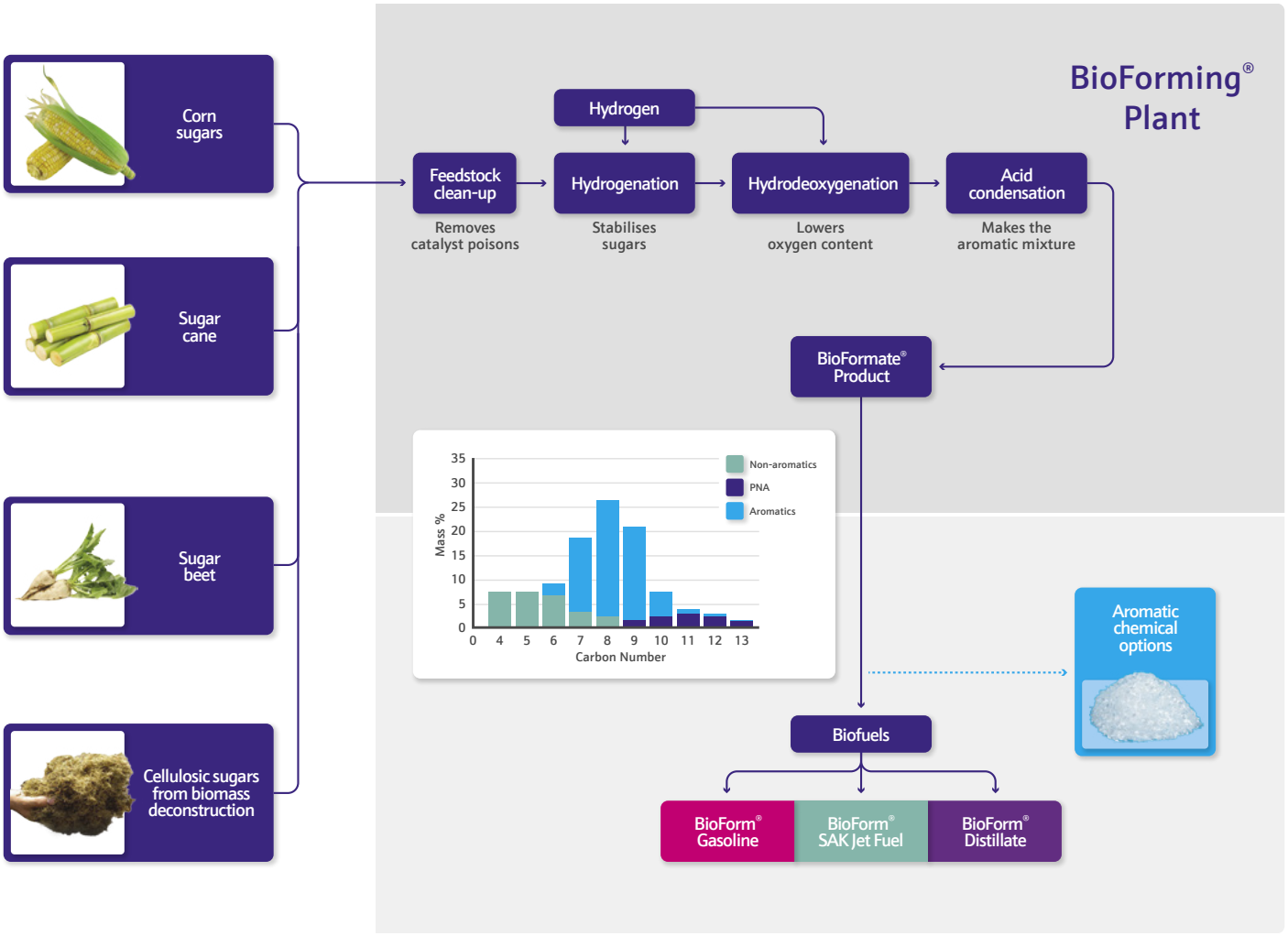
BioForming® Sugar to Aromatics (S2A)

Ready now and fit for the future

Johnson Matthey
Inspiring science, enhancing life

VIRENT

The BioForming® S2A process turns sugars into a drop-in aromatic feedstock, BioFormate®. Like its reformate namesake, BioFormate® can be utilised to make a variety of end products such as bio-gasoline, drop-in sustainable aviation fuel (SAF), and bio-BTX (benzene, toluene and xylenes) - molecules used as building blocks for many everyday products, such as pharmaceuticals, polymers and coatings.



Johnson Matthey and Virent, the original inventor of BioForming®, have been working in close collaboration since 2016 to develop and commercialise the technology. Our strong relationship alongside each company's unique partnerships, expertise, and technology have built a solid foundation, positioning us to help organisations across the world achieve sustainability goals.

Feedstock choices for the BioForming® S2A process

A key differentiator of BioForming® technology is its ability to use a wide variety of carbohydrate feedstocks. The patented catalytic process can convert sugar from an extensive range of crop feedstocks including beet sugar, sugar cane and corn starch, all of which are commercially available today. It is also compatible with cellulosic sugars produced from bagasse, corn stover, grasses, sorghum and wood.

The advantages of feedstock flexibility

The flexibility of BioForming® technology means that projects can be adapted to take advantage of locally available feedstock, better reflecting a user's dynamic commercial priorities. This means the technology is more resilient to the changing industry, providing greater long-term security for users.

A BioForming® facility can initially utilise existing commercially available sugar feedstocks, such as dextrose from corn to produce biofuels and biochemicals allowing the technology to be globally deployed. As cellulosic sugars become commercially available, the facility will then be able to utilise these sugars as feedstock generated from locally produced agricultural waste without major changes to the process or compromise on product quality.

Unlike biological processes that require a stream of C6 or C5 sugars for fermentation, BioForming® technology is able to process a mixture of plant sugars in addition to other soluble carbohydrates, including biomass degradation products that act as inhibitors in fermentation-based processes. Bioforming® also enables greater amounts of biogenic carbon to remain as useful products. This contrasts significantly with current major uses of industrial sugars, such as in fermentation where one third of the carbon present is lost as CO_2.

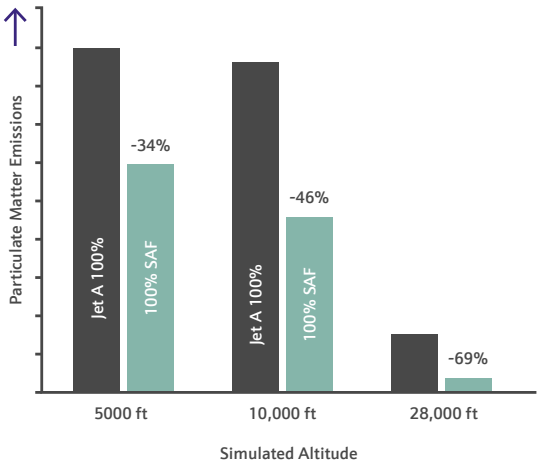
Deep feedstock expertise

The team has developed world-leading expertise in the analysis, handling, and application of sugars and carbohydrates. This experience informs our unrivalled support for our partners' feedstock selections. If you have samples of feedstocks you are considering for BioForming®, our scientists would be happy to help in the analysis and advise on suitability.

BioForming® SAK jet fuel
Ready for take-off

International standards require that jet fuel* has an aromatic content of 8-25%. Aromatics increase the density of the fuel and facilitate compatibility between the fuel of the the existing aircraft fleet and the ground-based fueling infrastructure. Sustainable aromatic components are therefore key to enabling the 100% drop-in sustainable aviation fuel required by the industry to meet its long-term sustainability targets.

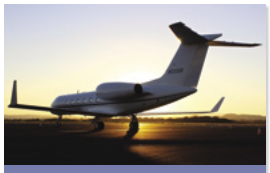
BioForm® Synthetic Aromatic Kerosene (SAK) is currently progressing through phase 2 of the ASTM approval process and will enable 100% SAF adoption without the need for changes to engines, airframes or fuel infrastructure. BioForm® SAK has also been demonstrated to have significantly lower particulate matter emissions versus its fossil equivalent.



BioForm® SAK has been demonstrated in multiple successful 100% SAF demonstration flights.
Scan the QR codes for more information:

United Airlines
December 2021

Bell Helicopters
December 2021



Gulfstream G650
December 2022

Emirates 777
January 2023

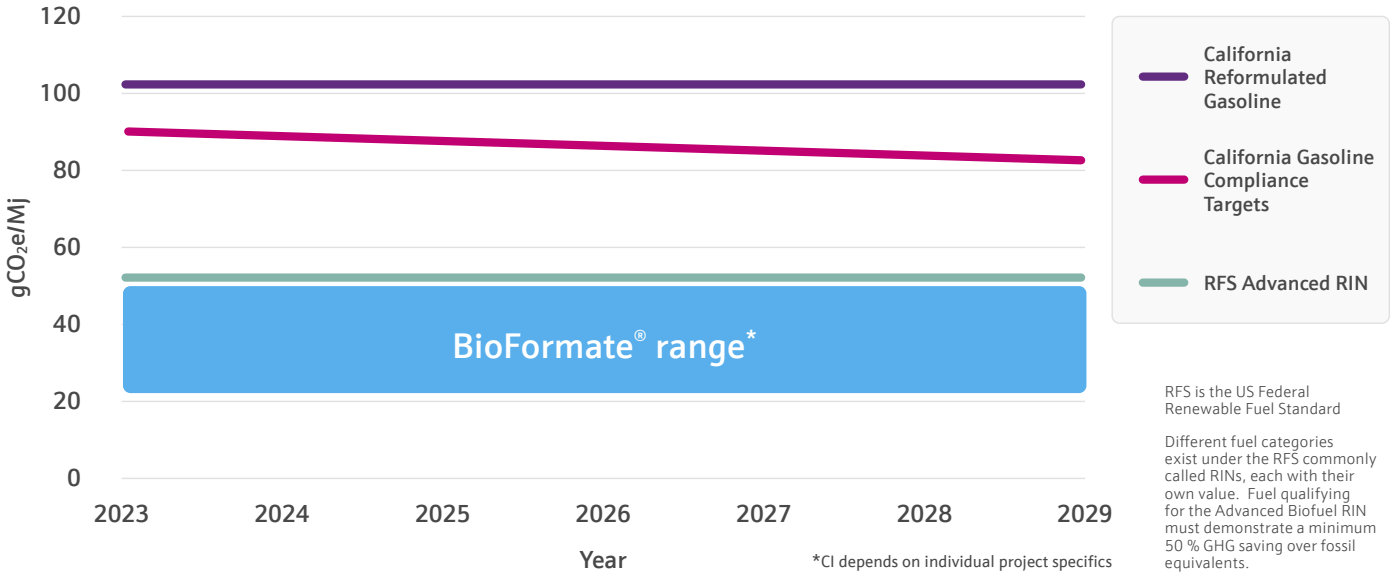
Virgin Atlantic, Boeing 787
November 2023

BioForm® gasoline
Low-CI and RIN ready

BioForm® gasoline can displace fossil-derived gasoline, lowering the overall carbon intensity (CI) of fuel blends. In addition, blending of BioForm® gasoline does not impact the ability to blend in ethanol up to existing limits enabling deep decarbonisation of the gasoline pool.

BioForm® gasoline has undergone EPA Part 79 registration, allowing a blend of up to 45% in gasoline and has also successfully passed no-harm vehicle testing.

The low CI gasoline blendstock produced via the BioForming® process is a drop-in fuel, meaning it can be used in existing petroleum infrastructure such as pipelines, tanks, pumps, and engines. While the carbon intensity of the BioFormate® will depend on some project-specific choices, we believe we can meet the requirements for the most advanced carbon reduction targets set to date.



*CI depends on individual project specifics

RFS is the US Federal Renewable Fuel Standard

Different fuel categories exist under the RFS commonly called RINs, each with their own value. Fuel qualifying for the Advanced Biofuel RIN must demonstrate a minimum 50 % GHG saving over fossil equivalents.

BioForm® for chemicals
Decarbonising plastics, fibres and films

BioForm PX® paraxylene is a critical component of biobased polyesters such as polyethylene terephthalate (PET). Biopolyester made with BioForm PX® is recyclable in the same way as petroleum-based products and can achieve significant reductions in carbon emissions. BioForming® can also be tuned to mostly produce bio-based BTX components that can be direct drop-in replacements in the supply chains for plastics, fibres, and films, enabling decarbonisation of a wide array of consumer markets. Scan the QR codes to learn more about our collaborations demonstrating BioForm PX® in a range of commercial applications.

Coca-Cola

ANA Inspiration of JAPAN

patagonia

ISSEY MIYAKE

Proven performance

The BioForming technology has been developed using Eagle, an integrated demonstration plant located in Virent's headquarters in Madison, Wisconsin. The Eagle demonstration plant has logged over 30,000 hours of operation and produced over 35,000 gallons of BioFormate®. Commercial scale catalysts manufactured by Johnson Matthey have been evaluated in Eagle and performed as expected while meeting lifetime targets. Over 3,000 gallons of BioForm® SAK have been produced enabling 100% SAF flight demonstrations and over 14 tonnes of BioForm PX® has been used in demonstrations of 100% bio-based consumer goods.

BioForming® S2A
Ready for commercialisation

Johnson Matthey and Virent are ready to license BioForming® at capacities over 8000 bbl/day (>100 million gallons, 450 million litres).

Transfer of our BioForming® technology would typically include an engineering package and ongoing support, advice, and catalyst supply. Being a BioForming® licensee means that both Johnson Matthey and Virent can offer our comprehensive expertise to ensure the success of your project.

Want to discuss your project?

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