three stakeholder meetings, the results of which also further informed this impact assessment:

- A stakeholder meeting on a strategic plan to reduce methane emissions in the energy sector, on Friday 20 March 2020.
- A stakeholder meeting on integrating methane measurement, reporting and verification and abatement into EU policies: Case studies and best practices in the agriculture, energy, and waste sectors, on 9 June 2020.
- A stakeholder meeting on reducing methane emissions: opportunities and barriers in waste and agriculture through biogas production, on 17 July 2020.

In addition, the Representation of the European Commission in Berlin held a workshop dedicated to "stocktaking methane emissions as a requirement for a sustainable and successful energy transition" on 10 January 2020.

Stakeholder workshops

From 15 to 17 March 2021, DG ENER held three online workshops on a proposal on reducing methane emissions in the energy sector. Each workshop was dedicated to a specific theme. In total 760 registrations for the three workshops were received, of which 111 for the workshop on measurement and mitigation of methane emissions in the coal sector, 284 for the workshop on venting and flaring of methane in the oil and gas sectors, and 356 for the workshop on leak detection and repair[189].

The three workshops hosted 17 external speakers from academia/research organisations, companies/business organisations, business associations, NGOs, and public authorities. Each workshop was coordinated by an official from DG ENER, introducing the topic and moderating the open discussions following the speakers' presentations.

Open Public Consultation

The open public consultation on legislation to measure and mitigate methane emissions in the energy sector took place between 05 February and 01 May 2020. The questionnaire contained multiple-choice and open questions to collect detailed views and suggestions from stakeholders and citizens on the full range of issues covered by the initiative. Stakeholders were also invited to submit (additional) comments via email.

Participants

The open public consultation received 131 responses, of those 126 were submitted by at least partial completion of the online questionnaire and five additional contributions were

[189] Note that actual participation numbers could not be ascertained with the online tool used for the workshops due to fluctuations in attendance during the event.

received in form of email submissions. Figure A.2.1 shows the distribution of responses by category of participant.

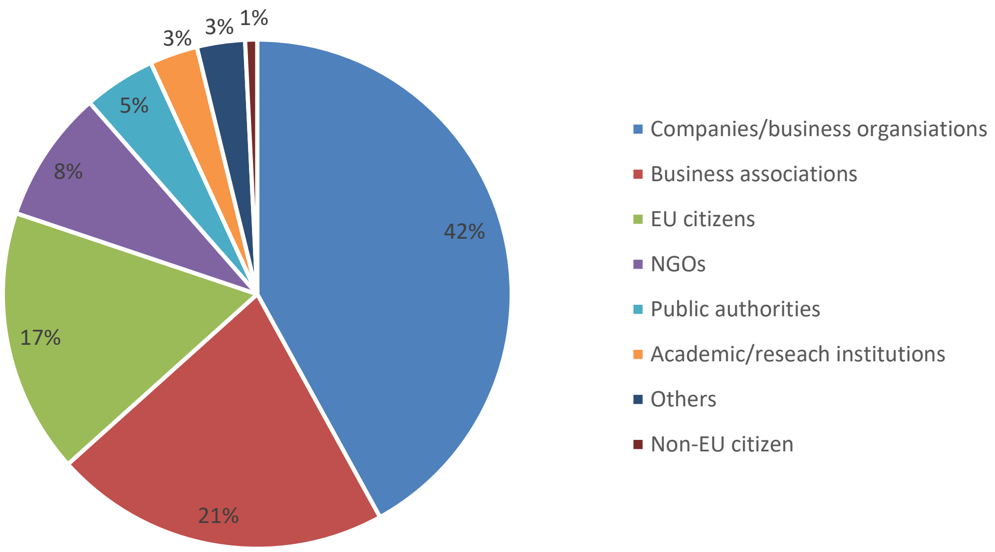

Figure A.2.1 Distribution of responses by category of participant

In terms of geographical coverage, 27 submissions were received from France, of which 18 identical or very similar from citizens, followed by Belgium (21), Germany (13), Italy (9), and Austria (8). Seven answers were received each from the Netherlands, Poland and Spain, four from Czechia, three from Denmark, two each from Slovakia and Slovenia, and one from Hungary, Ireland and Latvia, respectively. A significant number of responses also came from outside the EU, with the United States leading with seven, followed by the United Kingdom and Norway with three responses, respectively, and Japan and Switzerland with one response each.

The 18 identical or very similar responses (14% of the total respondents) received from citizens in France are identified separately in the analysis.

Note that many participants did not answer all questions contained in the questionnaire. To allow meaningful interpretation, the analysis is based on the responses received to each question and not the total number of respondents. In the following analysis, a response is considered the *majority* view if it represents more than 50% of participants who provided an answer to the relevant question. Where an option did not receive more than 50% but has the highest percentage of responses, it is referred to as the *most popular* or *most selected/chosen answer*. Similarly, if a response receives the least amount of support, it is considered the *least popular* or *least selected/chosen*.

Key outcomes of the open public consultation

As concerns the types of instruments to address methane emissions in the energy sector, there is strong support by stakeholders for prescriptive requirements to establish a robust measurement and reporting scheme. Specifically for measurement, reporting and verification (MRV) of emissions, a majority of responses support basing relevant proposals for the oil and gas sectors on the methodology of the OGMP.

In terms of sectoral, emissions, and supply chain coverage, the majority of responses:

- support the inclusion of coal in MRV and mitigation measures. Some respondents also indicated a preference for extending the scope of the proposals to end-users.
- support legislation covering all oil and gas entering the EU market.

However, less than half of responses were in support of including indirect emissions from a select list of sectors, namely industry, power generation, transport, residential or others, respectively.

As concerns legislating on leakage detection and repair, the majority view prefers flexibility for the choice of device used for detecting leaks and the methods used to quantify emissions, whereas it supports the inclusion of survey frequency.

The majority of responses thinks it is feasible to eliminate routine venting and flaring associated with energy produced and consumed in the EU, with views about the possible time-frame ranging from immediate (9%) to five years or more (71%). The majority agreed that a common set of definitions and parameters for venting and flaring are necessary. A majority of stakeholders defined the production part of the value chain as the most relevant for venting and flaring in the oil, gas and coal (only for venting) sector.

A majority of respondents considered that the overall benefits of putting in place legislative measures to ensure robust and effective MRV and mitigation of methane emissions outweigh the costs to the industry.

In terms of legislating mitigation of emissions from the coal sector, coverage of coalmine methane by EU regulation is supported by the majority view, as is addressing abandoned mine methane ownership rights.

Detailed responses to the questions

Section I: Types of instruments

Most jurisdictions with methane-specific oil and natural gas regulations have relied heavily on prescriptive requirements (such as MRV, LDAR or restrictions on flaring or venting) to achieve emissions reductions. An alternative approach to regulating methane emissions in the energy sector is via performance-based requirements, which establish a mandatory performance standard on regulated entities (such as targets set at the level of individual companies for a specific piece of equipment or facility, or a flaring efficiency standard) but do not dictate how the target must be achieved.

A majority of responses (65%) expressed support for prescriptive measures on measuring and mitigation requirements to establish a robust data foundation before considering performance-based requirements in a second step. The vast majority of responses (94%) considered that company or facility-wide performance-based requirements need a robust measurement and reporting regime and an accurate baseline understanding of the level of emissions to avoid underreporting and valid assessment of company performance. Many companies, business organisations and business associations raised the point that the development of an effective measurement and reporting scheme is a necessary precondition; however, some companies stressed the importance of flexibility in the implementation of requirements. Respondents also expressed preferences for a technology-neutral approach, sufficient implementation time, and differentiation according to the characteristics of the individual segments of the value chain. A majority of responding NGOs highlighted that prescriptive, ambitious and performance-based approaches are needed to achieve meaningful methane emissions reductions, and that MRV requirements should not lead to or justify a further postponement of mitigation measures.

The citizen responses expressed a preference for a price on methane emissions as the most effective and efficient measure to regulate methane emissions. Responding public administrations were either in favour of performance-based requirements or sector-specific approaches.

In conclusion, a vast majority of stakeholders' responses support strong prescriptive requirements to establish a robust measurement and reporting scheme.

Section II: Identifying models for an EU regulation on methane emissions in the energy sector

A majority of responses (78%) are supportive of basing a legislative proposal on MRV for oil and/or gas on the methodology of the OGMP. The majority of companies or business organisations indicated the OGMP 2.0 to be a good starting point. In contrast, a minority of companies/business organisation and a majority of business associations identified the OGMP 2.0 methodology as inappropriate by focusing on upstream emissions, failing to address super emitters and being inappropriate for the coal sector. Some respondents also do not consider the OGMP 2.0 initiative fit-for-purpose at certain levels of the value chain such as at the DSO level and for the coal sector. The Margogaz methodology, national MRV frameworks (Norway, Germany) and the EN 15446 standard for fugitive emissions were indicated as good examples to consider. A number of respondents, including the responses from academia, argued that the regulation should be flexible and adaptive. Among citizen responses, there is a preference for excluding the biogas sector from such a methodology. Some public authorities underlined that the definitions in the OGMP 2.0 are not clear and that the OGMP 2.0 framework should be fully consistent and compatible with current methodologies agreed internationally under the umbrella of UN greenhouse inventories. A majority of NGOs expressed reservations against the OGMP 2.0 framework, but stated that if it were to be used as basis an extension of its scope would be necessary to drive a scalable action. The majority of NGOs also expressed the view that the Commission should focus on mandatory frameworks rather than voluntary programs.

To conclude, a majority of responses support MRV proposals for oil and gas to be based on the methodology of the OGMP.

Section III: Sectoral, emissions and supply chain coverage and/or scope

The majority of responses are supportive of the inclusion of coal in the Commission's policy proposals on MRV (96%) and mitigation (95%). Respondents are split within all categories of stakeholders between setting specific MRV requirements for the coal sector and maintaining a level playing field among all energy carriers to avoid unintended incentives. However, they all agreed that methane emissions from coal mining operations are significant and justify mitigation.

Most stakeholders' responses (56%) are supportive of extending the coverage of the scope of the policy proposals on methane to end-users. For companies/business organisations, methane leaks should be accounted for the entire value-chain but can be considered in future implementations and not immediately. The majority of business associations argued that the administrative burdens for individual customers would outweigh the benefits from covering end-use. NGOs predominantly consider that the full supply chain needs to be documented to get the full picture of methane emissions. Public authorities also expressed concern about the inclusion of the end-use sector, arguing that this will most likely lead to duplicating emissions in different measurement systems.

A majority of stakeholders' responses (92%) are supportive of EU legislation on methane emissions in the energy sector covering all oil and gas entering the EU market. Companies/business organisations and business associations raised the point that companies that have immediate business relations with the EU should be part of the obligations because most emissions happen outside the EU. However, some respondents from this category criticised the feasibility of such measures. All NGOs agreed to such measures arguing that the largest share of methane emissions is occurring in the upstream segment. Public authorities, academia/research institutions and citizens argued such measures would benefit the level playing field for European fossil energy producers. Less than half of responses to the OPC were in support to include indirect emissions from any one of a list of categories provided in the OPC (industry, power generation, transport, residential or other).

Different conclusions can be drawn on sectoral, emissions and supply chain coverage and/or scope, starting with the support for the inclusion of coal in MRV and mitigation. In addition, a majority of respondents called the Commission to extend the coverage of the scope of the proposals to end-users. Finally, a majority of respondents consider that the legislation should cover all oil and gas entering the EU market.

Section IV: Legislating on leakage detection and repair

Fugitive (unintentional) leaks represent one of the main sources of methane emissions from the gas and oil sectors. It is widely considered that the main mitigation strategy for reducing emissions from fugitive methane leaks from pressurized equipment used in the oil and gas industry is a leakage detection and repair (LDAR) program.

Regarding the instruments for leak detection, most responses (58%) think EU regulation should not prescribe the type of device used. Companies/business organisations favour outcome-based strategies, with legislation allowing flexibility for operators to choose the most effective and most efficient solutions to perform LDAR, based on the context, type of facilities and local constraints. Business associations argued that a limitation to certain devices might hamper quickly evolving and new innovative methods and thus inhibit competition. Technical suggestions from amongst others academia/research institutions included the stipulation of minimum sensitivity thresholds for the devices used. The group of French citizens indicated that norm EN15446 already lists the kind of methods that may be used for LDAR. NGOs were in favour of requiring instrument-based inspections at defined frequencies. For public authorities, the legislation should mention minimum device requirements to ensure a level playing field.

Most responses considered that the frequency of LDAR campaigns should be fixed (64%). Furthermore, they indicated that the leak detection device/approach used, environmental concerns, the leak size, the results of previous LDAR campaigns, safety, and the environmental risk evaluation are highly important parameters to take into account and set into legislation. The accessibility/ease of repair as well as the cost-effectiveness of the campaign were perceived as less important by the majority of respondents.

On the quantification of fugitive leaks, most responses (55%) are supportive of not determining the methods to be used. Companies are in favour of the EU setting the standard for detection and measurement as long as it remains flexible with regard to the exact methods used and open to new technological developments. Business associations expressed the view that methods to quantify fugitive emissions from leaks should be defined by industry standards and that legislation could recommend but not determine them. The French citizens again stressed the relevance of norm EN15446. Some NGOs pointed out that quantification should not be the main component of LDAR surveys, while others stated that models are a good baseline if supplemented by measurements. Public authorities consider the quantification of leaks as challenging and not necessarily giving an accurate picture of emissions on site.

On repairs, a majority of stakeholders’ responses (76%) considered that EU legislation should determine the time taken for leaks to be fixed after detection according to a classification of the severity of the leaks. Company respondents mentioned that it is important that EU legislation takes into account existing contributions, and determines a set of criteria for prioritizing leaks for the repair together with the industry. Business associations specified that this point should be covered by national legislations, however, a maximum time by which each type of leak should be repaired could be implemented as well as guidelines/thresholds. The French citizen respondents stressed the need to focus first on the biggest leaks. All NGOs agreed that leaks should be required to be repaired immediately, with clear prioritisation of larger leaks. All public authorities agreed that repairs of leaks should not be postponed but undertaken immediately.

The main conclusion that can be drawn on the instruments used for leak detection is that a majority of respondents did not want to include the type of device used for detecting leaks and the methods used to quantify fugitive leaks but supported inclusion of the frequency in legislation as well as strict repair requirements.

Section V: Legislating on venting and flaring

When it comes to the feasibility of eliminating routine venting and flaring associated with energy produced and consumed in the EU, most respondents considered that it is feasible (61%), while a minority considered it not to be feasible (29%). Companies/business organisations are of the view that routine flaring and venting can be reduced significantly but cannot be eliminated completely in the midstream sector due to safety reasons. Most business associations argued that elimination of venting and flaring may be feasible in the gas sector, but not in the oil sector where it may be reduced but is unlikely to be eliminated entirely. NGOs and public authorities asked for a specific definition of ‘routine’.

Most responses (41%) considered that it would take more than 5 years to phase out routine venting and flaring. The main reasons for extended phase-out periods respondents named are the completion of extensive reduction programs, additional investment needs, technical and logistic reasons, and safety. Some respondents also argued for alignment with the World Bank Zero Routine Flaring by 2030 initiative.

On definitions, the majority of responses (98%) are supportive of a common set of definitions and parameters for venting and flaring. Companies/business organisations were in favour of adopting definitions of “routine”, “non-routine”, and “emergency circumstances” to provide a level playing field and avoid misunderstandings. Business associations argued that some countries are already regulating those practices. These two stakeholder categories insisted on the necessity to consider MARCOGAZ technical recommendations when elaborating the definitions. Academia/research institutions mentioned that this would decrease uncertainty and help to compare countries between each other. NGOs raised the point that these terms are not necessarily applicable to the coal sector. They also argued that only acceptable instances for venting and flaring should occur, such as for safety, testing or the safe disposal of harmful gases, for which evidence would need to be provided.

A majority of stakeholders’ responses considered that the production part of the value chain as the most relevant for venting in the oil (80%) and gas (84%) sectors. Companies/business organisations and business associations agreed that routine venting would be the type of activity that results in the greatest level of emissions, but called for cost-benefit analyses and sector specific consideration of the potential cost effectiveness of emission reductions by type of emitter. For the coal sector, the relevance of safety reasons for venting was highlighted. Academia/research institutions specified that some of the reasons for venting are not well known, especially for LNG and at the distribution level. NGOs mentioned that primary causes of venting include the deliberate release of gas for disposal, the release of gas by design through pneumatic devices and equipment, and emergency releases.

A majority of respondents considered that the production part of the value chain as the most relevant for flaring in the oil (85%) and gas (98%) sector.

To conclude on venting and flaring, a majority of stakeholders’ responses estimated that it is feasible to eliminate routine venting and flaring associated with energy produced and consumed in the EU, but with diverging views on possible time frames. A common set of definitions and parameters for venting and flaring are considered necessary.

Section VI: Mitigation costs and benefits

A majority of the respondents (84%) views the overall benefits – including economic, social, environmental and other relevant benefits – of putting in place legislative measures to ensure robust and effective measurement, reporting and mitigation of methane emissions in the energy sector to generally outweigh the cost to industry. Companies/business organisations highlighted the importance of legislative measures to mitigate emissions in the value chain; however, incentives should be aligned with global objectives. For business associations, a coordinated approach is important, as there may be additional costs in some areas that are not in relation to the cost savings, especially for DSOs/TSOs. Academic/research institutions pointed out that additional environmental benefits could be achieved by putting in place legislative measures that cover all oil and gas entering the EU market. Citizens raised the fact that careful considerations should be given to the impacts of such legislative measures on LNG market development in emerging economies. NGOs indicated that the reduction of methane emissions is one of the most cost-effective strategies to rapidly reduce the rate of global warming and that owners of the methane emitted may save money by mitigating their emissions. Public authorities mentioned that proportionality and cost-effectiveness should be taken into account.

In conclusion, a majority of respondents acknowledged that the overall benefits of putting in place legislative measures to ensure robust and effective MRV of methane emissions outweigh the costs to industry.

Section VII: Legislating mitigation of emissions from biogas/biomethane

Most stakeholders' responses (67%) are supportive of EU regulation obliging biogas/biomethane producers to reduce their fugitive methane emissions and the majority (64%) also agreed that separate mitigation measures should be developed in the upcoming regulation on methane in the energy sector complementing the Renewable Energy Directive II. Some companies/business associations raised the point that to allow biomethane to fulfil its potential as a decarbonized energy source, it will be important that methane emissions from its value chain are measured, reported and verified to the same standard as for the oil and gas sector. Other respondents from this same category are of the view that emissions from biogas/biomethane plants are negligible when compared to the entire gas value chain, and should not be penalised as it has a role to play as renewable energy. Business associations stressed a necessity to avoid the penalisation of the biofuel sector with added regulation to fasten its uptake, and also claim that it emits less methane than other conventional activities. For academia/research institutions, only big bioenergy plants should be subject to such obligations. Citizens argued that all methane emissions should be treated equally, and the French citizens highlighted that voluntary initiatives from this sector can help to limit methane emissions. For NGOs, this obligation should take into account the full supply chain of biogas/biomethane, including leaks beyond the processing stage to reduce fugitive methane emissions. Public authorities agreed with legislating mitigation of emissions from biogas/biomethane as these plants' methane emissions represent a relevant share of emissions.

Section VIII: Legislating mitigation of emissions from coal

A majority of respondents (76%) consider that the EU regulation to reduce methane emissions in the energy sector should cover coalmine methane and NGOs mentioned that it would incentivise the move away from coal. While some companies are of the view that coal must be addressed as a major emission source to achieve the EU's environmental targets, others insisted that the specificities of the mining sector should be taken into account. Some business associations mentioned that coalmine methane is a significant source of methane emissions and thus should be regulated, while others pointed out that some Member States are already measuring and reporting fugitive methane emissions in the coal sector using higher tier methods.

On coalmine methane mitigation, safety requirements for ventilation appear to be one of the most important considerations (75% of answers). On abandoned mine methane mitigation, a majority of respondents (80%) considered that AMM ownership rights should be addressed in EU legislation and most respondents (74%) agreed that EU methane legislation should set an obligation on mine operators to install recovery systems for future gas recovery after abandonment/closure.

Different conclusions can be drawn on legislating mitigation of emissions from coal. While stakeholders think EU regulation should cover coalmine methane, safety requirements for ventilation and the constraints they imply are considered highly important. Abandoned mine methane ownership rights should be addressed in EU legislation according to a majority of responses.

Section IX: Synergies with other sectors

Companies and business organisations underlined that MRV and LDAR measures from the energy sector should be assessed for transferability to the agriculture and waste sector. Some business associations mentioned that the production of biogas/biomethane from agriculture and waste sectors can contribute to the reduction of methane emissions as agriculture is the biggest emitter. Some respondents from this category also mention that the inclusion or extension of MRV legislation to landfills or waste treatment plants should be considered. NGOs specified that the upcoming methane obligations on MRV, LDAR, and BRVF should apply equally to co-products and components of oil and fossil gas that co-contribute to methane emissions at oil and fossil gas sites and facilities.

Consultation on costs of implementing MRV regulation based on OGMP

Following the Open Public Consultation, an additional questionnaire was transmitted to OGMP member companies via the main oil and gas associations (IOGP, Eurogas, GIE-Marcogaz-EntsoG), with detailed questions on the costs and administrative burden of implementing the requirements on MRV in line with OGMP (including also reporting to relevant national Member State authorities before the information is passed on to UNEP to allow the International Methane Emissions Observatory (IMEO) to perform its analysis on the reported information) on 28 May with a request for responses by 11 June 2021.

In total, the questionnaire received responses from 6 association and 30 individual companies from different parts of the supply chain (see figure A.2.2) and with a broad geographical coverage (see figure A.2.3).

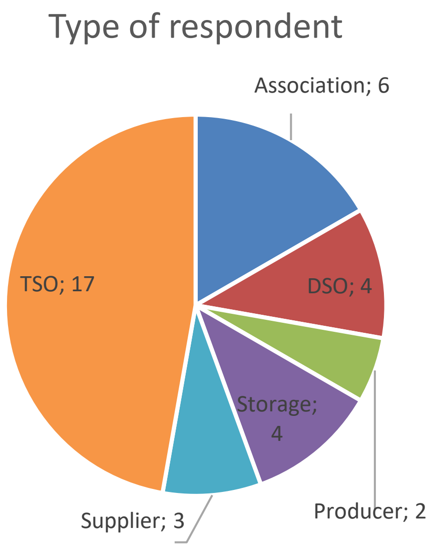

Figure A.2.2 Type of respondents

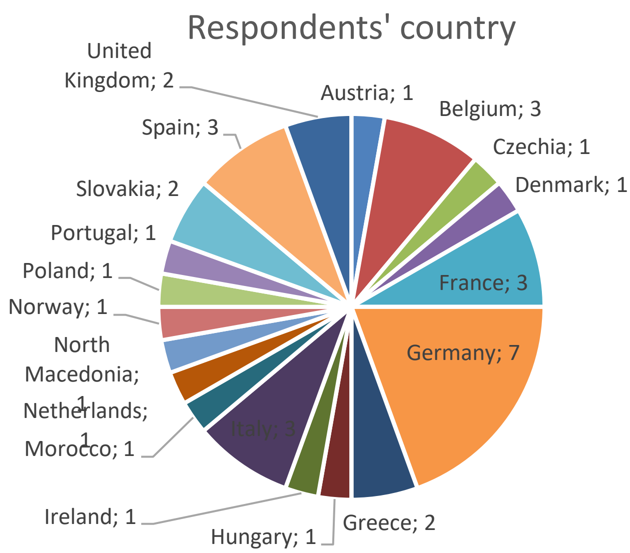

Figure A.2.3 Geographical coverage

Of the 30 responding companies, 22 have signed up to the OGMP 2.0 framework, 3 have not yet signed up but intend to do so, 4 have not signed up and have no (current) plans to do so, and 1 did not respond to the relevant question.

Qualifying the anticipated additional costs and administrative burden of implementing the requirements on methane measurement, reporting and verification in line with OGMP (including also reporting to the relevant national Member State national authorities before the information is passed on to UNEP and the IMEO for final verification), 64% of respondents consider them to be significant (Figure A.2.4 and A.2.5)[190], while 36% consider them not to be significant (qualifying them as either 'negligible', as representing 'no additional cost' or as 'not negligible but not significant'° Note that one of the two main industry associations that responded, the International Oil and Gas Association, considers both additional costs and additional administrative burden of signing up to OGMP to be neither negligible nor significant. The distribution across the different types

[190] Note that one association and one company each chose two answers to this question, which were both included in the total.

of respondents (figure A.2.6) further highlights a clear dichotomy of views on the issue of the size of extra costs/administrative burden among industry.

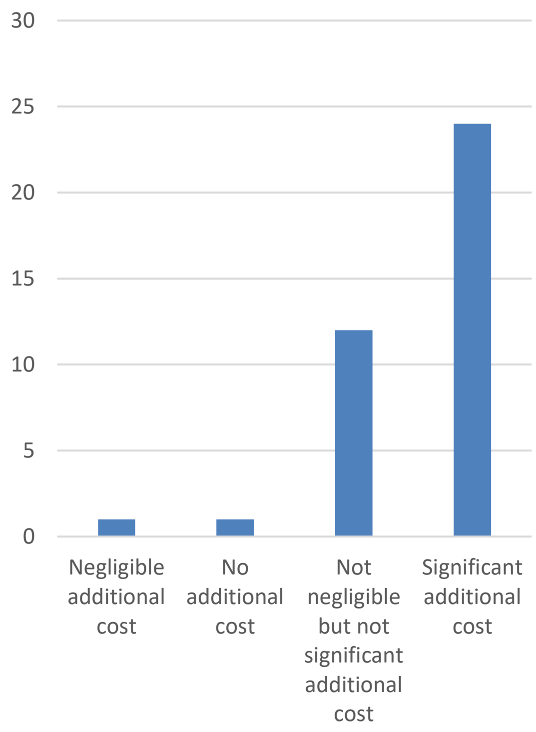

Figure A.2.4 Anticipated additional cost

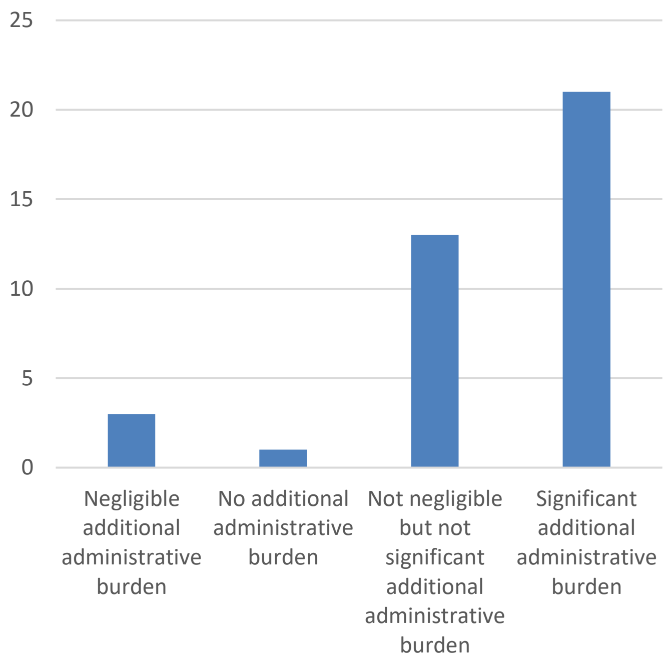

Figure A.2.5 Anticipated additional administrative burden

This could be explained by the fact that only five respondents express having actually estimated how much signing up to the OGMP would add to their regulatory implementation costs, so much of what the industry is expressing in response to this survey appears to be based on perception rather than real experience

Requests in the survey for estimates on the additional costs and administrative burden of signing up to OGMP garnered very few responses from only 3 of the 36 respondents and none of the information provided actually fully answered the question, thereby preventing an assessment of the ‘extra’ cost or burden for those companies. The responses received point towards higher costs in the initial phases with changes to measurement, setup of IT systems, and reporting structures, but smaller costs after initial implementation. Continuing development of requirements (e.g. for Level 5) was given as a key reason for uncertainties surrounding costs. Associations consider that companies will be facing different starting points and varying costs and administrative burdens are to be expected across Europe.

Nevertheless, 10 out of 36 respondents consider that the overall benefits of MRV in line with OGMP outweigh the proportionate extra cost and administrative burden. Among the

10 responses IOGP, the International Oil and Gas Association, considers that the benefits of implementing MRV requirements in line with OGMP will reinforce public confidence in the sustainability of the EU's gas system. Several other respondents also offer such an explanation, or something close to it, such as that MRV requirements in line with OGMP will contribute to methane emissions mitigation and will therefore contribute to the EU's climate-neutrality objective, which is key for the gas industry.

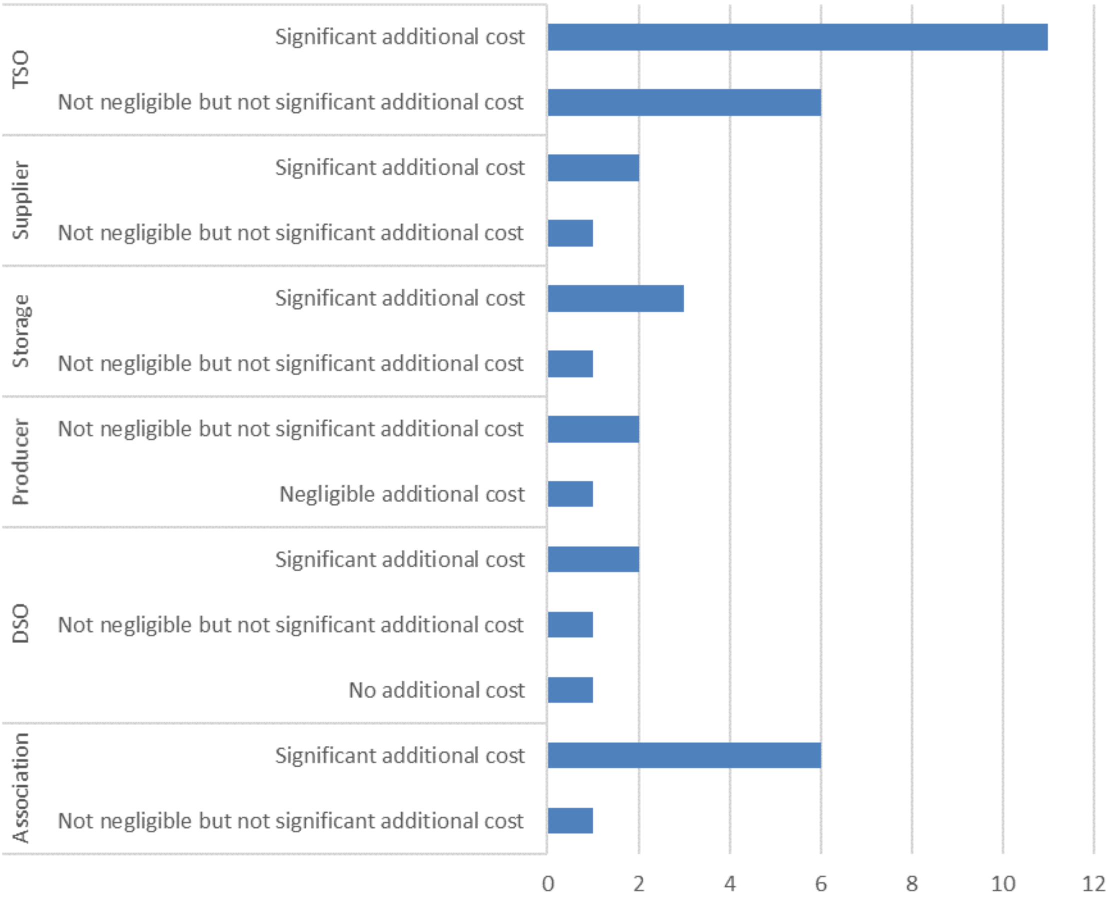

Figure A.2.6 Anticipated additional costs by type of respondent

In addition, a number of the responses which do not consider that the benefits will outweigh the costs make it clear that they have answered the question purely from a company's standpoint, yet provide the additional explanation that the benefits of OGMP requirements for MRV accrue to society.

Lastly, several responses from regulated companies consider that benefits will not outweigh the costs on the basis that in the current framework, the increased economic costs derived from the implementation of MRV enhanced techniques are not recognised by national regulatory authorities.

Respondents were asked about the importance of different benefits of signing up to OGMP in terms of i) visibility of corporate environmental responsibility, ii) Economic benefits from MRV contributing to better emission mitigation and recovery of sellable gas, and iii) Benefits in terms of increased capacity/knowledge of methane emissions management gained from working with peers and learning from one another. While visibility and capacity building are predominantly seen as important or very important, economic benefits are primarily seen as not at all or not very important (Figure A.2.7).

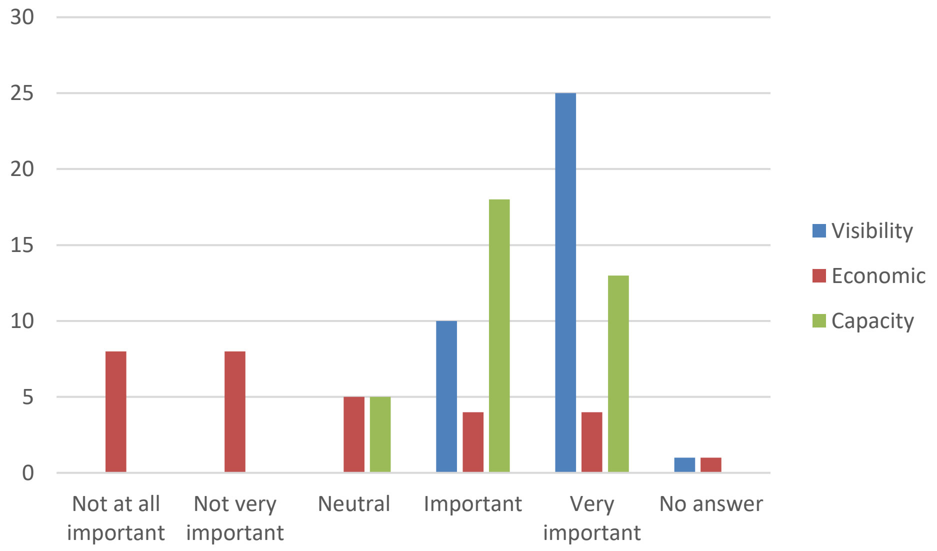

Figure A.2.7 Importance of different benefits of signing up to the OGMP

The most cited other benefit of signing up to OGMP is improvement of the reliability and the transparency of industry data along with establishment of common standards in measurement/calculation and reporting of methane emissions. Additional benefits provided include economic benefits arising from the implementation of MRV measures for super emitters; benefits linked to public confidence; the mitigation of venting hazards as well as other safety benefits; and the effect it may have on companies’ license to operate on long-term basis.

ANNEX 3: LIST OF ACTIONS IN THE METHANE STRATEGY

Cross-sectoral actions

1. The Commission will support improvements in measurement and reporting of methane emissions by companies across all relevant sectors, including through sector-specific initiatives.

2. The Commission will support the establishment of an independent international methane emissions observatory anchored in the United Nations framework, in cooperation with international partners. The observatory would be tasked with collecting, reconciling, verifying and publishing anthropogenic methane emissions data at a global level.

3. The Commission will strengthen satellite-based detection and monitoring of methane emissions through the EU's Copernicus programme, with a view to

contribute to an EU-coordinated capability for detecting and monitoring global super-emitters.

4. In order to deliver on the increased climate ambition of the 2030 climate target plan impact assessment, the Commission will review relevant EU climate and environmental legislation to more effectively address methane-related emissions notably the Industrial Emissions Directive and the European Pollutant Release and Transfer Register.

5. The Commission will provide targeted support to accelerate the development of the market for biogas from sustainable sources such as manure or organic waste and residues via upcoming policy initiatives. This will include the future gas market regulatory framework and the upcoming revision of the Renewable Energy Directive. The Commission will propose a pilot project to support rural areas and farming communities in building biogas projects and accessing funds for biogas production from agricultural waste.

Actions in the energy sector

6. The Commission will deliver legislative proposals in 2021 on:

- Compulsory measurement, reporting, and verification (MRV) for all energy-related methane emissions, building on the Oil and Gas Methane Partnership (OGMP 2.0) methodology.
- Obligation to improve leak detection and repair (LDAR) of leaks on all fossil gas infrastructure, as well as any other infrastructure that produces, transports or uses fossil gas, including as a feedstock.

7. The Commission will consider legislation on eliminating routine venting and flaring in the energy sector covering the full supply chain, up to the point of production.

8. The Commission will work to extend the OGMP framework to more companies in the gas and oil upstream, midstream and downstream as well as to the coal sector and closed as well as abandoned sites.

9. The Commission will promote remedial work under the initiative for Coal Regions in Transition. Best-practice recommendations and/or enabling legislation will be brought forward if necessary.

Actions in the agricultural sector

10. In the first half of 2021, the Commission will support setting up an expert group to analyse life-cycle methane emissions metrics. This group will look at livestock, manure and feed management, feed characteristics, new technologies and practices and other issues. It will also work in setting up a life cycle methodology on the overall emissions for livestocks.

11. By the end of 2021, the Commission – in cooperation with sectoral experts and Member States – will develop an inventory of best practices and available

technologies to explore and promote the wider uptake of innovative mitigating actions. These actions will have a special focus on methane from enteric fermentation.

12. To encourage carbon-balance calculations at farm level, the Commission will by 2022 provide a digital carbon navigator template and guidelines on common pathways for the quantitative calculation of greenhouse gas emissions and removals.

13. The Commission will promote the uptake of mitigation technologies through the wider deployment of 'carbon farming' in Member States and their Common Agricultural Policy Strategic Plans, as from 2021.

14. In the Horizon Europe strategic plan 2021-2024, the Commission will consider proposing targeted research on the different factors that effectively lead to methane emission reductions, focusing on technology and nature based solutions as well as on the factors leading to dietary shift.

Actions in the waste and wastewater sector

15. The Commission will continue to tackle unlawful practices and provide technical assistance to Member States and regions. This assistance will address issues such as sub-standard landfills. The Commission will also help Member States and regions to stabilise biodegradable waste prior to disposal and its increasing use for the production of climate-neutral, circular bio-based materials and chemicals, and divert this waste to biogas production.

16. In the review of the Landfill Directive in 2024, the Commission will consider further action to improve the management of landfill gas, minimise its harmful climate effects, and harness any of its potential energy gains.

17. In the Strategic Plan 2021-2024 of Horizon Europe, the Commission will consider proposing targeted research on waste to biomethane technologies.

International actions

18. The EU will step-up its contribution to the work of international fora, such as through the Climate and Clean Air Coalition (CCAC), the Arctic Council and the Association of Southeast Asian Nations (ASEAN).

19. As part of the EU's diplomatic and external relations action, the Commission will address methane emission reductions in all relevant sectors with partner countries and promote global coordination of efforts to address energy-sector methane emissions.

20. The Commission will seek increased transparency in the energy sector by working with international partners to develop a Methane Supply Index in the foreseen international methane emissions observatory.

21. The Commission will consider methane emission reduction targets, standards or other incentives for fossil energy consumed and imported in the EU in the absence of significant commitments from international partners.

22. The Commission will support the establishment of a detection-and-alert process for methane super-emitters using EU satellite capability, and share this information internationally through the foreseen international methane emissions observatory.

23. The Commission will support cooperation with international partners, including the Global Methane Initiative, the World Bank's Global Gas Flaring Reduction initiative, and the World Bank's initiative on Zero Routine Flaring by 2030, as well as the International Energy Agency.

24. The Commission will contribute to a series of key international events in the build up to the UN General Assembly in New York in September 2021, with the objective of securing a UN based pathway on coordinated actions at international level to reduce methane emissions.

Annex 4: Analytical methods

GAINS model

The GAINS (Greenhouse gas and Air Pollution Information and Simulation) model is an integrated assessment model of air pollutant and greenhouse gas emissions and their interactions. GAINS brings together data on economic development, the structure, control potential and costs of emission sources and the formation and dispersion of pollutants in the atmosphere.

In addition to the projection and mitigation of greenhouse gas emissions at detailed sub-sectorial level, GAINS assesses air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

Model uses include the projection of non-CO2 GHG emissions and air pollutant emissions for EU Reference scenario and policy scenarios, calibrated to UNFCCC emission data as historical data source. This allows for an assessment, per Member State, of the (technical) options and emission potential for non-CO2 emissions. Health and environmental co-benefits of climate and energy policies such as energy efficiency can also be assessed.

The GAINS model is accessible for expert users through a model interface[191] and has been developed and is maintained by the International Institute of Applied Systems Analysis[192]. The underlying algorithms are described in publicly available literature. GAINS and its predecessor RAINS have been peer reviewed multiple times, in 2004, 2009 and 2011.

<u>Sources for data inputs</u>

The GAINS model assesses emissions to air for given externally produced activity data scenarios. For Europe, GAINS uses macroeconomic and energy sector scenarios from the PRIMES model, for agricultural sector activity data GAINS adopts historical data from EUROSTAT and aligns these with future projections from the CAPRI model. Projections for waste generation, organic content of wastewater and consumption of F-gases are projected in GAINS in consistency with macroeconomic and population scenarios from PRIMES. For global scenarios, GAINS uses macroeconomic and energy sector projections from IEA World Energy Outlook scenarios and agricultural sector projections from FAO. All other input data to GAINS, i.e., sector- and technology- specific emission factors and cost parameters, are taken from literature and referenced in the documentation.

<u>Uncertainty in the GAINS model</u>

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[191] Source: http://gains.iiasa.ac.at/models/
[192] Source: http://www.iiasa.ac.at/

Several of the data sources come with uncertainties. The exact treatment of these uncertainties is described in detail in the publicly available document on GAINS model methodology (https://ec.europa.eu/clima/sites/default/files/strategies/analysis/models/docs/non_co2_methodology_report_en.pdf). In general, GAINS estimates emissions by multiplying detailed activity data with an emission factor and, where applicable, the application of mitigation options that change the emission factors. For instance, GAINS might calculate methane emissions from coal mining as the product of coal mining activity, the emission factor associated with coal mining, and the application (or lack thereof) of mitigation options such as pre-mining degasification. Uncertainty exists in all three of these factors:

- Activity data: activity data are projected into the future taking into account current economic activity and policies, as well as projections from other parts of the EU modelling suite (e.g., agricultural activity data from CAPRI). Projections are what if-statement and not necessarily forecasts. Instead, the baseline used can be seen as a best guess to represent reality. However, changes to activity levels (e.g., through unforeseen factors such as a pandemic) are always possible in reality and not captured by the modelling.
- Emission factors: GAINS follows IPCC methodology for emission factors as closely as possible. Where available, GAINS improves on existing emission factors by taking into account country-specific information to further increase precision. This includes regular technical exchanges with member states.
- Mitigation options: GAINS regularly follows developments in both academic and policy literature to incorporate the most recent estimates for the cost, availability and mitigation potential of different mitigation options. Uncertainty in this regard comes mainly from uncertainty about future technological developments. Abatement potential in the near term (e.g., in 2030), is relatively less uncertain than abatement potential in the longer term (e.g., in 2050).

UNEP/CCAC Global Methane Assessment, May 2021

The CCAC/UNEP Global Methane Assessment[193] was peer-reviewed by experts from the scientific community as well as multiple governments, and then by the UNEP publishing board prior to publication (review rounds Oct 2020; Dec, 2020; Apr 2021).

Modeling was carried out by five state-of-the-art composition-climate models that researchers who participated in the assessment used: the CESM2(WACCM6) model[194]

[193] UNEP & CCAC (2021) Global Methane Assessment. https://www.ccacoalition.org/en/resources/global-methane-assessment-full-report

[194] Danabasoglu, G., et al., 2020. The community earth system model version 2 (CESM2). Journal of Advances in Modeling Earth Systems, 12(2), https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS001916.
Gettelman, Aet al.. (2019). The Whole Atmosphere Community Climate Model Version 6 (WACCM6). J. Geophys. Res. https://doi.org/10.1029/2019JD030943

developed at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, US; the GFDL AM4.1/ESM4.1 model[195] developed by NOAA in Princeton, New Jersey, US; the Goddard Institute of Space Studies (GISS) E2.1/E2.1-G model[196] developed by the NASA in New York, New York, US; the MIROC-CHASER model[197] developed jointly by the Atmosphere and Ocean Research Institute, the University of Tokyo, Kashiwa, the National Institute for Environmental Studies (NIES), Tsukuba, the Japan Agency for Marine-Earth Science and Technology, Yokohama, and Nagoya University, Nagoya, Japan; and the UKESM1 model[198] developed jointly by the Met Office, Exeter, UK, and the United Kingdom's academic community. All these models are 'world-class' and are key participants in the Coupled Model Intercomparison Project's 6th phase (CMIP6) in support of the IPCC's AR6. The AR6 summarizes the uncertainties and assumptions within climate models, and multiple models were used in the GMA precisely in order to better characterize uncertainties.

Analyses of mitigation opportunities was carried out by Integrated Assessment Models. The GMA analysis is particularly interested in scenarios consistent with the 1.5°C target as assessed in the 2018 IPCC Special Report on Global Warming of 1.5°C[199]. Here those scenarios classified by IPCC as either having at least a 50 per cent likelihood of keeping temperatures below 1.5°C throughout the 21st century and those with a median temperature below 1.5°C in 2100 but with a 50–66 per cent change of overshooting that value during the century, typically by no more than 0.1°C, are considered. Many, but not all, of these scenarios were generated within the SSP framework.

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[195] Horowitz et al. (2020) The GFDL Global Atmospheric Chemistry-Climate Model AM4.1: Model Description and Simulation Characteristics. Journal of Advances in Modeling Earth Systems, 12(10). https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS002032.
Dunne et al. (2020) The GFDL Earth System Model Version 4.1 (GFDL-ESM 4.1): Overall Coupled Model Description and Simulation Characteristics. Journal of Advances in Modeling Earth Systems, 12(11). https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS002015

[196] Kelley et al. (2020) GISS-E2.1: Configurations and Climatology. Journal of Advances in Modeling Earth Systems, 12(8). https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS002025

[197] Sekiya et al., (2018) Global high-resolution simulations of tropospheric nitrogen dioxide using CHASER V4.0, Geosci. Model Dev., 11, 959–988, https://doi.org/10.5194/gmd-11-959-2018 ;
Watanabe et al. (2011) MIROC-ESM 2010: model description and basic results of CMIP5-20c3m experiments. Geosci. Model Dev., 4, 845–872, https://doi.org/10.5194/gmd-4-845-2011;
Sudo et al. (2002) CHASER: A global chemical model of the troposphere 1. Model description. Journal of Geophysical Research: Atmospheres, 107(D17), ACH 7-1-ACH 7-20, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2001JD001113

[198] Archibald et al. (2019) Description and evaluation of the UKCA stratosphere–troposphere chemistry scheme (StratTrop vn 1.0) implemented in UKESM1. Geosci. Model Dev., 13, 1223–1266, https://doi.org/10.5194/gmd-13-1223-2020
Sellar et al. (2019) UKESM1: Description and Evaluation of the U.K. Earth System Model. Journal of Advances in Modeling Earth Systems, 11(12). https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS001739

[199] IPCC 2018;
Rogelj et al. (2018) Scenarios towards limiting global mean temperature increase below 1.5 °C. Nature Climate Change, 8, pages 325–332, https://www.nature.com/articles/s41558-018-0091-3

Additional analyses of mitigation potentials at the sectoral level were analyzed by several teams, including IIASA[200] (Höglund-Isaksson 2020), US EPA (2019), the International Energy Agency[201] (IEA; 2020) and in a literature review by Harmsen et al. (2019)[202]. These analyses are similar in their aims but differ in coverage and methodology. In particular, the IEA analysis includes only the oil and gas subsector and analyses present-day abatement potentials associated with targeted control measures[203].

Impact analyses are similarly based on peer-reviewed publications, and characterize uncertainties associated with the underlying exposure-response functions (e.g. for mortality, labour impacts, etc.) and those associated with understanding the response of the physical system to emissions changes (by examining the variation across the physical models, assuming that range provides an indication of uncertainty in physical responses as independently developed models were utilized). A primary limitation of the impact analyses is that impacts that likely exist but for which exposure-response functions have not been published in the peer-reviewed literature were omitted.

For further details on methods and results descriptions, please see the UNEP/CCAC (2021) Global Methane Assessment documentation.

IEA Methane Tracker

The IEA's approach is described in the IEA World Energy Model Documentation (WEO-2020)[204]. It's estimation of "methane emissions from global oil and gas operations relies on generating country-specific and production type-specific emission intensities that are applied to production and consumption data on a country-by-country basis. [The] starting point is to generate emission intensities for upstream and downstream oil and gas in the United States. […] The 2017 US Greenhouse Gas Inventory is used for this along with a range of other data sources, including [an IEA] survey of companies and countries. The hydrocarbon-, segment-and production-specific emission intensities are then further segregated into fugitive, vented and incomplete flaring emissions to give a total of 19 separate emission intensities." (p.63)

The marginal abatement cost curves for methane emissions in the oil and gas sector presented in the Methane Tracker[205], and underlying the analysis used in this Impact

[200] Höglund-Isaksson, L., Gómez-Sanabria, A., Klimont, Z., Rafaj, P. and Schöpp, W., 2020. Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe–results from the GAINS model. Environmental Research Communications, 2(2), https://iopscience.iop.org/article/10.1088/2515-7620/ab7457.

[201] IEA Methane Tracker (2020) https://www.iea.org/reports/methane-tracker-2020

[202] Harmsen, J.H.M., van Vuuren, D.P., Nayak, D.R., Hof, A.F., Höglund-Isaksson, L., Lucas, P.L., Nielsen, J.B., Smith, P. and Stehfest, E., 2019. Long-term marginal abatement cost curves of non-CO2 greenhouse gases. Environmental Science & Policy, 99, pp.136-149. https://www.sciencedirect.com/science/article/pii/S146290111830889X

[203] IEA Methane Tracker (2020) https://www.iea.org/reports/methane-tracker-2020

[204] https://iea.blob.core.windows.net/assets/dd88335f-91ab-4dbd-8de7-d2dc4fee90e0/WEM_Documentation_WEO2020.pdf

[205] IEA Methane Tracker (2021) https://www.iea.org/reports/methane-tracker-2021

Assessment, are constructed by starting with these 19 possible emissions sources. These are then separated into 86 equipment-specific emissions sources (e.g. high bleed pneumatic devices) based on proportions from the United States, although a number of country-specific modifications are made.

Abatement options (e.g. install vapour recovery units) are next assessed for each of the 86 sources and the costs and savings of these included in the marginal abatement cost curves. Unfortunately, specific costs and applicability factors for the individual abatement options cannot be provided, as they are based on proprietary information gathered by ICF (although some data has made available publicly[206]). Costs are again based upon information from the United States, with modifications again for labour costs and capital costs across different countries. The marginal abatement cost curves also take into account the fact that many of the abatement options would save natural gas that could subsequently be sold, which is why there are a number of "negative cost" options available.

For this revenue calculation, the IEA use well-head prices in each country, which for the current data in the Methane Tracker is based on natural gas import prices in the WEO-2020. Prices assume that there are no domestic consumption subsidies, but some allowances for operational expenses are made so that the price at the well-head is slightly lower than the regional gas price.

The relevant well-head price for gas exporting countries is taken as the import price in their largest export market net-backed to the emissions source. For example, in Russia the export price is taken as the import price in Europe. Export taxes are then subtracted along with a further $0.5/MBtu to cover the cost of transport by pipeline.

In the marginal abatement cost curve, the costs and revenue for each technology or abatement measure are converted into net present value using a discount rate of 10% and divided by the volume of emissions saved to give the cost in dollars per million British thermal units (MBtu).

The IEA has been working to incorporate new studies and regional information from relevant stakeholders in these estimates, including satellite-data on large leaks, but a considerable level of uncertainty remains due to the overall lack of measured data on methane leaks and the scant information available for a number of countries. However, IEA estimates do fall in a similar range as other key references in this subject, including the Global Methane Assessment[207].

[206] ICF (2016a), Economic Analysis of Methane Emission Reduction Potential from Natural Gas Systems. Fairfax, VA, United States: ICF
ICF (2016b), Summary of Methane Emission Reduction Opportunities Across North American Oil and Natural Gas Industries. Fairfax, VA, United States: ICF.
[207] UNEP & CCAC (2021) Global Methane Assessment. https://www.ccacoalition.org/en/resources/global-methane-assessment-full-report

ANNEX 5: WHO IS AFFECTED AND HOW?

Policy Area 2

As indicated in the section on impacts of the policy options, these projections for coal and for oil and gas are taken from GAINS modelling results for the impact assessments for the Fit-for-55 package. The thresholds for 'low costs' and 'less than costs equivalent to sum of social and environmental costs' are taken from the Climate and Clean Air Coalition/United Nations Environment Programme May 2021 report 'Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions'.

Table A.5.1. GAINS projections of EU 27 coal sector baseline methane emission reductions and additional emission reductions available at different levels of abatement costs

	Total projected baseline emissions (kt CH4)			**Total projected baseline reductions in methane emissions (KT CH4) from 2020**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at all costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at zero costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at less than low costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at less than social and environmental costs of methane**		
Year	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
Coal mining	255	37	32				147	26	23	5	0	4	117	20	23	146	26	23
Abandoned coal mines	112	89	74				101	82	69	101	82	69	101	82	69	101	82	69
Total	***367***	***126***	***106***	***593***	***833***	***852***	***247***	***107***	***92***	***106***	***82***	***72***	***218***	***102***	***92***	***247***	***107***	***92***

Source: GAINS modelling results for the impact assessments for the Fit-for-55 package

Note 1: low cost is greater than zero and less than 2018 US$ 600 per tonne of methane = 509 Euros per tonne of methane (at average exchange rate for the year 2018 of 0.8475 euro/US dollar), or greater than zero and less than US$ 21.4 per tonne of CO2 equiv. = 18.1 Euros per tonne of CO2 equiv. in line with CCAC/UNEP 'Global Methane Assessment', May 2021

Social and environmental costs of methane emissions is equivalent to 2018 US$4,300 per tonne of methane or 3,644 Euros per tonne of methane or 130 euros per tonne of CO2 equiv. [Based on estimations of social benefits from CCAC/UNEP 'Global Methane assessment', May 2021

Table A.5.2. GAINS projections of EU 27 oil and fossil gas baseline methane emissions and additional emission reductions available at different levels of abatement costs

	Total projected baseline emissions (kt CH4)			**Total projected baseline reductions in methane emissions (KT CH4) from 2020**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at all costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at zero costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at less than low costs**			**Total projected reductions in methane emissions (KT CH4) on top of the baseline available at less than social and environmental costs of methane**		
Year	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
Gas transmission	215	152	173	38	101	80	213	150	172	118	89	105	118	89	105	118	89	105
Gas distribution	243	146	137	115	212	221	240	145	136	126	82	83	126	82	83	126	82	83
Oil and gas production	255	114	44	-28	113	183	217	100	38	49	32	34	118	90	34	214	99	38
Total	***713***	***412***	***355***	***125***	***426***	***483***	***670***	***394***	***345***	***292***	***203***	***222***	***361***	***261***	***222***	***458***	***270***	***225***

Source: GAINS modelling results for the impact assessments for the Fit-for-55 package

Note : low cost is greater than zero and less than 2018 US$ 600 per tonne of methane = 509 Euros per tonne of methane (at average exchange rate for the year 2018 of 0.8475 euro/US dollar), or greater than zero and less than US$ 21.4 per tonne of CO2 equiv. = 18.1 Euros per tonne of CO2 equiv. in line with CCAC/UNEP 'Global Methane Assessment', May 2021

Social and environmental costs of methane emissions abatement is equivalent to 2018 US$4,300 per tonne of methane or 3,644 Euros per tonne of methane or 130 euros per tonne of CO2 equiv. [Based on estimations of social benefits from CCAC/UNEP 'Global Methane assessment', May 2021

Table A.5.3: comparison of the share of projected GAINS methane emission reductions over and above the baseline level that can abated at different levels of abatement costs

Options	Year	Coal emissions	Oil and gas emissions	Oil, gas and coal emissions
Share of EU energy sector emissions covered*	**2019**	32%	33%	65%
Total projected reductions in methane emissions (KT CH4) on top of the baseline available at all costs**	**2030**	247	670	918
	2040	107	394	502
	2050	92	345	437
Share of total projected reductions in methane emissions that can be abated at zero costs**	**2030**	43%	44%	43%
	2040	76%	52%	57%
	2050	79%	64%	67%
Share of total projected emissions that can be abated at less than low costs***	**2030**	88%	54%	63%
	2040	95%	66%	72%
	2050	100%	64%	72%
Share of total projected emissions that can be abated at less than sum of social benefits****	**2030**	100%	68%	77%
	2040	100%	68%	75%
	2050	100%	65%	73%

All of these figures represent emission abatement which is available on top of the baseline (business as usual) scenario at different levels of costs effectiveness

** On the basis of 2019 GHG inventories data*

*** GAINS modelling results for the impact assessments for the Fit-for-55 package*

**** 'Low cost' is greater than zero and less than 2018 US$ 600 per tonne of methane, equivalent to 509 Euros per tonne of methane (at average exchange rate for the year 2018 of 0.8475 euro/US dollar), or greater than zero and less than US$ 21 per tonne of CO2 equiv., equivalent to 18.1 Euros per tonne of CO2 equiv. [Based on estimation of low costs from CCAC/UNEP 'Global Methane Assessment', May 2021]. Though cots effective, measures above 10 euros per tonne of oil equivalent considered eqivalent to high ambition methane mitigation.*

***** Social and environmental benefits of methane emissions abatement amount to 2018 US$ 4,300 per tonne of methane, equivalent to 3,644 Euros per tonne of methane or 130 Euros per tonne of CO2 equiv. [Based on estimation of social benefits from CCAC/UNEP 'Global Methane Assessment', May 2021]*

There are other projections that arrive at very similar conclusions as these GAINS model projections in terms of the types of cost-effective methane abatement measures available in the oil and gas sectors. For instance, the Climate Clean Air Coalition/United Nations Environment Programme May 2021 report ‘Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions’ states that 60% of targeted measures in the oil and gas sectors have low mitigation costs (of less than 18.1 euros per ton of CO2 equivalent) and 50% have negative costs, and that these include upstream and downstream leak detection and repair, recovery and utilization of vented gas and installation of flares.

Table A.5.4: Summary of costs and benefits for the options in policy area 2 in 2030

Options	2.1 (oil and gas)	2.2 (oil and gas)	2.3a (oil, gas and coal)	2.3a (coal only)	2.4 (oil, gas and coal)
Level of abatement costs	**Negative and zero costs**	**Social and environmental cost**	**Social and environmental cost**	**Social and environmental cost**	**Social and environmental cost**
Total methane emissions abatement in 2030 (kt methane)*	292	458	706	247	706
Total costs (million Euros) of measures to companies in 2030*	0	93	127	34	127
Total social and environmental benefits of abatement (million Euros) to society in 2030**	1064	1669	2573	900	2573
Net socio-economic benefits (Million Euros) in 2030	1064	1576	2446	866	2446
Annual premature deaths due to ozone prevented* in 2030**	418	655	1010	353	1010
Annual asthma-related accident and emergency department visits avoided* in 2030**	1168	1832	2824	988	2824
Annual hospitalizations avoided* in 2030**	26	41	64	22	64
Annual losses of wheat, soybean, maize and rice due to ozone exposure (in tons) avoided* in 2030**	42340	66410	102370	35815	102370
Annual hours of work loss due to extreme heat avoided (million hours)* in 2030**	117	183	282	99	282

Notes:

All of these figures on costs and benefits are on top of the baseline (business as usual) scenario

**Source: GAINS modelling results for the impact assessments for the Fit-for-55 package and social benefits based on estimations from CCAC/UNEP 'Global Methane Assessment', May 2021 Social benefits of abating methane amount to 2018 US$ 4,300 per tonne of methane, equivalent to 3,644 Euros per tonne of methane or 130 Euros per tonne of CO2 equiv.*

*** Social and environmental benefits of methane abatement amount to 2018 US$ 4,300 per tonne of methane, equivalent to 3,644 Euros per tonne of methane or 130 Euros per tonne of CO2 equiv. [Based on estimation of social benefits from CCAC/UNEP 'Global Methane Assessment', May 2021]*

**** Based on estimation of social benefits from CCAC/UNEP 'Global Methane Assessment', May 20*

Policy Area 3

Tables A.5.5 and A.5.6 below show key results of estimations from the International Energy Agency[208] of methane emission reductions that could be achieved in a sample of key exporting countries to the EU under various different abatement cost considerations. They also show the size of the overall and net social and environmental benefits that are implied by the abatement of methane emissions in those countries compared to if policy action was focussed only on the EU. The same basis for the estimations of benefits is used for those countries as for the EU (using UNEP/CCAC assessments).

They cover estimations for fossil gas and oil, as estimations for coal were not available. The results are not shown per country: they represent the sum of estimations of all energy sector methane emission reductions achievable in the following top (in volume terms) exporting countries of oil and fossil gas to the EU:

- Oil: Russia, Saudi Arabia, US, Iraq, Norway;
- Fossil gas: Russia, Norway, Algeria, Qatar, Nigeria, US.

Table A.5.5. Comparison of the share of estimations of methane emission reductions that can abated at different levels of abatement costs for a selection of top oil and fossil gas exporting countries to the EU*

Options	**Option 3.1 to option 3.3**
Total projected reductions in methane emissions (KT CH4)**	25,771
Share of reductions that can be abated at negative or zero costs	33%
Share of reductions that can be abated	98%

[208] IEA Methane Tracker 2020 (https://www.iea.org/reports/methane-tracker-2020)

at costs less or equal to low costs* **	
Share of reductions that can be abated at costs less than sum of social and environmental costs****	99%

Notes:

* This includes the following countries: (oil) Russia, Saudi Arabia, US, Iraq, Norway; (fossil gas) Russia, Norway, Algeria, Qatar, Nigeria, US.
** Source: IEA Methane Tracker 2020 (https://www.iea.org/reports/methane-tracker-2020)
*** 'Low cost' is greater than zero and less than 2018 US$ 600 per tonne of methane, equivalent to 509 Euros per tonne of methane (at average exchange rate for the year 2018 of 0.8475 euro/US dollar), or greater than zero and less than US$ 21 per tonne of CO_2 equiv., equivalent to 18.2 Euros per tonne of CO_2 equiv. [Based on estimation of low costs from CCAC/UNEP 'Global Methane Assessment', May 2021]
**** Social and environmental costs of methane amount to 2018 US$ 4,300 per tonne of methane, equivalent to 3,644 Euros per tonne of methane or 130 Euros per tonne of CO_2 equiv. [Based on estimation of social benefits from CCAC/UNEP 'Global Methane Assessment', May 2021]

Table A.5.6. Summary of costs and benefits for the options in policy area 3 for a selection of top oil and fossil gas exporting countries to the EU*

Options	3.1 to 3.3
Total projected reductions in methane emissions by 2030 (KT methane) achievable at costs less than sum of social and environmental costs**	25,513
Total costs (million US$) of measures available at cost less than social and environmental costs***	2,607
Total social benefits (Million US$) of measures available at cost less than social and environmental costs***	110,225
Net social benefits (Million US$)	107,618
Annual premature deaths due to ozone prevented****	36,656
Annual asthma-related accident and emergency department visits avoided****	102,535

Annual hospitalizations avoided**	2,307
Annual losses of wheat, soybean, maize and rice due to ozone exposure (in tons) avoided**	3,716,883
Annual hours of work loss due to extreme heat avoided (million hours)**	10,253

Notes:
** This includes the following countries: (oil) Russia, Saudi Arabia, US, Iraq, Norway; (fossil gas) Russia, Norway, Algeria, Qatar, Nigeria, US*
*** Source: IEA Methane Tracker 2020*
**** Social and environmental benefits of abating methane amount to 2018 US$ 4,300 per tonne of methane, equivalent to 3,644 Euros per tonne of methane or 130 Euros per tonne of CO2 equiv. [Based on estimation of social benefits from CCAC/UNEP 'Global Methane Assessment', May 2021]*
***** Based on estimations of social and environmental benefits from CCAC/UNEP 'Global Methane Assessment', May 2021*

The numbers in tables A.5.5 and A.5.6 are derived from estimations from the IEA Methane Tracker 2020 (https://www.iea.org/reports/methane-tracker-2020), but the basis for the calculations of the shares of emissions at less or equal to low costs and at less than costs equivalent to sum of social benefits are the estimations taken from the Climate Clean Air/United Nations Environment Programme May 2021 report 'Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions'.

The CCAC/UNEP report also highlighted relevant findings related to costs of measures from analysis of a number of global projections of methane emissions reductions which support the IEA projections, as follows:

- There are readily available targeted measures that can reduce 2030 global methane emissions by 30 per cent, around 120 Mt/yr. Nearly half of these technologies are available to the fossil fuel sector in which it is relatively easy to reduce methane at the point of emission and along production/transmission lines.

- Roughly 60 per cent, around 75 Mt/yr, of available targeted measures have low mitigation costs (Less than US$ 600 per tonne of methane reduced, which would correspond to ~US$ 21 per tonne of carbon dioxide equivalent if converted using the IPCC AR5 GWP100 value of 28) and just over 50 per cent of those have negative costs – the measures pay for themselves quickly by saving money. Low-cost abatement potentials range from 60–80 per cent of the total for oil and gas and from 55–98 per cent for coal. The greatest potential for negative cost abatement is in the oil and gas subsector where captured methane adds to revenue instead of being released to the atmosphere.
- Readily available targeted measures could reduce emissions from the oil and gas sector by 29–57 Mt/yr and from the coal sector by 12–25 Mt/yr. Targeted measures in the oil, gas and coal measures include:
    - Upstream and downstream leak detection and repair.
    - Recovery and utilization of vented gas: capture of associated gas from oil wells; blowdown capture; recovery and utilization of vented gas with vapor recovery units and well plungers; Installation of flares.
    - Coal mine methane management: pre-mining degasification and recovery and oxidation of ventilation air methane; flooding abandoned coal mines.
- The largest mitigation potential from oil and gas is in the Middle East, North America and Russia.

Additional findings supportive of both IEA and UNEP/CCAC findings on the low cost of methane mitigation measures in the enegy sector is also available from another recent study (Ocko et al: Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming, 25 January 2021), which highlights the following:

- For oil and gas emissions, we supplement IEA (2017) no cost abatement potential of 45% below present-day emissions with oil and gas company commitments of limiting upstream natural gas leaks to 0.2% of total production levels. This yields an increase in the abatement potential from 50% below 2030 levels to 77%.
- For oil and gas, we supplement the IEA (2017) abatement potential of 75% below current levels with voluntary company commitments of capping upstream leakage. This results in an 83% below 2030 level abatement potential rather than 77% without industry targets.
- Prominent methane mitigation measures in the oil and gas sectors that are specified in at least one assessment of marginal abatement cost curves and maximum technical abatement potentials include: upstream leak detection and replacement∗, replacing pumps∗, replacing with instrument air systems∗, vapour recovery units∗, blowdown capture∗, replace with electric motor, early replace ment of devices, replace

compressor seal or rod, install flares, install plunger, downstream leak detection and replacement (∗ indicates sometimes can be at no net cost);

- Prominent methane mitigation measures in the coal sector that are specified in at least one assessment of marginal abatement cost curves and maximum technical abatement potentials include: pre-mining degasification∗, coal drying∗, flooding abandoned mines∗, ventilation air methane with improved ventilation, open flaring ((∗ indicates sometimes can be at no net cost).

Overview of costs of the preferred option

		Type of costs	***Businesses***	***Administrations***	***Citizens/consumers***
Policy area 1: Improving measuring and reporting of methane emissions in the EU		Costs of abatement	No quantified costs of implementing MRV to companies were available but a survey of the oil and gas industry revealed that these would not be significant	N/A= not applicable	N/A
		Costs of verifying compliance and enforcement	N/A	No quantified costs of verifying compliance and of enforcement were available but competent authorities in the EU are already checking compliance with regulations requiring MRV of methane emissions (ex: E-PRTR) from sub-sectors not covered in the scope of this report and are also reporting and verifying methane emissions in the context of EU GHG	N/A

				inventories, so the extra costs are unlikely to be significant.	
		Impacts on energy prices	N/A	N/A	No quantified impacts on energy prices of implementing MRV were available but given the limited impacts expected on company costs, these would not be significant.
Policy area 2: Mitigation of methane emissions in the EU		Costs of abatement	127 million Euros	N/A	N/A
		Costs of verifying compliance and enforcement	N/A	No quantified costs of verifying compliance and of enforcement were available but the level of quantitative benefits are so significant compared to the costs of the abatement measures to companies, that the difference between the two is expected to more than adequately cover for all such costs.	N/A
		Impacts on energy prices	N/A	N/A	No quantified impacts of the costs of abatement measures on energy prices were available but the costs of the measures (127 million Euros) are insignificant relative to the overall costs to the EU of purchasing oil, fossil (184 billion Euros in

					2020/287 billlion Euros in 2019) gas and coal such that they would be negligible.
Policy area 3: Measuring, reporting and mitigation of methane emissions linked to EU fossil fuel consumption but occurring outside the EU		Costs of abatement	No quantified costs were available of the measures to abate methane emissions occurring abroad but linked to EU consumption of fossil energy. Estimations of the total costs of all abatement measures across a sample of the largest oil and fossil gas exporting countries were used instead as proxy. At social/environmental optimal level of abatement, they amount to 2,216 million Euros.	N/A	N/A
		Costs of verifying compliance and enforcement	N/A	No quantified costs of verifying compliance and of enforcement were available but the level of quantitative benefits across a sample of the largest oil and fossil gas exporting countries to the EU are so significant compared to the costs of the abatement measures to companies, that the difference between the two is expected to more than adequately cover for	

				all such costs.	
		Impacts on energy prices			No quantified impacts of abatement measures on energy prices were available but the level of costs across a sample of the largest oil and fossil exporting countries to the EU are small (2,607 million Euros) relative to the costs to the EU of purchasing oil, fossil gas and coal (184 billion Euros in 2020/287 billlion Euros in 2019) that they would unlikely be significant.

Benefits of options

For policy areas 2 and 3, the estimation of the benefits included in the section on impacts of the policy options are based on the estimations contained in the Climate Clean Air/United Nations Environment Programme May 2021 report 'Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions', as follows:

- The global monetised benefits for all market and non-market impacts are approximately US$ 4,300 per tonne of methane reduced (Monetary values are in 2018 US$), which amounts to 3,644 Euros per tonne of methane or 130 euros per tonne of CO2 equiv. Every million tonne (Mt) of methane reduced:
    - prevents approximately 1 430 annual premature deaths due to ozone globally. Of those, 740 would have died from respiratory disease and 690 from cardiovascular disease.
    - avoids approximately 4,000 asthma-related accident and emergency department visits and 90 hospitalizations per year.
    - avoids losses of 145,000 tonnes of wheat, soybeans, maize and rice ozone exposure every year. This is roughly equivalent to increased global yields of 55 000 tonnes of wheat, 17 000 tonnes of soybeans, 42 000 tonnes of maize, and 31 000 tonnes of rice annually for every million tonnes of methane reduced.
    - avoids the annual loss of roughly 400 million hours of work, approximately 180 000 years, globally due to extreme heat.

Overview of benefits of the preferred options

	Type of benefit	***Amount (if possible, otherwise qualitative statement)***
Policy area 1	Social and environmental impacts	No quantified benefits of implementing MRV for oil, fossil gas and coal were available but other than contributing to improving the quality of methane emissions data, better MRV allows for more targeted action to reduce methane emissions, which will ultimately contribute to greater reductions in such emissions, with all the associated environmental and social benefits.
	Economic impacts	No quantified benefits of implementing MRV for oil, fossil gas and coal were available but other than contributing to improving the quality of methane emissions data, better MRV allows for more targeted action to reduce methane emissions, a large share of which is achievable at high net socio-economic benefits to society (see policy area 2).
Policy area 2	Social and environmental	Additional methane emission reductions (on top of baseline emission reductions) of, respectively, 706, 377 and 317 kilotonnes of methane respectively in 2030, 2040 and 2050.

	impacts	The environmental and social benefits associated with 706 kilotonnes of methane emission reductions include: 1,010 annual premature deaths due to ozone prevented, 2,824 annual asthma-related accident and emergency department visits avoided, 64 annual hospitalizations avoided, 102,370 tonnes of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided, 282 million hours per year of work loss due to extreme heat avoided.
	Economic impacts	The total social and environmental benefits of avoiding 706 kilotonnes of methane emissions is 2,573 Million Euros. Taking into account total costs of measures of 127 million euros, the net socio-economic benefits therefore amount to 2,446 million Euros.
Policy area 3	Social and environmental impacts	No estimations were available of the amount of methane emissions occurring abroad but linked to EU consumption of fossil energy which could be abated at different costs levels. Estimations of methane emissions abatement across a sample of the largest oil and fossil gas exporting countries were used instead as proxy. At social/environmental optimal level of abatement, they amount to 25,513 kilotonnes of methane. The environmental and social benefits ssociated with that level of abatement include 36,656 annual premature deaths due to ozone prevented, 102,535 annual asthma-related accident and emergency department visits avoided, 2,307 annual hospitalizations avoided, 3,716,883 tons of annual losses of wheat, soybean, maize and rice due to ozone exposure avoided; 10,253 million hours per year of work loss due to extreme heat avoided.
	Economic impacts	No estimations were available of the net socio-economic benefits of the abatement of methane emissions occurring abroad but linked to EU consumption of fossil energy. Estimations of methane emissions abatement across a sample of the largest oil and fossil gas exporting countries were used instead as proxy. At social/environmental optimal level of abatement, the net socio-economic benefits amount to 91,475 million Euros.

ANNEX 6: NOTE ON LINKAGES

All “Fit for 55” initiatives, including this one build on the CTP and its underpinning impact assessment, but they also expand CTP analysis looking more in detail of actions in different sectors and creation of necessary enabling conditions. The CTP showed, on the basis of scenarios, that achievement of increased climate target of at least 55% net GHG emissions reduction in 2030 is feasible and enables a smoother trajectory to climate neutrality in 2050. It also highlights the need to step-up reductions in methane emissions. The different initiatives under the “Fit for 55” umbrella have a number of relevant interlinkages with methane emission measurement and mitigation.

1. EFFORT SHARING REGULATION

Under the current Effort Sharing Regulation (ESR), EU Member States have binding annual greenhouse gas emission targets for 2021-2030 for those sectors of the economy that fall outside the scope of the EU Emissions Trading System (EU ETS). These sectors, including transport, buildings, agriculture, non-ETS industry and waste, account for almost 60% of total domestic EU emissions. The ESR covers carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF3) and sulphur hexafluoride (SF6).

The Regulation recognises the different capacities of Member States to take action by differentiating targets according to gross domestic product (GDP) per capita across Member States. This ensures fairness because higher income Member States take on more ambitious targets than lower income Member States. However, an approach for higher income Member States based solely on relative GDP per capita would mean that some would have relatively high costs for reaching their targets. To address this, the targets are adjusted to reflect cost-effectiveness for those Member States with an above average GDP per capita. The resulting 2030 targets range from 0% to -40% compared to 2005 levels.

On 14 July 2021, the European Commission adopted a series of legislative proposals setting out how it intends to achieve climate neutrality in the EU by 2050, including the intermediate target of an at least 55% net reduction in greenhouse gas emissions by 2030. The package proposes to revise several pieces of EU climate legislation, including the ESR. The proposal for the revision of the ESR maintains the current scope, and hence non-distinct inclusion, of methane as well as existing flexibilities under the current Effort Sharing Decision (e.g. banking, borrowing and buying and selling between Member States) and provides two new flexibilities to allow for a fair and cost-efficient achievement of the targets.

This initiative is complimentary to the ESR as it introduces specific measures for the mitigation of methane emissions which will contribute to Member States fulfilling their targets. In addition, specific mitigation measures can not only trigger cost effective mitigation potential in the specific sectors covered by the ESR, they can also contribute to the trading potential in the ESR between Member States.

2. INDUSTRIAL EMISSIONS DIRECTIVE

The Industrial Emissions Directive or IED is the main EU instrument regulating pollutant emissions from industrial installations. It aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT). Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). This permit should contain conditions set in accordance with the principles and provisions of the IED. The IED is based on several pillars, in particular an integrated approach, use of best available techniques, flexibility, inspections and public participation.

The IED is currently undergoing review to enhance the legal framework or find alternative approaches to improve its performance. The options being assessed include the coverage of additional sectors, improvements to implementation, improvements to the Best Available Techniques Reference Document (BREF) process, and access to information, participation in decision making and access to justice, as well as the further exploration of its possible contribution to circular economy objectives and interaction with the decarbonisation of industry.

Methane is included in the IED through its requirement for installations undertaking certain industrial activities to operate in accordance with a permit and conditions which include emission limit values based on best available techniques. However, the scope of the IED excludes all fossil gas upstream mid and downstream (LNG, underground gas storage, transmission, distribution) as well as coal mining/extraction.

This initiative is hence complementary to the IED by addressing methane emissions along the entire fossil energy supply chain.

3. HYDROGEN AND DECARBONISATION OF GAS MARKETS PACKAGE

A fully functioning and interconnected internal energy market is crucial for maintaining security of energy supply, increasing competitiveness and ensuring that all consumers can purchase energy at affordable prices. Europe's cross-border gas networks operate according to rules that regulate who can use them and under what conditions. The Green Deal, the Energy System Integration Strategy and the Hydrogen Strategy all include as a key action the review of the legislative framework for competitive decarbonised gas markets.

For the decarbonisation of the gas system, important considerations relate to (i) setting-up a hydrogen market; and (ii) decarbonising the existing natural gas grid in the context of the wider energy system decarbonisation.

In line with the Hydrogen Strategy, a dedicated network of cross-border hydrogen pipelines is expected to emerge over time, partially from repurposed gas pipelines. The emergence of such a network will also affect methane emissions, as repurposed pipelines will no longer be subject to methane leakage.

As regards decarbonisation of the existing grid, the deployment of biomethane (and synthetic methane) is currently below its potential. The current gas market rules are focusing on fossil methane, imported via high-capacity pipelines with underlying long-term contracts that backed the construction of these pipelines. There is a need for a level playing field for renewable and low carbon gases, ensuring that the tradability and access of renewable and low carbon gases to markets is not limited compared to fossil gas, affecting the business case of renewable and low carbon gases producers and the costs for achieving the EU's climate objectives. Also technical questions like the effects of bio-methane and hydrogen on gas quality and integrated network planning need to be addressed.

Fragmented regulation on methane emissions may pose an additional problem for a fully functioning and integrated internal energy market if it affects the level-playing field between operators and companies across borders.

4. RENEWABLE ENERGY DIRECTIVE

The Renewable Energy Directive II (REDII) is the main EU instrument dealing with the promotion of energy from renewable sources. It was adopted in 2018 and has to be fully implemented by Member States on 1 July 2021. A targeted review is underway to ensure the implementation of the Climate Target plan and other key Commission initiatives such as the Energy System Integration Strategy and the Biodiversity Strategy, while ensuring coherence with the other initiatives under the "Fit for 55" package.

In its current form, the REDII establishes an EU-level binding renewable energy target for 2030 of at least 32 % to be collectively delivered by Member States on the basis of voluntary national contributions, calculated according to an indicative formula included in the Governance Regulation. The national (binding) 2020 targets set in REDI also act as a minimum share of renewables ("baseline") that Member States are obliged to maintain after 2020. REDII also sets an indicative target to increase renewables in the heating and cooling sector, includes a sectorial binding target for transport, strengthens the EU sustainability framework for bioenergy, and includes a number of enabling measures aiming to increase the renewable energy shares in the EU.

To count towards the targets established by REDII, biogas and biomethane need to fulfil a range of sustainability criteria. The REDII contains default GHG savings values which already include estimations of methane losses. These default values can be used by producers in their reporting of GHG savings of their production to demonstrate that they meet RED sustainability requirements and indirectly provide incentives for the reduction of methane emissions.

As they are already addressed by the REDII, biogas and biomethane production is not explicitly dealt with in this initiative.

5. TEN-E

The Regulation on trans-European energy networks (TEN-E) lays down rules for the timely development and interoperability of trans-European energy networks to ensure the functioning of the internal energy market and security of supply in the Union, to promote energy efficiency and energy saving and the development of new and renewable forms of energy, and to promote the interconnection of energy networks. The TEN-E is a policy that is focused on linking the energy infrastructure – electricity, natural and biogas, oil, CO2 – of EU countries. The TEN-E Regulation puts in place a framework for Member States and relevant stakeholders to work together in a regional setting to identify and implement projects of common interest to connect energy networks, connect regions currently isolated from European energy markets, strengthen existing cross-border interconnections, and help integrate renewable energy. As such, the TEN-E is a central instrument in the development of an internal energy market and necessary to achieve the European Green Deal objectives.

In December 2020, the Commission presented a legislative proposal to revise the TEN-E Regulation7 in order to better support the modernisation of Europe's cross-border energy infrastructure and achieve the objectives of the European Green Deal. Europe's progress towards a climate neutral economy powered by clean energy requires new infrastructure adapted to new technologies. The TEN-E policy supports this transformation through projects of common interest (PCIs), which must contribute to the achievement of the EU's emission reduction targets for 2030 and climate neutrality by 2050. The revised Regulation will continue to ensure that new projects respond to market integration, competitiveness and security of supply objectives.

Among others, the Commission's proposal includes:

- an obligation for all projects to meet mandatory sustainability criteria and to follow the ‘do no harm' principle as set out in the Green Deal;
- an update of the infrastructure categories eligible for support through the TEN-E policy, ending support for oil and natural gas infrastructure;
- a new focus on hydrogen infrastructure including transport and certain types of electrolysers;
- new provisions on smart grid investments for integrating clean gases (like biogas and renewable hydrogen) into the existing networks;
- new provisions on support for projects connecting the EU with third countries (Projects of Mutual Interest or PMIs) that demonstrate their mutual benefit and contribution to the Union's overall energy and climate objectives in terms of security of supply and decarbonisation;
- a revised governance framework to enhance the infrastructure planning process and ensure it is aligned with our climate goals and energy system integration principles, through increased stakeholder involvement throughout the process, a reinforced role of the EU Agency for the Cooperation of Energy Regulators (ACER) and improved oversight by the Commission;

Projects to reduce methane leakages are excluded from the scope of the TEN-E revisions, as they would be unlikely to demonstrate cross-border impact. Methane leakage projects consist of retrofits and repairs of different elements of a gas network. They often do not involve capital investments but rather network management and repair methods (more related to operational expenses). Such investments are therefore per definition related to one country’s network and aim at improving the efficiency of the network operation and emission savings but do not aim at increasing cross-border capacity. Therefore, projects specifically aiming at methane leakage reductions do not really fit the intervention logic of the TEN-E Regulation nor under the concept of projects of common interest of a trans-European importance.

6. EUROPEAN POLLUTANT RELEASE AND TRANSFER REGISTER (E-PRTR)

The European Pollutant Release and Transfer Register (E-PRTR)[209] is a Europe-wide register that provides key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland.

The register contains information on releases of pollutants to air, water and land, as well as off-site transfers of pollutants present in waste-water and waste as reported by industrial facilities to their national authorities. The register covers 91 pollutants as listed in Annex II of Regulation (EC) No 166/2006, including greenhouse gases, heavy metals, pesticides, and chlorinated organic substances. Releases are required to be reported when they exceed a certain threshold and originate from one of the 65 activities[210]. The majority of these activities are also regulated under the IED and include facilities in energy production.

Methane emission reporting is included for those facilities. With its focus on individual industrial facilities above a certain size threshold, the E-PRTR is not comprehensive for the energy sector, and this initiative covers those parts of the fossil energy supply chain not included in it.

[209] Established by Regulation (EC) No 166/2006 on the establishment of a European Pollutant Release and Transfer Register

[210] Listed in Annex I of Regulation (EC) No 166/2006

ANNEX 7: METHANE EMISSIONS DATA FROM GREENHOUSE GAS INVENTORIES

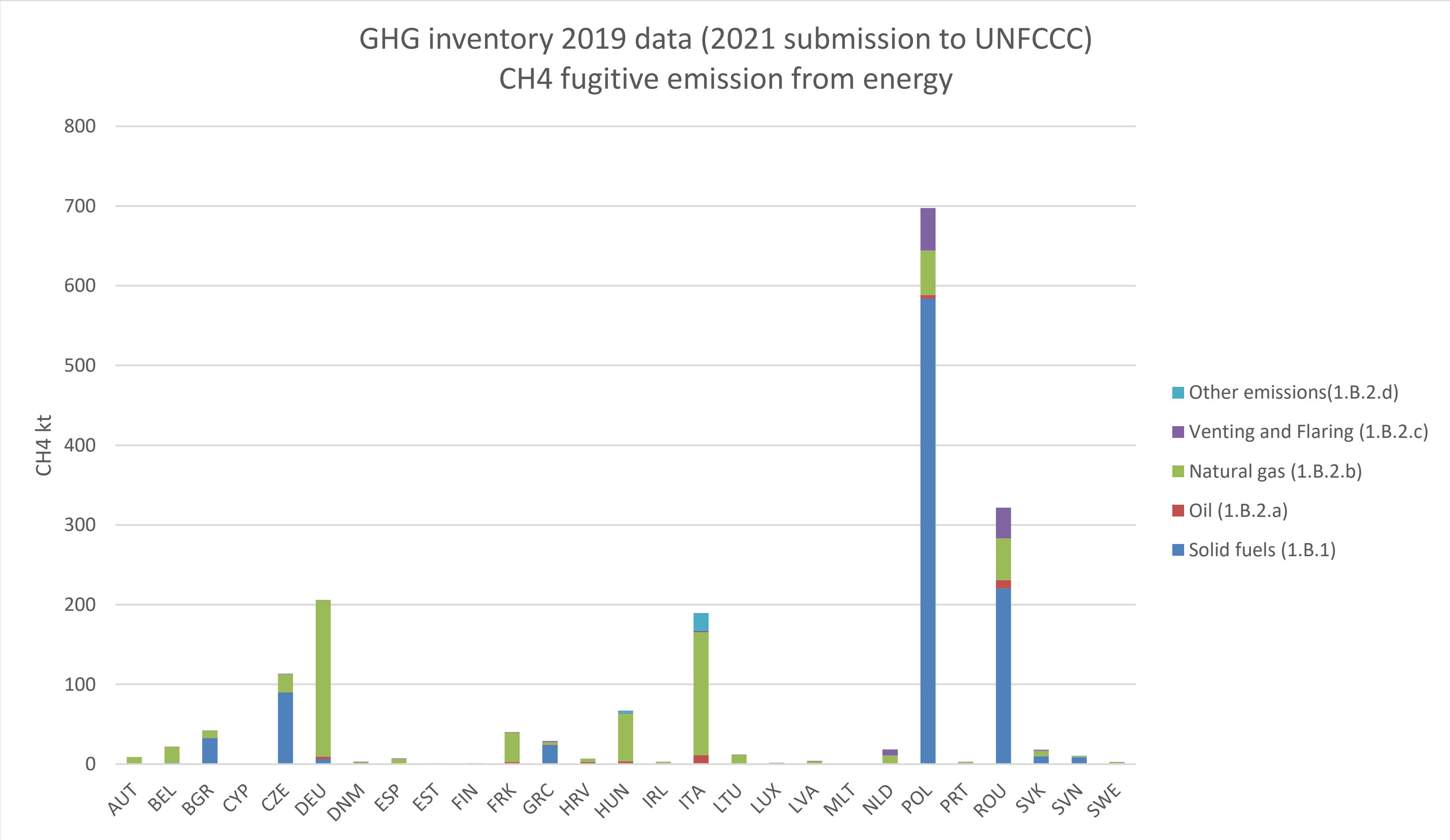
Table A.7.1. Methane emissions for the energy sector in Kt, disaggregated by emission category source, as reported to UNFCC in April 2021 by EEA on behalf of the EU https://unfccc.int/ghg-inventories-annex-i-parties/2021

Category	Sub-category (i)	Sub-category (ii)	Sub-category (iii)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Incomplete fuel combustion				**1299**	**1108**	**947**	**932**	**1059**	**972**	**979**	**998**	**984**	**974**
	Energy Industries			**49**	**63**	**71**	**89**	**125**	**154**	**159**	**162**	**167**	**173**
		Public electricity and heat production		28	41	50	72	105	135	140	142	145	150
		Petroleum refining		4	4	4	4	4	3	3	3	3	3
		Manufacture of solid fuels and other energy industries		17	18	17	13	16	16	16	17	19	20
	Manufacturing industries and construction			**52**	**57**	**69**	**90**	**76**	**80**	**78**	**86**	**91**	**93**
		Of which chemicals		6	8	11	15	10	13	12	15	17	18
		Of which other, incl. plastics		18	20	25	37	31	26	27	28	29	29
	Transport			**271**	**215**	**160**	**113**	**74**	**55**	**54**	**54**	**53**	**54**
	Commercial/instit-utional			**77**	**34**	**30**	**29**	**37**	**27**	**28**	**29**	**31**	**30**
	Residential			**796**	**688**	**576**	**566**	**659**	**574**	**578**	**580**	**557**	**536**
	Agriculture/ forestry/fishing			**42**	**49**	**40**	**42**	**86**	**80**	**80**	**85**	**85**	**88**
	Other			**12**	**2**	**1**	**3**	**2**	**2**	**2**	**2**	**0**	**0**
Direct emissions				**6553**	**5425**	**4183**	**3501**	**2833**	**2505**	**2387**	**2367**	**2260**	**2069**

Category	Sub-category (i)	Sub-category (ii)	Sub-category (iii)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
	Solid fuels			**3900**	**3115**	**2608**	**2031**	**1534**	**1382**	**1273**	**1255**	**1170**	**1002**
		Underground coal mining		3607	2855	2373	1792	1308	1168	1081	1050	975	828
			Mining activities	*2858*	*2075*	*1492*	*1079*	*820*	*753*	*678*	*658*	*594*	*460*
			Post-mining activities	*506*	*391*	*275*	*232*	*177*	*149*	*138*	*126*	*120*	*113*
			Abandoned underground mines	*243*	*389*	*606*	*481*	*311*	*266*	*265*	*266*	*261*	*255*
		Surface coal mining		277	247	224	227	216	205	184	197	187	166
			Mining activities	*263*	*235*	*213*	*216*	*205*	*194*	*174*	*186*	*177*	*157*
			Post-mining activities	*14*	*12*	*11*	*11*	*11*	*11*	*10*	*11*	*10*	*9*
		Solid fuel transformation & other		16	13	11	12	10	9	8	8	8	8
	Oil and natural gas			**2653**	**2310**	**1575**	**1470**	**1299**	**1123**	**1114**	**1112**	**1090**	**1067**
		Oil		272	243	71	65	53	48	44	44	45	44
			Exploration	*20*	*18*	*3*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
			Production and Upgrading	*225*	*203*	*44*	*43*	*34*	*32*	*29*	*29*	*30*	*29*
			Transport	*7*	*7*	*10*	*9*	*6*	*5*				*4*
			Refining / Storage	*20*	*15*	*14*	*13*	*11*	*9*	*9*	*9*	*9*	*9*
		Natural gas		2077	1786	1281	1195	1061	894	890	888	861	847
			Exploration	*4*	*3*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*

Category	Sub-category (i)	Sub-category (ii)	Sub-category (iii)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
			Gas production	*408*	*287*	*75*	*63*	*53*	*46*	*42*	*43*	*40*	*39*
			Gas processing	*55*	*56*	*29*	*24*	*21*	*19*	*18*	*17*	*17*	*16*
			Gas transmission and storage	*269*	*256*	*248*	*258*	*250*	*206*	*209*	*205*	*196*	*191*
			Gas distribution	*1079*	*1020*	*804*	*721*	*634*	*535*	*530*	*530*	*516*	*510*
			Other	*262*	*164*	*124*	*128*	*102*	*87*	*89*	*91*	*90*	*89*
		Venting		242	216	143	122	109	91	84	85	85	80
			Oil	*121*	*108*	*81*	*75*	*60*	*56*	*53*	*56*	*59*	*57*
			Gas	*65*	*52*	*42*	*32*	*34*	*23*	*20*	*18*	*18*	*15*
			Combined	*56*	*56*	*20*	*15*	*15*	*12*	*11*	*11*	*8*	*8*
		Flaring		50	53	66	70	58	68	72	71	73	71
			Oil	*39*	*40*	*53*	*59*	*48*	*60*	*64*	*63*	*65*	*61*
			Gas	*6*	*8*	*9*	*8*	*8*	*7*	*7*	*7*	*7*	*9*
			Combined	*5*	*5*	*4*	*3*	*2*	*1*	*1*	*1*	*1*	*1*
		Other		12	12	14	16	18	22	24	24	26	25
Biogas plants				**0**	**1**	**4**	**11**	**23**	**61**	**66**	**70**	**72**	**75**
TOTAL (Energy)				**7848**	**6534**	**5131**	**4439**	**3912**	**3534**	**3433**	**3437**	**3316**	**3116**

Figure A.7.1. Methane emissions for the energy sector in Kt, per Member States, as reported to UNFCC in April 2021 for 2019



GHG inventory 2019 data (2021 submission to UNFCCC)
CH4 fugitive emission from energy
CH4 kt
800
700
600
500
400
300
200
100
0
AUT
BEL
BGR
CYP
CZE
DEU
DNM
ESP
EST
FIN
FRK
GRC
HRV
HUN
IRL
ITA
LTU
LUX
LVA
MLT
NLD
POL
PRT
ROU
SVK
SVN
SWE
Other emissions(1.B.2.d)
Venting and Flaring (1.B.2.c)
Natural gas (1.B.2.b)
Oil (1.B.2.a)
Solid fuels (1.B.1)

ANNEX 8: DISCARDED OPTION

Option covering biogas/biomethane

Though national inventory data suggest that direct methane emissions from biogas/biomethane are small – only 1.9% of EU energy-related methane emissions – there have been demands from stakeholders to include biogas/biomethane in these proposals, on the basis from some that actual emissions from such plants could amount to much more than what this data suggests (which, for most EU Member States, is delivered on the basis of UNFCCC tier 1 estimations only). It is therefore considered by many stakeholders that measuring, reporting and mitigating of methane emissions from biogas/biomethane plants should be undertaken. In responses to the Open Public Consultation, 67% of responses were supportive of EU regulation obliging biogas/biomethane producers to reduce their fugitive methane emissions.

After some consideration however, we came to the conclusion that this would amount to double regulation, as the Renewable Energy Directive (RED) contains default GHG savings values which already include estimations of methane losses covering the full supply chain up to the point of injection into the distribution network. These default values can be used by producers in their reporting of GHG savings of their production to demonstrate that they meet RED sustainability requirements.

We however considered that the RED could be strengthened in a number of ways. Values of methane losses should be reviewed and updated with the latest estimations of methane losses occurring in biogas/biomethane plants, as the existing estimations were done in 2017. These values should be set at conservative levels (meaning, at higher levels than estimations suggest, in line with common practice in the RED for default values, in order to incentivise delivery of actual values) and should then be included explicitly in annex VI of the RED alongside the other, global, default values. In order to incentivise producers to conduct leakage detection, repair and reporting of actual measurements of methane losses to demonstrate better performance, a methodology for measuring actual values tailored to biogas/biomethane plants should also be developed, and could then be included via existing provisions to modify annex VI of the Directive. This proposal was included in the questionnaire of the OPC and was supported by respondents:

- 68% of responses in support of the proposal to regulate such emissions in the RED by explicitly including default values for processing methane leakages at conservative levels to incentivise mitigation and the delivery of lower actual values.
- 65% of responses in support to develop a methodology to estimate actual values of methane losses in biogas/biomethane plants, and to be included as part of sustainability compliance in the RED.

The technical work required is already the subject of an Administrative Arrangement with the JRC, with the aim to deliver proposals during the course of 2022.

Note that for methane losses from biomethane or any other renewable gasses occurring from the point of injection into the distribution network, these will be fully within the scope of these proposals as the obligation on transporters or distributors of methane will not distinguish between the various sources of methane.