WORLD BIOGAS ASSOCIATION

EXECUTIVE SUMMARY

Biogas: Pathways to 2030

> *If we do not address methane emissions from organic wastes all our efforts to tackle the climate crisis will fail. Anaerobic digestion is one of the ready to go, ready to scale technologies that can do this. The path we must take is clear.*
>
> **David Newman, President**
> **World Biogas Association**

Sponsors

ENGIE

SUEZ

WORLD BIOGAS ASSOCIATION

March 2021

Lead Author
Dr Nick Primmer

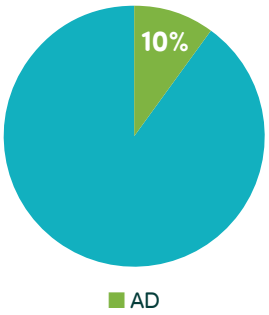
Contributors
WBA Policy, Innovation and Technical Committee (PITC):
Dr Amaya Arias-Garcia
Dr Gary Conboy
Elena Dorigo
Dr Liron Friedman
Olivier Grauwin
Dr Daniel Lee
Dr Keith Simons (Chair)
Jonas Svendsen

World Biogas Association (WBA):
Jon Hughes (Editor)
Charlotte Morton (Chief Executive)
David Newman (President)
Rebecca Thompson (Snr Policy Analyst)

Biogas: Pathways to 2030 Executive Summary

Humans directly or indirectly generate over **105 billion tonnes of organic wastes** globally each year, all of which release harmful methane and other greenhouse gas emissions directly into the atmosphere as they decompose. These organic wastes include food waste, sewage and garden wastes, food and drink processing wastes, and farm and agricultural wastes. **Today only 2% of these are treated and recycled.** By simply managing these important bioresources more effectively **we can cut global Greenhouse Gas (GHG) emissions by 10% by 2030**.

This report maps out how the global biogas industry can enable countries to deliver a 10% reduction in global GHG emissions by 2030. The pathways put humanity back on track to deliver by 2030 on the ambitions of both the Paris Agreement and UN Sustainable Development Goals (SDGs).



AD potential to abate GHG emissions by 2030

Methane accounts for 20% of all man-made GHG emissions (often measured in CO_2equivalence). Treatment of organic wastes through AD can cut 25% of all man-made methane emissions.

Therefore, by simply avoiding the methane emissions from the breakdown of organic wastes, AD can cut total GHG emissions by 5%. The remaining 5% arises from AD's ability to displace fossil fuels and artificial fertilisers.

Note: ~50-65% of total methane emissions are anthropogenic, arising from human activity. The remainder arise from nature.

AD Systems

Anaerobic Digestion (hereafter AD) is a series of biological processes in which micro-organisms digest organic wastes in the absence of oxygen, in sealed containers. It is the same natural process that we humans and mammals use to break down the food we eat in our stomachs. The process extracts the energy this organic material contains in the form of biogas, which is a mixture of methane (approx. 60%), carbon dioxide (approx. 40%) and other trace gases. The organic material left over, known as digestate or biofertiliser, is rich in organic matter and nutrients such as nitrogen, phosphate and potash. Returning all this organic material back to soil is vital for our food security, and explains why AD is at the heart of the circular economy of organic wastes.

AD systems are highly flexible, scalable and extract the greatest value out of organic wastes. AD can operate at sizes from that of a test tube to tanks of many thousands of cubic metres. As such it is adaptable and can just as well address 9 of the 17 Sustainable Development Goals[1] in the remotest parts of the global south to the organic wastes created by world cities such as New York.

Scale	Tank Size	Gas Use
Micro	0.2m³–100m³	**<20m³**: heating and cooking **>20m³**: heating or Combined Heat and Power (CHP) 3–25kWe, depending upon feedstock and loading rate. **0.2m³** tank is practical enough to provide cooking gas for a small household. **80–100m³** capacities are usually more economic to build a single fixed tank.
Small	100m³– ~1000m³	CHP ~ 10kWe–200kWe, depending upon feedstock and loading rate. Gas heating possible, as well, particularly at lower end.
Medium	~1,000m³+	CHP ~100kWe – 1MWe. Or biomethane upgrading >2.5MW
Large	~4000m³+	Biomethane upgrading 2.5 MW + (+ CHP to power AD plant)

© Table courtesy of Angela Bywater, EB-Net

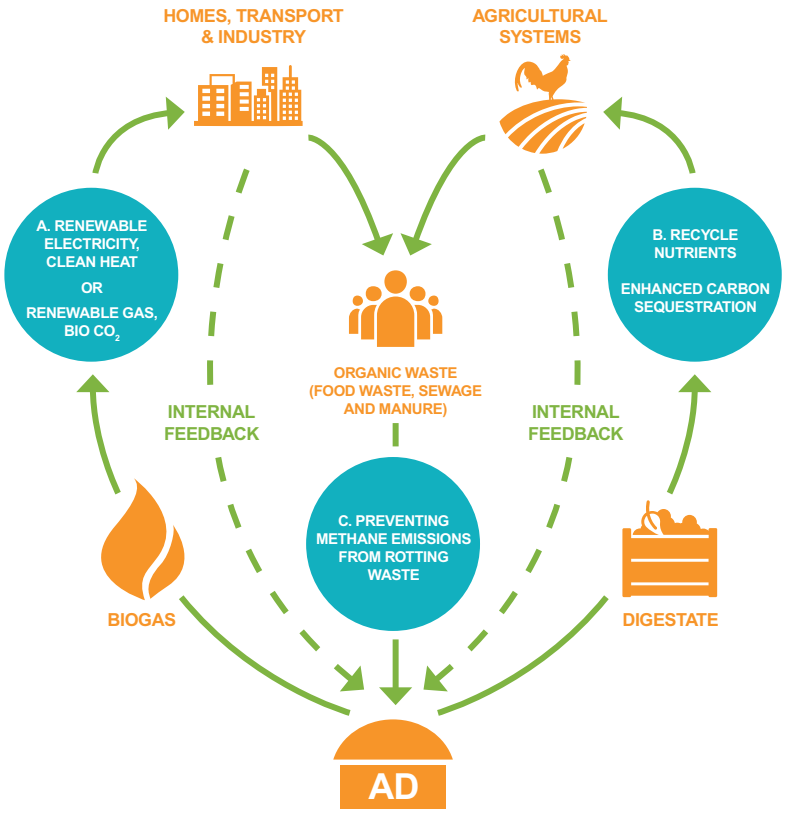
* The identification of scale is completely arbitrary since tank size/gas use are so dependent upon factors, particularly feedstock and loading rate. However, the notes provide good guides.

There are many types of AD system, depending on the feedstock. They can be designed to treat wet or dry wastes – known as wet-AD and dry-AD – or a mix of both. In countries where dry-AD is the norm the AD process often includes a composting phase.

Benefits of AD

"Biogas from anaerobic digestion is not merely a concept of production of renewable energy; it cannot be compared to a wind turbine or a photovoltaic array. Nor can anaerobic digestion be bracketed as just a means of waste treatment or as a tool to reduce greenhouse gases in agriculture and in energy. It cannot be pigeonholed as a means of producing biofertilizer through mineralisation of the nutrients in slurry to optimise availability, or as a means of protecting water quality in streams and aquifers. It is all these and more.

The multifunctionality of this concept is its clearest strength. Sustainable biogas systems include processes for treatment of waste, for protection of environment, for conversion of low-value material to higher-value material, for the production of electricity, heat and of advanced gaseous biofuel. Biogas and anaerobic digestion systems are dispatchable and as such can facilitate intermittent renewable electricity." **IEA**[2]



[1] https://sdgs.un.org/goals

[2] www.ieabioenergy.com/blog/publications/the-role-of-anaerobic-digestion-and-biogas-in-the-circular-economy/

Overview

Time and carbon budgets are running out. We have 10 years left to prevent runaway global warming, say the world's leading scientists[3]. Failure to act will result in worse droughts, floods, extreme heat events and poverty for hundreds of millions of people, animals and wildlife. This will mean mass climate-related migrations and brain drains, as energy, food and health insecurities erupt around the world, as the world is already starting to see. However, a just and affordable transition is possible. The scientists are supported in this view by the world's leading economists Joseph Stiglitz and Lord Nicholas Stern. The 'Build Back Better' paper[4] the pair released in 2020 was supported by treasury chiefs at over 250 national banks and government ministries.

The decade of decarbonisation

The Paris Agreement commits countries to achieve carbon neutrality by 2050, to achieve a balance after 2050 between atmospheric inputs of greenhouse gases by emission sources and removal into sinks (forests, oceans, and soil, which could be combined with technologies to extract and sequester carbon dioxide from power plants). This was signed by 197 countries in 2015, with the ambition to keep global warming below 2°C, to avoid the worst but not all the negative impacts of climate change (hence countries are now being asked to target 1.5°C). But most countries are way off target, according to the Climate Action Tracker[5]. That is why we need to act harder and faster over this decade.

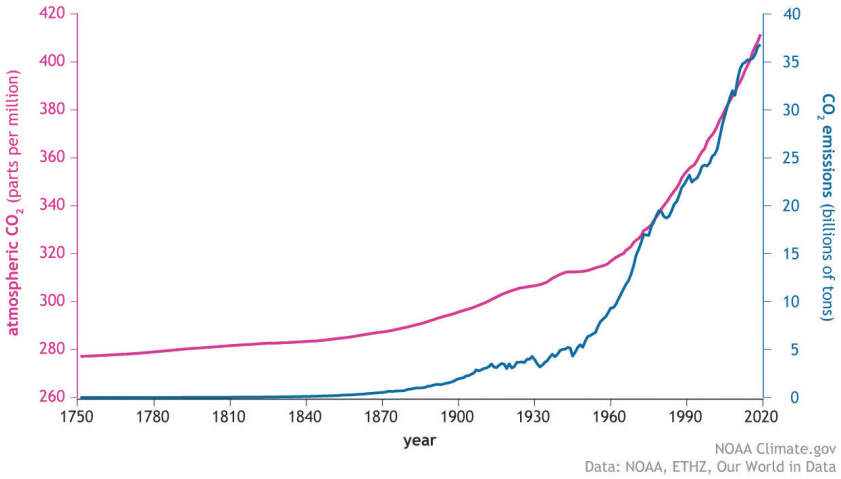
The two key drivers of global warming are widely accepted to be emissions of CO_2 (~80%) and methane (~20%) caused by human activity, although NOx and other such emissions also have a forcing effect. Addressing methane holds the key to success. This is because of the different life cycles of the greenhouse gases, during which they remain actively warming the planet. While methane typically stays in the atmosphere for 35 years, its global warming potential is far greater than CO_2. As a consequence, one tonne of methane released over the next decade is equivalent to releasing 83 tonnes of CO_2. The International Energy Agency, European Commission and US Environmental Protection Agency are among many concerned parties calling for urgent action and for methane to be high on the agenda at COP 26 in Glasgow.

The scale of the problem

To tackle the challenge of methane emissions we need to capture and treat the 105 billion tonnes of organic wastes directly or indirectly generated by human activity every year. By simply managing these important bioresources more effectively **we can cut global GHG emissions by 10% by 2030**.

Anaerobic digestion (AD) is recognised by multiple agencies as the solution, including;

- UN – "it is a win-win-win-win-win technology, ready to go, ready to scale"
- IEA – "AD sits at the heart of the circular economy, you can't close loops without it"
- EC Methane Strategy – "AD and biogas should be incentivised to address the methane crisis"



CO_2 in the atmosphere and annual emissions (1750-2019)

[3] www.ipcc.ch/sr15

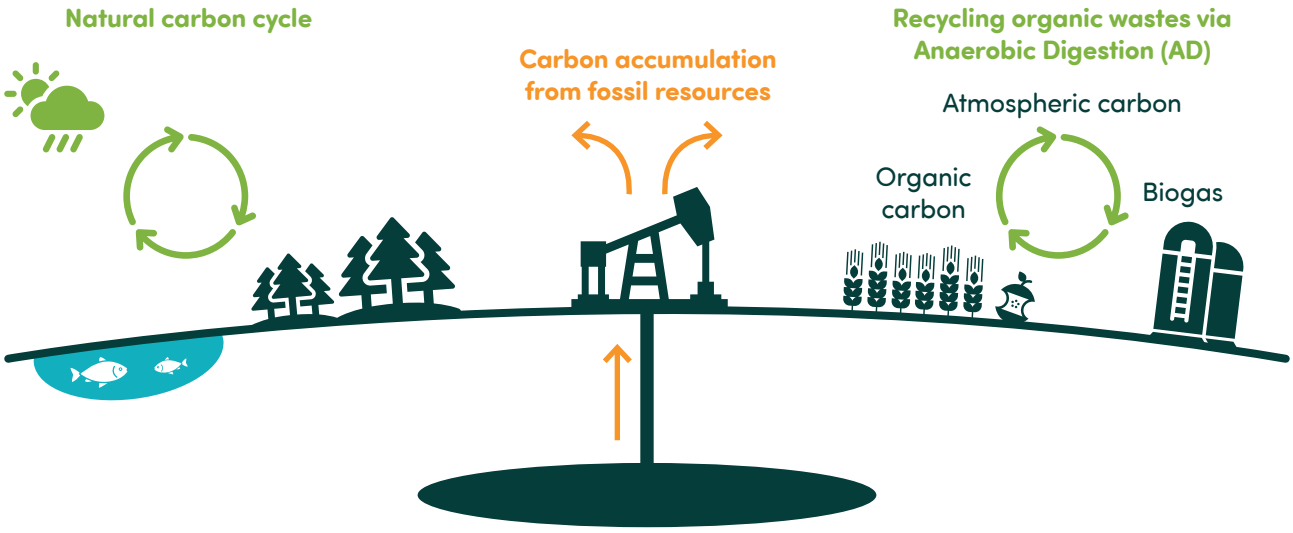
[4] www.ox.ac.uk/news/2020-05-05-building-back-better-green-covid-19-recovery-packages-will-boost-economic-growth-and

[5] https://climateactiontracker.org/countries/

Recycling organic wastes through AD is a nature-based solution that is part of the natural carbon lifecycle. Fossil fuels disturb the natural carbon lifecycle by putting carbon that nature has stored underground over millennia back into the atmosphere. It is the burning of fossil fuels over the past 150 years that has increased the amount of carbon in the atmosphere to its current level, which is causing Climate Change. All carbon within organic materials above ground originates from the atmosphere; and so digesting organic wastes and using all the outputs – biogas, bio-CO_2 and bio-fertiliser - simply completes the carbon cycle.

When organic wastes are recycled through an AD plant, carbon savings are delivered across multiple fronts:

(1) the harmful GHG emissions they would otherwise emit are prevented
(2) the energy they contain is extracted in the form of biogas, which is a mixture of biomethane and CO_2, displacing fossil sources of energy and associated CO_2
(3) the nutrients within organic wastes are recycled into an organic fertiliser (or 'digestate'), replacing the need for artificial fertilisers which are very energy intensive to produce
(4) the carbon in the digestate is returned to soil
(5) Unlike fossil fuels, which are extracted from the ground, the carbon in biogas originates from the atmosphere and is contained within the organic wastes
(6) CO_2 can be captured and stored, making the process carbon negative and actively reversing carbon emissions. Alternatively, CO_2 gas may be used within industry – e.g. food and drinks manufacture, refilling fire extinguishers etc – or to create platform chemicals. CO_2 and biomethane are also compatible with a hydrogen future and the creation of bio-based fuels for aviation and shipping.



The Pathways

This report is not prescriptive. It reflects the fact that different countries are on vastly different stages of their biogas journey. Denmark, for instance, is approaching 30% capacity while Bangladesh is just at the start of its journey. To that end, it sets out:

(1) the policy mechanisms to create an enabling environment to capture organic wastes, prevent methane emissions from them and turn them into valuable resources;
(2) opportunities arising from an emerging asset class and sustainable frameworks from institutional funds;
(3) and what the sector must do itself to enable the required growth.

Policy Mechanisms

The major barrier to growth of the AD industry is the fact that its many services are not recognised or rewarded financially. Treating organic wastes through AD tackles air pollution, which the Organisation for Economic Co-operation and Development (OECD) estimates costs $2.6 trillion and results in 6-9 million premature deaths worldwide each year, where children are one of the most vulnerable groups. It improves water quality and associated clean-up costs.[6] The biofertiliser produced from recycling nutrients improves the carbon capture capability of soils and improves biodiversity by mitigating the use of mineral fertilisers and pesticides. It creates skilled jobs and boosts rural economies. Yet AD is primarily viewed as a renewable energy generator at the expense of these beneficial health, environmental and social impacts.

An international carbon tax and trading scheme would be the most efficient means to price AD's services into the market and reflect AD's position at the heart of the circular economy. However, this will require a great deal of political will and global cooperation. It is therefore proposed as an end-goal, achievable towards the end of the decade, to set the industry up for ongoing success and independent viability, beyond the changeable whims of national governments.

We cannot wait until then to act. In the intervening years it is vital that countries commit to treating their organic wastes through AD in their respective Nationally Determined Contributions (NDCs).

One million tonnes of...	Biogas potential (GWh)	Decarbonisation potential (tonnes CO_2e)
Food waste	1,008	826,000
Sewage sludge	814	704,000
Livestock waste	412	161,000
Crop residues	2,378	450,000
Sequential crops	2,610	747,000

A raft of policies is needed across the different aspects of the AD industry to achieve these benefits, covering organic material recycling policies, digestate policies, and biogas utilisation policies. An overarching framework would look like this (page 8).

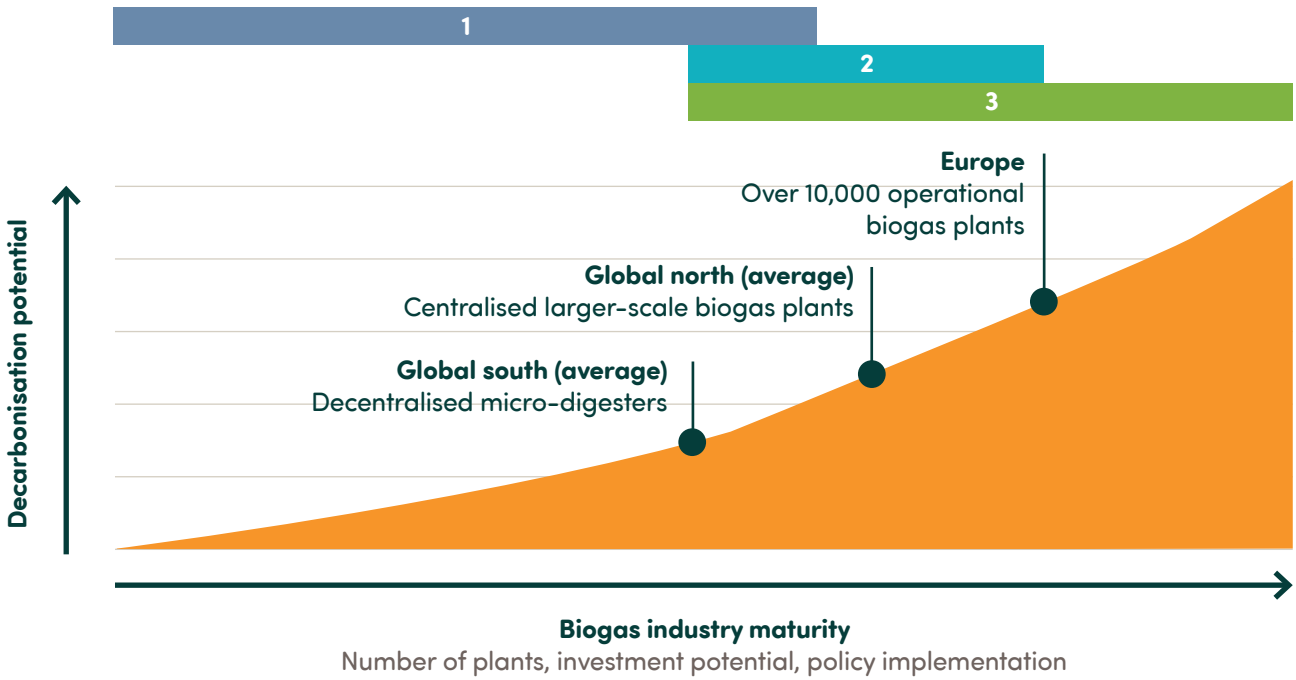
[6] www.oecd.org/env/air-pollution-to-cause-6-9-million-premature-deaths-and-cost-1-gdp-by-2060.htm

Overarching Policy Timeline

(1) Commitment to biogas in NDCs, backed by tariffs
Biogas should be incorporated into NDCs and backed up by effective national policies to incentivise growth in the industry targetting the recovery of organic material and nutrients to return to soils; the generation of biogas for energy and transport; and CCUS from biogenic wastes. At the early stages of biogas industry development these support mechanisms, for use and/or generation of biogas, bio-CO_2 and digestate should take the form of direct financial support, most likely a tariff. It is vital that infrastructure to support the industry growth, such as collection of organic wastes, accompanies the development of the industry to ensure there is sufficient feedstock available for AD plants.

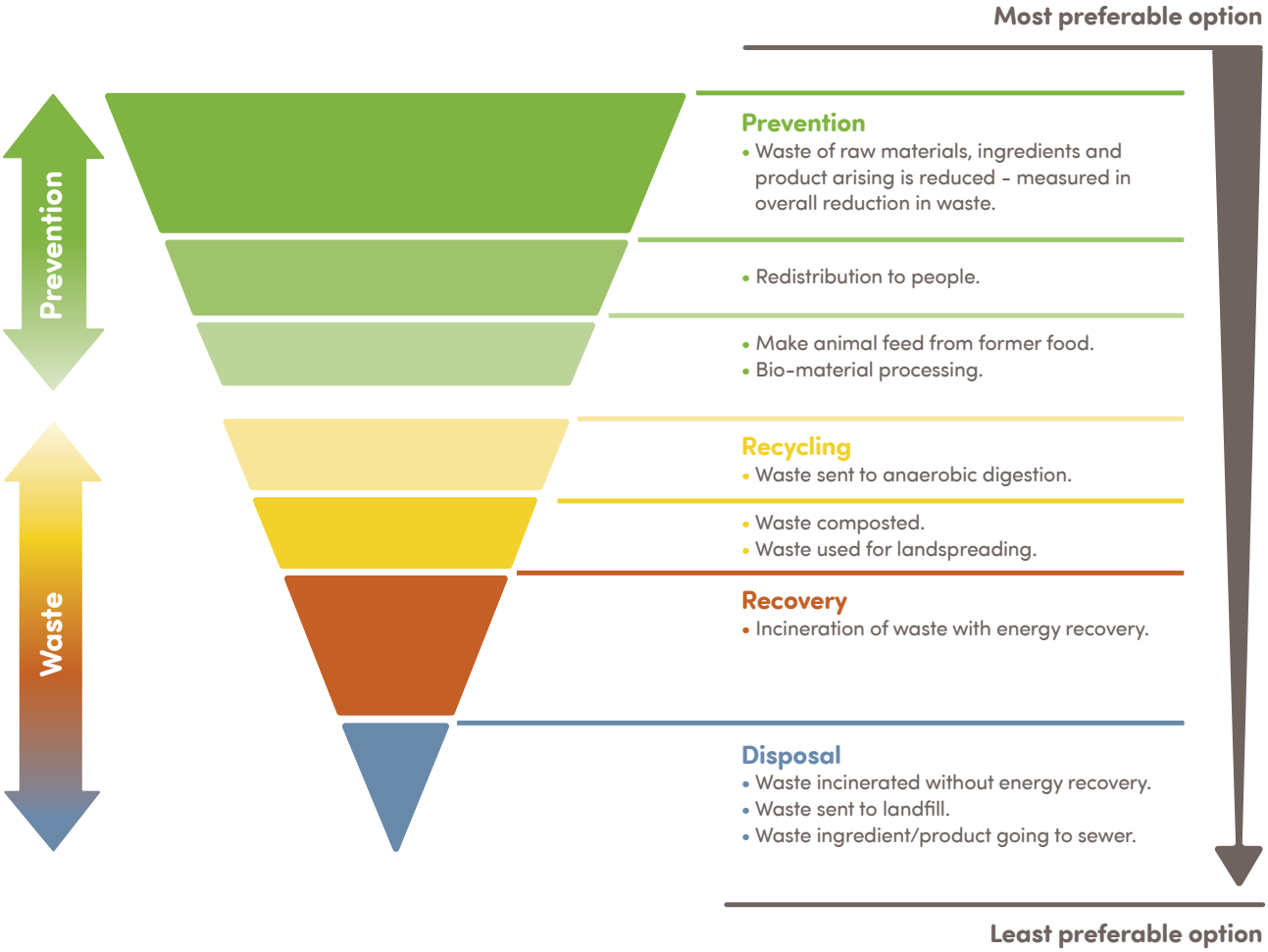
(2) Transition to more market based policy support
As the industry grows and matures, policy can move away from direct subsidy to facilitate a market for the environmental benefit delivered by the biogas industry, while enabling the national biogas industries to become independent of direct subsidy. This should be accompanied by the balanced removal of all direct support for the fossil industry to ensure there is a level playing field before any subsidies for biogas are removed. It will also be beneficial for governments to clearly set out their support for and backing of the biogas and organic waste recycling industry in a clear strategy to provide investor confidence as direct subsidies are tapered away.

(3) Carbon pricing policies
Introduction of national, regional and finally global carbon trading mechanisms to create an effective market for the climate benefits delivered by the biogas industry, pricing in the value of the carbon saving delivered and enabling biogas projects to stack up financially, independent of national policy support. It is vital that the scope and methodology of carbon pricing mechanisms developed effectively cover the biogas industry, e.g. they must cover GHG emissions, methane capture and carbon sequestration from agriculture and from organic wastes generated by human activity.



Specific policy recommendations across sectors are addressed in the report in detail. A principal requirement is for all organic wastes to be subject to an agreed waste material hierarchy, such as that issued by the UN Food and Agriculture Organisation on food waste. All organic wastes should first be prevented, then recycled before recovery and disposal is considered.

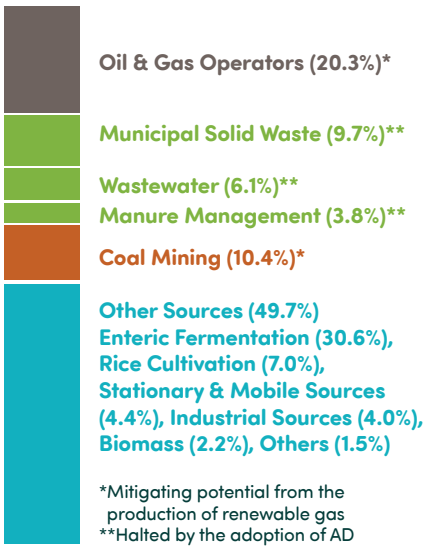
Food and drink material hierarchy



The hierarchy has proved successful in driving up levels of food waste collection across the globe, with many existing examples to draw on, from South Korea to Wales. The EU 27 + UK are to mandate it be followed from 2023. **Mismanaged food waste and wastewater is responsible for ~16% of global man-made methane emissions.**

Strategic frameworks to mitigate methane emissions, following the example of the EU's Methane Strategy, should include treatment of farm wastes through AD to cut agricultural emissions with robust domestic policies to support this. The BiogasDoneRight (BDR) model, using sequential cropping and digestate (biofertiliser) is becoming a globally recognised blueprint for this, with $10m being invested in pilot studies in the US. The BDR model reflects the "4 per 1000" principle – i.e., increasing the carbon sequestration capability of soils by 0.4% will enable nature to compensate for greenhouse gas emissions caused by human activity. In certain countries such as France, farmers are rewarded for treating their manures and slurries through AD. **Mismanaged manures and slurries and crop burning are responsible for ~11% of global man-made methane emissions.**

Estimated Global Methane Emissions from Human Activities in 2030



*Mitigating potential from the production of renewable gas
**Halted by the adoption of AD

Renewable Finance

Finance is shifting in favour of sustainable solutions, both institutionally and within an emerging asset management class associated with the transition to a green economy, in the form of renewable infrastructure funds. Renewable infrastructure funds listed on London Stock Exchange are worth a combined £10bn and have raised more than $6bn in further capital since their listing.

Companies are increasingly concerned about the sustainability of investments so have created a methodology to measure the Environmental, Social and Governance performance of listed companies. In 'Your Guide to ESG reporting' the London Stock Exchange states, *"Once upon a time, environmental, social and governance (ESG) factors were a niche interest among asset owners, asset managers, banks, brokers and investment consultants. No longer. Investors now routinely analyse information on ESG performance alongside other financial and strategic information in order to gain a better understanding of companies' future prospects."*[7]

Examples of the FTSE Green Revenues Definitions, FTSE Green Revenues Classification System:

Energy Generation Waste to Energy
Companies generating power through the use of domestic, agricultural and commercial refuse as fuel for both thermal and non-thermal energy creation where the reduction of greenhouse gas emissions is a significant function of the power generation process either on a life-cycle analysis basis or at the point of generation.

Energy Equipment Bio Fuels
Companies providing goods, products and services including components, specialist materials, bespoke manufacturing and maintenance processes, design and operational support capabilities that enable the generation of power through the use of crops, plants and other organic materials as fuels where the reduction of greenhouse gas emissions is a significant function of the power generation process either on a life-cycle analysis basis or at the point of generation.

Energy Equipment Waste to Energy
Companies providing goods, products and services including components, specialist materials, bespoke manufacturing and maintenance processes, design and operational support capabilities that enable the generation of power through the use of domestic, agricultural and commercial refuse as fuel for both thermal and non-thermal energy creation.

This is evidenced by the shift in corporate funds, to address their emissions from production (Scope 1) and down the supply chain (Scope 3). So we see the likes of Nestlé investing in AD at its production facilities but also offering 0% finance to its raw materials' suppliers, to green the company's supply chain.

Institutionally, the World Bank is proposing to restructure its lending policies. In its discussion document 'Transformative Global Finance' it says money should go to projects that deliver the best financial results and kick start wider infrastructure development to support actions on climate change.

The UN has an Ethical Finance division, in support of delivering its Sustainable Development Goals (SDGs) which are intended to be delivered by 2030. It also has a Sustainable Finance Initiative to deliver its climate goals.

Institutional funding can fast-track a country's adoption of AD and biogas for a country starting from a low base, such as Bangladesh. A city in the country could look to fund a massive infrastructure project to tackle its food waste and wastewater, benefitting householders with renewable energy and farmers with renewable fertiliser.

Meanwhile, the UK has just announced plans to launch a Green Bond to finance the green transition reflecting the fact that major global institutions, industry bodies and policy makers, including the G20, have backed the development of this market.

[7] www.lseg.com/esg

The EU is developing a taxonomy in support of its Green Deal, in which biogas generation from organic wastes is recognised. The taxonomy seeks to create common definitions of sustainable development across its 27 member countries. It is being called on to prohibit funding for energy from waste projects in favour of AD, as the former amounts to disposal of resources that could be recycled.

National Green Banks also have a role to play. A study by the Rocky Mountain Institute found that where green banks exist they have a leverage ratio of 2.3, i.e. against $24.5bn of their own capital, $45.5bn private capital was leveraged.[8]

To draw these streams of funding toward the development of AD and biogas requires action on behalf of the industry.

What we must do to enable growth

To capitalise on this financial revolution the AD industry needs to comply with the criteria being established. That means we must come together as a cohesive global biogas industry to develop and adhere to best-in-class principles and norms associated with responsible investing (including good governance and supply chain transparency).

We should also actively contribute to science-based thought leadership around carbon pricing, accounting and reporting, and adopt methods that successfully monitor and verify the sustainability and environmental safety of our processes (thereby providing comfort to the investor community). Within that framework the industry will have to develop best available techniques and standards for operation, which will require the development of certification and training schemes.

Developing such an audit for biogas would remove one of the greatest barriers we face and spur the political will to create the enabling environment the sector needs.

The biogas industry has proved itself more than capable of delivering this. In 2019, the leaders of major biogas corporations from around the world gathered in Paris to sign the World Biogas Association's Biogas and Climate Change Commitment Declaration. The signatories pledged to put their full human, financial and technological resources behind enabling the rapid expansion of biogas in all parts of the globe to deliver the decarbonisation and associated benefits addressed in the report.

The declaration was warmly welcomed by the UNFCCC, which governs the Paris Agreement. At its full potential, the AD industry can create over 10-15 million skilled jobs around the globe and address the ambitions set out in the Paris Agreement and the UN SDGs as well as meet the desire to 'build back better' environmentally and socially from the Covid-19 pandemic.

In nature, ecologists will tell you there is no such thing as waste. AD allows human activity to attune itself to nature. We need to quantify these multiple benefits.

Conclusions

Whilst giving a recipe suitable for every country is near to impossible there are undoubtedly some common elements that nations can adopt. Just helping them to understand the necessity of capturing all the organic wastes their society produces and the value they can obtain by recycling them through AD will be a major achievement.

This report seeks to ensure that no policy maker will be able to say, "I didn't know", as they consider how the biogas industry can be adopted into their own climate change policies, specifically their Nationally Determined Contributions to maintain climate warming well below 2°C.

As the volumes of organic wastes increase due to population growth, urbanisation, change of diets, they produce ever greater amounts of harmful gases impacting our climate and air quality, above all through the uncontrolled release of methane, black carbon (soot) and ammonia. This needs to stop and AD can deliver on this now.

[8] https://rmi.org/insight/state-of-green-banks-2020/

If harvested, these organic wastes will provide sources of renewable energy, green CO_2 natural fertilisers and other valuable bioproducts thereby playing a multifaceted role that other renewable energies cannot. Moreover, the production of biogas is continuous (baseload) and does not suffer from the fluctuation of wind, solar and hydro sources, making biogas a perfect integrator to these. Biogas can produce heat, electricity and fuel all off-grid and depending upon the geography of installations, one or the other uses may be more beneficial.

Investment in AD also has long-term security. Biogas is compatible with a hydrogen future. Low carbon biomethane can be converted into green hydrogen, or hydrogen can be converted to biomethane when mixed with biogas' CO_2. In this way biogas is future-proofed, adapting to the energy needs of the future.

The beauty of AD is its versatility. It can be installed on a micro level to recycle a household's waste, and for cities large scale merchant facilities can recycle 500,000 million tonnes annually. It can handle wet or dry wastes, or a mix of both, and can be used in conjunction with composting depending on the soil requirements in a given geographical area. It extracts the greatest value out of organic wastes and turns them into valuable renewable resources.

Each Government when reviewing its NDC under the Paris Climate Treaty should include the collection and recycling of organic wastes among its target instruments. The collection of urban food wastes, the reduction of uncontrolled burning of stubbles and harvesting of animal manures are all part of the policy landscapes which bring us greater sustainability and better-quality air, water and soil outcomes. Governments should therefore not simply measure biogas in terms of the cost of the kilowatt hour or megajoule of heat, but in the overall beneficial outcomes biogas produces through the whole range of its environmental services and wider benefits to humanity.

Above all, this is a technology that exists today. Can we afford not to take an opportunity to reduce global emissions by 10% by 2030, and at the same time improve our energy and food security and create millions of new green jobs worldwide?

Decarbonisation and defossilation

Throughout this Executive Summary, the term 'decarbonisation' is used to convey the act of cutting net GHG emissions. It conveys AD's ability to recycle carbon from atmosphere, while reducing the need to use non-renewable fossil resources. 'Decarbonisation' therefore encompasses the term 'defossilisation', which relates more specifically to cutting the use of fossil resources – i.e., preventing old carbon stored in fossil coal, oil and gas from entering the atmosphere.

The World Biogas Association

The WBA is a non-profit association dedicated to the development of biogas globally. We are available to offer services to countries, cities and industries wanting to know more about biogas, its technologies, the policies and incentives needed to ensure biogas is made a core solution to resolving global challenges around sustainable development, climate change and public health.

The future of biogas is now
Join us in realising our mission

E: **info@worldbiogasassociation.org**
T: +44 (0) 20 3735 8116

WORLD BIOGAS ASSOCIATION
Sustainable Bankside II, 25 Lavington Street, London, SE1 ONZ, UK | @WBAtweets
worldbiogasassociation.org | info@worldbiogasasscoiation.org | World Biogas Association