TECHNOLOGY FACTSHEET

ELECTRIC INDUSTRIAL BOILER

Date of factsheet	21-12-2018
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Sector	Industry: Generic
ETS / Non-ETS	ETS
Type of Technology	Electrification
Description	There are several types of commercially available industrial electric boiler systems. The most common are: • Using an electric heating element that acts as a resistance (electric boiler) • Using the conductive and resistive properties of the water itself to carry electric current (electrode boiler) There are also infrared- and induction boilers available, but they are small-scale and not commonly available. Electric boilers and electrode boilers mainly apply to utility-related processes (hot water and steam production). The implementation threshold is perceived as relatively low, as it does not require a complete redesign of primary processes (Berenschot, Matters, Delft, & Matters, 2017). Because of the working principle, electric boilers have lower thermal capacities than electrode boilers. Typical capacities of electric boilers are up to 5 MWe, whereas electrode boilers have capacities from 3 MWe up to 70 MWe. Superheated steam with temperatures of up to 350°C and >70 bar can be produced with commercially available electric/electrode boilers (capacities of up to 70 MWe). Advantages of this technology are the following (Berenschot, Matters, Delft, & Matters, 2017; Berenschot, Delft, & ISPT, Power to products, 2015): • An efficiency of up to 95-99.9% • Robust • Can be used as flexible capacity (at times of low electricity prices or as stand-by capacity for gas-fired boilers). Industrial electric boilers are a drop-in solution for steam production. They are implemented on-site at industrial plants where they heat a fluid (typically water for steam production) and require no primary process alterations (Berenschot, Matters, Delft, & Matters, 2017). Examples of electrode boiler manufactures and suppliers are PARAT, Vapor Power, Vapec, Allmech, Zander & Ingestrom, BVA Electrokessel. Examples of electric element boiler manufacturers and suppliers are PARAT, Vapor Power, AB&Co, Danstoker (Thermax) ATTSU, Lattner.
TRL level 2020	TRL 9
	Current TRL level is 9, established technology (Berenschot, Matters, Delft, & Matters, 2017).

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	MWth		20								
			15			-			70		
Potential	MWth	NL	Current			2030			2050		
			-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Market share	%		-			-			-		
			-	-	-	*Min*	-	*Max*	*Min*	-	*Max*
Capacity utlization factor	1.00										
Full-load running hours per year	8,760										
Unit of Activity	PJ/year	0.03									
Technical lifetime (years)	15										
Progress ratio											
Hourly profile	Yes										
Explanation	Electrode boilers can have a capacity of up to 70 MWe. For smaller units, electric boilers can be used (Berenschot, Matters, Delft, & Matters, 2017). Electric boilers are generally used as flexible capacity. This provides advantages during periods of low electricity prices (e.g. during temporary high contributions of wind energy and solar PV during off-peak hours) (Berenschot, Matters, Delft, & Matters, 2017). It is assumed electric/electrode boilers can be used to supply all of the industrial heat demand between 100°C – 200°C. Depending on the processes, heat demand of up to 350°C can also be supplied. According to VNP (2018), electric boilers have a refurbishment interval of 10 years. And according to Berenschot, Delft, & ISPT, Power to products (2015), electric boilers have a lifetime of 15 years.										

COSTS

		Euro per Functional Unit	Current			2030			2050		
Year of Euro	2015										
Investment costs		mln. € / MWth	0.17			-			-		
			0.10	-	0.50	*Min*	-	*Max*	*Min*	-	*Max*
Other costs per year		mln. € / MWth	-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)		mln. € / MW	0.0011			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Variable costs per year		mln. € / MWh	0.0000005			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Costs explanation	The bare equipment cost for an electric element boiler is around 140 €/kWe. The electric element accounts for about 65% of the bare equipment cost, and the control box system for 35% (ECN, 2018). The bare equipment cost for an electrode boiler varies from 17 to 60 €/kWe (Berenschot, Matters, Delft, & Matters, 2017; ECN, 2018), depending on the size of the installation. The total investment cost for an electric or electrode boiler is highly case-specific depending on the additional hardware needed and site-specific changes that have to be made, and it can vary from 100 to 500 €/kW-output (Noothout et al., 2019). The fixed O&M costs for an electric boiler are 1.1 €/kW/year, and the variable O&M costs are 0.5 €/MWh (Berenschot, Matters, Delft, & Matters, 2017).										

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Steam	PJ	-1.00			-			-		
			-1.00	-	-1.00	*Min*	-	*Max*	*Min*	-	*Max*
	Electricity	PJ	1.01			-			-		
			1.01	-	1.11	*Min*	-	*Max*	*Min*	-	*Max*
		PJ	-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
		PJ	-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Energy in- and Outputs explanation	Electrode and electric boilers have an efficiency of up to 90% (VNP, 2018) to 99.9% (Berenschot, Matters, Delft, & Matters, 2017).										

MATERIAL FLOWS (OPTIONAL)												
	Material	Unit	Current			2030			2050			
Material flows	Steam	ton	-1.00			-			-			
			-1.00	-	-1.00	*Min*	-	*Max*	*Min*	-	*Max*	
	Water	ton	1.00			-			-			
			1.00	-	1.00	*Min*	-	*Max*	*Min*	-	*Max*	
Material flows explanation	Typically water is used to produce steam.											
EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)												
	Substance	**Unit**	**Current**			**2030**			**2050**			
Emissions			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
Emissions explanation												

REFERENCES AND SOURCES

Berenschot (2017). Electrification in the Dutch process industry.

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