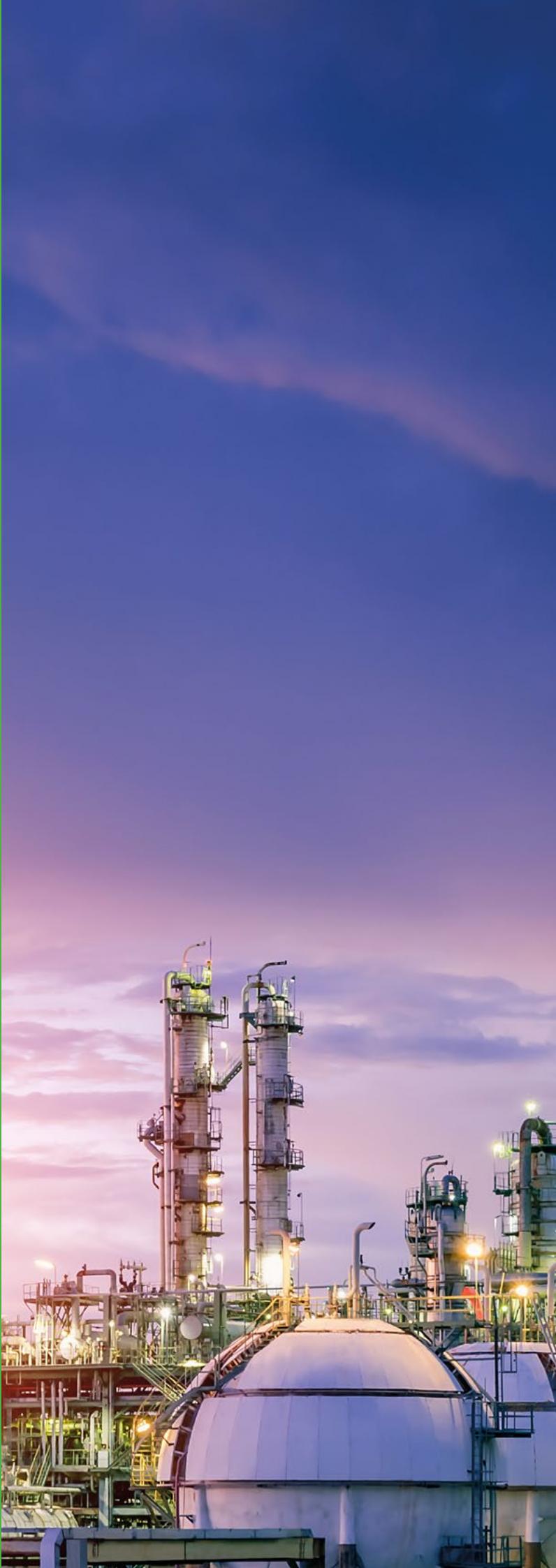


FLARE GAS SOLUTIONS

Delivering power
with associated
petroleum gas
(APG)

JENBACHER



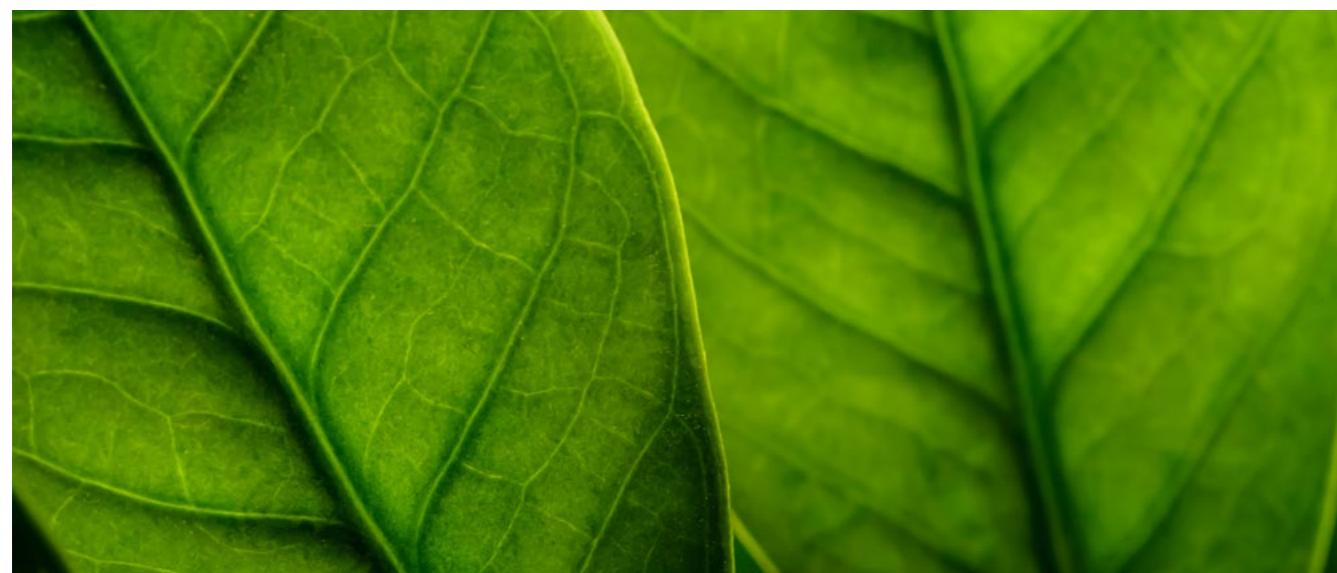
OIL PRODUCERS LOOK FOR WAYS TO LOWER EMISSIONS

By turning an oil byproduct into power

The COVID-19 pandemic brought with it a decline in the need for oil, and production dropped 8% in 2020 compared to the previous year—from 82 million barrels per day (b/d) in 2019 to 76 million b/d in 2020. Still, oil is considered essential for both commercial transportation, where it meets more than 80% of demand, and chemicals. It also is used in asphalt, lubricants, and other specialty products.¹

Governments, businesses, and communities are recognizing the need for resilience and sustainability in the energy industry—and fossil fuels are losing favor. For more than 160 years, oil producers have simply flared or vented into the atmosphere a by-product of oil exploration, so-called associated petroleum gas (APG). Annually, they release about 400 million tons of CO₂ equivalent emissions.

Aware of the accelerated pace of the energy transition, international oil companies have joined the sustainability movement with decarbonization plans that pave the way to net zero.² One way they can limit their environmental impact is by stopping the practice traditionally called “flaring.”



Associated petroleum gas and flaring

APG—the raw gas that comes from oil wells—can exist separately from oil in its formation (free gas) or can be dissolved in crude oil. Independent from the source of the natural gas, once separated from crude oil it commonly exists in mixtures with other hydrocarbons such as ethane, propane, butane, and pentanes. In addition, APG contains water vapor, hydrogen sulfide, carbon dioxide, nitrogen, and other compounds. APG that contains such impurities cannot be transported easily and cannot be used without treatment.

Because of the increase in environmental consciousness and a recognition that greenhouse gases from flaring are contributing to climate change, the practice now is sometimes avoided—or even prohibited. From 2019 to 2020, gas flaring dropped by 5%, with a 32% drop in the U.S. accounting for 70% of the global decline.

APG AS AN IMPORTANT ONSITE POWER SOURCE

Oil byproduct can replace diesel fuel

Technically, a number of options exist for handling APG:

- Preparing it as fuel in various forms, such as dried pipeline gas or liquefied petroleum gas (LPG), and exporting it via pipeline
- Reinjecting it for later recovery
- Processing it as liquefied natural gas (LNG) or LPG and exporting it via tankers
- Converting it to petrochemical industry feedstock
- Processing it as gas-to-liquids and gas-to-solids
- Converting it to other forms of energy for various uses such as thermal for district heating

- Generating electricity for transmission or onsite needs

In many countries, off-site transport of APG is economically and logically challenging. In the U.S., for instance, flare sites are scattered across the country, making quick connection from individual sites to a market a demanding task. In other countries, the sites often are quite remote.

Because of this lack of infrastructure, APG is much more valuable as an onsite energy source. In the past, diesel gensets often were used for power generation, but that solution is becoming less financially viable as the cost of both diesel fuel and its storage increases. As APG is already available on site, the oil byproduct can easily replace diesel as an energy source for onsite power generation. In addition, the specific CO₂ footprint of APG is approximately 30% lower than diesel.

Meanwhile, the composition of APG often is well suited for engines.

¹www.corporate.exxonmobil.com/energy-and-innovation/outlook-for-energy/energy-supply

²The World Bank, Global Gas Flaring Tracker Report, April 2021

A GREENER SOLUTION FOR THE OIL INDUSTRY

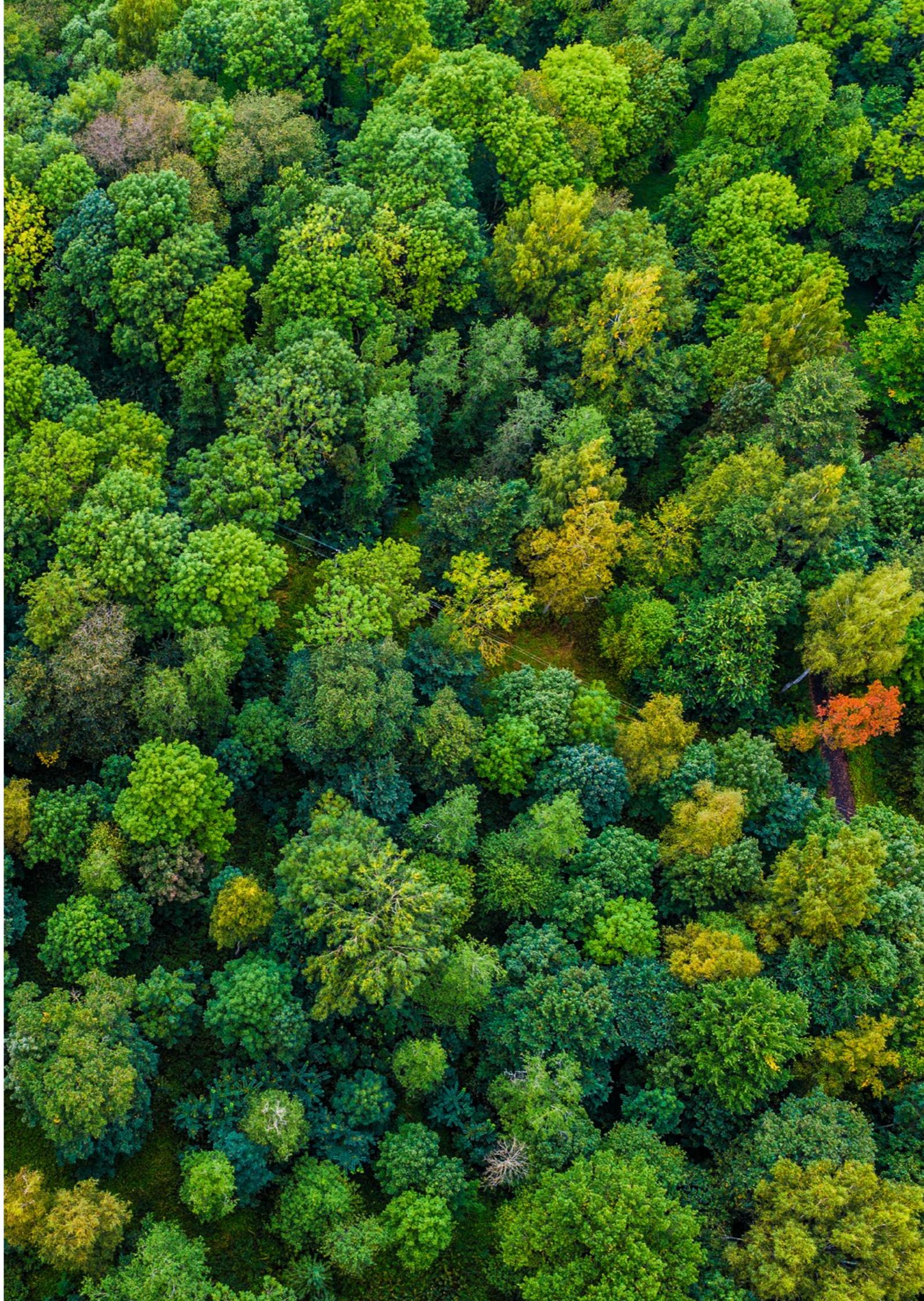
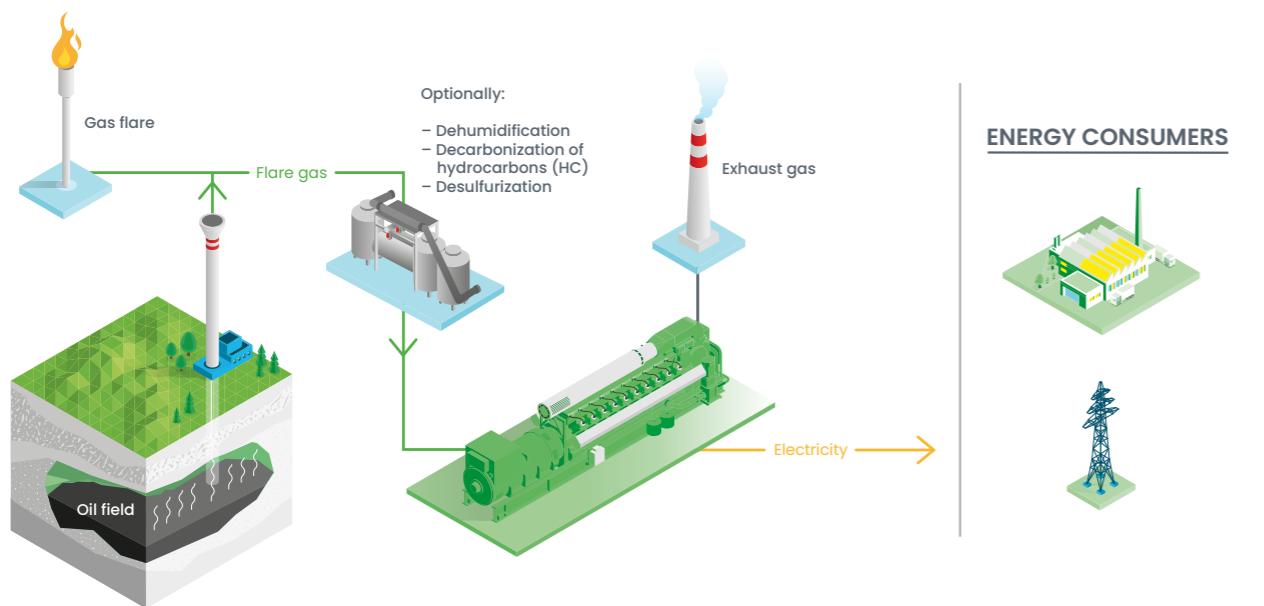
Jenbacher technology turns unwanted byproduct into onsite power

INNIO is enabling oil producers during the energy transition by providing solutions that work today and accelerate a cleaner tomorrow.

Our Jenbacher engines can turn APG into power for onsite electricity and even heat, eliminating the cost of diesel deliveries to remote areas. Plus, with APG, you'll reduce the CO₂ emissions that otherwise might result from diesel fuel consumption or from previous venting or flaring practices.

Although the composition of APG frequently is well suited for our Jenbacher solutions, in some cases dehumidification and removal of condensable hydrocarbons (HCs) might be needed. Because HC content often is relatively high, a derating of the nominal natural gas output may be required. Gas desulfurization also may be needed if hydrogen sulfide concentration is high.

With these treatments, this gas becomes a valuable fuel for independent power supply using engines. The engines usually are installed in containerized units with all peripheral systems (ventilation, silencers, cooling, and control room) mounted inside or on the roof. Depending on local needs, the waste heat from the engines also can be used for onsite heating purposes.



THE ADVANTAGES OF USING APG FOR ENERGY GENERATION

Boosting sustainability... and your bottom line

A Jenbacher combined heat and power solution offers benefits that let you:



Harness APG as an energy source, replacing diesel fuel with the by-product of the crude oil production process



Avoid the cost of diesel fuel storage and its transportation over long distances



Deliver an independent, onsite power supply



Receive high profitability with overall efficiencies of up to 95% with combined heat and power and up to 45% with power generation alone



Gain smooth operation despite fluctuations in gas composition and impurities (within given limits)



Receive excellent availability and reliability even at ambient temperatures as low as -50°C



Obtain quick installation through integrated containerized solutions

PROVEN JENBACHER TECHNOLOGY

For APG-fueled power generation

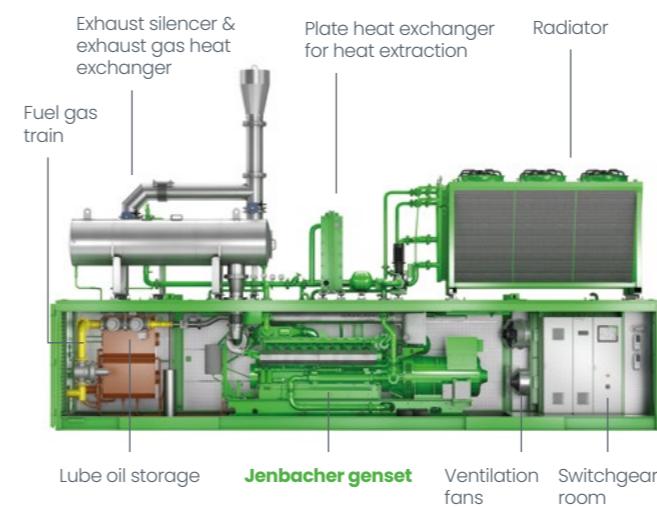
INNIO recognizes that you need a reliable and available energy source. With our quick and simple installation, our Jenbacher container solutions are an ideal fit for your site.

Containers are available for Jenbacher Type 2, 3, 4 and 6 engines with a broad range of options to meet your specific project requirements, such as sound attenuation, heat recovery, exhaust treatment, non-standard ambient temperatures, or earthquake safety.



The main benefits of our container solutions are:

- Quick and easy site installation due to pre-installed package with all necessary auxiliaries
- Less space consumed on site due to compact footprint
- Enhanced genset performance because all components are perfectly matched to the specific site requirements by Jenbacher engineering experts



Our containers incorporate the following main systems and features:

- Jenbacher genset
- VFD-controlled, positive-pressure ventilation system including weather grids, air filtration, and sound attenuation baffles
- Cooling systems with roof-mounted dump radiator and optional heat recovery equipment
- Fuel gas train
- Roof-mounted exhaust silencer and optional exhaust gas heat exchanger
- Lube oil storage and refill system
- Separate control room (air conditioning optional) for module control panel, generator circuit breaker, and VFDs
- Bunded floor for reliable fluid retention in the unlikely event of spills
- Multiple access doors to facilitate maintenance



A POWERFUL PORTFOLIO

For a variety of APG power generation applications

INNIO offers you a comprehensive portfolio for APG applications, from 330 kW up to 3.1 MW of single unit electrical power output. By using multiple gensets in one plant you can scale up your power output while significantly enhancing part load performance and reliability.

We offer a wide range of available generator voltage levels and flexible hydraulic integration variants for excellent integration into your existing electrical and thermal systems. Depending on your needs and capabilities, INNIO can provide you with the basic module, including its control system, or with an extended supply scope that includes balance-of-plant equipment.

Electrical output (kWel)



JENBACHER APG-FUELED TECHNOLOGY

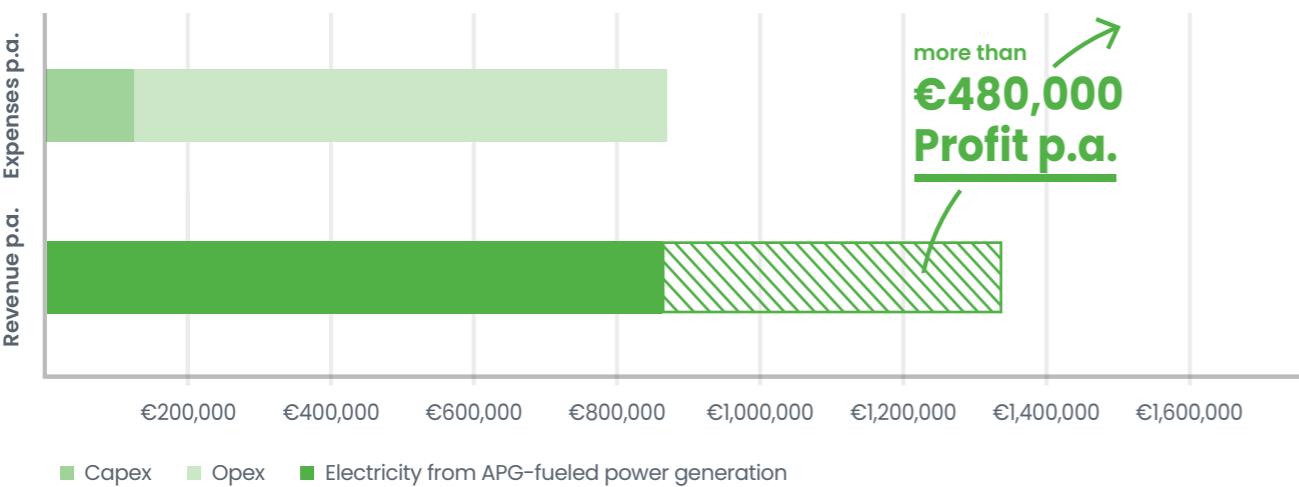
An investment that pays off

With INNIO's solutions for harnessing APG as an energy source, you gain economically—and so does the environment.

The following example use case shows that the utilization of APG in a Jenbacher power generation plant pays off. In addition to the economics of this application, the environmental aspect of not emitting the APG into the atmosphere is key for industry decision makers.

PLANT FACTS

Engine	1 x J420
Electrical output	1.5 MWe
Energy input	3,530 kW
Power generation	1,126 MWh/a



Return on investment: less than 2 years

Assumptions:

- APG Fuel Costs: 0.02 €/kWh
- Electricity Price: 0.12 €/kWh
- Based on a review period of 10 years, 10% interest rate p.a.
- Annual operating hours: 7,600

MORE THAN 25 YEARS OF JENBACHER EXPERTISE

The first Jenbacher systems using APG were installed in Italy in 1998

In total we have shipped more than 400 units worldwide. These plants potentially could generate about 4.8 million MW-hours³ of electricity a year—enough to cover the demand of more than 2 million European homes.⁴



³based on assumed 8,000 oph p.a.

⁴Based on average electricity consumption per EU household in 2018, www.odyssee-mure.eu/publications/efficiency-by-sector/households/electricity-consumption-dwelling.html

OUR COMMITMENT

to you

Flexibility and experience you can count on

For the last 65-plus years, Jenbacher has been an innovator of power generation technology. Today's highly efficient Jenbacher systems deliver energy independence through an efficient, low emission, secure and cost-effective energy solution.

Thinking long-term. Thinking circular

With our flexible, scalable, and resilient energy solutions and services, INNIO is embracing the circular economy—recycling, reusing, and upgrading our engines to meet the latest environmental requirements. For example, upgrading to hydrogen operations for a renewed life or using heat that normally would be wasted during power generation are sustainable solutions that can keep entire communities or businesses warm and electrified.

Through our service network in more than 100 countries and our digital capabilities, we provide life-cycle support for our globally installed units, helping to ensure a greater runtime for longer equipment life.



BENEFIT

from a powerful digital platform



Through our myPlant Performance digital solution, INNIO provides digital remote support for our connected customer-operated systems across the globe. Today, more than 12,000 engines are managed remotely, with more than 1.2 trillion data points evaluated annually—a powerful proof-point of INNIO's knowledge and experience.

Fulfill emission requirements

Our engine and fleet emission monitoring solutions help you more easily comply with emissions requirements—until you can operate your plant with 100% H₂ and become carbon-free.

Improve business planning

Increase your power system's lifespan by taking advantage of self-learning algorithms that analyze component condition and calculate parts lifetime.

Optimize engine management

Real-time engine monitoring and operations provide you with remote access to your assets via desktop or app, whenever you need it, by aligning operational practice with maintenance requirements.

Achieve greater availability

With the ability to solve more than 50%* of logged cases remotely, you can reduce the need for travel to your site—saving time and money.

Rely on INNIO's engagement to sustainability

For INNIO, ethics and compliance, along with a sustainable way of conducting business, are front and center of everything we do. By selecting INNIO as your supplier, you enter a long-term relationship with a dependable collaborator. Our fundamental mission to accelerate the world's transition to net zero was recognized with the prestigious EcoVadis ratings. INNIO joined the "Race to Zero" campaign, initiated by the United Nations, to bring together global leadership for a healthy transition to a net-zero future. Thanks to our efforts, INNIO's ESG Risk Rating secures again the number one position across more than 500 companies globally in the machinery industry assessed by Sustainalytics.**

* The number refers to connected Jenbacher engines.

** Rating took place in March 2023

INTERESTED?

INNIO is among the world's technological leaders in energy solutions and services for APG applications.

Let us develop a powerful energy concept for your company.

Reach out today by completing the contact form online: jenbacher.com/contact

Our Sales team will get back to you.



INNIO is a leading energy solution and service provider that empowers industries and communities to make sustainable energy work today. With our product brands Jenbacher and Waukesha and our digital platform myPlant, we offer innovative solutions for the power generation and compression segments that help industries and communities generate and manage energy sustainably while navigating the fast-changing landscape of traditional and green energy sources. INNIO is individual in scope, but global in scale. With our flexible, scalable, and resilient energy solutions and services, we enable our customers to manage the energy transition along the energy value chain wherever they are in their transition journey.

INNIO is headquartered in Jenbach (Austria), with other primary operations in Waukesha (Wisconsin, U.S.) and Welland (Ontario, Canada). A team of more than 4,000 experts provides life-cycle support to the more than 55,000 delivered engines globally through a service network in more than 100 countries.

INNIO's improved ESG Risk Rating again secures the number one position across more than 500 companies globally in the machinery industry assessed by Sustainalytics.

For more information, visit the INNIO website at www.innio.com

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ENERGY SOLUTIONS.
EVERYWHERE, EVERY TIME.



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available

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In general, "Ready for H₂" Jenbacher units can be converted to operate on up to 100% hydrogen in the future. Details on the cost and timeline for a future conversion may vary and need to be clarified individually.

Jenbacher is part of the INNIO Group

