

Wind Energy from the Windy City

September 24, 2013

Wind Energy from the Windy City

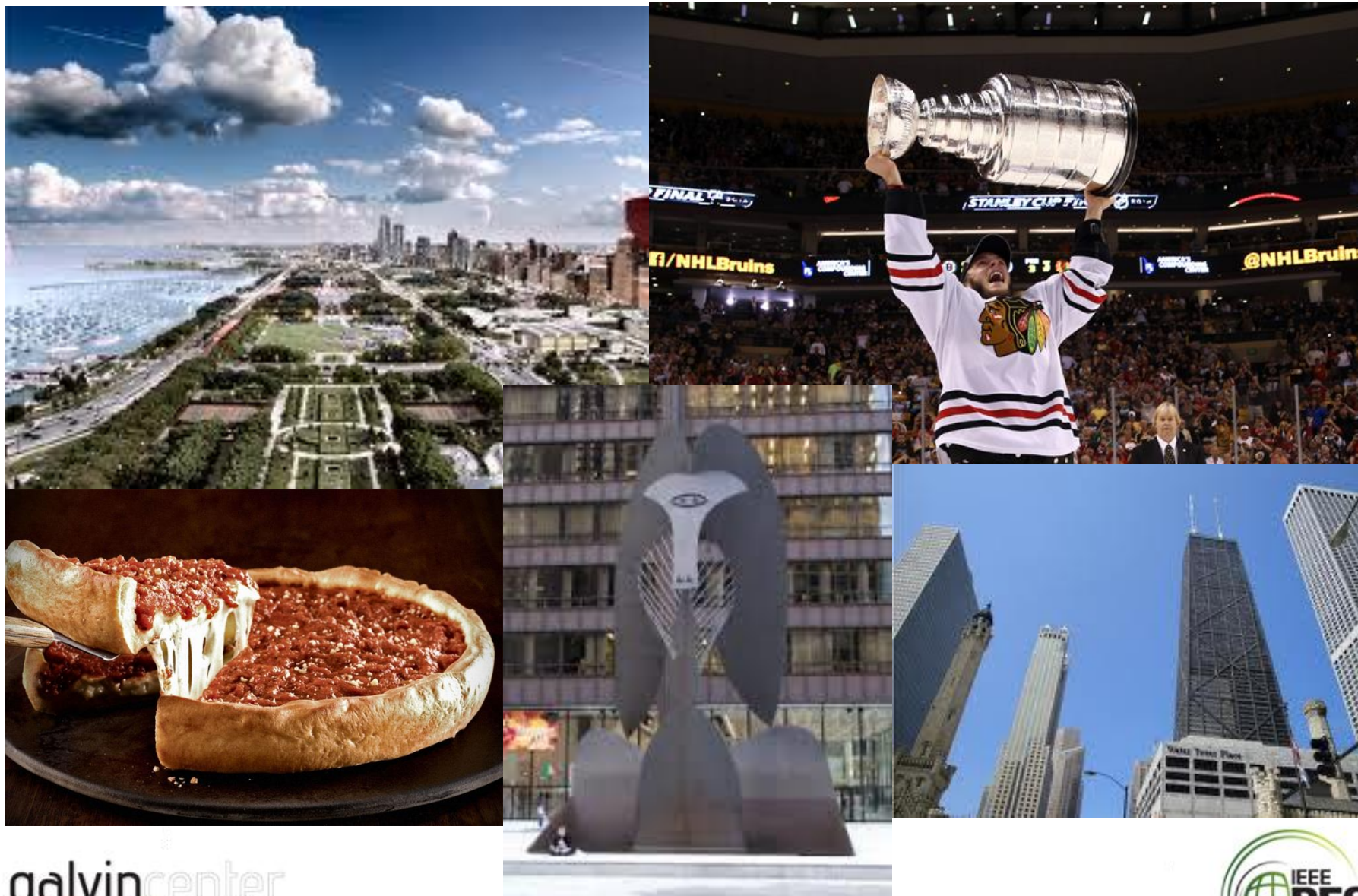
Harry L. Holtz III

founder/chair



CHICAGOLAND
WIND COUNCIL

Welcome to Chicago



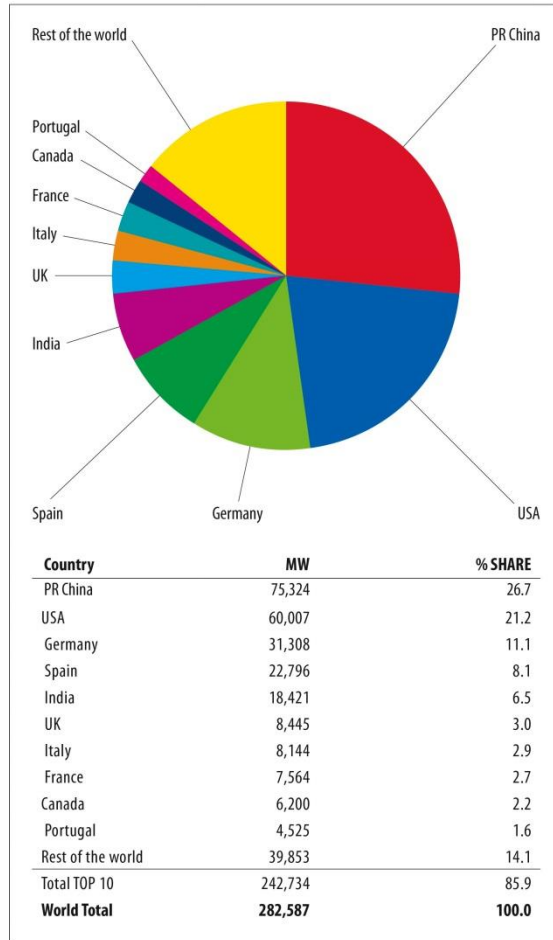
Chicago is the Wind Industry hub in North America!

Wind Energy Innovation in Chicago -



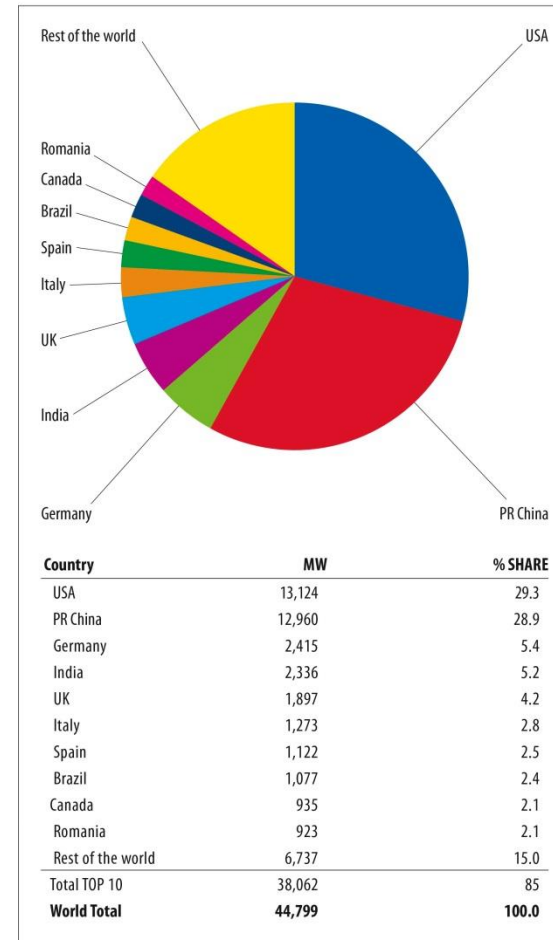
The Wind Power Industry -

Top 10 Cumulative Capacity (December 2012)



Source: GWEC

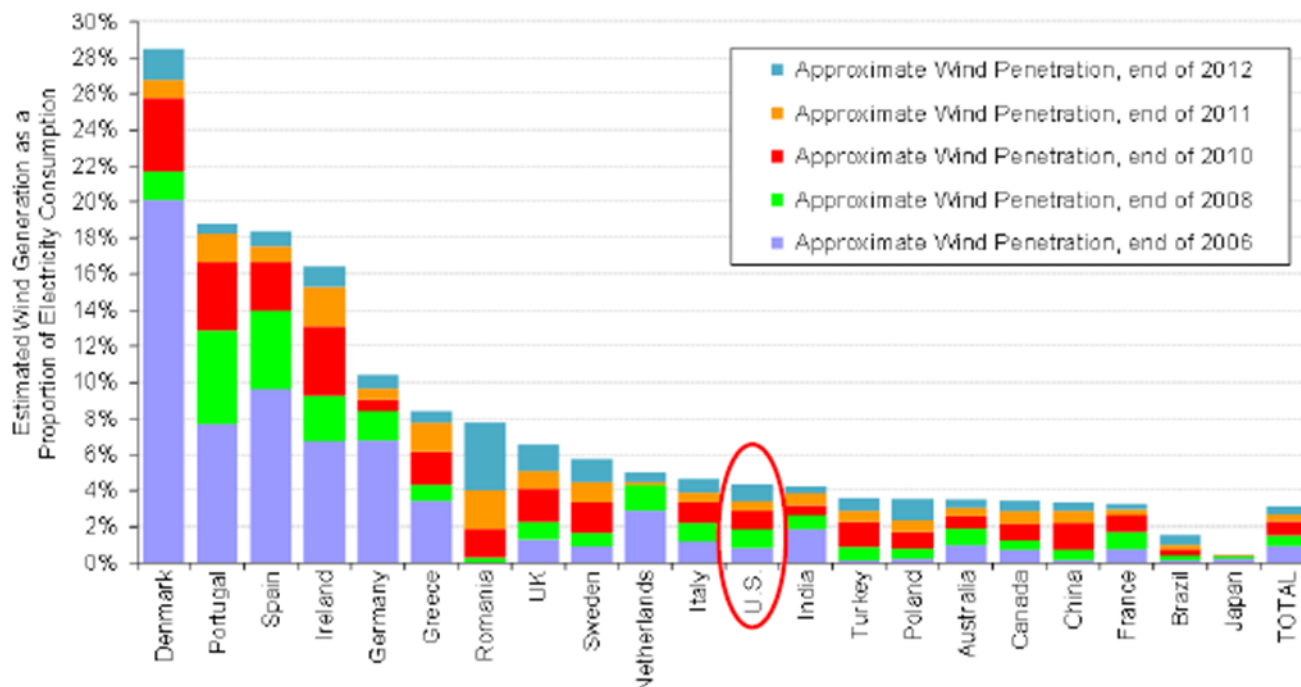
Top 10 New Installed Capacity (Jan-Dec 2012)



Source: GWEC

The Wind Power Industry

U.S. Lagging Other Countries in Wind As a Percentage of Electricity Consumption



Note: Figure only includes the countries with the most installed wind power capacity at the end of 2012

Steve Spethmann, Supply Chain Director, Suzlon Wind Energy Corporation



Suzlon Group at a glance today

Suzlon Energy Ltd.



Global

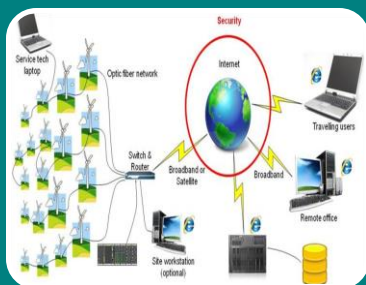
- Over 18,000 MW operational in 28 countries
- Over 13,000 employees
- Annual capacity of 5,900MW/yr
- Headquartered in Pune, India
- Revenues ~\$4Bn in FY 10-11

US

- Over 2,900MW operational in 19 states
- Nearly 500 employees
- Headquartered in Chicago for Suzlon and Denver for REpower
- Service and maintain over 2,600 MW

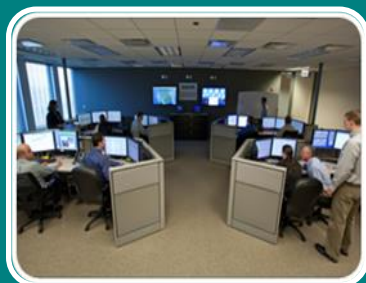
Customer focused Suzlon capabilities

Suzlon Energy Ltd.



SCADA

- Increased bandwidth and VPN connections provide high speed secure access
- ‘Out of the Box’ functionality with multiple secure access points and full data viewing capabilities
- Fully capable Enterprise Database solution provides customer with easy and flexible access to data for cross-platform monitoring and additional analysis



Monitoring

- Over 1,850 turbines around the world are monitored from Suzlon’s HQ in Chicago
- The daily impact to availability is approximately 3-5%
- Respond to events within 7 minutes



Project Execution

- With the 2,500MW installed, the Suzlon Projects team has the experience to deliver completed projects
- From turbine supply to full turn key EPC, Suzlon is experienced and capable of offering logistics, design, engineering, installation and BOP

Customer focused Suzlon capabilities

Suzlon Energy Ltd.



Operations, Maintenance & Service

- Over 25 offices and 300 technical staff
- Providing OMS to nearly 2,500 MW
- Successfully maintain fleet at over 97% availability
- Complete service packages up to 10 years of operation



Safety and Training

- State of the art training facility near Suzlon's HQ in Chicago with a live complete S88 nacelle dedicated to training
- All Suzlon technicians are trained in work practice requirements that exceed regulatory standards
- Building on Suzlon's strong safety stance, Suzlon created industry benchmarking safety manual, the 257 page "Guide to Getting EHS Right"



Co-Development

- Under Suzlon's co-development arm, SURE Power, Suzlon is able to assistance in the development to bring projects to completion
- Offering assistance in a number of areas including wind & site, design & engineering, permitting, power marketing, financing, and project execution SURE power is interested in getting near-term projects to the finish line

LOGISTIC\$ → location, location, location

Suzlon Energy Ltd.

Distribution Center

Technology Drive

Elgin, Illinois



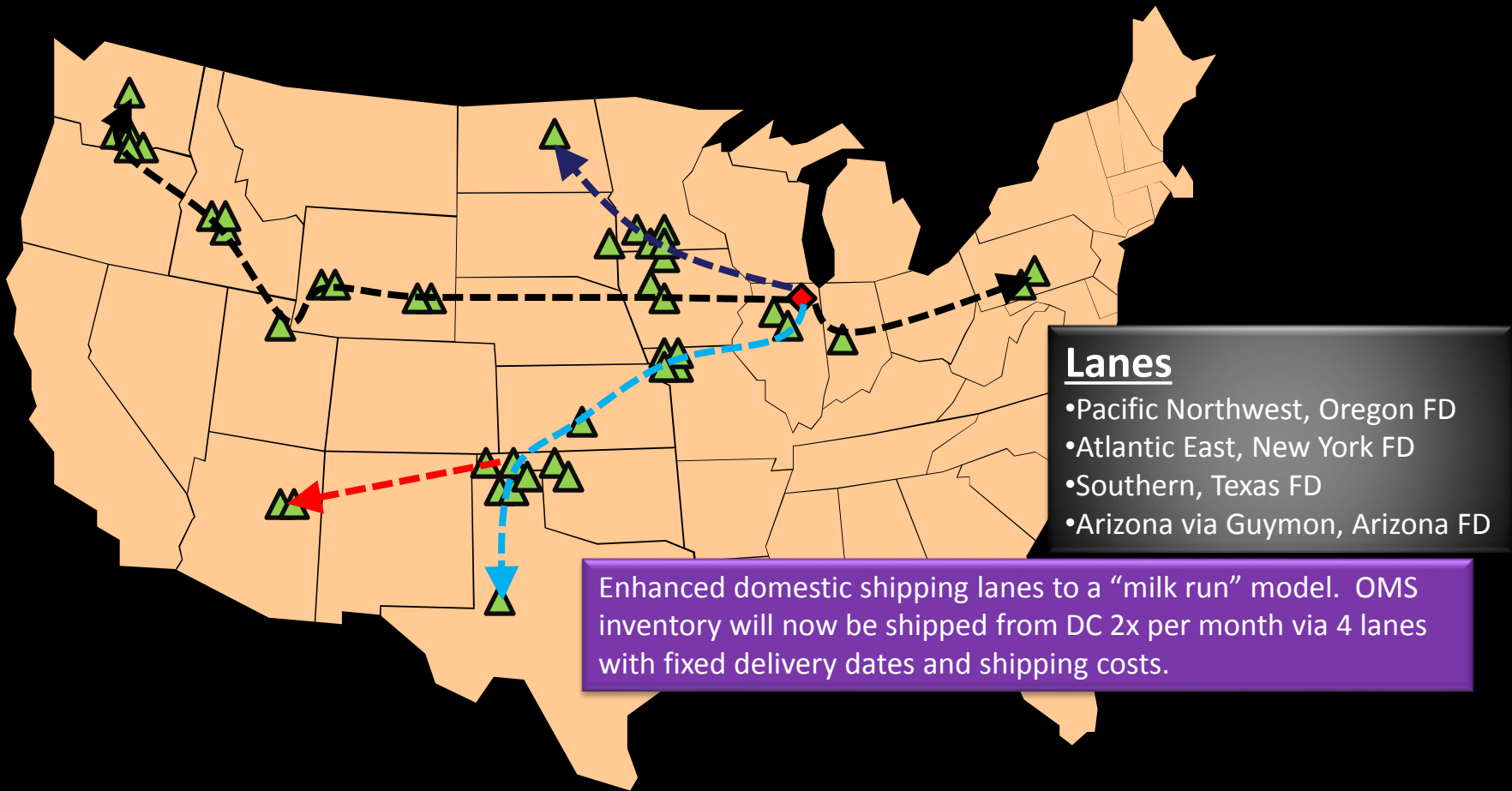
Customer Service – includes providing Parts

- Preventative maintenance supplies delivered to sites
- Storage and logistics services for major components

Suzlon Energy Ltd.



Milk Runs = transportation savings



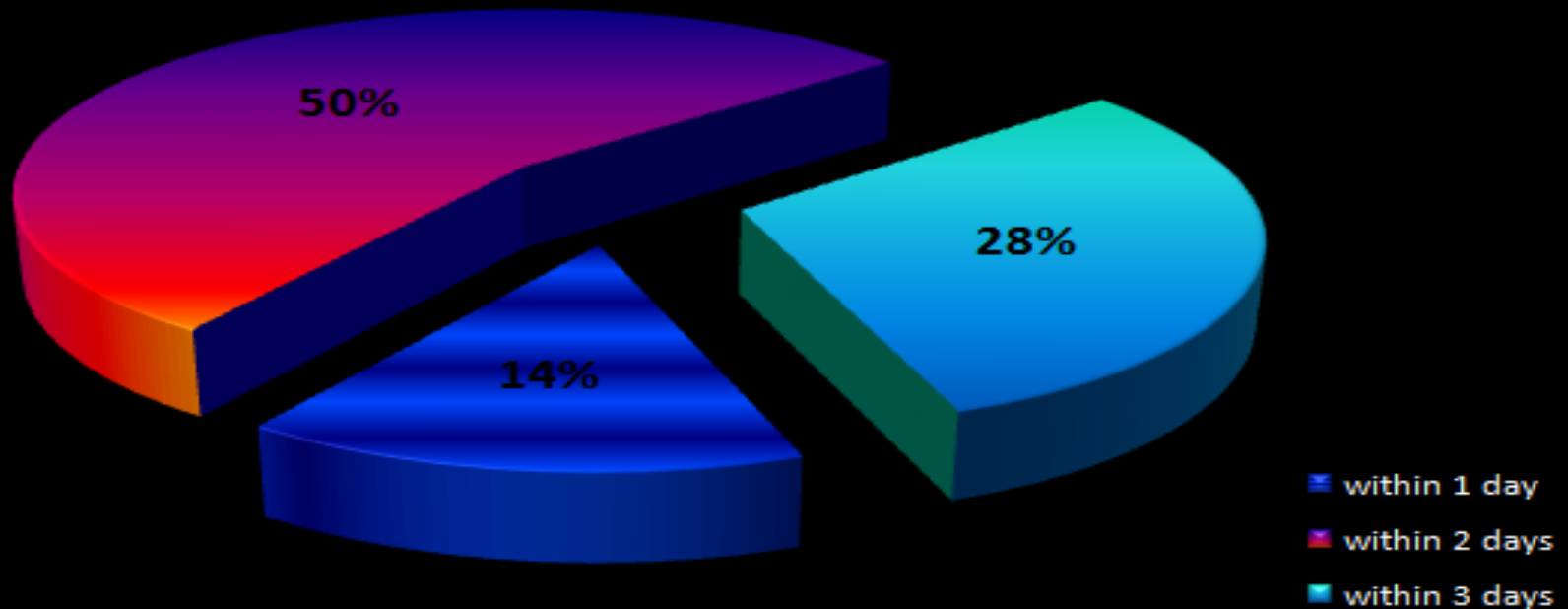
RUSH Shipment !!!

Time in Transit

Suzlon Energy Ltd.

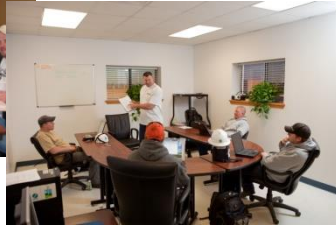
- Chicago can hit all locations in US within 2.5 days
- 50% of all shipments from Chicago will deliver within 2 days
- Chicago can hit 14% of the US within 1 day

Chicago



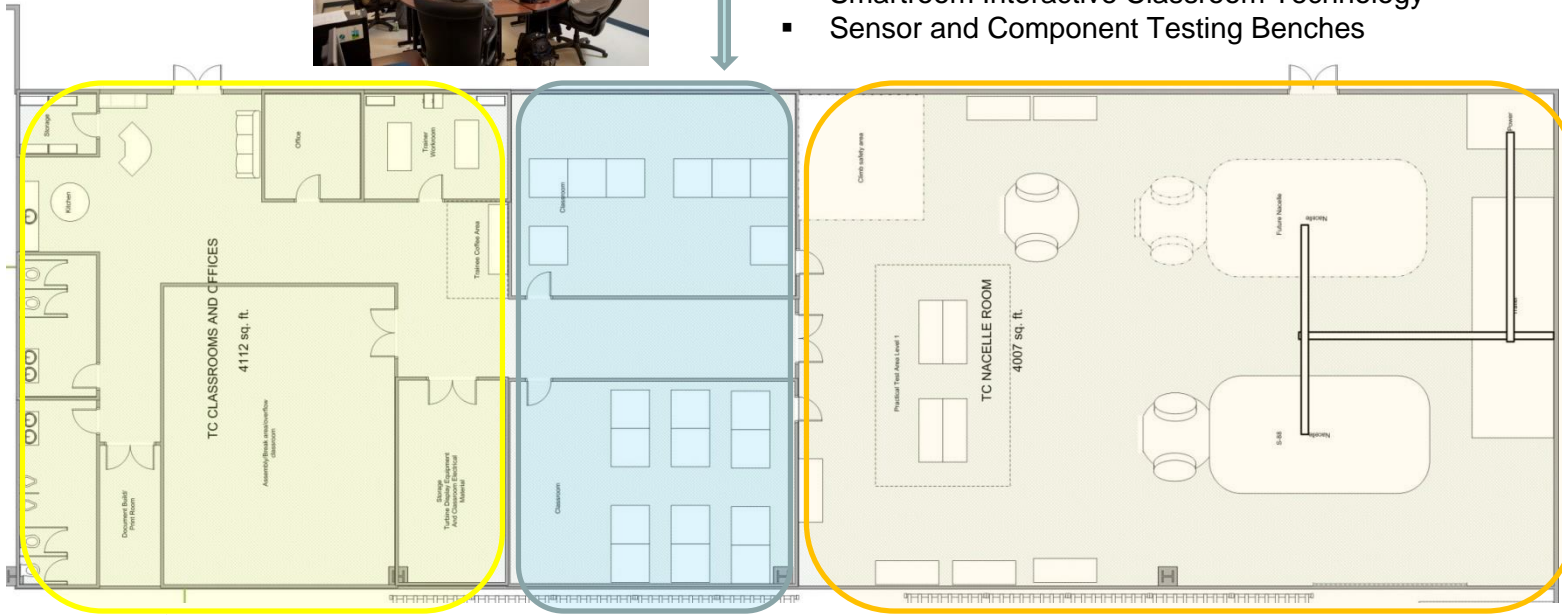
Training Facility –Build Out

Suzlon Energy Ltd.



2 Classrooms:

- Overhead projection
- Wireless access
- Smartroom Interactive Classroom Technology
- Sensor and Component Testing Benches



- Staff Offices
- Conference Room
- Break Area for Students



The Simulation Laboratory :

- Mechanical Alignment Bench
- Working at Height and Climb Safety Stations
- Pitch Communication and Control Stations
- Motor Test Benches
- S-88 Functional Turbine (With expansion room for the new models)



Development of Training Center

Suzlon Energy Ltd.



Development of Training Center

Suzlon Energy Ltd.



SUZLON
POWERING A GREENER TOMORROW

Partnering with sustainability since 1995.

•• THEREFORE
SUZLON



Joseph Reisinger, Vice President-Product Management, Broadwind Energy



We make wind work better

Joseph Reisinger

Vice President, Product Management

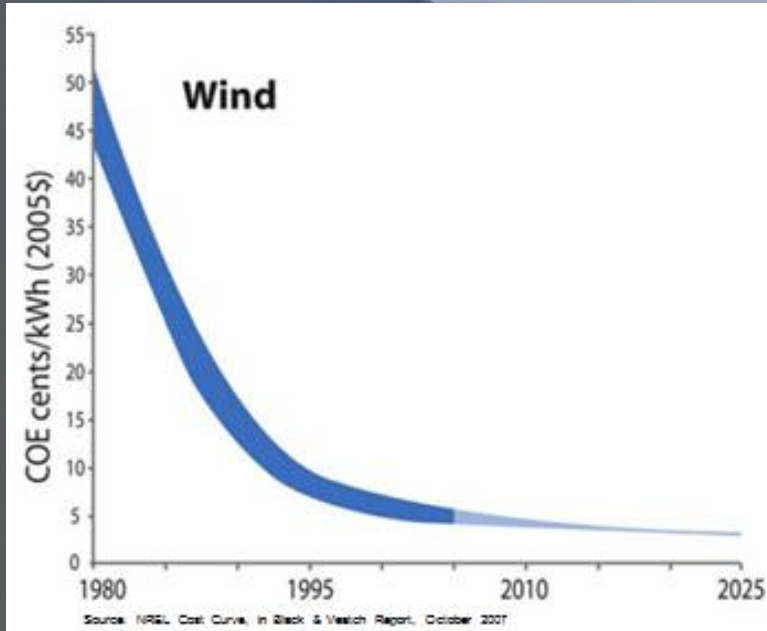
Broadwind Energy

Broadwind Energy at a glance

- Broadwind provides components and in-field services to energy markets
 - Wind towers
 - Gearing
 - Major components
- More than 800 employees throughout the U.S.
- ISO 9001:2008 certified
- Publicly-traded:
NASDAQ:BWEN



Improving economics



➤ Over the past 5 years, wind represented 35% of new capacity brought online in the U.S.

Data Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2011
Data Source: AWEA, Energy Information Administration, SEIA, SNLair

Wind energy cost per kWh has declined 90% since the early 1980s



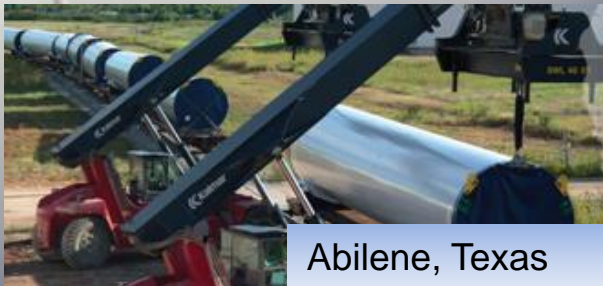
We make wind work better.™ | **TOWERS**

Maximize the power of wind

- Flexibility
- Quality
- Customer focus

Robust capabilities

- State-of-the-art production facilities
- Custom-designed welding equipment
- Industry leading lifting capacity



A towering perspective

Wind Turbine
394 feet
(120 M)



Willis Tower
1,730 feet
(527 M)



We make wind work better.™

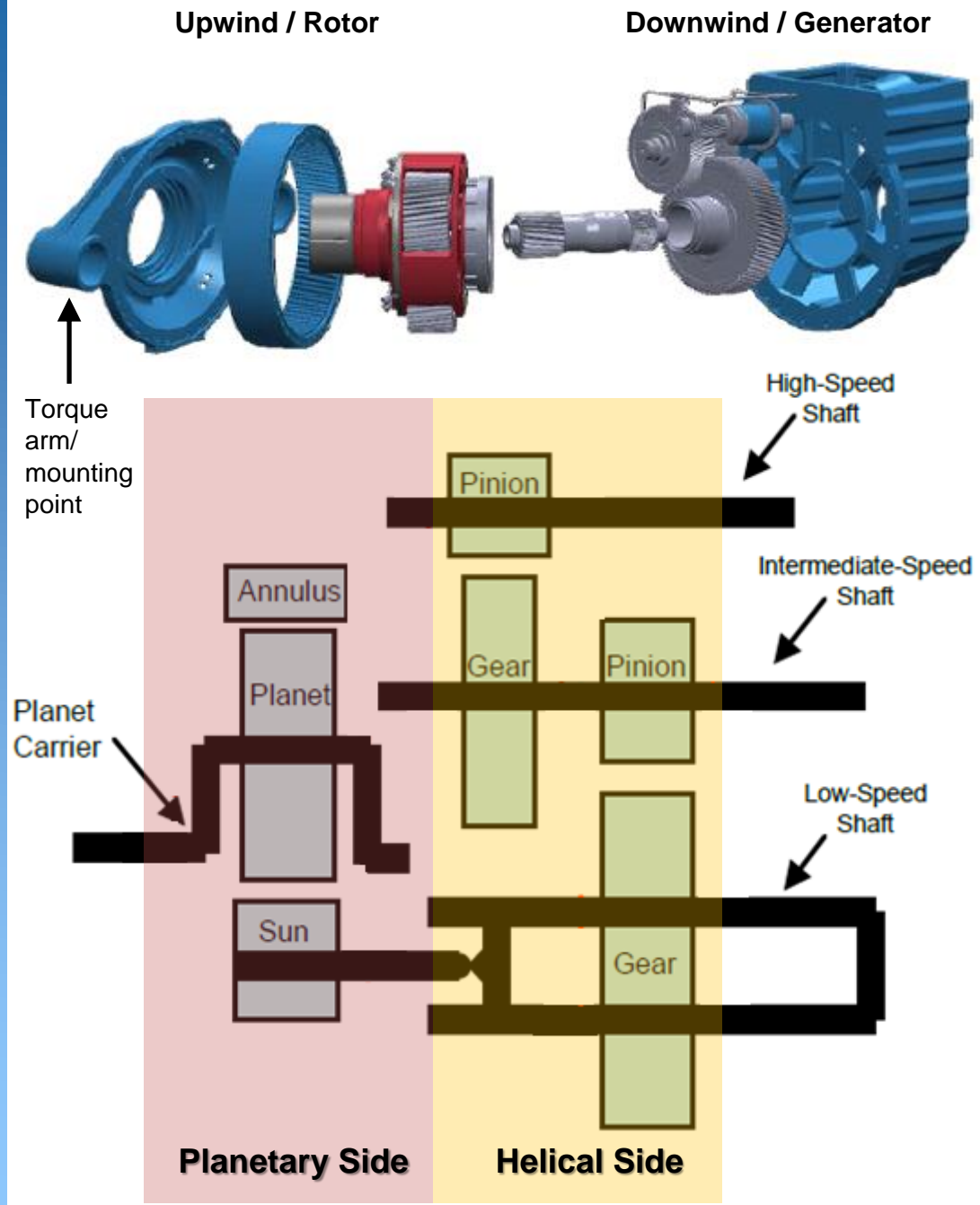
Drive**MAX**[™]
SOLUTIONS

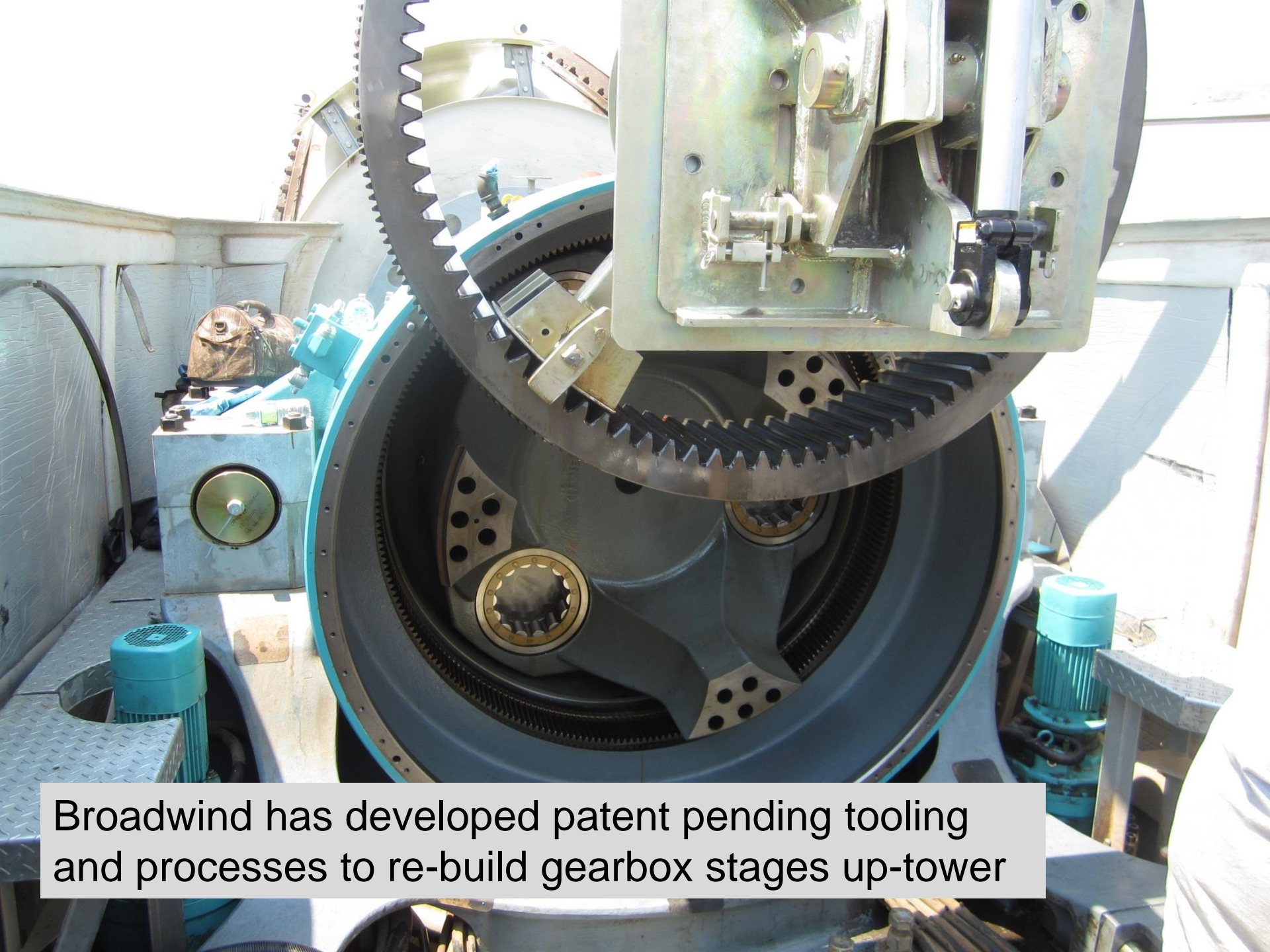
Maximize the lifecycle of your drivetrains

- Uptower drivetrain solutions
- Gearbox remanufacturing
- Gearbox inspections & failure mode analysis
- Oil changes

Gearbox basics

- WTG gearboxes are complex, often designed with multi-stage planetary gearing systems
- Large diameter rotor blades turn as slow as 15 RPM requiring gearbox speed ratios up to 100:1
- Wind gearboxes increase speed to drive the generator at 1,800 RPM
- 7ft X 7ft gearbox weighs approx. 35,000 lbs.





Broadwind has developed patent pending tooling and processes to re-build gearbox stages up-tower

A man with a beard and safety glasses, wearing a green long-sleeved shirt, is holding a thick red cable. He is looking towards the camera with a slight smile. The background is dark.

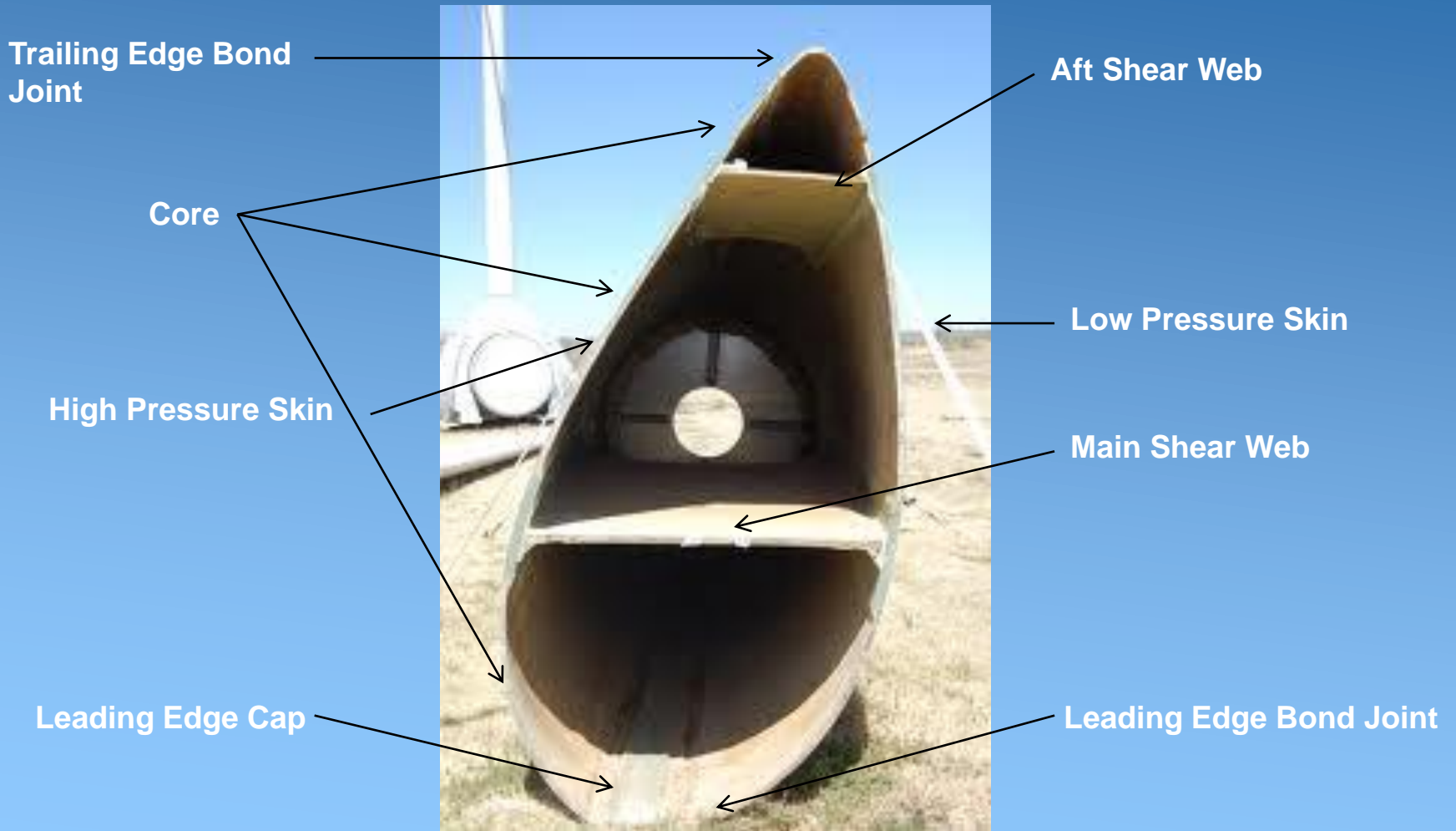
We make wind work better.™ | **BladeMAX**™
SOLUTIONS


Maximize the lifecycle of your blades

- Uptower blade inspection/maintenance/repair
- Leading edge protection
- Vortex generators

Blade Basics

Cross Section of a typical modern blade





Broadwind recommends a proactive blade maintenance strategy.

Broadwind Energy is committed to helping customers maximize performance of their energy and infrastructure investments—quicker, easier and smarter.

Contact Information:

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Vice President, Product Management

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Phone: 708-780-4800

Visit us at: www.BWEN.com



Dan McDevitt, President & CEO, Nordex



NORDEX USA, INC.
GREAT LAKES SYMPOSIUM



CHICAGO
24 Sep 2013



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About Nordex

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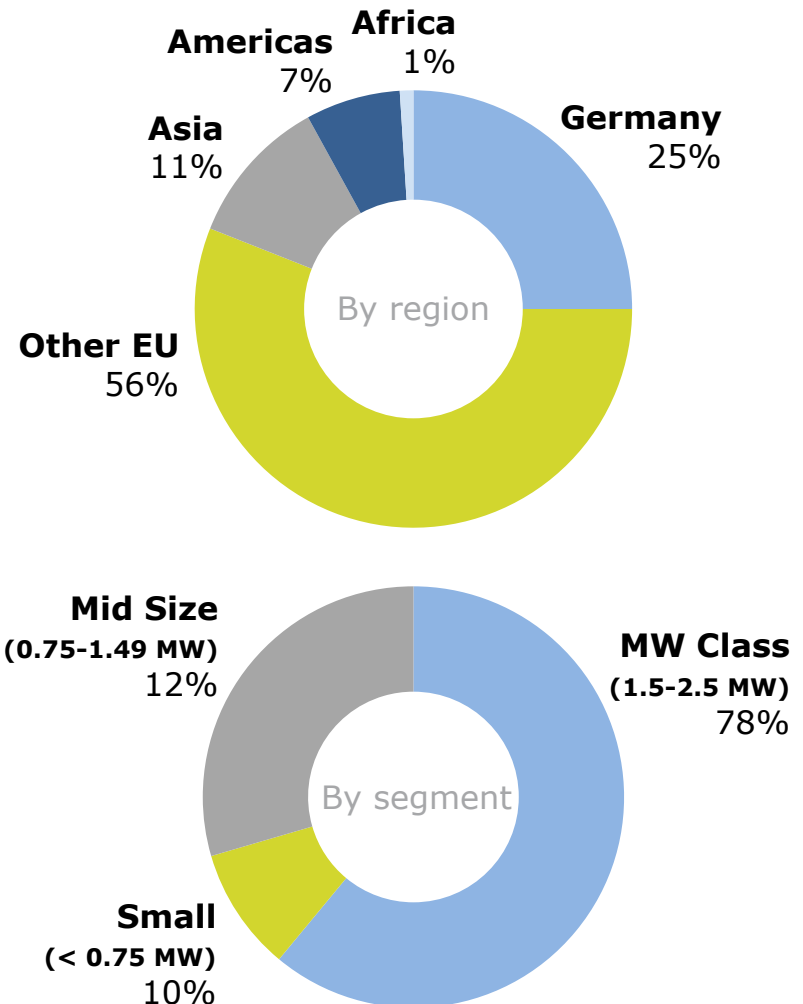
Wind Industry Challenges & Our Responses

NORDEX GROUP: KEY FACTS

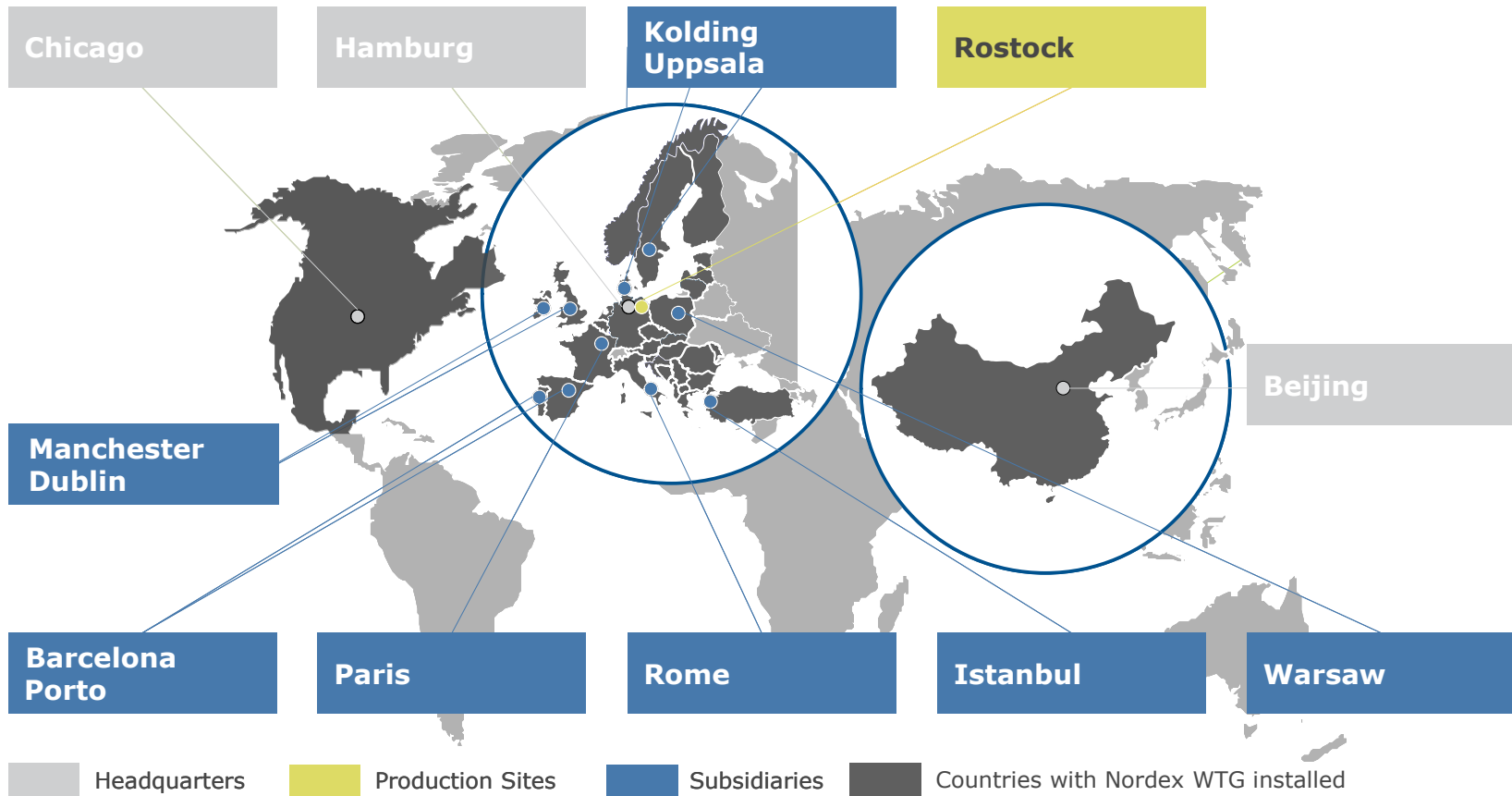
- Global manufacturer of wind energy turbines with a focus on 2.5 MW class
- 28 years experience
- Global headquarters in Hamburg, Germany, listed on the Frankfurt Stock Exchange
- Nacelle + Blade Production in Germany (Rostock)
- Extensive use of platform technology (same or similar components across all WTG types)
- Variants for different wind and climate conditions
- 2,536 employees as of 31 Dec 2012
- Total installations in 39 countries as of 15 Apr 2013
8,776 MW /
5,397 WTG



INSTALLED BASE



GLOBAL PRODUCTION, SALES AND SERVICE NETWORK

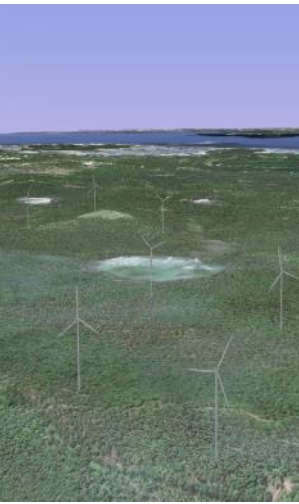


GLOBAL / AMERICAS

NORDEX IS MORE THAN A MANUFACTURER



Project Development



- ✓ Selection of location
- ✓ Optimal siting
- ✓ Wind measurements
- ✓ Soil survey
- ✓ Noise / shadow emission
- ✓ Economic viability
- ✓ Grid connection
- ✓ Environmental permitting + studies
- ✓ Building permitting
- ✓ Co-development

Wind Farm System Planning



- ✓ Micrositing
- ✓ Electrical + Civil Planning
- ✓ Support customers during development

Manufacturing & Installation



- ✓ WTG design
- ✓ Production of nacelles and rotor blades
- ✓ Transportation to site
- ✓ WTG installation and commissioning
- ✓ Testing

Balance of Plant



- ✓ Project construction
- ✓ Civil Works: foundation + roads
- ✓ Electrical Works: substation, internal park cabling, transformers
- ✓ Interconnection

Service and Maintenance



- ✓ > 2,700 WTG worldwide currently under Nordex service
- ✓ Full service contract offerings up to 20 year terms: Basic, Extended, Premium

Wind Farm Operations



- ✓ Comprehensive Technical Wind Farm Operations (including switching operations)
- ✓ Administration of Land Lease Agreements and Land Owner Relationships
- ✓ Oversight of Relationship with Offtaker and Grid Operator

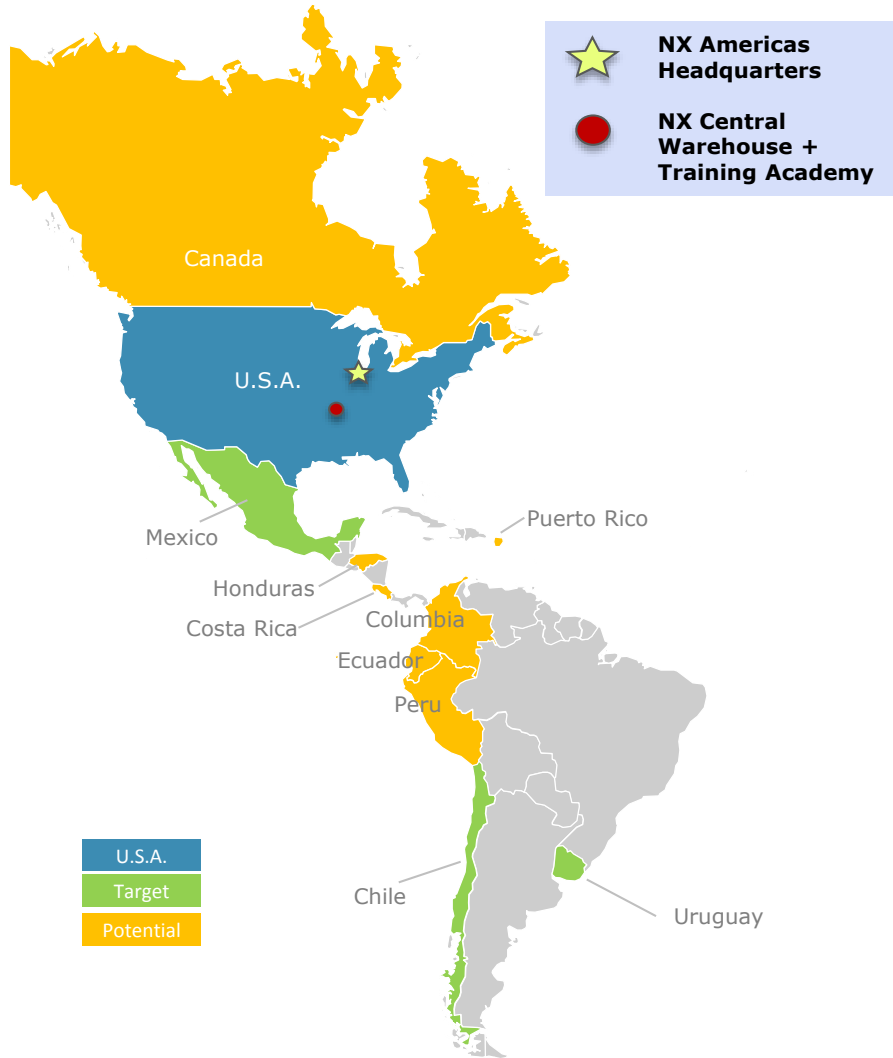
GLOBAL / AMERICAS

WORLDWIDE INSTALLATIONS AS OF 15 APRIL 2013



	up to 1000 kW	N60/1300 N62/ 1300	S70/1500 S77/1500 N77/1500	N82/1500	N90/2300	N80/2500	N90/2500	N100/2500	N117/2400	Total Installations	Total MW
Austria	6	3								9	5.30
Belgium								18		18	45.00
Bulgaria		4					1			5	7.70
Canada		20								20	26.00
China	178	43	360	2			1	3		587	709.60
Columbia		15								15	19.50
Czech Republic			3			3				6	12.00
Denmark	125	52			2		1			180	148.55
Egypt	105									105	63.00
Estonia					8					8	18.40
Finland		3								3	3.90
France	58	35			145	24	195	65		522	1,125.45
Germany	544	353	451	1	85	38	32	67	29	1,600	2,063.25
Greece	46						25			71	91.35
India	263									263	57.85
Ireland		4				36	63			103	252.70
Italy	2		49		90	16	87	19		263	587.10
Japan	16	29				2	9			56	73.10
Netherlands	10	2				25	17	5		59	127.30
Norway						16	21			37	92.50
Pakistan			33							33	49.50
Poland	1		7		9	4	25	26		72	168.95
Portugal	3	32			96		54			185	399.80
Romania								8		8	20.00
Spain	25	54					34	15		128	207.70
Sweden	1						53	53		107	265.60
Turkey							154	90		244	610.00
UK	9	84			26	134	145	2		400	878.10
USA	12	12					106	105	34	269	635.55
Others*	21									21	11.70
Total Installations	1,425.00	745.00	903.00	3.00	461.00	298.00	1,023.00	476.00	63.00	5,397	
Total MW:	744.95	968.5	1,354.50	4.5	1,060.30	745.00	2,557.50	1,190.00	151.20		8,776.45

Target Markets



Target Market Plans

- Participation at AWEA, Chilean + Uruguayan wind conferences
- Create service organization near contracted projects
- Contract local suppliers of installation, domestic transportation, and maintenance services
- First installation in target markets outside the US beginning in 2013 (Uruguay)

Target Market Presence and Activity

	MW Installed ¹	MW under Construction ¹	MW under Development ¹
USA	673 MW		1,500 MW
Canada	26 MW		
Uruguay		50.4 MW	
Honduras			300 MW
Columbia	19.5 MW		

¹ as of Apr 2013

NORDEX AMERICAS AT A GLANCE

- Headquarters in Chicago, IL to support Sales and Service for the Americas
- Central Warehouse, Service Support + Training Academy in Jonesboro (AR)
- Headcount as of July 2013: 184 FTEs
- Organizational set-up with over 400 years of wind industry experience:
 - ✓ Engineering
 - ✓ Project Procurement
 - ✓ Project Management
 - ✓ Service
 - ✓ Health & Safety
 - ✓ Sales
 - ✓ Project Development
- Products: N90/2500 + N100/3300 (IEC 1a), N100/2500 + N117/3000 (IEC 2a), N117/2400 (IEC 3a)
- 646.6 MW of installed capacity in the US since 2009



AMERICAS

US FACILITIES & INSTALLATIONS



- ★ Headquarters/
Service Warehouse
& Training Facility
- Installed 2.5 MW
WTG through
2012: **622.5 MW**

1

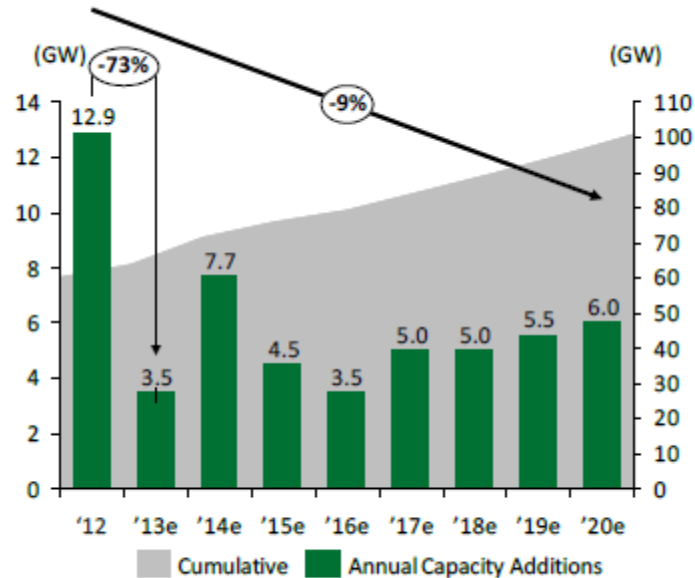
About Nordex

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Wind Industry Challenges & Our Responses

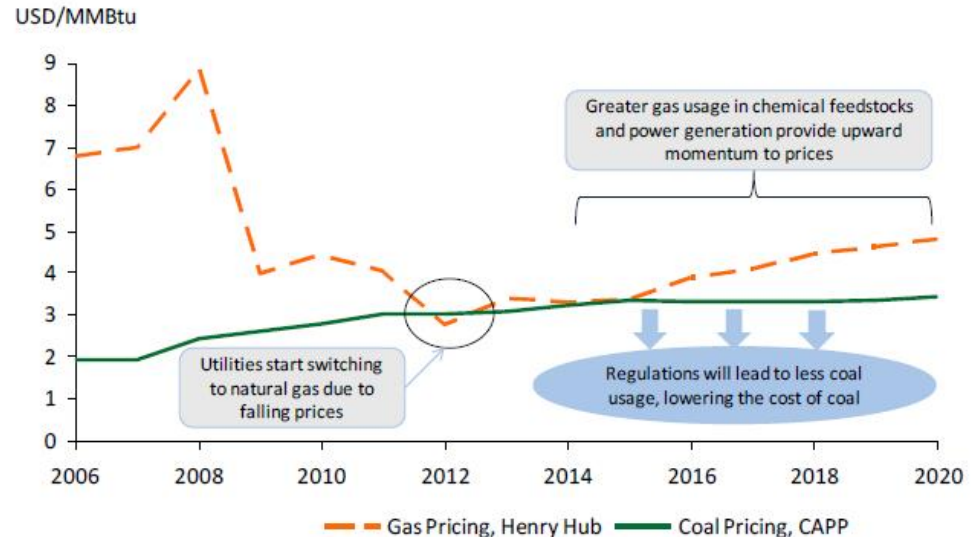
US Market Outlook, 2012-2020e



Note: All numbers are based on grid-connected capacity.
Source: MAKE Consulting

- PTC renewal timing
- PTC expiration or phase out
- Supply chain impacts
- Offset by growth in Americas

Natural Gas Pricing, 2006-2020e



Note: Pricing data collected in February 2013.
Source: MAKE Consulting, EIA, NYMEX

- Impact of financial crisis, economical slowdown
- Future impact of fracking
- PPAs set by natural gas pricing

THE NORDEX EFFICIENCY CLASS

PRODUCT PORTFOLIO BUILT ON MORE THAN 8.7 GW OF INSTALLATIONS



Type	MW	IEC Wind Class*	Sound dB(A)	Net Capacity Factor** (%)							
				6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
N80/2500	2.5	Ia	103.0					35.7	39.5	43.0	46.3
N90/2500	2.5	I & II	105.5				38.1	42.2	46.0	49.4	52.6
N100/2500	2.5	II & III	106.0		33.3	37.9	42.3	46.3	49.9	53.3	
N117/2400	2.4	III	105.0	35.7	40.7	45.3	49.4	53.0			
N100/3300	3.3	I	105.5					39.1	42.9	46.4	49.7
N117/3000	3.0	II	106.0			40.0	44.3	48.2	51.8	55.0	



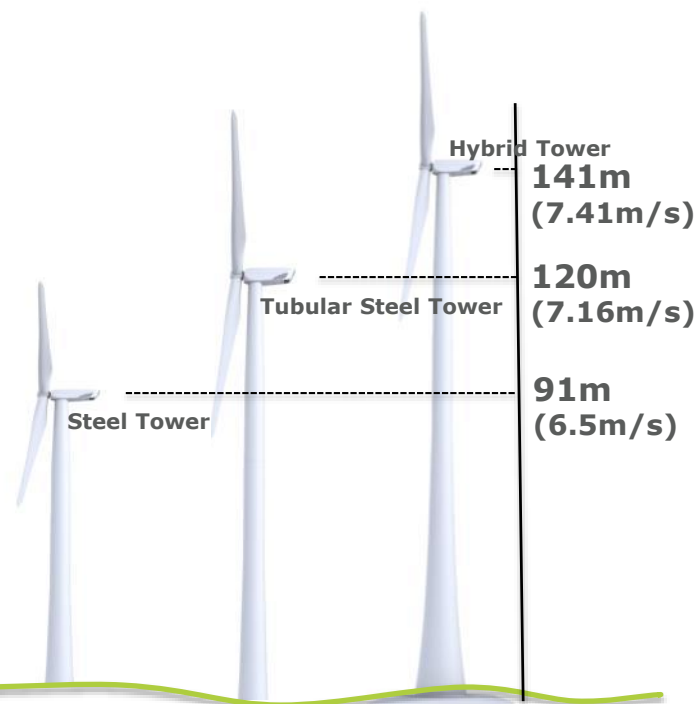
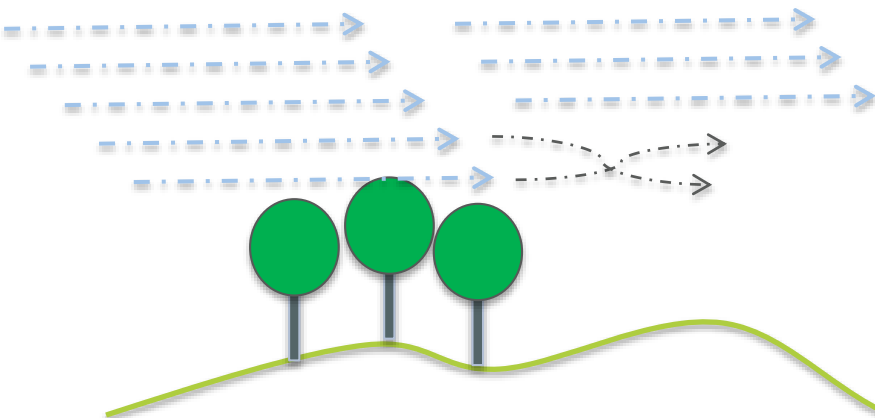
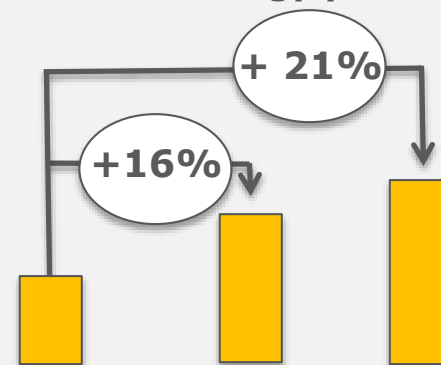
* IEC I: strong wind; IEC II: moderate wind; IEC III: light wind

** Assuming net losses of 13% (wake, electrical, icing, technical availability), standard air density of 1.225 kg/m³ and Weibul k=2.5; average wind speed at hub height

Higher yield due to greater hub heights

Topographical obstacles, such as trees, may result in lower yields. At higher hub heights, the wind quality is better.

N117/2400: annual energy yield



Maintaining the highest possible level of power output in any season, from very low to very high ambient temperatures.

-30° to +40° C

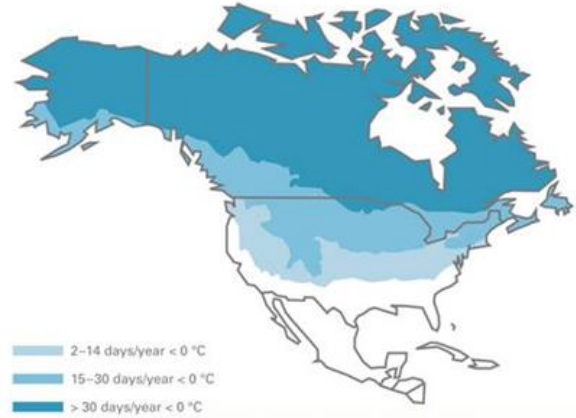
- Heated pitch, yaw, hydraulic station, cabinets
- CCV oils, lubes and coolants
- CCV casting materials + steel
- Thermal bypass integrated into cooling system
- Additional cooling vents

THE NORDEX EFFICIENCY CLASS

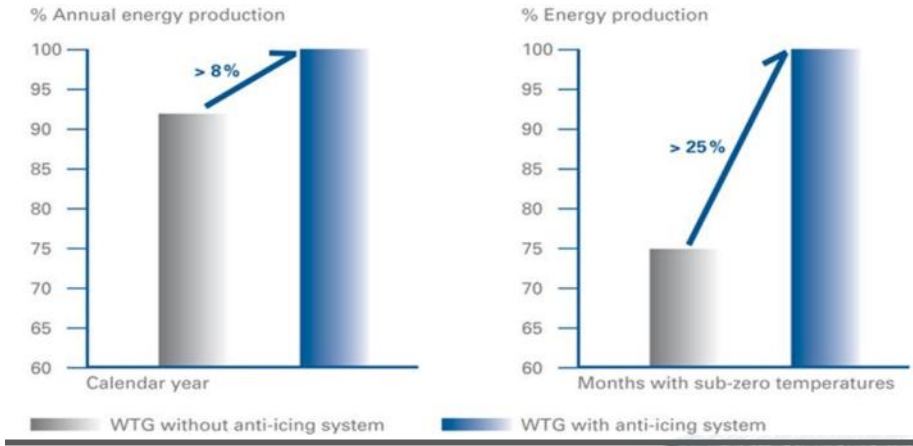
ANTI ICING OPTION TO IMPROVE YIELD DURING WINTER MONTHS



REGIONS EXPOSED TO THE RISK OF ICING IN NORTH AMERICA



COMPARISON OF ENERGY YIELDS



Test evaluation of the system in Jokkmoksliden, Sweden:

Yield increased

- Increase of more than 8% AEP in the year 2011 in comparison to the reference WTG
- Increase of more than 25% EP in the frost period (December through April)

Cost/Benefit

- The payback period of the system will typically be less than 5 years, based on only a few weeks of icing per year

System consumption

- The energy consumption of the system is negligible (<0.3%)

Nordex has won the largest order awarded for an onshore wind project in Sweden to date: As of summer 2012 "Blaiken" 150 MW wind farm will be built.



2.5 MW GLOBAL AVAILABILITY

1 Jan 2012 - 31 Dec 2012	# all WTG¹: 1,868	Ø Availability: 98.09%
1 Jul 2011 - 30 Jun 2012	# all WTG: 1,746	Ø Availability: 97.70%
1 Jan 2011 - 31 Dec 2011	# all WTG: 1,447	Ø Availability: 97.54%
1 Jul 2010 - 30 Jun 2011	# all WTG: 1,340	Ø Availability: 97.33%

¹ 2.5 MW installations globally with Nordex Availability Warranty; total installed base comprises 2,022 WTG as of 31 Dec 2012

2.5 MW US AVAILABILITY

1 Jan 2012 - 31 Dec 2012	# all WTG²: 225	Ø Availability: 98.56%
1 Jul 2011 - 30 Jun 2012	# all WTG: 178	Ø Availability: 98.44%
1 Jan 2011 - 31 Dec 2011	# all WTG: 113	Ø Availability: 97.75%
1 Jul 2010 - 30 Jun 2011	# all WTG: 33	Ø Availability: 97.03%
1 Jan 2010 - 31 Dec 2010	# all WTG: 25	Ø Availability: 97.09%

² total installed base in the United States comprises 270 WTG as of 31 Dec 2012

THANK YOU !

Nate Kipnis, Citizens' Greener Evanston

Evanston, Energy and the Environment

The Answer is Blowing in the Wind

September 24, 2013



How much power is in wind?

$$\text{Power} = \frac{1}{2} d \times A \times v^3$$

d = air density

A = swept area

v = wind speed

For standard turbines;

$A = \pi r^2$, so

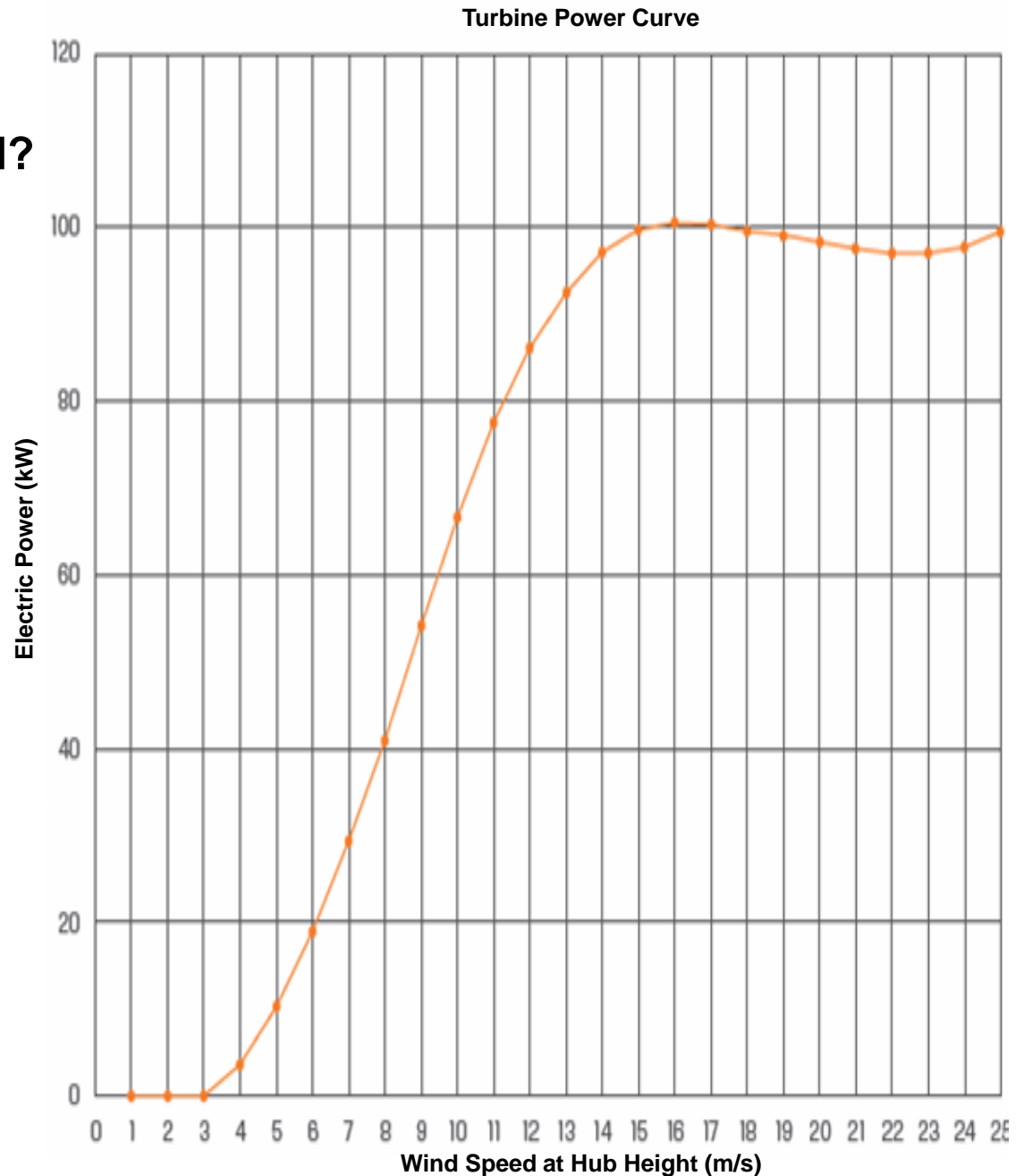
$$\text{Power} = \frac{1}{2} d \times \pi r^2 \times v^3$$

2x blade radius = 4x power

2x wind speed = 8x power!!

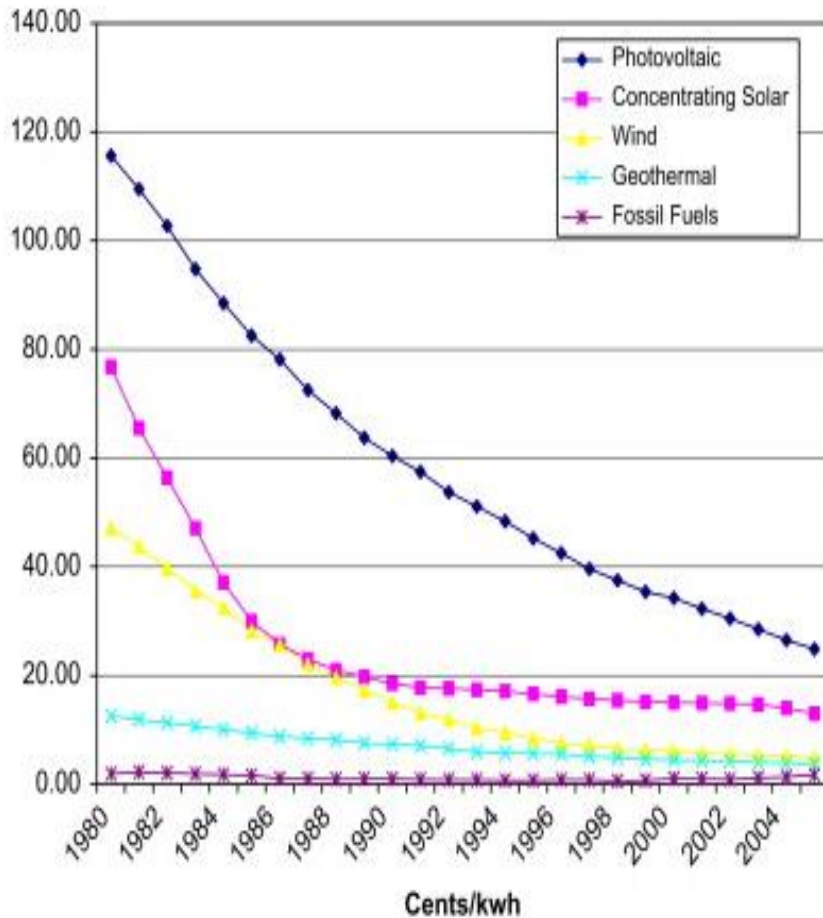


Wind Power Physics



Levelized Cost of Energy (LCOE)

LCOE is the initial capital, discount rate plus the costs of continuous operation, fuel and maintenance



Source:
US Dept. Energy Information Administration

Plant Type	LCOE (\$/MWh)
Natural Gas CC	\$66
Conventional Coal	\$94
Advanced Nuclear	\$114
Terrestrial Wind	\$97
Solar Photovoltaic	\$210
Offshore Wind	\$243
<i>Offshore Wind 2020*</i>	<i>\$100</i>
<i>Offshore Wind 2030*</i>	<i>\$70</i>

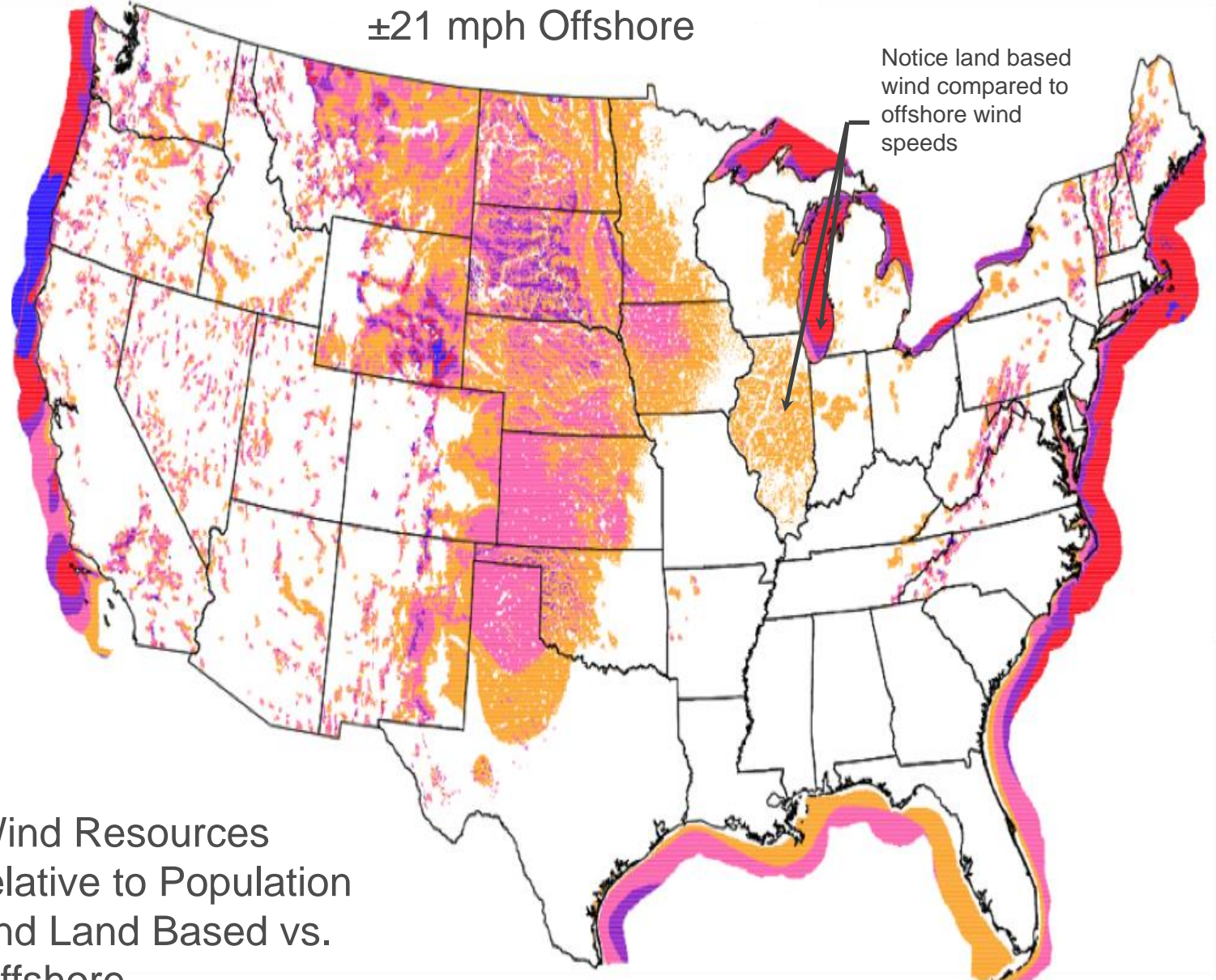
Source:
Energy Information Administration, Annual Energy Outlook
2011

*From National Offshore Wind Strategy, US DOE/DOJ
2011



Historic Costs/kWh of Renewable Energy

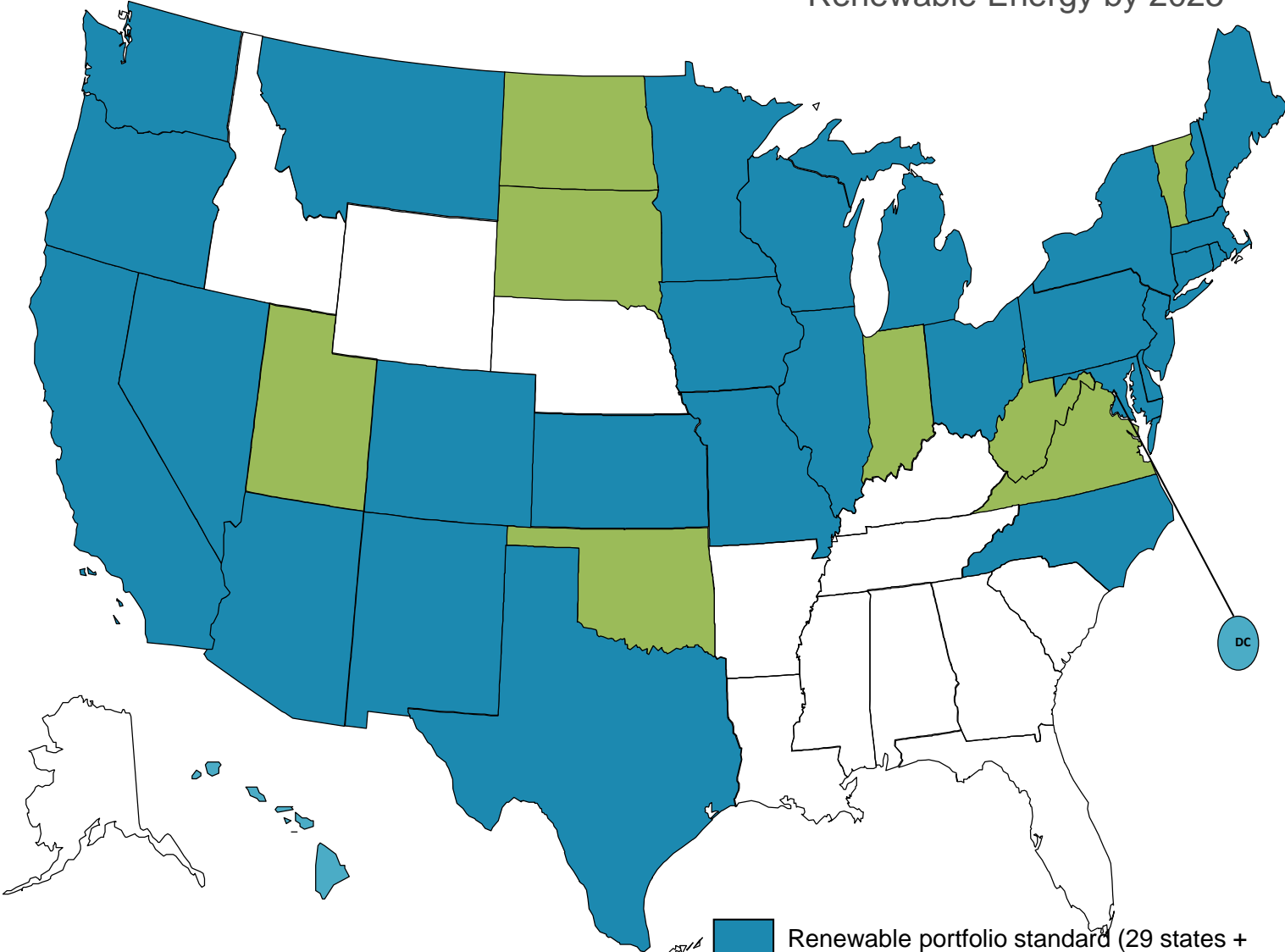
±15 mph or Less Land Based
±21 mph Offshore





Wind Resources
relative to Population
and Land Based vs.
Offshore



Illinois' RPS is 25%
Renewable Energy by 2025



Renewable Portfolio Standards (RPS)

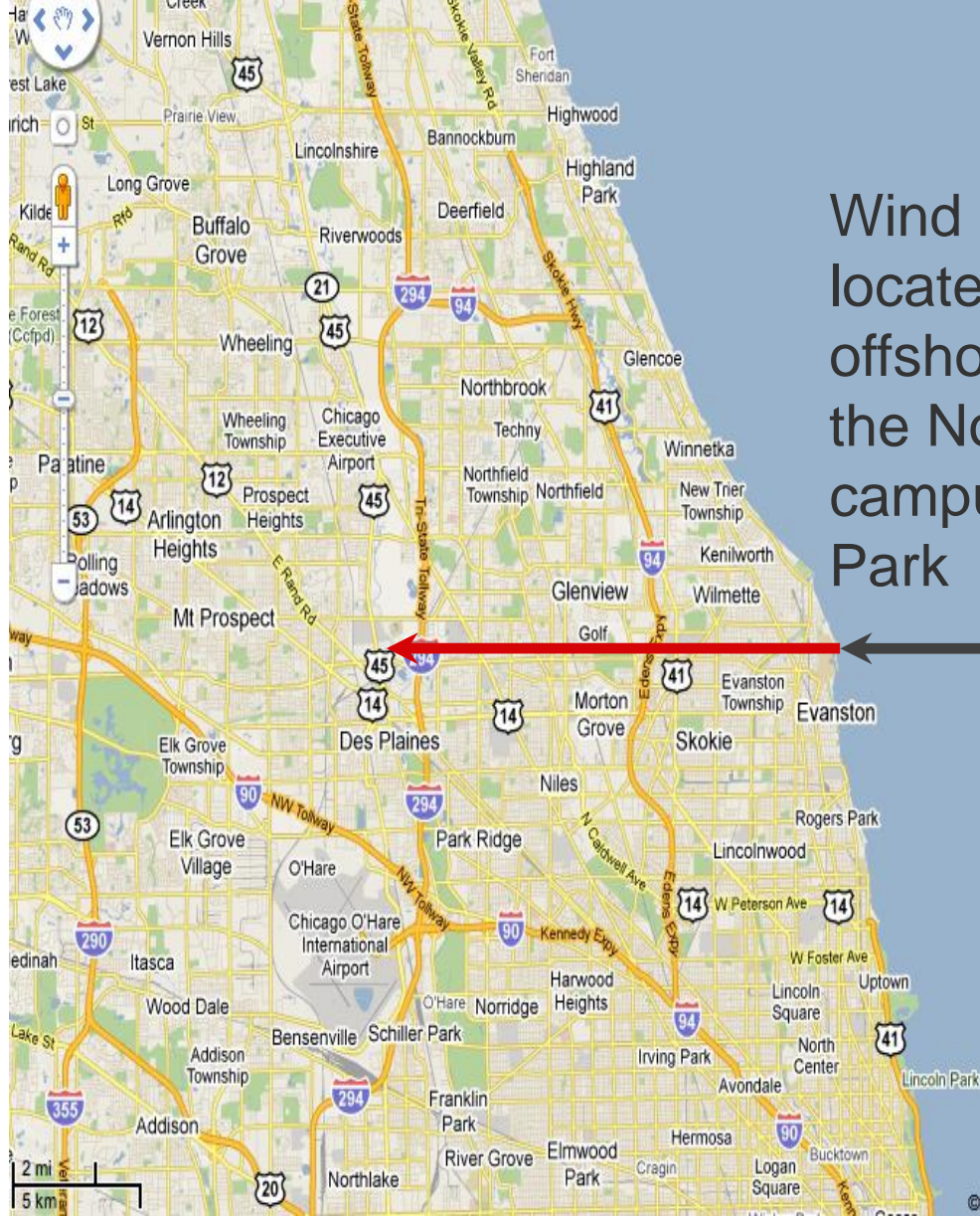
-  Renewable portfolio standard (29 states + DC)
-  Renewable portfolio goal (8 states)



- (40) 5MW Wind Turbines
- Enough power for approx. 59,000 households (based on 18 mph wind) - Evanston has 30,000 households
- CO2 abatement per 40 turbine array = 490,700 MTCO2E
- Would meet multiples of the CO2 abatement goal of the Evanston Climate Action Plan ($\pm 336\%$)



Wind Park Overview



Wind Park could be located 7 miles offshore, in line with the Northwestern campus and Dawes Park

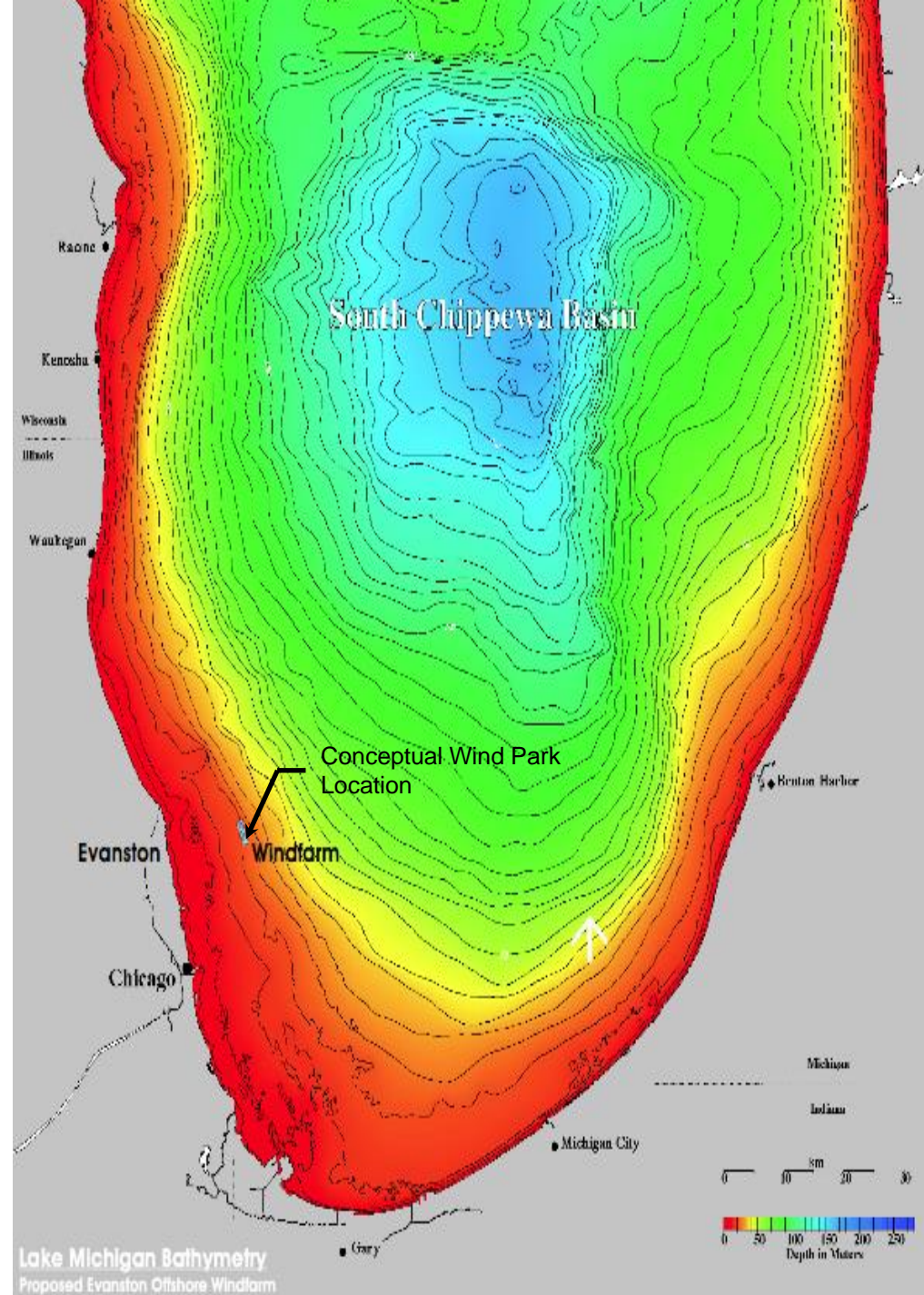
7 Miles



Conceptual Wind Park Location

At 7 miles out, Lake Michigan's water depth is approx. 70' and about 90' deep at 9 miles out.

Foundations are typically cost effective to 30m (98') water depth



Lake Michigan Depth Chart



±View from Shore

CAD
simulation



MAYOR'S WIND FARM COMMITTEE

Report to the City Council
June 20, 2011

Lake Michigan Offshore Wind Energy Report



Prepared by the Illinois Department of Natural Resources

June 2012

House Bill 2753

Lake Michigan Wind Energy Act

- Groundwork: map the lake for siting; regulatory toolkit; study offtake; enabling legislation
- Bid process: for site assessment rights
- Application: to convert bid rights into license for construction, maintenance and operation, and decommission



Local and State Governmental
Committees/Legislation

Mid-Lake Testing - June 2012

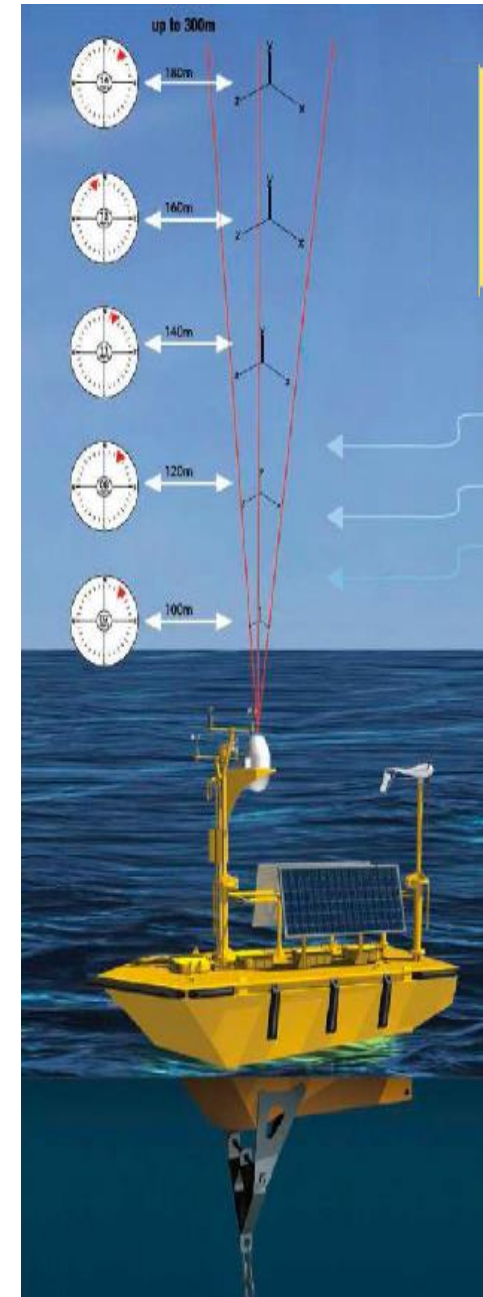
Sensor No.	Height (m)	Average speed (mph (m/s))	Average direction (degree)	Total time of data (hours)	Capture of available data (%)	Average power generated for reporting period (MW)	Average energy generated per day (MWh)
1	75 (246)	21.62(9.66)	234.77	708.67	98.5%	0.474	11.376
2	90	22.2(9.92)	232.05	712	99.1%	0.492	11.808
3	105	22.32(9.98)	230.17	711.5	98.9%	0.489	11.736
4	125 (410)	22.08(9.87)	228.19	691.17	96.1%	0.472	11.328
5	150	25.08(11.21)	228.19	432.83	60.2%	0.562	13.488
6	175	25.29(11.3)	227.51	200.5	27.9%	0.634	15.216

Source: Grand Valley State University (2012)

Buoy recorded 22 mph average wind speed in the middle of the Lake this past year



Wind Testing



The Process:

If started now, complete ± 2020 at *the earliest*

- Advisory Council
- GIS Mapping (now)
- Wind Study (now)
- Further Advisory (economics, offtake)
- Legislation (2013)
- Bidding
- Assessment
- Application
- Permitting
- Construction and Operation
- Operational Phase (20+ years)



Process Moving Forward

Why Offshore Wind?

- Greater wind speed = lower levelized cost
- Closer to demand centers
- Avoidance of some viewshed issues
- Fewer competing uses
- Larger turbines possible offshore
- Economic development



Why Offshore Wind?

Wind Energy from the Windy City

Questions?

Wind Energy from the Windy City

Thank You!