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The Global Rise of Biogas: Renewable Energy, Regenerative Agriculture and Anaerobic Digesters

Biogas from anaerobic digestion has the potential to significantly offset global fossil fuel use by utilising natural renewable gas, which is circular in the carbon cycle. The process of anaerobic digestion converts organic waste streams into biogas, capturing the associated greenhouse gas (GHG) emissions, which can then be used as a renewable energy source.

Several co-benefits are also now being realised through anaerobic digestion, including the enhancement of on-farm regenerative agricultural practices and the production of uniform, nutrient-dense digestate. Additionally, anaerobic digestion offers attractive revenue streams and energy security, making it a sensible option from both a capital investment and sustainability perspective.

All the necessary levers are in place to create a successful energy and sustainability proposition, positively reflecting on the agri-food sector.

The Climate Crisis

In 2016, international communities agreed to limit global warming to 1.5°C above preindustrial levels, or well below 2°C, through the Paris Agreement, following repeated warnings from climate scientists. In 2024, the 1.5°C limit was temporarily reached, underscoring the urgency of climate scientists' recommendations.

In addition to posing an existential threat to plants, animals and humans, climate change has been described as the most threatening issue to economic stability globally. This is certainly true for agriculture, which is already seeing negative impacts through weather extremes and an increase in natural disasters, including hurricanes, droughts and flooding.

Climate change, under a 2°C warming model, poses an even more significant threat to agricultural production. And the closer the climate gets to that threshold, the more severe the impact. At 2°C above preindustrial levels, climate models suggest drops in crop yield, a decline in aquaculture output, and decreases in milk and meat production.

These impacts highlight the urgent need for a transition away from fossil fuel use, both to protect the planet and to improve food security.

Agriculture's Role in Climate Change

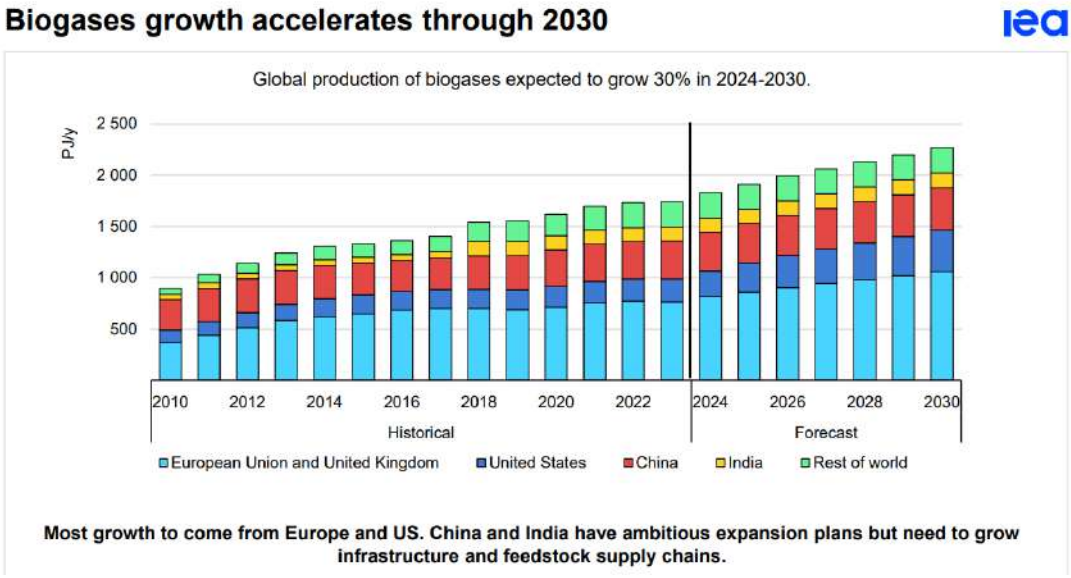
While burning and extracting fossil fuels for energy accounts for 73% of CO_2 equivalent (CO_2e) of global GHG emissions, agriculture is also under pressure for its environmental footprint, contributing 18% of global CO_2e emissions. This includes emissions from livestock, manure, crop production, deforestation and soil management.

Waste management contributes to 3% of all emissions, including wastewater and landfill GHG emissions. The agri-food sector has a role to play here as well, as poorly managed organic waste, including food waste and manure, are significant contributors to anthropogenic GHG emissions. Nitrous oxide (N_2O), typically linked to fertiliser volatilization, soil enzymatic activity and manure management, is 273 times more warming than carbon dioxide (CO_2), while methane (CH_4) is 28 times more warming than CO_2.

This is where anaerobic digestion can play a key role. Redirecting organic landfill, food waste and livestock manure to anaerobic digestion creates an opportunity to trap those gases and use them as energy sources. This helps provide energy that is locked into the natural carbon cycle, thus being a "net zero" energy option.

Building a Biogas Revolution

While progress has been building across the globe in the coordinated attempt to avoid and reduce greenhouse gas emissions, the scientific community warns that efforts need rapid scaling to make significant progress toward targets.



https://www.europeanbiogas.eu/wp-content/uploads/2024/10/24-Oct_All-Day-Sessions.pdf

Currently, renewables – including biogas, wind, solar, hydro and geothermal energy – meet about 15% of the world's energy demands. Biogas makes up 2% of that share, indicating significant scope for growth. If the full potential of biogas is to be met, up to 9% of total global energy consumption can be fulfilled. It is also estimated that this output could replace up to 30% of coal use globally, or transition 100% of agricultural energy requirements from fossil fuel to biogas. This suggests that biogas production will be a key lever in the transition to renewable fuel sources. In fact, it's estimated that biogas could reduce global GHG emissions by up to 13%.

At scale, this source of energy has the ability to sharply reduce the impact of agri-food-related emissions, driving the industry toward a more sustainable future.

The Power of Digestate

The benefits of anaerobic digestion go well beyond biogas. Digestate, a byproduct of anaerobic digestion, plays a unique role in regenerative agriculture.

Nutrient recycling through anaerobic digestion offers significant environmental benefits. By diverting farm and food waste to anaerobic digestion, nutrients are trapped in stored and controlled fractions. This process helps recycle nutrients within the agri-food system, reducing the need for additional nitrogen synthesis and phosphorus extraction. Consequently, it mitigates greenhouse gas emissions, minimises environmental damage from extraction activities, and prevents ecological issues such as eutrophication of waterways.

This organic matter component can also be used to introduce carbon to soil, helping feed beneficial plant symbionts that can help reduce dependency on pesticide inputs and nutrient use. The digestate can be applied to land in a controlled manner, reducing the need for additional nutrient applications to crops and pasture. And it can improve both nutrient availability to plants and soil enzymatic activity. In fact, it is estimated that digestate could potentially remove the need for up to 7% of all inorganic fertiliser, providing the needs of 82 million hectares of land. This demonstrates how anaerobic digestion, through the power of digestate, plays a key role in regenerative land management.

The Economics of the Shift to Biogas

Anaerobic digestion infrastructure offers significant economic benefits to farmers and rural communities. Farmers can diversify their revenue streams through the sale of electricity, heat and fuel, as well as organic nutrients and animal bedding. Anaerobic digestion reduces energy costs and creates opportunities for selling excess energy to the grid. Additionally, the construction and operation of anaerobic digesters stimulates rural economic growth by creating local jobs and increasing tax revenue from rural communities. Various government programme and incentives further support farmers in adopting this technology, making it a financially viable and environmentally sustainable solution.

In fact, governments and private entities are making substantial investments in biogas production, motivated by policies that promote carbon neutrality, energy diversification and security. This market expansion is particularly evident in municipal, agricultural and industrial waste processing, where anaerobic digestion is utilised to convert organic waste into biogas and digestate, thereby reducing reliance on landfills.

Globally, the potential of anaerobic digestion is already being realised in many geographies, with a current market size of 17 billion and a market potential of US$40 billion expected by 2031. This represents a compound annual growth rate of 10%.

The drivers of this growth stem from increasing global emphasis on renewable energy, sustainable waste management and energy security.

What is Alltech's Role?

Alltech views biogas production as a crucial area for the sustainable future of the agri-food industry and has been actively investigating sustainable solutions to assist in the anaerobic digestion of organic waste and animal manure.

Alltech's research has demonstrated significant advancements in enhancing biogas production by optimising co-digestion ratios, enzyme treatments and trace element supplementation. Key findings include the identification of optimal enzyme concentrations that significantly boost methane yields, as well as the synergistic effects of co-digesting chicken litter with plant biomass to improve process stability and biogas output.

Research on enzymatic and mineral preparations has revealed additional benefits, such as:

- Increased biogas production with lower substrate requirements
- Reduced viscosity and parasitic load in reactors
- Stabilised biogas production despite substrate variations
- Minimised floating layers

Alltech has also partnered with several key anaerobic digester projects, serving as a strategic technical advisor on fermentation processes. These collaborations aim to maximise resource utilisation and enhance biogas production, demonstrating Alltech's commitment to advancing sustainable energy solutions.

Conclusion

Anaerobic digestion presents a transformative opportunity for the agri-food sector to contribute significantly to global sustainability efforts. By converting organic waste into biogas and nutrient-rich digestate, this process not only reduces greenhouse gas emissions but also enhances regenerative agricultural practices. The potential for biogas to offset fossil fuel use and provide renewable energy is substantial, with promising market growth driven by increasing investments and supportive policies.

As the world faces urgent climate challenges, anaerobic digestion stands out as a key solution for achieving energy security, reducing environmental impact, and fostering a sustainable future for agriculture.

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