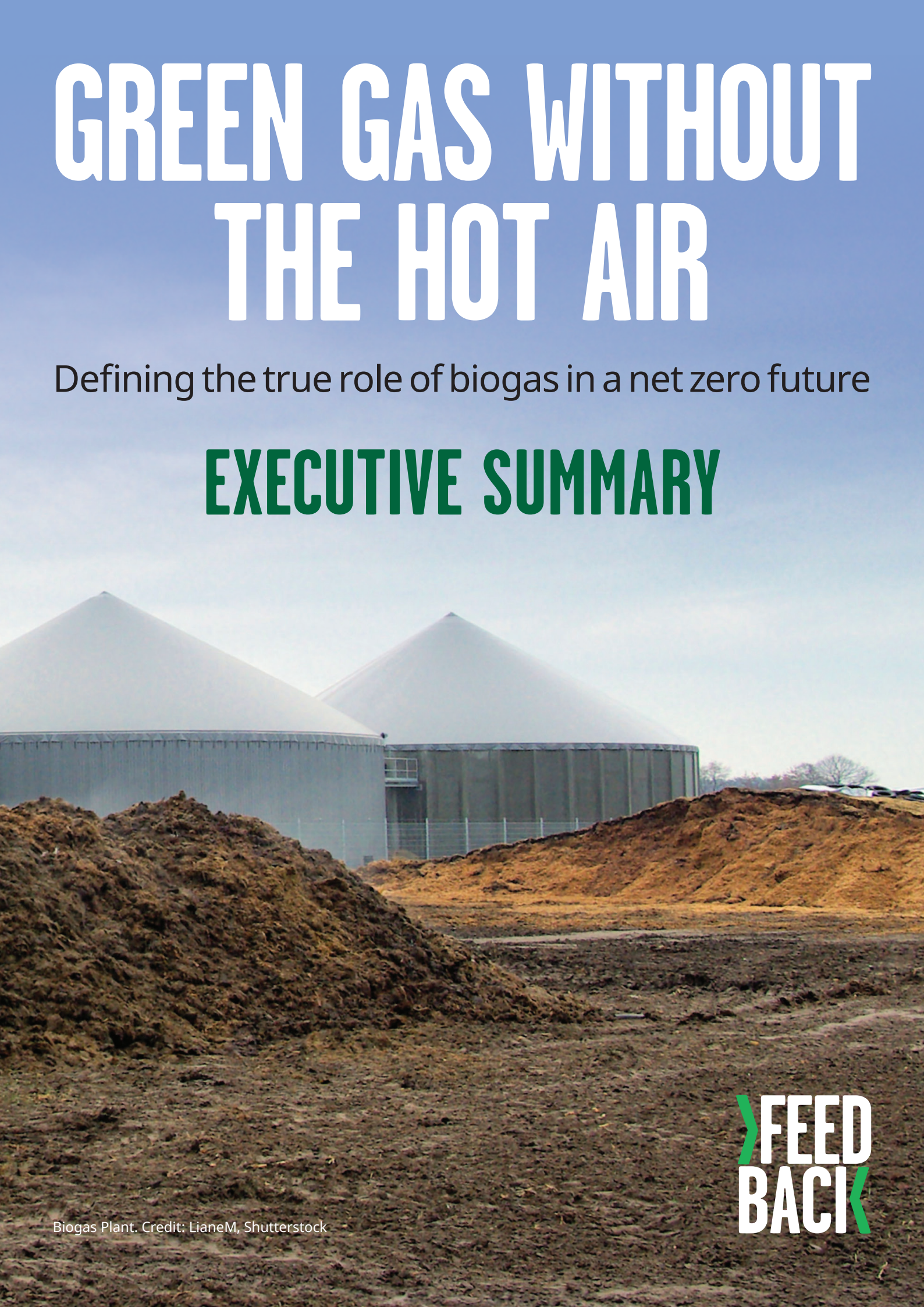
GREEN GAS WITHOUT THE HOT AIR

Defining the true role of biogas in a net zero future

EXECUTIVE SUMMARY



Biogas Plant. Credit: LianeM, Shutterstock

FEED BACK

EXECUTIVE SUMMARY

As countries and companies commit to net zero greenhouse gas (GHG) targets of varying ambition, anaerobic digestion (AD) has been framed as an environmental silver bullet, a form of renewable energy to rival wind and solar in its desirability and environmental credentials. 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. In the UK, the AD industry portrays itself as both a panacea for difficult-to-decarbonise sectors like heating and transport – by providing a sustainable source of power – and a solution to organic waste management – for multiple sectors from livestock farming to retail. At conferences with titles like *There's No Net Zero Without Biogas* (ADBA, 2019b), the industry argues that the AD and biogas sector is already cutting UK emissions by 1% annually, and has the potential to reduce emissions by 6% (Whitlock, 2019). This report takes a detailed look at whether the reality of AD can fulfil these promises in the context of an ambitious net zero future.

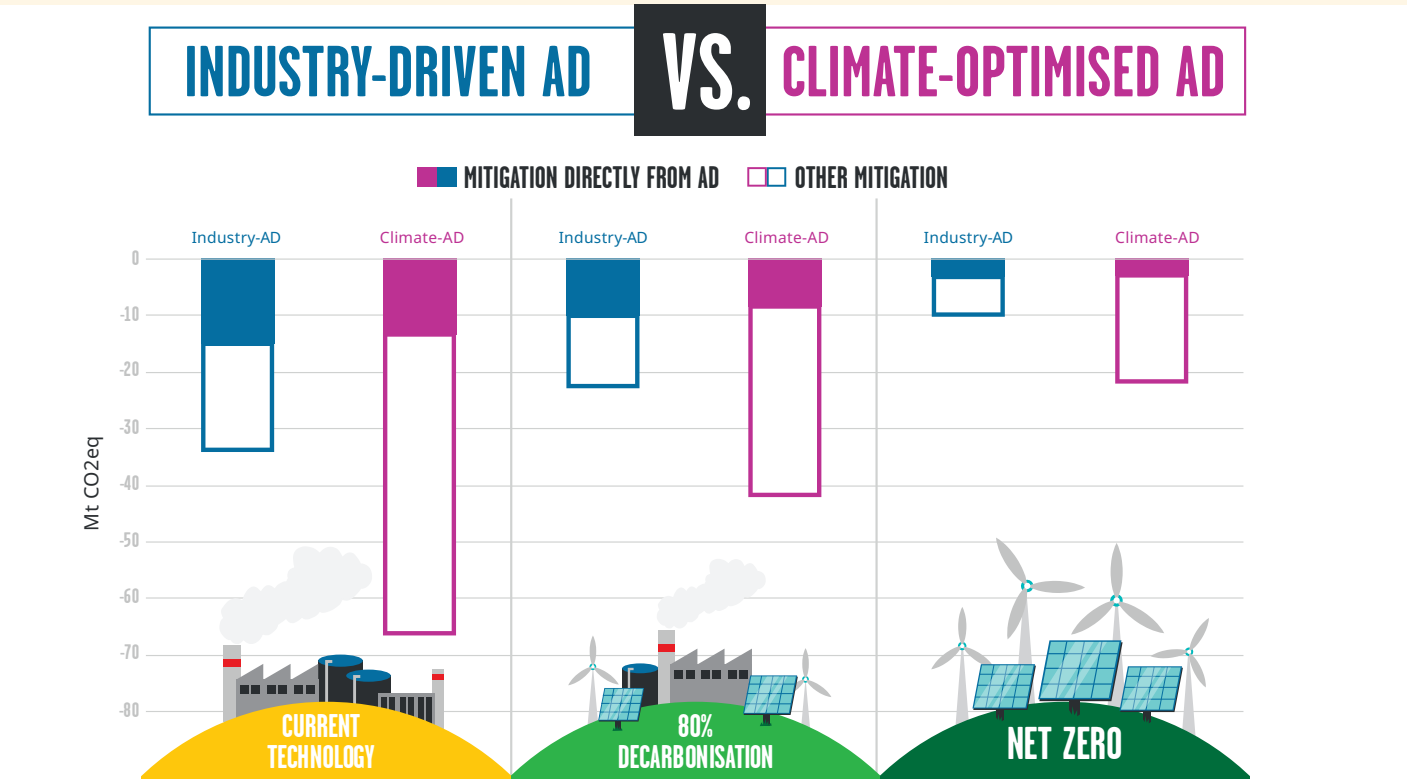
In the early to mid-2010s, AD was generously subsidised, making it a lucrative industry which grew significantly. Many finance companies, some of them based in tax havens, have generated significant profits from AD, largely as a result of subsidies. As subsidies have declined, the growth of the sector has recently stalled, but the AD industry still hopes to grow to 16–30 times its current size by 2032 (ADBA, 2018, p. 15), which would mean building around 100 new AD plants every year (WRAP, 2019a). More AD plants mean more feedstock inputs, and along this path to growth, the industry would increase its use of food waste, roughly double its use of crops, and more than triple its use of animal manures and slurries (ADBA, 2018, p. 16). To reach its goals, the AD industry is lobbying for the government to renew and increase subsidies to ensure it can compete with cheaper green energy alternatives like solar and wind. Key to the AD industry's sustainability claims are comparisons between AD and environmentally damaging alternatives for both energy generation and waste disposal, such as petrol and natural gas, landfill and open storage of manure. AD compares favourably to these options – presenting AD as the only alternative to 'unavoidable' waste streams and 'hard-to-decarbonise' sectors.

To date, the AD industry's claims have largely gone unchallenged. However, by comparing the AD industry's ideal scenario – one that maximises growth and draws the greatest subsidies – with a scenario in which policy decisions maximise proven climate change mitigation policies, this report shows that the benefits of AD have been overstated. Worse, the industry's ambitions may be crowding out better environmental alternatives. This report uses the results of a life cycle assessment (LCA) conducted in collaboration with researchers at Bangor University to shed some much-needed light on the limitations of AD, and show what role there is (and is not) for AD in a sustainable future.

We used two scenarios to build our LCA. In the first scenario – 'industry-driven AD' – the volume of feedstocks processed by AD is maximised roughly in line with the industry's growth ambitions, alongside some limited food waste prevention.

In the second scenario – 'climate-optimised AD' – fewer feedstocks are sent to AD, and sustainable alternatives to AD are prioritised instead, such as scaling up food waste prevention, afforestation of land, planting food for human consumption, and building solar photovoltaic (solar PV). These two scenarios were modelled in three contexts – our current context in terms of energy mix and land use, a context in which the UK economy was 80% decarbonised, and a net zero context (for more detail on our LCA modelling, see Section 4).

The results are startling.



In the current context, the climate-optimised AD scenario achieves roughly twice the emissions mitigation of the industry-driven AD scenario. It also produces enough additional solar PV energy output to meet 8% of current UK energy consumption, and enough extra food production to feed 8.6 million more people annually (13% of the UK population). The value of AD for emissions mitigation dwindles as the UK economy decarbonises and more environmentally friendly forms of renewable energy become dominant. **By the time the UK reaches our net zero context, the climate-optimised AD scenario would still achieve over twice the emissions mitigation compared with the industry-driven scenario.**

Our key findings and recommendations across four climate policy issue areas are set out below.

ENERGY GENERATION – ELECTRICITY AND GAS

Wind, solar and other renewables produce far lower emissions and are generally lower cost than AD, so the case for AD has usually rested on it providing biomethane ('green gas') for sectors that are more difficult to decarbonise – like gas heating and heavy goods vehicles (HGVs). Here too, there may be alternatives: it is important to carefully weigh up whether investments in faster and more comprehensive electrification of transport and heating systems might be preferable to sinking money into expensive biomethane-reliant infrastructure, locking in demand for AD feedstock long into the future (with many subsidies currently guaranteed over periods of up to 20 years).

Priorities such as building greater infrastructure for electric cars and converting heating systems to be run on electricity (for example, through heat pumps) may be more prudent long-term investments than investing in AD plants. For instance, there has been encouraging research into how even heavy freight vehicles could be electrified by the 2030s (Ainalis, Thorne and Cebon, 2020), one the sectors the AD industry has been keen to portray as difficult to electrify.

We recommend that renewable electricity subsidies are not given to AD, and support is instead directed to rapidly upscaling more efficient modes of production like wind and solar, plus energy storage solutions like batteries. For instance, AD should be excluded from Contracts for Difference (CfD) subsidies – but onshore wind and solar should be included, with levels of subsidy support increased for these technologies. We recommend that further comparative research is conducted into the relative economics and sustainability of prioritising biomethane or electrification of heat and transport systems.

Credit: Liane M

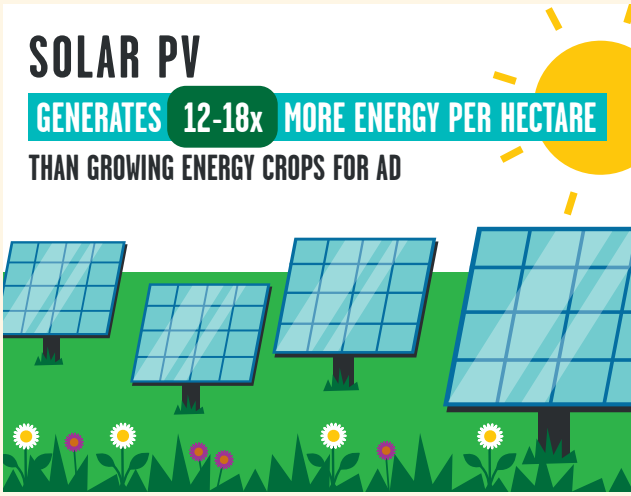
CROPS – PRIORITISING NUTRITION AND ENVIRONMENTAL REGENERATION

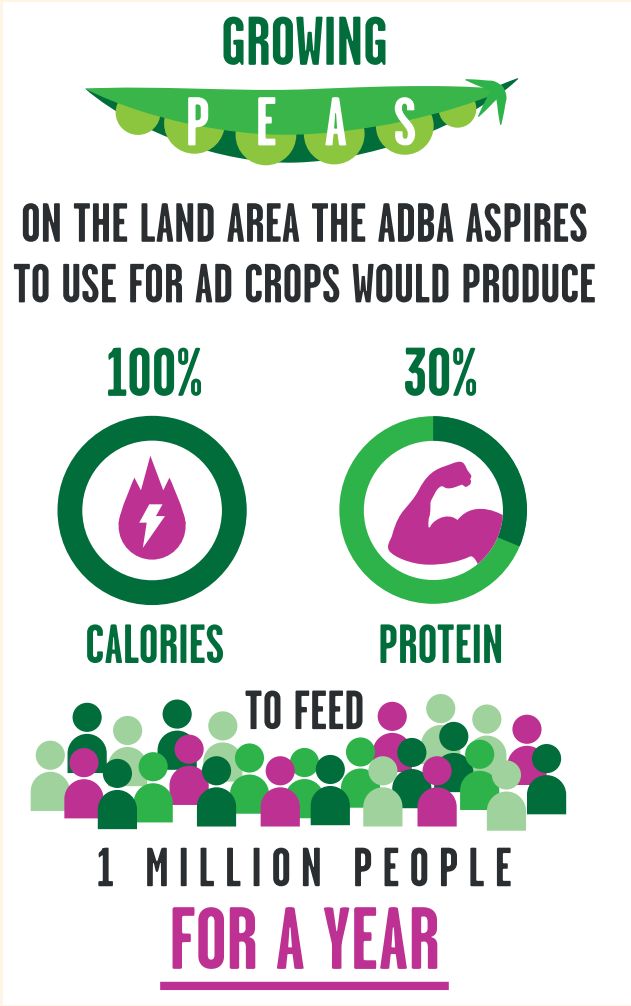
Even in our current energy and land use context, there are many better uses of land than 'bioenergy' crops like maize and grass. We found that **solar PV generates 12–18 times more energy per hectare than maize or grass grown for AD**. Alternatively, growing forests on land currently used to grow AD feedstocks would achieve between 2.6 times (vs maize biogas) and 11.5 times (vs grass biogas) more net GHG mitigation.

As the UK decarbonises, the emissions savings from growing crops for AD diminish even further. **By the time the UK reaches net zero, crop-based AD feedstocks become completely ineffective in emissions mitigation**, even assuming carbon capture and storage (an as yet unproven technology) is deployed at AD plants. In this context, grass AD feedstocks even become a net **producer** of emissions.

Currently, the crop most commonly grown for AD is maize, which is one of the most damaging crops for soils and uses valuable agricultural land which could be used for food production. **Beans, pulses and vining peas would be excellent candidates to replace maize when grown in rotation** – these would have a far better impact on soil quality, contribute to the UK's food security and assist the UK's transition to more plant-based proteins. If peas were grown for human consumption on the land area the ADBA aspires to use for AD crops, this would produce enough food for over 1 million people – 100% of their recommended calories per year, including roughly 30% of their recommended protein for a year. Oilseed rape is another alternative. Growing maize or grass as AD feedstocks has no role in a sustainable food system – whether the aim is energy generation, emissions mitigation or food security, far better alternatives are available.

We recommend that policy measures disincentivise maize and grass crops being used for AD – including removing subsidies for growing maize and grass as energy crops, and renewable heat incentive (RHI) subsidies for AD facilities using primarily crops. Potential future candidates for AD feedstocks should be rigorously evaluated to determine their sustainability and economic viability, as this is currently highly uncertain.





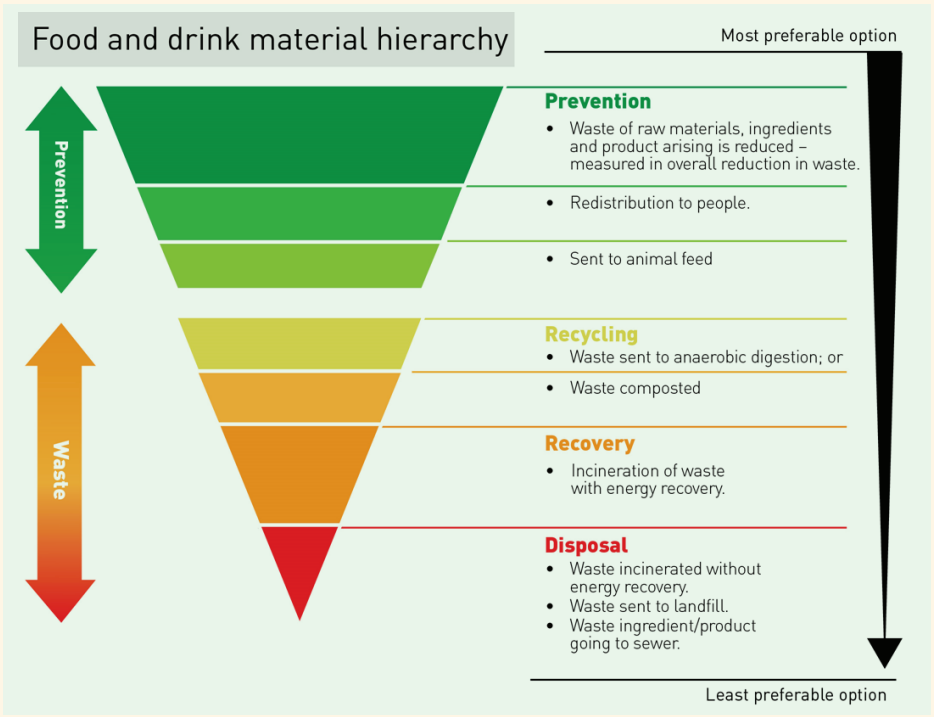
FOOD WASTE – A 'PREVENTION-FIRST' APPROACH

In the current context, preventing food waste results in direct emissions savings **over nine times higher than sending food waste to AD** (per tonne of food waste). If the grassland used to produce the meat and dairy that ends up as waste is instead afforested, emissions savings are **on average 40 times higher than sending the same volume of food waste to AD**, with spared cropland from other types of food waste also available to grow considerable volumes of food[1]. This means that preventing one tonne of food waste is environmentally equivalent to sending between 9 and 40 tonnes of food waste to AD.

1 In practice, most of the grassland saved in this way comes from the prevention of beef, lamb and milk waste – so reducing these types of food waste could result in far higher emissions mitigation per tonne saved. Foods grown on cropland would produce less or no extra emissions mitigation (unless trees were planted on former cropland) but could be used for considerable extra crop production to improve the UK's food security.

Prevention performs even better relative to AD in a net zero context. **Using food waste as animal feed saves nearly three times more emissions than sending it to AD** – and also saves significant areas of cropland for food production. Therefore, only unavoidable food waste that is inedible to humans or animals should be sent to AD, in line with the food waste hierarchy.

Figure 1: Food and drink material hierarchy



(WRAP, 2019b, p. 3)

AD is often used as a sticking plaster in place of the political ambition or imagination to achieve more fundamental change. **One of our LCA's most striking findings was that under the 'climate-optimised AD' scenario, halving UK food waste, with afforestation on the roughly 3 million hectares of grassland spared, would save and offset approximately 51 million tonnes CO_2eq – about 11.3% of the UK's current total GHG emissions. In**

addition, it would save 800,000 hectares of cropland which could produce 6.5 billion kcal per year more than the 'industry-driven AD' scenario – enough to feed 7.9 million people, nearly 10% of the UK population[2].

This scenario assumes an ambitious but achievable goal of halving UK food waste, in line with Sustainable Development Goal (SDG) 12.3, adopted by the UK in 2015, facilitated by greater regulation of food businesses. The scenario is significantly more ambitious than the pace of change currently set by the UK's voluntary food waste agreements – which would yield (at most) 63% lower emissions mitigation. In contrast, even in our most ambitious modelling for AD, **the maximum emissions mitigation attributable to AD is 3.3% of the UK's 2018 emissions**.

(The UK's current voluntary food waste targets aim to halve edible food waste only, using a baseline of 2007 onwards and excluding primary production from concrete targets. An ambitious regulatory target aims for 50% reduction of all food waste (in practice, a greater than 50% reduction of edible food waste) from farm to fork against 2015 baselines.)

2 This would decline in future decarbonisation contexts, but still be substantial.

This report finds that far from only dealing with 'unavoidable waste', when AD subsidies are set very high, as the AD industry is calling for, AD can actively hinder waste prevention, particularly when paired with a lack of regulation and funding for the better alternatives. Companies and redistribution charities have reported that edible food can be diverted down the food waste hierarchy to AD when incentives are skewed towards AD, hindering prevention efforts. Government funding for food waste prevention has been cut over the last decade, while AD has been heavily subsidised.

We recommend that the government makes funding for food waste prevention a top climate priority. Being eaten by people is, by a considerable margin, the environmentally optimal destination for food. Where this is not possible, the next priority should be sending food to animal feed. Fiscal policy, like subsidies, taxes and penalties, should be structured to ensure that it makes more economic sense to prevent food waste or send surplus food to animal feed in preference to AD, in line with the food use hierarchy. In addition, taxes on landfill and incineration should be increased so that AD is incentivised as a last-resort option, with the revenue raised used to fund greater food waste measurement and prevention. Regulations should be introduced to go beyond the pace of change set by voluntary agreements and achieve 50% reductions in all food waste from farm to fork by 2030, against 2015 baselines.

Credit: Feedback

MANURE AND SLURRIES – DISINCENTIVISING INDUSTRIAL LIVESTOCK PRODUCTION

The use of manure and slurries from livestock for AD shows the highest potential for emissions savings – mainly because of the staggering volumes produced by the intensive livestock sector. However, processing slurries may not be economically viable without huge subsidies, because slurries and manure have a very low energy density per tonne, which is why they are usually digested in combination with purpose-grown crops – which, as previously discussed, have questionable sustainability.

Again, there is a better alternative to AD – **preventing the manure and slurries from being produced in the first place (plus all the other emissions impacts of intensive livestock production), through reduced meat and dairy production and consumption.** This would reduce emissions substantially more than the mitigation potential offered by AD, and also has the potential to free up vast quantities of land for tree planting and additional carbon sequestration. The emissions mitigation from processing manure also significantly declines in future decarbonisation contexts because emissions from slurry storage and fertiliser production are projected to decline anyway.

A report commissioned by the Committee on Climate Change (CCC) estimates that a 50% reduction in the UK's beef, lamb and dairy consumption by 2050 could result in a 37% reduction in the total UK agricultural sector's domestic emissions by 2050 (CEH and Rothamsted Research, 2019, p. 29). It would also free up an estimated 4.2 to 6.9 million hectares of grassland[3]. If trees were planted on 4.2 million hectares, this would result in an estimated 54 million tonnes CO_2eq annual average carbon sequestration by 2032[4], which (assuming UK agriculture's emissions fall by 37%) would be enough to offset remaining UK domestic agricultural emissions nearly twice over[5]. Dietary shifts away from chicken and pork are also very effective – on average, switching from poultry meat to tofu results in reductions of 65% in emissions and 69% in land use (Poore and Nemecek, 2018 Figure 1).

AD subsidies may also actively facilitate the expansion of intensive livestock farming, through lowering the costs of waste disposal and helping factory farms obtain planning permission. The UK AD industry is advocating for AD subsidies to be raised to the same levels as in the early 2010s, which are roughly equivalent to the levels of AD subsidies which facilitated an explosion of intensive factory farming in Northern Ireland. **In this case, AD risks perpetuating and expanding the very polluting industry whose environmental effects it proposes to mitigate.**

3 The figure of 4.2 million hectares is 50% of the pastureland which Harwatt and Hayek (2019) estimate is currently used for animal agriculture. The higher figure is from the report commissioned by the CCC, which compares land use savings relative to a future 'business as usual' scenario where 12.26 million hectares of grassland are assumed to be used for agricultural production by 2050.

4 Extrapolated from Harwatt and Hayek (2019).

5 Based on the UK's domestic agricultural emissions in 2018: 45.4 million tonnes CO2eq (BEIS, 2020).

To make the best use of AD's potential for the mitigations emissions from manure production, we recommend that subsidies for AD of manure feedstocks should be reserved for smaller-scale, more sustainable livestock farms which have been in operation for at least 10 years and intend to own a stake in the AD plant. This support should be conditional on the farm not expanding its livestock production. Carbon, methane and ammonia emissions should be taxed (which would also disincentivise sending food waste to landfill), the 2027 ban on uncovered slurry and manure stores should be brought forward, and other measures should be taken to disincentivise the most environmentally destructive livestock farming. These measures will incentivise farmers to invest in AD over more damaging disposal methods, but will also make the most polluting sections of the livestock industry less financially viable. Revenues raised from these taxes could be used to fund a just transition for farmers into plant-based protein production, lower-impact meat production and becoming eco-stewards of newly afforested national parks. These schemes should be complemented with increased taxation on imported meats and animal feed, to ensure UK production is not simply replaced by imports.

Pig manure lagoon, Sussex. Credit: Farms Not Factories

A ROLE FOR AD IN A SUSTAINABLE NET ZERO FUTURE?

Climate science tells us that only the highest ambition will save us from the climate crisis. Especially fast and deep cuts in emissions are required in rich countries if climate equity is to be achieved (Civil Society Review, 2018; Climate Equity Reference, 2019; Jackson, 2019), and current pathways to achieve net zero emissions by 2050 show no signs of bringing about such cuts. To avoid catastrophic global heating, we need to imagine the most ambitious path we can to a better future and throw everything we have at making this a reality, using the best available evidence as our guide. Where AD is not the optimal solution, we do not have the luxury of settling for second best.

AD does have a 'sustainable niche', but it is much smaller than the role the industry envisages for itself. As a destination for food waste that cannot be prevented or sent to animal feed, AD can be preferable to landfill. It also mitigates manure and slurry emissions where meat and dairy are produced within a sustainable food system, for example as part of a mixed, regenerative and nutritionally optimised agricultural system. While we should not let 'perfect be the enemy of the good', nor should we use public funds to prop up an industry whose primary goal is the optimisation of profits, not the true minimisation of emissions.

We hope this report kick-starts a much-needed conversation about AD's role in a rapidly decarbonising economy. It is time to broaden our imagination to encompass the possibilities if we stop wasting land and resources, and start using them instead to restore nature, tackle the climate crisis and ensure high quality, healthy and planet-friendly diets.

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