IEA Bioenergy
Technology Collaboration Programme

Status report on thermal gasification of biomass and waste 2025
Output: Chemicals (MeOH & EtOH)

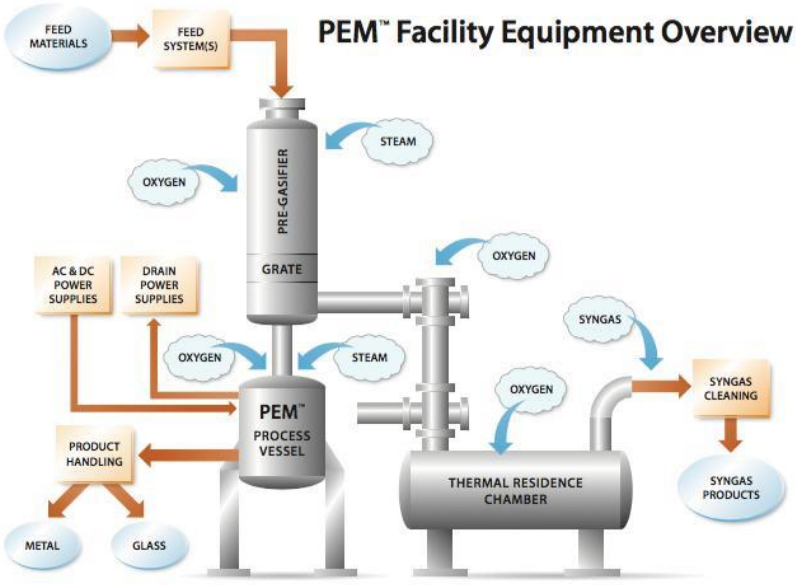
Dr. Jitka Hrbek and Antonia Biebighäuser

Annex 4
Gasification facilities for CHP production with Chemicals (MeOH & EtOH) Output - operational, under construction / under commissioning, on hold

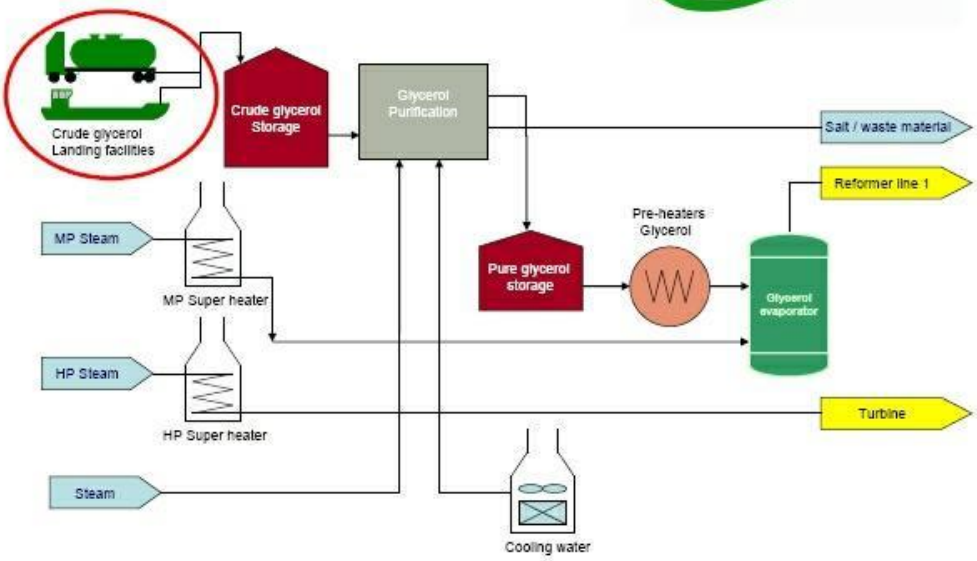
Output: Chemicals (MeOH & EtOH)

	Operational
	Planned
	Under construction / under commissioning
	On hold / Non operational

CATEGORY	INFORMATION
PROJECT OWNER	Aemetis/Lanzatech
PROJECT NAME	Project Aemetis Riverbank
STATUS	planned
LOCATION	United States
CITY	Riverbank
STATE	California
TYPE	TRL 8 First-of-a-kind commercial
TECHNOLOGY	
TECHNOLOGY ADDITIONAL INFORMATION	InEnTec gasifier, Lanzatech syngas fermentation
RAW MATERIAL	agricultural residues
OUTPUT 1	ethanol (36,000 t/y)
OUTPUT ADDITIONAL INFORMATION	12 mill. US gallons per year
FUNDING EXPLANATION	USDA loan guarantee ($125 M) and California Energy Commission ($5M)
CONTACT INFORMATION	Jeff Welch (jeff.welch@aemetis.com)



CATEGORY	INFORMATION
PROJECT OWNER	BioMCN (OCI NV)
PROJECT NAME	BioMCN
STATUS	operational
STARTUP	2009
LOCATION	Netherlands
CITY	Farmsum
STATE	Groningen
TYPE	TRL 8 First-of-a-kind commercial
TECHNOLOGY	Fuel Synthesis
RAW MATERIAL	other
INPUT 1	biomethane
OUTPUT 1	methanol (65,000 t/y)
PARTNERS	Waterland, Teijin, NOM
TECHNOLOGY BRIEF	constructed for converting glycerine (a by-product from biodiesel production) into bio-methanol, but currently feeding on biomethane
ADDITIONAL INFORMATION	the facility currently simply turns biomethane into biomethanol, using only a fraction of their capacity Connected to the national natural gas grid – itself connected to the integrated NW Europe network ✓ Easy logistical access to major European end markets via rail and sea freight from Delfzijl and road and barge from terminal in Rotterdam ✓ Winner of Dutch National Enlightenmentz Awards for an innovative green methanol production process converting carbon dioxide and hydrogen into bio-methanol ✓ Capable of producing both methanol and bio-methanol
CONTACT INFORMATION	info@biomcn.eu


Crude glycerol
Landing facilities
Crude glycerol
Storage
Glycerol
Purification
Salt / waste material
Reformer line 1
Pre-heaters
Glycerol
MP Steam
MP Super heater
Pure glycerol
storage
Glycerol
evaporator
HP Steam
HP Super heater
Turbine
Steam
Cooling water

CATEGORY	INFORMATION
PROJECT OWNER	Enerkem
PROJECT NAME	Varennes Carbon Recycling
STATUS	under construction
STARTUP	2025
LOCATION	Canada
CITY	Varennes
TYPE	TRL 9 Commercial
TECHNOLOGY	Fuel Synthesis
RAW MATERIAL	organic residues and waste streams
INPUT 1	Forest residues and non-recyclable waste (200,000 t/y)
OUTPUT 1	methanol (99,000 t/y)
OUTPUT ADDITIONAL INFORMATION	advanced biofuels and circular chemicals, 125000 m^3/a
TOTAL INVESTMENT	CAD 875,000,000
PARTNERS	In December 2020, Enerkem announced the construction of a C$875 million biofuels plant in Varennes with a group of strategic partners including Shell, as lead investor, as well as Suncor and Proman, and Hydro-Québec, which will supply renewable hydrogen and oxygen, and with the support of the governments of Quebec and Canada.
TECHNOLOGY BRIEF	The plant will leverage green hydrogen and oxygen produced through electrolysis, transforming Quebec's excess hydroelectricity capacity into value-added biofuels and renewable chemicals. Enerkem's proprietary thermochemical process will enable the recycling of the carbon and hydrogen contained in non-recyclable waste and wood waste currently landfilled or burned. In addition to providing a second life to waste material, VRC will expand the overall supply of alternative fuels and increase biofuel production in Québec increasing its leadership in renewable energy and innovation. Commissioning of the first phase is scheduled for 2023.
ADDITIONAL INFORMATION	https://enerkem.com/company/facilities-projects/
CONTACT	Amelie Desrosiers, ADesrosiers@enerkem.com

CATEGORY	INFORMATION
PROJECT OWNER	Enerkem
PROJECT NAME	Westbury commercial demonstration facility
STATUS	operational
STARTUP	2009
LOCATION	Canada
CITY	Westbury
STATE	Quebec
TYPE	TRL 6-7 Demonstration
TECHNOLOGY	Fuel Synthesis
RAW MATERIAL	forest residues
INPUT 1	Treated wood (i.e. decommissioned electricity poles, and railway ties), wood waste and MSW (48 t/d)
OUTPUT 1	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.
ADDITIONAL INFORMATION	http://enerkem.com/facilities/enerkem-westbury/ in operation since 2009 (syngas), 2010 (methanol), 2012 (ethanol)
CONTACT INFORMATION	n.n.

CATEGORY	INFORMATION
PROJECT OWNER	Enerkem
PROJECT NAME	Synthesis Enerkem Sherbrooke
STATUS	operational
STARTUP	2003
LOCATION	Canada
CITY	Montreal
STATE	Quebec
TYPE	TRL 4-5 Pilot
TECHNOLOGY	
RAW MATERIAL	lignocellulosics
INPUT 1	municipal solid waste, wood chips, treated wood, sludge, petroleum coke, spent plastics and wheat straw
OUTPUT 1	ethanol (375 t/y)
OUTPUT 2	methanol (475 m^3/y)
OUTPUT 3	SNG
PARTNERS	University of Sherbrooke
TECHNOLOGY BRIEF	Enerkem has developed a gasification-based process technology that transforms sorted municipal solid waste (MSW) and residues from the forest and agricultural industries into transportation fuels, high-value chemicals and electricity.
ADDITIONAL INFORMATION	Pilot Plant Facility, Sherbrooke, Quebec, Canada: Enerkem has been operating the pilot plant in Sherbrooke since 2003, accumulating over 4,000 hours of operation.
CONTACT INFORMATION	Amelie Desrosiers, ADesrosiers@enerkem.com

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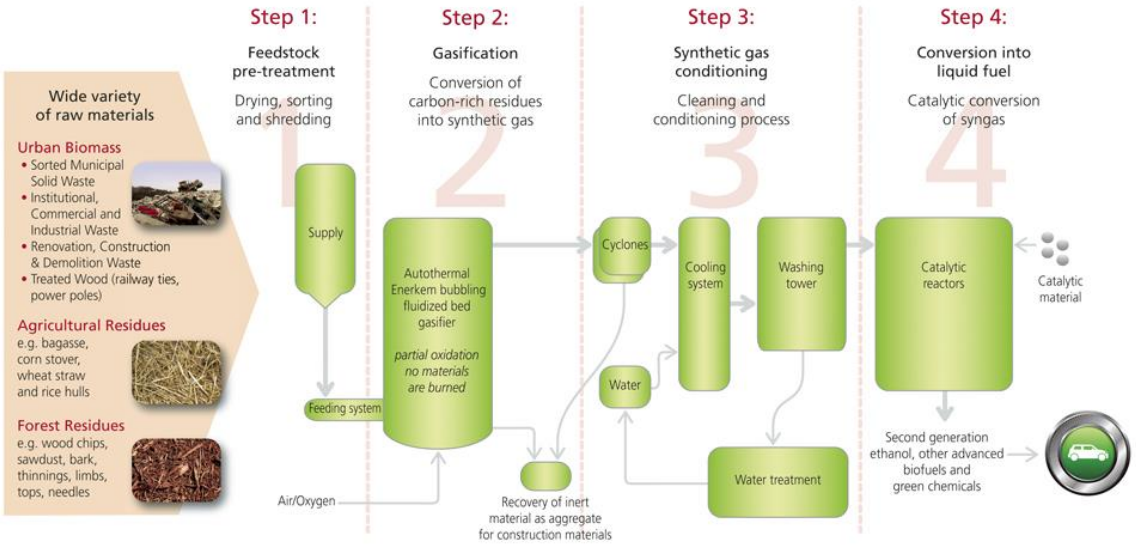

CATEGORY	INFORMATION
PROJECT OWNER	Enerkem Alberta Biofuels LP
PROJECT NAME	Edmonton Waste-to-Biofuels Project
STATUS	non operational
STARTUP	2014
LOCATION	Canada
CITY	Edmonton
STATE	Alberta
TYPE	TRL 8 First-of-a-kind commercial
TECHNOLOGY	Fuel Synthesis
RAW MATERIAL	organic residues and waste streams
INPUT 1	Post-sorted municipal solid waste (MSW) (100,000 t/y)
OUTPUT 1	ethanol (30,000 t/y)
OUTPUT 2	methanol
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.
ADDITIONAL INFORMATION	Initiated production (biomethanol) in 2015; ethanol module added later; ethanol production started in 2019. Plant produced five million litres of biofuels and operated for more than 15,000 hours. The facility achieved ISCC and ISCC+ certifications and was the world's first industrial-scale biofuels project to use municipal solid waste as feedstock. Plant is being decommissioned and closed in 2024 after reaching its objectives of demonstrating commercial-scale technology. The project contributed significant learnings for future waste diversion and decarbonization strategies.
CONTACT INFORMATION	Marie-Helene Labrie mlabrie@enerkem.com

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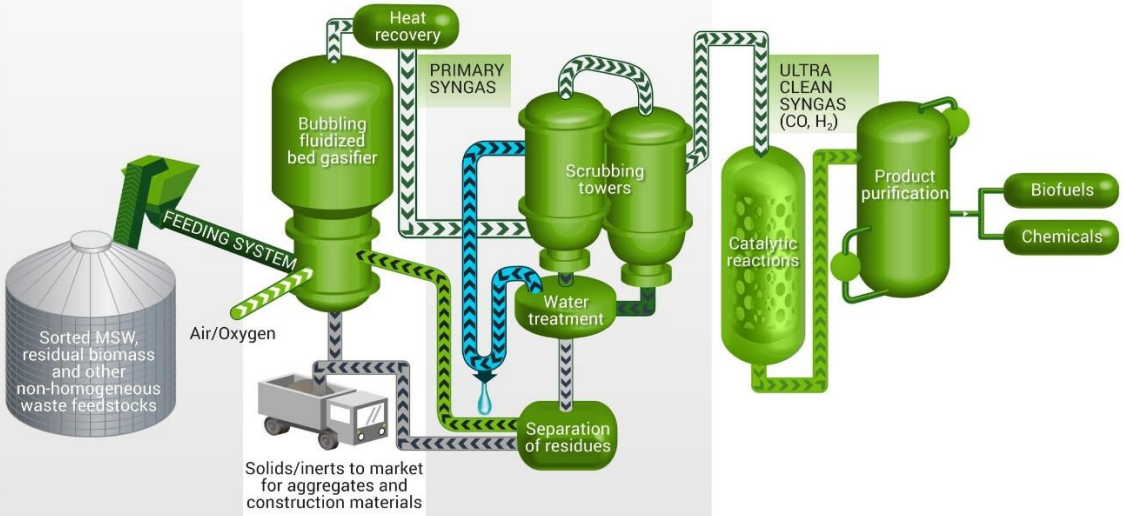
Feedstock preparation	Gasification	Cleaning and conditioning process	Catalytic synthesis and product purification
Sorting, shredding, drying (if required) and feeding	Conversion of carbon-rich residues into synthetic gas	Primary syngas purification	Conversion of chemical-grade syngas into final renewable products

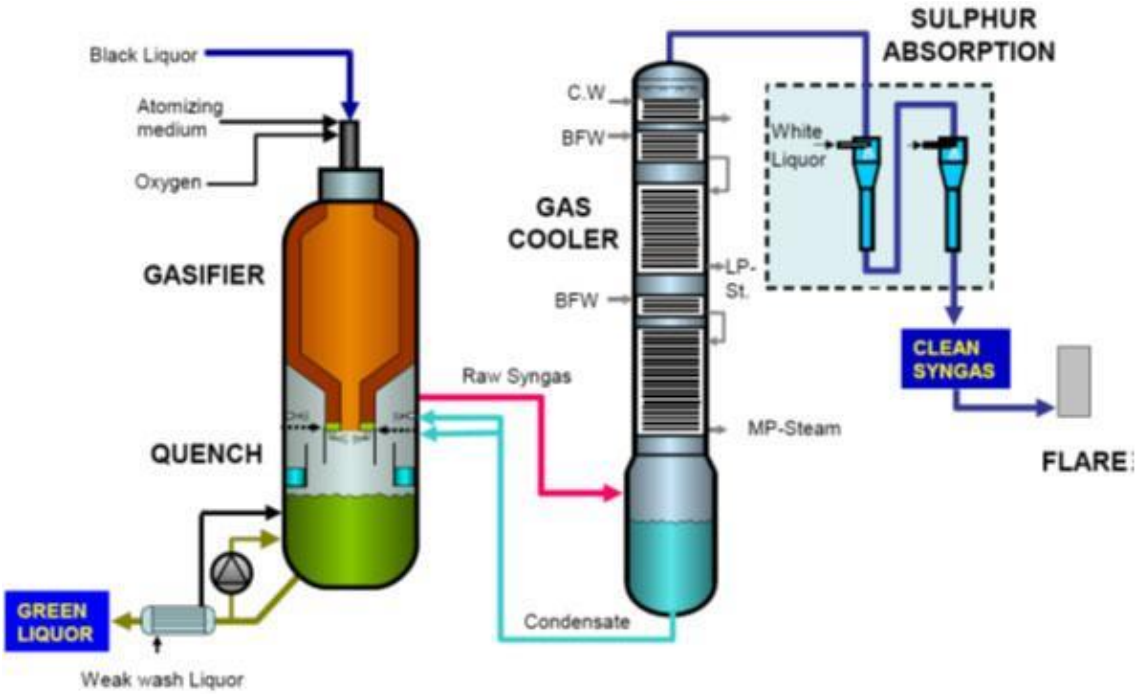


** Municipal solid waste*

CATEGORY	INFORMATION
PROJECT OWNER	JV controlled by ENI
PROJECT NAME	Waste to Methanol
STATUS	planned
STARTUP	2023
LOCATION	Italy
CITY	Livorno
ZIP	57100
TYPE	TRL 8 First-of-a-kind commercial
TECHNOLOGY	Fuel Synthesis
RAW MATERIAL	other
INPUT 1	RDF - PLASMIX (550 t/d)
OUTPUT 1	methanol (300 t/d)
PARTNERS	ENI and others
TECHNOLOGY BRIEF	High-temperature melting gasifier converts waste into syngas, which is purified and synthesized into methanol. Ash becomes inert granulate.
ADDITIONAL INFORMATION	https://nextchem.it/what-we-do/technologies/waste-chemicals
CONTACT INFORMATION	COMMERCIAL: a.angeletti@nextchem.it PRESS: i.catastini@nextchem.it

CATEGORY	INFORMATION
PROJECT OWNER	LTU Green Fuels
PROJECT NAME	DP1+DME pilot
STATUS	idle
STARTUP	2011
LOCATION	Sweden
CITY	Pitea
TYPE	TRL 6-7 Demonstration
TECHNOLOGY	
RAW MATERIAL	other
INPUT 1	Black liquor
INPUT 2	Pyrolysis oil (co-gasif. with black liquor)
OUTPUT 1	clean syngas (2 MW)
OUTPUT 2	DME (4 t/d)
OUTPUT 3	methanol (4 t/d)
PARTNERS	Chemrec AB, Haldor Topsöe, Volvo Truck, Preem, Smurfit Kappa, Sveaskog, Perstorp, Södra, Holmen, Flogas, ETC
TECHNOLOGY BRIEF	The Chemrec process uses a refractory-lined entrained bed reactor for gasification at ~1000°C. Black liquor/pyrolysis oil is decomposed into melt droplets (sodium compounds) and syngas (H_2/CO). A quench dissolver separates melt (forming green liquor) and gas, which is cooled, scrubbed, and used for fuel/syngas. A 160 MSEK R&D program (2014) focused on new gas cleaning/synthesis technologies.
ADDITIONAL INFORMATION	Operated until May 2016: entrained flow gasifier (27,000 hours at 30 bar pressure, 3 MWth fuel flow), co-gasified pyrolysis oil (1,000+ hours in 2016). Syngas train operated 12,000 hours, producing >1,000 t DME and 50 t methanol. Fuels tested by Volvo Trucks, Flogas, and Perstorp. Pyrolysis oil sourced from Fortum (Finland) and Empyro (Netherlands).
CONTACT INFORMATION	Rikard Gebart (ph: +46 920492196, email: rikard.gebart@ltu.se)


CHEMREC


SULPHUR ABSORPTION
Black Liquor
Atomizing medium
Oxygen
GASIFIER
QUENCH
C.W
BFW
GAS COOLER
BFW
LP-St.
White Liquor
CLEAN SYNGAS
FLARE
Raw Syngas
MP-Steam
GREEN LIQUOR
Weak wash Liquor
Condensate

CATEGORY	INFORMATION
PROJECT OWNER	Tembec Chemical Group
PROJECT NAME	Synthesis Tembec Chemical Quebec
STATUS	operational
LOCATION	Canada
CITY	Temiscaming
STATE	Quebec
TYPE	TRL 6-7 Demonstration
TECHNOLOGY	SulfitePower boiler (gasification of spent sulphite liquor)
RAW MATERIAL	lignocellulosics
INPUT 1	spent sulphite liquor feedstock
OUTPUT 1	ethanol (13,000 t/y)
ADDITIONAL INFORMATION	Converts pulping byproduct (red liquor) into ethanol and green electricity. Integrated with a CAD 273 million facility reducing SO_2 emissions by 70% . Operates alongside specialty cellulose production for pharmaceuticals/food .
CONTACT INFORMATION	Lyle Biglow (lyle.biglow@tembec.com)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