Netherlands

Advancing biobased energy

Dutch technology and innovation are raising the bar

Biobased excellence and innovation

The Netherlands is successfully transitioning to a biobased economy. Thanks to strong partnerships between industry, government and universities - smart minds and courageous business leaders and politicians. These collaborations have already led to many innovations that contribute to tackling the climate issues of today and tomorrow and bridging the gap between various stakeholders.

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Biobased technology, born and bred in the Netherlands

In the short term, biomass energy appears to be the only practical, feasible method of reducing greenhouse gas emissions and meeting part of the growing demand for energy. This calls for more efficient use of biomass for energy and materials and in the longer term for game-changing breakthroughs in the energy and chemical sectors.

The current linear approach to the use of fossil fuels will not help with that. We need to move towards a more circular system. This requires a great deal of research and pioneering work. Work that is already happening on a large scale in the Netherlands. For years, Dutch high-tech companies and research groups have been at the leading edge of the successful development and implementation of new applications of organic material.

The Netherlands is a perfect breeding ground for the transition to a biobased economy. The mindset is right: we are at the forefront of tackling climate change, we are not afraid to get off the beaten track and we are champions of collaboration between different disciplines and organisations. Add to this the mix of technologically advanced agriculture and horticulture sectors, smart multinationals, a vibrant landscape of creative start-ups and research groups focusing on biobased products and processes. The Dutch government also contributes by actively supporting collaborations and partnerships. So-called Consortiums for Knowledge and Innovation (TKIs) coordinate and finance initiatives that bridge the gap between innovative ideas and successful market introductions. One of these consortiums focuses specifically on the biobased economy.

The Netherlands has already made great strides in the transition to a biobased economy and is constantly raising the bar. Thanks to its experience, knowledge, products and services, the Dutch bioenergy sector is the ideal partner in the transition to a biobased economy.

In this Biobased Energy Guide, we proudly show you the Dutch innovations in this sector.

Marcel Werther
Topsector Energy

Kees de Gooijer
TKI Biobased Economy

Kenneth Colijn
Netherlands Enterprise Agency

Aafke Mak
FME

Building a biobased economy

Not only does climate action require a large-scale transition to renewable energy sources, it also means we should try to find alternatives for fossil-based fuels, chemicals and raw materials. Especially since fossil resources are finite and reserves are dwindling rapidly. In short, the case for a biobased economy has never been more compelling.

Every year, the world consumes billions of tonnes of fossil material. While most of it is used to generate energy, a substantial quantity serves as feedstock for producing chemicals or other raw materials. In both cases a finite resource is consumed which, in one form or another, is then discarded, often with harmful effects for our climate and the environment.

It is widely accepted that this 'linear' approach is unsustainable, and that we need to create a more circular system in which residual materials are collected and reused. This awareness has triggered a global surge in research and investment in biomass as an alternative fuel and feedstock. In the Netherlands alone, dozens of high-tech companies and research groups are developing new applications for an ever more diverse array of organic materials.

Biobased climate action

The close connection between tackling climate change and building a circular (and largely biobased) economy is widely recognised in the Netherlands. In 2019, over a hundred signatories of the country's Climate Agreement committed to an ambitious set of decarbonisation targets for 2030, in which biomass in its various forms plays an essential role.

For example, new biofuels will enable road haulage and inland shipping to radically cut carbon emissions. The Dutch have also drawn up ambitious plans to transition from natural gas – the primary source of energy for most Dutch households – to clean alternatives, including biogas. And both the country's prominent chemical industry and advanced agricultural sector will intensify their search for biobased alternatives to raw materials and artificial fertilisers.

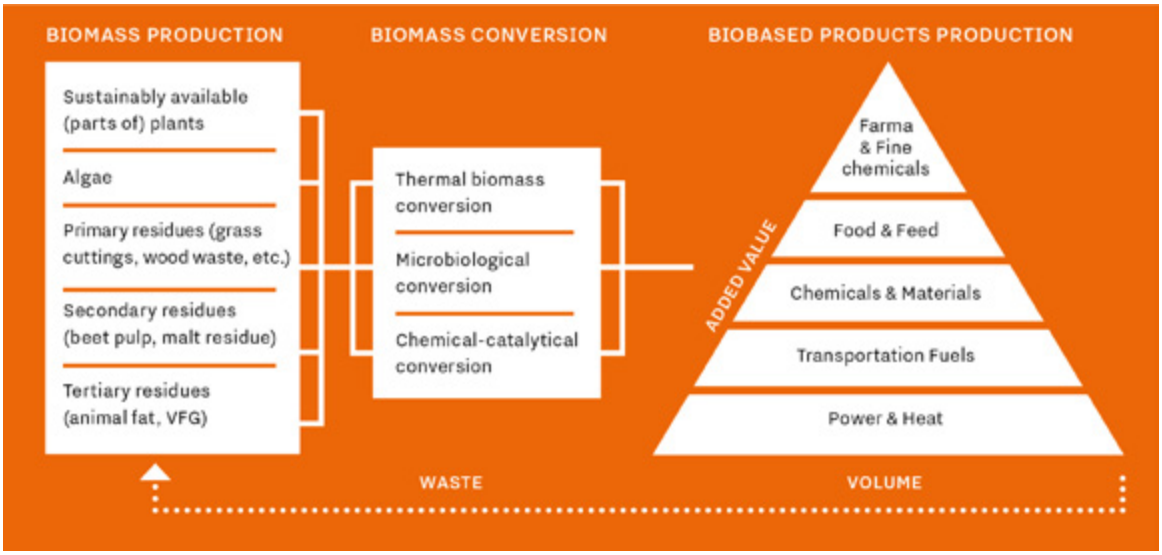
Aiming for value

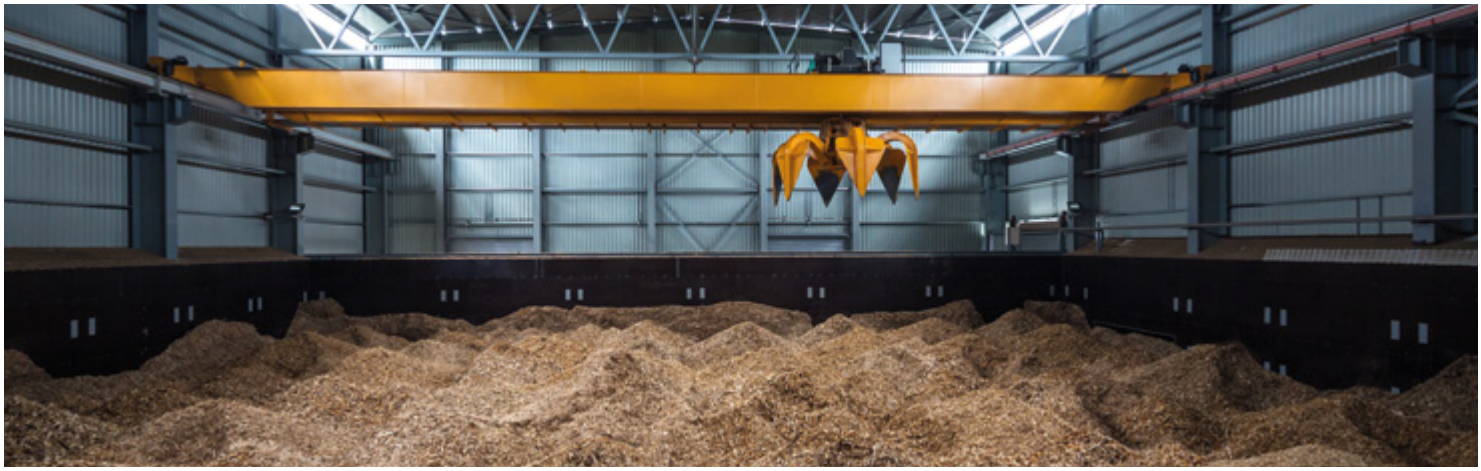
A crucial guiding principle in the Dutch plans for a biobased economy is to focus on extracting maximum value from the available biomass. Currently, most biomass applications focus on burning it to generate energy. In 2019, roughly 7% of the global energy demand was met through traditional biomass sources. Yet, when we burn biomass, we also destroy a range of compounds that, with the right technology, can be transformed into valuable raw materials. This creates new opportunities to reduce our dependence on fossil materials and other finite resources.

Transitioning to a biobased economy will require reliable supply chains and huge amounts of biomass, of a stable quality.

Many Dutch innovations are aimed at exploiting this hidden potential. As part of a nationwide research programme, businesses and universities are developing new technology using the 'cascading' principle. The idea is to separate biomass into its constituent components. Those with the highest added value can be used as sustainable building blocks in complex manufacturing processes. Less valuable components may be suitable for producing bulk materials. Finally, the remaining biomass can be used to generate energy in the form of electricity or heat. And here too, the emphasis is on creating more value, for example through improved efficiency or by capturing and reusing CO_2.

Biobased Economy Concept





Truly sustainable biomass

Transitioning to a biobased economy will require reliable supply chains and huge amounts of biomass, of a stable quality. To prevent extra pressure on land use and biodiversity, it is important to maximise the potential of authentic residue streams. The challenge is not only to identify genuine excess volumes of biomass residue (see the box for some examples), but also to develop technologies that can process these into affordable and versatile commodities. Other Dutch innovations focus on biomass residues that are available closer to home, yet which are currently underused because they present challenges for conventional conversion technologies, especially 'wet' residue streams such as sewage sludge or even nappies.

Identifying and upgrading residual biomass

Examples of biomass streams that can be developed into truly sustainable supply chains include coconut shell, empty fruit bunch (EFB), bagasse, citrus pulp, olive residues and wheat straw silage. However, to be economically feasible, such residues need to be available in the right quality and quantities, at an acceptable price and in a form that allows for a range of business cases. That requires suitable processing technologies, such as torrefaction, steam explosion treatment or pelleting.

The Dutch biobased ecosystem

The technology required for a biobased economy is developed at the intersection of biological and chemical sciences and process technology. In all these areas, the Netherlands has world-class expertise. Just as importantly, the Dutch have a remarkable talent for cooperation and for translating ideas into commercially feasible propositions.


3C

The Netherlands is a small country, but in many areas it punches far above its weight. For example, it is the world's fifth largest exporter overall and the second largest exporter of agricultural products. The country is home to the fourth largest chemical sector in Europe (and the tenth largest worldwide). And in terms of technological innovation, the Netherlands has the world's second largest number of patents per million inhabitants and ranks fourth in the Global Innovation Index.

The country's strength in biobased innovations is underpinned by its technologically advanced agricultural and horticultural sectors and by its chemical industry, which includes multinationals with considerable R&D budgets and track records, such as Akzo Nobel and DSM, as well as a vibrant ecosystem of creative start-ups. The country is also home to the world's leading agricultural university, and a network of other research groups that focus on biobased materials and processes.

Throughout the country, companies with complementary expertise have formed 'biobased clusters'

However, Dutch efforts towards a biobased economy have more to draw on than just expertise. They're also driven by a characteristic mindset that bears the stamp of living in a small, densely populated country. On the one hand, the fact that space is scarce has encouraged farmers to make the most of every square metre of arable land, by finding new uses (and customers) for agricultural 'waste'. And farmers have often done so in close cooperation with other farmers and/or technology providers or researchers.

This cooperative aspect is another important characteristic of the Dutch approach to innovation, certainly in the field of biobased technology. Throughout the country, companies with complementary expertise have formed 'biobased clusters', which often maintain close ties with universities and research institutes (see graphic below). The country's compact size both encourages and facilitates close cooperation. International visitors are often surprised to see how easily companies which compete in the same market are able to join forces in open innovation projects.

The Dutch government, meanwhile, actively encourages and supports such industry collaborations and public-private partnerships, including technological field labs and long-running joint innovation programmes. A particularly effective approach has been to set up Top Consortiums for Knowledge and Innovation (TKIs), which coordinate and fund joint efforts to bridge the gap between innovative ideas and successful market introduction. One such TKI focuses on biorefineries and conversion technologies and has, in recent years, enabled more than a hundred innovation projects to be carried out.

All in all, the Netherlands is a fertile breeding ground for biobased innovations, which in many cases are already used far beyond the country's borders to work towards a more circular and sustainable world.

Biobased technology clusters in the Netherlands

1. Chemport Europe
2. Carbohydrate Competence Centre
3. University of Twente
4. Biotech Campus Delft
5. Utrecht University
6. Wageningen University & Research
7. Brightlands Chemelot Campus
8. Centre of Expertise Biobased Economy
9. Circular Biobased Delta

Three examples of joint biobased innovation

In the eastern part of the Netherlands, a recently unveiled Green Mineral Plant processes pig manure into biogas, phosphate fertiliser, nitrogen-potassium concentrate, as well as low-phosphate organic material that can be used as compost. The installation is a joint initiative by local agrarian company Groot Zevert, water technology provider Nijhuis Industries and scientists at Wageningen University and Research, and is part of a bigger movement supported by dozens of cattle farmers to reduce the region's dependence on artificial fertiliser.

The CAPCOM-NL consortium is currently working on the development of a 'clean agro pellet' which will enable the large-scale use of biomass residues for the production of electricity, heat, liquid fuels, chemicals and materials. The consortium partners cover the entire supply chain, from farmers to technology providers, harbour facilities and possible end users.

Biorizon is a cross-border initiative of research institutes TNO and Vito, which together with industry partners co-creates technologies for the commercial production of bio-aromatics. Aromatics are important building blocks for the chemical industry, for example in the production of plastics, resins and coatings.

Thermal biomass conversion

Burning biomass is the earliest form of converting it into energy. Modern thermal conversion technology has taken this principle to ever more advanced levels, to generate heat, power and produce renewable fuels and biogas. And Dutch innovations continue to raise the bar, by increasing the efficiency of the conversion process and by enabling the use of more sustainable feedstock.

The Netherlands is home to several companies specialising in biomass combustion systems, including some of Europe's leading manufacturers. Their portfolios range from large-scale industrial installations to tailor-made CHP systems that allow companies, such as timber-processing plants and nurseries, to convert their own biomass waste into energy. Innovations are often aimed at enabling combustion of new biomass residue streams, or at complementary technology, such as CCS.

To be truly sustainable, wherever possible, bioenergy should be generated from genuine residues instead of from crops grown for that purpose. Yet to be technically and economically feasible, power plants also need a feedstock of consistent quality and with the right fuel characteristics. This has led several Dutch companies to focus on developing treatment technologies that allow new or 'difficult' commodities to be used.

For example, Dutch companies are among the global pioneers in torrefaction technology, which can convert biomass into a coal-like material with similar fuel characteristics. It's an excellent way of converting 'woody' types of biomass into stable, storable material with a high energy density. Some innovations aim at upgrading low-value residue streams into high-quality pellets. Others focus on the speed and exact specifications with which a wide variety of biomass can be converted into large, stable volumes of torrefied pellets.

Another example is pyrolysis technology, which uses higher temperatures (> 500 degrees Celsius) to convert biomass into a mixture of char, oil and gases. For many years, the eastern region of Twente has been a hub of research and development in this area. BTG, a spin-off company from the University of Twente, has developed a fast pyrolysis technology that is used in a local plant to produce high-quality bio oil from wood chips. The technology is already used abroad, for example in Malaysia and Sweden, to produce bio oil from empty fruit bunches (EFB) and wood waste respectively, and the company recently unveiled plans for a new plant where sawdust and grass cuttings will be processed into high-quality biodiesel for ships.

At even higher temperatures than those reached in pyrolysis, gasification can convert biomass into a mixture of gases. This 'producer gas' or 'syngas' can then be used to generate power or heat, or can be upgraded into biomethane, which is indistinguishable from natural gas. Dutch researchers at ECN, part of TNO, developed a patented technology which enabled a much wider range of solid biomass materials to be converted into green gas of this type. The technology has been refined and developed in cooperation with Dutch companies and is now being used in biomass plants in Europe and Asia.

Another strand of Dutch innovation focuses on creating a more compelling business case for the use of biomass, by creating additional revenue streams. For example, the company Torrgas developed a two-step technology that not only converts torrefied biomass into syngas, but also produces biochar, a commercially attractive soil improver which traps CO_2 in soil for centuries. Another Dutch company, Mavitec, developed gasification units that allow farmers to convert manure into syngas and heat, as well as an unusually nutrient-rich form of char.

Two of the Netherlands' remaining coal-fired power plants are in the process of completely replacing coal with biomass. The impact of such a transition can be substantially increased by capturing and reusing CO_2. Converting coal-fired power plants into BECCS installations (Bioenergy with Carbon Capture & Storage) can achieve up to four times the emission reductions than would be the case if the plant were 'simply' closed and can even result in negative carbon emissions, effectively removing carbon from the atmosphere.

Blackwood Technology is the company behind the world's leading industrial-scale torrefaction technology. Its Flashtor Technology was first developed and demonstrated in the Netherlands and Blackwood pellets have since been successfully co-fired in large power plants throughout Europe.

Yilkins' torrefaction technology requires less energy to produce pellets with a high energy value and much lower moisture content. The technology is used by one of the world's largest torrefaction production facilities, in Portugal, which can produce 120,000 tonnes of torrefied pellets and 85,000 tonnes of regular pellets each year.

Upcycling Gemert has developed a robust controlled fermentation system that can process virtually any type of wet biomass. First developed to convert spent mushroom compost into heat and a high-quality soil improver, the technology's potential has already been noted internationally as a possible way of generating district heating from local garden waste, or for processing large amounts of seaweed.

Betaprocess is a patented pre-processing technology that can be easily integrated into existing fermentation units. It increases the substrate's digestibility and reduces the time-consuming hydrolysis phase of fermentation processes, boosting the yield of biogas and bioethanol processes by 10-15%.

Microbiological conversion

Perhaps the most natural way of converting biomass – at least in principle – is by allowing yeasts and bacteria to break it down. Fermentation processes can yield ethanol, CO_2 and other products, yet to create maximum value from them, technological innovation is essential. Dutch expertise in (bacterial) anaerobic digestion technology is opening up more and more opportunities for producing biobased energy, fuels and materials.

At hundreds of sites throughout the Netherlands, biomass is digested to produce a range of biogas and digestate for fertiliser. The country produces substantial amounts of bioethanol from fermented corn, fermentation processes are also used to create natural flavourings and biobased polymers.

Biogas production in particular has taken off in the Netherlands, thanks in part to its large dairy farming sector, which has invested substantially in digesters to process manure. Many wastewater treatment plants have also adopted the technology to convert sludge into biogas. Over 25 treatment plants throughout the country upgrade biogas to green gas, which can be fed into the natural gas grid, or can be processed into clean fuels such as bioLNG. And over the next few years, biogas production is expected to show strong growth, especially from livestock manure, seaweed, grass and sewage sludge.

Against this background, it is not surprising that dozens of Dutch companies specialise in biogas technology. The country is home to some of Europe's leading providers of turnkey biogas installations, both at an industrial scale and for use on farms or in a residential/urban environment – one example being digestion units that can be used in restaurants to generate energy from food waste. Other companies focus on specific treatment technology, either of the biomass feedstock or of the resulting digestate or gas. For example, several Dutch companies have developed effective solutions for ammonia stripping, desulphurisation or for recovering valuable components, such as phosphate, CO_2 or nitrogen.

Isobionics produces fragrance and flavour ingredients from sugar using a proprietary fermentation technology, a much cheaper and faster alternative to existing production methods.

Yet biological technology is not restricted to biogas production. Fermentation of biomass is already used to produce biobased polymers, chemicals, nutrients and soil improvers. Here, again, the Dutch often display their talent for creating multiple revenue streams. For example, in the Achterhoek region, the Groot Zevert installation uses pig manure to produce methane as well as fertiliser and an organic soil improver. In the country's main mushroom-growing region, a technology was developed for recycling spent compost in a unique, closed and controlled digestion setup, which can easily be adapted to virtually any type of 'wet' biomass.

In addition to the aforementioned proven technology, which in many cases has already been successfully used in biomass projects in other countries, Dutch companies and researchers continue to explore and develop new innovations. A recurring theme is the need to scale up production volumes of biogas, for example by accelerating the digestion process. The country has agreed on an ambitious target to drastically reduce its use of natural gas, and while electrification is expected to fill most of the gap, a substantial demand for renewable gas remains.

Other innovation projects, many of them coordinated through the national Topsector Biobased Economy, target new ways of extracting valuable components from biomass. A few examples are: grass residues from forestry and landscaping can be processed into high-quality fibres, for example, for paper manufacturing. High-quality chemicals can be extracted from wastewater, using a combination of fermentation techniques. New biorefinery methods are also expected to pave the way for the successful introduction of new biobased materials, from plastics and coatings to biofuels, such as second-generation bioethanol and sustainable fuels for the shipping and aviation sectors.

Chemical-catalytical conversion

Many industries rely heavily on bulk and fine chemicals made from a fossil feedstock, such as crude oil or natural gas. The process used – adding a catalyst to spark or accelerate a chemical reaction – can also be applied to biomass alternatives. Yet designing a reliable, cost-effective catalytical process starting from biomass feedstock can be quite a challenge – which Dutch researchers and companies have been successfully addressing over the past decade.

Catalysis is a field of study in which Dutch academia and industry have been remarkably adept for decades. For many years, there has been a structural and very fruitful interaction between academic research groups at different universities, as well as between academics and the country's prominent (petro)chemical industry. And many of those efforts have been directed at applying catalytical processes to biomass instead of fossil feedstock.

From this background, new and successful companies have emerged, which have managed to translate chemical-catalytic principles into economically viable production processes for biobased materials. One of the most prominent examples is Avantium, a spin-off from Royal Dutch Shell which, early on in its history, decided to focus on renewable chemistry starting from biomass. The company played a key role in the development of breakthrough technologies for the production of biobased plastics, which have enabled global brands such as Coca-Cola to introduce 100% renewable packaging materials made from plant-based polymers.

Current research and innovation are aimed at a wide range of biomass materials, including sugar beet (which has huge potential as a feedstock for biopolymer), potato starch and especially lignin. Lignin is derived from the 'woody', non-edible part of plants and is one of the richest natural sources of aromatic compounds, essential building blocks for the complex chemicals used in the plastic, food and pharmaceutical industries.

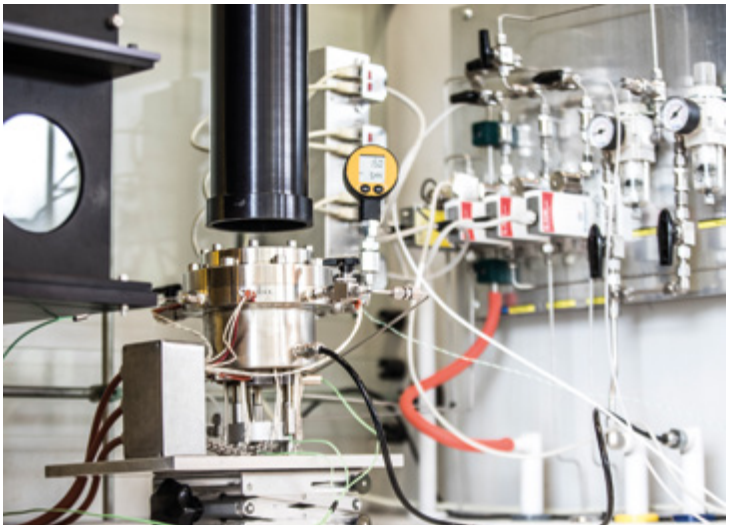
Although such biomass feedstocks contain many valuable components, they also present considerable challenges. Compared to fossil-based materials, their chemical composition is often very complex and diverse, making it difficult to design proper chemical conversion processes and catalytic materials that will lead to reproducible and scalable results. These new feedstocks also contain a wide variety of impurities, which may have a negative impact on the activity and stability of biomass-based conversion processes. Here, once again, the close connections between Dutch industry and academic researchers are proving invaluable. Specialist expertise and research facilities at several Dutch universities enable researchers to analyse different types of biomass and catalytical processes in extreme detail.

That knowledge can help researchers identify suitable catalyst materials and explore new ways of breaking up biomass into individual, valuable molecules – which in turn provide a starting point for the production of new materials or biobased alternatives to existing materials. And increasingly, the huge complexity of biomass is not seen as an obstacle to processing it, but as an opportunity. Instead of manipulating biomass to try and copy existing chemicals or materials, Dutch researchers recognise that it's better to build on the strengths of a particular type of biomass, and use it as the starting point for developing entirely new and better materials. In fact, it is often not even necessary to completely break down biomass-derived polymers, which can already provide starting material for the synthesis of products such as coatings.

Avantium catalytically converts plant-based sugars into FDCA (furandicarboxylic acid) and materials such as the new packaging material PEF (polyethylene furanoate), a 100% plant-based recyclable plastic with superior performance properties compared to petroleum-based materials.

Cosun Beet Company, part of Royal Cosun, converts plant-based residual material (for example from sugar beet and chicory root) into biodegradable ingredients for a wide range of formulations, for example, as stabilising, softening, hydrating, bonding, and rinsing agents.

Researchers at Eindhoven University of Technology recently unveiled a “mini-reactor” that, similar to leaves in nature, absorbs sunlight and drives chemical reactions. To demonstrate its effectiveness, they succeeded in having the reactor actually produce two types of medicine. The reactor can be easily scaled up, can be used for a wide range of chemical reactions and maintains stable production under changing weather conditions.



TNO and Hasselt University (Belgium) have developed an innovative method which uses sunlight to directly power chemical processes, without the intermediate step of generating electricity. Researchers succeeded in converting CO_2 into methane fuel using only sunlight, and with a much higher efficiency (55%) than conventional photocatalysts, which require high temperatures and use only the UV component of sunlight.

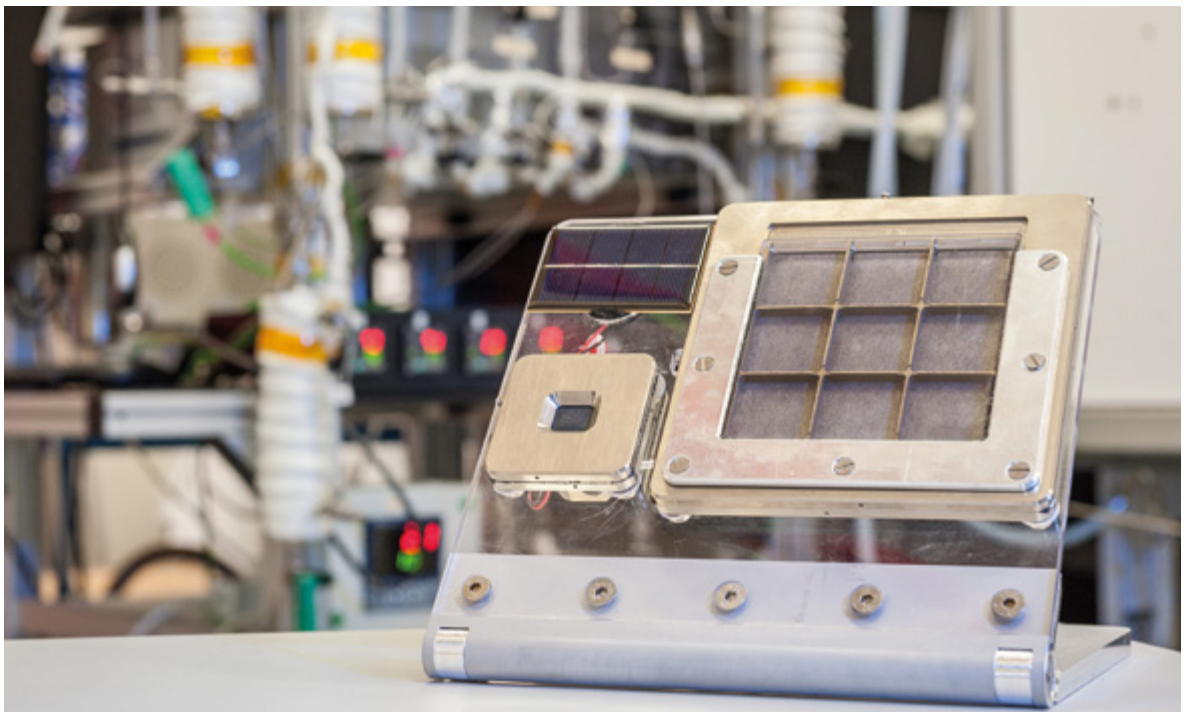
Solar capturing

Replacing fossil fuels and raw materials with biobased alternatives is urgently needed if we are to limit climate change and build a more sustainable and circular economy. Yet there may be an even better and more efficient alternative: solar capturing.

Essentially, biomass in all its forms – including its fossilised versions - is solar energy that has reacted with carbon and water to produce the incredible variety of chemical building blocks and energy stored in biomass. As the biobased economy takes shape, we're getting better and better at deconstructing biomass and reusing these individual building blocks. Yet would it be possible to bypass this step altogether, and find ways of directly producing the materials we need from sunlight?

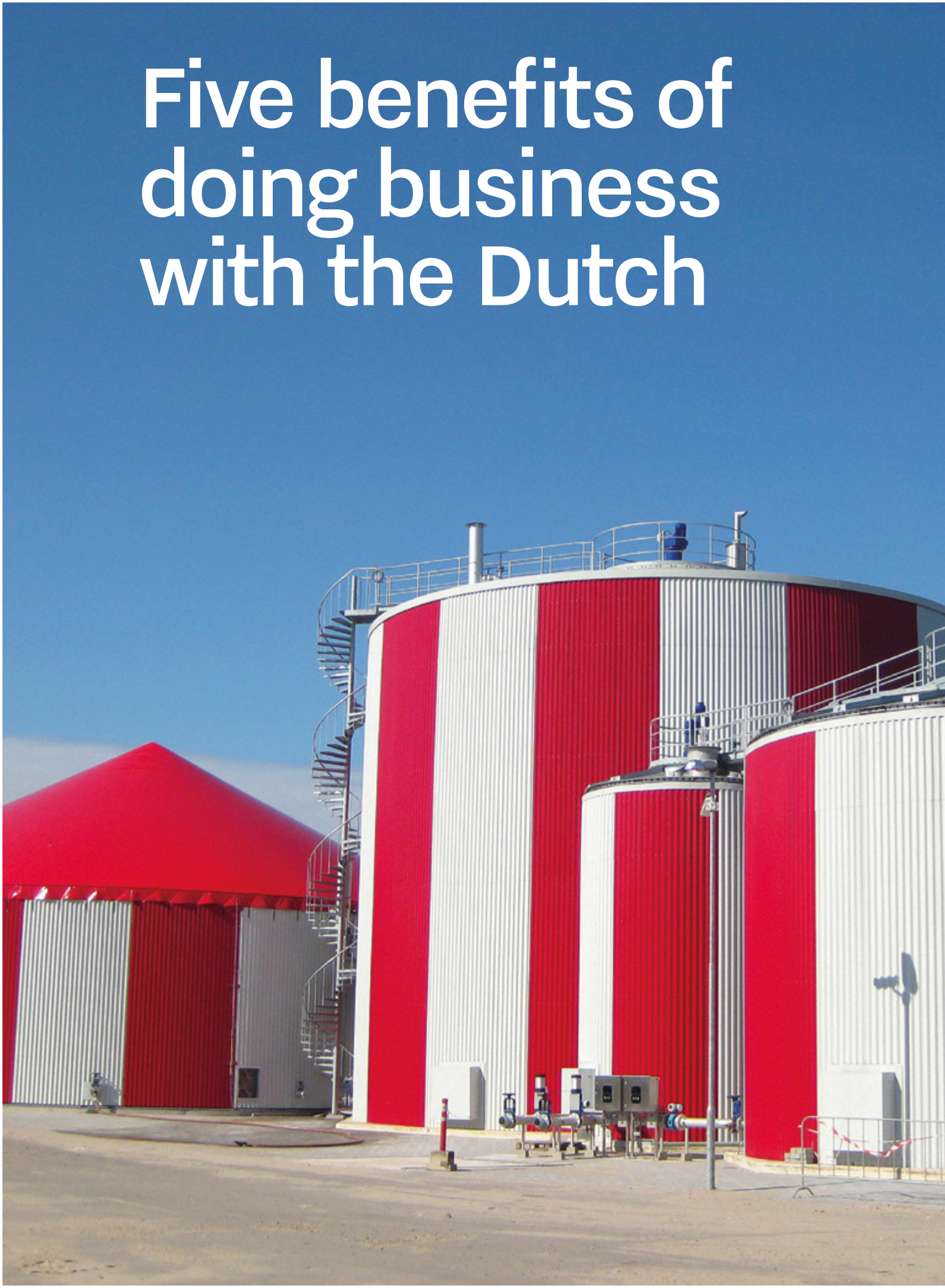
There are good reasons for exploring the possibilities of 'solar capturing', or 'solar-to-products' technology, one of which is because the natural photosynthesis process is relatively inefficient. Only 1-2% of the sunlight that reaches a plant is actually converted into chemical energy. Dutch scientists are at the forefront of developing ways of improving this efficiency in plants, which would substantially increase crop yields and the amount of biomass available to the world as food, fuel and feedstock.

New technology and research in the Netherlands is seeking to increase efficiency further still, by creating products directly from sunlight, CO_2 and water, without the intermediate step of plant growth. This can be done indirectly, by designing electrocatalytic processes powered by the sun, or directly, by developing biological or synthetic processes to convert sunlight into chemicals. This research should make it possible to create clean fuels, platform chemicals and complex molecules.



It sounds like magic: you put a dedicated device in contact with air, expose it to sunlight and it starts producing fuel, for free. That is the basic idea behind the fundamental research conducted by DIFFER, the Dutch Institute for Fundamental Energy Research, in association with Toyota Motor Europe (TME). The partnership aims to develop a device that absorbs water vapor, and splits it into hydrogen and oxygen directly using the sun's energy.

Five benefits of doing business with the Dutch



1. Quality and reliability

The Dutch combine first-class technical expertise and innovative strength with a commitment to delivering high-quality, reliable products and solutions. Working with Dutch technology means you can be certain of compliance with the highest (European and international) standards.

2. An international outlook

The Dutch have been doing business abroad for centuries. They understand what it takes to work successfully across borders and cultures, and are regularly ranked as having the world's most proficient non-native English skills.

3. High-tech excellence

The Netherlands has a long history in high-tech innovation. In terms of the number of patents per capita, it ranks second in the world. It is home to world-class research institutes in clean energy technology, global players in semiconductor technology and excellent machine manufacturers.

4. Joint innovation

The Dutch excel in creating flexible, fast-moving networks of specialist companies and research institutes. The Netherlands is home to dozens of 'field labs' in which such networks translate fundamental research into innovative solutions and test them in real-life pilot environments.

5. Easy access to specialist expertise

The Netherlands has organised its clean energy expertise into national consortia. These networks offer fast and easy access to the right technology providers, researchers or combination of specialists.

Dutch expertise throughout the biobased production chain

In this section we present a cross-section of Dutch companies and knowledge institutes with specialist expertise in various biobased technologies and conversion methods.

To find out more about the latest developments in Dutch biobased technology and the right partners for your particular requirements, please contact redesk@rvo.nl or internationaal@fme.nl.

FEEDSTOCK

Oil crops (e.g. palm, canola, sunflower)
Sugar and starch crops (e.g. sugar cane, corn, cereals)
Lignocellulosic biomass from forestry, agriculture and other industries (e.g. bio-mass fraction of MSW, wet wastes from agriculture)
Aquatic biomass (diverse species of micro- and mac-roalgae and aquatic plants)

PRODUCTION PROCESSES

Transesterification
Fermentation
Advanced biofuel processes
Chipping
Pelletisation
Pyrolysis
Gasification
Sorting, separating and fuel preparation
Anaerobic digestion
Catalysis

PRODUCT

Biodiesel
Bioethanol
Renewable diesel
Cellulosic ethanol
Other advanced biofuels
Woodchips
Pellets
Pyrolysis oils
Bio-synthetic gas (Syngas)
Refuse-derived fuel (RDF)
Biogas
Biobased chemicals

FINAL APPLICATION

Biofuels for transport
Combustion for electricity
Combustion for heat
Biomass-based materials and products
Chemical manuacturing
Pharmaceutical ingredients

Creating partnerships in biobased energy

Energy is a necessity of life for people all over the world and global demand for energy is increasing rapidly. One of the greatest challenges of our time is to provide reliable, affordable and renewable solutions for all. Besides increasing demand for energy, we also have to prepare for global climate change. Climate change requires a different kind of energy supply and calls on us to develop new solutions and systems for a durable supply of clean energy.

The Netherlands has made substantial strides in the areas of renewable energy and energy efficiency, attaining a leading position in biobased energy innovations. The biobased energy sector contributes substantially to Dutch national revenue, exports and employment.

Approaching complex energy issues

The Dutch energy sector enjoys a strong global position. This success is founded on a typically Dutch quality: the willingness to share knowledge within tight-knit alliances between industry, research, NGOs and government. This has made us a frontrunner in public-private research and open innovation partnerships and is how we prefer to approach complex energy issues.

Effective and clean solutions

This cooperative approach is manifest in our biobased energy solutions, which offer complete, effective and coherent products and services geared to what people and companies truly need. The Netherlands regularly paves the way from knowledge to skills to new biobased products and services, leading to integrated, sustainable and effective solutions to meet energy demand.

Win-win solutions

The Dutch energy sector is an ideal partner with experience, knowledge, products and services in the field of biobased energy. The Dutch offer solutions to deal with complex energy supply and demand, both in developed and developing countries. Cooperating and doing business with the Netherlands means all parties invest in a win-win solution. Citizens, companies, research institutions, investors and governments can all work together to achieve results that make a difference.

The biobased Energy Guide showcases innovative Dutch organisations operating in the biobased energy sector. It is with great pride that we present these organisations to you.

Manon Janssen
Chair Top Sector Energy

TOPSECTOR ENERGIE
Empowering the new economy

Adverio BV
Mr W. Vrieling
Rozenburglaan 13
9727 DL Groningen
The Netherlands

+31 (0)50 2071313
www.adverio.eu
info@adverio.eu

ADVERIO

Adverio's focus is on engineering (EPCM) and realization of the energy projects based on processing of organic (waste) streams into the most suitable form of renewable energy, from initiation till realization. Our philosophy to the client is about finding the technical partner you can trust and work throughout the entire process and long after the start-up. Choosing the right partner will ultimately guarantee the best return on client's investment.
Adverio's objective is finding practical solutions and innovative technology which is business driven, but is above all about people, about building relationships and working towards optimum satisfaction.

Over 30 years of experience has taught us what works – a collaborative approach to engineering and project management that shares clients vision to build renewable energy projects, whether a small scale waste-to-energy project or a large scale energy plant. We say what we do and we do what we say and adhere to a fast and direct interaction. We don´t just work for you, we work with you. Based on Design to Built.
Adverio is a network company. Through our international partnerships we have a global presence. Adverio provides a full spectrum of service for clients all over the world. Adverio has worked in China, Korea, Russia, Middle East, Africa, South America and most of Europe.

Biobased Energy Solutions BV
Mr Adolf Ufkesi
Scheepswervenweg 13
9607 PX Foxhol
The Netherlands

+31 (0)6 23376509
www.biobasedenergysolutions.com
ufkes@biobasedenergysolutions.com

BIOBASED ENERGY SOLUTIONS BV

Biobased Energy Solutions (B.E.S.) is on an international level involved in sustainable development projects. B.E.S. plays a role in different innovations, both large (centres of excellence) and small (private developments). B.E.S. reviews these projects on strengths and weaknesses and looks into possibilities to combine them with other developments. If optimization is possible, B.E.S. develops a business case, including possible financing and more.

We are currently supporting a large-scale forest renewal project we have developed in Switzerland, where old wood is converted into electricity. We also take inventory in the reduction of the CO_2 footprint and convert it into tradable certificates.

Biogas Plus Systems BV
Mr Martin van Warmerdam
Dubloen 6
5751 PX Deurne
The Netherlands

+31 (0)492 345 025
www.biogasplus.nl
info@biogasplus.nl

Biogas Plus specializes in the design, engineering, construction and operation of biogas installations. Biogas Plus has over 12,5 years of experience with all kinds of biogas installations, both large industrial and farm scale.

The design philosophy implicates that an installation must be capable of handling all kinds of substrates. Robustness, simplicity and flexibility are key for a successful biogas project. Biogas Plus advocates a separate hydrolyses phase.

Biogas Plus has developed some specific key components like the innovative pump system Vacuum Pressure Tank. The pump system makes it possible to pump sludges with a relatively high dry matter in combination with low maintenance and a very high reliability. The components can also be delivered stand-alone. Biogas Plus also delivers biogas upgrading systems for the production of biomethane.

Since April 2018 Biogas Plus is part of Engie. Engie is a leading international energy and technology company.

BiogasJG BV
Mr Jeroen Geers
Gemeynte 33
4631 MG Hoogerheide
The Netherlands

+31 (0)164 655 138
www.biogasjg.com
info@biogasjg.nl

BiogasJG is a Dutch limited company that supports biogas producers globally in managing their desulphurisation process and improving their methane production. We supply additives that can be supplied directly into the digester as well as products that can clean gas as an end-of-pipe solution. With our partner laboratory, biological analysis and service can be provided to improve the biological process and to increase methane production.

To improve the health of the microorganisms in the anaerobic digestion process and to increase the biogas production, we supply trace elements mixtures and different types of enzymes. We have developed our own generic trace element mixtures and can produce trace element mixtures customised to the specific needs of your system.

Our FeSfix desulphurisation additives are based on iron oxide variants such as FeO, Fe_2O_3, FeOOH. Iron oxide reacts with hydrogen sulphide (H_2S) in the digestate during the process of anaerobic fermentation and prevents H_2S being formed.

Our dry scrubber and filter systems remove impurities directly from your gas. We design, build, and install complete dry scrubber systems for general gas and air treatment. Many types of impurities, for example H_2S, VOC's and siloxanes, can be addressed with our Metalox iron oxide particles and different types of activated carbon. Moreover, we supply our filter media also independently from our filter systems.
Visit our website for the latest updates on our products and services.

Blackwood Technology BV
Mr Maarten Herrebrugh
Siriusdreef 17
2132 WT Hoofddorp
The Netherlands

+31 (0)23 568 92 47
www.blackwood-technology.com
info@blackwood-technology.com

Blackwood Technology is a leading biomass torrefaction technology company. Its FlashTor® technology can be used to transform woody biomass and/or agricultural residues into torrefied biomass, a high grade solid bio-fuel. Torrefied biomass is a renewable drop-in replacement for fossil coals in power stations and/or steel plants.

The FlashTor® technology was developed by Blackwood's predecessor Topell Energy, one of the early pioneers of biomass torrefaction. The technology was proven in a commercial scale demonstration plant in Duiven, the Netherlands. And Blackwood has worked with large European utilities to conduct successful co-firing tests of torrefied biomass in pulverized coal power stations.

The company's technology development was funded by Innogy Ventures Capital, the renewable venture capital fund of German utility RWE, which is still a shareholder.

Blackwood has started its international roll-out in 2016 by signing a first licensing agreement with South African utility Eskom. Currently Blackwood is working on several projects in Asia and North America. Blackwood seeks partnerships with parties which have a strategic interest in setting up supply chains of torrefied biomass.

Bright Biomethane
Ms Tamarah Swensen
Thermen 10
7521 PS Enschede
The Netherlands

+31 (0)53 460 90 88
www.brightbiomethane.com
info@brightbiomethane.com

Bright Biomethane offers biogas upgrading systems using membrane technology to upgrade biogas to biomethane. Bright's PurePac systems are designed to upgrade biogas from any form of waste or biomass feedstock and are applicable in any industry. Due to a standardized, but modular system, Bright is able to deliver a total range from small to large biogas upgrading systems suitable for any existing or new biogas plant type.
Biomethane is flexible in its application. Likewise is the produced biomethane in a PurePac which is suitable for injection in the gas grid, compression to bio-CNG for use as vehicle fuel and compression for the use in a virtual pipeline system. At a virtual pipeline, the gas is compressed to a high pressure enabling it to be economically and safely transported to a remote facility with grid entry point where the gas is injected into the pipeline. This is an ideal solution when no pipeline or grid infrastructure exists at the production location.
For the separation of carbon dioxide (CO_2) to obtain biomethane, membranes with the highest selectivity are used. The 3-step membrane arrangement assures high biomethane quality, according to specifications, with maximum methane recovery of >99.5%.
Biogas purification is a valuable and attractive alternative compared to using a combined heat and power (CHP) system that generates electricity and heat. The PurePac system can be extended with a CO_2 recovery module to recover and liquefy the gaseous CO_2 that is produced during the upgrading creating an extra source of revenue for the plant owner.

BTG-Bioliquids BV
Mr Gerhard Muggen
Josink Esweg 34
7545 PN Enschede
The Netherlands

+31 (0) 53 486 1199
www.btg-btl.com
office@btg-btl.com

As BTG Bioliquids we replace fossil fuels by Fast Pyrolysis Bio-Oil (FPBO), an advanced biofuel that can be used directly as a renewable heating fuel to replace heating oil or natural gas, and that can also be converted into a drop-in fuel for transportation. The associated greenhouse gas savings are up to 93%. As a technology provider and product leader we are committed to the commercial deployment of our fast pyrolysis technology. We built the first commercial pyrolysis plant in the Netherlands (Empyro) in 2015 and are currently constructing two more plants in Scandinavia; one in Finland for Green Fuel Nordic and one in Sweden for Pyrocell. The Empyro plant produces 20 million litres/ year of pyrolysis oil using the pyrolysis process developed by BTG. The plant is self-sustaining and produces an excess of renewable electricity and steam as by-products, which are supplied to nearby factories.

The plant for Green Fuel Nordic will also produce 20 million litres of pyrolysis oil per year that will be used as a renewable heating oil. The plant for Pyrocell (operational in 2021) will produce around 25,000 tonnes of pyrolysis oil.
These developments show that our fast pyrolysis is proven at commercial scale and worldwide capacity is expanding. Further applications of FPBO are under development.

Byosis
Mr Jan van den Broek
Drosteweg 8
8101 NB Raalte
The Netherlands

+31 (0)85 130 23 82
www.byosis.com
info@byosis.com

Byosis stands for practical, feasible and customer specific solutions. Whether the input material is crops, agricultural residues, industrial waste, green waste, sludge, municipal waste or highly contaminated wastewater, Byosis offers solutions to recover the nutrients, remove ammonia and significantly improve the efficiency and capacity of your process. We strongly believe in and contribute to the circular economy.

Colsen
Mr Jurgen Brekelmans
Kreekzoom 3
4561 GX Hulst
The Netherlands

+31 (0)114 311 548
www.colsen.nl
info@colsen.nl / sales@colsen.nl

Colsen

water, energy & environment

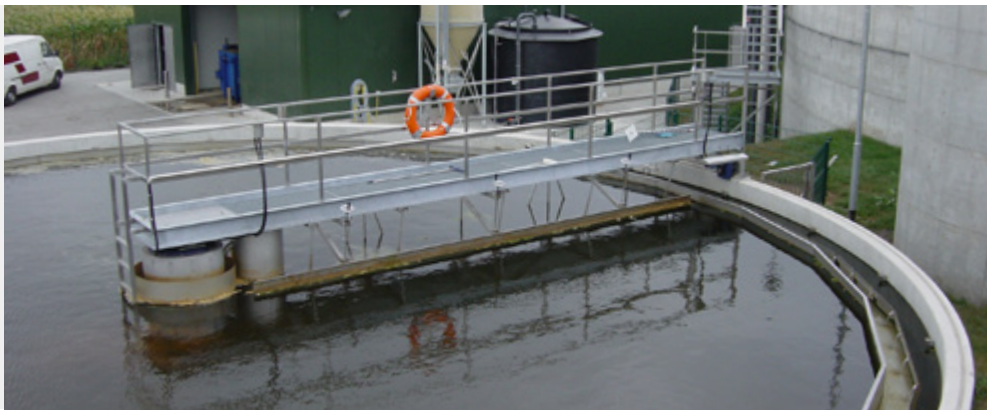
Colsen is an innovative technology supplier for municipal and industrial waste water treatment, and animal manure treatment. With offices in the Netherlands, Spain and South Africa, and a network of agents across the world, we are able to deliver local support for every project.
Your question is the basis for our solution. Depending on your need, we offer tailor made support. This varies from independent consultancy, technology & engineering packages to turn-key delivery of plants or key parts of your installation.

Across our markets, we have some premium technologies that diversify us from our colleagues.

- In municipal waste water treatment we offer side stream treatment with Annamox bacteria.
- Also in municipal WWTP we offer thermophilic sludge digestion, biological biogas desulphurization and phosphate recovery as struvite.
- In industrial WWTP we offer total solutions for food processing industries and other waste waters with organic pollutions.
- In manure treatment we offer total treatment of manure, with biogas production, nitrogen recovery and treatment to dischargeable water.
- For poultry manure, we offer special technology for mono-poultry manure digestion, including nitrogen recovery.

Colubris Cleantech BV
Mr Maurice Nijrolder
Stevinstraat 11-15
7102 DZ Winterswijk
The Netherlands

+31 (0)543 55 13 70
www.colubriscleantech.com
info@colubriscleantech.com



COLUBRIS cleantech

Colubris Cleantech is a collective of specialized brands with over 35 years' experience in environmental technologies. We are committed to purifying industrial wastewater, separating a wide range of waste flows and offering a variety of bioresource solutions. We offer complete tailor-made projects, from design and construction to hand-over and maintenance. We work towards a circular economy.

Cryonorm Systems BV
Mr Piet Tel
Koperweg 3
2401 LH Alphen aan den Rijn
The Netherlands

+31 (0)172 418 080
www.cryonorm.com
ptel@cryonorm.com

Cryonorm based close to Amsterdam, the Netherlands is a leading designer and supplier of tailor made LNG or LBG (liquefied biogas) systems and vaporizers. The LNG systems are developed to meet the highest international standards as well as applicable regulations.

The LNG systems include:
- Marine LNG fuel systems
- LNG bunkering systems
- Liquefaction of natural or biogas to LNG
- LNG and LCNG filling stations
- LNG regasification systems for industries and power generation

DMT Environmental Technology
Ms Marjolein Overbosch
Yndustrywei 3
8501 SN Joure
Netherlands

+31 (0)513 63 6789
www.dmt-et.com
moverbosch@dmt-et.nl

When it comes to biogas upgrading and recovering resources from biomass streams, there is no doubt that DMT should be your choice. Equipped with over 30 years of experience we serve our customers and help them with their environmental challenges. DMT has developed a vast amount of biogas treatment and resource recovery technologies. DMT offers one or a combination of technologies to economically manage your project. By not pushing one technology, DMT can provide the best solution for your specific project. DMT is your partner, a reliable total solutions provider who helps you with your biogas treatment project. Our cost-effective solutions help you to achieve your goals! From start to finish we are there, every step of the way.
Our sustainable technology for the recovery of raw materials and nutrients from waste water is one of the most efficient technologies on the market to date. Biomass Hydrolysis of waste activated sludge (WAS) results in up to 35% more biogas during the digestion process, and 30% TS more dewatering can be achieved.
By using TurboTec® the capacity of existing digesters can be increased, or smaller digesters can be installed for new treatment plants.

Econvert Water & Energy
Mr Pascal Telaar
Venus 35
8448 CE Heerenveen
The Netherlands

+31 (0)513 226 600
www.econvert.nl
info@econvert.nl

We believe in a world in which people are responsible for their ecological footprint, and where they're able to control it. A world in which 'waste' is a word used by people who lack the imagination to see the true value of residues. That's why we continuously work to perfect the art of reuse. Econvert designs and implements technology for the treatment of industrial wastewater and biogas. Wastewater is a valuable source of energy and raw materials, in a world where they are becoming increasingly scarce. Econvert develops reactors for recovering and utilizing valuable resources like biogas from industrial wastewater. Founded on in-depth process knowledge, Econvert offers customized solutions. The company focuses on the food industry, paper industry, breweries and distilleries, as well as companies working with chemicals, flavors and fragrances.
We can help you to save money in a green way. We design and construct the following water treatment plants: UASB (Upflow Anaerobic Sludge Blanket), EGSB (Expended Granular Sludge Bed), IR (Internal Recirculation) and Dsulph (biological biogas desulphurization).

Edvisory
Mr Edwin Hoogwerf
WF Hermansstraat 16
2652 KK Berkel en Rodenrijs
The Netherlands

+31 (0)6 52 38 46 71
www.edvisory.nl
edwin@edvisory.nl

Edvisory supports companies with project development, EPC project management advise and business development. The focus is in the markets for renewable energy (waste-to-oil, waste-to-chemicals) and its interface with the oil & gas / petrochemical markets.
The forms of support can vary, with the following key possibilities:

- Market studies
- Business development
- Management support and project execution strategy
- Project management support
- Training and workshops for effective project management, using the Edvisory methodology

Enki Energy
Mr Stefan Blankenborg
Leuvensbroek 1228
6546 XS Nijmegen
The Netherlands

+31 (0)6 55 73 29 14
www.enki-energy.com
info@enki-energy.com

Enki Energy is an expert on small-scale anaerobic digestion. Enki Energy developed a compact, anaerobic digester with an advanced process control system (patent granted).
The digestion process is fast. Small-scale installations are available for many applications. The biogas produced is used to generate heat or electricity on site, or it can be used for cooking. The compact systems of Enki Energy are well suited for small and large waste streams. They are used by restaurants, neighborhoods and food processing industry. Anaerobic digesters have been placed inside (apartment-)buildings.

Larger installations are mostly placed outside existing buildings.
Enki Energy selected and grew a (proprietary) unique bacterial culture. All micro-organisms are of natural origin. Enki Energy builds (demonstration) digesters. Furthermore, Enki Energy executes feasibility studies and demonstration projects.

ENVAQUA
Zilverstraat 69
2718 RP Zoetermeer
The Netherlands

+31 (0)88 400 85 45
www.envaqua.nl
info@envaqua.nl

ENVAQUA is the industry association of ambitious water and environmental technology companies. We work together to keep our environment liveable and healthy and our mission is to limit and control climate change. Technological solutions are indispensable for returning to clean fresh air, water, soil and raw materials. ENVAQUA has 108 leading member companies that are active worldwide in the depth of these four sectors and at the intersections between them. With a combined turnover of 4.2 billion euros and 20,000 FTE, we are therefore the point of contact for clients and other stakeholders at home and abroad.

The advantages:

- Joining a large network: government, knowledge institution and business
- Meeting colleagues from the industry at member and expert group meetings
- Meeting existing and future customers at theme meetings
- Access to export facilities (fairs, meetings, subsidies)
- Influence of laws and regulations

Flexxolutions BV
Mr Ronnie Beld / Mr Yvan Lara
Jaartsveldstraat 5
7575 BP Oldenzaal
The Netherlands

+31 (0)541 760 400 / +33 (0)782 833 246
www.flexxolutions.nl
info@flexxolutions.nl
yvan.lara@flexxolutions.nl

Innovators in the field of technical textiles. Flexxolutions provides innovative and durable silo closure systems, biogas storage systems, liquid digestate storage systems with mixers, and disinfection solutions. We are driven by our passion for innovation and want to offer the best quality to our customers.

Flexxolutions offers sustainable and innovative solutions for silo covers and storage of (bio) gases, liquids and solids. These solutions and products are used in many sectors, such as biogas, (greenhouse) horticulture and agriculture. We also offer practical solutions, such as disinfection mats, for the industrial and transport sector or the medical sector. We are driven by our passion for innovation and want to offer our customers the best quality. Our strength lies in the combination of an enthusiastic group of employees with a passion for technology and a range of innovative products that contribute to a better and healthier world. We want to be the best and most innovative supplier of these products! Are you curious about us or our products?

Fluor
Mr Wouter van der Bijl
Taurusavenue 155
2132 LS Hoofddorp
The Netherlands

+31 (0)23 543 24 32
www.fluor.com

Fluor is one of the world's largest publicly-traded engineering, procurement, construction (EPC) and maintenance companies. We work with Clients in diverse industries globally to design, construct and maintain their capital projects.

We promote a caring, preventative culture where no one gets hurt. Our sustainability mission is to conduct business in a responsible manner to the benefit of current and future generations. Clients rely on us to help address sustainability challenges and issues, including the need to improve energy efficiency, reduce greenhouse gas emissions and to design and build more environmentally friendly, less costly facilities. Our Clients expect ethical conduct; high levels of employee knowledge and expertise; excellence in health, safety and environmental matters; and an aggressive supply chain and procurement methodology.

With offices located in Hoofddorp, Bergen op Zoom, Geleen and Rotterdam. We successfully completed projects in Europe for more than 75 years using a multi-office execution approach.

Our comprehensive solutions span the entire project life cycle and deliver capital efficiency. Industries served includes Advanced Technologies & Life Sciences, Oil & Gas, Refining, Chemicals and Petrochemicals, Gas Processing & Underground Gas Storage.

FME
Ms Aafke Mak
Zilverstraat 69
2718 RP Zoetermeer
The Netherlands

+31 (0)79 353 11 00
www.fme.nl
internationaal@fme.nl

FME POWERED BY DUTCH TECHNOLOGY

FME is the Dutch employers' organisation in the technology industry. The 2,200 affiliated companies include technology start-ups, trading companies, small and medium-sized industrial enterprises as well as large industrial conglomerates. Our members are active in the fields of manufacturing, trade automation and maintenance in the metal, electronics, electrical engineering and plastics sectors. Around 400 members are active in the renewable energy sector. FME members employ a total of 220,000 people, have a combined turnover of € 91 billion and their exports total € 49 billion. FME members therefore account for one-sixth of all Dutch exports.

We connect and mobilize companies, knowledge institutes, end users and investors in order to find solutions to the global challenge for a greener future.

Please connect with us if you are looking for a specific company, product or service. Let's work together!

Frames
Mr Jordi Zonneveld
Eikenlaan 237
2404 BP Alphen aan den Rijn
The Netherlands

+31 (0)172 461 600
www.frames-group.com
info@frames-group.com

FRAMES

Frames designs, builds and delivers process installations for:

- Biogas upgrading for off-grid, grid injection and bio-LNG applications
- Pre- and post-combustion CO_2 capture (CCS/CCU)
- Hydrogen generation and storage

At Frames, we feel it is our responsibility to offer sustainable systems and solutions for energy production. Our systems and solutions are energy-efficient, reliable and are accompanied by minimal operational costs, and environmental footprint. We do this by developing and implementing innovative technologies.

We have decades of experience in managing and realizing turn-key systems and solutions with lowest total cost of ownership, which means we can offer complete solutions for complete biogas upgrading and CO_2 capture installations along with our offering in hydrogen systems and solutions. We play an important role in the decarbonization of the global energy consumption.

We are headquartered in the Netherlands and have seven international offices worldwide. Visit our website or send us an email to see how your project can benefit from our solutions.

Gastreatment Services BV
Mr Mathieu de Bas
Timmerfabriekstraat 12
2861 GV Bergambacht
The Netherlands

+ 31 (0)182 621 890
www.gtsbv.com
info@gtsbv.com

Gastreatment Services (GtS) is an engineering firm engaged in gas treatment in the broadest sense of the word. GtS has more than 50 years of in-house experience in the field of the natural gas and biogas processing and utilization. This enables us to design, build and put into operation both standard and complex, custom-made installations. GtS has developed unique purification systems for the treatment of landfill gas, digester gas and biogas.

GtS provides advice, project management, procurement and the realization of projects in the petrochemical and environmental field. Aside from gas treatment systems, GtS offers the choice from different flare installations, from open to closed flare systems in line with the NER regulations.

GtS produces all the necessary software inhouse. This allows GtS to log in remotely and monitor and adjust all installations and make adjustments where necessary. This is done on a regular basis, so that everything can continue to run as optimally as possible, in collaboration with the operator of the project.

Most of the products GtS developed for biogas treatment are also suitable, sometimes after some adjustments, for Geothermal Energy.

GIDARA Energy
Hofweg 33
2631 XD Nootdorp
The Netherlands

+31 (0)15 820 07 00
www.gidara-energy.com
info@gidara-energy.com

GIDARA Energy is focused on converting non-recyclable waste into advanced biofuels by using patented technologies. Our High Temperature Winkler (HTW®) technology can be utilized to produce value products such as advanced biofuels for use in the road transport, marine and aviation sectors, helping these sectors to reduce their carbon emissions and become more sustainable.

Our patented HTW® technology is the leading gasification process, with decades of waste gasification experience at commercial scale. Over the years, the technology has been significantly improved to achieve better results and handle a broad range of feedstocks.

GIDARA Energy's flagship facility Advanced Methanol Amsterdam will produce approximately 90,000 tons of advanced methanol per year by converting local non-recyclable waste equivalent to that of 290,000 households yearly, which otherwise would be landfilled or incinerated. The advanced methanol meets governmental objectives to achieve CO_2 emission reductions as defined in the European and National frameworks. The produced renewable fuel will replace fossil fuels, creating significant carbon savings.

Our objective is to meet the demand of cleaner fuels, reduce global carbon emissions and create a more circular economy, with more advanced biofuel and biochemical facilities to come.

We make sure our waste isn't wasted.

Greenmac
Mr Geurt Aalderink
Nijverheidsstraat 10
3861 RJ Nijkerk
The Netherlands

+31 (0) 33 247 10 50
www.greenmac.nl
info@greenmac.nl

GREENMAC
biogas upgrading

Greenmac is specialized in amine and membrane based systems for biogas upgrading.
We design, supply, start-up, commissioning and maintain (24/7 support) the systems all over Europe. The state-of-the-art systems are efficient, reliable, highly automated and controlled.

Greenmac is a pioneer in the biogas upgrading market. In 1987 we built the world's first Vacuum Pressure Swing Adsorption (VPSA) plant for biogas-upgrading. We were also the world's first company with an amine wash system for biogas upgrading (2001). In 2005 we built our first membrane upgrading installation.

Although the amine wash system has some big advantages (low methane emission of 0.1% and low electrical consumption), the membrane system is in general more feasible for lower capacities because of the low CAPEX and no heat consumption.

For both systems high-quality components are used, which results in high availability and low maintenance costs. The systems operate fully automatically with an advanced control system, which quickly adjusts the installation to fluctuations in biogas and capacity. All systems are supplied with extensive remote process monitoring. This makes it easy to change settings and contains an extensive trending, alarm and error analysis. The installations can be supplied in capacities of 60-5000 Nm3/h and adapted to further customer specific requirements.

Hemat
Mr Harrie Eggen
Vuurdoornstraat 20
6101 MA Echt
The Netherlands

+31 (0)475 482 555 / +31 (0)6 20 17 12 22
www.hemat.nl
bioenergie@hemat.nl

HEMAT
Du Compost à l'Énergie

Energy from composting digestate and organic residual flows with a high-quality compost as end product.

HoSt Bioenergy Systems
Mr Tjeerd Smit
Thermen 10
7521 PS Enschede
The Netherlands

+31 (0)53 460 90 90
www.host-bioenergy.com
info@host-bioenergy.com

HoSt is a major turn-key supplier of bioenergy systems. Offering a total bioenergy plant solution for the anaerobic digestion, combustion, and gasification of organic biomass and waste streams, HoSt successfully realized hundreds of bioenergy projects worldwide. Our biomass energy plants contribute to ensuring the success of a circular economy by producing renewable energy, solving waste management challenges, and creating valuable end-products from organic waste.

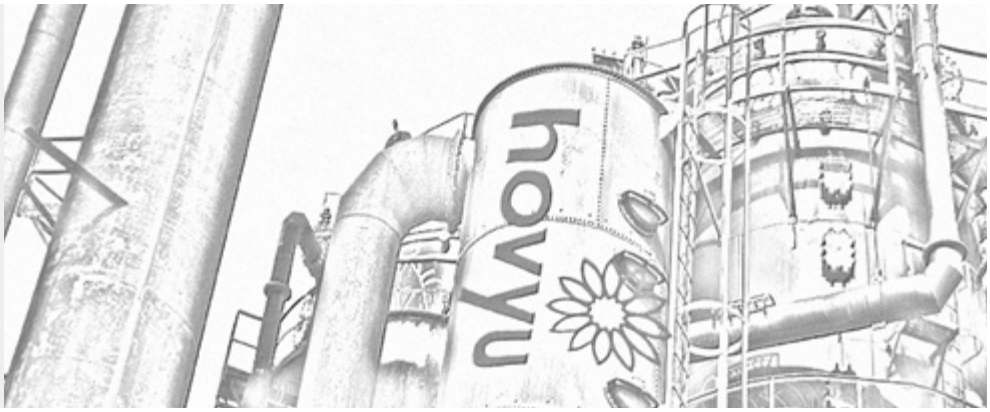
The expertise of HoSt focuses on the technological development and innovation of the processing of a broad range of biomass and waste streams. Biogas plants, biogas-to-biomethane upgrading systems, biomass heat and power plants, biomass boilers, and gasification plants are offered. All can be adapted and supplied in different sizes, capacities and for various industries and available feedstock.

Taking care of the entire process is part of the total solution that comprises of: engineering, supplying, constructing, commissioning, and 24/7 service and maintenance. HoSt can also perform feasibility studies, process analysis and optimization, laboratory tests, obtaining permits, and project development and engineering activities.

Together with HoSt's international offices and partners, and having a strong focus on research and developement, our engineers are developing more and more waste-to-bioenergy solutions that are tailored to local customer requirements.

Hovyu BV
Mr Diego Di Domenico Pinto
Watermunt 72
2408 LS Alphen aan den Rijn
The Netherlands

+31 (0)6 30 20 40 37
www.hovyu.com
info@hovyu.com



Hovyu stands for green in Tupi-Guarani language. Our name reflects our passion: to contribute to the development and implementation of sustainable processes. We participate in the transition towards a sustainable and responsible industry by providing technical assistance services in the fields of carbon capture and utilization (CCU), biogas cleaning and upgrading and waste valorization.

Our current projects focus on the production of green energy and biofuels, with activities such as techno-economic feasibility studies, conceptual plant designs and engineering support. Hovyu is currently assisting the implementation of several biogas cleaning and upgrading units in Brazil. We design tailor-made solutions for each gas source: either biodigesters or landfills. Our optimized solutions for H_2S and CO_2 removal and gas dehydration increase the lifetime of generators, lowering the costs of green electricity, and lead to cost-competitive biomethane with fuel- or pipeline-grade.

Hovyu is also actively involved in waste valorization and the promotion of a circular economy. In this way, we mitigate the costs and environmental impacts associated with waste disposal. For organic wastes, we offer a range of solutions including composting, gasification and bio digestion via partnerships with multiple technology suppliers. In this way, Hovyu can help defining the optimal technology for each application.

KARA Energy Systems
Mr Erwin Hekkelman
Plesmanweg 27
7602 PD Almelo
The Netherlands

+31 (0)546 876 580
www.karaenergysystems.com
kara@kara.nl

KARA Energy Systems believes in the strength and value of bio-energy. From biomass combustion towards energy. From 250 kW to 15 MW. We have the ambition to use high-quality technology and development to make a contribution to the energy need of and optimal return for our customers. Always custom-made, entirely engineered and produced in The Netherlands, turn-key delivered and functioning in accordance with the strictest emission and environmental requirements. KARA Energy Systems is a worldwide partner and offers you an energy source for: warm water, steam, thermal oil and/or electricity. From the first idea to the first flame.

Our roots are in biomass, based on wood or wood related products. Dry or wet biomass (with a moisture content up to 58%) is the fuel for our installations to start up the bio-energy combustion process. But there are also other eco-friendly or sustainable energy sources available to be used as a fuel. What about combustion of straw or reed? We know the ins and outs.

Since 1910, KARA has been dealing with the following practical applications: heating buildings; heating for drying kilns; steam for process heating; generation of electricity, for personal use or sales to the utility grid; district heating.

KROHNE Nederland
Mr Erik Stokman
Kerkeplaat 14
3313 LC Dordrecht
The Netherlands

+31 (0)78 630 62 01
www.krohne.nl
infonl@krohne.com

KROHNE ranks among the world's leading companies involved in the development and production of innovative and reliable process measuring technology for all sectors around the globe.

Founded in 1921 in Duisburg, Germany. Steadily grown to more than 3.500 employees and a turnover of over 500 million euros, the company has 17 production facilities and owns 44 companies and joint ventures.

KROHNE develops, manufactures, supplies and services products and systems which measure, transmit and control process information. Enabling our customers to operate and manage processes in a safe, reliable, economical, profitable and environmentally responsible way.

Our customers are involved in diverse branches of industry that include chemicals, water, wastewater, food & beverages, pharmaceuticals, oil and gas, powerplants, mining and shipping.

For KROHNE, service starts at our first contact with the customer and lasts throughout the life of our systems installed. Quality and reliability are key to maintaining the highest service standards. All KROHNE feeder factories are ISO 9001 certified.

When it comes to process measurement, our level of expertise is unique, not just in standard applications but also for those challenges that demand customized solutions.

Lek/Habo
Mr Hans Neven
Spanjeweg 6
2411 PX Bodegraven
The Netherlands

+31 (0)172 619 342
www.lekhabo.nl
info@lekhabo.nl

Lek/Habo has been one of the leading companies in the cogeneration market in the Netherlands and Belgium for decades. With its roots in horticulture, Lek/Habo has developed into an important supplier of technical installations in horticulture, wastewater treatment plants and industrial markets.
In the Biogas market, Lek/Habo offers a wide range of products including CHP units, Biogas Cleaning & Drying Installations, Control Systems, Transformer and Low Voltage Distribution Systems etc.
The CHP's generate green electricity and equally make optimal use of the combustion heat generated from the engines which can be used to suit customer's Individual needs. For example in drying organic products such as solid fraction from digestate.

With CHP's in a wide range of brands and sizes ranging from 50 kWe up to 3600 kWe, this allows us to optimally build-to-order according to the customers requirements and needs. Naturally we also offer solutions for on-Grid or off-Grid running of the installations and energy management solutions, this may for example also be combined with solar panels and wind turbines.
Lek/Habo can offer a total EPC contracting solution and carries out the entire process from start to finish.
Founded in 1948 in the Netherlands, Lek/Habo has grown into a company with 7 branches in the Netherlands, Belgium, Germany and Poland with more than 300 employees. We look forward to being of service to you. Feel free to contact us with your questions and queries, our professionals will be glad to assist you.

Mavitec BV
Mr Hendrik Hijlkema
Galileistraat 32
1704 SE Heerhugowaard
The Netherlands

+31 (0)72 574 59 88
www.mavitec.com
info@mavitec.com

Mavitec Group is specialized in rendering, gasification and green energy solutions. We provide complex process solutions in a simple, efficient and cost effective way, customized to our clients' needs. Mavitec is an expert in engineering, designing, manufacturing, installation and servicing from individual components up to complete turnkey projects.
Mavitec, international leader in the rendering industry, is known for its high quality systems and equipment for rendering animal by-products that create the best nutrient values in the market. The key of this technology is successfully applied into two other divisions.
Mavitec Green Energy's food waste and depackaging solutions handle, depack and resize organic by-products and provide the highest separation results in the market. The Paddle Depacker separates the organic material from the packaging and delivers a very clean organic output (>99,5% clean) that is extremely suitable for use in biogas installations.
Recently Mavitec Environmental developed an innovative gasification system that converts various kinds of manure into green energy and high value EcoChar: a new way of solving manure issues! Gasification offers a multitude of advantages such as volume reduction up to 85%, production of renewable energy and EcoChar - a powerful soil improver - and CO_2 reduction. The produced energy can be used as steam, hot water, electricity and hot air.

Micro Turbine Technology BV (MTT)
Mr Willy Ahout
Esp 310
5633 AE Eindhoven
The Netherlands

+31 (0)88 688 00 00
www.mtt-eu.com / www.enertwin.com
info@mtt-eu.com

Micro Turbine Technology (MTT) is an innovative company specialised in development and commercialisation of micro turbines for various applications. MTT collaborates with leading research institutes, industry partners, energy utilities and qualified installers.

MTT's EnerTwin is a heating system that also produces electricity. Based on MTT's micro turbine, this is a micro CHP system (Combined Heat and Power) that will change the game in the distributed energy market. The highly cost-efficient EnerTwin produces up to 15,6kW heat and 3,2kW electricity. Maintenance costs are only a fraction of those of competing micro CHP systems, and installation is done within half a day. The lifetime is equal to traditional boilers. EnerTwin fulfils the latest emission standards and it is CE certified for use of a wide range of clean fuels including biomethane, green gas, natural gas with up to 23% hydrogen content and biogas. Fuel flexibility, remote monitoring system and relatively low weight make this system suitable for remote locations too. Also in large economies that still lean on coal-fired, centralised energy generation, EnerTwin can be one of the first steps in their energy transition processes.Installing an EnerTwin in a building can lead to a better energy certificate, improving it by up to two energy efficiency classes in only one day. This can be particularly interesting for historic buildings and industrial buildings built before the end of the 20th century, where the costs of renovation and greening can skyrocket unexpectedly. EnerTwin offers an environmentally friendly solution for these locations: greening can be achieved fast in a simple and sustainable way.

The Netherlands Enterprise Agency (RVO.nl)
Mr Kenneth Colijn
Prinses Beatrixlaan 2
2509 AC The Hague
The Netherlands

+31 (0)70 379 80 00
english.rvo.nl
redesk@rvo.nl

The Netherlands Enterprise Agency stimulates entrepreneurs in sustainable, agricultural, innovative and international business. It aims to improve opportunities for entrepreneurs, strengthen their position and help them realise their international ambitions with funding, networking, know-how and compliance with laws and regulations. As a government agency, it operates under the auspices of the Ministry of Economic Affairs and Climate Policy, and its activities are commissioned by the various Dutch ministries and the European Union. The Netherlands Enterprise Agency runs a number of programmes and supports business initiatives with various grant schemes.

Energy and Climate is one of the agency's key topics. The Dutch government is investing billions of euros in energy efficiency, sustainable energy and CO_2 reduction. In line with this, the Netherlands Enterprise Agency supports Dutch and international entrepreneurs and researchers in developing sustainable projects related to energy, climate and the environment. Innovation and public-private partnerships are key to the Dutch approach: the government, private sector, and academia co-operate on topics such as sustainable energy technologies, green materials, built environment, sustainable mobility, chain efficiency, sustainable electricity, new gas, and greenhouses as a source of energy.

New Cosmos - BIE
Mr Dries Boereboom
Maxwellstraat 7
1704 SG Heerhugowaard
The Netherlands

+31 (0)72 576 56 30
www.newcosmos-europe.com
sales@newcosmos-europe.com

NEW COSMOS - BIE
Gas Detection Solutions

New Cosmos - BIE is a manufacturer of stationary, portable, and personal gas detection equipment, mixing high qualified gas detectors with smart forms of communications suitable for applications in a wide range of industries. You can find our detectors in production areas (clean rooms) for solar panels and electronics production, in and around fuel cells, at hydrogen filling stations, at biogas plants but also at residential areas near hydrogen or methane smart gas meters or boilers. With more than 60 years of experience in gas detection, New Cosmos – BIE serves beside Europe also customers in the Middle East and North Africa. Our mission is to create a safer global environment with a reduced number of accidents.

Our strengths: Sensor technology in house; Over 60 years of experience; Reliability; Unique Selectivity; Long lifetime; Extended range of sensors for different gases.

Solutions for the following markets: New Energy Markets; Oil & Gas Exploration; Chemical & Petrochemical; Automotive Industry; Laboratories; Micro Electronics; PV Industry; Residential areas.

Product range: Fixed gas detectors (diffusion/ suction); Portable gas detectors; Control panels; Software supervision systems; Grease/ oil dust meter; Odor level indicators; Residential detectors.

Services: Maintenance; Upkeep; Repair; Training; Survey.

Nordsol
Mr Léon van Bossum
Kosterijland 70
3981 AJ Bunnik
The Netherlands

+31 (0)30 202 96 70
www.nordsol.com
info@nordsol.com

nordsol
The future is liquid.

Nordsol is committed to making bio-LNG a clean and safe advanced biofuel that is widely available at an affordable price.

Nordsol's solid bio-LNG market expertise has its roots in our progressive technology. The founders have largely reinvented the process of making LNG by carefully considering the key differences between natural gas and biogas. The result is a compact, highly integrated system of biogas treatment and liquefaction, which makes small-scale bio-LNG production economically viable. The process scheme enables the production of ultra-pure bio-LNG from biogas, in an installation with high energy efficiency, zero methane slip, integrated CO_2 liquefaction, and no heat demand.

To help develop the new bio-LNG market, Nordsol also applies its market expertise to bridge the gap between the worlds of waste management and transport fuels. Working closely with biogas production partners and committed bio-LNG clients, Nordsol develops new bio-LNG projects that are grounded by a solid business framework. In these projects, Nordsol can be a business partner in organizing the full value chain from biogas to bio-LNG offtake. This is a unique concept in the market that offers significant benefits to biogas producers.

The Nordsol bio-LNG-plant in Amsterdam, the first bio-LNG plant in the Netherlands, produces 3.4 kilotons of bio-LNG and 6.3 kilotons of bio-CO_2 per year. The plant has been operational since October 2021.

Nijhuis Industries
Mr Emiel Koster
Innovatieweg 4
7007 CD Doetinchem
The Netherlands

+31 (0)314 749 000
www.nijhuisindustries.com
info@nijhuisindustries.com

Nijhuis Industries delivers solid solutions for sustainable water use and resource recovery, with the highest level of intelligent innovations across a wide range of industries. We meet today's challenges as well as those of the future, as a response towards a circular economy in a 'fluid' world. To accommodate the customer requirements, Nijhuis offers customized installations, to create profit out of (waste) water, process water and waste.

Our mission is to help customers to reduce, reuse and recover water and resources to create profit. We help our customers to meet their increasingly demanding sustainability requirements, lower their environmental footprint, combine productivity and energy efficiency and reduce life cycle cost at the same time.

We provide a multidisciplinary team and a unique in-house portfolio, realizing smart and game-changing solutions and systems in sustainable water use and resource recovery, combined with our intelligent services.

With headquarters in the Netherlands, Nijhuis Industries is active in all geographical regions around the world, serving over 2,600 references from its Sales & Service Centers in China, Dubai, England, Poland, Russia, Singapore, USA & Latin America.

Paques Europe BV
Ms Vera Groot Kormelinck
T. De Boerstraat 24 / P.O. Box 52
8560 AB Balk
The Netherlands

+31 (0)514 608 500
www.paques.nl
v.grootkormelinck@paquesglobal.com

For more than 35 years, Paques has been one of the world's leading companies in the field of development and construction of cost-effective purification systems for (waste)water and gases, based on innovative biotechnology. With 3,000 reference installations worldwide, Paques has helped companies and municipalities to contribute to one of the major challenges of today: to reduce their water and carbon footprints and reclaim valuable resources. The biogas produced by the wastewater treatment plants can be used as green energy in boilers or gas engines. Paques has subsidiaries and/or production locations in Russia, China, Brazil, Argentina, Colombia, United States of America, India, Malaysia, Thailand and Vietnam. In many other countries, Paques is represented by licensed partners.

Paques is world market leader in the field of anaerobic purification plants. With BIOPAQ® technology, bacteria convert organic pollutants in industrial wastewater into biogas, which can be reused as (green) energy. In this way, effluent discharge costs are reduced while green energy is produced. BIOPAQ®ICX is the latest new development in the BIOPAQ® product line. BIOPAQ®ICX is a flexible anaerobic effluent treatment based on BIOPAQ®IC technology and implementable in existing assets of any supplier. With THIOPAQ®, Paques has introduced innovative (bio) gas cleaning processes for removal of inorganic compounds. The ANAMMOX® process is a recent breakthrough in efficient and cost effective nitrogen removal from wastewater.

Partners for Innovation
Mr Emiel Hanekamp
Withhoedenveem 8
1019 HE Amsterdam
The Netherlands

+31 (0)20 620 05 11
www.partnersforinnovation.com
e.hanekamp@partnersforinnovaton.com

Partners for Innovation (PfI) is the leading consultancy for sustainable innovation. Together with our clients, we realize profitable solutions, with a focus on a biobased and circular economy powered by sustainable energy. PfI was founded in 2006 and has offices both in The Netherlands and Niger, with 24 and 9 employees respectively. Our Renewable Energy team works for industry, government and non-governmental organisations like GIZ, RVO, SNV, UNIDO, and WorldBank. Projects range from feasibility studies, market research, project development and funding for renewable energy and biomass value chains in Sub-Saharan Africa and The Netherlands.
Partners for Innovation (PfI) is one of the major shareholders of Coega Biomass Centre (CBC), a wood a pellet factory in Port Elizabeth, South Africa. CBC is currently mothballed but will commence production Q4 of 2022. The plant will use wood waste and residues from Alien Invasive Plant clearing (exotic trees that are mandatory to clear as they are the biggest cause of draught in South Africa) and sawmill wastes. PfI has been instrumental in the development of the Bio2Watt 4.2 MWth biogas plant in Bronkhorstspruit, South Africa. The plant became operational in 2016 and is currently enlarged to 8 MWth.
Partners for Innovation is the cluster coordinator for the 'PIB Solid Biomass Opportunities in South Africa'. This covenant aims at developing bio energy business plans in South Africa using solid biomass residues.

Haffmans BV (Pentair Haffmans)
Mr Michel Brueren
Marinus Dammeweg 30
5928 PW Venlo
The Netherlands

+31 (0)77 323 23 00
foodandbeverage.pentair.com
info@haffmans.nl /
michel.brueren@pentair.com

Pentair is a global leader in providing smart sustainable solutions for life that empower our customers to make the most of life's essential resource. One of the strong branded product lines of Pentair, Pentair Haffmans, located in Venlo, the Netherlands, supplies quality control equipment, microfiltration, carbon dioxide (CO_2) and biogas upgrading systems for the food and beverage and industrial markets. We focus on optimizing our customers' processes and collaborating with them to achieve their sustainability and performance goals.
Carbon footprint reduction and the utilization of waste as green energy is pushing requirements in the industry. With our biogas upgrading technology, we take the next step into a sustainable world combining biogas upgrading with CO_2 Recovery. This offers two substantial advantages compared to conventional systems.

1. The upgrading systems recovers 100% of the methane, which eliminates the environmentally harmful 'methane slip'.
2. In addition, by product CO_2 is recovered as well, and can be sold, providing you with an additional source of income.

A true example of: Creating Value. For Life.

Perpetual Next
Mr Hidde Draper
Kraanspoor 36, 4th floor
1033 SE Amsterdam
The Netherlands

+31 (0)20 308 59 10
www.perpetualnext.com
info@perpetualnext.com

Perpetual Next is a climate tech company that recovers carbon from organic waste. We develop technologies to enable industries becoming more sustainable by replacing fossil resources with renewable carbon. We call our product: Perpetual Carbon.

The focus of our technology and its applications is carbon removal: extracting CO_2 from the atmosphere and storing carbon in products that would otherwise end up in the atmosphere. This way we are making industries and businesses around the world more sustainable on our mutual journey towards a carbon-neutral 2050.

To prevent further climate change, less CO_2 must be emitted and more CO_2 must be extracted from the atmosphere. Fossil raw materials must therefore be replaced by sustainable raw materials. The future is now. The future is Perpetual.

Perpetual Next is committed to reducing climate change by upgrading organic waste streams to valuable raw materials and products for sustainable use. Perpetual Next aims to removing 1 Gigaton of CO_2 from the atmosphere by 2050, to contribute to the transition from an economy based on fossil raw materials to a circular economy.

Currently over 100 people work at Perpetual Next in five different countries. Our operational sites are located in three different countries: United Kingdom, the Netherlands and Estonia. Headquarters is located in Amsterdam (NL).

QM Environmental International BV
Mr R. Wagenveld
Henricuskade 123A
2497 NB The Hague
The Netherlands

+31 (0)85 876 88 62
www.qmes.eu
info@qmes.nl

QM Environmental International specialises in environmental (bio)technology and offers integrated solutions for environmental problems in soil, water and air. Since its foundation in the year 2000, QM Environmental International has provided solutions for hundreds of environmental issues in the field of domestic & industrial wastewater treatment, biological soil & groundwater remediation, drain, trap, sewer and pumping station maintenance, algae control in ponds & lakes, biogas & odour control.
QM Environmental International offers solutions for environmental issues that will help improve the quality of life in densely populated areas. Technically there are few limits to the usefulness of the QM Environmental International approach where environmental pollution problems are concerned. So far the QM Environmental International approach has proved itself in:

- Municipal & Industrial Wastewater treatment
- Waste Processing / Composting
- Drain & Grease Trap Cleaning in Commercial Kitchens
- FOG & H_2S Control in Industrial & Municipal Sewers
- Ground & Groundwater Decontamination
- Biogas production
- Agriculture & Aquaculture

When QM Environmental International is presented with a problem it tries to find the friendliest environmental solution. This means that during the design of remedial programs the positive yield for the environment is always an important factor. The final product or application is a combination of cost efficiency and environmental yield.

Rolls Royce Power Systems
Mr Alex Romijn
Merwedestraat 86
3313CS Dordrecht
The Netherlands

+31 (0)78 639 57 77
www.mtu-solutions.com
mtubenelux_info@ps.rolls-royce.com

Rolls-Royce Power Systems AG

Rolls-Royce provides world-class power solutions and complete life-cycle support under the product and solution brand MTU. Through digitalization and electrification, we develop drive and power generation solutions that are even cleaner and smarter and thus provide answers to the challenges posed by the rapidly growing societal demands for energy and mobility. We deliver and service comprehensive, powerful and reliable systems, based on both gas and diesel engines, as well as electrified hybrid systems. These clean and technologically-advanced solutions serve our customers in the marine and infrastructure sectors worldwide.

The MTU EnergyPack is the ideal energy storage solution for whenever and wherever you need power the most. Similar to a big battery bank, it's packed with all the latest technology built to withstand harsh environments and housed in a 40-foot steel container. MTU EnergyPack stores electricity from any source – grid power or local output from solar panels, wind turbines or generator sets – ready to deliver power at the flick of a switch. Whether you need a fully autonomous off-grid facility or simply want to manage your power supplies more efficiently – such as engaging in peak shaving, load-shifting or grid stabilization – the MTU EnergyPack is a scalable, plug-and-play solution that provides reliable power, anytime and anywhere.

SkyNRG
Mr Oskar Meijerink
Paradijsplein 1
1093 NJ Amsterdam
The Netherlands

+31 (0)20 470 70 20
www.skynrg.com
info@skynrg.com

SkyNRG

SkyNRG is a pioneer and global leader in sustainable aviation fuel with the industry's biggest dedicated sustainable aviation fuel team. We aim to replace fossil kerosene with SAFs, driven by sustainable practices throughout the supply chain. Always following a technology-agnostic approach focus on analysing, developing, and executing SAF production projects by creating investment-grade business cases -e.g., our own dedicated SAF production plant, DSL-01.
We source, produce, blend, and distribute SAF. We guarantee sustainability throughout the supply chain, and develop customer programs -e.g., the Board Now program, to help co-fund the price gap over conventional jet fuel. Simultaneously, these programs offer organizations a practical solution to curtail carbon emissions from their business air travel or air cargo.
To ensure we make the right decisions regarding the sustainability of our operations, projects, and products, SkyNRG is structurally advised by an independent Sustainability Board, including WWF International, the European Climate Foundation, Solidaridad Network, and the University of Groningen representatives. SkyNRG's operations are also certified by the Roundtable on Sustainable Biomaterials (RSB), the highest possible certification standard for sustainability.
SAF is a clean substitute for fossil jet fuels. Rather than being refined from petroleum, SAF is produced from sustainable feedstocks such as waste oils from biological origin, agri residues or biogenic CO_2 . SAF is a so-called drop-in fuel, which means that it can be blended with fossil jet fuel and that the blended fuel requires no special infrastructure or equipment changes. Once it is blended, our fuel is fully certified and has the same characteristics and meets the same specifications as fossil jet fuel.

Sympower BV
Mr Dirk-Jan Middelkoop
Oudezijds Achterburgwal 237
1012 DL Amsterdam
The Netherlands

+31 (0)20 210 14 80 /
+31 (0)6 57 06 81 07 (Dirk-Jan)
www.sympower.net
info@sympower.net /
dirk-jan.middelkoop@sympower.net

Sympower unlocks revenue streams by maximising the value of flexibility across energy markets and industries. Flexibility means temporarily adjusting power generation and consumption based on its value and the grid's needs. We buy flexibility to stabilise the grid, rewarding our customers in return.

Our highly-scalable platform is secure by design thanks to exceptional software developed in-house. Our non-intrusive solutions, which combine software and hardware when required, allow our customers to enhance the value of their energy assets, from air conditioners and heating devices to machines and motors.

Our advanced and automated demand response capabilities monitor and balance electricity supply and demand in real-time. Connecting to our platform does not incur any upfront costs. We offer services independently from a particular energy company, meaning that we can work with any industry, grid operator or utility. This allows us to support fast and unrestricted scaling across sectors and countries.

Sympower was born international. With dedicated teams based in five countries, we are able to react quickly and create extra value wherever opportunities arise. Our outstanding international cross sector knowledge and experience is actively contributing to a carbon-free future.

Flexibility is vital for a successful energy transition, that is why we are pushing traditional industries to be more sustainable and enabling the shift from fossil fuels to renewables.

Synova
Mr Jan van Leeuwen
Scheldeweg 10
3144 ES Maassluis
The Netherlands

+31 (0)10 790 08 94
www.synovapower.com
jan.vanleeuwen@synovapower.com

Synova provides breakthrough technologies to deliver cost-effective, mass-scale solutions that transform biomass and waste, as well as mixed-material and contaminated plastics, into valuable gas for the production of chemicals, fuels and electricity. Synova's revolutionary process upcycles waste into clean, dense and hydro-carbon rich gas at high efficiency. In turn, Synova delivers on the mandates for sustainable development goals, addressing the energy transition to a circular economy and improved waste management.

Synova is disrupting the world's approach to wastes:

- A feedstock flexible process that minimizes the need to sort, clean, and pre-process while maximizing the variety all types of waste — including plastics, paper and cardboard — more affordably than any other system.
- Valuable output options (chemicals, fuels, electricity), due to high conversion efficiency and hydro-carbon rich gas.
- Standard design approach allows Synova to quickly replicate its process, limiting construction risk and enabling a faster time-to-market.
- Scalable solution – via its MILENA gasifier and OLGA tar removal systems.

TechnipFMC
Mr Koos Overwater
Afrikaweg 30
2713 AW Zoetermeer
The Netherlands

+31 (0)79 329 37 39
www.technipfmc.com
koos.overwater@technipfmc.com

TechnipFMC is a leader in the refining industry and is committed to meet the world's energy challenges by leveraging its refining experience to provide alternative 'green' energy and bio-based products. Our 50+ year experience with hydrogen plants includes not only grey hydrogen, but also blue hydrogen, featuring CO_2 capture. Driven by our historical track record in grey and blue hydrogen projects, we see our involvement into green hydrogen as a logical next step in our contribution to the Energy Transition.Our bio-based offerings include Fast Pyrolysis Bio-Oil (FPBO) technology which converts biomass into pyrolysis oil. Pyrolysis oil is a renewable, second-generation bio-liquid that can be used as a sustainable alternative to fossil fuels for the production of renewable energy and chemicals. FPBO technology transforms non-food lignocellulosic biomass into liquid. All kinds of biomass residue, such as wood residues, straw, sugar cane bagasse, and sun flower husks – can be used. Pyrolysis oil is easy to store, transport, and conveniently used in versatile applications including heat, power, transportation fuels and in bio refineries for a bio-based economy. TechnipFMC delivers complete turnkey FPBO plants, based exclusively on BTG Bioliquids (BTL) FPBO licensed technology. BTL's experience in the design and commercial operation of one of the world's first FPBO production facilities (Empyro located in the Netherlands) combined with TechnipFMC's global strength in technology, engineering, procurement and construction, fosters our joint commitment to provide our customers with proven technology, EPC expertise and commercial pyrolysis oil production facilities.

Topconsortium for Knowledge & Innovation Biobased Economy (TKI-BBE)
Dr. Ir. C.D. de Gooijer
Nieuwe Kanaal 9A
6709 PA Wageningen
The Netherlands

+31 317 480 593
www.biobasedeconomy.nl/tki-bbe/
kees.degooijer@tki-agrifood.nl

The transition towards a biobased economy is a necessity from a sustainability point of view. At the same time this transition offers important opportunities for businesses. The Dutch government, private sector and research centres/universities have set up a Top Sector Alliance for Knowledge and Innovation for the Biobased Economy (TKI-BBE), in order to build, maintain and execute a knowledge and innovation agenda for the biobased economy, as well as to organize financial support for research and innovation projects. The TKI-BBE is an initiative of three clusters within the Dutch 'top sector' approach: Agri & Food, Chemicals and Energy.

TNO
Mr Jaap Kiel
PO Box 15
1750 ZG Petten
The Netherlands

+31 (0)6 26 43 49 26
www.tno.nl
jaap.kiel@tno.nl

Your reliable R&D partner for the transition towards a circular bio-based economy. The Biomass to Fuels and Chemicals program of TNO Energy Transition is developing knowledge and technology for efficient and cost-effective thermochemical processing of biomass, biogenic residues and waste into biofuels, chemicals, materials and energy in the framework of a circular bio-based economy. Our work covers the entire process chain, from feedstock to product synthesis.

TNO provides R&D support and bio-based technology solutions in the areas:
- Biomass, biogenic residues and waste characterisation and application
- Fractionation, pre-treatment and upgrading
- Thermochemical conversion: e.g., torrefaction, gasification, combustion, pyrolysis
- Combined thermochemical-biochemical conversion concepts
- Syngas treatment and catalytic conversion to biofuels and biochemicals
- Smart co-production of energy, chemicals and materials involving cascading and biorefinery concepts
- Resource-efficient residues utilisation

Would you like to know more? Visit www.tno.nl/en/focus-areas/energy-transition/expertise/biobased-and-circular-technologies/biomass-to-fuels-and-chemicals/

TorrCoal
Mr Randy Hagenbeek
Brightlands Chemelot Campus
Office TorrCoal: 01.3.71
Urmonderbaan 22
6167 RD Sittard-Geleen
The Netherlands

www.torrcoal.com
info@torrcoal.nl

We do torrefaction. TorrCoal firmly believes in torrefaction (mild pyrolysis from 270ºC to 350ºC): a process to produce bio-carbon from bio-residuals like forest maintenance wood, demolition wood, SRF, etc. A process that we have perfected into our own TorrCoal technology C-Vertr. C-Vertr can be used to generate bio-carbon streams to replace fossil carbons for various applications. The heat is on! Our products and services:

1. C-Newable: Bio-carbon supply
Bio-carbon
- in powder
- at specific energy and carbon contents
- made from bio-residuals (recycled wood/SRF waste streams/woody biomass)

2. C-Vertr: Torrefaction technology & equipment
C-Vertr
- is our core technology
- provides the process technology
- provides supply of the reactor equipment
- includes our services by studies, licensing and supply of the entire equipment

3. C-Novation: knowledge development & sharing
TorrCoal supports
- to analyze and validate the usability of bio-carbon as an alternative for current fossil carbons
- to assess and optimize the feasibility of the torrefaction process
- to educate stakeholders on the potential of torrefaction and bio-carbon

We believe in the power of bio-carbon streams.

Torrgas
Mr Robin Post van der Burg
Herikerbergweg 292
1101 CT Amsterdam
The Netherlands

+31(0)6 21 29 53 94
www.torrgas.nl
r.postvanderburg@torrgas.nl

Torrgas Holding is a privately held technology licensing company that has developed a disruptive, proprietary and scalable biomass gasification technology. The company provides novel and economic routes to building blocks (synthetic gas) which serves as a biobased feedstock for synthetic chemicals and fuels but also for de-centralized heat and power production. Torrgas unique and patented process provides a sustainable pathway to produce platform chemicals that serve as building blocks to biobased products. The Torrgas technology creates zero waste and only valuable products and is carbon negative due to the carbon storage in biochar. This is the basis for a process that is disarmingly simple, yet innovative and effective. Torrgas technology distinguishes itself by two essential aspects:

1. Scalable & modular; by applying a moisture free, high energy density, torrefied biomass gasifyers can be scaled to 100 MW or more.
2. Affordable; co-production of biochar and liquified CO_2 creates a superior business model that produces biobased molecules at fossil competitive costs.

Torrgas projects under development: Torrgas Delfzijl, a 30 MW SNG plant to be operational in 2023. This plant will apply torrefied recycled wood as feedstock. Project partners include Gasunie, the national Dutch natural gas infrastructure and transportation company operating in the Netherlands and Germany. BrigH2 Chemelot, a 50 MW green hydrogen plant. This plant will produce 6,500 mt per year of green hydrogen at costs below 2.5 per kg. BrigH2 is a JV between Torrgas and Brightlands. Torrgas has several 100 MW biomethanol projects in Conceptual Design phase.

Torrgreen
Mr Robin Post van der Burg
Herikerbergweg 292
1101 CT Amsterdam
The Netherlands

+31(0)6 21 29 53 94
www.torrgas.nl
r.postvanderburg@torrgas.nl

Food commodities like wheat and corn produce large quantities of waste straw, which is often a liability and an increasing environmental issue. So far, the potential of these feedstocks is completely underutilized. Owners have no sustainable outlet for this waste. Or even worse, at plantations around the globe vast quantities are combusted, creating enormous pollution with hazardous gas emissions. Therefor not only an almost unlimited renewable feedstock opportunity for the production of renewable energy or bio-fuels and green chemicals exists, but also a solution for environmental harmful practices.

The key problem is that biowaste products, like straws, have very low energy densities and cannot be efficiently transported. Via Torrgreen's unique mobile torrefaction units, low quality waste feedstocks are converted into a high energy density solid biofuel with roughly 40 times the energy density as the original agricultural feedstock. This enormous energy densification will allow efficient transport of torrefied product.

The Torrgreen process is profitable in various ways: environmental, social and economical. Environmental by avoiding hazardous combustion of biowaste or rotting resulting in bio-methane emissions. Social by creating local jobs in remote areas and economical by applying this biowaste as feedstock for the production of renewable energy and production of biofuels and green chemicals.

TransitionHERO
Mr Stef Clevers
Stationsplein 45
3013 AK Rotterdam
The Netherlands

+31 (0)6 14 04 47 39
www.transitionhero.nl
stef.clevers@transitionhero.nl

We are TransitionHERO, the engineering firm tailored for industrial Green Technologies. We believe in Green Technology as solution for delivering positive impact to climate change and transforming the industry into something better. We love the challenge of growing green technologies and supporting ambitious industry leaders to create impact. Our creativity and professional experience combined with our algorithmic solutions are key to our approach. And having a bit of fun along the way. We design and scale up green technologies smarter and faster.

Probably your design journey started already with the idea, tested in a lab and verified in a first pilot. Your next challenge is to scale-up to an industrial demonstration or full-scale plant. We have developed especially for Green Technologies our IndustryReady program. In short design cycles we tackle business uncertainties and design challenges. We use our extensive industrial background to bridge the gap between the greentech and industrial companies, by speaking the same language and having the same mentality.

Triogen BV
Mr Jos van Buijtenen
Nieuwenkampsmaten 6-01
7472 DE Goor
The Netherlands

+31 (0)54 782 09 00
www.triogen.nl
jos.vanbuijtenen@triogen.nl

Triogen is making Organic Rankine Cycle (ORC) a viable technology for converting relatively high temperature residual heat into electricity. Main heat sources are heat from reciprocating engines and industrial processes, and heat from the combustion of off-spec fuels like biomass. Since 2001, Triogen has focused on developing and deploying a compact, modular, highly efficient ORC power plant. We have sold over 50 ORCs in 11 European countries and accumulated over 1,000,000 operating hours. ORC power plants in combination with gas or diesel engines increase the power output of the engine by up to 10% without requiring any additional fuel. For engines in the 1 - 3 MW range, a single ORC is the best fit. The major suppliers have approved connecting a Triogen ORC to the exhaust of their engines.

Triogen ORC power plants enable Combined Heat and Power (CHP) at a decentralized scale for local district heating networks and/or drying processes, and provide power to the grid. As an example, the ORC unit is combined with a 1,2 MWth furnace consuming 2.500 - 3.000 tons of solid biomass per year. The Triogen ORC has a typical heat intake of 940 kWth at 530°C and provides up to 200 kWe power and 680 kWth heat at 80°C or higher. Triogen focuses on supplying the ORC; in addition, we gladly provide engineering support for the system integration with different burners. As the flue gas can enter straight into the evaporator, the cost and complexity of an intermediate loop is eliminated.

Van der Kooy
Mr Sebastian Exenberger
Denariusstraat 19-A
4903RC Oosterhout
The Netherlands

+31 (0)88 369 42 40
www.vdkooy.nl
sebastian@vdkooy.nl

van der Kooy Pijnacker B.V.

Van der Kooy is a family run company originated in 1958 and operates in a waste refinery factory. From our location in Oosterhout, The Netherlands, we upgrade contaminated oils and fats to a clean BioHeating Oil (BHO). The Oosterhout location has a storage capacity of 25.000 m^3 plus an additional 6.500 m^3 for bulk loading.

Van der Kooy is specialized in producing renewable liquid biomass, Bio Heating Oil, to use as renewable fuel in district heating systems.

Benefits of Bio Heating Oil:
- High in Energy content > 36 MJ/kg
- Low ash content < 0.05%
- Short CO_2 cycle due to annual crops
- Not competing with food or feed chain
- Easy to use as fuel during demand peaks

Our fully equipped in-house laboratory monitors each step of the refining process in the factory. This allows us to produce Bio Heating Oil that meets the client's specifications and sustainability criteria. Yearly audits and the strict schemes of REDcert/ISCC ensures the end user to receive a proven CO_2 reducing Bio Heating Oil that meets the European Renewable energy directive.

When you are looking for a reliable partner to supply high quality renewable liquid biomass, Bio Heating Oil, please don't hesitate to contact us for further information or inquiries.

Vertoro
Mr Michael Boot
Urmonderbaan 22
6167 RD Geleen
The Netherlands

+31 (0)6 28 83 25 95
www.vertoro.com
michael@vertoro.com

Vertoro

Vertoro, founded in 2017 and based on the Brightlands Chemelot Campus (Geleen, Netherlands), produces a lignin-rich oil, Goldilocks®, exclusively from sustainably sourced forestry and agricultural residues by means of a patented thermochemical process. Like fossil oil, Goldilocks® can be used as a platform for fuel, chemical and material applications. It is already sold into markets as diverse as antioxidants and marine fuel. Vertoro's side stream is cellulose, which can be used to produce bio-based materials and chemicals, such as paper and ethanol, respectively. A 1ktpa demo plant is currently under construction and is set to be commissioned by June 2022. Vertoro has raised over €8M in funding, including from EU H2020 programs, Brightlands Venture Partners, LIOF, SHIFT Invest, and Maersk Growth.

ViVoChem BV
Sales team (sales@vivochem.nl)
Darwin 5
7609 RL Almelo
The Netherlands

+31 (0)546 577 774
www.vivochem.com
info@vivochem.nl

ViVoChem is a wholesaler and distributor of chemicals, or chemical (basic) raw materials, which are used in many industries and sectors. Every day ViVoChem supplies a wide range of, among other things, acids, alkalis, solvents, glycols, surfactants, peroxides, etc. all over the world. We also offer storage for chemicals. Chemical storage must meet strict safety requirements and is not even allowed at many locations. Therefore, have your chemicals stored safely and responsibly at ViVoChem. In addition to taking care of bulk deliveries in tankers, ViVoChem can also fill your products for you in the desired packaging. Using an ultramodern filling system, chemical bulk goods are safely and responsibly filled in 1000 liter IBCs or 200 liter drums.

Wiefferink BV
Mr Jos van Nederpelt
Textielstraat 16
7575 CA Oldenzaal
The Netherlands

+31 (0)541 571 617
www.wiefferink.nl
info@wiefferink.nl

Wiefferink is an internationally oriented supplier of flexible cover and storage solutions. We work on products with diverse applications in agriculture, energy production and industry. Our portfolio is varied: from the storage of manure and gas in biogas installations to flexible water depots. The company is built on craftsmanship, since many of the steps in production and mounting can't be automated. Our dedicated team consists of people who know how to roll up their sleeves. As well as people who use their expertise to develop new products and applications.

In order to offer maximum quality, we like to keep the entire process in our own hands. Design and production for example, but also the assembly.

Wiefferink has spacious and modern equipped production halls in Oldenzaal and Wykroty (Poland).The assembly is done carefully by our own experienced teams. Going international is an important part of our mindset. The centre of gravity of our activities lies in Europe, but we also worked on some exciting projects in countries farther away, such as Guatemala, Thailand, Japan and South-Africa. Wiefferink has been founded in 1956 and has more than 60 years of experience in processing all kinds of foil for multiple applications.

Xebec Europe
Mr Sierk Coolsma
Westervoortsedijk 73 HG
6827 AV Arnhem
The Netherlands

+31 (0)88 949 43 08
www.xebecinc.com
sales@hygear.com

Xebec is a global provider of clean energy solutions for renewable and low carbon gases used in energy, mobility and industrial applications. We specialize in deploying a portfolio of proprietary technologies for the distributed production of hydrogen, renewable natural gas, oxygen and nitrogen.

Tailoring to the customers' needs, we offer our products as stand-alone systems or as part of an integrated package of solutions, including the recycling and recovery of industrial gases, as well as the entire gas mixing and delivery system. Our decentralised gas production provides a safer, more reliable and cost efficient alternative to conventional hydrogen supply.

By focusing on environmentally responsible gas generation systems, Xebec has helped thousands of customers from around the world in the reduction of operating costs and carbon footprints.

Yilkins
Mr Joris Spaan
P.O. Box 8210
9702 KE Groningen
The Netherlands

+31 (0)6 22 34 74 79
www.yilkins.com
info@yilkins.com

Yilkins enables modern biomass conversion and optimizes value chains. We develop and manufacture fully integrated, mobile, small-scale as well as large-scale solutions for economic drying and torrefaction of a wide range of biomass materials, from high value foodstuff up to and including upgrading of low-value forestry residues. Yilkins plants are modular, semi-transportable and have a compact footprint. They are scalable, which makes them suitable for both small- and large-scale projects.
Our innovative and revolutionary dryers apply the principles of 'Fluidized Bed' . We have designed our process for lowest capital and operational costs. We are working closely together with our customers to integrate our modular technology in the most effective manner. Our technology also allows distributed manufacturing as it can be operated remotely and autonomously. This allows to optimize total costs of supply. An independent due-diligence by a reputable, international organization has classified Yilkins' torrefaction technology as proven and 'bankable'. Among other Yilkins licenses its patented drying and torrefaction technology for the production of wood pellets for small and large-scale industrial energy generation.

The Yilkins team will work with you to find the best, customized and sustainable solution that enables the circular economy.

This is a joint publication by:

Netherlands Enterprise Agency (RVO)
Croeselaan 15
P.O. Box 8242
3503 RE Utrecht
The Netherlands
T +31 (0) 88 042 42 42
E redesk@rvo.nl
W www.rvo.nl

FME
P.O. Box 190
2700 AD Zoetermeer
The Netherlands
T +31 (0)79 353 11 00
E internationaal@fme.nl
W www.fme.nl

TKI BBE
P.O. Box 557
6700 AN Wageningen
The Netherlands
T +31 (0)6 – 1432 8077
E kees.degooijer@tki-bbe.nl
W www.biobasedeconomy.nl

Top Sector Energy
Ministerie van Economische Zaken en Klimaat
Directoraat-generaal Klimaat en Energie
Bezuidenhoutseweg 73
P.O. Box 20401
2500 EK Den Haag
The Netherlands
W www.topsectorenergie.nl

This publication was edited by Kenneth Colijn and Kees Kwant (RVO), Kees de Gooijer (TKI Biobased Economy), Marcel Werther (Top Sector Energy), Rogier Blokdijk (FME). Concept development, copywriting and design by Fortelle.

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Version: March 2022

Netherlands

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