TECHNOLOGY FACTSHEET

TNO

PRODUCTION OF PYROLYSIS BIO-OIL FROM SOLID BIOMASS VIA FAST PYROLYSIS

Date of factsheet	17-12-2019 (25-09-2020 update)
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Sector	Industry: Generic
ETS / Non-ETS	Non-ETS
Type of Technology	Biomass
Description	Production of pyrolysis oil from solid biomass (clean solid woody biomass) is done in three main steps: biomass preparation, pyrolysis reaction and product recovery. Solid biomass is milled to particle size below 3 x Y x Z mm to allow high conversion (BTG-BTL, 2020), dried to low moisture content (5-10%) and exposed to high temperature (approx. 500˚C) without oxygen. In the reactor, the particles are mixed with hot sand, which is used as a heat carrier, and the pyrolysis occurs around 500°C (JRC,2019) . The resulting products are: pyrolysis bio oil (liquid), biomass char (solid) and residual gas; the last two are separated from the oil by cyclones and condenser. The sand is recycled back to the reactor. Char is used to provide heat to the pyrolysis reactor and the residual gas is typically used to generate electricity and heat via a CHP unit. The energy generated is normally suficient to meet the energy demand of the drying process and the surplus can be exported.
TRL level 2020	TRL 8
	Existing plant in Hengelo owned by Empyro-Twence (with BTG-BTL technology) and since 2018 it operates in full capacity of 25 MWth (feedstock).

TECHNICAL DIMENSIONS

Capacity	Functional Unit		Value and Range								
	MWth		15.00								
			15.00			-			30.00		
Potential	EU	MWth	Current			2030			2050		
			100.00			-			-		
			100.00	–	100.00	*Min*	–	*Max*	*Min*	–	*Max*
Market share		%	-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Capacity utlization factor	0.85										
Full-load running hours per year	7,500.00										
Unit of Activity	PJ/year										
Technical lifetime (years)	30.00										
Progress ratio	0.37										
Hourly profile	No										
Explanation	Capacity and potential values based on pyrolysis bio-oil production. Currently, there are: 1 pyrolysis plant in the Netherlands (15 MW), one in Finland (30 MW), one in Latvia (22 MW) and another one in Estonia (30 MW) (SGAB,2017).										

COSTS

Year of Euro	2015								
	Euro per Functional Unit	Current			2030			2050	
Investment costs	mln. € / MWth	1.68			1.34			-	
		1.68	–	1.68	1.34	–	1.51	*Min*	–	*Max*
Other costs per year	mln. € / MWth	-			-			-	
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / MWth	0.08			0.07			-	
		0.08	–	0.08	0.07	–	0.08	*Min*	–	*Max*
Variable costs per year	mln. € /	-			-			-	
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Costs explanation	OPEX is considered to be 5% of the CAPEX. No feedstock costs are included. CAPEX includes all the installations mentioned in the process description, including utilities systems (e.g. CHP). Medium-term cost reductions for pyrolysis oil production is estimated to be from 10-20% (IEA, 2020) and the reduction is expected to be related to economies of scale effects.								

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Pyrolysis bio-oil	PJ	-1.00			-			-		
			-1.00	–	-1.00	*Min*	–	*Max*	*Min*	–	*Max*
	Biomass (wood)	PJ	1.14			-			-		
			1.14	–	1.14	*Min*	–	*Max*	*Min*	–	*Max*
	Steam	PJ	-0.33			-			-		
			-0.33	–	-0.33	*Min*	–	*Max*	*Min*	–	*Max*
	Electricity	PJ	-0.03			-			-		
			-0.03	–	-0.03	*Min*	–	*Max*	*Min*	–	*Max*
Energy in- and Outputs explanation	All the ratios use pyrolysis bio-oil as main output. The inputs and outputs are based on the Empyro-Twence pyrolysis plant, located in Hengelo, the Netherlands. The electricity and heat values are net, i.e. the internal consumption of energy is not shown in the figures. No efficiency improvement projections for 2030 and 2050 for this technology were found in the literature.										

MATERIAL FLOWS (OPTIONAL)

	Material	Unit	Current			2030			2050		
Material flows			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Material flows explanation											

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)

	Substance	Unit	Current			2030			2050		
Emissions	CO_2 - biogenic	kton	63.39			-			-		
			63.39	–	63.39	-	–	-	-	–	-
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Emissions explanation	Biogenic CO_2 is represented per PJ of pyrolysis bio-oil. Considering that all energy consumed in the reactor and in the drying process is provided via bio-char and biobased residual gas, only biogenic CO_2 is emitted. For the bio-char 97.5 kg CO_2/GJ was considered and, for the biobased residual gas, the factor used was 56.5 CO_2/GJ. No information about emissions of other pollutants was found in the literature.										

OTHER

Parameter	Unit	Current			2030			2050		
		-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
		-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
		-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
		-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Explanation										

REFERENCES AND SOURCES

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