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8 rue Adèle Riton
67000 Strasbourg
Tel 03 88 37 07 58

The climate balance of biogas from pig slurry.
A plea for sobriety.

Author: Anne Vonesch

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The climate balance of biogas from pig slurry. A plea for sobriety

Preliminary comment*: the comments below relate solely to the anaerobic digestion of pig slurry, focusing primarily on the impact on the climate, as nitrogen-related issues are widely debated in Brittany. The text does not include any assessment or judgement on the methanisation of other substrates. Certain considerations are valid for other livestock effluents.*

Summary

GHG emissions from pig production amount to 2,470 gCO_2 eq/kg live weight (according to ADEME data).

1 kWh produced by biogas from pig slurry implies the emission of 2,740 g CO_2 eq/kWh due to pig production, i.e. 62 times more GHG than the 44.1 gCO_2 eq/kWh PCI claimed as biomethane emissions by its promoters, or 10 times more than the European thermal mix, which is 279 gCO_2 eq/kWh, or 12 times more than fossil natural gas, which is 227 gCO_2 eq/kWh. The emission factor of 44.1 g CO_2 eq/kWh is based on the representative mix (2018) of the different biomethane production sectors: the local and agricultural sector, which includes livestock effluents as well as plants and highly methanogenic agri-food waste (71%); non-hazardous waste (10%); wastewater (10%) and household waste (9%). The pig industry therefore benefits from the allocation of an average emission factor from substrates that have a history, rationale and impact very different from pig production. While pigs have a major environmental impact, pig slurry is conventionally considered as a waste product entering the anaerobic digestion system with no carbon footprint. This bias is not innocent.

Based on the quantity of pork products (meat and charcuterie) that reach the plate and are therefore really useful (excluding low-value waste and by-products), we can estimate that **between 6,200 and 12,400 g CO_2 eq correspond to each kWh** produced by the methanisation of slurr. This is **between 141 and 282 times** the average emission for biomethane (44.1 g CO_2 eq/kWh) and 22 to 44 times that of the European thermal mix (279 gCO_2 eq/kWh).

The advocates of pig slurry biogas point to **avoided emissions**.

First and foremost, it would replace the combustion of fossil natural gas. The IPCC accepts this calculation because the plants used would not emit any additional GHGs in a short carbon cycle. The weakness of this argument is that it does not take into account possible alternative uses for these plants and the land that produced them, which could be much better for the climate, the environment and human nutrition than intensive pig production.

According to calculations, biogas production, by replacing fossil natural gas, would reduce GHG emissions from pork production by **around 185 g CO_2 eq/kg live weight**, i.e. around 7%, or a reduction of only 1.5 - 3% per kg of useful product on the plate.
Announcing, as some people are doing[1], an 80% reduction due to production of renewable energies is grossly misleading. For example, you don't need pigs to install photovoltaic panels.
As for the avoidance of methane emissions from the storage and spreading of liquid manure, this theoretical argument clashes with the realities of installations in Brittany and the weakness of controls.
As for saving on mineral fertiliser thanks to digestate, digestate can only contain fertilising materials that have been fed into the system upstream (mainly mineral fertiliser and soya), and even if this were done using legumes as the main crop or intermediate crops for energy production, you need land (not pigs) to make fertiliser from it.
Calculations of the carbon footprint for so-called renewable energies from pig manure are inadequate as long as no account is taken of other planetary limits, in particular land use.
But if land use allows and plans to produce socially useful energy that is not wasted, there is no point in using pork, which only makes the environmental balance much worse.
Biogas is being used to hide the fact that most of the slurry produced will no longer have to exist in a sustainable agricultural and food system.
So it's high time we moved towards **food sobriety**. That's why we've put together **a table comparing pork products and pulses.** Plant proteins are clearly better for the environment and for a healthy, sustainable diet than pork.
In the end, the gas produced by the methanisation of pig slurry is a gas produced by animal distress. Will the French heat their homes with the suffering of pigs? It's time for the specialists and promoters of these so-called renewable energies to realise the gravity and perversity of what they are doing, and for the professions concerned to adopt ambitious ethical guidelines.
Choices have to be made every day: consolidate the absurd, or build change? Bring biogas plants to pig farms, or deconstruct industrial pig farming?

[1] Presentation by Sergio Piccinini of CRPA to the European Pigmeat Reflection Group

Introduction

Numerous forecasts highlight the need to reduce the production and consumption of animal proteins in order to build a healthy, fair and sustainable food system that respects the planet's limits, in particular the climate and biodiversity. Faced with this challenge, the animal sectors, with considerable support from the public authorities, are multiplying the indicators, actions, communication campaigns and labels to meet it without reducing the volumes produced and without calling into question the essential nature of the systems.

Pork production is regularly criticised for its environmental impact, mainly nitrogen pollution, which generates green algae in the sea and fine particles in the air, and greenhouse gas emissions. Just as regularly, biogas is put forward as a (debatable) response to the problems of managing effluents and as a means of producing so-called renewable energy that could make the sector virtuous.

This is why it is important to take a closer look at the promises of slurry anaerobic digestion for the climate. We are entering a complex field, where assessments are heavily influenced by a segmented approach to reality and by a number of conventions, assumptions and biases. The aim here is to gain a clear understanding of these approaches, to broaden our horizons, and to confront the Life Cycle Assessment calculations with a rigorous discourse that also incorporates respect for the living world.

What GHG emissions and kWh production are associated with pig slurry?

Firstly, we need to understand the figures on which the carbon footprint claims are based.

First, I calculate the amount of slurry per fattened pig[2] . I include the sow's corresponding share for 25 piglets/sow/year, i.e. 1/25 of a sow's annual slurry: 6,200 l : 25 = 248 l.

So the slurry generated by the production of one porker pig is 480 l (fattening) + 90 l (piglet) + 248 l (sow) = 818 l.

To calculate the amount of methane that can be produced[3] , I first convert the litres of slurry into tonnes: 818 l slurry = 0.95 x 818 l = 0.777 t slurry

MS dry matter is estimated at 5.3% (I chose to use the average of Methasim slurry values[4]), so 41 kg for 777 kg of slurry.

Organic matter (OM) is approximately 75% (the average of Methasim slurry values) of DM: 0.75 x 41 kg = approximately 31 kg.

To calculate the methanogenic potential, I use the average value of the 17 Methasim values: 327 m3 CH_4 /t OM or 0.327m3/kg OM. 0.327 x 31 kg = approximately **10 m^3 CH_4 per pig.**

[2] TechPorc March-April 2013 n°10

[3] Methasim IFIP

[4] This is the most precise approach possible within the limited scope of our estimate.

Assuming a live weight of 115 kg, this works out at 10 : 115 = **0.09 m^3 CH_4 / kg live weight** (for the record, this includes the sow's share). This is biomethane, not biogas (which is a mixture of different gases before purification).

It produces 9.95 kWh/m3 CH_4 , so for 0.09 m^3 per kg live weight, it produces **0.9 kWh per kg live weight**[5] or **103 kWh per** 115 kg **pig**.

The GHG emissions from the production of a pig come to 2,470 gCO_2 eq / kg live weight, using the ADEME database[6] as the basis for the various LCA calculations of pig emissions. If 0.9 kWh of pig manure is produced, corresponding to 1 kg of live weight, this equates to an emission of 2.74 $kgCO_2$ for each kWh produced by pig manure.

At this stage of the calculation, **1 kWh produced from pig slurry therefore emits 2,740 g CO_2 eq/kWh.** However, the "avoided emissions" thanks to biomethane still need to be taken into account, and this is where more fundamental methodological questions arise (see below).

Until now, the calculation has been based on kg of live weight of pork. Moreover, the figures given could vary slightly if we assume a live weight at slaughter other than 115 kg. Secondly, live weight is very different from carcass weight (75% of live weight) and even more different from the **final weight of pork products that end up on the plate**[7] . In order to have a representative balance sheet, it is therefore necessary to evaluate emissions in relation to the weight of the final, useful product on the plate, which justifies all this production. According **to Agribalyse, the impact is therefore 5,660 - 11,880 gCO^2eq/kg of useful product**[8] **, i.e. between 2 and 4 times more than in relation to live weight**. In fact, only a minority of the live weight makes its way to the plate. So we have to include emissions from the slaughterhouse and the various processing operations, without which pork would not be eaten or reared. It would therefore be much more honest to use these values as the basis for an overall climate balance for pig production[9] than to use kg of live weight. Moreover, animal production tends to have a much higher impact downstream of the farm than plant production, given the processing and conservation requirements.

As the impact is increased by between 2 and 4 times when it is no longer related to the live weight but to the final product on the plate, it seems logical to apply these same factors to the carbon cost of the kWh of pork (even though the quantity of slurry produced for the live weight obviously does not change). But since part of the live weight will be waste or barely recovered, it makes

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[5] SOLAGRO uses the figure of 0.93 kWh per kg of live weight.

[6] ADEME uses an estimate of 2.47 gCO^2eq / kg live weight in its database.
In ADEME Empreintes sol énergie carbone 2020 part1 Annexes 4.1. ADEME quotes three figures: 2.35 (Agribalyse), 2.78 (Solagro), 3.04 (CIRED).
In the BasCarbone dossier in RéussirPORC n°298 May2022 page 20, the reference quoted is 2.7 with an example of an extreme drop to 1.93.
In 2009, IFIP estimated emissions at 2.69 ± 0.40 CO_2 eq/kg live weight.
Stanley Zira et al, for Sweden, calculate 3.3 (2.5 per kg of carcass if co-products are used).
According to FIBL Austria, switching from imported soya to regional soya reduces the carbon footprint of 'Gustino' straw-fed pigs from 4.3 to 2.5 kg CO_2 eq per kg of live weight.
There are a large number of different estimates, often with more or less significant differences in scope.

[7] The proportion of pork that would arrive cooked on the plate would correspond to 36% of the live weight, and the weight on the shop shelf would be 59% of the live weight (all pork products combined), according to Stanley Zira et al: A life cycle sustainability assessment of organic and conventional pork supply chains in Sweden, 2021, page 27.

[8] according to Agribalyse. This is consistent with other studies, e.g. for Sweden the emission would be 7,100 g CO^2eq/ kg of meat, whether the pork is conventional or organic.

[9] provided that we compare what is comparable, i.e. the comparison with other foods in terms of impact should also be made for the plate, including processing and cooking.

sense to allocate the impact solely to the weight of the recovered product ending up on the plate. If we decide to allocate the overall emissions from pig production and processing to the actual quantity of useful product reaching the plate, we can put forward an estimate of **between 6,200 and 12,400 g CO^2eq corresponding to each kWh** from the methanisation of slurry corresponding to this same production of products from one pig.

Various figures have been put forward for the total net GHG impact of the regional and agricultural biomethane sector. They are 35.1 g CO^2eq/kWhLHV biomethane, which is higher than the average for all biomethane sources, which is 23.4, according to GRDF[10] ; these figures take into account certain so-called avoided emissions. However, the figures for biomethane (all sources combined) have since been updated: the emission factor for biomethane is **44.1 gCO_2 eq / kWh LHV** (Lower Heating Value), excluding certain so-called avoided emissions. These are emissions from the entire biomethane production process. This emission factor is now based on the representative mix (2018) of the different sectors: land and agricultural (71%), non-hazardous waste storage facility (10%), wastewater treatment (10%) and household waste (9%)[11] . The pig industry therefore benefits from the allocation of an average emission factor from substrates that have a very different history, raison d'être and impacts from pig production.

However, according to the solid calculations described above, **1 kWh produced by pig slurry implies the emission of 2,740 g CO^2eq/kWh, which is inseparable from the production of the slurry, i.e. 62 times more GHGs than the 44.1 gCO_{2e} / kWh PCI claimed by the various consultancies working with GRDF to promote supposedly renewable and climate-friendly biogas.**

By way of comparison, **average emissions for thermal energy are 279 g CO^2eq/kWh** (European thermal mix)[12] .

The fallacious argument of avoided emissions

The methanisation of liquid manure defends its environmental record, arguing that it avoids emissions. But what are we to think?

Avoided emissions" are first and foremost the result of an assumption or convention that the combustion of a fuel classified as "renewable" (biomethane) would produce little or no GHG compared with a fossil fuel, which is surprising given that combustion is still combustion. The idea is that these combustion GHGs would already be offset upstream, since the growth of the plants used CO_2 from the air, so the balance would be balanced in the context of a short carbon cycle, as opposed to the long cycle of fossil fuels. In this short cycle, the natural decomposition of plants emits greenhouse gases anyway. So be it. This assumption is accepted by the IPCC because, unlike fossil fuels, the combustion of biogenic gas produces no additional greenhouse gases.

[10] https://www.grdf.fr/institutionnel/actualite/dossiers/biomethane-biogaz/etude-biomethane-gaz-effet-serre and https://www.bioenergie-promotion.fr/wp-content/uploads/2020/04/evaluation-des-impacts-ges-biomethane-_synthese-quantis_2017.pdf

[11] ADEME https://bilans-ges.ademe.fr/fr/accueil/documentation-gene/index/page/Gaz2

[12] https://bilans-ges.ademe.fr/documentation/UPLOAD_DOC_FR/index.htm?emissions_evitees.htm

Let's calculate these "avoided emissions" in due form[13] using figures from French databases. Natural gas emits 0.227 kg CO_2 eq/kWh ICP[14] provided that the efficiency is 100%; the reality is that the efficiency is at best 96%, so the figure is 0.243 kg CO2eq/kWh ICP. So if we replace natural gas with biogas, which supposedly (by convention) emits no carbon, we save these 0.243 kg CO_2 eq/kWh NCV. In relation to the pig's live weight (let's assume 115 kg), this represents a saving of 226 g CO_2 eq/kg live weight (since there are 0.93 kWh produced per kg live weight, based on an emission of 2,470g CO2eq/kg live weight and on the gas injection technique). These GHG savings are tempered by the emissions generated by the anaerobic digestion process, which are estimated at 0.044 kg CO2eq/kWh ICP, giving emissions of 0.041 kg CO2eq/kg liveweight. Note that this is an average value for biogas, and does not specifically take into account pig production, where the slurry constitutes a very large mass with low methanogenic power. For the purposes of this calculation, for want of anything better, let's accept it. The avoided emission of 226 g CO_2 eq/kg live weight due to the substitution of fossil natural gas minus the emission of 41 g CO_2 eq/kg live weight due to the biogas production process gives an avoided emission of 185 g CO2 eq/kg live weight, for an emission of 2,470 g CO_2 eq/kg live weight.

According to these figures, anaerobic digestion would reduce pig production emissions per kg of live weight by around 7%.

Based on the kg of product on the plate (which totals **5,660 - 11,880 gCO_2 eq/kg of useful product, according to Agribalyse),** the reduction in GHG emissions from pork thanks to methanisation is only 1.5 - 3%.

The result is as follows. According to GRDF, **the natural gas** consumed in France emits 243g of $C0_2$ eq per kWh ICP. This is 11 times less than 1 kWH from pig slurry, the production of which emits 2,740 g of $C0_2$ eq per kWh. The European thermal power mix emits an average of 279 gCO_2 eq/kWh, which is 10 times less than generating biomethane from pig manure. For electricity, the French national mix is 79 gCO eq/kWh$_2$[15], 35 times less than injected biomethane from pig manure. Note that the balance is even more unfavourable when biogas produces electricity; the efficiency drops from 96% to 20, 40 or 60% depending on whether or not the heat is used in cogeneration. Gas injection is by far the most efficient way of converting the heat.

In conclusion, the balance sheet for biomethane from pig slurry remains very unfavourable once we consider the emissions actually produced by the production of slurry pigs.

If you want to produce biomethane, you don't have to pass the biomass through the pig, which only worsens the balance. There could be more beneficial food or bioeconomic uses for this biomass than feeding it to pigs.

Despite its derisory carbon performance, anaerobic digestion of pig slurry is attracting considerable interest and support. Yet the environmental impact of pigs is catastrophic. Moreover, Eau et Rivières de Bretagne has just taken the French government to court for its inaction in the face of water pollution by nitrates. Like all intensive livestock farming sectors, the pork industry needs to improve its image through actions, indicators and labels. For example, it is preparing a

[13] ENEA: idem

[14] ADEME Base carbone Documentation générale, version août 2022 page 56 https://bilans-ges.ademe.fr/fr/basecarbone/donnees-consulter

[15] https://bilans-ges.ademe.fr/documentation/UPLOAD_DOC_FR/index.htm?emissions_evitees.htm Other sources indicate 57 g.

"low carbon label" based essentially on the intensification of production and the sourcing of soya. Biogas production is helping to scrape together a few points of reduction in impacts, thanks to this 7% reduction.

Above all, biogas serves to justify a new flow of public money, thanks to guaranteed feed-in tariffs, to pig farmers, in the knowledge that the operation of a biogas plantr requires the collection of substrates other than slurry. The political forces at play have nothing to do with saving the climate or pure water. They are seeking to save an industrial sector of concentrated livestock farming, with its obscene slaughterhouses where millions are invested to control suffering while keeping up the pace, with its agri-food industries, its cooperatives, its pesticide sellers, etc.

Methanisation is being used to hide the fact that most of the slurry produced has the vocation of no longer existing in a future sustainable agricultural and food system.

Other very hypothetical avoided emissions

As for the emissions **avoided** thanks to methanisation, it is worth digging a little deeper. The 2015 Quantis-ENEA/GRDF report[16] discusses the impacts and benefits induced. It is accepted that increasing the quantity of slurry and manure processed in an anaerobic digestion plant leads to a direct increase in induced impacts. This increase would be offset by the capture of methane emissions, which would reduce methane emissions during spreading by 90%. "*This reduction justifies the use of liquid manure for biomethane production, despite its relatively low methanogenic capacity".* (page 94). Really? So here we have the real and only justification for the methanisation of pig slurry...

Methane emissions from slurry are proportional to the length of time the slurry is stored. In its Report on the Life Cycle Assessment of Biomethane from Agricultural Sources, INRAE[13] writes on page 40: *"For scenarios involving methanisation, only a brief stage of raw effluent storage is taken into account..."*. However, the testimony of our Breton friends reveals that this "brief stage" is nothing more than wishful thinking. In practice, storage is prolonged, whether on the farm or at the biogas plant. Covering the digestate pits, which INRAE claims provides an 80% reduction in all emissions (NH_3 , NO_X , N_2 O, CH_4), is neither general nor necessarily effective. Compliance checks (including the compulsory covering of pits) are ineffective, given the lack of resources available to competent authorities[17] . In this context, the reduction factor applied by INRAE to methane emissions from slurry storage, i.e. 8/180 = 0.044 (8 days' storage instead of 180 days), is not credible**[18]** .

The reduction applied to the storage of digestates is also excessively optimistic. It assumes that the biogas is captured by covering the digestate **(**INRAE page 41**).** As for the digestates, the emission factor is only 2%**. "*According to Ineris, the methane emissions identified in the literature***

[16] Quantis for GRDF: Evaluation of the GHG impacts of the production and injection of biomethane into the natural gas network - summary report, 2017

[17] Cour des Comptes : Supervision and control of facilities classified for environmental protection (ICPE) in the agricultural sector, 2022

[18] INRAE page 40

are highly variable and can account for up to 25% of the methane produced. Overall methane losses at the scale of the installation, under nominal and optimised conditions, are more likely to be between 1 and 6% of the methane produced".[19] This information comes from the INERIS MethanEmis project[20] , monitoring methane emissions.

Incidentally, for methane, the emission factor for solid manure (containing straw) is 15 times lower than that for slurry[21] . As far as N_2O is concerned, the other major greenhouse gas, liquid slurry has the edge over solid manure. As for the storage of liquid and solid digestates, the N_2O emission factors are exactly the same as for slurry and manure respectively, so there is no improvement linked to methanisation.

This complexity of effects confirms that, ultimately, the only truly effective way to protect the climate and the environment is to reduce manure, slurry and livestock numbers all at the same time.

As for land application, INRAE writes: *"it is therefore considered that the introduction of methanisation within a territory tends to favour the adoption of better land application techniques than those used for spreading raw effluent".* This idea allows INRAE to apply more ammonia abatement factors for the scenario with anaerobic digestion, whereas the scenarios without anaerobic digestion do not model any abatement factors for spreading (page 43). Such modelling may be suspected of being biased in favour of the anaerobic digestion scenario (they so want to believe it!). However, if the ICPE authorisation procedure for industrial livestock farms under the IED directive were even remotely serious and effective, spreading techniques of the pendillard type or immediate incorporation in the soil should have been implemented a long time ago, with or without biogas production. Yet these spreading techniques, which are effective in reducing ammonia volatilisation, do absolutely nothing to improve N_2O emissions from farmland - the only useful thing is to reduce and adapt nitrogen inputs.

On such a flimsy and arbitrary basis, in view of the emissions that may one day be avoided, but in a highly uncertain manner, INRAE considers that, if the scenario without anaerobic digestion has a climate impact of 100, the scenario with anaerobic digestion would have a climate impact of 28.9, so the reduction in greenhouse gases would be 71.1% (Figure 32). This answer is based on assumptions and hypotheses that influence the result. The very production of livestock effluent remains untouchable. However, an interesting warning is expressed: *"The low energy content of slurry and manure, which are present in large quantities in the mix of 'livestock' substrates, leads to a high demand for these substrates. The quantity of digestate produced is much greater than in the 'crop' scenario. As a result, the environmental impact of poor digestate management in terms of storage and spreading can have a very negative impact on the comparison with the scenario without anaerobic digestion".* Our Breton friends know this very well. So let's stop dabbling in hypothetical abatements to save the beloved biogas-from-slurry soldier. Effective abatements

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[19] http://www.senat.fr/rap/r20-872/r20-8721.pdf Senate information report: Methanisation in the energy mix
: issues and impacts, September 2021, by Daniel Salmon

[20] https://www.ineris.fr/sites/ineris.fr/files/contribution/Documents/Rapport-Ineris-20-167265-2515796_MethanEmis-version-finale-v1.pdf MethanEmis project, monitoring methane emissions from agricultural methanisation facilities, February 2021

[21] It is not clear whether the emission factors in Table 4 apply with or without pit covers.

involve reducing slurry. The best way to reduce emissions is to reduce livestock numbers. Why should we opt for vague (and costly) hypotheses?

Indeed, if some people put forward optimistic assumptions such as *"anaerobic digestion will lead to improvements in certain practices, which will reduce emissions"*, then there is good reason to respond with an altogether more worrying certainty that **heavy investment in anaerobic digestion around intensive monogastric and cattle farms is leading to the perpetuation of these overproduction and overconsumption of animal proteins, which have catastrophic impacts** on the planet.

Finally, let's look at another category of emissions that are supposedly avoided. It is also claimed that the production of digestate from methanisation would make it possible to replace and therefore save (a little) on chemical fertilisers[22] , which cost a lot of energy to produce. But nothing comes from nothing. If nitrogen can be spread, it has been introduced into the system upstream, through mineral fertiliser or soya in animal feed; this is not saving, but wasting. If more legumes contribute more nitrogen to the digestate, it means that these legumes also occupy more land, which may be relevant. And it certainly won't be thanks to the pigs!

More propaganda than science

Our calculations give **solid** results**, far** from the 80% reduction in emissions from the pork sector that the presentation by Mr Sergio Piccinini of CRPA[23] claims. He claims to have gone from 5.08 kg CO2eq/kg live weight without renewable energy production to just 1.06 kg CO2eq/kg live weight with renewable energy production. He gives no details of his calculations, but according to him, he includes in this renewable energy not only biomethane but also the photovoltaic panels on the roof. This calls for three comments:

- The baseline for its abatement calculations is twice the emissions estimated for French pork production. The French assumption is lower than other European calculations. The higher the starting point, the greater the reductions displayed.
- the biomethane to which he refers is largely due to substrates other than liquid manure, some of which are highly methanogenic, supplementing liquid manure with very low methanogenicity. It is therefore not very subtle to attribute the credit for this biomethane to the pig industry.
- photovoltaic panels on the roof can be installed without pig production. There are more than enough roofs and other artificial surfaces that can be used for photovoltaic systems without any pigs. Here again, it is not very rigorous to credit pig production for this alternative energy. Is CRPA going to credit the pig industry when it changes its light bulbs?
- In order to make people believe that the pig industry is the greatest benefactor of energy savings, he points to the enormous figures for mass pig production in Europe. In reality, it is the environmental impact of pigs that is enormous, and northern Italy is one of the regions most polluted by nitrogen. The relative contribution in terms of renewable energy is derisory

[22] ENEA: How to assess the climate benefits of a circular economy sector: the example of biomethane, February 2021
[23] Presentation to the European Pigmeat Reflection Group, 12 september 2022

compared to the damage caused by the industry. It is therefore essential to take into account the land use required by these farms and to adapt to global limits. Methanisation therefore becomes not a help but an obstacle to a sustainable food system.

The European Commission should not be fooled by the propaganda effort underway to greenwash the pork industry.

Life Cycle Analysis: where is the sobriety?

Pig production has a significant environmental impact, and the GHG emissions mentioned above are only part of it. However, the "liquid manure" substrate is conventionally classified as waste; it's there, all that's left to do is recycle it, no questions asked. INRAE[24] explains: *"Livestock effluents are considered as waste and enter the system without any environmental charge. Entry into the boundaries of the system corresponds to the start of the manure and slurry storage stage".* This decision, by convention, is nevertheless arbitrary. The aim of INRAE's LCA (Life Cycle Assessment) work is to compare scenarios with and without methanisation, all other things being equal. With such a narrowly defined objective, the contribution of knowledge will be just as narrowly limited, confined to *business as usual* which, obviously, should not be called into question, but of little use in clarifying the choices that need to be made for a serene climate future.

In short, these classifications and conventions take plants, waste and pigs out of the context in which they are produced and used, and above all fail to address and avoid the question of their relevance, usefulness and availability, which are fundamental issues. The example of the explosion in the price of wood pellets should be a wake-up call: carbon storage by plants is not a service that is available at will and that can be included in the system according to convenient definitions. There are also major differences between waste that can be avoided (albeit more or less easily) and waste that is more or less unavoidable (such as sewage sludge), between a product that meets a real need and a product that is superfluous or even harmful, between food that is produced and consumed and food that is thrown away, and between healthy and unhealthy food.

As long as LCA does not raise the question of the relevance and usefulness of the products and raw materials it assesses, and as long as it is not concerned with planetary limits, its conclusions cannot be taken as guides and references for taking action for the climate and for humanity.

These remarks tie in with **the conflict between two competing functional units in LCA: analysis by unit of mass and analysis by unit of area**. Efficiency per unit mass does not take into account the over-consumption of animal protein, where a reduction in impact per kg leads to a higher total impact due to an increase in mass production. In contrast, the *sufficiency perspective* considers available land to be the limiting condition[25] .

[24] INRAE: Rapport d'Analyse du Cycle de Vie du biométhane issu de ressources agricoles, 2021. Page 40

[25] Stanley Zira et al: A life cycle sustainability assessment of organic and conventional pork supply chain in Sweden page 23

What is the best use of agricultural land? Isn't there something better to do than mass-produce pigs? Meeting real food or bioeconomic needs? Restore biodiversity? Get away from pesticides? Store more carbon? Incidentally, growing crops to feed pigs tends to lead to soil carbon loss[26] .

The key point, and the limit of the system, is the use of land to produce feed for pigs. The availability of arable land is an absolute global limit.

The question of a fair distribution of land uses between food and non-food uses (which have always existed)[27] arises in the light of the many old and recent challenges. Unbridled appetite for biomass could lead to a disaster for biodiversity.

There is a considerable risk that LCA will be presented as a tool, not to say a ruse, which, on the pretext of improving the LCA of a product and an industry, will be used to avoid tackling **the vital imperative of food sobriety and sobriety in terms of land use.** Unfortunately, this is exactly what is happening in the pork industry.

That's why a **comparison between pork and vegetable proteins** derived from legumes brings our discussion to a close.

Beware, too, of the **risk of misunderstanding**, whether deliberately or in good faith. Some defenders of the food vocation of agriculture put forward the slogan "feed people and animals" as if it were necessary, as a good father of a family, not to let animals go hungry. That's no longer the case. Today, farm animals consume two-thirds of the cereals used in Europe. This is a huge structural waste, with a staggering overproduction and overconsumption of animal proteins.

Furthermore, it is extremely disturbing that the players and promoters of methanisation, and not only them, should equate animals with sources of biomass and consider them in terms of the LCA balance and not in terms of sentient beings. This is deeply perverse.

The gas of suffering, a new war against animals

The overwhelmingly predominant conventional production of pigs on slurry is incompatible with respect for animal welfare. The animals are subjected to extreme deprivation and violence, in total denial of their physiological needs (other than productive performance) and their behavioural, emotional and cognitive needs. They have no comfort or occupation, they are frustrated and stressed, they are separated from each other without consideration, they are crammed into sordid environment, the sows are immobilised, pigs are mutilated in cruel conditions, they are driven to hyperprolificity that is incompatible with their emotional needs and good health, and they are transported and slaughtered in fear and violence.[28] The industry knows perfectly well that **these cruelties are not the exception but the rule**, hence the attempt to discourage the associations

[26] Stanley Zira et al: A life cycle sustainability assessment of organic and conventional pork supply chains in Sweden, 2021, page 31

[27] ACTA-Agreenium Webinar: Does the bioeconomy promote the sustainability of food chains? https://www.youtube.com/watch?v=crSScr2zmKc

[28] https://www.l214.com/enquetes/2021/cochons-ortillon-herta/
https://www.tierschutzbuero.de/westfleisch-skandal/
https://www.ciwf.fr/actualites/2022/07/une-enquete-majeure-de-ciwf-revele-les-terribles-conditions-delevage-des-truies-en-cage

that are doing the work of alerting the public where the veterinary services are appallingly ineffective, not to say complicit, or subject to heavy pressure, and in any case lacking in resources.
With the methanisation of livestock effluent, the war on gas is becoming a new war on animals. The promotion of anaerobic digestion will need to be backed up by an ethical and deontological charter with regard to animals.

Comparison between pork proteins and legume proteins

The various elements of comparison are grouped together in the table below. Here are a few comments.
From a nutritional point of view, legumes are universally acknowledged to be of great benefit[29] to health, due to their fibre, mineral and micronutrient content. They even contain more protein than pork. Charcuterie, on the other hand, should only be eaten up to 150g a week according to official recommendations, mainly because of the salt it contains. While this recommendation is a welcome one for opponents of factory pig farms, it is also deeply disturbing. After all, most pork has to be processed into **charcuterie**. So should these parts of the animal be thrown away because they don't meet the new nutritional standards? When we have just become aware of food waste? At a time when schoolchildren are being taught not to throw things away, adults are being told to reject fatty animal parts such as poultry skin! What an affluent society we live in! In truth, this latest absurdity simply confirms once again that mass production of pigs makes no sense.
One original thought is that **wasting** (if we waste at all!) legumes has less impact than wasting meat, given the lesser impact of legumes. Yet meat waste is terrifying: according to German figures, the equivalent of 640,000 pigs are thrown into household waste bins every year. Even more nightmarish are the figures for pigs killed and destroyed, or buried dead or alive, as a result of the ASF (African swine fever) epizootic: in China, the figure is 200 million, an order of magnitude beyond imagination. The loss of these animals has given false hope to European exporters; the Chinese herd is being rebuilt at breakneck speed to kick-start the delirious escalation in meat consumption. China holds the world's largest reserves of maize and soya. The planet is being plundered for carnage.
The carbon footprint of pork has been covered extensively above. The carbon footprint of pulses is around 10 times lower per kg of product on the plate. What's more, pulses save on mineral fertiliser and reduce emissions of N_2O, a powerful greenhouse gas. The European TRUE consortium for pulses assesses the environmental footprint by nutritional density, which is relevant and gives a particularly favourable result for pulses.
The impact on agricultural soils is a critical issue for sustainability. Different sources give varying figures, but all are favourable to legumes. In terms of square metres, soil use is around 2 to 5 times more favourable to legumes. The Agribalyse indicator assesses in points the impact of an activity on land degradation, with reference to the 'natural state': the advantage for legumes is a factor of 2 to 12. What's more, legumes are of major **agronomic interest**, and when integrated

[29] https://www.mangerbouger.fr/l-essentiel/les-recommandations-sur-l-alimentation-l-activite-physique-et-la-sedentarite/augmenter/augmenter-les-legumes-secs

into crop rotations, they reduce the use of pesticides. At the same time, maize grown for pigs needs **irrigation**, which is becoming untenable with the recurring severe droughts.

For **the overall European PEF indicator**, which summarises 16 indicators, the factor in favour of legumes is around 10.

A factor that has not yet been mentioned, but which is bound to become increasingly important in the future, is **the externalised cost to the environment and health**. According to a German study, **legumes cost the community 100 times less.**

Ultimately, pig production is based on immense animal suffering. **Legume proteins are an excellent way of getting out of animal distress systems, with a healthier, more ethical diet that** leaves room for compassion towards sensitive living things.

Table: comparison between pork and pulses for human consumption

	Pork	**Pulses**	**Comment**
Calorie content	100-900kcal/100g	300-420 kcal/100g (dry) 60-160 kcal/100g (cooked)	Pork: depending on the cut, the proportion of fat and water varies greatly. - Pulses are very rich in fibre, minerals and micronutrients.
Protein content	18 g/100g (meat)	20-40 g/100g [30]	
Waste factor	Meat thrown away in Europe estimated at 4-11% of quantities consumed[31]	Wasting legumes has less impact than wasting animal proteins (21% of waste for 77% of greenhouse gases). [32]	Germany: household waste equivalent to 640,000 pigs[29] . China: 200 million dead/killed pigs (due to ASF).
Carbon footprint	IFIP: 2.35-3.04kgCO_2 eq/kg live weight [33] Italy: 5.08 kgCO_2 eq/kg live weight[34] Sweden: 3.3 kgCO_2 eq/kg bodyweight ADEME: 2.47 kgCO_2 eq/kg live weight Westhoek: 4-11 kgCO_2 eq/kg product[35] Agribalyse: 5.66-11.88kgCO_2 eq/kg product Germany: 5.54 kgCO_2 eq/kg product without LUC and 9.56 with LUC[36]	1-2 kgCO^2/kg dry product[38] TRUE: <0.2kg/kg of product[37] Agribalyse: 0.31-0.89 kgCO^2/kg product (cooked or dry) Germany: 0.03 kg CO^2eq/kg product[11]	Legumes: major differences between species. Legumes save on mineral fertiliser and N emissions$_2$ O. They have a particularly low environmental footprint per nutritional density.[13]
Impact on agricultura l soil	3.35-10.75 m^2/kg live weight[38] or 8-15 m^2/kg of product[42] GlobalDataBase: 10,7m^2/100g protein Agribusiness land use : approx. 330-750 Pt/kg depending on piece	3-8 m^2/kg dry product[39] GlobalDataBase: per 100g of protein: peas 3.5 m^2; tofu 2.2m^2. Agribusiness analysis: soil use/ 100g, in Points: Lentils: 63; Broad beans: 65; Soya beans: 162; Split peas: 182	For Agribalyse, land use is a complex indicator (measured in Points). The surface area occupied is not given.
Agronomic	Pigs: nitrogen pollution	Pulses: of major agronomic	Pesticides reduced in legume

[30] Elisabeth Vierling: Aliments et boissons, page 151. Dried peas, beans, lentils and broad beans have > 20g protein/100g, the extremes being chickpeas (13-24.9) and soya (34-40).

[31] Fleischatlas 2021, Heinrich-Böll-Stiftung

[32] according to ADEME, 2016

[33] The IFIP uses 2.7 kg CO^2 eq/kg live weight as a benchmark and gives the example of a farmer who would be at 1.93 kg CO^2 eq/kg live weight by producing feed with local cereals, lowering the consumption index and creating a new building.

[34] according to Sergio Piccinini, CRPA, presentation to Reflection group pig meat on 12 September 2022; this figure of 5.08 kg CO^2eq/kg live weight would fall to 1.06 CO^2ex/kg live weight when renewable energy is produced. EEB disputes this calculation.

[35] according to Westhoek quoted by ADEME Empreintes... Annex 4.5.

[36] based on M Pieper, A Michalke, T Gaugler: Calculation of external climate costs for food highlights inadequate pricing of animal products, 2020. LUC stands for Land Use Change, i.e. deforestation linked to the production of imported soya.

[37] TRUE Transition paths to sustainable legume-based systems in Europe : The Environmental assessment of diets, 2020: Fig 6 page 34

[38] according to ADEME based on Agribalyse, Solgro, CIRED

[39] according to Westhoek quoted by ADEME Empreintes... Annex 4.5.

impact	Corn irrigation	interest[40]	rotations[41] ; see TRUE[13]
PEF	Agribalyse: 0.65-1.88	Agribalyse: 0.05-0.21	Pork: certain allowances depending on the economic value of the cut
Climate costs	1/kg of product without LUC 1.72/kg produced with LUC [11]	0.01/kg product (0 if organic)[11]	These are externalised costs for the environment and health
Ethical values	Immense animal suffering; violence, deprivation, lack of respect for their needs	Essential in the transition to sustainable ethical food	Ethics towards living things is also an indicator of sustainability

Conclusion

The environmental benefits claimed for the methanisation of pig slurry are based on conventions that allow for a segmented, rather than global, approach. Global limits remain out of scope. We have followed in detail the usage calculations concerning the reduction in the carbon footprint of pigs thanks to methanisation. This reduction would be around 7% per kg of live weight and 1.5 - 3% per kg of product on the plate.

It is not these figures but their interpretation and the consequences to be drawn from them that are the subject of debate.

For the pig industry, this reduction is even a service that deserves to be remunerated. It would be part of a 'low carbon label' giving entitlement to private carbon credits.

For an outside perspective, concerned about the environmental impact of the industry, animal distress and the urgent need for a healthy, fair and sustainable food system, the interpretation is very different. Firstly, this carbon footprint assessment shows up certain weaknesses or inadequacies in the method. Secondly, it illustrates the environmental absurdity of methanisation coming to the rescue of industrial pig farms. Ultimately, it would be appropriate to develop a shared culture of respect for living and sentient beings. This would save us from making a number of mistakes.

There's nothing really new about all this.

There are just choices to be made every day: to consolidate the absurd, or to build change? Bring biogas plants to pig farms, or phase out industrial pig farming?

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[40] Terres Inovia https://www.terresinovia.fr/documents/20126/726505/legumineuses_GES-converti-1.pdf/5941caf5-ba0f-57a0-8832-154fdddcfb7e?t=1558600199582 :
Protein seeds = 70% less greenhouse gases than other agricultural raw materials
Pea crop = 5 to 10 times less greenhouse gases measured in the field than oilseed rape or wheat
Rotation with 20% protein peas = 13% less greenhouse gas emissions compared with the succession without peas before insertion in a conventional cereal system. - One pea between 2 wheats = 13,000 MJ and 2.2 t eqCO2 saved in 5 years - Growing protein peas and other grain legumes contributes to France's 'low carbon' and 'protein plan' objectives.

[41] Pulses for sustainable agricultural and food systems https://agriculture.gouv.fr/sites/default/files/legumineuses-ouvrage-quae-2015.pdf page 328