2EN profile
Featuring a high level of expertise, vast experience on RES studies and highly trained staff, 2EN [Enallaktiki Energiaki SA] undertakes all the tasks, from planning, designing and legal procedures to materials procurement, construction, operation and maintenance of projects.

2EN goals
- developing and constructing high-quality projects,
- developing meteorological measurement systems,
- strengthening its international sales network,
- improving service quality by complying to international standards

2EN dynamic
- We evolve in an ever-changing environment, striving to achieve the goals and vision of the company’s human resources, customers and partners.
- We are flexible to meet the market’s needs, using the appropriate technology.

2EN experience
Many meteorological stations have been installed by 2EN during the past, at different sites in Greece, Albania, Cyprus, Turkey, Libya and Mongolia.

The sites accessed by the company are of different terrain topography, ground morphology, and weather conditions.

The company’s field experience, including tests and studies regarding the proper choice of materials and dimensions, have led to the construction of wind towers of proven endurance and reliability under unfavourable climatic conditions.

This experience, combined with a strong scientific background has led us to design and produce a range of lattice meteorological masts.
Over the past years, 2EN has installed and monitored hundreds of meteorological masts all across Greece and abroad, some of which on difficult terrain and extreme conditions sites.

2EN's long experience, CAE analysis and testing of mast dimensions and materials have helped developing highly reliable masts for every weather condition.

✓ **Stiffness & Light weight**

2EN lattice tower stiffness allows the structure to be supported by less guy wire levels.

Consequently this results to an easier erection and significantly smaller total length of guy wires which leads to less loads on the structure.

✓ **Advanced design**

The lattice tower design was implemented using CAD CAE technology.

Modelling design and assembly as well as finite element analysis techniques were integrated within NX10 platform (formerly known as Unigraphics).

The software is equipped with NX - Nastran 10.0 Solver which is widely used for the finite element analysis.

These techniques improve the design and optimize the strength of the components for the specific system development.

All 2EN towers are certified for euro code compliance.
**Durability and reliability in extreme weather conditions**

In high altitude areas, (> 1000) the heavy snowfall during winter might build ice over the guy wires, which results in heavy loading of the anchors and the lattice structure. 2EN Lattice towers are designed to withstand very high winds with 10 minute average higher than 50m/sec with icing.

**Material quality & added value**

All profiles are made of high strength aluminium alloy which has excellent anticorrosive properties, along with being a high value recyclable material.

**Limitless transportation**

Wind farms and the antennas are usually installed in high altitude sites and not necessarily with vehicle access road.

2EN Lattice towers are light and transported in parts in inaccessible areas by trucks, 4X4 vehicles, even using helicopters.

Road opening to the installation site is not required, saving great cost and useful time that usually takes throughout the permitting process.

**Adaptation & Compatibility**

All lattice models of the same lateral length are compatible. The spare parts used to assemble the masts are of the same dimensions which results the model flexibility.
Assembly on the ground

- All individual parts are designed considering to give to the personnel the convenience and speed of assembly required.
- The assembly of the tower is carried out at the installation site.
- No need for crane or other heavy machinery.
- The tower can be assembled on the ground, equipment full and then erected.
- Validation of proper sensor operation before tilt-up.

Foundation without concrete

Tower anchoring does not require concreting leaving zero environmental footprint after the removal of the structure. There is a wide range of anchoring types, depending on the type of soil and can be used independently or in combination.

- Earth anchors
- Rods nailed with hydraulic hammer
- Steel rods
- Propeller anchors
- Chemical anchors

High level of safety

- Working on the ground secures personnel safety.
- No high risk activities are required during assembly & tilt up of the tower.

Tilt-up without a crane

- Tower erection is performed with gin pole system which articulates on a specific base plate. It is a system of aluminum triangular structure, designed and manufactured also by 2EN.
- During the erection, the hydraulic winch pulls the gin pole.
- Hydraulic tifors are used during the erection, resting on a stable point and applying the power to the gin pole.
- All the staff is working safely away from the tower, simply manipulating the guy wires keeping the tower straight.
- Climbing by qualified personnel is not required.
All profiles are made of high strength aluminum alloy series 6005 with T5 aging heat treatment.

Within the flexibility offered by the extrudability of the metal in combination with the low weight, high strength and durability over time, the aluminum is an ideal raw material for the meteorological 2EN towers.

The mechanical properties of the alloy are shown at the tables below.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>2.70 g/cm³</td>
</tr>
<tr>
<td>Melting Point</td>
<td>605</td>
</tr>
<tr>
<td>Modulus of Elasticity</td>
<td>70 GPa</td>
</tr>
<tr>
<td>Electrical Resistivity</td>
<td>0.034x10⁻⁶Ω·m</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>188 W/m.K</td>
</tr>
<tr>
<td>Thermal Expansion</td>
<td>24x10⁻⁶ /K</td>
</tr>
</tbody>
</table>

The lattice sections are manufactured in factories using extrusion and then enter a CNC treatment center to get the final form.

CNC treatment of the profile is ensuring dimensional accuracy and repeatability of the final product.

The treatment involves cutting, final shaping, drilling holes and painting. Using this method and this technology, there is no need for welding parts, just assembly parts.

All lattice towers are electro-statically painted in two different colors (red/White) to comply to the civil aviation authority requirements.

The electrostatic paint has special marine treatment in order to be more stable in marine environment.
The tower construction has been studied and verified using finite element analysis.

Every part is verified and checked separately and the whole structure has been certified for euro code compliance.

This construction is made to withstand very high winds with 10 minute average higher than 50m/sec which leads to gusts over 80m/sec at the top of the mast.

**Design standards**

This lattice tower is designed according to the following standards.

- **Eurocode 1.**
  EC1PART1.4En1991-1-4 Wind Actions, EC1 PART1.3 En 1991-1-3 Snow Loads.

- **Eurocode 3.**
  EC3 PART3.1 1993-3-1 Towers and Masts,
  EC3 PART1.11 1993-1-11 Design of structures with tension elements.

- **Eurocode 8.**

- **Eurocode 9.**
  EC9 Aluminium structures.

- **BS EN 795** - Protection against falls from a height - Anchor devices - Requirements and testing.

**Patents**

**2EN-LAT 370mm & 2EN-LAT 470mm**

Greek Industrial Property Organization Patent Number: 1006352

**2EN-LAT 600mm**

Greek Industrial Property Organization Patent Number: 1007941

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**TUV HELLAS** (member of **TUV NORD** Group) certifies that the structural study for each tower model complies with the requirements of Eurocode 1, 3, 8, 9, BS EN 795:1997.

The ultimate load strength diagram expressed by the mean Wind speed vs. radial ice on the cables and tower body has also been certified by TUV NORD.
The F.E.M is based on the requirements of the previous standards.

The main objective of the analysis is to certify the Eurocode compliance of the towers and have the ultimate load condition scenarios in a strength graph for each tower model.

All models have been studied as a full structure model, and a separate components of the structure.

All the models are solved using EC3 Part 3.1 methodology for the dynamic wind loads, taking into account the non linear cable structure behavior.

The case of a falling climber who is attached with the proper absorbing equipment on the main frame of the section is successfully checked.

The results confirm that the tower withstands this load with a safety factor over 2.

The results which confirm that the stress due to the load case is below yield stress with a safety factor over 2 are presented in the following figures:
DISCLAIMER

The tower is climbable. Tower climbing is performed with the responsibility of the climber.

The climber agrees that he is capable to perform this kind of work at high heights and also declares that he is appropriately trained and aware of the associated risks.

The climber also agrees that he is aware of the technical characteristics of the mast which fully satisfy him, so that he decides to climb at his own risk.

Important Notice

Meteo-tower installations should be calculated and carried out only by specialised professionals due to the associated responsibility they entail. The mounting instructions provided in this technical Specifications document are intended for information only.

The data given does not, in any way, affect the responsibility of the manufacturer who only guarantees his own products, provided that they are used under normal conditions. A minimum of 6 persons is required for the installation.

An installation project will need to be carried out for each individual installation. This project should consider the specific relevant requirements as well as the foundation calculation in accordance to the corresponding geotechnical study.

As part of our policy of continuous improvement we reserve the right to change the specification of this product at any time without any notice.