FUELLING NORTH A RENAISSANCE IN ANAEROBIC DIGEST

Shawn Kreloff, Bioenergy Devco Founder and CEO, USA, discusses the best way North Am cool down the fast-warming planet through emissions reduction.

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Clean energy advocates say to adopt photovoltaics, geothermal, hydropower, or wind. Others urge for the conversion of transport from fossil fuel to electricity or hydrogen fuel cells. Still, more seek forest restoration or no-till farming that locks carbon in the ground.

Each answer plays an important role, yet a landmark study by the climate science organisation, Project Drawdown, found the most impactful solution to reducing greenhouse gas emissions is to reduce food waste.[1]

Slashing food waste eases pressure on habitats, reduces toxic runoff, and avoids up to 102 billion t of emissions.[2] That is equivalent to removing 30 000 coal plants or adding 30 million wind turbines. Each week, dump trucks load 1 million t of food waste and haul it off to be incinerated, where it is combusted and emitted as an environmental pollutant,[3] or taken to a landfill, where it decomposes and releases methane, a harmful greenhouse gas.

Bagged, spread, or buried in pockets without sunlight or oxygen, organic waste gets broken down by microorganisms through a natural, four-stage process called anaerobic digestion (AD). In a landfill setting, this process releases methane into the atmosphere, compounding negative environmental effects that may have been generated through the food supply chain.

But this natural process of AD can be harnessed, and the biogas it generates can be used as a source of clean, renewable energy to provide heat and electricity to homes or alternative fuels for vehicles.[4]

The use of anaerobic digestion

AD is both natural and timeless. For billions of years, microbes have broken down dead organic matter into rich muck and swamp gas. But in the past few centuries,

scientists have explored the biochemical processes of AD, and innovators have found ways to utilise its outputs.

Starting in the industrial age, entrepreneurs designed special tanks and systems – anaerobic digesters – that generate methane to fuel streetlights or power homes. Over time, these plants have grown more technologically complex, efficient, and sophisticated, unlocking enough renewable energy to offer a viable alternative to fossil fuels. In Europe and Asia, hundreds of thousands of plants have quite literally empowered cities and farms to manage waste in ways that are affordable, reliable, efficient, productive, odourless, and clean.

AD is a process through which microbes break down organic matter in the absence of oxygen. When this process takes place in a controlled, sealed vessel called a digester, organics (such as animal manure, food waste, grease, and oils) can be used for biogas production,[4] utilising the naturally occurring methane for clean energy, rather than being emitted into the environment. Additionally, this process generates digestate, which can then be used as a safe, nutrient-rich soil amendment, returning organic material back to the very ground from which it grew.

Figure 1. Bioenergy Devco's Maryland Bioenergy Center, Jessup, houses the largest commercial scale anaerobic digesters in the USA.

Figure 2. Crioengergie facility, located in Macron, near Venice.

The North American Renaissance

The use of anaerobic digesters to generate renewable energy is a common practice around the globe. Now, North America is poised to catch up and potentially surpass other continents. Governments and industries seek to develop and integrate modular industrial anaerobic digesters that could divert the bulk of indiscriminate food disposal. Rather than bury or incinerate it to pollute our air, this could transform food waste into beneficial outcomes, such as clean energy and soil enrichment that help grow more food.

Far from hypothetical, the North American eco-friendly AD Renaissance is already underway.

Instead of abandoning food to rot in landfills, regional alliances have begun to carefully and responsibly divert organic feedstock into and process it through enclosed AD waste processing and conversion systems. Today's next-generation anaerobic digesters master every aspect of breaking down food waste: the content, density, consistency, volume, flow, moisture level, temperature, and microbial activity.

In goes discarded waste; out come precious resources. Because the system is sealed airtight, anaerobic digesters refine the generated biogas into clean energy, such as: renewable natural gas (RNG), electricity, or even green hydrogen. Fresh water can flow back into the basin, cleansed of any risks from harmful contaminants, pathogens, or chemicals. And the solid byproduct is a nutrient-rich soil amendment, digestate – much like compost.

Behind this 21st Century AD Renaissance is a convergence of economic, political, and regulatory forces.

Landfills near cities have grown prohibitively expensive to approve, build, and operate. Incineration plants have fallen out of favour due to their negative impacts on local air quality. Food growers, processors, and municipal waste agencies seek ways to reduce operating costs and carbon footprints. Federal agencies now welcome and want to scale up AD systems to reduce methane emissions, displace fossil fuels, recycle organic waste, and replace synthetic fertilizers with the macro and micronutrients already present in waste.

A growing demand

Looking ahead, the American Biogas Council asserts that the construction of 13 500 new AD projects would generate 23 000 long-term jobs, generate enough energy to power 7.5 million homes, and cut emissions equivalent to taking

more than 15 million cars off the road. All these lead Acumen research to give North America the dominant share of a growing global market, driven by surging "demand for renewable energy sources, strict government guidelines to reduce greenhouse gas emissions, and expanding volume of solid waste."[5]

To meet demand for AD systems in America, Bioenergy Devco has adopted what works so well everywhere else. It has adapted and innovated to meet the contours of local needs, economies, and demographics. Rather than focus only on just one aspect – funding, siting, building, operating, technology, or human resources – the company combines it all together in one seamlessly integrated package. It brings financing to the table; anticipates legal concerns and complies with waste legislation; and integrates food production problems, municipal constraints, and local community demands. Finally, based on stakeholder needs, the company builds to scale and links to the grid or pipeline, applying a seasoned team and proprietary technology to the equation.

Achieving results

Can a billion-year-old biological process really be all that complex? The simple answer is yes.

Running an efficient anaerobic digester is a proven and predictable science. The process requires exactly the right combination of ingredients, broken down to the right size and sequence. The proportions of water, microbes, and organic content (plants, cooking oil, protein, animal fats, etc.) must be precisely and constantly measured and adjusted, while monitoring temperature and gas production. For such a simple living organism, microbes can be astonishingly fussy about what they eat and under which conditions. Too cold or too hot, too dry or too solid, and the whole AD process can be disrupted. But the results are extraordinary on multiple levels.

Case study: Maryland, USA

Bioenergy Devco's latest commercial scale bioenergy centre in Jessup, Maryland, the US, is designed to ingest 115 000 t of excess waste food scraps, fats, oils, and greases (FOG), along with other organic material. The centre can produce more than 300 000 million Btu of RNG. Injected into the grid, the RNG reduces carbon dioxide (CO_2), equivalent to taking more than 12 500 gasoline-powered cars off the road for a year. The fully-enclosed anaerobic digesters eliminate the groundwater pollution often caused by excessive land application and landfill operations, minimising runoff that can poison ecosystems and cause significant human health problems, meaning the facility does not require fresh water to process materials. The resulting greenhouse gasses prevented from being released into the atmosphere have the equivalent environmental impact of approximately 70 000 acres of US forests in one year – 82 times the size of Central Park.

A useful byproduct

These green outcomes are in and of themselves remarkable. But there are other local benefits to consider, from reducing transport costs to preventing algae blooms and toxic runoff. Additionally, AD yields another byproduct prized by gardeners and farmers alike: digestate.

Digestate, much like compost, is an organic conditioner that traps CO_2 as organic matter, feeds the soil microbiome, and returns and cycles waste back into the landscape, reducing the use of chemical, petroleum-based amendments. Like composting, the digestate output from anaerobic digesters optimises the conditions for naturally occurring microbes (i.e., protozoa, microbes, rotifers, fungi) to continue their magic, improving the tilth, life, health, and fertility in soils. Moreover, digestate has even higher concentrations of nutrients than compost, enhancing food production in a closed-loop process that captures the essence of our shift toward a circular economy. The company's Maryland plant produces more than 16 t of rich, fertile soil amendment for agricultural and other land use.

Conclusion

Anaerobic digester systems hold tremendous potential for renewable energy solutions. Yet one of the more novel and exciting prospects is adapting the process to produce hydrogen.

With just one proton and one electron, hydrogen is Earth's simplest and most abundant element. While it can store and deliver usable energy, hydrogen rarely exists by itself. It must be extracted from other compounds produced from hydrocarbons in emissions-intensive processes that can defeat the purpose. Anaerobic digesters, by contrast, could be adapted to produce green hydrogen using a proven steam upgrading process.

That massive promise lies in hydrogen's combination of efficiency and versatility of applications. Hydrogen is so clean that, when burned, it produces only water and heat. The energy can be used by trucks, shipping, buses, auxiliary power units, and even aircraft.

Every technological innovation – from electric cars to the Internet – has to overcome initial resistance. The quest to change the world by recycling food waste into clean energy is no different. It can only happen through the convergence of public support, consumer demand, government backing, and private innovation. Once widely embraced, it crosses a tipping point, pushes back old constraints, and opens new directions and possibilities.

In this way, anaerobic digester systems in North America are poised for a 21st Century Renaissance, a transformation that unlocks greener energy, cleaner air, purer water, and richer soils.

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