

<http://www.nordicwindpower.com/history.html>

## **In 1975, research began in Sweden that led to the Nordic Windpower line of turbines.**

### Early Research and Development

**Through a state-funded R&D program, extensive theoretical work and practical development was directed toward producing a cost-effective, reliable turbine.**

Key engineers behind the Nordic concept were involved from the beginning.

Two large, multi-MW, two-blade wind turbines (one at Maglarp (3 MW) in Skåne and the other one Näsudden I (2 MW) at Gotland) were important steps in the development of the knowledge and expertise behind Nordic 1000. The two turbines were erected and put into operation in 1982. Thorough measurements and evaluations were carried out for 6 years, until 1988.

Näsudden I was of a stiff design, while Maglarp was a flexible one. This important difference proved valuable as the flexible design concept could be verified through comparative tests and evaluations. Dynamics and loads of the flexible Maglarp design were convincingly demonstrated where the characteristic key components were two blades, a teeter hub, a free yaw system, and the drive train configuration. In addition, the eigenfrequency oscillations of the tower and the blades were chosen to allow for overcritical operation relative to rotation speed. This wind turbine concept was thoroughly verified and tested beginning in 1982. This lighter, flexible design is the foundation of the Nordic design and is now Nordic Windpower's intellectual property. It is worth noting that the second R&D model of the Näsudden 3-MW prototype is the world record holder for power production and accumulated operating hours.

**A specialized dynamic systems analysis tool, VIDYN, was developed and validated against the tests and measurements on the two prototypes.**

Teknikgruppen AB, a highly regarded Swedish analysis group still closely tied to Nordic, performed most of the evaluation of the turbine dynamics and loads behavior. VIDYN has unique capabilities to model the linear and non-linear dynamics of a two-blade, teeter turbine system. The updated VIDYN is still used in Nordic turbine simulations today.

The current Nordic 1000 turbine was developed based on the same principles as the earlier designs, with additional funding provided by the European Union Program for the Development of Non-Nuclear Energy Sources, by Elforsk AB, The Swedish National Energy Administration, and by Vattenfall AB.

By 1996, the first Nordic 1 MW turbine was in operation. When the performance of the prototype had been validated, the technology team started to design larger turbines and offshore foundation technology. This forward-looking R&D is ongoing.

**There are currently four Nordic 1000 turbines in operation in Gotland and Halland, Sweden, the oldest with 13 years of operating history.**

Demonstrating unusually high reliability, these units have over 140,000 hours of combined operational history, during which time they have achieved availability approaching 98%. No significant maintenance issues or major component failures have occurred. The turbines have proven to be almost maintenance-free, not even requiring oil changes. The most significant maintenance issue has been the replacement of the elastomeric bumpers on the teeter hub approximately every five years, which is a fairly simple and inexpensive operation.

The Gotland site is on an island in the Baltic, adjacent to the sea. Three N1000-54 turbines are in operation there. The wind flow is laminar at times and fairly turbulent at other times. The site has experienced hurricane conditions (most recently in winter 2007, with winds over 40 mps), during which the Nordic turbines have been undamaged. The Halland site is inland, with lighter winds but high turbulence. One N1000-59 turbine is in operation there.

The N1000 turbine is in the process of receiving a type certification to the IEC IIIb (International Electrotechnical Commission) WT 01 (“System for Conformity Testing and Certification of Wind Turbines – Rules and procedures,” 2000) specification from DNV Certification, a division of Det Norske Veritas. The certification covers the wind turbine, including the tower and the proposed type of connection between tower and foundation. It also covers the requirements governing the foundation, insofar as they arise from the wind turbine design and may include one or more foundation designs.

Starting in 1999, the Nordic technology passed from the government-funded R&D program to a Swedish company known as Nordic Windpower AB (distinct from Nordic Windpower LLC), which was owned and managed by the technologists who conducted the R&D program. Ownership passed through another cycle, most notably with an entity called Deltawind AB. Nordic Windpower in its current form was founded in 2005 as a US entity for global commercialization of the Nordic turbine technology. Nordic Windpower received its first major funding in 2007.