

## HIGH VOLTAGE NETWORK

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Sector	Infrastructure
ETS / Non-ETS	Non-ETS
Type of Technology	Network
Description	<p>This factsheet describes overhead high voltage alternate current (HVAC) lines as a part of the high voltage network. These networks transmit large blocks of electricity over long distances. Long-distance transmission is possible due to the high voltage at which HVAC lines operate, usually ranging from 110kV to 400kV. Electricity in high voltage networks goes from power plants to substations close to end-consumers [4]. Power transformers step-up/down voltages between different areas of the transmission network, producers and distribution networks.</p> <p>HVAC overhead lines typically transport electricity in the transmission network. Only in Europe, there are over 474 thousand kilometres of HVAC lines [10]. Underground cables also carry electricity at high voltages. Nevertheless, the initial cost of the underground transmission system is higher compared to the overhead lines since it requires digging and trenching. HVAC lines also interconnect different areas or countries, increasing the security of supply and improving the reliability of the electricity system. Europe counts with more than 390 cross-frontier lines [10].</p>
TRL level 2020	TRL 9 Commercial technology.

## TECHNICAL DIMENSIONS

Capacity	Functional Unit km	Value and Range											
		Current			2030			2050					
		-											
		Min			Max			Min			Max		
Potential		-											
		Min			Max			Min			Max		
Market share	%	-											
		Min			Max			Min			Max		
Capacity utilization factor		1.00											
Full-load running hours per year		-											
Unit of Activity													
Technical lifetime (years)		50.00											
Progress ratio													
Hourly profile													
Explanation	The ageing of the existing infrastructure is making it obsolete, and higher penetration of intermittent generation is causing more congestion on HVAC lines. The IEA estimates that between 2012 and 2035, the global total required transmission and distribution investment will be of around 5.5 trillion Euros. Non-OECD countries require more new capacity to expand their high voltage network. Investments in these countries make up to 60% of the global required transmission and distribution investment [4]. For the OECD region, most of the transmission and distribution investment goes to refurbishing and replacing existing infrastructure rather than building new assets.												

## COSTS

Year of Euro	2015									
Investment costs	Euro per Functional Unit mln. € / km	Current			2030			2050		
		0.41	-	1.83	0.41	-	1.83	0.41	-	1.83
Other costs per year	mln. € / km	-			-			-		
		Min	-	Max	Min	-	Max	Min	-	Max
Fixed operational costs per year (excl. fuel costs)	mln. € / km	-			-			-		
		Min	-	Max	Min	-	Max	Min	-	Max
Variable costs per year	mln. € /	-			-			-		
		Min	-	Max	Min	-	Max	Min	-	Max
Costs explanation	Only Alternate Current (AC) cables are taken into account for this factsheet. The nominal voltage of the network is the biggest cost driver. In this case a 380-400 kV, 2 circuit overhead line was taken into consideration. The costs include: engineering and commissioning, installation, materials and manufacturing. The variation for 380-400kV HVAC line was not defined by terrain difficulty or rating [1]. A typical thermal rating for a 380 kV line is 1450MVA [5].									

## ENERGY IN- AND OUTPUTS

Energy carriers (per unit of main output)	Energy carrier	Unit	Current			2030			2050		
			-0.99	-	-0.98	-0.99	-	-0.98	-0.99	-	-0.99
Electricity	PJ	PJ	1.00			1.00			1.00		
			1.00	-	1.00	1.00	-	1.00	1.00	-	1.00
Propane	PJ	PJ	-			-			-		
			Min	-	Max	Min	-	Max	Min	-	Max
Energy in- and Outputs explanation		PJ	-			-			-		
			Min	-	Max	Min	-	Max	Min	-	Max
At a higher voltage, the power loss due to resistance is reduced. Electricity losses are lower in HVDC than in HVAC over longer distances. For an HVAC line, losses are around 7% per 1,000 km [4]. In the Netherlands, the annual losses in transmission & distribution are about 4.7% [7], from which 2% are due to transmission [8]. Losses depend on each system and its operation. Developments of advanced cables with lower losses and higher capacity capabilities can support new installations. These new cables are expected to reduce transmission losses.											

## MATERIAL FLOWS (OPTIONAL)

Material flows	Material	Unit	Current			2030			2050		
			-	-	-	-	-	-	-	-	-
			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))

Emissions	Substance	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
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	CE DELFT (2017). Net voor de Toekomst.
3	PBL's ENSYSI Model Database.
4	IEA (2014). ETSAP. Electricity Transmission and Distribution.
5	D. Bekaert et al (2009). "How to increase cross border transmission capacity? A case study: Belgium," 2009 6th International Conference on the European Energy Market, Leuven.
6	IEA(2016). Large-scale energy interconnection. Technology and prospects for cross-regional networks.
7	The World Bank. Electric power transmission and distribution losses.
8	CEER (2017). CEER Report on Power Losses.
9	Tennet (2019). Annual Market Update 2019.
10	ENTSO-E (2019). Statistical factsheet.
11	World Economic Forum (2020). Global innovations from the energy sector, 2010-2020.