National Offshore Wind Research and Development Consortium
Overview | June 2019
DOE’s Goal: Facilitate a nationally-focused, not-for-profit organization collaborating with industry on prioritized R&D activities to reduce levelized cost of energy (LCOE) of offshore wind in the U.S. and maximize other economic and social benefits

Desired Impacts:
- Innovations directly responsive to the technical and supply chain barriers faced by offshore wind project developers in the U.S.
- Build strong networks connecting technology innovators, investors, and industry
- Increase U.S. content and job opportunities

Administrator: (competitively awarded by DOE in 2018): New York State Energy Research and Development Administration (NYSERDA)

Project Value: $41 M ($20.5 DOE funds, matched by NYSERDA) – plus member contributions

Duration: 4 years under current funding (+ 3 years to complete all projects); goal is to become self sustaining indefinitely through research partner funding
National Offshore Wind R&D Consortium
An independent not-for-profit designed for long-term self-sufficiency

Members
Public Sponsors
• U.S. Department of Energy
• NYSERDA
• Virginia DMME
• Massachusetts CEC
• Maryland Energy Administration

Independent Members
• Bob Catell, AERTC (Chair)
• Jan Matthiesen, the Carbon Trust (Vice-Chair)
• Doug Pfeister, Renewables Consulting Group
• Sam Aronson, director emeritus BNL (Secretary)
• John Bruckner, National Grid NY (Treasurer)

Developer Members
• Avangrid
• EDF Renewables
• EDP
• EnBW North America
• Equinor
• Innogy
• Northland Power
• Ørsted
• Shell
• Vineyard Wind

Private Sponsors
• Anbaric

Advisory Groups
Research and Development Advisory Group (RDAG)
Strategic Advisor Network (SAN)
Tech to Market Group (TTM)
Manufacturing, Supply Chain & Service Council (MSSC)
Roadmap and Solicitation

- Prioritized **Research and Development Roadmap** published in November 2018

- PON 4124 supports three **Research Pillars:**
  1. Offshore Wind Plant Technology Advancement
  2. Offshore Wind Power Resource and Physical Site Characterization
  3. Installation, O&M and Supply Chain Solutions

- Go to: [www.NYSERDA.ny.gov/Funding-Opportunities](http://www.NYSERDA.ny.gov/Funding-Opportunities) for complete details, and to submit your proposal!
Pillar 1 Technical Challenge Areas

Array Performance and Control Optimization
- modeling array effects
- wind plant controls
- increasing energy density

Cost-Reducing Turbine Support Structures for the U.S. Market
- Innovative substructure designs, and methods
- Reduce the dependency on foreign flagged or heavy lift vessels
- Life extension of the substructure

Floating Structure Mooring Concepts for Shallow and Deep Waters
- Addressing complexity of Atlantic siting in 50 m - 90 m depths
- Addressing issues with Pacific siting >500 m depths

Power System Design and Innovation
- Assessment of power system infrastructure barriers
- Innovative OSW power system technologies
- New cable technology or array power system technology
Pillar 2 Technical Challenge Areas

**Comprehensive Wind Resource Assessment** – Addressing the uncertainties and inaccuracies of the current resource data bases for wind, extreme wave

**Development of a Metocean Reference Site** – Providing an ocean based reference site to calibrate and verify instrumentation for wind energy areas
Pillar 3 Technical Challenge Areas

Heavy Lift Vessel Alternatives — Alternative, innovative vessel solutions realized through new ship designs or the repurposing of existing U.S.-flagged vessels. Vessel alternatives enabling quayside assembly and installation of 12 MW+ wind turbines. Includes vessels involved in offshore wind construction, cable laying, crew transfer, and service operation vessels.

Offshore Wind Digitization through Advanced Analytics - Reduce labor at sea through SCADA data analytics, machine learning, condition monitoring technologies, advanced sensors, artificial intelligence, turbine-based robotics, drones, autonomous vessels, and self-healing materials.

Technology Solutions to Accelerate U.S. Supply Chain - New technologies that accelerate the maturation of the U.S. supply chain and concepts that result in increased utilization of existing U.S. manufacturing, new manufacturing, and new system designs that favor local content.
Questions?

richard.bourgeois@nyserda.ny.gov | nationaloffshorewind.org
Bladt produces critical components to the offshore wind industry

**Bladt core business**

- **Offshore wind farm elements**
  - WTG (Turbine)
  - Tower
  - Jacket foundation
  - Transition piece
  - Inter-array cable
  - Export cable
  - Substation topside
  - Substation jacket
  - Monopile foundation
  - High voltage AC substation
  - Onshore substation

**Bladt offshore wind products**

- **Substation topsides and jackets**
- **Monopile foundations**
- **Transition pieces**
- **Jacket structure foundations**
Bladt Industries A/S

- Steel fabricator founded in 1965
- Locations: Denmark, Poland, Taiwan (US)
- Employees: 1000
- Business areas: Offshore wind, Oil & Gas, Infrastructure
Wind Energy
Secondary steel components.
Secondary steel structures.

Secondary Steel structures including concrete platform.

Per one foundation is to be used:

- **Internal platform.** Steel. HDG. 15 tons \( \Phi = 7 \text{ mtr.} \quad H = 8 \text{ mtr.} \)
- **Airtight Platform.** Steel. Painted. 6 tons \( \Phi = 7 \text{ mtr.} \quad H = 0.5 \text{ mtr} \)
- **Anode Cages.** Steel. Alu and Zinc. 18 tons \( \Phi = 12 \text{ mtr.} \quad H = 3 \text{ mtr} \)
- **Boat Landing Platform.** Steel. Painted. 16 tons \( W = 4 \text{ mtr.} \quad L = 14 \text{ mtr.} \quad H = 2 \text{ mtr.} \)
- **External platform.** Steel. Painted. 25 tons \( W = 10 \text{ mtr.} \quad L = 13 \text{ mtr.} \quad H = 2 \text{ mtr.} \)
- **External platform.** Concrete structure. 130 tons \( W = 10 \text{ mtr.} \quad L = 13 \text{ mtr.} \quad H = 2 \text{ mtr.} \)

- **Total tonnage per foundation approx.** 80 tons steel structures.
  - or
- 55 tons steel + 130 tons concrete structures.
US Fabricator Certifications

CSR, COC, Quality, health, safety and environment are all factors that we keep at the highest priority at our preferred fabricators.

Bladt Industries carry out full scale audit according to:

- **CSR. UN Global compact**
- **COC. Code Of Conduct**
- **EN/ISO 9001 or IATF 16949**
- **OHSAS 18001/ ISO 45001 or similar**
- **EN 1090: Declaration method? 1, 2, 3**
- **ISO 3834**
- **DIN 18800**
- **EN/ISO 14001 or similar**

We need US fabricators to certify and implement accordingly.
US Fabricator Audit Process

Bladt Industries provides a step-by-step roadmap to become a preferred supplier.

<table>
<thead>
<tr>
<th>Road map to be added onto Bladt list of preferred suppliers.</th>
<th>Slow track:</th>
<th>Fast track:</th>
</tr>
</thead>
<tbody>
<tr>
<td>✅ Screening meeting on site.</td>
<td>Week 1</td>
<td>Week 1</td>
</tr>
<tr>
<td>✅ Two Questionnaires to be submitted.</td>
<td>Week 3</td>
<td>Week 1</td>
</tr>
<tr>
<td>✅ RFQ’s to be submitted.</td>
<td>Week 5</td>
<td>Week 2</td>
</tr>
<tr>
<td>✅ Full scale audit.</td>
<td>Week 10</td>
<td>Week 5</td>
</tr>
<tr>
<td>✅ LOF. List of findings to be closed one by one.</td>
<td>Week 36</td>
<td>Week 6</td>
</tr>
<tr>
<td>✅ Re-Audit if needed.</td>
<td>Week 39</td>
<td>Week 8</td>
</tr>
<tr>
<td>✅ Added onto Bladt Industries list of preferred suppliers.</td>
<td>Week 40</td>
<td>Week 8</td>
</tr>
<tr>
<td>✅ First possible contract.</td>
<td>Nine months</td>
<td>Two months</td>
</tr>
</tbody>
</table>
Facilities – Aalborg, Denmark

- **Total area:** 35 hectares
- **Covered shops:** 27,000 m²
- **Covered painting areas:** 7,400 m²
- **Max units u/cover:** 70x30x15 m
- **Office facilities:** 2,000 m²
- **Quay strength:** 5,000 tonnes
- **Water depth:** 9.4 m
Facilities – Lindø, Denmark

- Workshop 1: 11,220 m²
- Workshop 2: 10,566 m²
- Workshop 3: 5,747 m²
- Paint shop 4: 2x1,350 m²
- Stock: 2,000 m²
- Quay depth: 7.5 m

Total area: 93,000 m²
steel solutions built for the future
A leading provider of wind power solutions to customers around the globe

Offshore
• #1 in global Offshore market

Onshore
• #4 in global Onshore market
• #1 in India and LATAM

Service
• #2 in service backlog
• #2 in serviced fleet size

Top 3 market share* position in several main countries

* Based on MW installations
Source: MAKE Global Wind Turbine OEM 2016 Market Share

© Siemens Gamesa Renewable Energy
Key facts

Order Book
€~20.4 bn

Annual revenue
€~11.5 bn

Installed capacity worldwide
~80 GW

Employees worldwide
> 25,000

Market capitalization
€~8.2 bn¹

Figures as of June 2017

¹Calculated based on share price on October 17, 2017
Shaping the renewable industry –
A broad portfolio

Onshore  Offshore  Service
Our offshore business

Key Facts

~ 3,000 WTG’s installed so far
installed in Denmark, UK, Germany, Norway, Sweden, Finland, Netherlands, Belgium, China and Taiwan

~ 12.5 GW installed base = (in total 18,5GW ~ 70%)

~ 52 Offshore Projects executed or in execution

Our accumulated Contribution (since 1991)

88 billion kWh of clean energy generated
67 million tons of CO₂ emissions avoided
267 billion liters of water saved
Many projects under installation and to come
First order secured in the US and an ambition to have market leadership

Arkona, DE
60x SWT-6.0-154

Albatros, DE
16x SWT-7.0-154

Hohe See, DE
71x SWT-7.0-154

Coastal Virginia, US
2x SWT-6.0-154

Danish Kriegers Flak, DK
72x SG 8.0-167 DD

Vesterhav Projects, DK
41x SG 8.0-167 DD

East Anglia ONE, UK
102x SWT-7.0-154

Beatrice, UK
84x SWT-7.0-154

Hornsea Two, UK
171x SWT-7.0-154

Borssele 1+2, NL
94x SG 8.0-167

Formosa 1, Phase 2, TW
20x SWT 6.0-154

Rentel, BE
42x SWT-7.0-154
SGRE Typical Scope of Supply

- Wind turbines
- Transport
- Pre-assembly
- Installation
- Commissioning
- O&M Services
Overall Procurement organization and sub-units within SGRE Offshore

**Direct Procurement**
SGRE P CM

- Wind turbine related components
  - Power & Drive
  - Mechanical
  - Metal processing/Composites
    - Blade
    - Tower

**Indirect Procurement**
SGRE P IM

- Catalogue items, office supplies, travel, rental cars, hotels, IT, training, third party labor supply, mailing services, etc.
- Indirects

**Project Procurement Offshore**
SGRE OF P PP

- All services and products outside of the turbine to install a wind park. E.g., crane & installation services, civil works, waste management services, site facilities, etc.
- Logistics
- Construction
- Services
- BOP
Supplier Qualification

Siemens Gamesa is committed to using local suppliers wherever possible.

It makes sense commercially and technically.

These are the criteria which would qualify a supplier as “ready for business” (R4B)

- Approach to Health, Safety and the Environment
- Reliable Delivery
- Competence & Quality
- Value for money
Offshore Overview – Some Examples

Sea Transport
- Sea transport of main components (tower sections, nacelles, blades) from port of manufacturing to port of pre-assembly
- Provision of vessels, bunker, stevedores and agents
- Activities before and during preassembly activities

Cranes
- Provision of equipment and personnel for transport and lifting activities at pre-assembly port
- Transport of main components (tower sections, nacelles, blades) at pre-assembly port
- Lifting and stacking of tower sections for pre-assembly on quayside

Crew Transfer Vessels
- Provision of CTV charter for the transfer of technicians, tools and equipment supporting offshore operations
- Includes provision of vessel crew, maintenance and fuel
- For activities spanning installation, O&M and major component repair/exchange
Offshore Overview – Some Examples

Ports
- Provision of preassembly ports suitable for inbound logistics, storage, pre-assembly and installation vessel loading
- Ensure heavy duty and well prepared storage and quays
- Ensure suitable swift and easy setup for Installation vessels

Quayside Equipment
- Provision of equipment for quayside and vessel including sea-fastening like compact tower frames and bolts
- Sourcing of turnkey providers for fabrications; including the production of quayside equipment and sea-fastening as well as related mobilization and demobilization services

Manpower – Field Services
- Provision third party labor providers and labor for Offshore service activities
- HV techs, statutory inspectors, site related labor,
- Provision of project certifications
Operations and Maintenance Overview – Some Examples

**O&M Facilities**
- Design, construct and manage service base facilities to support O&M activities and potential helicopter operations
- Quayside improvements to support offshore mobilization such as port side cranes and pontoons
- Waste management and bunkering activities

**Vessels and Logistics**
- Crew Transfer Vessels
- Service Operation Vessels (SOVs)
- Jack Up Vessels
- Helicopters
- Marine and Aviation Coordination

**Manpower – Field Services**
- Supplemental workforce to our O&M organization
- Specialized workforce such as rope access and high voltage
- Specialized consultants – port survey, engineering studies, etc.
- Training providers - GWO certified programs
Operations and Maintenance Overview – Some Examples

- **Substation**
  - HV asset integrity maintenance
  - HV switching operations
  - Facility management to include:
    - Air conditioning equipment
    - Fire suppression equipment
    - Overall building integrity

- **Underwater Survey**
  - Export and inter-array cable burial surveys
  - Scour protection surveys
  - Monopile ROV work
  - Substation substructure ROV work
  - Protection species observers

- **Tooling, parts and equipment**
  - Hydraulic and electrical torque and tension tooling
  - Calibrated equipment and associated calibration services
  - Local procurement of consumables such as cleaning supplies, oil, greases, filters, potable water, etc.
Some of our initial requirements

Details of any QHSE accreditations

HSE performance including TRIR rates

Details of experience in Offshore wind or relevant experience from complimentary sectors
How to Engage

- Contact one of our team at the event today
- Use our Contact Form

Thank You
Focusing portfolio for growth & shareholder value creation

### GE GOING FORWARD

<table>
<thead>
<tr>
<th>Industry</th>
<th>Revenue (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>$30.6B</td>
</tr>
<tr>
<td>Power</td>
<td>$27.3B</td>
</tr>
<tr>
<td>Renewable Energy</td>
<td>$15B</td>
</tr>
</tbody>
</table>

Digital, Additive, and financing expertise of GE Capital

- Leading franchises solving tough problems with advanced technology
- Technology is the DNA of the company
- Valuable installed base with track record of increasing asset productivity & improving margins

### UNLOCKING VALUE

- Merging with Wabtec to create global leader for rail equipment, services and software
- Positioned to grow ... diversified transportation business with large installed base
- Leading healthcare solutions provider
- Enabling precision health with leadership in diagnostics, therapeutics and monitoring
- Full-stream oil & gas company for land and offshore solutions
- Supported by digital solutions backbone

<table>
<thead>
<tr>
<th>Industry</th>
<th>Revenue (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>$3.9B</td>
</tr>
<tr>
<td>Healthcare</td>
<td>$19.8B</td>
</tr>
<tr>
<td>Baker Hughes</td>
<td>$22.9B</td>
</tr>
</tbody>
</table>

Revenue from 2018 Annual Report
GE Renewable Energy

$15B revenue • 40,000 employees

Broadest portfolio in the industry; gives us scale, scope and capability to fulfill our mission
Block Island, USA
First US offshore wind farm

Developer: Deepwater Wind

Wind Farm:
US pilot wind farm with 5 HALIADE 150-6MW* (30MW)
Off the coast of Rhode Island: 5km
Water depth: 24m to 28m

Foundations: Jacket type

Generating 125,000 MW/h annually
1st offshore windfarm in the US
GE Renewable Energy is developing Haliade-X 12 MW, the biggest offshore wind turbine in the world, with 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.

- **12 MW capacity**
- **220-meter rotor**
- **107-meter long blades**
- **248 meters high**
- **63% capacity factor**
- **38,000 m² swept area**
- **Wind Class IEC: IB**

Generates **double the energy** as previous GE Haliade model

Generates almost **45% more energy** than most powerful wind turbine available on the market today

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>Eiffel Tower</th>
<th>Haliade-X 12 MW</th>
<th>Chrysler Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>1063 ft</td>
<td>1046 ft</td>
<td>814 ft</td>
</tr>
<tr>
<td>324 m</td>
<td>319 m</td>
<td>248 m</td>
</tr>
</tbody>
</table>

Generates double the energy as previous GE Haliade model

Generates almost 45% more energy than most powerful wind turbine available on the market today

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.
Demand Scenario US Northeast Demand
2 GW w/ revenue, +3 GW to be awarded, +8-10 GW targeted

<table>
<thead>
<tr>
<th>Year</th>
<th>Project</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Coastal Virginia Offshore Wind (12 MW)</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2021</td>
<td>Vineyard Wind (800 MW)</td>
<td>Vineyard Wind</td>
</tr>
<tr>
<td>2022</td>
<td>South Fork (130 MW)</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2023</td>
<td>Skipjack Windfarm (120 MW)</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2023</td>
<td>Revolution Wind (700 MW)</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2024</td>
<td>U.S. Wind (248 MW)</td>
<td>US Wind</td>
</tr>
<tr>
<td>2025</td>
<td>Empire Wind</td>
<td>Equinor</td>
</tr>
<tr>
<td>2025</td>
<td>Bay State Wind</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2025</td>
<td>Atlantic Shores</td>
<td>Shell</td>
</tr>
<tr>
<td>2025</td>
<td>Ocean Wind</td>
<td>Ørsted</td>
</tr>
<tr>
<td>2026</td>
<td>Dominion Commercial Lease</td>
<td>Dominion Energy</td>
</tr>
<tr>
<td>2027</td>
<td>Kitty Hawk</td>
<td>Avangrid</td>
</tr>
</tbody>
</table>

* Projections based on current estimates and/or standard timeline
2018 Year GE Renewable Energy in Review

- Launch of Cypress, GE's largest onshore wind platform
- Announced Haliade-X, world's most powerful offshore wind turbine
- GE reclaimed #1 for manufacturers in ’18 (40% US capacity installations)