Life Cycle Assessment new 380 kV HV Towers

Steps to reduce the C02 footprint

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Scope new 380 kV Overhead lines in the Netherlands

Target grid 2045

- Double the use of electricity
- 40-60% of the total use of electricity will exist of renewable sources (now 20%)
- Large impact of AC connections

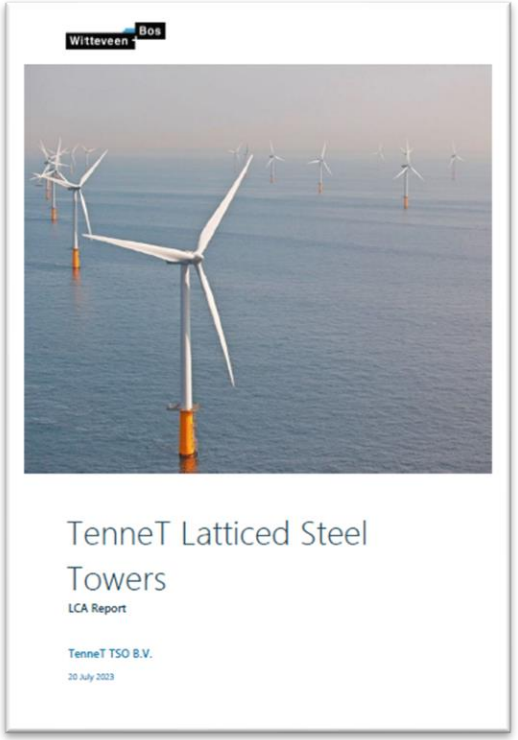
Planned AC in the Netherlands:

- 350 km of Overhead lines
- Need of 1000x new 380 kV towers

Life Cycle Assessment lattice steel structures (Approach)

LCA is based on average ton (1000 kg) of lattice steel.
The motivation is that it can be scaled because steel tower vary by size and configuration

- Angle sections (DIN EN 10025-2 in the killed grade S 355 J2): 800 kg.
- Steel plates (grade S355 J2 +N): 120 kg.
- Fasteners (DIN 7990 of strength class 5.6): 50 kg.
- Hot dip galvanisation (all steel parts, in accordance with DIN EN ISO 1461 ‘t Zn k’): 30 kg.
- Factory coating (17 sqm per 1 tonne steel) (70 % W1, 30 % W2): 17 square metres per 1 tonne of steel.



Inside scope

- A1 Primary resource and semi products production
- A2 Transport to Assembly site
- A3 Assembly of components
- A4 Transport to installation site

Outside scope

- Installation on site
- Use
- Decommissioning
- Transport for procession
- Procession materials and final procession waste

Life Cycle Assessment lattice steel structures (Approach)

- A1 Primary resource and semi products production

Rolled steel processed in angle sections and steel plates.
Quality S355J2 80% European steel and 20% Turkish steel

- A2 Transport to Assembly site

European scenario: 1797 km by truck (80%)
Turkish scenario: 1400 km by truck and 6200 km by ship

- A3 Assembly of components

Contains galvanisation and coating 30 kg
0,679 kg zinc per m2

- Transport to installation site

Transport within EU, averaged on 300 km EURO 5 emissions

Goal is to identify supply chain hotspots and steer emissions reductions!

Life Cycle Assessment lattice steel structures (Results)

Fgure 4.1 Climate change impact (GWP) in kg of CO_2-eq per component in 1 tonne of lattic

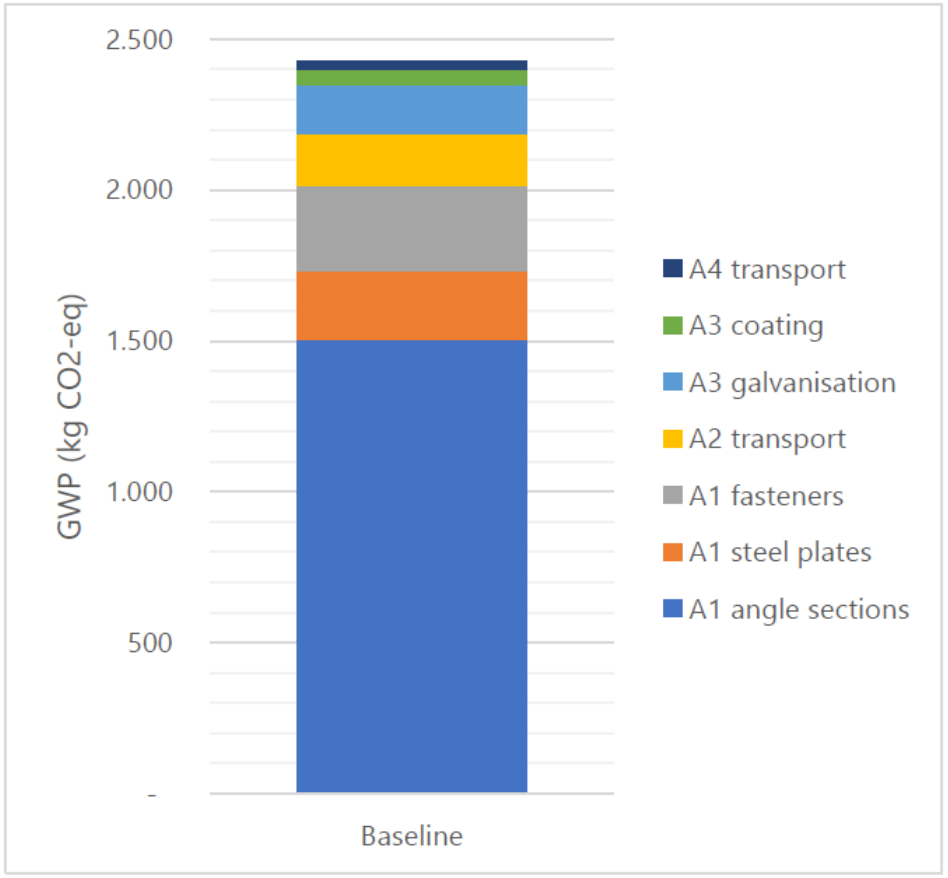


Table 4.1 Climate change impact (GWP) contribution in kg of CO2-eq per component of 1 tonne latticed steel structure

Component	GWP (kg CO_2-eq)	% Contribution
A1 angle sections	1,507	62 %
A1 steel plates	226	9 %
A1 fasteners	283	12 %
A2 transport	173	7 %
A3 galvanisation	158	7 %
A3 coating	53	2 %
A4 transport	27	1 %
Total	**2,427**	**100 %**

83%

- A1 - Producing steel contributes 83 % to climate change impact (CO2)
- Contribution of the rest (A2- A3- A4) is limited (17%)

Production of steel is the main contributor to CO2-eq emissions

Possibilities to reduce CO2 emissions (Recommendations)

- Source secondary steel and invest in green (primary) steel production
- Optimisation of galvanisation/anti-corrosion
- Optimise logistics (i.e. shorten transport distances) to reduce transport emissions.
- Use electric or low-emission vehicles for transport.
- Reduce the steel mass of a tower.

Note: As the functional unit is fixed at one ton of latticed steel tower, the impact of using less material for a tower is not covered by this analysis. However, the IEA expects material efficiency/demand reduction to be the highest driver of emissions decreases in the iron and steel sector.

https://corporate.arcelormittal.com/media/news-articles/arcelormittal-acquires-steel-recycling-business

Next steps for TenneT
Reduce the steel mass of a tower

Wintrack Suspension tower
- Pole tower
- Weight 80 ton steel mass
- Concrete ±200 m3

Moldau Suspension tower
- Lattice tower
- Weight 36 ton steel mass
- Concrete <10 m3

Next steps for TenneT
Reduce the steel mass of a tower

Use of S460 steel

- Investigate using S460 steel instead of S355 steel to reduce steel mass
- S460 steel has a higher steel strength and less material is needed (±10%)
- Not part of our EN 50341-1-1 (main body)
- Most useful for high loaded structures such as high loaded angle towers or river crossings
- Elia investigate use of S460 steel for very large tower (240m)
  Performed high loaded compression test on s460 steel part (Figure)*

Steel S460 will have a limited effect for the majority of the standard steel towers

Deformed S460 steel member

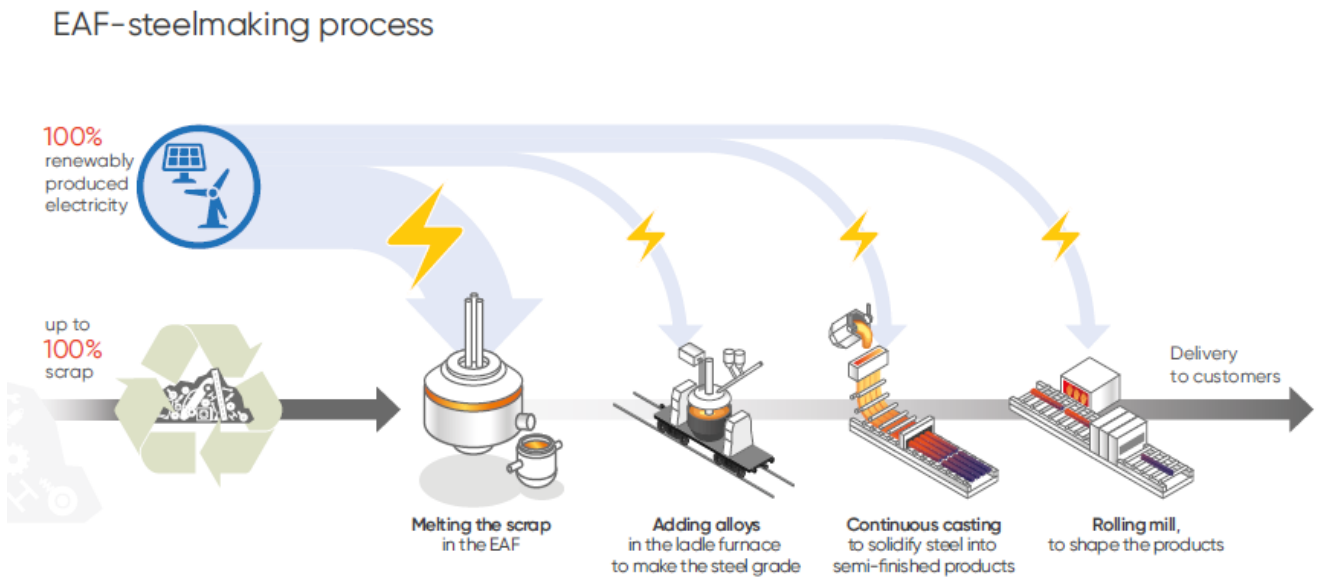
Structure 58, Buckling resistance of star-battened angle members made of high-strength steel , Marios-Zois Bezas a,, Sofia Antonodimitraki a,b, Andre Beyer c, Jeroen Van Wittenberghe d, Muhammad-Omer Anwaar e, Jan Maesschalck f, Jean-Pierre Jaspart a, Jean-François Demonceau

Next steps for TenneT

Source secondary steel and invest in green (primary) steel production

- Invest in 100% secondary steel and Electric arc furbase (EAF) renewable energy (can lower C02 footprint up to 70%)

TenneT is investing how this can be incorporated in the next tender



- Reuse steel profiles
  - Legislation is in process that infrastructure should log their materials for next use
  - NTA 8713 “Nationaal Technische Aanbeveling” has been set up for technical rules for reuse
  - Only applicable for steel member not effected during its lifetime

For future steps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