NORDEX RADAR FRIENDLY OPERATION OPTION

Izmir, Turkey
24 Dec 2011

NORDEX
We've got the power.

AGENDA

1. **Nordex in Turkey**
2. **Radar systems and wind parks**
3. **Overview of technical reasons for interference**
4. **Today's solutions to minimize interferences**
5. **Nordex' solution: „Radar Friendly Operation Option"**
6. **Next steps of Nordex**

GENERATION GAMMA

The Efficiency Class Portfolio

	IEC 1a	IEC 2a	IEC 3a
Current Portfolio	N 80	N 90	N 100
Tower heights	60m	70m | 80m [2] 100m [1]	80m | 100m 140m
New Additions	N 90	N 100	N 117
Tower heights	80m	80m | 100m	90m [3] | 140m
	Available from 07/2011		07/2012

[1] N90 LS – IEC 3a. [2] N90 HS - IEC 1b. [3] Tip height right below 150m.

What do we do?

Turbine Sales Responsibility	Site Feasibility Report	Turnkey Solutions	Project Management and Installation	Turbine Services and Maintenances
•Customer Relations • First performance assessment of the site and reporting • Turbine selection • Presenting bidding • Contract preparations • Service maintenance agreements	•Preparing Micrositing Reports about site efficiency according to wind data • Layout optimization to assure the highest efficiency	•Turbine Delivery Pursuit •Transportation, crane and installation services • Ground Survey • Foundation Design • Road Construction and construction • Electrical works	• Project management • Construction Site Management • Job Security Planning • Engineering • Supervisorship	• 96% availability guarantee • 5 and 9+3 years maintenance agreements • Spare parts guarantee

WIND & SITE ASSESSMENT LOCALLY IN TURKEY

- ✓ Customer peace-of-mind with optimal turbine type and farm configuration
- ✓ Micrositing Engineering by local Turkish engineers
- ✓ Site visits by engineers

Sophisticated solutions for climate conditions of Anatolia

Cold Climate Version

- Special materials and components for performance between -30…+40 °C

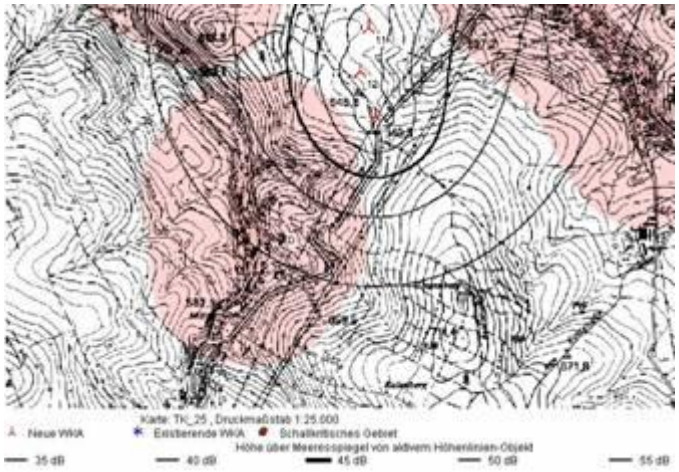
Hot Climate Version

- Special air condition
- Additional cooling units

TURNKEY SOLUTIONS

	Project Development
✓	• Selection of location
✓	• Ownership
✓	• Optimal siting
✓	• Wind measurements
✓	• Access road
✓	• Soil survey
✓	• Noise emission and shade
✓	• Economic viability
✓	• Grid connection

Project-Engineering



Micrositing

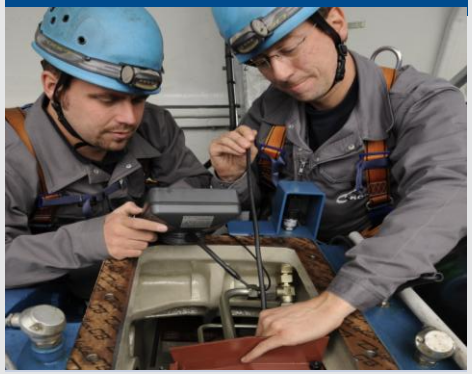
Substation

Wind farm management

NORDEX SERVICE – *Extensive Portfolio from a single source*

Service Products

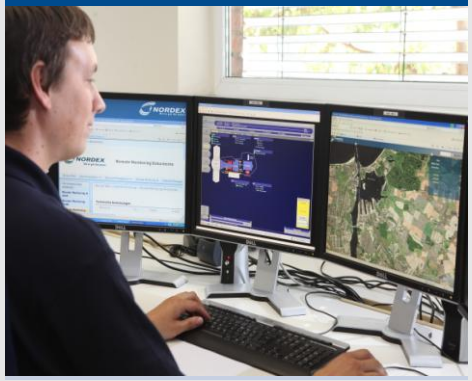
Maintenance & Inspection



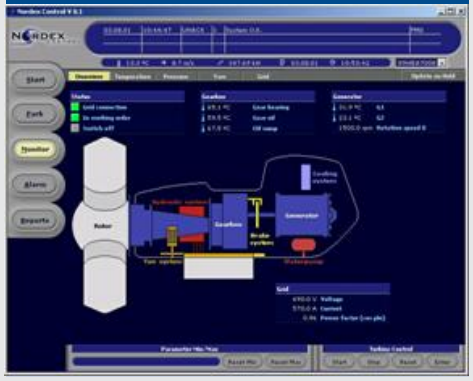
Trouble Shooting & Repair

Service Parts & Logistic

Remote Services



Upgrades & Modernisation



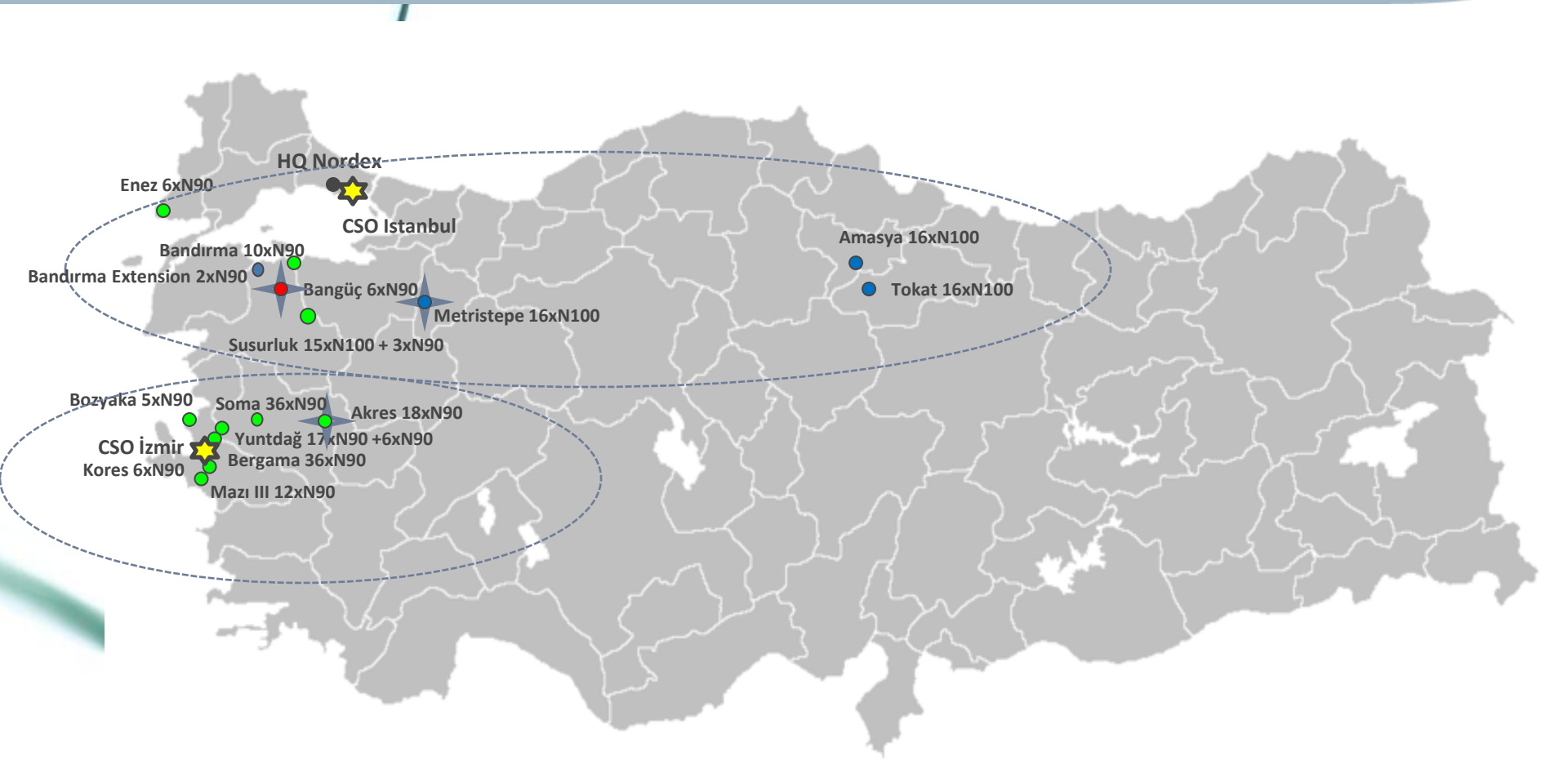
Nordex Academy Training

Service Agreements

Customers can choose from three different standard contracts:

- BASIC
- EXTENDED
- PREMIUM

Nordex Projects in Turkey Map



Projects in operation | Projects under construction | Projects signed | Turnkey Projects | Customer Service Office

Nordex Projects In Operation, Turkey*

Customer	Project	WTG	MW
Dost Enerji	Yuntdağ	17 x N90	42,5 MW
Dost Enerji	Kores	6 x N90	15 MW
Ener Holding	Enez	6 x N90	15 MW
Bilgin Enerji	Mazı III	12 x N90	30 MW
As Makinsan	Bandırma	10 x N90	25 MW
Bilgin Enerji	Bergama	36 x N90	90 MW
Bilgin Enerji	Soma	36 x N90	90 MW
Alentek	Susurluk	15 x N90	37,5 MW
		3 x N100	7.5 MW
Best A.Ş.	Akres (Turnkey)	18 x N90	45 MW
Kardemir Haddecilik	Bozyaka/ Kar-Demir	5 x N100	12,5 MW
	TOTAL	**156 x N90 8 x N100**	**410 MW**

•Chronological order and as of 1st of December 2011

Projects under construction*

Customer	Project	WTG	MW
Can Enerji	Metristepe	16 X N100	40 MW
Dost Enerji	Yuntdağ (Extention)	6 X N90	15 MW
Güçbirliği Holding	Bangüç (Turnkey)	6 X N90	15 MW
Alentek (Eksim Holding)	Amasya	16 x N100	40MW
Alentek (Eksim Holding)	Tokat	16 x N100	40 MW
Bilgin Enerji	Bandırma Extension	2 x N90	5 MW
	TOTAL	**62 WTG**	**155 MW**

*As of 1st December 2011

Akhisar Wind Farm – First Turnkey Project in Turkey

Metristepe Wind Farm, Bilecik - Turnkey

Metristepe Wind Farm, Bilecik - Turnkey

WIND PARKS CAN INFLUENCE RADAR CONTROL

Radar systems fulfill important and security relevant functions all over the world

➢ Air traffic control and aerial defense

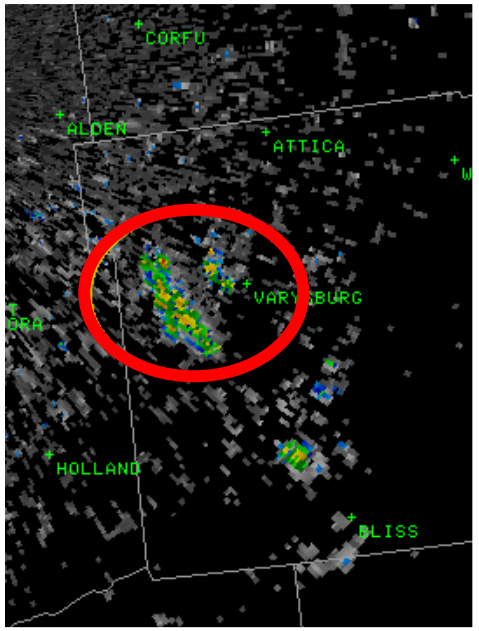
- Primary targets are weaken by inter-ferences above wind parks
- Especially military and aerial defense radars are sensitive as of in-motion objects

➢ Weather forecast

- Interferences can lead to apparent local weather phenomena
- Especially short-term weather forecasts can be affected

➢ Navy radars

Weather radar



Aviation radar

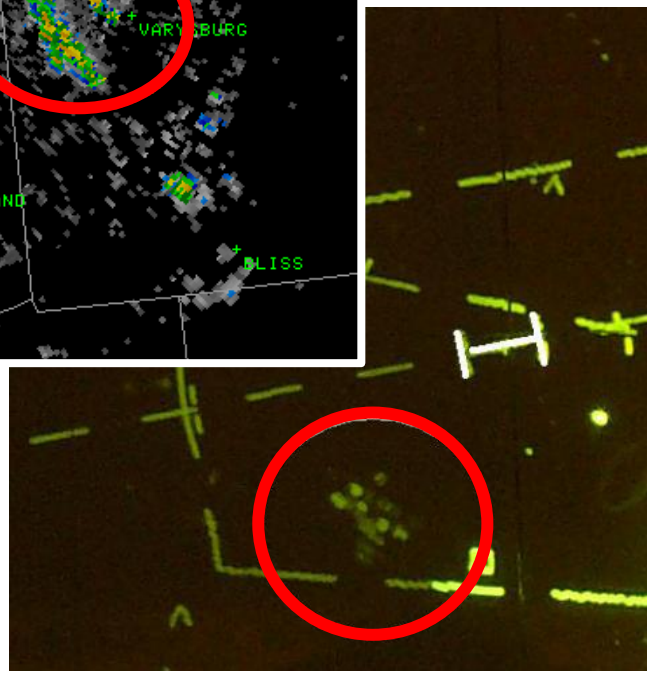


Image source: www.compositesblog.com
„Jahresbericht 2008", EADS Deutschland GmbH; Writers: Dr. Ing. Andreas Frye, Christoph Neumann, Alexander Müller

UPDATED TURKISH REQUIREMENTS NEED SOLUTIONS

- Defined **„No-Go" areas** for wind parks in Turkey
- Wind parks need approval by Ministry of Energy and Natural Resources, Turkey
- **Project specific electromagnetic compatibility studies** of wind turbines are organized by TÜBITAK
- Nordex is in close contact with TÜBITAK and provided all necessary data and information

RADAR SYSTEMS ARE AFFECTED BY WIND PARKS

Exemplary influences of wind parks and radar systems

Possible causes...

- Increasing number of wind parks enforce interference challenges
- Radar systems and wind parks are prevailing located in rural areas.
- Less affecting objects like e.g. housings increase the efficiency of wind parks and radar systems.

... are affected by:

- **Wind park**
  - Site location
  - Wind park layout
- **Wind turbine**
  - Shape of the turbine
  - Employed material
  - Rotor speed, pitch- and azimuth angle
- **Weather**
  Different weather conditions affect the characteristics of the interferences.

NO SOLE 100% SOLUTION FOR GLOBAL REQUIREMENTS BY NOW

Exemplary overview of solutions to minimize interferences

WIND TURBINE AND WIND PARK

Operational Restrictions on Wind Turbines

- Sector cut out
- Lower rotor speed
- Control of blade position
- Temporary shut down of WTGs

Park layout

- Restricted Areas
- Optimized layout
- Limiting number of WTG's

Physical modification

- Radar-absorbing coatings (stealth blade)
- New materials and optimized structures
- Modified internal structure e.g. lightning conductor

RADAR SYSTEM AND AIRCRAFT

Additional Radar System

- Additional radar stations near the WP
- Radar repeater station on turbine platform

Radar system modifications

- Enhanced radar systems to distinguish WTG from aircraft
- Software upgrades to remove false signals

Operational Restrictions on Aircraft

- Restricted airspace
- Transponder requirements

NORDEX FOCUS INITIALLY ON SHORT TERM POTENTIAL

Wind turbine manufacturer & Project Developer can influence multiple affects

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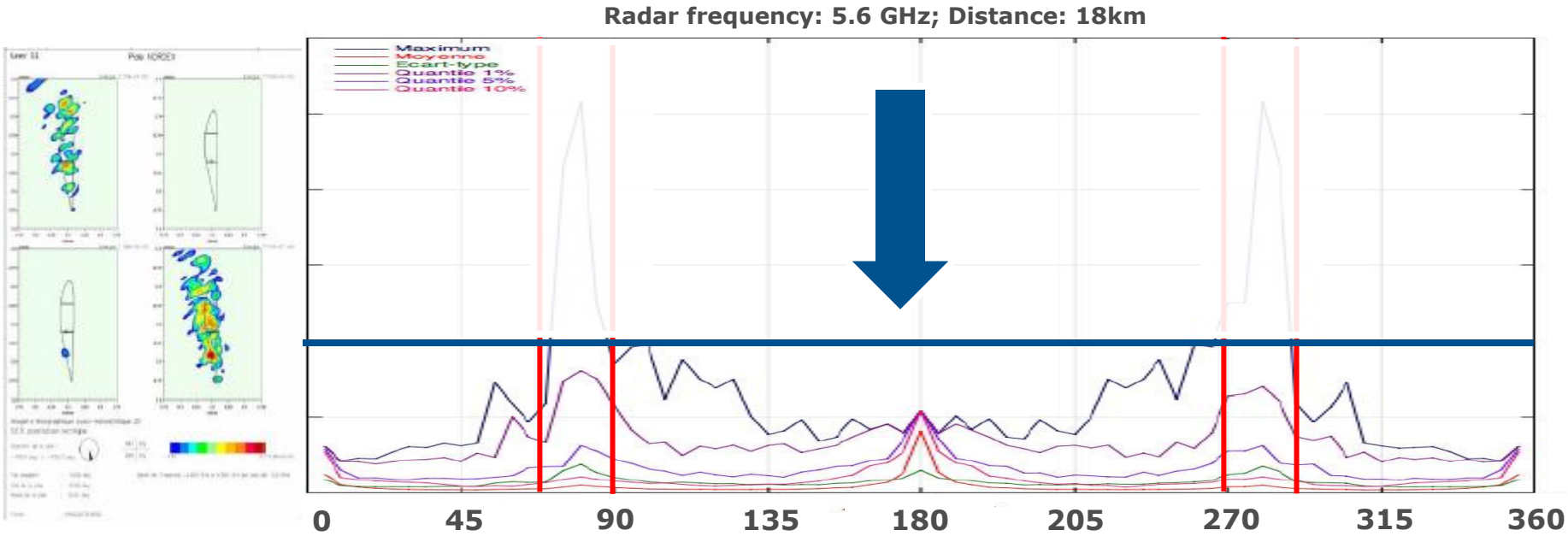
Short- and mid-term potential

Can be influenced by wind turbine OEMs & Project Developers

Mid-term potential

SECTOR MANAGEMENT AVOIDS STRONG IMPACT ON RADAR

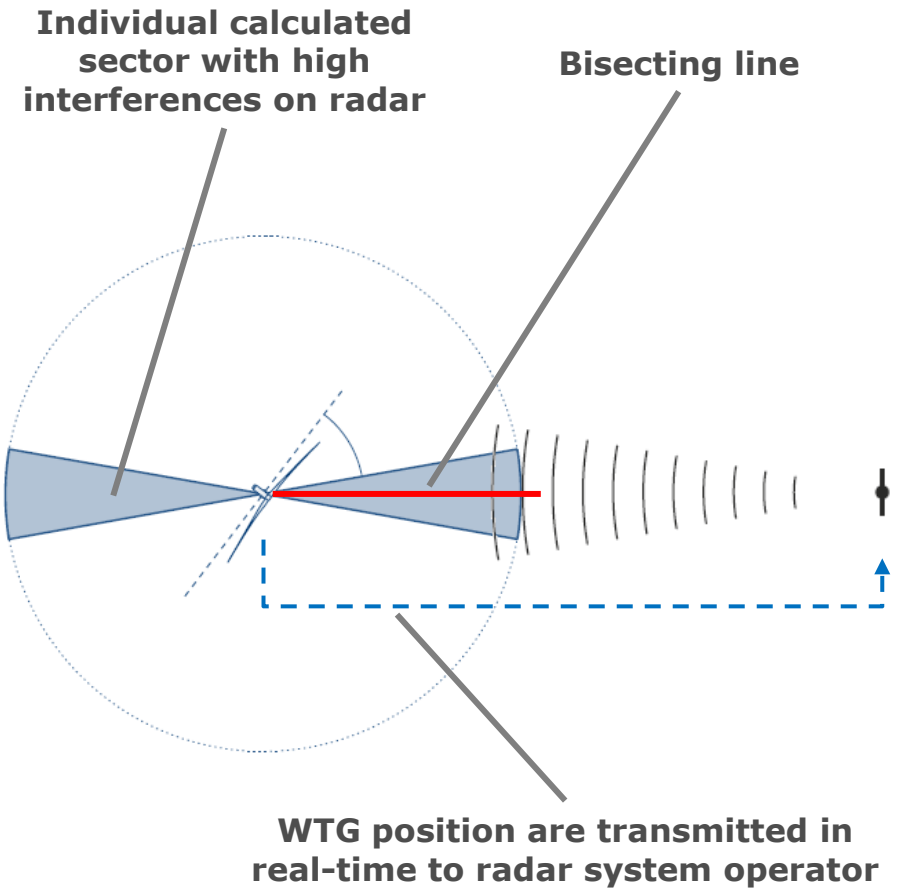
Simulation results for Nordex N90/2500



- **Nordex' first steps:** N90/2500 blade simulations by ONERA (French aerospace lab) in 2006
- Two worst case yaw positions were identified for Wind Park Berry, France
- A sophisticated sector management minimizes strongest interferences on radars

Technical features - RADAR FRIENDLY OPERATION OPTION

- **Active avoiding** of turbine specific sectors which severly affecting the radar system
- Fast drive through avoided sector if needed to **maximize energy yield**
- **Ongoing production** at sector border due to **optimized cross-flow characteristics**
- **Monitoring real time impact** on radar via communication option to radar operator



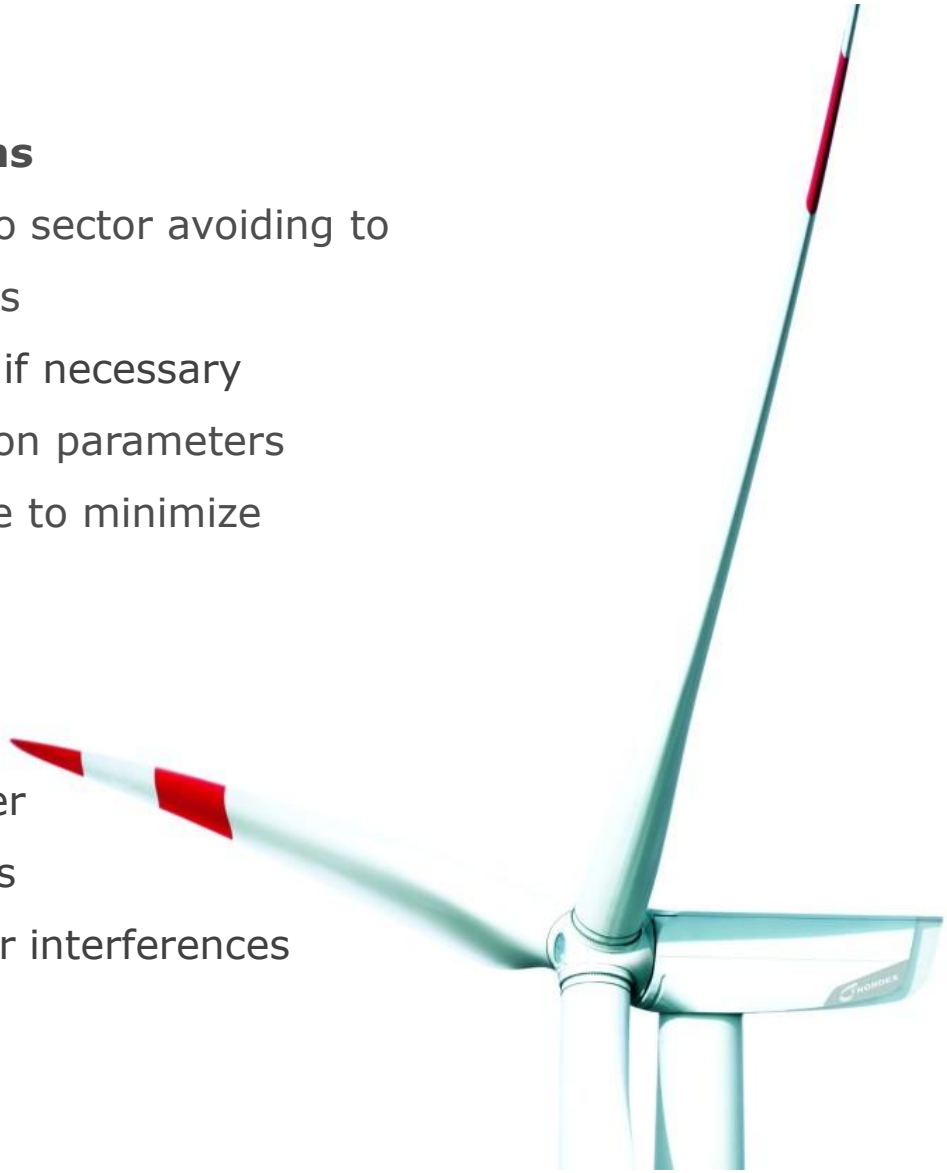
NORDEX UNBLOCKED FIVE WIND PARK BUILDING PERMITS

- Experimental phase with Météo France started in April 2011
- 2 wind parks with Nordex N100/2500 wind turbines are equipped with **Radar Friendly** option already
- 3 wind parks with **Radar Friendly** option will be installed in 2012
- Monitoring of the impact of 8 Nordex Wind Turbines on the Météo France radar in real time
- Nordex **unblocked 5 wind park building permits** in Berry area
- Further Results will be available mid of 2012

NEW OPORTUNITIES FOR WIND PARKS IN RADAR SENSITIVE AREAS

- **Minimized effects on radar systems**
  - Minimized false radar signals due to sector avoiding to fulfill safety relevant radar functions
  - Fast drive through avoided sectors if necessary
  - Real-time set-up of turbine operation parameters
  - Turbine specific optimization on site to minimize interferences on radar systems

- **Optimized cost-efficiency**
  - Ongoing production at sector border
  - Optimized cross-flow characteristics
  - No shut downs of WTG due to radar interferences
  - Minimized losses of energy yield



NEXT STEPS OF NORDEX

- Nordex focus initially on short-term potential to react quickly on market requirements
- Grow a strong partnership with Météo France to optimize our Radar Friendly solution
- Nordex is open for discussions with wind park developern, governmental departments and commitees
- Nordex analyzes the market continuously to identify and to work on further practicable solutions for the future.

RADAR FRIENDLY OPTION WILL BE AVAILABLE AS OF DECEMBER 2012

MANY THANKS FOR YOUR ATTENTION.

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