

**Status report on thermal gasification of biomass and waste 2019**

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**Annex 3**

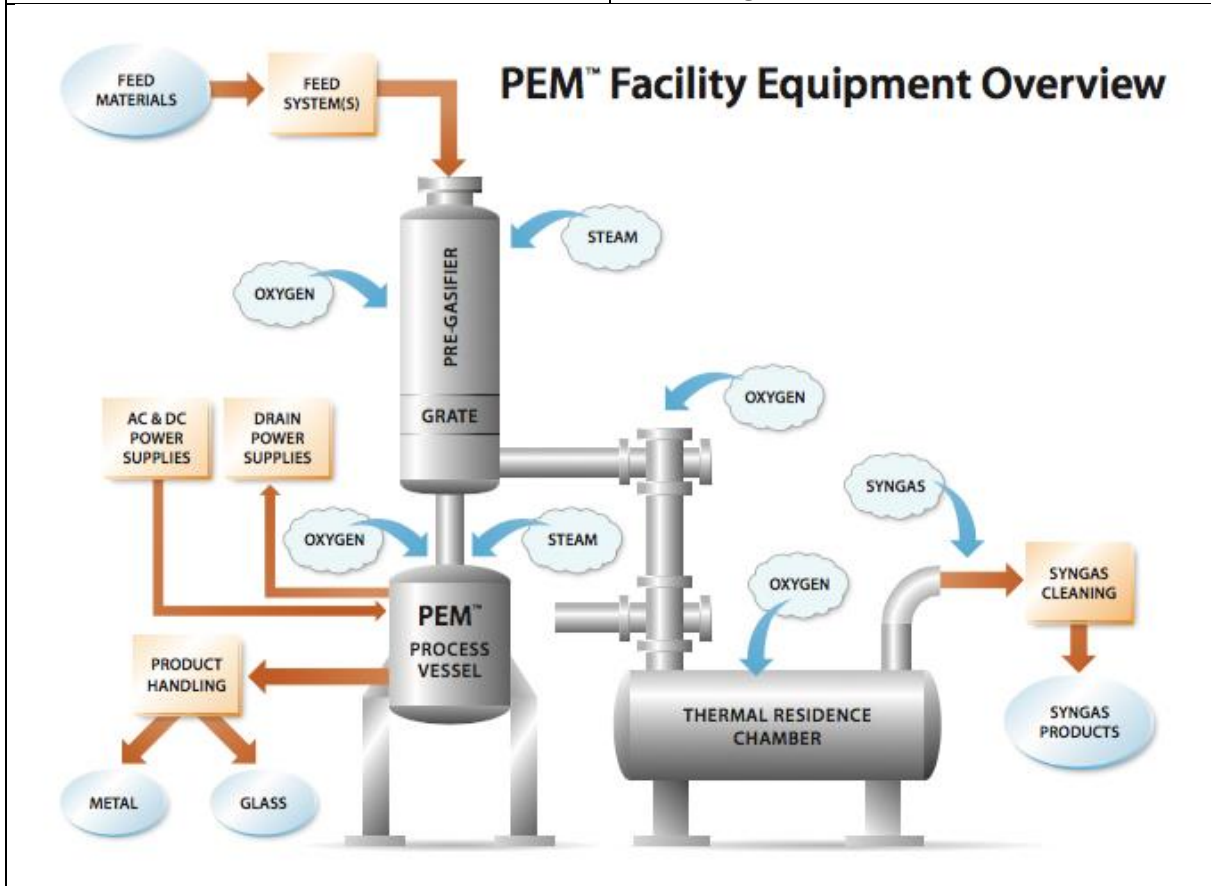
**Gasification facilities for fuel synthesis – operational, under construction, under commissioning**

In this annex, the thermal gasification facilities for fuel synthesis with TRL 6-9 are included. Only few, important facilities with lower TRL could be found here as reference.

	Operational
	Under construction / under commissioning

	Owner	Name	Country	Page
	Aemetis/Lanzatech	Project Aemetis Riverbank	USA	2
	Total	BioTfuel demo	FR	3
	Enerkem	Westbury commercial demonstration facility	CA	4
	Enerkem Alberta Biofuels LP	Edmonton Waste-to-Biofuels Project	CA	5
	GDF Suez + consortium	Gaya	FR	6
	Go Green Fuels Ltd	GoGreenGas	UK	7
	KIT bioliq	bioliq	DE	8
	Tembec Chemical Group	Synthesis Tembec Chemical Quebec	CA	9
	Vanerco (Enerkem & Greenfield Ethanol)	Varennes Cellulosic Ethanol	CA	10
	West Biofuels	LLC Thermal Reformer Synthesis West BiofuelsWoodland , CA	US	11

Project name	Project Aemetis Riverbank
Project owner	Aemetis/Lanzatech
Status	Planned (securing financing)
Start up	TBD (construction planned to begin 2020)
Country	USA
City	Riverbank, CA
Type	TRL 8
Technology	Fuel synthesis
Raw Material	Agricultural waste
Output 1 Name	Cellulosic ethanol
Output 1 Capacity	12 mill.
Output 1 Unit	US gallons per year
Funding	USDA loan guarantee (\$125M), California Energy Commission (\$5M)
Technology Brief	Gasification with syngas fermentation (InEnTec gasifier, Lanzatech syngas fermentation)
Contact	Jeff Welch Jeff.welch@aemetis.com

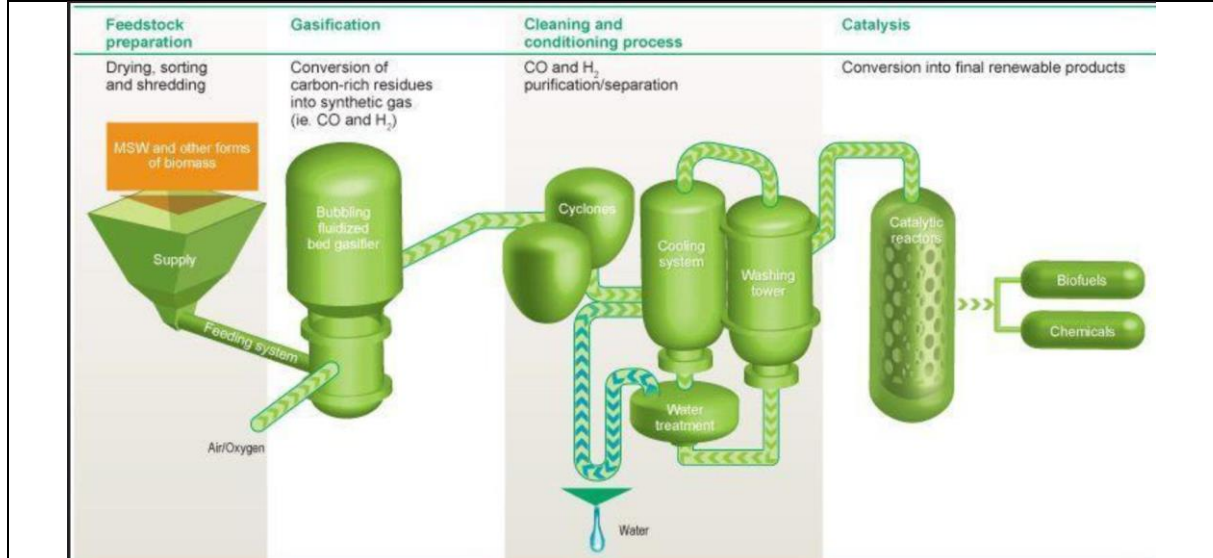


Project name	BioTfuel demo
Project owner	Total
Status	Under commissioning
Start up	
Country	France
City	Dunkirk
Type	TRL 6-7 demo
Technology	Fuel synthesis
Raw Material	Forest waste, straw, green waste, dedicated crops
Output 1 Name	FT liquids (jet fuel component)
Output 1 Capacity	8000
Output 1 Unit	t/y
Partners	Axens, CEA, IFP Energies Nouvelles, Avril, ThyssenKrupp Industrial
Technology Brief	The BioTfuel project is focused on developing an innovative process for converting biomass into high-quality biodiesel and bio-jet fuel. Gasification makes it possible to produce biofuels from lignocellulosic material, such as agricultural by-products, forest waste and energy crops. The process can also convert fossil feedstock mixed with biomass to account for seasonal variations in resource availability. The biomass feedstock is torrefied and then converted into syngas in a gasifier. Once the syngas has been cleaned and conditioned, it is converted into a hydrocarbon mixture that can be used to produce fuel.
Contact	<a href="http://www.total.com/en/energy-expertise/projects/bioenergies/biotfuel-converting-plant-wastes-into-fuel">http://www.total.com/en/energy-expertise/projects/bioenergies/biotfuel-converting-plant-wastes-into-fuel</a>

DIAGRAM OF THE THERMOCHEMICAL CONVERSION PROCESS



Project name	Westbury commercial demonstration facility
Project owner	Enerkem
Status	Operational
Start up	2009
Country	Canada
City	Westbury, Quebec
Type	TRL 6-7 Demonstration
Technology	Fuel Synthesis
Input 1 Name	Treated wood (i.e. decommissioned electricity poles, and railway ties), wood waste and MSW (48 t/d)
Output 1	cellulosic ethanol (4,000 t/y )
Output 2	methanol (1,000 )
Output 3	various chemicals
Technology Brief	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Contact	Louis Dénommé ldenomme@enerkem.com



Project name	Edmonton Waste-to-Biofuels Project
Project owner	Enerkem Alberta Biofuels LP
Status	Operational
Start up	2014
Country	Canada
City	Edmonton, Alberta
Type	TRL 8 First-of-a-kind commercial demo
Technology	Fuel Synthesis
Input 1 Name	Post-sorted municipal solid waste (MSW) (100,000 t/y )
Output 1	Ethanol (30,000 t/y )
Output 2	Methanol
Output 3	Various chemicals
Partners	
Technology Brief	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Contact	Marie-Helene Labrie mlabrie@enerkem.com

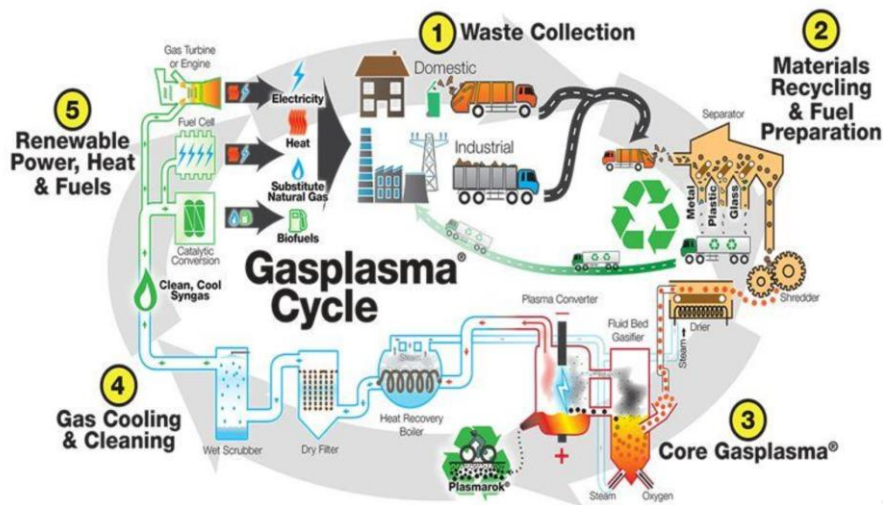
Project name	Gaya
Project owner	GDF Suez + consortium
Status	Comissioning, commercial operation 2023
Start up	2017
Country	France
City	Lyon
Type	TRL 1-3 Research
Technology	Fuel synthesis
Input 1 Name	Wood pellets, wood chips
Output 1	SNG 0,1 t/y
Partners	Engie, Repotec, UCFF, LGC, LRGP, UCCS, Rapsodee, CEA, CIRAD, CTP, FCBA
Technology Brief	<a href="http://www.projetgaya.com/en/">http://www.projetgaya.com/en/</a>

Project name	GoGreenGas
Project owner	Go Green Fuels Ltd
Status	Under construction
Start up	2019
Country	United Kingdom
City	Swindon
Type	TRL 8 First-of-a-kind commercial demo
Technology	Fuel Synthesis
Input 1 Name	Refuse derived fuel and waste wood (7,500 t/y )
Output 1	SNG (1,500 t/y ) Product: 4 MW, 22 GWh
Total investment	GBP 25 000 000 11 million pound sterling public funding, 6 million pound sterling private funding

Partners

Technology Brief

The Gogreengas pilot plant is a development facility for proving and optimizing the process for manufacturing Bio-SNG from Refuse Derived Fuel (RDF) and biomass feedstocks. The project is a partnership between Cadent (aka National Grid Gas Distribution), Advanced Plasma Power (APP), Progressive Energy and Carbotech (a subsidiary of Viessmann). The funding and strategic backing for the project comes from the UK energy regulator Ofgem's Network Innovation Competition, the European BioEnergy Securing the Future ERANET programme and the project partners. Dried RDF and other feedstocks are converted to syngas in a two-stage gasification process using APP's Gasplasma® technology (fluidized bed gasifier at atmospheric pressure designed by Outokompou Energy, close-coupled with a plasma converter). The plasma stage removes tars leaving a syngas which is predominantly CO and H<sub>2</sub> and is also used to vitrify the ash. After further conventional gas processing, the syngas undergoes a water gas shift to adjust the proportions of the CO and H<sub>2</sub>, followed by catalytic methanation. The arising CO<sub>2</sub> is removed from the methane using a pressure swing absorption unit to produce pipeline / vehicle quality Bio-SNG. The design incorporates provisions to evaluate a number of reactor configurations and a variety of catalyst bed geometries during the testing period. The plant has been commissioned and initial experimental work undertaken using test gases. End-to-end operation is about to commence, initially at low dilutions, and the plant will be progressively brought on stream and optimized during the remainder of 2016. The process challenges include the removal of heat in the highly exothermic methanation reactions given the smaller scale than conventional fossil plants, and the production of a substitute natural gas that meets the stringent regulations for gas grid injection.



Project name	Synthesis bioliq - process Karlsruhe
Project owner	Karlsruhe Institute of Technology (KIT)
Status	operational
Start up	2012
Country	Germany
City	Karlsruhe
Type	TRL 4-5 Pilot
Technology	Fuel synthesis
Raw Material	Lignocellulosic crops
Input 1 Name	Straw
Input 1 Capacity	1
Input 1 Unit	t/h
Output 1 Name	Gasoline type fuels
Output 1 Capacity	608
Output 1 Unit	t/y
Partners	KIT, Lurgi, MUT, MLR
Total Investment	64 mio.
Total Investment Currency	Euro
Technology Brief	The bioliq process, developed at the Karlsruhe Institut für Technologie (KIT) aims at the production of synthetic fuels and chemicals from biomass. The bioliq technology is based on a two step process with decentral pyrolysis for the production of transportable slurry from biomass (e.g. straw) and central slurry gasification and BtL production. At KIT Karlsruhe a pilot plant with 2 MW fast pyrolysis and biosyn-crude production and 5 MWth high pressure entrained flow gasifier operated up to 8 MPa (both in cooperation with Lurgi GmbH, Frankfurt), as well as the hot gas clean-ing (MUT Advanced Heating GmbH, Jena), dimethylether and final gasoline synthesis (Chemieanlagenbau Chemnitz GmbH) are in operation.
Additional Information	
Contact	Mark Eberhard mark.eberhard@kit.edu



Project name	Synthesis Tembec Chemical Quebec
Project owner	Tembec Chemical Group
Status	Operational
Country	Canada, Quebec
City	Temiscaming
Type	TRL 6-7 Pilot
Technology	Fuel synthesis
Raw Material	Lignocellulosic crops
Input 1 Name	spent sulphite liquor feedstock
Output 1 Name	Cellulosic ethanol
Output 1 Capacity	13 000
Output 1Unit	t/y
Contact	Lyle Biglow lyle.biglow@tembec.com

Project name	Varenes Cellulosic Ethanol
Project owner	Vanerco (Enerkem & Greenfield Ethanol)
Status	Under construction
Country	Canada
City	Varenes, PQ
Type	TRL 6-7 Demonstration
Technology	Fuel Synthesis
Raw Material	Organic residues and waste streams
Input 1 Name	Sorted industrial, commercial and institutional waste
Output 1 Name	Ethanol
Output 1 Capacity	30 000
Output 1Unit	t/y
Contact	Marie-Helene Labrie mlabrie@enerkem.com



Project name	LLC Thermal Reformer Synthesis West BiofuelsWoodland , CA
Project owner	West Biofuels
Status	Operational
Start up	2007
Country	USA, CA
City	Woodland
Type	TRL 6-7 demo
Technology	Fuel synthesis
Raw Material	Forest residues
Input 1 Name	clean wood, waste wood
Input 1 Capacity	5
Input 1Unit	t/d
Output 1 Name	FT liquids
Output 1 Capacity	-
Output 1Unit	t/y
Partners	University of California
Technology Brief	West Biofuels uses dual fluidized bed thermal reforming system that breaks down biomass into its molecular components through chemical reactions brought on by high heat, oxygen and steam at low pressure.
Additional Information	Woodland Biomass Research Center, Woodland, CA, USA: The Woodland Research Center is located approximately 20 miles northwest of Sacramento in Woodland, California. The facility was built in cooperation with the University of California
Contact	Matt Summers matt.summers@westbiofuels.com