THANKS TO OUR EVENT SPONSORS
THE BUILDING EDUCATION SERIES 2019:
THE OSWALD BUILDING, 1100 SUPERIOR
7:30 AM COFFEE AND REGISTRATION
8:00 – 10:00 AM PRESENTATION

JANUARY 17:  INNOVATIONS IN CLEVELAND
FEBRUARY 21: FACILITY MANAGERS ROUNDTABLE
MARCH 21:  SOLAR AND WIND TECHNOLOGY
MAY 16:  WATER: THE HEALTH OF LAKE ERIE AND THE BURNING RIVER ANNIVERSARY
JULY 25:  CLIMATE CHANGE: A CANDID DISCUSSION
SEPTEMBER 19:  DEMYSTIFYING BUILDING CERTIFICATIONS
NOVEMBER 21: ENVIRONMENTAL HEALTH AND IMPACTS ON HUMAN HEALTH
TODAY’S SPEAKERS:

Eric Pempus - Risk Manager, DesignPro Insurance Group / Kent State University College of Architecture & Environmental Design

Don Scipione - President, Acme Express, Inc.

Lorry Wagner - President, LEEDCo

Patrick O'Connor - Team Member, Cleveland Power of Wind Action Team

Tom Schock - Team Leader, Cleveland Power of Wind Action Team
Eric O. Pempus, FAIA, Esq. is a risk manager for the last 14 years in professional liability for architects and engineers. He has 40 years of combined experience in the design professions, land use and construction law, and an adjunct professor teaching graduate school courses for the last 31 years at Kent Stat University’s College of Architecture & Environmental Design. His courses include “Leadership, Ethics & Office Management” and “Contract & Planning Law.” Eric is a Fellow of the American Institute of Architects, a member of the AIA National Ethics Council, and a Leadership Group member of the AIA’s Construction Contract Administration Knowledge Community. He has presented numerous risk management and loss prevention programs to design professionals across the United States and Canada. He is chair of his city’s Board of Zoning & Building Appeals, and is a licensed architect, attorney, and property & casualty insurance agent.
Solar Access Rights/Cast No Shadow on my Solar Collector

Course Number: FR116
Friday, May 20, 2016 7:00 – 8:00 am EDT
Learning Units: 1.0 LU/HSW/GBCI/RIBA
Understanding Your Environmental Ethics & Environmentally Responsible Design

Course Number: FR105
Day, Date, and Time: Friday, April 28, 2017, 7:00-8:00 am
Learning Units: 1.0 HSW

“The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction.”
– Rachel Carson, 1954
Modified 2016 AIA Agenda for Today

• **We need energy, so what’s the problem?**
• History of shading
  - rights to natural resources
  - codes & regulations
• Case studies
• Site analysis & selection
• Policy making for solar access rights
We need energy, ...
The Problem Is …

• Most sun rays reach land at an angle
• Very little from directly above
• Most come across adjacent properties

- *rarely do I have rights of access*
Eden Roc v. Fontainebleau Hotel

- 2 Miami Beach luxury hotels
- **Shadow** 2 pm - end of day (cabana, pool, sunbathing areas)
- Fontainebleau’s addition
- Injunction “stop work”?  
- Malicious & spiteful?
- If you like the view (access) - buy it

[Image: https://zh.wikipedia.org/wiki/File:Kerry_Hotel_Hong_Kong_Level_4_swimming_pool_2017.jpg]

[Image: https://es.m.wikipedia.org/wiki/Archivo:Location_map_Miami.png]
“No legal right to the free flow of light and air from adjoining land”

• Florida Supreme Court ruled in favor of Fontainebleau (1959)

• Addition faced Eden Roc with a vast blank facade

• Only one set of windows, incorporated into owner's suite
  - so he could look at the shaded pool below
Native American Vernacular Architecture


Mesa Verde NP, Cliff Palace

AIA New England COTE

E.S. 2.4 Environmental Equity and Justice Members should promote fairness and safety in providing professional services and make reasonable efforts to advise their clients and employers of their obligations to the environment, including: access to clean air, water, sunlight and energy for all; sustainable production, extraction, transportation and consumption practices; a built environment that equitably supports human health and well-being and is resistant to climate change; and restoring degraded or depleted natural resources.
American Law takes much the from the U.K.

• But not all
  - example of borrowed law - MYLEGs …

• *Parker v. Foot, N.Y., 19 Wend., 309* (1838) *6 years* after the British Act of 1832

• The British view “may do well in England, but it cannot be applied in the *growing cities of this country* without working most *mischievous consequences*.”
Perscription Act of 1832

Whereas the expression “time immemorial, or time whereof the memory of man runneth not to the contrary,” is now by the Law of England in many cases considered to include and denote the whole period of time from the Reign of King Richard the First, whereby the title to matters that have been long enjoyed (20 years) is sometimes defeated by shewing (by showing of) the commencement of such enjoyment, which is in many cases productive of inconvenience and injustice; …

www.legislation.gov.uk
Nisshoken – Japan’s Sunshine Rights

• Onetime compensations for interference with light
  - $420 to $1260 for each hour of sunlight lost
  (National Geographic “Tokyo: Profile of Success,” 1986)

• Increased if children effected
  - but not always enforced
Rights in Others’ Land: Adverse Possession, Eminent Domain, Easements & Covenants

- Occupation of other’s land with intention of possessing it as one's own
- State laws vary widely on length of time
- **Eminent domain** is a close cousin to taking rights away *(the 5th)*
Riparian Rights

- Upstream land owner - *can only use a “reasonable” amount*
- Downstream has some “reasonable” left-over rights
- Right to water in UK, Canada, Australia
  - in the U.S. (e.g. Indiana, Illinois, Wisconsin)
- Hmm - do you have a right even when selling the water?
Living Building Challenge 3.0

• LBC - built environment's a **rigorous performance standard**

• To be certified:
  
  - *projects must meet a series of ambitious performance requirements* …

• **7 Petals** - Place, Water, Energy, Health & Happiness, Materials, **Equity**, Beauty

AIA Convention 2016
May 19-21, Philadelphia
Equity Pedal

- Current 3.1 (#16) Universal Access to Nature & Place
- Sunlight may not be blocked above a maximum height on adjacent façade measured on Winter Solstice between 10 am – 2 pm
LBC Case Study

IDeAs $Z^2$ Design Facility
San Jose (LBC 3.0 certified)

• Does not block adjacent properties’ access (setbacks)
Urban Growth Boundaries
http://www.oregonmetro.gov/urban-growth-boundary

• To preserve green spaces, UGB
  - creates more density
  - Oregon law

• In urban areas
  - greater need for solar access rights

https://www.flickr.com/photos/la-citta-vita/6045594699
Corvallis #1 - Solar Access Permit

• **Solar Access Protection**
  - right to unobstructed access
  - 4 hours between 9am - 3pm

• **Solar Envelope for Permit Holder**
  - 3-D space over a neighboring site
  - providing solar access protection
Corvallis #2 - Residential

- Lots with east/west orientation
- North/south- **bad**
- Sufficient dimensions for south solar access devices
San Francisco – Solar Access Rights

- Only Recreation & Parks properties
- New Construction over 40’
- “Shadow Fan” diagram

http://syedshuttari.com/21habits/
Other Legislation

- **Colorado** Solar Easement Act, Ch. 326 §2, 1975, Session Law 1430:
  “The general assembly hereby finds … this act is necessary for the immediate preservation of the public peace, health and safety.”

- **Kansas** Ch. 58-3801, creation of solar easements

- **Maryland** Real Property Code, H.B. 117, April, 2008

- **New Mexico**, Art. 3, Sec. 47-3, Solar Rights
Federal Solar Opportunity & Local Access Rights Act (SOLAR)

• H.R. 1598 (112th), April 15, 2011
• Died in a previous Congress, not enacted
• Sponsor: Rep. Dennis Cardoza, CA's 18th congressional district

https://commons.wikimedia.org/wiki/File:Rep_Dennis_Cardoza.jpg
Whose Bright Idea Was This?
LA Times, Feb. 21, 2205

• The opposite side of the coin - unwanted light

• Walt Disney Concert Hall reflects light on condos across the street
  “… exuberant curves and shimmering stainless steel”

Architect: Frank Gehry

https://www.flickr.com/photos/thadz/35183685161
Analogous to Solar, Views & Water

- Blocking a wind generator or windfarm
- Who was there first?
- Nuisance law?

https://pxhere.com/en/photo/1042091

Property line

Wind

PHILAIADELPHIA!

AIA Convention 2016
May 19-21, Philadelphia
Sausalito & Tiburon, CA

- “Story Poles” and the right to view
- Analogous to solar access

https://www.buymarco.com/marco-island-beach-homes.php
§ 3.2.5.1 The Architect shall consider **sustainable design alternatives**, such as material choices and **building orientation**, together with other considerations based on program and aesthetics, in developing a design …
www.solaraccessresearch.org

• Now under reconstruction
• Research on solar energy access
• Assemble and disseminate scholarly, educational and practical information, providing a central updated source
• Better design solutions to access solar energy in natural/built environments
RFIs?/Contact Information

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DesignPro Insurance Group
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Office (330) 920-7653

Kent State University College of Architecture & Environmental Design
epempus@kent.edu
Cell (440) 823-5927
Dr. Scipione is a scientist, businessman, and entrepreneur. He is a native Clevelander (St. Ann's and Cathedral Latin) who returned home after college at Carnegie Institute of Technology and graduate school at University of California San Diego, where he was a researcher at General Atomic Division of General Dynamics, Lawrence Berkeley Laboratory, and Brookhaven National Laboratory.

Don was awarded innovation research grants from the Ohio Third Frontier, U.S. Department of Education, National Institutes of Health, and U.S. Department of Energy. He served on the boards of MidTown Cleveland, Cleveland-Cuyahoga County Workforce Investment Board, Lyric Opera Cleveland, Opera Cleveland, Cleveland Opera Theater, Cleveland World Trade Association, World Trade Center Cleveland, and Northeast Ohio Software Association.

In 1980, he started Acme Express, Inc., a technology company that developed software applications for transportation, medical staff scheduling, accounting, customer relationship management, and early (K-3) math education. Over the last ten years, Don’s interests have centered on building a sustainable opera company and environmental issues focused on wind, solar, and CO2 capture.
Reducing the cost of Photo Voltaic Energy


Research funded by the U. S. Department of Energy, Small Business Innovation Research Grant 18SC501917
MidTown Cleveland
Self Financed

Better Together Solar

Host

IRS

FirstEnergy

$100,000

$60,000

$369,000

6¢

12¢

$9,800

SREC
• **2016 – 2019:** The tax credit remains at **30 percent** of the cost of the system. This means that in 2017, you can still get a major discounted [price for your solar panel system](#).

• **2020:** Owners of new residential and commercial solar can deduct **26 percent** of the cost of the system from their taxes.

• **2021:** Owners of new residential and commercial solar can deduct **22 percent** of the cost of the system from their taxes.

• **2022 onwards:** Owners of new commercial solar energy systems can deduct **10 percent** of the cost of the system from their taxes. There is no federal credit for residential solar energy systems.
Figure 9: Quality ratings by different regions of manufacturing (audits conducted from mid-2016 to mid-2018).
Annual Global PV Demand

- While most analysts estimate a decrease in global PV installations in 2018, projections range from 75 GW to 102 GW.
  - The expected drop in Chinese installations in 2018 is projected to be larger than the total drop in annual global installations, offsetting significant increases in demand from ROW countries.

- Analysts expect China, with 25%-40% of the total global market, to remain the largest PV market through 2022.

- Median analysts’ figures estimate that 530 GW of PV will be installed globally from 2018 to 2022, more than doubling current installed capacity.

Note: P = projection. Bar represents median projection. Error bars represent high and low projections.
Sources: BNEF (August 2018); Cowen & Co. (09/26/18); Credit Suisse (08/20/18); Goldman Sachs (09/18/18); Wood Mackenzie Power and Renewables (October 2018).
SunShot Progress and Goals

*Levelized cost of energy (LCOE) progress and targets are calculated based on average U.S. climate and without the ITC or state/local incentives. The residential and commercial goals have been adjusted for inflation from 2010-17.
Figure 1 shows the profile (end-on view) of the rack. Solar modules are supported by edges A and B. The rack provides a complete wind shield (C, in Figure 1) that reduces the uplift force, and consequently the ballast weight needed to secure the array, provides a “ballast tray” (D, in Figure 1). Figure 2 shows the end view of a series of rows of the solar panel array.

Figure 1. Rack Profile

Figure 2. End view of a row of solar modules (colored red) and racks (colored black). The left edge of the rack (A, in Figure 1) supports the low end of the row of modules to the left. The right edge of the rack (B, in Figure 1) supports the high end of the row of modules to the right.
The rack will be produced using the well-established manufacturing process of roll forming, which is extensively used in the gutter business for onsite custom length gutters, an example of which is shown in Figure 4.

**Figure 4. Gutter roll forming machine**

The proposed innovation envisions that the gutter roll forming production and installation process can automate solar panel rack manufacturing and installation for the flat roof commercial market. The Phase I technical approach will be to build a prototype of such a racking system, verify its wind aerodynamics, and confirm its expected 9% reduction of LCOE.

https://www.facebook.com/watch/?v=155000032111154
Load #1: Down

Load #2: Lift
Figure 9: Von Mises Stress Results – *Load #2 - Lift*

* Under 25 lbf/ft² lift load, the mounting frame has peak stress above the material yield strength (safety factor of .89 from yield).
<table>
<thead>
<tr>
<th>BOS cost item</th>
<th>Current cost ($/W)</th>
<th>Costs with Innovation ($/W)</th>
<th>Innovation Savings ($/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>.15</td>
<td>.08</td>
<td>.07</td>
</tr>
<tr>
<td>Install labor</td>
<td>.17</td>
<td>.11</td>
<td>.06</td>
</tr>
<tr>
<td>EPC Overhead (Engineering, Procurement, and Construction)</td>
<td>.19</td>
<td>.15</td>
<td>.04</td>
</tr>
<tr>
<td>Total</td>
<td>.51</td>
<td>.34</td>
<td>.17</td>
</tr>
</tbody>
</table>

Table 1. Automated racking system estimated savings of $.17/W, a 9% savings in LCOE and 30% of the savings required to meet the SunShot 2020 goal of $1.30/W.
CO2 emissions vs Atmospheric CO2 Levels

Atmospheric CO2 levels
(Total Amount of CO2 in the atmosphere)

- CO2 Levels from Mauna Loa, Hawaii
- CO2 Levels from Law Dome ice core

Total CO2 Emissions
(Total amount of CO2 emitted by humans)

- Cumulative CO2 emissions

Year

1000 1200 1400 1600 1800 2000

CO2 Level (gigatonnes)
Scientific agreement on human-caused global warming

Scientific Consensus (%)

Low Expertise in climate science High

0 10 20 30 40 50 60 70 80 90 100
Change in Earth’s Total Heat Content

- **Ocean Heating**
- **Land + Atmosphere + Ice Heating**

Change in Total Heat Content since 1961 (10^3 Joules)

Dr. Lorry Wagner has served as president of the Cleveland-based Lake Erie Energy Development Corporation (LEEDCo) since May of 2010. Previous energy project experience includes nuclear, hydroelectric, solar, as well as wind. He received his degrees from Purdue University where he developed several new heat transfer technologies for fusion reactors. Off the clock, he was team engineer for KR Offshore Powerboat Racing (1992 World Champion) and coached swimming at various Division I universities, high schools, and clubs.

Dr. Wagner has developed innovative solutions to industrial sensing challenges as well as building land-based wind projects in the U.S. He previously served as CEO of several startups as well Director of Research for Global Asset Management. As a lifelong boater and member of Cleveland Underwater Explorers (CLUE), he brings extensive knowledge of the maritime environment, central to the deployment of offshore wind turbines.

Dr. Wagner was awarded the Purdue Distinguished Engineering Alumnus award, was appointed by Governor Strickland as the Public Member of the Ohio Power Siting Board, and has served as Chair of the School of Nuclear Engineering Advisory Committee.
The Technology of Offshore Wind

Cleveland 2030 District
Lorry Wagner, PhD.
March 21, 2019
A Non-Profit, Public Private Partnership

Created to Build
the First
Great Lakes
Offshore Wind Project

Lake Erie Energy Development Corporation
Putting Cleveland on the Map Again!

1st
Freshwater Offshore Wind Project in North America

2nd
Offshore Wind Project in North America

1 of 2
U.S. DOE Demonstration Projects
**Progress & Status**

**LEEDCo secured a partnership with Fred. Olsen Renewables**
(A leader in the European Offshore Wind Industry) as the developer and equity investor in the project.

Together they have already secured the following:

- **$50 Million DOE Funding**
- **Ohio Submerged lands lease**
- **Environmental Assessment** Finding of No Significant Impact
- All Federal Permits Received; Ohio Power Siting Board only one left
- Manufacturing in 2021
- First freshwater offshore wind power 2022
# Project Icebreaker

The first fresh water windfarm in North America and the first step in creating a new industry in Ohio

<table>
<thead>
<tr>
<th>Resource</th>
<th>IEC Class II wind regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>20.7 MW total&lt;br&gt;6 x V126 3.45 MW turbines</td>
</tr>
<tr>
<td>Water Depth</td>
<td>18 m</td>
</tr>
<tr>
<td>Location</td>
<td>13 km off the coast of Cleveland, Ohio in Lake Erie</td>
</tr>
<tr>
<td>Installation Port</td>
<td>Port of Cleveland&lt;br&gt;- 20 minutes travel time for CTV&lt;br&gt;- 1 hour for installation vessels</td>
</tr>
<tr>
<td>Operations Port</td>
<td>Great Lakes Towing&lt;br&gt;- 30 minutes travel time for CTV</td>
</tr>
<tr>
<td>Grid Connection</td>
<td>PJM Interconnection Grid&lt;br&gt;- Approved</td>
</tr>
<tr>
<td>Interconnect Point</td>
<td>Cleveland Public Power&lt;br&gt;Lake Road Substation</td>
</tr>
<tr>
<td>Consent</td>
<td>On track to obtain all permits&lt;br&gt;Submerged lands lease secured</td>
</tr>
</tbody>
</table>
Why Offshore Wind vs Onshore?

- Higher capacity factors
- Lower seasonality effects
- Close to load centers
- Largest turbines possible, 10 MW translates to lower power prices
- Good fit in densely populated areas or with land constraints

- Limited visual impact
- Lack of noise constraints
- Price is dropping fast

Source: Bloomberg, Goldman Sachs Global Investment Research.
The U.S. is Now a $50 Billion Industry

### US Offshore Wind Project Timeline

<table>
<thead>
<tr>
<th>MW</th>
<th>Pre-Bid Planning</th>
<th>Site Control</th>
<th>Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Block Island, RI, Deepwater Wind</td>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>800</td>
<td>Vineyard Wind, MA, CIP / Avangrid</td>
<td></td>
<td>400 MW 2021, 400 MW 2022</td>
</tr>
<tr>
<td>-</td>
<td>Bay Wind, MA, Ørsted</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>Equinor</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>Mayflower Energy, Shell &amp; EDP</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>Vineyard Wind</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>600</td>
<td>Revolution Wind, MA, Deepwater Wind</td>
<td></td>
<td>2023</td>
</tr>
<tr>
<td>100</td>
<td>South Fork, RI, Deepwater Wind</td>
<td></td>
<td>2022</td>
</tr>
<tr>
<td>800</td>
<td>Empire Wind, NY, Equinor</td>
<td></td>
<td>~2023</td>
</tr>
<tr>
<td>-</td>
<td>New Jersey Project, NJ, Shell &amp; EDF</td>
<td></td>
<td>2023</td>
</tr>
<tr>
<td>-</td>
<td>Ocean Wind, NJ, Ørsted</td>
<td></td>
<td>~2024</td>
</tr>
<tr>
<td>-</td>
<td>Garden State, DE, Ørsted</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>120</td>
<td>Skipjack, DE, Ørsted</td>
<td></td>
<td>2022</td>
</tr>
<tr>
<td>246</td>
<td>Maryland Project, MD, US Wind</td>
<td></td>
<td>2021</td>
</tr>
<tr>
<td>12</td>
<td>Research Lease, VA, DMME/DOH</td>
<td></td>
<td>~2020</td>
</tr>
<tr>
<td>-</td>
<td>Commercial Lease, VA, Dominion</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>North Carolina Project, NC, Avangrid</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>
A Leadership Opportunity for Ohio

1. Offshore Wind is a proven job creator
2. The Great Lakes has the resource
3. The Midwest is “Industrial U.S.A.”
4. Ohio needs the benefits
5. OSW is now here in the U.S.
6. Price Competitive on East Coast
7. Projects in China, Japan, Taiwan, Korea, India, Turkey, Russia, Poland…
8. The Atlantic States are “All In”
9. Clean and renewable
10. Uses no water for cooling
11. Coincident peak matches load
12. We have the grid
Wind Turbine Size Progression

Offshore wind turbines
growing by leaps and bounds

Vindeby
Year: 1991
Diameter: 35m
Height: 55m
Capacity: 0.45Mw

Middelgrunden
Year: 2001
Diameter: 76m
Height: 64m
Capacity: 2.00Mw

Nysted
Year: 2003
Diameter: 82m
Height: 69m
Capacity: 2.30Mw

Horns Rev 2
Year: 2010
Diameter: 93m
Height: 68m
Capacity: 2.30Mw

Anholt
Year: 2013
Diameter: 120m
Height: 82m
Capacity: 3.60Mw

Westermost Rough
Year: 2015
Diameter: 154m
Height: 102m
Capacity: 6.00Mw

Burbo Bank Extension
Year: 2017
Diameter: 164m
Height: 113m
Capacity: 8.00Mw

Boeing 747-8
Length: 76m
Next Step is 12 MW

HALIADE-X 12 MW

GE Renewable Energy is developing HALIADE-X 12 MW, the biggest offshore wind turbine in the world, with a 220-meter rotor, 107-meter blade, leading capacity factor (63%), and digital capabilities, that will help our customers find success in an increasingly competitive environment.

One HALIADE-X 12 MW can generate 67 GWh annually, which is 45% more annual energy production (AEP) than most powerful machines on the market today, and twice as much as the HALIADE 150-6MW.

The HALIADE-X 12 MW turbine will generate enough clean power for up to 16,000 European households per turbine, and up to 1 million European households in a 750 MW configuration windfarm.

<table>
<thead>
<tr>
<th>12 MW capacity</th>
<th>220 meter rotor</th>
<th>107-meter long blades</th>
<th>260 meters high</th>
<th>67 GWh gross AEP</th>
<th>63% capacity factor</th>
<th>38,000 m² swept area</th>
<th>Wind Class IEC: IB</th>
</tr>
</thead>
</table>

Flat Iron Building: 285 ft 87 m  
Statue of Liberty: 305 ft 93 m  
Washington Monument: 555 ft 169 m  
Chrysler Building: 1046 ft 319 m  
Empire State Building: 1454 ft 443 m  
Hallade-X 12 MW: 883 ft 260 m  
Eiffel Tower: 1061 ft 324 m  
London Eye: 443 ft 135 m  
Big Ben: 315 ft 96 m  
Tower of Pisa: 186 ft 57 m  
Arc de Triomphe: 162 ft 49.5 m
A Foundation for Every Soil or Not

Floating wind turbine concepts

Monopile  Tri-pod  Jacket  Suction caisson  Gravity base

Ballast stabilised “sparbuoy” with catenary mooring drag embedded anchors
Mooring line stabilised tension leg platform with suction pile anchors
Buoyancy stabilised “barge” with catenary mooring lines

I Don’t Need A Hammer – Mono Bucket

Dogger Bank Offshore Wind Site
Meteorological Masts Turnkey Installation

Universal Foundation
Fred. Olsen Windcarrier
Harland and Wolff
Global Wind Service
SeaRoc
Everyone Always Asks About Ice
## Ice Characteristics – Super Fun

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Recommended Values for 50 year Load Calculation</th>
<th>Typical Extreme Ranges or Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Ice Thickness, 50-year (^1)</td>
<td>0.6m</td>
<td>0 to 0.6m</td>
</tr>
<tr>
<td>Ridge Consolidated layer Thickness ((h_c)) (^2,3)</td>
<td>1.1m</td>
<td>0 to 1.1m</td>
</tr>
<tr>
<td>Ridge keel thickness ((H_k)) (^1)</td>
<td>16m</td>
<td>0 to 22m (limited by water depth)</td>
</tr>
<tr>
<td>Angle of Internal Friction ((\theta_k)) (^2)</td>
<td>35°</td>
<td>20° to 70°</td>
</tr>
<tr>
<td>Ridge keel bottom width ((b_k)) (^1,2)</td>
<td>5m</td>
<td>0 to 100m</td>
</tr>
<tr>
<td>Top width (level Ice)</td>
<td>50m</td>
<td>30 to 200m</td>
</tr>
<tr>
<td>Level ice flexural strength ((\sigma_{lb})) (^2)</td>
<td>500kPa</td>
<td>Up to 700kPa</td>
</tr>
<tr>
<td>Consolidated layer flexural strength (^2)</td>
<td>350kPa</td>
<td>Up to 500kPa</td>
</tr>
<tr>
<td>Keel rubble: Initial cohesion ((c)) with (\phi = 0) (^2)</td>
<td>12kPa top: 6kPa bottom</td>
<td>24kPa at top: 12kPa at bottom</td>
</tr>
<tr>
<td>Keel rubble: Residual friction ((\phi)) with (c=0) (^2)</td>
<td>30°</td>
<td>Up to 40°</td>
</tr>
<tr>
<td>Keel rubble porosity ((\epsilon)) (^2)</td>
<td>0.25</td>
<td>0.15 to 0.35</td>
</tr>
<tr>
<td>Keel rubble effective buoyancy (^2)</td>
<td>0.7kN/m(^3)</td>
<td>0.6 to 0.85kN/m(^3)</td>
</tr>
<tr>
<td>Dynamic friction coefficient (ice-steel) (^4)</td>
<td>0.15</td>
<td>0.1 to 0.3</td>
</tr>
<tr>
<td>Ice crushing strength ((\sigma_c))</td>
<td>Not relevant for global loads</td>
<td>Local ice pressures,(^2)</td>
</tr>
<tr>
<td>Ice speed (^2)</td>
<td>0.5m/s</td>
<td>0 to 0.5m/s (plus background current)</td>
</tr>
</tbody>
</table>
Ice Loads
70% of Wind & Much Less Than 100 ft Waves

Figure 7-5: Summary of ice loads due to “50 year” level ice 0.6m thick [ISO 19906, Ref. 6 - Case 3]

Figure 7-7: Summary of ice loads due to a “50 year” ridge
24 Years of Freshwater Offshore Wind

Lake Ijsselmeer Netherlands

Lake Vanern Sweden

Bay of Bothnia Finland
Tell Your Reps: Ohio Can Be a Leader

![Map of Northeastern States with Ohio highlighted.](#)

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>Developer</th>
<th>STATE</th>
<th>SIZE (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VINEYARD WIND</td>
<td>CIP/Avangrid</td>
<td>MA</td>
<td>800</td>
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<tr>
<td>REVOLUTION WIND</td>
<td>Ørsted</td>
<td>RI/CT</td>
<td>700</td>
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<td>SOUTH FORK</td>
<td>Ørsted</td>
<td>NY</td>
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<td>SKIPJACK</td>
<td>Skipjack</td>
<td>MD/DE</td>
<td>120</td>
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<tr>
<td>US WIND</td>
<td>US Wind</td>
<td>MD</td>
<td>246</td>
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<tr>
<td>COASTAL VA OSW</td>
<td>Dominion</td>
<td>VA</td>
<td>12</td>
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<tr>
<td>ICE BREAKER</td>
<td>LeedCo</td>
<td>OH</td>
<td>30</td>
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</tbody>
</table>

**by 2023**

60% Reduction in energy costs for offshore wind since 2012

6.5¢ kWh Massachusetts offshore wind price

13¢ kWh Maryland offshore wind price
A First Step Toward a Vibrant Future
View from Edgewater Beach

Simulation Information

Photograph Data
Date Taken: August 3, 2016
Time: 1:13 PM
Weather: Sunny and Clear

Camera Information
Camera Make/Model: Nikon D610
Sensor Dimensions: 35 mm
Lens Focal Length: 50.0 mm
Camera Height: 5'

View Location
Orientation: North Northwest
Location: Edgewater Park Beach

Structure Information
Model: Vestas V126 3.45 MW
Hub Height: 83 meters
Rotor Diameter: 126 meters
Overall Turbine Height: 146 meters

Visual Simulation Notes:
1. Visual Simulation is based on 2D data collected at the site near Edgewater Beach, Milwaukee, Wisconsin. It is only an estimate of the original structure and is not guaranteed by EDR.
2. This simulation depicts land use relative to the power plant, and considers the effects of reflection and occlusion of the earth.

Technical Information
Software: AutoCad, 3ds Max, Adobe Photoshop
GCC, Digital Zenith data services, 3D-GIP: digital EDR.
### Activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Revenue pool 2017E – 2030E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine Manufacturing</td>
<td>€129bn (1.9x of total annual revenues for OEMs)</td>
</tr>
<tr>
<td>Foundation</td>
<td>€46bn</td>
</tr>
<tr>
<td>Transmission</td>
<td>€33bn (2.1x annual revenues)</td>
</tr>
<tr>
<td>Array Cables</td>
<td>€5.3bn</td>
</tr>
<tr>
<td>Construction &amp; development</td>
<td>€36bn</td>
</tr>
<tr>
<td><strong>TOTAL (ex China)</strong></td>
<td><strong>€249bn</strong></td>
</tr>
</tbody>
</table>

### Currently in the European market:

- **20,000+ MW** installed capacity
- **30,000 MW** projects in the pipeline

Source: Goldman Sachs Global Investment Research, Wind Europe.
Federal & State Approvals Required

- U.S. Department of the Interior
- Bureau of Ocean Energy Management
- Bureau of Safety & Environmental Enforcement
- U.S. Fish and Wildlife Service
- The Federal Aviation Administration
- U.S. Department of Defense
- U.S. Army Corps of Engineers
- U.S. Department of Homeland Security
- U.S. Department of Energy
- U.S. Coast Guard
- National Oceanic & Atmospheric Administration
- Occupational Safety & Health Administration
- Grid Operator (PJM, NYISO, etc.)
- Coastal Zone Management
- Natural Resources & Environment
- Public Utilities Commission
- Environmental Protection Agency
- Department of Transportation
- Division of Watercraft
- State Historic Preservation Office
- Division of Wildlife
- Department of Health
- Soil and Water Resources
- Geological Office

Federal & State Agencies
# Federal & State Permitting Success

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>AGENCY</th>
<th>SUBMIT</th>
<th>OBTAIN</th>
<th>STATUS</th>
<th>NOTES</th>
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</thead>
<tbody>
<tr>
<td>1 Submerged Lands Lease</td>
<td>ODNR</td>
<td>3-Sep-2013</td>
<td>1-Feb-2014</td>
<td>Lease Obtained</td>
<td>Approved</td>
</tr>
<tr>
<td>3 Finding of No Significant Impact (FONSI) [NEPA Environmental Assessment- EA]</td>
<td>DOE, USACE, USCG</td>
<td>18-Aug-2017</td>
<td>2-Oct-2018</td>
<td>Permit Obtained</td>
<td>Approved; Final EA Issued with FONSI</td>
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<tr>
<td>5 Water Quality Certification Section 401</td>
<td>OEPA</td>
<td>17-Oct-2017</td>
<td>26-Jul-2018</td>
<td>Permit Obtained</td>
<td>Approved</td>
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<tr>
<td>6 Federal Navigation Project Section 408</td>
<td>USACE</td>
<td>1-Feb-2017</td>
<td>8-Sep-2017</td>
<td>Permit Obtained</td>
<td>Approved</td>
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<tr>
<td>7 Permit for Private Aid to Navigation Form 2554</td>
<td>USCG</td>
<td>1-Mar-2019</td>
<td>30-Jun-2019</td>
<td>Permit Obtained</td>
<td>Routinely approved; will follow OPSB</td>
</tr>
<tr>
<td>8 Determination of No Hazard to Air Navigation</td>
<td>FAA</td>
<td>22-Jul-2016</td>
<td>22-Feb-2017</td>
<td>Permit Obtained</td>
<td>Approved</td>
</tr>
<tr>
<td>9 Letter of Concurrence that Project does not Impact Water Levels and Ice Flows</td>
<td>US State Department</td>
<td>9-Dec-2016</td>
<td>30-Jun-2017</td>
<td>Permit Obtained</td>
<td>Approved</td>
</tr>
<tr>
<td>10 In-Water Work Restriction Waiver for work in Lake Erie between April 15 and June 30</td>
<td>ODNR</td>
<td>1-Jun-2019</td>
<td>31-Aug-2019</td>
<td>Permit Obtained</td>
<td>To be submitted after OPSB approval</td>
</tr>
</tbody>
</table>
Overwhelming Public Support

“I pledge to buy a portion of my electricity from the Great Lakes’ first offshore wind project. I want this premium source of electricity and would be willing to pay an additional $________ per month.”

7,931 Pledges Collected  92% Support the Project

$12.72 Average Pledge  60% Signed the Pledge
Port Activity
Tom Schock, now retired, was President of Schock Development Consulting, focusing on commercial real estate development. The company provided financial consulting and project management for non-profit and for-profit businesses. With over 30 years of experience in all phases of real estate development, Schock Development offers an in-depth knowledge of the various tools and funding sources available to make a project a financial success. The company twice received the Cleveland Restoration Society / AIA Preservation Award as part of a team working on the ASM World Headquarters and the GAR Foundation offices.

Patrick O’Connor is originally from Le Roy, NY, a small village between Buffalo and Rochester. He came to Cleveland to attend John Carroll University. After a 40-year career in sales, he retired and took up advocacy for wind development in Ohio.
Large-scale Renewables Have Emerged as Lowest Cost Supply

Unsubsidized wind and solar power is cheaper than electricity from natural gas

US Unsubsidized Levelized Cost of Energy (Figures by Lazard)

| Natural gas plant |

**Significant cost declines (LCOE 2009-2016):**
- Wind: -66%
- PV: -85%

| Fuel Type: Wind, Utility-Scale Solar PV, Gas Combined Cycle, Coal, Natural Gas Reciprocating Engine, Biomass, Community Solar PV, Geothermal, IGCC, Nuclear, Gas Peaking | $/MWh |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| Wind | | | | | | | | | | |
| Utility-Scale Solar PV | | | | | | | | | | |
| Gas Combined Cycle | | | | | | | | | | |
| Coal | | | | | | | | | | |
| Natural Gas Reciprocating Engine | | | | | | | | | | |
| Biomass | | | | | | | | | | |
| Community Solar PV | | | | | | | | | | |
| Geothermal | | | | | | | | | | |
| IGCC | | | | | | | | | | |
| Nuclear | | | | | | | | | | |
| Gas Peaking | | | | | | | | | | |

Light blue = low estimate. Dark blue = high estimate.
Notes: Project area boundaries are provided by applicants. Case and construction status is determined by the case filings. The nameplate capacity shown is the maximum capacity that could be built based on the number of approved turbines and the highest nameplate capacity of the approved turbine models. Map produced on 2/21/2019. Prepared by: Adam Bargar
<table>
<thead>
<tr>
<th>Case Number</th>
<th>Related Cases</th>
<th>Project Name</th>
<th>Online Date</th>
<th>County</th>
<th>Turbines</th>
<th>MW</th>
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</thead>
<tbody>
<tr>
<td>09-1066-EL-BGN</td>
<td>T1-1099-EL-BGA, T1-3644-EL-BGA</td>
<td>Blue Creek</td>
<td>6/14/12</td>
<td>Paulding, Van Wert</td>
<td>152</td>
<td>304</td>
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<td>09-0980-EL-BGN</td>
<td>T5-2031-EL-BGA</td>
<td>Timber Road I</td>
<td>12/8/16</td>
<td>Paulding</td>
<td>18</td>
<td>37.8</td>
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<td>10-0369-EL-BGN</td>
<td>T0-3726-EL-BGA</td>
<td>Timber Road II</td>
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<td>10-0369-EL-BGN</td>
<td>T5-2030-EL-BGA</td>
<td>Timber Road III</td>
<td>12/8/16</td>
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<td>09-0277-EL-BGN</td>
<td>T1-0757-EL-BGA, T1-5542-EL-BGA</td>
<td>Hog Creek I</td>
<td>12/19/17</td>
<td>Hardin</td>
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<td>10-0854-EL-BGN</td>
<td>T6-1423-EL-BGA</td>
<td>Hog Creek II</td>
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<td>13-0197-EL-BGN</td>
<td>T6-0343-EL-BGA, T6-1687-EL-BGA, T7-1099-EL-BGA</td>
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**TOTALS:** 327 669.8

### Approved Wind Facilities

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<tr>
<th>Case Number</th>
<th>Related Cases</th>
<th>Project Name</th>
<th>Approval Date</th>
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<th>Turbines</th>
<th>MW</th>
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<tbody>
<tr>
<td>08-0666-EL-BGN</td>
<td>T3-2090-EL-BGA, T7-2516-EL-BGN</td>
<td>Buckeye I</td>
<td>3/22/10</td>
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<td>09-0479-EL-BGN</td>
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<td>Hardin¹</td>
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<td>Hardin</td>
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<td>T6-0469-EL-BGA, T6-3404-EL-BGA</td>
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<td>T8-0677-EL-BGA</td>
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<td>10-2865-EL-BGN</td>
<td>T4-1591-EL-BGA, T7-2516-EL-BGN</td>
<td>Black Fork</td>
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<td>Crawford, Richland</td>
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<td>T7-2517-EL-BGN</td>
<td>Buckeye II</td>
<td>5/28/13</td>
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<td>13-0990-EL-BGN</td>
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<td>Huron</td>
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<td>13-1177-EL-BGN</td>
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<td>Hardin, Logan</td>
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<td>T7-1776-EL-BGA</td>
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<td>18-0091-EL-BGN</td>
<td>T8-1473-EL-BGA</td>
<td>Timber Road IV</td>
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**TOTALS:** 568 1,191.1

### Pending Wind Facilities

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<tr>
<th>Case Number</th>
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<th>Filing Date</th>
<th>County</th>
<th>Turbines</th>
<th>MW</th>
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<tbody>
<tr>
<td>16-1871-EL-BGN</td>
<td>Icebreaker</td>
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<td>Cuyahoga</td>
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<td>17-2295-EL-BGN</td>
<td>Republic</td>
<td>2/2/2018</td>
<td>Seneca, Sandusky</td>
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<td>200</td>
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<td>18-0488-EL-BGN</td>
<td>Seneca</td>
<td>7/16/2018</td>
<td>Seneca</td>
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<td>18-1607-EL-BGN</td>
<td>Emerson Creek</td>
<td>1/31/2019</td>
<td>Erie, Huron</td>
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<td>297.7</td>
</tr>
</tbody>
</table>

**TOTALS:** 204 730.4
Apex in Ohio
Clean, Homegrown Energy for the Buckeye State

Republic Wind  |  200 MW  |  2019
$38.8 million in landowner payments
$36 million in school payments
$18 million in county and township payments
100 local jobs during construction
10 long-term local operations jobs

Emerson Creek Wind (North)  |  300 MW  |  2020
$51.3 million in landowner payments
$54 million in school payments
$27 million in county and township payments
130 local jobs during construction
15 long-term local operations jobs

Emerson Creek Wind (South)  |  300 MW  |  2021
$51.3 million in landowner payments
$54 million in school payments
$27 million in county and township payments
130 local jobs during construction
15 long-term local operations jobs

Emerson West Wind  |  200 MW  |  2020
At least $30 million in landowner payments
$36 million in school payments
$18 million in county and township payments
95 local jobs during construction
10 long-term local operations jobs

Long Prairie Wind I  |  500 MW  |  2021
$75 million in landowner payments
$84 million in school payments
$51 million in county and township payments
400 local jobs during construction
30-40 long-term local operations jobs

Honey Creek Wind  |  300 MW  |  2021
$40 million in landowner payments
$36 million in school payments
$18 million in county and township payments
100 local jobs during construction
10 long-term local operations jobs

Benefits for Ohio

Private Investment
$4.2 Billion
$1.3 Billion

Energy Potential
1.8 GW
800MW

Homes Powered
~500,000
1300+ Construction
235,000+

Jobs
1300+ Construction
350 Operations
55-70 Operations

All values calculated over 30-year project life
January 2019