BRIEFING

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The climate risk of allowing feed crops in an EU biomethane target

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The European Commission released the RePowerEU strategy in March 2022 for the purpose of reducing Europe's reliance on Russian natural gas. The strategy includes an EU-wide biomethane production goal of 35 billion cubic meters (bcm) in 2030, which could represent nearly 20% of gas demand in the EU.[1] Earlier this year, the European Parliament voted to include this target in amendments to the Proposal for a Regulation on the Internal Markets for Renewable and Natural Gases and for Hydrogen (recast), referred to here as the Gas Regulation.[2]

While the intention of a biomethane target is ostensibly to help reduce EU natural gas imports and decarbonize the gas sector, it may in fact pose major climate and sustainability risks if poorly implemented. Without specifying the types of materials, or feedstocks, that can be used to produce the biomethane used to meet the target, policymakers risk incentivizing the use of food crops for compliance. As with liquid biofuels, biomethane can only help meaningfully decarbonize the European gas sector if produced primarily from sustainable feedstocks that generate high greenhouse gas (GHG) savings relative to fossil gas and are not used for food or livestock feed.

In this paper, we explain the risks associated with biomethane produced from food and feed materials. We then identify how Annex IX of the RED II could be referenced to ensure biomethane does not disrupt food markets and unintentionally increase GHG emissions from the gas sector. We also summarize the findings from two recent ICCT

1 European Commission Directorate General for Energy, "EU reference scenario 2020," (Accessed 13 September 2023), https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en

2 European Parliament Committee on Industry, Research and Energy, "Report on the proposal for a regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen (recast) [Report-A9-0032/2023]," February 16, 2023, https://www.europarl.europa.eu/doceo/document/A-9-2023-0032_EN.html#_section1

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studies on the cost and GHG impact of low-GHG biomethane pathways that do not disrupt food and feed markets and conclude with a set of policy recommendations.

BIOMETHANE PRODUCED FROM SILAGE MAIZE

A significant proportion of biogas, the precursor to biomethane, is produced from silage maize in Europe.[3] When dedicated cropland is used to produce feedstocks for biomethane production instead of for human food or animal feed, it diverts land from supplying those existing markets. That demand does not disappear, and can drive land conversion elsewhere, thus generating indirect land-use change (ILUC) emissions. Put differently, food and feed crops are global commodities; bioenergy policy drives up their price by increasing demand, which in turn brings more land into production. As existing cropland is utilized for biofuel production in response to policy targets, it creates pressure for land expansion in other locations to meet the displaced demand for food and feed.

Due to the ILUC emissions attributable to their demand, biomethane produced from silage maize and other food and feed materials does not provide the deep GHG emissions reductions needed to decarbonize the European gas sector. Figure 1 illustrates the life cycle GHG emissions of several biomethane production pathways, obtained from a previous ICCT study.[4] The GHG emissions of petroleum fuel (94 gCO_2e/MJ) is represented by the dashed line in the figure. Due to variations in factors impacting these life-cycle emissions,[5] illustrated by the error bars in the figure, the combustion of silage maize could release as much emissions as fossil fuel in a worst-case scenario. Implementing a 35 bcm biomethane target might also require fiscal support at the EU level or from individual Member States. Assuming biomethane from silage maize costs on average €1.19 per m^3 to produce and natural gas cost remains as high as in 2022 (€0.68 per m^3), governments could spend €18 billion to bring biomethane, an alternative energy that in some cases is no better than fossil fuel, to cost parity with fossil gas in order to meet the target.[6]

3 International Energy Agency, "Outlook for biogas and biomethane: Prospects for organic growth," (2020), https://www.oecd-ilibrary.org/energy/outlook-for-biogas-and-biomethane_040c8cd2-en

4 Yuanrong Zhou, Diana Swidler, Stephanie Searle, Chelsea Baldino, "Life-cycle greenhouse gas emissions of biomethane and hydrogen pathways in the European Union," (Washington, DC: ICCT, 2021), https://theicct.org/publication/life-cycle-greenhouse-gas-emissions-of-biomethane-and-hydrogen-pathways-in-the-european-union/

5 See Table 2 in Zhou, Swidler, Searle, and Baldino, "Life-cycle greenhouse gas emissions of biomethane and hydrogen pathways in the European Union."

6 We retrieve the current cost of biomethane production of 19 to 49 USD per MMBTU from Dagmar Nelissen, Japer Faber, Reinier van der Veen, Anouk van Grinsven, Hary Shanthi, and Emiel van den Toorn, "Availability and costs of liquefied bio- and synthetic methane: The maritime shipping perspective," (CE Delft, 2020), https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_190236_Availability_and_costs_of_liquefied_bio-_and_synthetic_methane_Def.pdf. We convert this cost into 2022 prices using an inflation calculator (https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=34&year1=202001&year2=202201). To calculate the subsidy needed to meet a 35 bcm target, we assume a natural gas price (without taxes) of 0.68 euros per cubic meter, the 2022 average, which we retrieve from Eurostat, "Gas prices for non-household consumers- bi-annual data (from 2007 onwards)," (2023), https://ec.europa.eu/eurostat/databrowser/view/NRG_PC_203/default/table?lang=en.

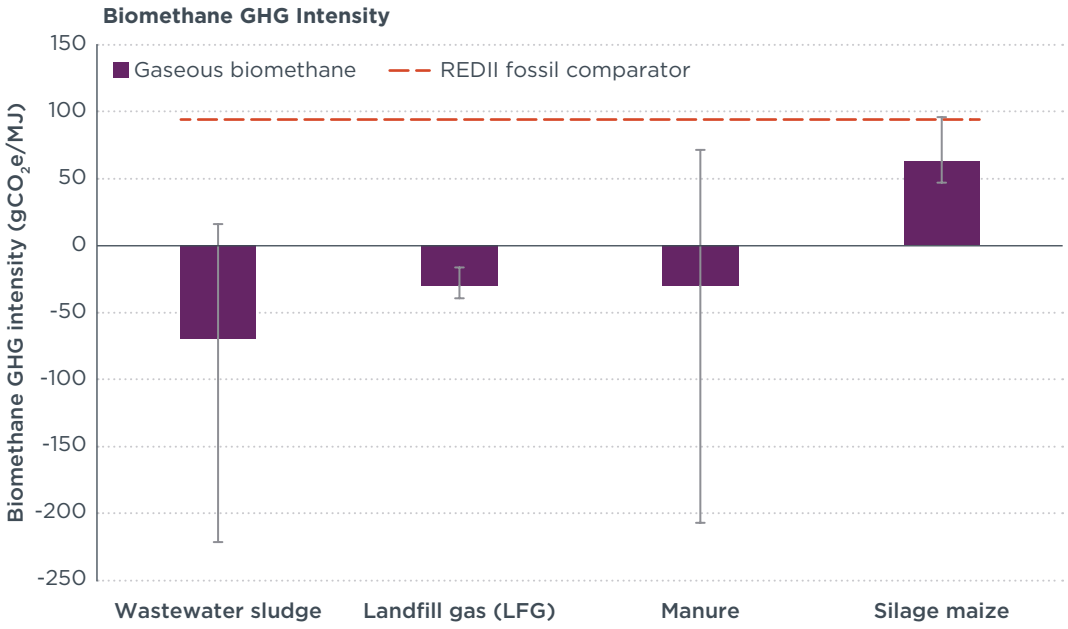

Figure 1. Life-cycle greenhouse gas intensities of biomethane pathways using 100-year global warming potential. Error bars represent key parameters influencing the life-cycle emissions of each pathway.

Methane leakage, one of the factors influencing the error bars in Figure 1, also has the potential to undermine biomethane's climate benefits, as methane is a strong climate forcer. A previous ICCT literature review found that methane leakage from anaerobic digesters can be as high as 10%, and leakage during biogas upgrading to biomethane can be as high as 5%.[7] These high leakage rates can lead to significant GHG emissions from biomethane. Particularly for pathways with marginal GHG savings, such as silage maize biomethane, the impact of methane leakage across the supply chain can further reduce the benefits of producing this fuel.

In addition to inducing climate impacts, food prices also directly impact human nutrition. This is particularly the case in regions like the Global South, where a higher proportion of household income is spent on raw food commodities.[8] Maize is an important food crop in sub-Saharan Africa, Latin America, and some Asian countries, where it represents over 20% of food calories.[9] Maize is currently the second most widely produced crop after wheat, and its global production is expected to surpass wheat production by 2030.[10] Since 1995, maize production has more than doubled, with half of that growth due to increases in yield and half to expansion of land cultivation.[11]

Silage maize is typically grown in the EU due to the shorter growing season and wetter climate in north-western Europe. Since maize is harvested unripe and is

7 "Life-cycle greenhouse gas emissions of biomethane and hydrogen pathways in the European Union"

8 USDA Economic Research Service, "Percent of Consumer Expenditures Spent on Food, Alcoholic Beverages, and Tobacco That Were Consumed at Home, by Selected Countries," (2019), https://www.ers.usda.gov/ media/10271/2013-2018-food-spending_update-april-2019.xls.

9 Bekele Shiferaw, Boddupalli Prasanna, Jonathan Hellin, Marianne Baenziger, "Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security," *Food Security*, vol. 3, (23 August 2011), https://link.springer.com/article/10.1007/s12571-011-0140-5

10 Olaf Erenstein, Jordan Chamberlain, and Kai Sonder, "Estimating the global number and distribution of maize and wheat farms," *Global Food Security*, vol. 30, (September 2021), https://doi.org/10.1016/j.gfs.2021.100558

11 Olaf Erenstein, Moti Jaleta, Kai Sonder, Khondoker Mottaleb, B.M. Prasanna, "Global maize production, consumption and trade: trends and R&D implications," *Food Security*, vol. 14 (17 May 2022), https://link.springer.com/article/10.1007/s12571-022-01288-7

therefore not fit for human consumption, it is typically used in animal feed.[12] Silage maize represents 45% of EU feed along with other roughage sources like grass.[13] It is important feed material for cattle because of its energy content and easy digestibility, and it is known to increase the milk production of dairy cows.[14] As developing economies continue to grow and livestock numbers increase, so will demand for silage maize for animal feed. Market analysts project that by 2032, the global silage maize market will grow by 7.1%.[15]

SAFEGUARDS FOR AN EU BIOMETHANE TARGET

In recognition of the climate and food security issues associated with including food and feed feedstocks in bioenergy policies, the European Commission issued a communication document, *Safeguarding food security and reinforcing the resilience of food systems*, in March 2022.[16] The document called on Member States to reduce food and feed-based biofuel blending to relieve pressure on the markets for food and feed commodities. However, the proposed 35 bcm biomethane target in the Gas Regulation could promote the use of these feedstocks if eligibility criteria are not clarified.

To avoid incentivizing the use of food and feed crops, policymakers could reference the Renewable Energy Directive (the current RED II or recently revised RED III) in the biomethane target, but they would need to be precise about how they referenced the eligibility criteria within the Directive. Biomethane may be used to meet RED III targets if it meets the 50%–80% GHG reduction requirements found in Article 29, which vary depending on the sector the biomethane is used in and the date the production facility goes into operation.[17] However, because ILUC is not accounted for in the RED II's GHG methodology, it is possible for biomethane produced from silage maize to meet these requirements. In recognition of ILUC, the Commission decided to limit the contribution of food- and feed-based fuels (both gaseous and liquid) in transportation in Article 26, capping them at a maximum of 7% of transport energy. However, other sectors, such as heating and power, do not have this safeguard.

The solution to ensure only low-GHG biomethane feedstocks would be allowed in a biomethane target would be to reference the low-GHG feedstocks found in the RED II's (and by reference, the RED III's) Annex IX. Feedstocks not included in Annex IX may pose sustainability risks or have high indirect emissions caused by displacing them from their existing uses. The European Commission recently proposed to expand the list of eligible feedstocks, and there is a legislative process in place to ensure that the Annex is regularly reviewed and any missing low-GHG, low-risk feedstocks are added. There is already policy precedence to allow only Annex IX feedstocks to count towards a biofuels policy; the European Commission's initial ReFuelEU proposal for mandatory SAF targets allowed only Annex IX feedstocks, which highlights that the only biological feedstocks suitable for decarbonization, whether for liquid or gaseous fuel, are found in this Annex.[18]

12 Patrick Ruedelsheim and Greet Smets, "Baseline information on agricultural practices in the EU Maize (*Zea mays* L.)," (Perseus, 2011), https://www.yumpu.com/en/document/read/19573992/baseline-information-on-agricultural-practices-in-the-eu-europabio

13 Chris Lyddon, "EU feed sector facing many challenges," *World-Grain.com*, April 9, 2020, The https://www.world-grain.com/articles/14191-eu-feed-sector-facing-many-challenges

14 Nandini Choudhury, "Corn Silage Market Outlook (2022-2032)," Future Market Insights, Accessed on November 1, 2023, https://www.futuremarketinsights.com/reports/corn-silage-market

15 Ibid.

16 European Commission, "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: Safeguarding food security and reinforcing the resilience of food systems," 2022, https://agriculture.ec.europa.eu/system/files/2022-03/safeguarding-food-security-reinforcing-resilience-food-systems_0.pdf

17 The fossil comparator also varies depending on the end use sector (found in Annex VI).

18 European Commission, "Proposal for a regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport," (Brussels, July 14, 2021), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0561

Proponents of a biomethane target in the EU argue that growing silage maize as an intermediate crop outside the primary growing season would help to avoid ILUC. In Europe, intermediate crops are usually grown for ecologically beneficial reasons, such as increasing soil carbon and reducing erosion.[19] In other regions, and particularly in climates with extended growing seasons, intermediate crops are often grown as food and feed cash crops. For example, maize is a cash crop in Brazil typically grown as an intermediate crop.[20] Unlike in the EU, in Brazil these types of secondary crops are already well-integrated into global food and feed markets; growing them for biogas would necessarily result in similar land use impacts as using primary crops for biofuel. Furthermore, large volumes of intermediate crop biogas could be produced from such cash crops and could potentially overwhelm any biomethane target.

Referencing Annex IX feedstocks in a biomethane target could still provide a means to allow silage maize as an intermediate crop, while creating an important safeguard to ensure that its inclusion does not generate additional demand for cropland. Specifically, the European Commission recently proposed to include intermediate crops in Annex IX, part B, stating: [21]

> *Intermediate crops, such as catch crops and cover crops that are grown in areas* ***where due to a short vegetation period the production of food and feed crops is limited to one harvest*** *and provided their use does not trigger demand for additional land and provided the soil organic matter content is maintained.*

The bolded text would exclude intermediate crops grown in regions such as Brazil from counting towards the Annex IX definition because the climate in those regions easily allows multiple harvests in a year. It is possible most or all of the EU could be considered an area where there is a short vegetation period limited to one harvest due to its climate. Data on the current amount of cover cropping is scarce, but a recent JRC mapping study suggests that most of the European continent does not produce intermediate crops.[22] This would mean it is possible any intermediate crops grown in the EU could qualify towards the definition in Annex IX, B. However, this would require a change in how silage maize is typically grown; EU farmers surveyed in Spain, France, Romania, and the Netherlands grow silage maize in the primary growing season.[23] Further, in the RED II, Annex IX, B feedstocks are capped at 1.7% of transport energy. Thus, while intermediate crops from the EU are low-risk and therefore low-GHG, policymakers could introduce a similar cap on the contribution of these feedstocks in the EU biomethane target as an additional safeguard. This would reduce the risk of any unintended land use change emissions associated with these feedstocks.

19 Sebastien Haye, et al, "Assessment of the potential for new feedstocks for the production of advanced biofuels," (E4Tech, ICCT, Cerulogy, Wageningen University, Navigant, SCS Global, 2022), https://op.europa.eu/en/publication-detail/-/publication/ec9c1003-76a7-11ed-9887-01aa75ed71a1/language-en

20 Chris Malins, "Multiple and cover cropping in Brazil: Status and opportunities for biofuel production," (London: Cerulogy, 2022), https://theicct.org/publication/bio-fuels-production-brazil-jan22/

21 European Commission, "Annex to the Commission Delegated Directive amending Annex IX to Directive (EU) 2018/2001 of the European Parliament and of the Council, as regards adding feedstocks for the production of biofuels and biogas [draft]" (2022), https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13484-Biofuels-updated-list-of-sustainable-biofuel-feedstocks_en

22 Arthur Fendrich, Francis Matthews, Elise Van Eynde, Marco Carozzi, Zheyuan Li, Raphael D'Andrimont, Emanuele Lugato, Philippe Martin, Philippe Ciais, and Panos Panagos, "From regional to parcel scale: a high-resolution map of cover crops across Europe combining satellite data with statistical surveys," *Science of the total environment*, 873, (2023), https://publications.jrc.ec.europa.eu/repository/handle/JRC131295

23 Bert Smit, Bas Janssens, Wiepie Haagsma, Wil Hennen, Jose Luis Adrados, and Jonas Kathage, "Adoption of cover crops from climate change mitigation in the EU," (European Commission Joint Research Centre, 2019), https://data.europa.eu/doi/10.2760/638382

THE POTENTIAL AND COST OF LOW-GHG BIOMETHANE IN THE EU

A 2022 ICCT study estimated the potential for low-GHG biomethane in the EU-27 in 2030 from the feedstocks not associated with land use change emissions, i.e. the waste and residue feedstocks in the RED II's Annex IX, A.[24] The technical potential for producing biomethane from waste and residue feedstocks, which we show in Figure 2, does not consider costs. This analysis was based on a 2021 ICCT study on the sustainable availability of forestry and agricultural residues in individual European member states.[25] In this 2021 assessment, we considered the amount of feedstock needed to maintain soil quality and biodiversity in forests and on farms. We also considered any current and projected use of the feedstocks. An additional consideration when assessing a biomethane target in the EU is that many of these same limited waste and residue feedstocks will be needed to meet the ambition for sustainable aviation fuel in the recently finalized ReFuelEU aviation regulation. In the 2022 estimate of the potential for low-GHG biomethane in the EU, we subtracted the feedstocks needed to meet the sustainable aviation fuel targets in 2030.

We also illustrate a potential of biomethane from the 2022 study that is cost dependent in Figure 2. Most waste and residue biomethane will be too expensive to produce, even with high subsidies. With a feed-in tariff of 1.79 euros for grid-injected biomethane, which is double the average in France,[26,] only around 14 bcm of biomethane could be produced (Figure 2). For comparison, the average EU wholesale natural gas price was 0.68 euros per m^3 (19 euros per GJ) in 2022.[27] This volume is approximately 40% lower than the total technical potential. This is due mainly to the fact that the production, conversion, and compression of biogas from livestock manure is costly, and there is currently a lack of natural gas infrastructure near rural farms. A 2018 ICCT study demonstrated that it is much more economical to utilize energy from livestock manure biogas by combusting it on-site at the farm than cleaning and compressing it for injection into the grid.[28]

24 Bryan Comer, Jane O'Malley, Liudmila Osipova, and Nikita Pavlenko, "Comparing the future demand for, supply of, and life-cycle emissions from bio, synthetic and fossil LNG marine fuels in the European Union," (Washington, DC: ICCT, 2022), https://theicct.org/publication/lng-marine-fuel-sep22/

25 Camilla Carraro, Stephanie Searle, and Chelsea Baldino, "Waste and residue availability for advanced biofuel production in the European Union and the United Kingdom," (Berlin: ICCT, 2021), https://theicct.org/publication/waste-and-residue-availability-for-advanced-biofuel-production-in-the-european-union-and-the-united-kingdom/

26 Alexander Eden, "Bio-Methane Support Policy in France [For Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU)]," (Ecofys and Adelphi: 2018), https://www.euki.de/wp-content/uploads/2018/09/fact-sheet-bio-methane-support-policy-fr.pdf

27 Eurostat, "Energy statistics- main indicators," Accessed June 2023, https://ec.europa.eu/eurostat/data/database

28 Chelsea Baldino, Nikita Pavlenko, and Stephanie Searle, "The potential for low-carbon renewable methane in heating, power, and transport in the European Union," (Berlin: ICCT, 2018), https://theicct.org/wp-content/uploads/2021/06/Renewable_Gas_EU-28_20181016.pdf

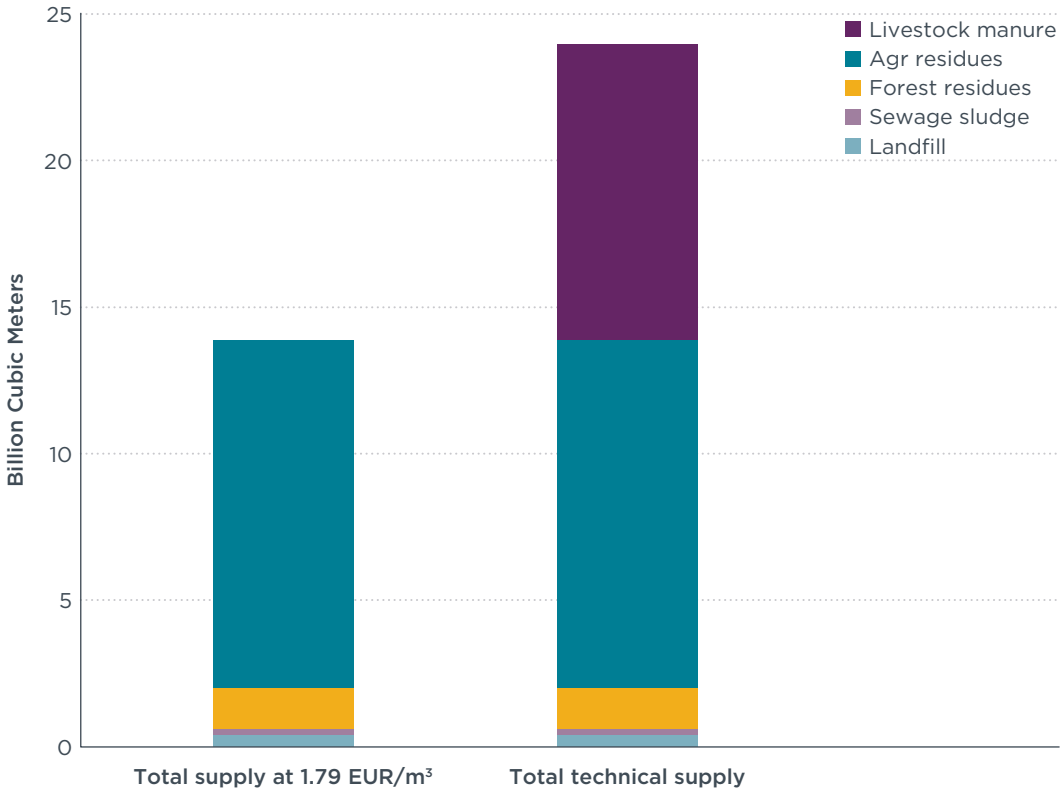

Figure 2. Total technical potential and economically viable potential of low-GHG biomethane with 1.79 euros per m^3 subsidy (50 euros per GJ) in 2030.

POLICY RECOMMENDATIONS

We make the following recommendations based on the conclusions in this study:

- **Referencing the RED II sustainability criteria alone, and in particular the GHG reduction criteria in Article 29, would not be enough to ensure unsustainable feedstocks are not used to meet a biomethane target in the EU.** This is because silage maize, which is associated with significant ILUC emissions, qualifies towards the RED II sustainability criteria.
- **Limiting a biomethane target to only those feedstocks in Annex IX in the RED II could ensure only low-GHG biomethane is incentivized in the EU.** There is policy precedence for referencing only Annex IX feedstocks in the European Commission's ReFuelEU aviation regulation. Were intermediate crops to be included in the Annex IX expansion, such a measure could allow biomethane produced from intermediate crops from most, if not all of Europe, to count towards a target, while ensuring maize grown in other regions as a cash crop would be ineligible.
- **A target of less than 35 bcm would better align with the amount of biomethane that could feasibly be produced from Annex IX feedstocks in Europe**. If subsidies of 1.79 euros were provided per cubic meter of biomethane produced, a target of 14 bcm could be achieved.