E-82 - Standard 1
Transformer station inside WEC

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1 E-82 Standard 1

Since the E-82 wind turbine offers the possibility of locating the transformer and the medium-voltage switchgear assembly inside its tower base, there is no need of an external transformer station. ENERCON calls this tower-integrated transformer station "Standard 1". This standard is the transformer station variant which most of the company's customers prefer. For further details please see the description below.

2 Arrangement of electrical equipment inside the tower

In compliance with ENERCON Standard 1, the electrical components in the E-82 wind energy converter (WEC) are housed in a so-called "E-module", whose design depends on the tower type.

2.1 Steel tower

The E-module consists of three levels (see figure 1). Cabinet levels 1 and 2 bear the control cabinet, the power cabinets and the UPS cabinet (option). The transformer, the low-voltage distribution system and the medium-voltage switchgear assembly are located on the transformer level, which makes the connection to the medium-voltage grid. All electrical components are provided with insulation and interconnected via cables or copper busbars.

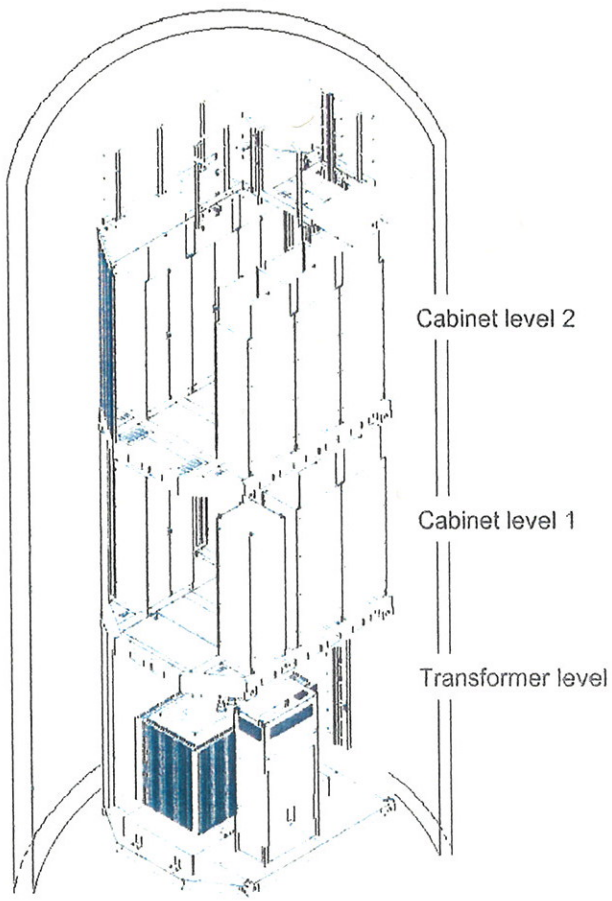

Figure 1: Schematic cross-section tower base

2.2 Concrete tower

Two containers (see figure 3), which house the electrical components, are installed on the foundation level. The control cabinet, the power cabinets and the low-voltage distribution system are located inside the "cabinet container". The "transformer container" comprises the transformer, the medium-voltage switchgear assembly and the UPS cabinet (option).

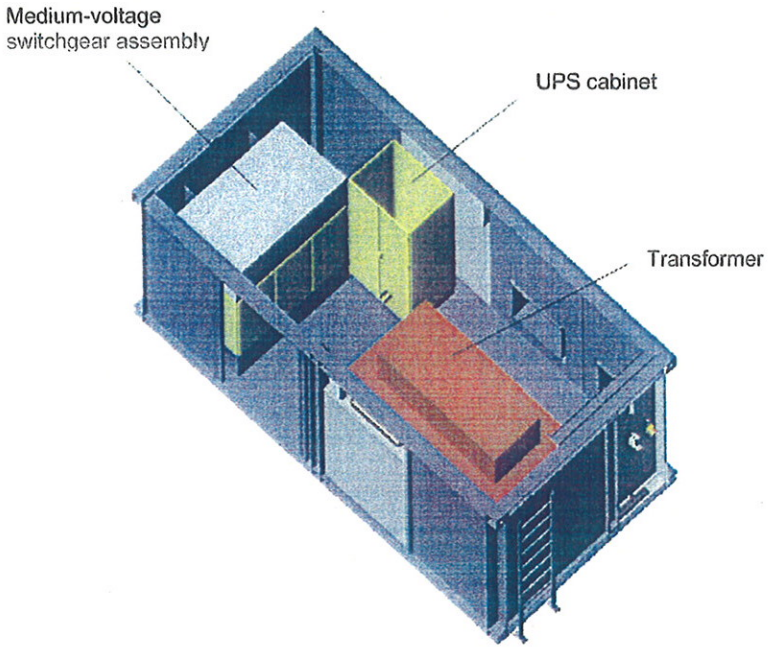

Figure 2: 3D model: Transformer container

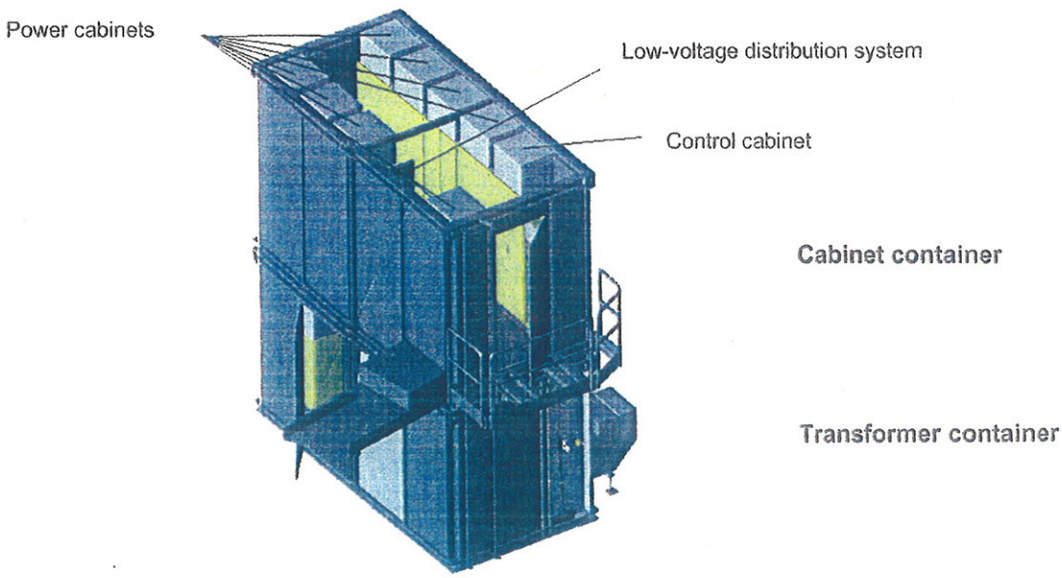

Figure 3: 3D model: Cabinet and transformer containers

3 Single-line diagram and scope of supply

In order to avoid missing or wrong materials and thus delays in wind turbine commissioning, it is important to define the scope of supply during the planning phase.

ENERCON delivers all electrical components installed between the generator and the medium-voltage switchgear assembly inside the WEC. **The medium-voltage switchgear assembly is included in ENERCON's scope of supply.** The contractor for the electrical infrastructure on the wind farm has the following tasks: Delivering and installing the medium-voltage cables and the data cables, inserting them into the foundation through the dummy tubes provided for this purpose, connecting the medium-voltage cables to the medium-voltage switchgear assembly and connecting the data cable to the provided termination box / splice box.

Only an authorised company may carry out installation and connection work.

The single-line diagram (figure 4) shows the border of the scope of supply (red line) between ENERCON and the contractor for the electrical infrastructure.

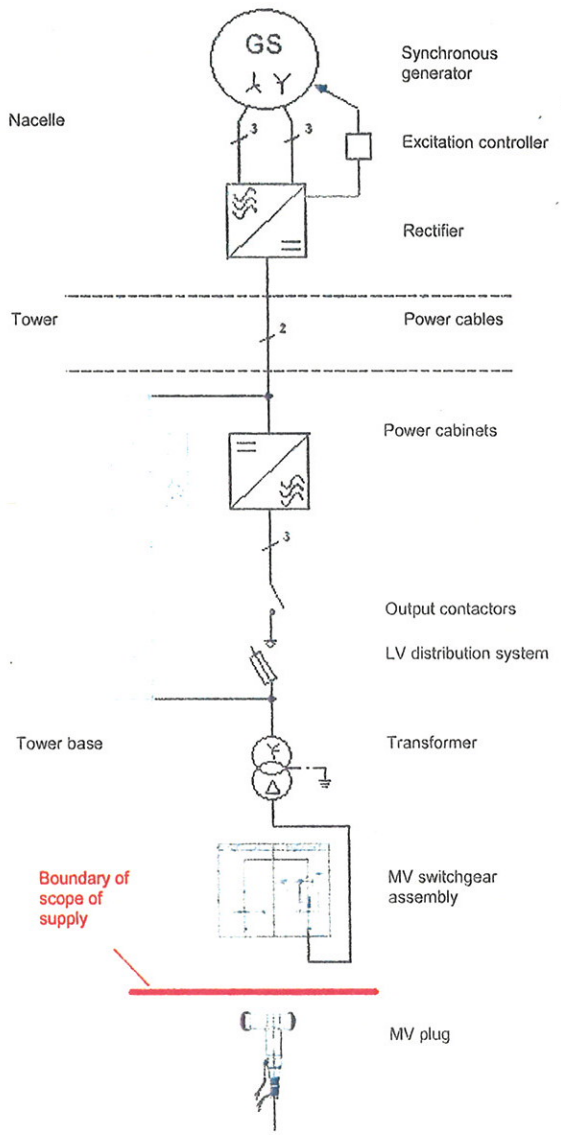

Figure 4: Single-line diagram

4 Description of the electrical equipment included in ENERCON's scope of supply

This chapter provides photos, descriptions and technical specifications of the electrical components installed in the tower-integrated transformer station supplied by ENERCON.

4.1 Low-voltage distribution system

The low-voltage distribution system is the point of connection between the transformer and the power cabinets. Each power cabinet is linked to a three-pole fuse-switch-disconnector (500A/500V fuse link, characteristic gL/gG) via three low-voltage cables (e.g. H07RNF-O 1*300mm²). Copper busbars (2*140*10 per phase and 1*140*10 for the neutral conductor) connect the transformer to the low-voltage distribution system. Flexible connectors (2*68*20 per phase and 2*68*10 for the neutral conductor) decouple the transformer and the low-voltage distribution system.

In order to measure the generated energy, a set of current transformers is installed between the transformer and the low-voltage distribution system.

WEC operation is not possible without these current transformers. A copper cable of the type "Y-JZ 7*6 mm²" (VDE standard) makes the connection to the meter inside the control cabinet.

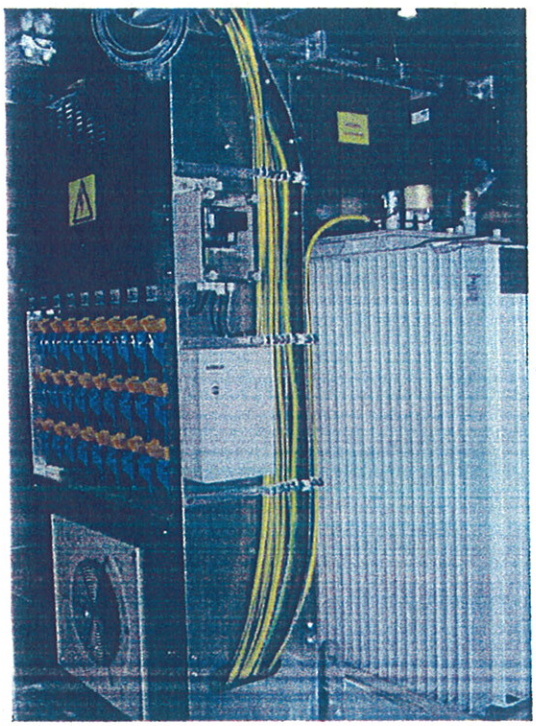

Figure 5: Low-voltage distribution system and transformer in steel tower

Current transformer	
Secondary current (A)	5 A
Primary current (A)	4000 extended 120 %
Rated power (VA)	15
Accuracy class	0.5
Frequency (Hz)	60
Manufacturer	RITZ or similar
Thermal current (kA)	70 * In
Standards	DIN / IEC

Figure 6: Technical specifications current transformer

4.2 Transformer

The transformer steps up the WEC voltage from 400V to medium voltage.

ENERCON installs three-phase hermetically sealed silicone oil transformers. Special synthetic oil with a flash point of more than 300°C insulates and cools the transformer. The table below shows the technical specifications for standard transformers.

Power transformer		
Manufacturer	Pauwels, Areva or similar	
Type	Three-phase hermetically sealed	
Rated power (kVA)	2300	
Rated frequency (Hz)	60	
Low voltage (V)	400	
Tapping point	+4 x 2.5 %	
Vector group	Dyn5	
Impedance voltage (%)	6 at 2300kVA	
No load loss (W)	<3100	
Load loss at 115°C (W)	<18000	
No-load current %	<0.33	
Insulation levels (kV) - HV: Um = 34.5kV - LV: Um = 1.2kV	LI/AC 200/70 LI/AC 30/10	
Temperature rise: Oil/ winding (K)	75/115 Nomex transformer steel tower	50/55 Standard transformer concrete tower
Ambient temperature (°C)	-25 to +50	
Temperature alarm threshold (°C)	110 Nomex transformer	90 Standard transformer
Temperature trip level (°C)	115 Nomex transformer	95 Standard transformer
Cooling medium	Silicone oil	
Cooling type	KNAN	
Installation height above sea level (m)	max. 1000	
Sound power level LwA in dB(A) approx.	≤78dB(A)	
Operation	Permanent operation	
Outer dimensions L*W*H approx. (mm)	2400x770x2125 Nomex transformer	2100x1180x2400 Standard transformer
Weight approx. (t)	5.00 Nomex transformer	5.72 Standard

Figure 7: Technical specifications power transformers

For voltages above 36kV please contact the project manager in charge. In comparison to dry type transformers, oil transformers have the following advantages:

- Compact and safe structure
- Lower iron losses
- Less sensitivity to overload and rapidly varying load
- Less sensitivity to overvoltage
- Less sensitivity to mechanical stress

Figure 8: NOMEX transformer manufactured by Pauwels

The hermetically sealed and earthed housing, the safe medium-voltage bushings and the covers on the LV connections guarantee protection against indirect contact.

A coating on the basis of zinc flakes protects the transformer housing against corrosion. Waterborne paint RAL 7033 is applied as a top coat.

In order to order transformers for the correct high voltage, it is important to ask the utility company in charge during the planning phase for the grid voltage at the point of common coupling.
The grid voltage value should be listed in the sales contract.

4.3 Medium-voltage switchgear assembly

The reasons for the use of SF6 gas-insulated switchgear assemblies are their compact design, their high operational safety and the provided protection against harmful external influences. These switchgear assemblies are equipped with bursting discs and pressure channels. If an internal defect causes an electric arc, an expanded metal mesh cools leaking gases and gas pressure is reduced to a minimum. The remaining pressure escapes though the top of the pressure channel on the side turned away from the operator.

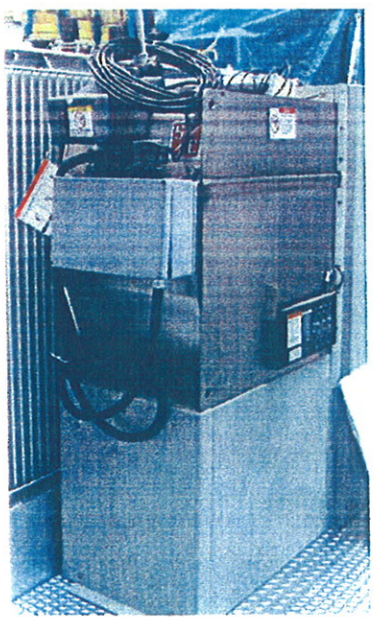

Figure 9: S&C switchgear assembly

Since the switchgear assembly is almost completely enclosed, the customer gets a safe and long-life product that only requires low maintenance. Figure 10 lists the technical specifications for switchgear assemblies up to a voltage of 38kV. A remote control system located in the entrance area allows remote switching. This way, it is possible to turn the switchgear assembly off outside the medium-voltage area.

Medium-voltage switchgear assembly		
Application	1<U<29 kV	29<U<38 kV
Rated voltage (kV)	29	38
Rated frequency (Hz)	60	
Manufacturer	S&C or similar	
Number of wind farm cables to be connected	2	
Insulating gas	SF_6	
Design	Compact	
Operation	Permanent operation	
Rated current (A)	600	
Protection	Load-Interrupter Switch	
BIL (kV)	125	150
Short-circuit making current (Peak)	41600 A	
Short-circuit making current (Symmetrical)	16000 A	

Figure 10: Technical specifications medium-voltage switchgear assembly

4.4 Cables

ENERCON uses low-voltage and medium-voltage cables that comply with IEC/DIN.

In order to explain the cables' specifications, we have classified them into three groups:

1. Low-voltage power cables
2. Medium-voltage power cables
3. Control / data cables

4.4.1 Low-voltage power cables

Copper cables with 0.6/1kV rubber insulation and without shielding (three for each power cabinet) connect the power cabinets to the low-voltage distribution system. 300*10 tubular cable lugs are used for the power cabinets and 300*12 tubular cable lugs for the fuse-switch-disconnectors of the low-voltage distribution system.

Earthing cables (e.g. H07VK 1*95 gr/ye) connect the power cabinets to the bonding bar of the low-voltage distribution system.

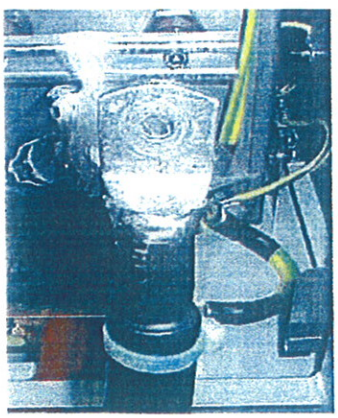

Figure 11: Connection in power cabinet

4.4.2 Medium-voltage power cables

The three medium-voltage cables installed between the transformer and the switchgear assembly are copper cables and have a length of 7m each. The conductor has an ethylene-propylene rubber (EPR) insulation, and the cable is provided with a copper shielding and an outer PVC jacket.

Figure 12: Medium-voltage cable between transformer and medium-voltage switchgear assembly

4.4.3 Control cables

ENERCON's scope of supply comprises the following 0.6/1kV control cables:

- Y-JZ 7*6 with copper conductor, PVC conductor insulation and external PVC cover. This cable is used to connect the current transformers to the electricity meter in the control cabinet.
- Y-Z 3*1.5 with copper conductor, PVC conductor insulation and external PVC cover. This cable is used to connect the control cabinet to the transformer's temperature sensor.
- Y-JZ 2*1 with copper conductor, PVC conductor insulation and external PVC cover. This cable is used to connect the medium-voltage switchgear assembly to the trigger unit of the ENERCON transformer protection system E-TFS1.

5 Instructions on how to construct the electrical infrastructure on the wind farm

In compliance with Standard 1, the contractor for the electrical infrastructure on the wind farm is, amongst others, responsible for:

- Delivering the required medium-voltage and data cables (wind farm)
- Trenching
- Cable installation (incl. cable insertion into WEC foundation and sealing of required dummy tubes)
- Delivering and installing fasteners
- Testing installed equipment

Only an authorised company may carry out these operations. Furthermore, it is necessary to test the installed equipment.

Further technical requirements:

- Medium-voltage cables should be XLPE single core cables. Avoid cross sections above 300mm² as large cross sections may cause installation problems (If required, contact the ENERCON project manager in charge [Electrical Works]).
- Select suitable MV plugs and joints.
- It is generally possible to install double connectors in the connection panels on the medium-voltage switchgear assembly.
- Before commissioning, perform appropriate medium-voltage cable tests to ensure that the cables are not damaged and that all joints and plugs are correctly installed.

For further information on how to construct the electrical infrastructure, please refer to the Electrical Works instructions "Anschluss von ENERCON WEA".