TECHNOLOGY FACTSHEET

POWER TRANSFORMER HV-MV

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Sector	Infrastructure
ETS / Non-ETS	Non-ETS
Type of Technology	Network
Description	The main purpose of power transformers is to couple networks that operate at different voltage levels. Power transformers reduce/increase voltage, located between HV (high voltage) and MV (medium voltage) networks and MV and LV levels. Carrying electricity at higher voltages allows large amounts of power transportation with lower loss. A transformer is an electrical machine that, based on the principles of electromagnetic induction, transfers energy from one electrical circuit to another, without changing the frequency. During the transfer, the voltage and current change. A transformer increases or decreases the alternating current when necessary. Transformers are highly customizable and can be attached with cooling systems, that use panel radiators, fans, oil pumps and coolers. These machines help improve the safety and efficiency of energy systems during their distribution and regulation over long distances.
TRL level 2020	TRL 9
	Commercial technology. In the European Union, there are around 4 million transformers [3].

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	MVA		-								
			Min		-			Max			
Potential			Current			2030			2050		
			-			-			-		
			Min	–	Max	Min	–	Max	Min	–	Max
Market share		%	-			-			-		
			Min	–	Max	Min	–	Max	Min	–	Max
Capacity utlization factor	1.00										
Full-load running hours per year											
Unit of Activity											
Technical lifetime (years)	25-40										
Progress ratio											
Hourly profile											
Explanation	Power transformers are rated according to their maximum continuos current (A) and nominal voltage (V) output, wich result in the nominal “apparent power” output (VA).										

COSTS

Year of Euro	2015									
	Euro per Functional Unit	Current			2030			2050		
Investment costs	€ / MVA	9,900.00			9,900.00			9,900.00		
		6,880.00	–	16,000.00	6,880.00	–	16,000.00	6,880.00	–	16,000.00
Other costs per year	€ / MVA	-			-			-		
		Min	–	Max	Min	–	Max	Min	–	Max
Fixed operational costs per year (excl. fuel costs)	€ / MVA	50.49			45.54			36.63		
		33.66	–	81.60	30.36	–	73.60	24.42	–	59.20
Variable costs per year	€ /	-			-			-		
		Min	–	Max	Min	–	Max	Min	–	Max
Costs explanation	The rating of transformers (MVA) is a highly significant cost driver. Particular attention is put on the choice of HV/MV transformer short circuit impedance (zt) value as it has a high impact on the cost and performance of the electrical installation [5]. The costs per MVA are average prices for transformers ranging 150-800 MVA [1]. Fixed O&M costs are 0,51%. It is assumed that these costs are reduced by 1% per year due to efficiency improvements [2].									

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Electricity	PJ	-0.98			-0.98			-0.98		
			-0.98	–	-0.98	-0.98	–	-0.98	-0.98	–	-0.98
	Electricity	PJ	1.00			1.00			1.00		
			1.00	–	1.00	1.00	–	1.00	1.00	–	1.00
	Propane	PJ	-			-			-		
			Min	–	Max	Min	–	Max	Min	–	Max
		PJ	-			-			-		
			Min	–	Max	Min	–	Max	Min	–	Max
Energy in- and Outputs explanation	A transformer can suffer some core losses from iron and losses from copper in the windings. The former occurs due to the alternating flux in the core of the transformer. These losses can be further divided into eddy current and hysteresis losses. Losses from copper occur due to the loss of heat during the circulation of current around the copper windings, resulting in loss of electrical energy. These are the most significant losses in the operation of an electrical transformer. The intensity of the energy loss determines the efficiency of an electric transformer, represented in terms of energy loss between the primary and secondary windings. Ideally, the efficiency of an electrical transformer should be around 98% [2]										

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			-			-			-		
			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											

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

1	ACER (2015). Report on unit investment cost indicators and corresponding reference values for electricity and gas infrastructure.
2	Energinet (2017). Technology Data – Energy transport.
3	IEA (2014). ETSAP. Electricity Transmission and Distribution.
4	ENTSOE (2019).Technologies for Transmission System. Technical Final version after public consultation and ACER opinion.
5	Schneider Electric (2017). Medium Voltage technical guide. Basics for MV design according to IEC standards.