

GGFR Technology Overview – Utilization of Small-Scale Associated Gas



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The Global Gas Flaring Reduction partnership (GGFR) is a public-private partnership that was formed in 2002 by multilateral organizations, governments, and oil companies. It is hosted and managed by the World Bank. GGFR provides a platform to support national governments and the petroleum industry in their efforts to reduce flaring and venting of gas associated with the extraction of crude oil.

2 Gas Processing

Processing of associated gas for entry into a pipeline system or where further utilization (e.g. CNG, Mini-GTL) requires heavier components and/or contaminants to be removed.

Each summary includes basic information on performance, technical requirements to implement and operate the equipment, the technology developer's business model, and existing applications currently in operation.

5 Mini-LNG – Liquefied Natural Gas

Small-scale LNG technologies used to liquefy (associated) gas to increase its energy density, thereby allowing economic transport of the gas to markets.

Where a pipeline may be uneconomic or not yet constructed, small-scale LNG offers a ‘virtual pipeline’ to transport gas to supply power plants, industrial and domestic gas users, and/or for use as a fuel for cars and trucks. LNG has a higher energy density than CNG, making it a more attractive option for transporting larger (>~ 5 MMscf/d) gas volumes and/or distances to market. Its higher capital cost, however, can make it economically unattractive for small gas volumes.

LNG liquefaction requires pre-processing of the (associated) gas to remove contaminants such as CO₂, H₂S and mercury. To meet gas specification, removal of N₂ and/or higher hydrocarbons may also be required.

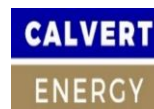
LNG is used in many parts of the world to supply gas (following re-gasification) to power plants and industrial/domestic gas users. It is also being increasingly used in liquid form as a fuel for large trucks.

Each summary includes basic information on performance, technical requirements to implement and operate the equipment, the technology developer’s business model, and existing applications currently in operation.



Calvert Energy Group/Cosmodyne

Since 2015, Calvert Energy Group has been appointed as Cosmodyne's exclusive alliance partner for market and project development for Mexico, Africa and Middle East to develop Nitrogen & Oxygen LNG plants, Air Separation Plants, Nitrogen Gas Generators and Re-Gasification Plants. LNG plants range from 5,000 t/d to 850,000 t/d
 The Calvert Energy Group also offers small-scale GTL plants using OXEON technology (see separate mini-GTL summary)



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Calvert Energy - Technology & Operating conditions	Size range & Cost			Additional operational requirements	O&M	Offshore suitability	Business model	Regasification
Small-scale modular LNG liquefaction plants Refrigerant options: Nitrogen expansion, Methane, Mixed refrigerant, Closed cycle. Options for regasification, storage and transport	Model	Mt/d	MMscf/d	Plants require water (for start-up; no additional water required during operation) and power supply. The necessary power generation units can be supplied by Calvert Energy Group with the GTL plant	Can be operated by operators with basic rotating equipment experience	Suitable for offshore application. Footprint: 10m x 22m for 100 mtd plant	Sale, lease, Build, own and operate, Build, own, operate and transfer Calvert Energy Group designs and manufacturers all systems in Europe. Financing can also be provided.	Combustion, Ambient and Shell & tube options for regasification Capex: ~ \$ 0.34mln per MMscf/d capacity Requires supply of electricity and water
	Linex -5	8	0.4					
	Linex -25	42	2.1	Calvert can provide the gas pre-treatment equipment			Experience to date 16 liquefaction plants in operation in USA, Mexico and Nigeria	Transport Truck mounted ISO containers for onshore transport; Barges for offshore transport with 3000 to 15,000 m3 capacity
	Linex -60	100	5					
	Linex -100	170	8.4					
	Linex -250	425	20.9					
	Linex -350	595	29.3					
	Linex -500	850	41.9					
Inlet pressure : 45 to 65.5 bar	Modular and scalable. Each module is 12m x 18m							
Pre-treatment of the feedgas required to meet inlet specifications of: CO2<50 ppm, H2S, Mercaptans & Water< 500 ppm, Oxygen< 10 ppm, Mercury< 10 ng/m3	EPC cost approx. 1.2 US\$ mln for a 1 MMscf/d plant OPEX: Approx 4.5% of capex							
Plants can handle +/- 25% variation in gas supply volume								
								Storage ISO and prismatic containers, and barge storage

6 Mini-GTL – Gas to Liquids

Technologies to convert (associated) gas into synthetic crude or other liquid hydrocarbons, e.g. gasoline, diesel, naphtha, methanol.

Advances in GTL technologies have recently enabled small-scale GTL, and even micro-scale GTL, to be operationally and potentially economically feasible.

The final GTL product may be syncrude, which can be injected into an oil pipeline, thereby avoiding the need to transport another product to market, or higher-value fuels or chemical feedstocks such as gasoline, diesel, naphtha, methanol or di-methyl ether (DME).

Conversion of (associated) gas to a liquid significantly increases the gas' value and its ease of transport, but the conversion process is relatively complex and expensive compared to other direct gas utilization options such as CNG or mini-LNG.

Many of the conversion technologies used require no pre-processing of the gas other than to remove contaminants.

Each summary includes basic information on performance, technical requirements to implement and operate the equipment, the technology developer's business model, and existing applications currently in operation.

Calvert Energy Group/OXEON

The Calvert Energy Group offers modular GTL (Flare & Stranded Gas to Diesel plants ranging in size from 0.2 MMscf/d to 100 MMscf/d. The OXEON technology used is exclusively licensed to Calvert Energy Group by OXEON.

The Calvert Energy Group also offers small-scale LNG plants using Cosmodyne liquefaction technology (see separate mini-LNG summary)

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Calvert Energy - Technology & Operating conditions	Size range & Cost	Additional operational requirements	O&M	Offshore suitability	Business model	Experience to date
Mini-GTL producing synthetic diesel using associated gas, landfill gas, coalbed methane, refinery flare gas	0.2 MMscf/d (20 b/d) to 100 MMscf/d (10,000 b/d) using 1 MMscf/d modules. Technology is scalable. With higher gas volumes additional GTL modules are added and interconnected.	100 m3/d water required for start-up; no additional water required during operation. Clean water is a byproduct	Catalyst (Chevron Fiber) replacement every 40 months. Plants are designed for remote operation; it is recommended however to have one dedicated operator on site.	Suitable for offshore application	Sale, Build, own and operate with gas purchase, Calvert Energy Group designs and manufacturers all systems in Europe. Financing of plants can also be provided.	A syngas plant is in operation in Argentina (500 b/d) since mid-2016, and a complete GTL plant is in operation in N. Dakota (USA) (25 b/d) since end-2017. Three additional plants are under contract for 2018 in Iraq, Zimbabwe and Nigeria
	Modular and scalable. Each module is 3m x 3m x 6m high, weight 22 tons	Plants require power supply: 1 MW per 150 b/d of product. The necessary power generation units can be supplied by Calvert Energy Group with the GTL plant				
Inlet pressure : 2 to 30 bar	Product yield: 100 bbl diesel, 1 bbl wax, 2 bbl clean water per MMscf feedgas	Calvert can provide H2S and CO2 removal				
Plasma reformer converts feedgas to syngas. Can handle unprocessed associated gas including gas containing H2S, N2, CO2.	EPC cost approx. 45 US\$ mln for a 10MMscf/d plant OPEX: ~1.2% of Capex per year					
Plants handle 50% turn-down in gas supply within 2 minutes						