North Burgenland wind farm
Construction of foundations for expansion of wind power in North Burgenland

Introduction
A wind turbine uses its rotor to capture the wind’s energy, which is converted into electric power and fed into the grid. The decision where to locate a wind turbine is dependent on topological features and prevailing wind conditions. The foundation serves to anchor the turbine in the ground. It not only ensures the turbine’s stability but also transmits all forces deriving from the rotation of the blade and movement of the turbine itself into the ground.

History
Wind power is one of the oldest forms of energy used by man. Long ago, mechanical tasks such as grinding corn and pumping water were already being carried out using wind-driven mills, hence the name “windmill”. The very first tapping of wind power goes back to the simple windmills used in the Arab world in antiquity. In the last few centuries, wind power became more widespread; one of its applications was to drain the dykes in the Netherlands. In the mid-19th century there were as many as 200,000 windmills in Europe, but these were replaced by other means of power at the beginning of the 20th century. Modern wind-tapping systems used for the generation of electricity appeared in Denmark just before the turn of the 20th century. However, the ongoing boom only started after the first energy crisis in 1973/74 as the result of an effort to reduce dependency on oil. The energy crisis also sparked off Austria’s interest in renewable energy sources. It was long believed that Austria’s wind potential was insufficient for use in turbines. It was only through measurements taken by wind power supporters at the end of the 1980s that the favourable conditions were revealed. Several locations in eastern Austria, particularly in Burgenland, are even able to compete with areas lying 15 km off the coasts of Denmark and Germany. 1994 saw the first introduction of a wind energy support scheme, which was followed by the construction of Austria’s first sizeable wind turbine, with an output of 150 kW, in Marchfeld. By 1996, wind turbines were producing an output of 500,000 kW. The adoption of the Austrian Electricity Industry and Organisation Act (EIWOG) in 1998 for the first time created a purchase obligation with fixed rates (feed-in rates) for eco-electricity plants, and triggered a building boom.

Wind energy in Burgenland:
1997: Construction and operational start-up of first wind farm in Zurndorf
2003: Construction of wind farms in Neusiedl am See, Weiden, Gols and Pama
2004/2005: Construction of further wind farms: Neudorf, Kittsee, Parndorf, Deutschkreutz, Potzneusiedl
2005: Historic date: 27 August is the first day that more electricity was produced by wind power than is consumed by the whole of Burgenland.
2005: In September, wind energy expansion in Burgenland is provisionally complete.
2009: New Eco-Electricity Act allows for development of further locations.
2010: Drawing up of Environmental Impact Assessment for several wind farm projects.

According to the latest rankings of the European Wind Energy Association (EWEA), the Burgenland district of Halbturn and Andau is to accommodate Europe’s eighth largest wind farm. Produced by Enercon, 79 E-101 turbines with a total capacity of 237 MW are being installed and will feed clean wind power into the Burgenland grid for use in around 150,000 households. The TEERAG-ASDAG company (Burgenland branch) has been commissioned to construct the foundations.

The wind farm is scheduled to be completed in 2014 and will be operated by Energie Burgenland Windkraft (formerly AWP), ImWind and the Püspök Group. Among wind farms installed with the modern 3 MW class of turbines, Halbturn and Andau is the largest wind farm in Europe and will remain so until 2016.

Burgenland is set to double its wind energy output in the next two years. By 2014, the easternmost federal state will be producing more eco-electricity than it consumes, enabling it to become the first region worldwide to export eco-electricity.

Wind energy economics
Constructing wind turbines in Austria brings high added value. The whole wind energy sector in Austria, including suppliers and service providers, creates around 3,300 jobs. 2011 was a successful year for Austrian wind energy, with 31 turbines with a combined output of 73 MW being installed. At the beginning of 2012, Austria had a total of 656 wind turbines in operation with a combined output of 1,084 MW. In 2012, more than 100 turbines with a capacity exceeding 300 MW are being installed, which will increase output by nearly one third. The current wave of expansion will increase
Austria’s annual output of wind-generated electricity from 2.2 billion kWh to 2.8 billion kWh, bringing the number of households supplied with clean wind energy to 800,000, or one fifth of households in Austria. The rapid expansion of wind energy set to take place in the coming years can and will eliminate imported nuclear-generated electricity from the Austrian power grid.

**Nickelsdorf Wind Project Presentation:**
The period between March 2012 and August 2012 saw the construction of 22 wind turbine foundations, 13 of which were shallow foundations without uplift protection and nine were shallow foundations with uplift protection.

**Foundation without uplift protection:**
Image: PORR

**Foundation with uplift protection:**
Image: PORR

**General building procedure for constructing wind turbine foundations**
Before construction can begin, a complete service road network needs to be developed by the operator to enable easy access to the turbines.

The bedrock is inspected in advance by a geotechnical expert to determine the measures required to ensure the stability of the foundation and later the tower.

During this process, test pits are constructed and deep drilling used to determine ground consistency.

The groundwater level and granulation of the soil can be such that special foundation engineering measures are required, leading to considerable additional overheads.

Inspection of the bedrock establishes which ground improvement measures need to be carried out and whether a shallow or deep foundation is required.

Construction work begins once the client has indicated the midpoints necessary for correct positioning and measurement of the foundations.

Concrete displacement columns (VCC; the appropriate deep foundation piling system chosen for this project) are installed from the site surface down to the compact bedrock to achieve a secure base for the foundation.

After the VCC procedure, excavation for the foundation can begin. The earth is sorted according to consistency and transported to the disposal site or stored nearby for subsequent filling.
When the previously specified excavation base level has been reached, plate load-bearing tests are used to determine whether the ground is sufficiently stable or whether further improvement measures are necessary.

The next stage involves starting to build up the load-distribution matting, which varies in strength with each foundation. A compression test is carried out between layers.

Successful testing of the load-distribution cushion is followed by installation of the blinding layer.

Now the construction of the foundation can begin. First the foundation core formwork is assembled.

At the same time, reinforcement for the foundation is delivered so that on completion of the foundation core, reinforcement assembly work can begin.

For shallow foundations subject to uplift, installation of the blinding layer must be followed by construction of a base slab to exclude subsequent foundation uplift. As a precautionary measure, an injection tube is attached to the base slab to allow future compression.
The reinforcement steel is assembled into a cage-like structure with radially bent steel. Between 70 and 100 t of reinforcement steel is required for each foundation. The earthing system and empty conduits are installed in parallel.

Now concreting can begin. The volume of concrete required for each foundation amounts to between 680 m³ and 920 m³. Using a pump, concrete is introduced into the formwork under vibratory shock. Concrete mixer lorries arrive on site almost by the minute in order to guarantee a continual concreting process.
To prevent any defects in the concrete, several after treatments need to be carried out after concreting has been completed on account of the sheer volume of concrete and resulting shrinkage.

Next, the remaining steel earthing strips are connected and filling is carried out in layers. Specific values relating to the construction of the tower must be achieved.

As soon as the concrete has reached the required rigidity, the supporting formwork is stripped and the concrete structure inspected by the client so that filling and covering can proceed.

After the foundation has been successfully filled, it is handed over to the site road builder so that an appropriate access route can be constructed to facilitate crane assembly and tower construction.
Now there are no obstacles to constructing the tower and the rest of the turbine.

**Project data**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity/Dimensions</th>
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<tbody>
<tr>
<td>Foundations</td>
<td>22</td>
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<tr>
<td>Earth excavation</td>
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<td>Earth replacement</td>
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<td>Filling and compaction</td>
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<tr>
<td>Turf edging stones</td>
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<tr>
<td>Concrete</td>
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</table>

To date, TEERAG-ASDAG (Burgenland branch) has been commissioned to construct 317 wind turbine foundations, 245 of which have already been completed and 72 of which are still under construction and scheduled for completion by the middle of 2013.