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BRIEFING

The 35 bcm biomethane target

At best unattainable, at worst an environmental disaster

Feedback EU's analysis[1] **of the feedstock assumptions underlying the 35 billion cubic meter biomethane**[2] **target shows that at best it will be simply impossible to reach this target. At worst, strong policy support for the target will lock in dangerously unsustainable agricultural, land use and energy practices.** We acknowledge that there is a niche role for anaerobic digestion of unavoidable organic waste streams, but the volume of biomethane produced will need to be much smaller than envisaged by the gas industry to avoid negative impacts on food security, the environment and the climate.

The proposed Gas Regulation[3] lays down that Member States shall ensure that by 2030 at least 35 billion cubic meters (bcm) of sustainable biomethane is produced and injected into the natural gas system, with the aim of safeguarding the security of the EU's gas supply and decreasing dependence on fossil fuel gas imports. In terms of the evidence base for this target, the proposed Gas Regulation refers to a 2021 study *"Assistance to assessing options improving market conditions for biomethane and gas market rules"* by experts and the European Commission's Joint Research Centre (JRC). This **EC Assessment concluded that around 24 bcm (259 TWh) of biomethane could be produced sustainably by 2030**[4].

The proposed Gas Regulation relies on the assumption that the gas infrastructure and gas market development measures set out in the RepowerEU action plan[5] will smooth the way to increase this figure to 35 bcm. However, it appears that the only detailed feedstock analysis behind the actual 35bcm figure was carried out by the gas industry group "Gas for Climate"[6] in its "Feasibility of RePowerEU"[7] report (GfC report). The RePowerEU action plan lists a set of criteria aimed at avoiding negative impacts on food security or land use but does not detail any evidence regarding feedstock volumes which would substantiate the 35bcm goal. EU member state governments also were briefed by the biogas and oil and gas industry experts on the target at a workshop organized by the International Energy Agency[8], but as far as we were able to ascertain there were no sustainable food system or agriculture experts presenting at this event.

Overarching policy recommendations

- Abandon the target of 35 billion cubic meters of biomethane by 2030, and
- Given that the only detailed analysis of the feedstocks needed to meet the 35bcm target has been performed by the energy sector and the gas industry itself - replace the target with a much lower, evidence-based target developed in conjunction with sustainable food system experts so that it can meet the RePower EU ambition of avoiding impact on food security and unsustainable land use.[9]
- For more detailed recommendations, see the section after the feedstock analysis table

A note on **methane leakage**: a recent meta-analysis of 51 previous studies[10] has found that methane emissions from the biogas supply chain are twice as big as estimated by the International Energy Agency (IEA). This means that **currently the amount of methane released relative *to total biogas production* is higher than for fossil gas**. In other words, on average one unit of biogas is more polluting than one unit of fossil gas, unless methane leakage is controlled much more tightly.

Feedstock Analysis

The table below identifies the main feedstocks[11] considered for biomethane production in the EU and provides our overall assessment of the sustainability credentials of each feedstock at the volumes proposed in the GfC report. **Our conclusion is that, from a sustainable land use or food security perspective, most of these feedstocks are either unsuitable for biomethane production and/or insufficiently available to achieve the 35 bcm target set out in the current legislative proposal**.

The traffic lights illustrate our overall assessment of the sustainability credentials of each feedstock at the volumes proposed in the GfC report.

RED	This feedstock type is either unsustainable altogether, or we are extremely concerned about the environmental impact if the feedstock is to be provided at the proposed volumes.
YELLOW	There are discrepancies between current volumes, the GfC report and the JRC assessment, or, different fractions of the feedstock have different sustainability outcomes.
GREEN	Overall the sustainability outcome of the feedstock is positive.

The percentage[12] next to the traffic light indicates the proportion of the total 35bcm target that each feedstock is expected to supply according to the GfC report.

Energy crops

0%

Acknowledging energy crops' significant negative impact on food security and the environment – as highlighted in the RePowerEU plan – the gas industry's GfC report excludes energy crops from its 2030 feedstock projections. However, energy crops provide over 40% of biogas feedstock currently[13] and it is not clear how the biogas industry proposes to phase out of this feedstock completely by 2030.

Agricultural residues

24%

The GfC report estimates that around 9 bcm will come from agricultural residues by 2030[14]. However, an earlier GfC study put the figure at only 5 bcm of biomethane by 2050[15]. In its most sustainable scenario, the EC Assessment states that it expects less straw to be available than the earlier GfC projection of 5bcm due to uncertainties around the impact of excessive straw removal on soil health[16]. In short, **the agricultural residues needed to achieve the 35bcm target are based on a study by the industry projecting nearly twice as much availability as the 2021 assessment by the EC JRC.[17]**

Manure

Treating manure via anaerobic digestion (AD) can help mitigate manure-related GHG emissions and produce digestate to replace chemical fertiliser. However, **inaccurate projections of manure volumes risk severely undermining** these **potential benefits**:

32%

- In contrast to the GfC report, the **EC assessment** assumes all manure goes to biogas (which is easier to produce at small-scale locally, given no biomethane upgrading technology is needed) and does **not consider manure in its biomethane calculations[18]** due to spatial and infrastructure constraints[19].
- By assuming no change in meat and dairy consumption patterns[20], the EC assessment and the GfC report ignore the broad scientific consensus on the health and climate benefits of reduced meat production and consumption[21]. Lower livestock production would constrain manure availability for biomethane production.
- A further 2022 study by the JRC[22] concludes that better manure management is **not** sufficient to address the nitrogen issue … "**dietary change is a pre-condition for achieving the substantial reduction of nitrogen needed in EU agriculture**." Basing biomethane targets on current livestock production volumes[23] will lock in an agricultural system unable to meet the Nitrates Directive or the Farm-to-Fork nutrient waste reductions.
- Promoting the use of manure for biogas and biomethane production risks sustaining or even increasing the scale of livestock production, driving an overall increase in emissions (see annex 2).

Sequential cropping

(see annex 1 for an explanation of this practice)

21%

The **EC assessment excludes sequential crops from its most sustainable scenario citing uncertainties around the sustainability of the practice[24].**

- A study by the French government[25] warns that **a late harvest of the sequential crop can result in a 10 to 15% yield reduction of the primary crop.** It is **not clear how governments will monitor the risk of such indirect impact on food security and land use, nor how they will ensure that sequential crops grown for biomethane production do not displace crops that can be grown to maturity** (for instance as a result of warmer winters).
- The gas industry projections for sequential cropping are based on one theoretical study[26] assuming the mono-digestion of these crops. In practice, AD plants usually co-digest different feedstocks together to avoid performance and technical issues[27]. The **GfC report offers no spatial analysis of where different feedstocks can be supplied together for an efficient AD process**.
- Sequential cropping remains largely untested in Europe, except in Italy and France[28]. Cited case studies are based on livestock farms where the sequential crop is co-digested with manure[29]. This means that the digestate returned to the soil contains additional nutrients imported through animal feed (e.g. if chicken manure is used, these chickens may have been fed on imported soya[30]). **Analysis is needed on the impact on soil health if only a poorer digestate from mono-digested sequential crops is returned to the soil.**

Industrial wastewaters

9%

Pre-treating wastewaters heavily loaded with organic matter via anaerobic digestion reduces the need for energy intensive conventional treatment. However, half of the wastewaters for AD are expected to come from biodiesel production[31] when according to the IEA, there is a biodiesel feedstock supply crunch[32]. Europe already burns nearly 19 million bottles of rapeseed and sunflower cooking oil every single day[33]. As demand for used cooking oil outstrips supply, consumption of vegetable oil for biofuel production is expected to increase by 46% to 54 million tonnes by 2027[34]. **4.5% of the 2030 biomethane feedstock is based on an industry which is a major driver of food-feed-fuel competition.**

Permanent grassland

5%[35]

Permanent grassland. From a climate perspective, biomethane from grass feedstock does not measure up to other uses of this land. **Compared with grass-biomethane transport fuel, solar electricity generation can avoid 16 times more fossil energy and afforestation can mitigate 6 times more GHG per hectare of land occupied**[36]. Mowing grasslands just once or twice per year can optimise species richness[37], however, we were unable to ascertain the number of times grassland would be mown in the GfC projection[38].

Biowaste / Food waste

5%

The GfC[39] report takes account of the Circular Economy Package recycling ambitions regarding municipal waste. However, there seems to be **no mention of the EC's food waste reduction targets**[40]. While AD can recycle unavoidable food waste no longer fit for human or animal consumption, **preventing food waste at source saves nine times more emissions than sending it to AD** and 40 times more if the land saved is used for reforestation[41]. Sending food waste to animal feed saves on average 3 times more emissions than sending it to AD. Policy needs to ensure that food waste prevention followed by animal feed, are financially and logistically more attractive to those producing food waste. If not, incentivising food waste-based AD risks disincentivizing the prevention of food waste.

Sewage sludge

2%

Recent research confirms that AD is the best option for the treatment of sewage sludge[42], although digestate from this feedstock needs to be handled with caution due to the risk of freshwater ecotoxicity because of heavy metal concentrations in the digestate[43]. The GfC report assumes that, by 2030, 100% of sewage treatment plants will apply AD.

Biomass from marginal or contaminated lands

0%

Research around this feedstock has been carried out in various H2020-funded projects. Strong criteria must be developed to ensure that no food or feed crops can be grown on lands deemed "marginal", and independent life cycle assessments must be done to ascertain the most effective climate mitigation strategies for this land (reforestation, rewilding, biomass production or other). The GfC report decided not to include this feedstock in its projection, citing a lack of data.

Policy recommendations

1. **Abandon the target of 35 billion cubic meters by 2030** and **replace this target with a much lower, evidence-based target developed in conjunction with sustainable food system experts[44].**
2. **Methane leakage:** To ensure that biomethane emits less greenhouse gases than conventional fossil gas, it is crucial that the Gas Regulation legislates for continuous emissions measurement and enforcement of greenhouse gas emission prevention (methane leakage) along the whole biomethane supply chain.
3. **Agricultural plant biomass** (45% of 35bcm target): explicitly prohibit the use of energy crops and commission independent agricultural and food system expert assessment to determine at which volumes agricultural residues and sequential crops can be produced without directly, or indirectly, impacting food security or land use - for instance through reducing the yield of the primary food crop[45].
4. **Manure** (32% of 35bcm target): Significantly reduce any livestock production related feedstock targets (manure, meat and dairy industry waste waters) so that biomethane feedstock demand for manure does not undermine overall climate mitigation, nitrogen waste[46] and population health objectives. To ascertain sustainable volumes of manure, commission an independent multi-disciplinary expert team so that all livestock-related scientific knowledge is considered. Given the broad scientific consensus on these issues, an expert team can do this within a short timeframe.
5. **Food waste** (5% of 35bcm target): ensure that demand for food waste feedstock does not undermine the EC food waste reduction targets, or the Sustainable Development Goal of 50% food waste reduction by 2030, by ensuring that food waste reduction at source is prioritized in policy and financial incentives. Ensure that incentives for biogas and biomethane do not indirectly or directly reduce food waste reduction efforts.
6. **Data transparency**: Make complete, fully disaggregated, and transparent data sharing compulsory for the biogas and gas industries – possibly via Eurostat - so that policy makers, scientists and civil society actors can monitor the industry's environmental impacts, both positive and negative.

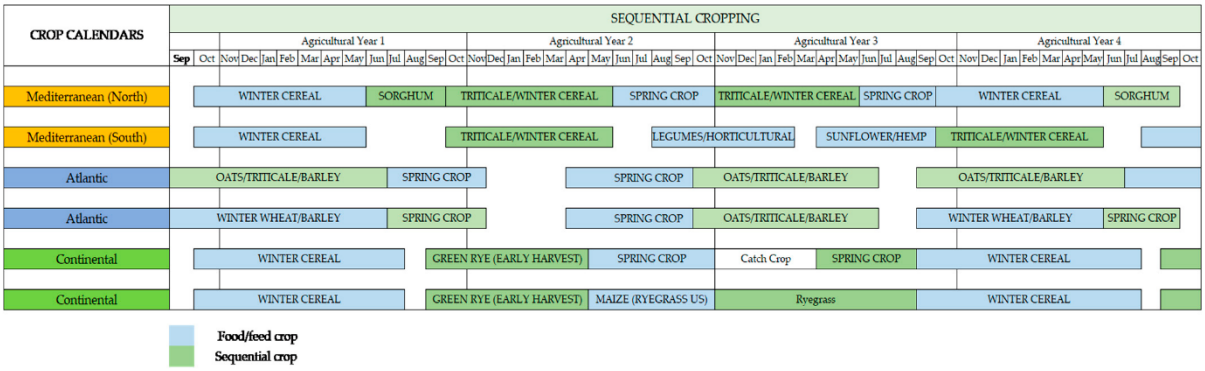
Annex 1: sequential cropping

According to the Gas for Climate report: “Sequential cropping (also referred to as multi-cropping, double cropping or growing a “harvestable cover crop”) is the cultivation of a second crop before or after the harvest of the main food or feed crop on the same agricultural land during an otherwise fallow period.” In France, these crops are referred to as CIVE (culture intermédiaire à vocation énergétique).

In theory, according to the same report: “sequential cropping does not impact existing food or feed markets as no existing food or feed is used for biogas production. As the sequential crop is put whole into the anaerobic digestion plant, it does not necessarily require a fully matured crop to be grown. Therefore, given the right climatic conditions, it can be implemented in a way which does not impact the yield of the main crop.”

The difference with catch crops (mostly used to prevent nitrate leaching), cover crops (mostly used to prevent soil erosion) and green manures (often legumes used to fix nitrogen) is that sequential crops are harvested immaturely, rather than cut and left on the field, to be used as a feedstock for anaerobic digestion. The resulting digestate is returned to the field in lieu of the catch or cover crop, and can partially replace chemical fertiliser. Sequential crops are mostly lignocellulosic crops such as triticale, ryegrass, barley, oats and maize (grown to 30 to 60% of maturity).

Example sequential cropping calendars on which the Gas for Climate projections are based[47]



Annex 2: examples of where incentivising manure-based AD risks increasing intensive livestock production

Biomethane and biogas production can create perverse incentives to sustain and expand the livestock industry through three main mechanisms: 1) helping livestock facilities gain planning permission, 2) helping lower waste disposal costs (or in some cases actually providing a source of revenue for the manure), and 3) locking in demand for manure for years, to pay off the upfront costs of building the biomethane plant.

Disposal of litter and manure, within environmental legislation, is often a key constraint to the expansion of the intensive meat industry, because producers are faced with the challenge of what to do with the extra animal wastes in order to obtain permits. By providing an infrastructure for dealing with these wastes, AD may create perverse incentives for to increase livestock production. For instance, some studies have found that AD may only be viable for large-scale intensive livestock facilities. As slurries and manure have a very low energy density, very large amounts of wastes are required to make it economically viable, alongside subsidies for bio-energy crops for co-digesting with manures. There are already many examples where biogas from manure is being used to scale up intensive livestock production. For example, when Broadley Copse Farm in the UK applied to significantly expand its operation to 50,000 bacon pigs a year, a biogas plant was “key to getting the project up and running” and gaining the permit. Now, in order to pay off the £10 million this biogas plant cost to build, it must be supplied with 70 tonnes of pig manure per day, along with straw and some 20 tonnes of maize – locking in demand for the huge volumes of manure and damaging energy crops for decades.

Badly designed subsidies for biogas can create perverse incentives to sustain and expand the polluting livestock industry, as illustrated by Northern Ireland. In 2013, Northern Ireland’s Going for Growth strategy was launched to drive a huge expansion of intensive pig and poultry production locally. By highly subsidising AD plants, the government was able to provide an outlet for all the extra animal wastes, lower waste disposal costs and help factory farms to gain planning permission and bypass nitrate regulations. Instead of paying for their chicken litter to be disposed of, at about £90 per tonne, producers were now paid for their wastes by the AD plants. For Moy Park farms, NI’s biggest poultry producer, Feedback has calculated this would result in at least £12 million per year in savings. By 2020, Northern Ireland was producing 41% more pigs and 30% more chickens than in 2013, mainly in intensive farming facilities.

ENDNOTES

References are in italic, explanatory notes are in normal font.

[1] Feedback's full analysis of the 2030 biomethane feedstock will be published by November 2023.

[2] Biomethane is a type of renewable gas which is produced by anaerobic digestion (AD). AD is the process of taking organic materials, known as 'feedstocks', both purpose-grown, like maize and other crops, and waste streams, like food waste and manure, and breaking them down using micro-organisms in the absence of air. This produces methane-rich biogas, which can be used to generate heat or electricity, and nutrient-rich digestate, which can be used as a fertiliser. After a purification process this gas can be injected into the gas grid or used as a fuel and is therefore presented by the industry as a viable replacement for fossil fuels.

[3] *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. 16.2.2023 - (COM(2021)0804 – C9-0470/2021 – 2021/0424(COD)) - https://www.europarl.europa.eu/doceo/document/A-9-2023-0032_EN.html

[4] *Report prepared for the European Commission, 2021 "Assistance to assessing options improving market conditions for biomethane and gas market rules" – https://op.europa.eu/en/publication-detail/-/publication/d24343db-5ee8-11ec-9c6c-01aa75ed71a1/language-en?pk_campaign=ENER%20Newsletter%20December%202021.*

On p. 280, the study estimates the sustainable biomethane potential at 259TWh, we converted this using the industry conversion factor of 1bcm = 10.61TWh (for instance see p.23 in the Gas for Climate report cited next).

[5] *Commission Staff Working Document of 15 May 2022 'Implementing the RepowerEU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets'*

[6] "Gas for Climate is a group of eleven leading European gas transport companies (DESFA, Enagás, Energinet, Fluxys, Gasunie, GRTgaz, Nordion, ONTRAS, Open Grid Europe, Snam, and Teréga) and three biogas industry associations (Consorzio Italiano Biogas, European Biogas Association and German Biogas Association) *https://gasforclimate2050.eu/gas-for-climate/who-we-are/.*

[7] The GfC report: *Sacha Alberici, Wouter Grimme, and Gemma Toop, "Biomethane Production Potentials in the EU: Feasibility of REPowerEU 2030 Targets, Production Potentials in the Member States and Outlook to 2050. A Gas for Climate Report." (Guidehouse, 2022), https://gasforclimate2050.eu/wp-content/uploads/2022/10/Guidehouse_GfC_report_design_final_v3.pdf*

The GfC report projects a total of 41bcm of biomethane potential by 2030 (38bcm via anaerobic digestion and 3bcm via thermal gasification). For consistency, we applied the percentages of each feedstock of the GfC report to the proposed EU goal of 35bcm.

[8] The agenda for the IEA workshop for EU policy makers lists speakers from the following organisations or companies: IEA, EC, European Biogas Association (EBA), Nature Energy, TotalEnergies, Shell, European Renewable Gas Registry, Isinnova, Guidehouse (Author of the GfC report analysed in this briefing), Biogasdoneright, SWEN Capital, Energinet, Enagas. Moderators were from Columbia University (hydrogen and natural gas expert), German Biogas Research Centre, the Norwegian Institute for Sustainability Research (biogas expert) and the EBA. Judging by the agenda, there was not one speaker from the food or agricultural sector. The full agenda can be found here: *https://iea.blob.core.windows.net/assets/abca6697-2903-4c5e-b122-e76a3ce1e4db/IEAWorkshop_Scalingupbiomethane_Agendafinal.pdf*

[9] *European Commission, "Implementing the RePower EU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-Methane Targets. COM(2022) 230 Final," 2022, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2022%3A230%3AFIN&qid=1653033922121*.

[10] *Semra Bakkaloglu, Jasmin Cooper, and Adam Hawkes, "Methane Emissions along Biomethane and Biogas Supply Chains Are Underestimated," One Earth 5, no. 6 (2022): 724–36*

[11] Beyond 2030, both the GfC and IEA projections include large amounts of woody biomass as a feedstock for biomethane through thermal gasification. Analysis of woody biomass as a feedstock is outside of the scope of this briefing.

[12] Percentages as cited in the Gas for Climate 2022 report.

[13] *Daniela Thrän et al., "The Potential Contribution of Biogas to the Security of Gas Supply in Germany," Energy, Sustainability and Society 13, no. 1 (2023): 1–15.*

[14] 24% of 38bcm (which is GfC 2022 report total biogas volume via AD for 2030) equals 9.12bcm. This volume is based on a study commissioned by Concawe whose members range from multi-national oil and gas companies that operate in exploration and production, refining, and chemicals, to European regional and National Companies operating one or more refineries in the EU, UK, Norway or Switzerland. *https://www.concawe.eu/about-us/membership/.*

Concawe study*: Calliope Panoutsou and Kyriakos Maniatis, "Sustainable Biomass Availability in the EU" (Imperial College London, 2021), https://www.fuelseurope.eu/publications/publications/sustainable-biomass-availability-in-the-eu-to-2050.*

[15] *Terlouw, Wouter, et al. "Gas for Climate. The optimal role for gas in a net-zero emissions energy system." Navigant Netherlands BV, März (2019). https://gasforclimate2050.eu/sdm_downloads/2019-gas-for-climate-study/.* See p. 23 for feedstock projections.

[16] *EC Assessment "Assistance to assessing options improving market conditions for biomethane and gas market rules"* See pp. 274-275 and 280.

[17] The IEA estimates the technical potential of crop residues at around 20bcm by 2050, much larger than either the GfC or JRC estimates. *IEA (2022) Scaling up biomethane in the European Union: Background paper. https://iea.blob.core.windows.net/assets/9c38de0b-b710-487f-9f60-f19d0bf5152a/IEAWorkshop_Scalingupbiomethane_backgroundpaper.pdf*

[18] See p. 275 of the EC Assessment where it is stated that "manure potentials are assumed to be directly converted into electricity and heat on-site in small plants, as this substrate not being worthy of transport." The EC assessment also clarifies that some manure will be used in biomethane, just as some of the other feedstocks (such as crop residues or grass) will be too distant from biomethane plants. This means that they expect the totals to balance out in terms of the amount of feedstock to be used for biogas, and the amount of feedstock for biomethane. Biomethane plants located too far from the grid can instead produce bio-CNG (compressed natural gas) or bio-LNG (liquified natural gas), but the viability at very small scale is not clear.

[19] The EC assessment and the GfC report base their projections on estimated manure volumes published in 2018 by a team of researchers at the EC Joint Research Centre. *Scarlat et al., "A Spatial Analysis of Biogas Potential from Manure in Europe," Renewable and Sustainable Energy Reviews 94 (2018): 915–30.* This study mainly looked at manure availability, but it did not consider energy infrastructure. Therefore, the authors recommend that as a next step it is necessary to "explore the potential to integrate the biogas produced by AD plants into the natural gas grid and the supply of electricity production into the existing electricity grid. This will require more information on the energy infrastructure, such as the existing low voltage electricity grid and the low pressure gas grid (distribution grids) that can be used by the biogas plants. This more detailed analysis would include a spatial multicriteria decision making approach based not only on distance to gas pipelines or power lines but also social, environmental and economic constraints such as heat demand, land use/land cover restrictions, transportation costs, etc.

The International Energy Agency estimates the manure potential to be more than twice the amount projected by the study by Scarlat et al. Given the detailed volume analysis carried out by Scarlat at al. – which in itself did not account for dietary change or infrastructure issues - we conclude that the manure volume estimate by the IEA is very unrealistic. *IEA (2022) Scaling up biomethane in the European Union: Background paper. https://iea.blob.core.windows.net/assets/9c38de0b-b710-487f-9f60-f19d0bf5152a/IEAWorkshop_Scalingupbiomethane_backgroundpaper.pdf.* See p. 10, the IEA estimates the manure potential by 2050 to be 40bcm, compared to around 18bcm by Scarlat et al. (2018).

[20] Setting specific meat consumption guidelines is controversial, but to get some idea of the sort of change required for achieving health and environmental outcomes, we can look at the universal reference diet produced by the Eat Lancet commission. Eat Lancet recommends consuming no more than 98 grams of red meat (pork, beef or lamb) and 203 grams of white meat per week. The Nordic Nutrition Recommendations recommend no more than 350g of red meat per week. However, current mean total meat intake by European adults ranges from 525g to over 1600g of meat per week (Cocking et al. 2020).

Chris Cocking et al., "The Role of Meat in the European Diet: Current State of Knowledge on Dietary Recommendations, Intakes and Contribution to Energy and Nutrient Intakes and Status," Nutrition Research Reviews 33, no. 2 (2020): 181–89

[21] The European Court of Auditors concludes that **without limiting or reducing the production of farm animals** the €100 billion of Common Agricultural Policy funds attributed to climate action will have little impact on emissions from agriculture. *European Court of Auditors, "Special Report: Common Agricultural Policy and Climate: Half of EU Climate Spending but Farm Emissions Are Not Decreasing.," 2021, https://www.eca.europa.eu/Lists/ECADocuments/SR21_16/SR_CAP-and-Climate_EN.pdf.*

Priyadarshi R. Shukla et al., "Technical Summary. IPCC, 2019: Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems," 2019, https://www.ipcc.ch/site/assets/uploads/sites/4/2022/11/SRCCL_Technical-Summary.pdf.

[22] *Leip et al., "Halving Nitrogen Waste in the European Union Food Systems Requires Both Dietary Shifts and Farm Level Actions," Global Food Security 35 (2022). https://www.sciencedirect.com/science/article/pii/S2211912422000384*

[23] Around 81-87% of the total emissions related to EU agriculture of ammonia (NH_3), nitrate (NO_3) and of nitrous oxide (N_2O) - the third most important GHG after CO_2 and methane - are related to livestock production.

Westhoek, H et al.. Nitrogen on the Table: The Influence of Food Choices on Nitrogen Emissions and the European Environment. NERC/Centre for Ecology & Hydrology, 2015. https://www.pbl.nl/en/publications/nitrogen-on-the-table-the-influence-of-food-choices-on-nitrogen-emissions-and-the-european-environment

[24] The International Energy Agency excludes sequential cropping from its current feedstock projections.

[25] *Esnouf A., Brockmann D., Cresson R. (2021) Analyse du cycle de vie du biométhane issu de ressources agricoles - Rapport d'ACV. INRAE Transfert, 170pp.* https://www.inrae.fr/sites/default/files/pdf/Rapport%20ACV_Biomethane%20issu%20de%20ressources%20agricoles_INRAE%20Transfert_GRDF....pdf. See p. 27

[26] *Francesca Magnolo et al., "The Role of Sequential Cropping and Biogasdoneright™ in Enhancing the Sustainability of Agricultural Systems in Europe," Agronomy 11, no. 11 (2021): 2102.*

[27] Drawbacks of mono-digestion are digester instability, limited year-round availability of some feedstock, presence of heavy metals and low biogas /methane yield. Mono-digestion of manure also often leads to ammonia toxicity but this can be prevented through co-digestion with carbon rich feedstocks. Benefits of co-digestion include enhanced system stability and methane yield through better nutrient balance, a more diverse microbial community, dilution of toxic compounds, safe and better quality digestate for agricultural applications and reduction of antibiotic resistant genes and bacteria. The mono-digestion of crops which are proposed to be grown as sequential crops - sorghum, triticale, ryegrass, barley, oats and maize - comes with challenges similar to other lignocellulosic feedstocks, which are described as highly recalcitrant feedstocks due to their slow rate of hydrolysis. These feedstocks either require costly pre-treatments or co-digestion with other types of feedstocks. (references available upon request).

[28] In the European Biogas Association's statistical report 2022 (https://www.europeanbiogas.eu/__trashed-3/), there is no data showing the proportion of sequential crop feedstocks in the Italian and French biogas and biomethane industry. For the 16 countries for which data is shown, only the United Kingdom, Serbia and Greece appear to use sequential crops. In Greece, sequential crops made up less than 5% of feedstock. Serbia does not currently produce biomethane and is one of the smallest biogas producers in the EU.

[29] *Laura Valli et al., "Greenhouse Gas Emissions of Electricity and Biomethane Produced Using the Biogasdoneright™ System: Four Case Studies from Italy," Biofuels, Bioproducts and Biorefining 11, no. 5 (2017): 847–60.*

ADEME and Solagro, "La Méthanisation, Levier de l'agroécologie, Synthèse Des Résultats Du Programme MéthaLAE," 2018https://solagro.org/images/imagesCK/files/domaines-intervention/methanisation/2016/2019/methalae_10_pages_web.pdf

[30] To meet demand for animal-source food, the EU relies on imports of protein-rich animal feeds, especially soybean, which constitutes almost one-third of all protein used for animal feed in the EU . Soybean trade is associated with agricultural expansion and deforestation, particularly in South America where more than 50% of global soybean is produced. As highlighted in the Farm to Fork Strategy, agricultural policy reforms must incentivize domestic protein feed production, overcome import dependency and reduce land demand in deforestation-prone regions (Karlsson et al. 2021)

Karlsson, Johan O., et al. "Halting European Union soybean feed imports favours ruminants over pigs and poultry." Nature Food 2.1 (2021): 38-46.

[31] *EBA-European Biogas Association, "The Role of Biogas Production from Industrial Wastewaters in Reaching Climate Neutrality by 2050," 2021, https://www.europeanbiogas.eu/wp-content/uploads/2021/04/Paper-The-role-of-biogas-production-from-wastewater-in-reaching-climate-neutrality-by-2050.pdf*

[32] *https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch*

[33] Based on the most recent 5-year average, Europe alone burns over 17,000 tonnes of rapeseed and sunflower oil - the equivalent of nearly 19 million bottles of best cooking oil, every single day. https://www.transportenvironment.org/wp-content/uploads/2022/06/Food-vs-Fuel_-Part-2_Vegetable-oils-in-biofuels.pdf

[34] *https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch*

[35] A further 2% of feedstock is expected to come from roadside verge grass. An analysis of the sustainability aspects of this feedstock (for instance, does additional mowing and transporting such grass outweigh the climate benefits from the biomethane produced, or not?) is outside the scope of this briefing.

[36] *Styles, David, et al. "Climate mitigation efficacy of anaerobic digestion in a decarbonising economy." Journal of Cleaner Production 338 (2022): 130441.*

Futher to this, a study in Nature Sustainability found that shifts in global food production to plant-based diets and using the spared land to reforest could lead to sequestration of 332–547 gigatonnes of CO 2, equivalent to 99–163% of the CO2 emissions budget consistent with a 66% chance of limiting warming to 1.5°C. *Matthew N. Hayek et al., "The Carbon Opportunity Cost of Animal-Sourced Food Production on Land," Nature Sustainability 4, no. 1 (2021): 21–24.*

A similar study for the UK found that reforesting land currently devoted to pasture in the UK results in the carbon dioxide removal of 3,236 million tonnes CO 2 , equal to offsetting 9 years of current UK CO 2 emissions. *H. Harwatt and M. Hayek, "Eating Away at Climate Change with Negative Emissions: Repurposing UK Agricultural Land to Meet Climate Goals," Cambridge, Mass.: Animal Law and Policy Program, Harvard Law School, 2019.*

[37] *Piseddu, Francesca, Gianni Bellocchi, and Catherine Picon-Cochard. "Mowing and warming effects on grassland species richness and harvested biomass: meta-analyses." Agronomy for Sustainable Development 41.6 (2021): 74.*

[38] The GfC report only considers grass as a feedstock in Germany.

[39] The GfC projections for biowaste and food waste were based on the following study: *Calliope Panoutsou and Kyriakos Maniatis, "Sustainable Biomass Availability in the EU" (Imperial College London, 2021), https://www.fuelseurope.eu/publications/publications/sustainable-biomass-availability-in-the-eu-to-2050.*

[40] *https://food.ec.europa.eu/safety/food-waste/eu-actions-against-food-waste/food-waste-reduction-targets_en*

Achieving Sustainable Development Goal 12.3 of halving food waste by 2030 would significantly restrict the availability of food waste feedstocks.

[41] https://feedbackglobal.org/wp-content/uploads/2021/07/Feedback-2020-Green-Gas-Without-the-Hot-Air-Exec-Summary.pdf. This report was developed into a scientific publication by experts at the University of Bangor: *Styles, David, et al. "Climate mitigation efficacy of anaerobic digestion in a decarbonising economy." Journal of Cleaner Production 338 (2022): 130441.*

[42] *Morsink-Georgali, Phoebe-Zoe, et al. "Compost versus biogas treatment of sewage sludge dilemma assessment using life cycle analysis." Journal of Cleaner Production 350 (2022): 131490.*

[43] *Tarpani, Raphael Ricardo Zepon, et al. "Life cycle environmental impacts of sewage sludge treatment methods for resource recovery considering ecotoxicity of heavy metals and pharmaceutical and personal care products." Journal of Environmental management 260 (2020): 109643.*

[44] At a minimum Annex IX of the RED II should be referenced to ensure biomethane does not disrupt food markets and unintentionally increase greenhouse gas (GHG) emissions from the gas sector. However, we need to go further and set a cap on manure volumes used as feedstock to ensure biomethane production does not undermine other crucial climate mitigation efforts in the food system.

[45] This assessment will also need to carry out a spatial analysis to ascertain where digestate will not have the expected nutrients (current sequential cropping systems import huge amounts of nutrients through co-digestion with manure on non-agricultural feedstocks), or vice versa, where intensive livestock production means there isn't enough local demand for digestate.

[46] *Leip et al., "Halving Nitrogen Waste in the European Union Food Systems Requires Both Dietary Shifts and Farm Level Actions," Global Food Security 35 (2022). https://www.sciencedirect.com/science/article/pii/S2211912422000384*

[47] *Francesca Magnolo et al., "The Role of Sequential Cropping and Biogasdoneright™ in Enhancing the Sustainability of Agricultural Systems in Europe," Agronomy 11, no. 11 (2021): 2102.*

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