WIND SYSTEMS MAGAZINE

WIND SYSTEMS

POTENTIAL ECONOMIC IMPACTS FROM OFFSHORE WIND IN THE UNITED STATES – THE SOUTHEAST REGION

A ROAD MAP FOR EFFICIENCY

COMPANY PROFILE:
TEAM-1 Academy

Q&A: AJAY SWAMY
ACCIONA Windpower

CONSTRUCTION
Signal Energy Constructors

MAINTENANCE
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OFFSHORE WIND

OCTOBER 2013

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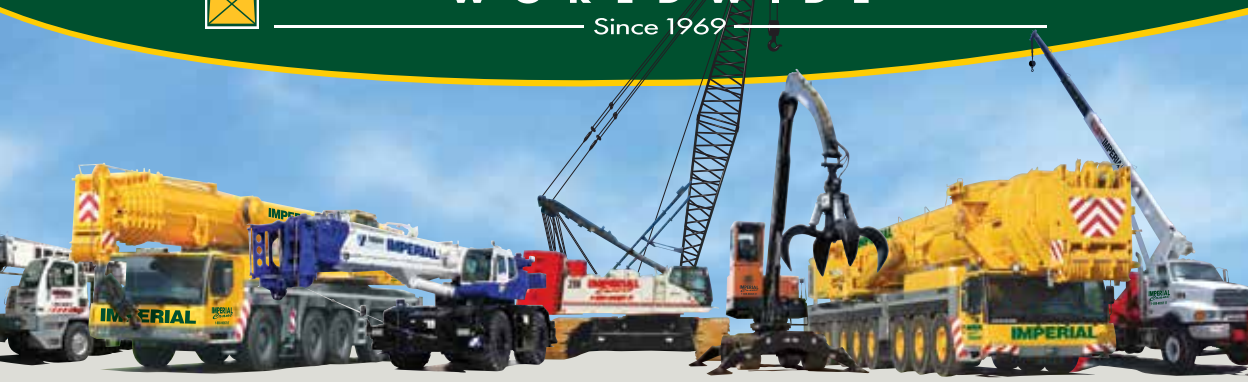

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EDLETTER

I'm going to skip the long-winded, shiny object-induced diatribe this month, and instead take a brief look at a topic that, until recently, I've pretty much ignored—offshore wind.

If my gut is correct, then I'm not alone in that. When I first began to acclimate myself to this industry, it was relatively easy to determine that distributed wind was the red-headed stepchild of the wind energy industry. Now, I find myself questioning that assessment. Looking back, I had heard even less about U.S. offshore wind at the time.

The reasoning behind that attitude makes a little more sense now. We weren't hearing much about offshore wind because… well… we don't have any offshore wind.

It's misleading to say that it wasn't being talked about at all. The little I learned was through technical articles written primarily by academics. This only served to portray offshore wind in an elitist, "pie in the sky" philosophy, rather than a viable, economical source of renewable energy.

I've since warmed to offshore a good bit, but I'm still not completely on board. Despite the fact that technology is expanding rapidly and costs are expected to drop significantly, the challenges may still be a little more than we can handle right now.

Recent headlines, however, make it a little easier to be enthusiastic about offshore wind. In a span just longer than a month, the Interior department has held two successful offshore land use auctions—the first at the end of July and another at the beginning of September.

Word of these projects, the first by Providence, R.I.-based Deepwater Wind, followed by Dominion Virginia Power, is very promising. Similarly, it's encouraging to hear about the economic impact that offshore wind could provide, as evidenced this month in a meaty article by Dane Zammit of the Virginia Center for Wind Energy at James Madison University.

It's estimated that it'll still likely be a decade before any offshore wind projects will be transmitting electricity to the U.S. grid. If that's the case, considering our awkward, hesitant history in embracing offshore wind, we should begin getting heavily involved and enthusiastic starting today—right now—so that when these projects do go online, we won't be THREE decades behind the rest of the offshore world.

Now for a little housekeeping…

Next month, in our November issue, *Wind Systems* will publish its annual Buyer's Guide issue. This is one of the best resources we publish—a compendium of wind energy industry manufacturers, suppliers, consultancies, and service providers.

Many of you have told us that this one issue is one of your most valued wind energy industry resources.

We pride ourselves on making our Buyer's Guide as most up-to-date and comprehensive as possible.

But we can only do that if we have accurate information. If you know for sure that your company has not been listed in our Buyer's Guide in the past, please take a minute this week to email us your information. We'll need to know the company name, address, phone and fax numbers, and your company's industry segment (which products or services you provide to the wind energy industry.

Your company listing in our Buyer's Guide is a service *Wind Systems* provides and comes at zero cost to either the company or the reader.

If your company would like to be listed in our 2014 Buyer's Guide, please email the information I mentioned to editor@windsystemsmag.com no later than October 14.

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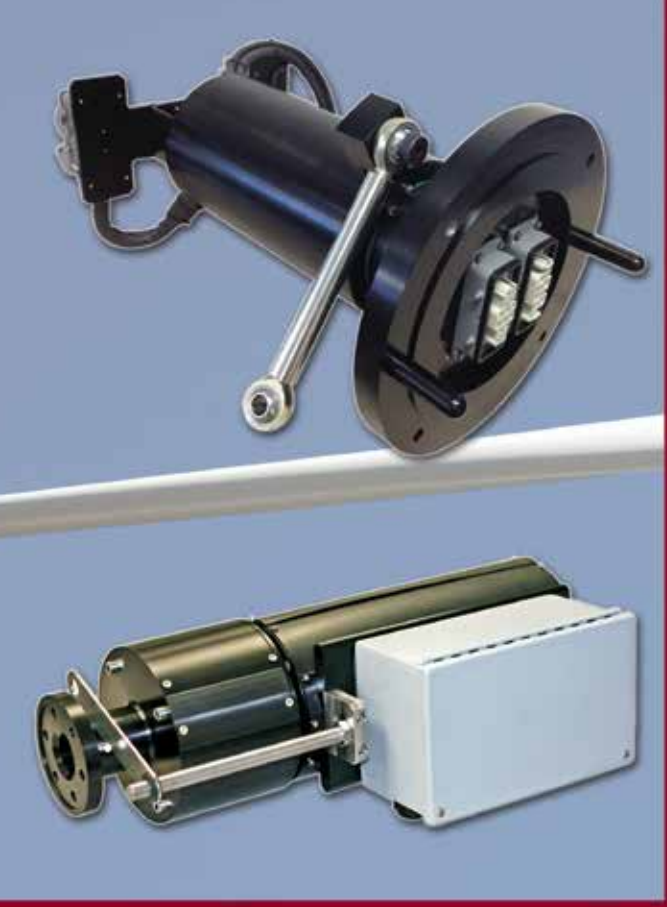
TORONTO WELCOMES CANWEA FOR 29TH ANNUAL CONFERENCE & EXHIBITION

The Canadian Wind Energy Association will hold its 29th Annual Conference and exhibition from October 7-10 at the Metro Toronto Convention Centre in Toronto, Ontario. CanWEA 2013 Conference & Exhibition is Canada's largest wind energy conference. Organizers expect to attract nearly 200 exhibitors and 2,000 attendees from around the world to the four-day event. Participants can expect to see products and services, learn industry brand names, network with leading industry decision makers, and generate numerous high-quality business leads.

CanWEA 2013 exhibitors are leaders in the wind industry, and are dedicated to supporting CanWEA's efforts to push forward wind energy industry policy, regulatory, and business development objectives.

Past attendees will notice a few changes and enhancements to the event over years past. Exhibition times have been condensed and scheduled as a two-day event on Tuesday and Wednesday. Additionally, the association has has added some service functions to exhibitors and attendees. CanWEA will have a theater set up on the show floor providing companies with the opportunity to showcase their products or services. CanWEA also recognizes the importance of having private spaces available for companies to hold meetings outside of their booth and off the show floor, while still staying within the walls of the show. CanWEA will have meeting rooms on the show floor this

Companies wishing to submit materials for inclusion in this section should contact Stephen Sisk at editor@windsystemsmag.com. Releases accompanied by color images will be given first consideration.



Pitch Control Solutions.

Moog has developed direct replacement pitch control slip rings for today's wind turbines. The slip ring provides reliable transmission of power and data signals from the nacelle to the control system for the rotary blades.

The Moog slip ring operates maintenance free for over 100 million revolutions. The slip ring uses fiber brush technology to achieve long life without lubrication over a wide range of temperatures, humidity and rotational speeds. In addition, the fiber brush has the capability to handle high power while at the same time transferring data signals.

Moog's proven fiber brush technology has become synonymous with high performance slip rings around the world. With over 50 years of experience and more than 10,000 slip ring designs, our engineers work together with your design team to find a solution that is right for you.

Looking for more?
Scan to view specifications for direct replacement pitch control slip rings.

Fiber Brush Advantages:

- High reliability
- Maintenance free
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year. These rooms can be rented for the duration of the show, or can be rented by the hour.

In another first, CanWEA has added a job fair to the 2013 Conference and Exhibition. The Association has secured the participation of a number of exhibiting companies who have confirmed that they will have jobs available in the wind industry within the next year. Are you a graduating student, recent graduate, or an individual who is interested in exploring the opportunities available in the wind energy industry? If so, make plans to participate in the CanWEA 2013 Career Fair, which will be held on Wednesday, October 9 from 1 p.m. to 6 p.m. in Exhibit Hall D (an entrance fee of $50.00 will be charged).

CanWEA 2013 gets underway on Monday, October 7 with a one-hour exhibitors' reception starting at 3:30 p.m., followed by the opening reception at 5 p.m.

The opening session on Tuesday borrows its topic from the host province, and is entitled: "The Wind Energy Experience in Ontario." Ontario is the largest market for wind energy in Canada—currently with more than 2GW of wind power capacity. Presenters slated to speak are: CanWEA Board Chair Roby Roberts, Ontario Minister of Energy Bob Chiarelli, and CanWEA President Robert Hornung. Through these presentations and the acompanying roundtable discussion, participants will examine both successes and challenges for Ontario concerning wind energy, investigating how lessons learned can contribute to a long-term energy plan for the province.

The next day, the focus shifts back to Canada as a whole under the "Wind Energy Across Canada" theme. More than two-thirds of Canada's installed wind energy capacity can be found outside Ontario. In British Columbia, Alberta and Quebec, formal processes are now underway that will determine the opportunities available for new wind energy development over the next 5-10 years. Each of these markets is unique and this plenary session will highlight wind energy's successes in these markets to date and discuss the unique actions required in each market for wind energy to capture its full potential. This session features a procurement and opportunities update, as well as case studies and regional updates.

On the final day of the conference, the plenary session takes on "Renewable Energy Advocacy & Review of the Long Term Energy Plan." This final half-day session shifts the topic of discussion beyond wind and into the energy renewables arena. CanWEA brings you a panel of energy association leaders and provocative key speakers including environmental activist, Ms. Tzeporah Berman, and journalist, Mr. Tyler Hamilton.

Educational sessions will be offered concurrently with the exhibition on Tuesday and Wednesday. These 90-minute sessions take a narrower focus on specific wind energy topics, such as: finance, wildlife and ecology, global markets, wind integration, operations and maintenance, siting, forecasting, and more.

More information about CanWEA's 29th Annual Conference & Exhibition, including conference agenda, floor plan, and exhibitor directory can be found online at http://canwea2013.ca.

ENERGY STORAGE SUMMIT CO-LOCATED WITH ASSOCIATION CONERENCE

The Renewable Energy Storage Summit—hosted by Canadian Clean Energy Conferences—will be co-located with CanWEA 2013 in Toronto on Monday, October 7. By solving key challenges around integration, curtailment and dispatchability, energy storage is set to shift the wind business landscape and open new project opportunities across Canada.

The Renewable Energy Storage Summit will bring together wind developers and suppliers, system operators, utilities, investors and regulators to discuss the economics, finance and practicalities of energy storage and give critical insight into how the structure of the wind sector will change as a result of energy storage.

The Summit will provide the complete picture of how storage is changing the wind business including:

- Changing procurement regimes
- Changing business models
- New market opportunities
- Operational challenges
- Investor insight and market development

The Summit will be held from 9 a.m. until 5 p.m.

For more information, including a list of speakers, and the summit agenda, visit www.ress2013.com.

DOMINION VIRGINIA POWER WINS FEDERAL OFFSHORE WIND AUCTION

Dominion Virginia Power, a subsidiary of Dominion, on September 4 bid $1.6 million to win the lease for 112,800 acres of federal land approximately 23.5 nautical miles off the coast of Virginia to develop an offshore wind turbine farm capable of generating up to 2,000 megawatts of electricity, enough for 700,000 homes.

"Offshore wind has the potential to provide the largest, scalable renewable resource for Virginia if it can be achieved at reasonable cost to customers," said Mary C. Doswell, senior vice president-Alternative Energy Solutions with Dominion Virginia Power. "We will now proceed with the BOEM timetable for development of the commercial wind energy area while advancing our research proposal and looking for ways to lower the cost of bringing offshore wind generation to customers."

BOEM has several milestones that Dominion must meet to keep the lease. The lease will have a preliminary term of six months during which Dominion must submit a Site Assessment Plan to BOEM for approval. A Site Assessment Plan describes the activities (e.g., installation of meteorological towers and buoys) the lessee plans to perform for the assessment of the wind resources and ocean conditions of its commercial lease. After a Site Assessment Plan is approved, Dominion will have up to four and a half years in which to submit a Construction and Operations Plan (COP) for approval, which provides a detailed outline for the construction and operation of a wind energy project on the lease. If the COP is approved, the lessee will have an operations term of 33 years.

Dominion expects the first turbine to be installed in about 10 years pending project approval by state regulators.

The sale follows a July 31 auction of 164,750 acres offshore Rhode Island and Massachusetts for wind energy development that was provisionally won by Deepwater Wind New England, LLC, generating $3.8 million in high bids.

"This year's second offshore wind lease sale is another major milestone in the President's all-of-the-above energy strategy and demonstrates continued momentum behind a robust renewable energy portfolio that will help to keep our nation competitive and expand domestic energy production while cutting carbon pollution," said Secretary of the Interior Sally Jewell. "Today's sale is the result of a great deal of collaboration and planning with the Commonwealth of Virginia, which has been a leader in advancing offshore renewable energy for the Atlantic coast and an enthusiastic partner in this effort."

"Today's renewable energy lease sale offshore Virginia is another significant step forward in the President's call for action to address climate change and the Administration's all-of-the-above energy strategy," said Bureau of Ocean Energy Management (BOEM) Director Tommy Beaudreau. "I congratulate (Dominion Virginia Power) and we look

forward to overseeing their development of the Virginia wind energy area, which will create jobs, increase our energy security and provide abundant sources of clean renewable power."

Eight companies, including Dominion, were approved to bid, but only two firms participated. The auction lasted six rounds.

Others that BOEM had approved to bid were Apex Virginia Offshore Wind LLC of Charlottesville, Va; Energy Management Inc. of Boston; EDF Renewable Development Inc. of San Diego; Fishermen's Energy LLC of Cape May, N.J.; Iberdrola Renewables Inc. of Portland, Ore.; Sea Breeze Energy LLC of Philadelphia; and Orisol Energy U.S. Inc. of Ann Arbor, Mich.

Dominion is involved in other offshore wind research projects. Dominion and its team was one of seven projects selected to receive $4 million each in federal matching funds to undertake initial engineering, design, and permitting for a demonstration facility of two six-megawatt turbines with a goal of finding innovative ways to lower costs of offshore wind. The Department of Energy will select up to three of the projects for follow-on phases to move forward with the final design, permitting, and ultimate construction of these demonstration projects. The projects must be in operation by the end of 2017.

BOEM is expected to announce additional auctions for Wind Energy Areas offshore Maryland, New Jersey, and Massachusetts later this year and in 2014.

EDF EN CANADA COMMISSIONS 150MW IN QUEBEC

EDF EN Canada Inc., a subsidiary of EDF Energies Nouvelles, has announced that the second phase of the Lac-Alfred Wind Project (150MW) in Quebec was declared for commercial operation on August 31.

Lac-Alfred represents one of the seven wind energy projects in total awarded to the company in 2008 and 2010 through Hydro-Quebec Distribution calls for tenders. By the end of 2015, EDF EN Canada will have developed and built a total of 1,003.2 MW in the province.

The Lac-Alfred Wind Project is located in the municipalities of Saint-Cléophas, Sainte-Irène, Saint-Zénon-du-Lac-Humqui and the unorganized territory (UT) of Lac Alfred in the MRC de La Matapédia and in the municipality of La Rédemption and UT Lac-à-la-Croix in the MRC de La Mitis. The 300MW project was constructed in two phases, 150MW each, comprising of a total of 150 wind turbines supplied by REpower and made with regionally-manufactured blades, towers and converters. Lac-Alfred Phase 1 was commissioned in January 2013.

The project created more than 350 jobs during the construction phase, and will provide 15 permanent operations and maintenance jobs. Enbridge Inc., participates in Lac-Alfred (phase 1 and phase 2) as a co-owner through a 50 percent investment.

EDF EN Canada Inc.'s operation and maintenance affiliate, EDF Renewable Services Inc. will provide long-term

operations and maintenance (O&M) services. Hydro-Quebec will buy the power under 20-year power purchase agreements (PPA).

For more information, visit www.edf-en.ca.

PENN STATE OFFERS WIND ENERGY GRAD DEGREE ONLINE

Penn State is now offering an Intercollege Master of Professional Studies in Renewable Energy and Sustainability Systems (iMPS-RESS), including a wind energy option. This degree program is designed to prepare professionals to lead the transformation from an unsustainable, fossil-energy economy to a renewable, sustainable one. The program is offered through Penn State's World Campus, a worldwide leader in online education. Designed in a strong partnership between four colleges and eight academic departments, the program draws on the expertise and unique perspectives of world-class faculty members with diverse backgrounds.

This program focuses on helping students develop the technical expertise and project management skills they will need to effectively create or manage successful renewable and sustainable energy systems. Options in bioenergy, sustainability management and policy, solar energy and wind energy allow students to tailor the degree to their career goals. For those not interested in pursuit of the full degree program, certificates are also under development for each option.

Projected growth in the global wind industry indicates an increasing need for professionals with advanced training in wind energy. As wind projects are developed in increasingly challenging locations and wind regimes, companies will continue to seek professionals who have a broad understanding of the wind project development process, as well as technical depth in turbine technology and the science of siting wind turbines. The iMPS-RESS Wind Energy Option aims to provide a balanced curriculum that will equip individuals to advance the wind energy industry as well as their own careers.

Applications are now being accepted for Penn State's online iMPS-RESS degree. For more information, visit www.worldcampus.psu.edu/degrees-and-certificates/renewable-energy-sustainability-wind/overview or email info@ress.psu.edu.

GE EXPANDS FACILITY, INSTALLS 500TH TURBINE IN BRAZIL

GE announced the expansion of its Campinas, São Paulo, manufacturing facility and the creation of 35 new skilled jobs. Co-located with Brazilian machinery manufacturer and GE Group subsidiary GEVISA,

the facility will produce machine heads, also known as nacelles, for GE 1.7-100 and 1.85-82.5 wind turbines. The machine head is a primary component of a wind turbine and houses the power generation equipment including the gearbox, generator and controls.

To quickly and efficiently respond to the rapidly growing demand for advanced wind energy services, GE has announced the opening of two wind services centers in Brazil. The first center will be located in Bahia and the second will open in Rio Grande do Norte. Together, they will employ more than 100 service technicians. Engineers at the new facilities will monitor wind operations and weather as well as dispatch local technicians to wind farms to perform maintenance.

The company recently announced its 500th wind turbine installation in Brazil. The 1.6MW turbine was installed at DESA's 38MW Eurus project in João Camara in the state of Rio Grande do Norte.

GE has had a presence in Brazil since 1919 and today employs more than 8,500 people in the country. The company has operations throughout Brazil, including in Bahia, São Paulo, Minas Gerais and Rio de Janeiro. The local team leverages GE's global expertise of engineers, field service technicians and logistics excellence to ensure the highest quality and strongest execution is on point for customers in Brazil.

The Campinas facility also is the production site for GE's wind turbine hubs.

For more information, visit www.ge.com.

SIEMENS TO SUPPLY DIRECT-DRIVE TURBINES TO FRANCE

Siemens has received an order from France for the supply, installation and commissioning of a total of 24 direct-drive wind turbines for four French wind projects, located in the Nord Pas-de-Calais and Picardie regions in northern France. Project investors are Diamond Generating Europe Limited (DGE) and the French renewable energy company EDF Energies Nouvelles (EDF EN). The model SWT-3.0-101 wind turbines ordered for these projects each have a capacity of 3MW and a rotor diameter of 101 meters. This marks the first order for Siemens from France for gearless wind turbines. Erection and commissioning are scheduled for 2014. Siemens is also responsible for maintenance of the wind turbines over a period of 15 years.

"Compared to conventional wind turbine technology, our direct-drive wind turbine has half the components and substantially fewer rotating parts," said Jan Kjaersgaard, CEO of Siemens Wind Power for the EMEA sales region. "This enhances reliability and reduces the maintenance scope for the plants. We are

pleased to be installing this future-oriented technology for the first time onshore in France."

The French government plans to install a total of 25GW of wind power by 2020, of which 7.5GW was already in place at the end of 2012.

For more information, visit www.siemens.com.

NREL STUDY: WESTERN RENEWABLES COST GAP COULD NARROW

A new Energy Department study conducted by the National Renewable Energy Laboratory (NREL) indicates that by 2025 wind and solar power electricity generation could become cost-competitive without federal subsidies, if new renewable energy development occurs in the most productive locations.

The report, "Beyond Renewable Portfolio Standards: An Assessment of Regional Supply and Demand Conditions Affecting the Future of Renewable Energy in the West," compares the cost of renewable electricity generation (without federal subsidy) from the West's most productive renewable energy resource areas—including any needed transmission and integration costs—with the cost of energy from a new natural gas-fired generator built near the customers it serves.

"The electric generation portfolio of the future could be both cost effective and diverse," said NREL Senior Analyst David Hurlbut, the report's lead author. "If renewables and natural gas cost about the same per kilowatt-hour delivered, then value to customers becomes a matter of finding the right mix.

"Renewable energy development, to date, has mostly been in response to state mandates," Hurlbut said. "What this study does is look at where the most cost-effective yet untapped resources are likely to be when the last of these mandates culminates in 2025, and what it might cost to connect them to the best-matched population centers."

The study draws on an earlier analysis the lab conducted for the Western Governors' Association to identify areas where renewable resources are the strongest, most consistent, and most concentrated, and where development would avoid protected areas and minimize the overall impact on wildlife habitat.

Among the study's findings:

- Wyoming and New Mexico could be areas of robust competition among wind projects aiming to serve California and the Southwest.
- Montana and Wyoming could emerge as attractive areas for wind developers competing to meet demand in the Pacific Northwest.
- Wyoming wind power could also be a low-cost option for customers in Utah, which also has its own diverse portfolio of in-state resources.
- Colorado is a major demand center in the Rockies and will likely have a surplus of prime-quality wind potential in 2025.

For more information, visit www.nrel.gov.

Julian Bell
Signal Energy Constructors

Unforeseen subsurface conditions: Mitigating the risks of what can't be seen.

CONSTRUCTION CONTRACTS REQUIRE owners and contractors to accept risk as part of the project construction. Two closely related risks on wind energy projects are unforeseen subsurface conditions and pre-existing hazardous materials. Properly evaluating and handling these risks is a necessary part of being a successful wind energy contractor.

Wind energy balance of plant (BOP) contracts typically contain clauses requiring the contractor to acknowledge that it is familiar with the local conditions of the project site. In addition, BOP contracts commonly require the contractor to assume much of the risk of these local conditions. Contractors must be skillful in limiting the scope of these clauses by using carefully drafted language specifying the contractor's responsibility for unforeseen subsurface conditions and pre-existing hazardous materials.

Wind energy contractors must approach the risks of unforeseen subsurface conditions and pre-existing hazardous material with caution. Examples of how to mitigate risks associated with wind energy projects include:

SUBSURFACE CONDITIONS CLAUSE

The subsurface conditions clause (also called an "unforeseen subsurface condition" or "unforeseen conditions" clause) should be drafted to give the contractor the right to schedule and/or cost relief under certain conditions:

1. Subsurface or latent physical conditions at the project site are materially different from the conditions described in the contract documents, including the geotechnical report and other materials provided to the contractor by the owner.
2. Conditions are discovered at the project site that are previously unknown and are of an unusual nature, or are materially different from those conditions that are ordinarily encountered and generally recognized as inherent in working at the project location, or
3. The contractor encounters hazardous materials or conditions that exist at the project site as of the time of the contract and were not brought to the site, or created by, the contractor or its subcontractors (defined as pre-existing hazardous materials or conditions).

In order for this clause to protect the contractor and afford potential cost and schedule relief, the contractor needs to make a thorough review of all of the documents that are provided to it by the owner. In addition, the contractor must make itself familiar with the subsurface conditions that actually exist at the site and that are normally expected in the project location.

GEOTECHNICAL INVESTIGATION

The best way to become familiar with the subsurface conditions of a project site is to conduct a thorough geotechnical investigation of the site (or make sure that one is provided by the owner). The report should be performed by a reputable and experienced geotechnical engineer, and should be based upon borings made at every turbine location and at selected points along the roads and substation locations. The report should contain a description of the soil types at each boring, groundwater elevations, electrical and thermal resistivity testing results, and a full array of laboratory analyses of the soil (particle size, moisture content, Atterberg limits, compaction testing results, chemical analyses, etc.). In addition, the report should contain recommendations for the type of foundations that are appropriate for the soils conditions, as well as recommendations for the civil infrastructure design parameters.

A properly performed geotechnical report can provide the information the contractor needs to evaluate the risks of any surprises from unforeseen subsurface conditions. In addition, the report will provide the information needed to design the roads, foundations and electrical collection system without any undue risk of errors caused by unanticipated subsurface condition. In contract terms, the report should demonstrate that the contractor has performed the necessary due diligence required to become familiar with the local subsurface conditions, and avoid the risk of differing site conditions.

PRE-EXISTING HAZARDOUS MATERIALS

Contractors should strive to limit their responsibility with respect to the presence of hazardous materials at the project site to things that they can control (i.e. hazardous materials that are brought to the site by the contractor or its subcontractors). The obvious major risk is the presence of hazardous materials that are unbeknownst to either the contractor or the owner. In such cases, the risk should be on the owner since they are party with the greater ability to control the risk. In instances where pre-existing hazardous materials or conditions are encountered by the contractor, its responsibility should be limited to first promptly notifying the owner, and then performing any legally required "emergency" actions before leaving the area (with its costs borne by the owner). As long as the contractor's actions are not negligent, it should not be responsible for the existence, discovery, or release of pre-existing hazardous materials.

Julian Bell is the director of preconstruction for Signal Energy Constructors, an EPC/BOP utility-scale renewable energy contractor. For more information visit: www.signalenergy.com.

Jack Wallace
Frontier Pro Services

Listen to the story that turbine data is trying to tell you, and let it be your trigger for action in avoiding surprise failures.

I DON'T WANT TO WASTE MY TIME, labor, or money doing unnecessary things.

This year I have spent much of my time here talking about data collection on wind turbines in a variety of forms. This is because I want to know when I should do something—when I should react. I am looking for a trigger point to intelligently move into action.

Let's face it, wind turbines will eventually have problems. So far, every machine I have ever worked on has needed grease, and has broken down. When it comes to maintenance, I figure that you have two options. The first option is to collect data and determine where you should be spending your time, labor, and money. The alternative—your second option—is to just guess or wait until the machine breaks down, and then react to fix it.

The problem with waiting and reacting is that you may never catch up. You will always feel like you are in the dark and be frustrated by the loss of control of the consumption rate of your resources. Besides slowly falling behind, surprise failures affect the entire team's morale, demolish budgets due to high repair costs, and cause revenue losses due to the turbine being off line. The best you can hope for is an insurance claim, such as when a turbine totals itself out (e.g. a failure due to fire).

Even when you have data from multiple sources, the machines are still subject to failure. The difference is there are fewer surprises when you can see the failure coming at you. Sometimes data collection allows you to catch and solve the problem in one machine, and make proactive repairs to other turbines before the the same failure affects all the machines in the fleet.

Sometimes, it makes sense to just let the machine fail. But there is a difference in knowingly letting it fail and having a failure occur without warning. Armed with data, the failure doesn't catch you by surprise. The team knows what is going to happen and can plan for it accordingly.

It's kind of like going to the dentist. When I go to the dentist, I like to know what the dentist is planning on doing. I sure I don't want him surprising me.

Many of the articles written here this year concerned with different ways of collecting data so as to get a feel as to what is going on for each turbine's critical components. Each one of these data collection methods is a way to get data to trigger an action. The action part is key. Data collection by itself is not the goal. This data needs to be formatted so that it is able to be reviewed by someone. This should be done immediately in order to maximize the benefits. As such, it makes sense to incorporate incentives for employees who review the data. They should constantly be asking "Where is the new data for us to review?"

I'm sure many feel that they are overloaded with data, but this data is very important, and for some types of failures, time is money. The quicker you are able to react to what the data is telling you can often mean the avoiding significant unplanned added costs.

Even those who are not familiar with the intricacies of the different machinery components can notice trends, and will be able to tell when things are out of the norm. They may not know what is going on, but they can see that something is different and can ask for help from someone who is more experienced.

Sometimes I hear or see that maintenance data is not being reviewed on a timely basis. Ignoring that constant stream of data may seem trivial most of the time. It may seem like you are reducing your workload. Maybe you are. But in reality it just means that, in the event of a failure, you may realize that the data you ignored was telling you a story. The failure may even have been avoidable. Instead, it caught you by surprise and cost your team.

Oil sampling, for example, is a common data collection method that requires analysis. If not followed through properly, there are many areas in which data from oil sampling can fail to be functional.

The first area of failure is taking the oil sample improperly. There are many ways to mess this up, and all have their failure modes. Taking the oil sample at the wrong location or at the wrong time (such as during a period of long-term machinery standstill) introduces the risk of the sample becoming contaminated.

Another failure in prompt data collection occurs when the retrieved oil samples are allowed to bounce around a few days in a truck, or to sit on the counter or desk for weeks before finally sending them in for analysis.

The next failure point in the oil sample cycle occurs when emails containing oil sample data are ignored by the recipient.

A bad oil sample is a trigger to cause action, not an action in itself. The final step in an oil sample cycle should be the review of the data by the technician who took the sample. The technician should be asking to see the oil sample results. If the technician sees the results of their work, they are more likely to perform the task properly, eliminating sampling failures before the data is collected, because they will want to know the results of their work.

Do any of these problems seem familiar? If so, it is time to step up and improve your data collection review.

That's just one example of how data can be used to trigger a service or action.

Jack Wallace is director of wind turbine technical services for Frontier Pro Services. He can be contacted at jwallace@frontierpro.com. For more information on Frontier Pro Services, visit www.frontierpro.com.

Wayne Harmond
Environmental Quality Consulting, LLC

Tower Ring method for cleaning wind towers significantly raises safety and environmental standards.

HEALTH AND SAFETY EXPERTS will tell you: "The best way to reduce risk, is to eliminate the risk." Pretty simple logic, right? Try applying that philosophy to cleaning 300-foot-tall wind towers!

Wind power generation has been around for decades now. Local, state and federal initiatives are supporting (and in many cases, mandating) the movement toward renewable energy production—with wind power leading the way. While wind energy production has many proven advantages over less "green" electrical power generating sources, wind turbine generators (WTG's) are still subject to mechanical failures that can result in environmental, health, and safety impact. For example, gearboxes can (and sometimes do) leak. Seals, fittings, and hoses can (and sometimes do) fail. These leaks and failures can allow lubricants, mineral oils, synthetic oils, hydraulic fluids, and greases to escape. With the major components of the WTG being housed uptower, any significant oil, grease, hydraulic leak or catastrophic failure is going to have those substances running down the length of the tower—making their way to the ground/soils or water table. Not only is the leak unsightly (ugly), it also creates an environmental hazard.

Traditionally, the preferred way to clean WTG towers was to have technicians hanging/suspending from ropes; raised in a man lift, boom truck, or crane; or attached to a hoisted scaffolding system (sometimes more than 300 feet above the ground). In addition to the possibility of falling from heights, these methods submit technicians directly to wind, heat, rain, and other weather conditions—exposing them to even greater risk.

Brothers Sonny and Broque Fraughton of Evanston, Wyoming-based Gladiators Cleaning, make their living washing trucks and cleaning coal mining equipment. Through their knowledge of and expertise with heavy equipment and vehicle cleaning, the pair devised a practical and ingenious solution and applied it to the wind power industry. Instead of using people to clean the towers, they developed a high-pressure, heated water, washing "ring system," that fits entirely (360˚) around the tower, to do the work (see photo).

For the past two years, the brothers have been working with a team of wind energy professionals, electrical engineers, and auto wash system experts

to perfect their "un-manned" WTG tower cleaning system. After developing and patenting their tower ring apparatus, they took their equipment (remote controlled hoist truck and pressure wash system) out to the wind farms. There, they met and partnered with Greener Solutions (www.greenersafer.com) to identify and utilize safe, high-powered, environmentally friendly cleaning chemicals to safely and quickly remove the dirts, oils, greases and other contaminates from the WTG towers and equipment. In addition, they also employ the use of microbial based cleaners/de-greasers for bioremediation (using hydrocarbon feeding microbes to "eat" the contaminates).

The risks associatied with high winds and dangerous weather (safety regulations) related to technicians hanging from ropes or being raised in man lift baskets, are much higher than when using the unmanned ring tower cleaning method and equipment.

This allows for the ring system to be safely utilized in scenarios where traditional methods would put people and their equipment at higher risk.

It also means less stand-by/down time when wind conditions become marginal. As a result, Greener Solutions and Gladiators Wind are now approved product and service providers for clients like: Suzlon, PacifiCorp Energy, EDF, EDPR, GE Wind, Iberdrola Renewables, among others. The unique ring apparatus design and industrial cleaning methods are giving OEM's, wind farm owners, and service providers a safe, efficient, responsible option to consider when it comes to WTG tower cleaning.

Wayne Harmond is managing partner of Environmental Quality Consulting, LLC in the state of WA. Environmental Quality Consulting works in multiple industries identifying practical and cost-effective ways to improve Environmental, Health & Safety standards.

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TEAM-1 ACADEMY

By Tim Byrd

Oakville, Ontario-based TEAM-1 Academy draws on two decades of emergency rescue experience in delivering its portfolio of training, services, and equipment to the wind energy industry.

FOR TEAM-1 ACADEMY, one success has led to another. Success in the hazardous waste management and industrial cleaning markets, complimented by a grand total of zero injuries, planted the seeds for their HazMat response team. HazMat response teams, formed in 1995 and sold in 2008, specialized in cleaning up high-hazard chemical spills and conducting high-hazard confined space entry work.

"Many of these confined space jobs involved technical rope rescue, which allowed us to get into doing stand-by rescue for confined spaces and working at heights," said Scott Connor, director of training for TEAM-1 Academy. "Our rescue/safety equipment division came from repeated requests by many of our customers to provide such a service. We are the authorized distributor of many of the top manufacturers in the world of safety and rescue. We only promote manufacturers that our own rescue teams use their products. So right now we have three main departments: training, equipment sales, rescue/rope access services."

Successful in these areas, TEAM-1 naturally became a popular choice to conduct training sessions to the fire service, police, and the military—both in Canada and the U.S.

Continuing that trend of evolution and expansion into emerging industries, TEAM-1 has been able to grow with the wind industry sector since the company began. "It's growing everywhere," Connor said. "Our company deals with all industry sectors, and the wind/renewable energy sector is an exciting one."

It's a natural progression from TEAM-1 to the wind industry; its fall protection/rescue-from-heights courses are widely recognized. Connor said, "So much of the work that is done on the wind turbines involves some type of fall protection and having rescue capabilities. It was a natural transition for many of our customers that already use us in their other divisions to start using us in their wind businesses."

In addition to safety/training courses, TEAM-1 also performs on-site services such as equipment inspections and confined space stand-by rescue services. The company also sells top-line safety and rescue equipment, including fall protection gear and hand/eye/ear/foot protection.

One example of TEAM-1's commitment to the wind energy industry is its regular presence at industry trade shows and exhibitions. The company will be exhibiting this year at the Canadian Wind Energy Association's Annual Conference and Exhibition in Toronto (booth 1100).

"We look forward to the CanWEA show every year," Connor said of the event. "All our customers attend and it is great to see them and show them our newest products. We look forward to meeting new customers and will answer any questions they have should they come to visit us. The CanWEA show is a great show and we are proud to be a part of it."

As members of SPRAT (Society of Professional Rope Access Technicians) and ISFP (International Society of Fall Protection), TEAM-1 encounters various wind energy scenarios on a regular basis. It's helped them develop fast and professional solutions to difficult access problems such as blade inspection, painting, and cleaning.

Fully-insured and offering CEU's, TEAM-1 provides training courses and other services for Canadian government (provincial and federal) environmental, safety, and inspection agencies, along with some of the largest companies in the world. Last year, TEAM-1 attained ISO9001 and 18000 certification (their company facilitates close to 1,000 safety and rescue courses per year without any injuries); many of their clients have been with them for over 20 years.

One of the key contributors to TEAM-1's being recongnized as an authority in rescue and at-height safety training, Connor explained, is its staff of experienced, communicative instructors, who do more than simply "instruct." These instructors have the benefit of extensive experience and are the backbone of these sessions.

"It is easy to find people that know the information," Connor said. "Very few people can convey it professionally. We will only hold a training course if we can do it very well—we don't just hire any instructor. It may take years before an assistant instructor with our company becomes a lead instructor."

So when a customer calls last minute with a need for a training session, TEAM-1 makes an effort to cover it with one of their 16-plus instructors. If no instructor is available, there's no settling for less.

"We refuse to contract some so-called instructor off the street to make a buck. Imagine if an accident occurred during a training exercise or on the job—when the investigation team or prosecution learns of this, they will have a heyday."

The training normally takes place at the

For more information visit www.team1academy.com.

customer's site. TEAM-1 travels all over the world to conduct training sessions to ensure the customer is learning their equipment at their location. Of course, this on-site option isn't ideal for all customers, some of whom can't free up the location or have too many on site disruptions, so TEAM-1 offers three training locations, located in southern Ontario, to be used at no extra charge.

"The customer may have employees that need to travel to the training location from all corners of the continent," Connor said. "Our southern Ontario training centers are close to major airports and hotels and are very safe places to be."

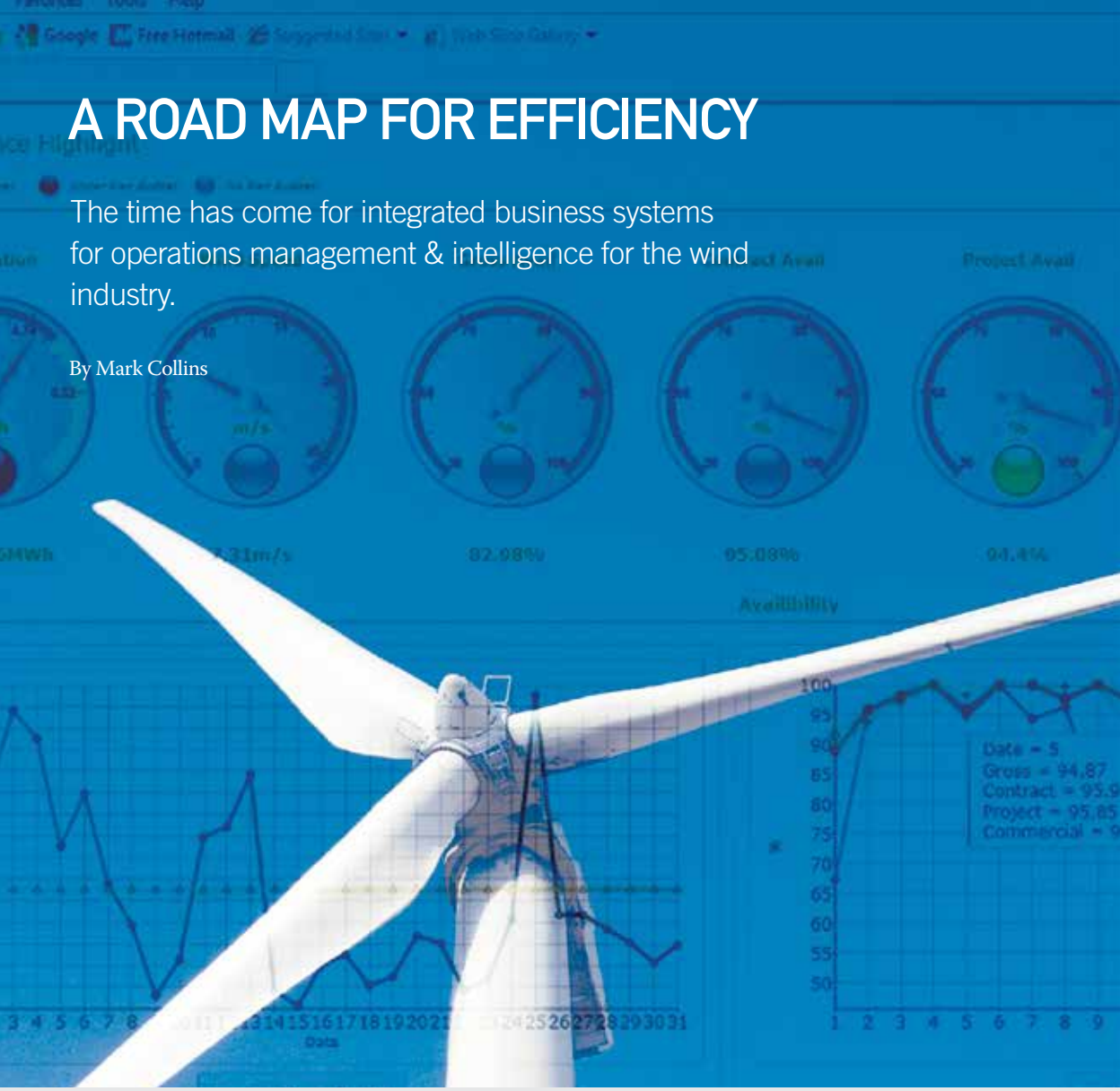
"People are most impressed that we could do such dangerous work and never have an injury," Connor continued. "That record remains to this day. We encourage our potential customers to do their homework and their due diligence and they will see why we are the most recommended and trusted name in rescue and safety. Our philosophy is simple: provide services that are the benchmark for the industry and maintain this under all costs. A company works so hard to get a reputation like ours and our employees realize that. Our employees are proud of the company name and reputation."

A TEAM-1 Academy crew works atop a nacelle.

A ROAD MAP FOR EFFICIENCY

The time has come for integrated business systems for operations management & intelligence for the wind industry.

By Mark Collins



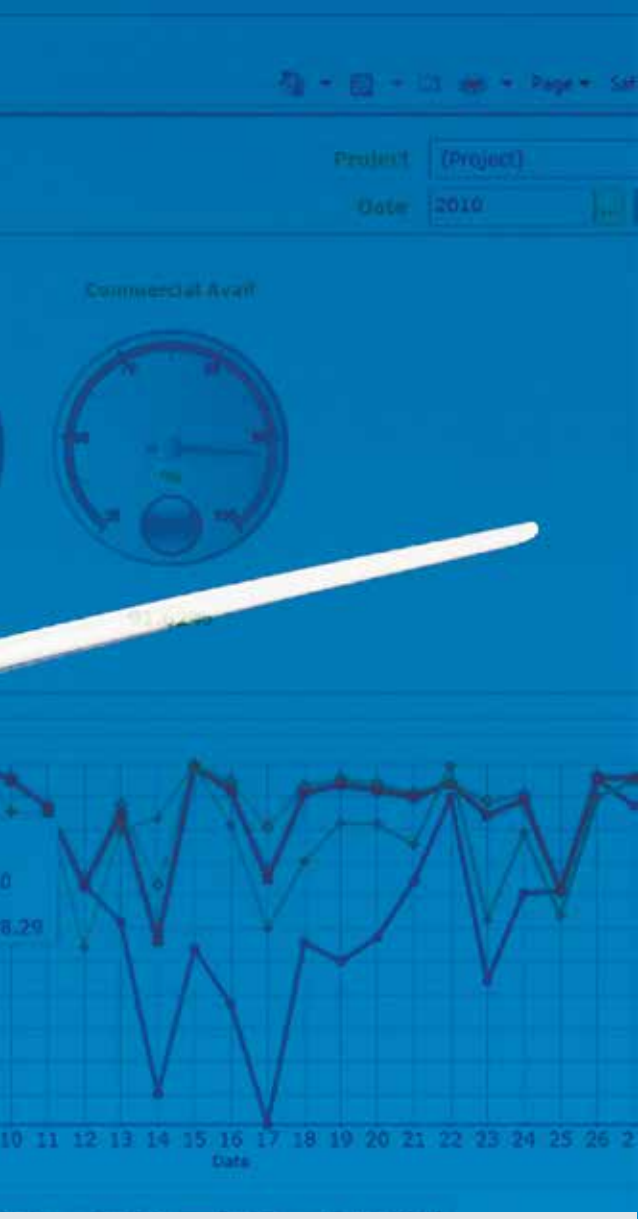
Mark Collins is the President of Ekhosoft. He can be reached at (425) 922-1900, or by email at mark.collins@ekhosoft.com. For more information about Ekhosoft and the Ekho for Wind software, call (450) 462-8105 Ext 111.

THERE HAVE BEEN MANY SIGNIFICANT advances in software for the wind energy industry over the past decade. A search of the Internet reveals hundreds of different software products for the wind industry, covering specific topics such as: site selection, wind forecasting, turbine design, wind data analysis, wind farm modeling and visualization, and flow modeling, among others. These are primarily engineering and design tools. While they are important in their own right, they do not help in the day-to-day operation of the business.

You can also find standalone products from other industries for applications such as: project management, maintenance & spares inventory, health and safety, land lease and royalty payments, and contract management, as well as standard enterprise resource planning (ERP) solutions for accounting and finance, which can be applied to any industry.

However, this same search does not return a single result for an integrated solution for the overall management of wind farm operations—a solution that would bundle together all of the required operations management and intelligence applications into a single, integrated solution for running the business.

This situation has also existed—and has been successfully addressed—in other industries. Initial solutions tended to be "point solutions," which were focused on a specific topic.



Over time, problems developed with duplication of data and processes, and there were difficulties in integrating the different "islands of automation."

Further solutions were later developed to address these problems, initially in discrete manufacturing, and subsequently in process industries. In those industries today, we see two very important developments which have resulted in the elimination of the problems:

- The creation of standards for deploying information systems
- The development of integrated solution maps for the required applications.

As a result, software companies started building integrated solutions, with industry-standard interfaces. In manufacturing today, there is a wide selection of integrated solutions available to the benefit of all prospective customers.

These same developments need to be brought into the Wind Industry.

DEVELOPMENT OF STANDARDS

A key example of standards for manufacturing systems is ISA 95, as seen in Figure 1.

These same levels of automation exists in the wind industry. While significant progress has been made at the lowest level by integrating sensors and SCADA systems, as well as standard ERP solutions for accounting and finance, little has been done in developing integrated solutions for the middle layer—operations management and intelligence.

SOLUTION MAP

The time has come to specify a similar solution map for the wind industry, in which:

- all of the functions required for operations management (running the business) are addressed;
- the solution provides the operational intelligence for performance management;
- the system is built around a common, shared database;
- the solution provides seamless integration of related systems and data from operations (SCADA, data historians), with the business systems (ERP, financials), as well as the Internet (forecasting and pricing).

The following represents an initial proposal for the desired content of a solution map for an operations management and intelligence system for the wind energy industry.

Just like the ISA 95 standard for the manufacturing industry, the standard model for the wind industry should consist of five layers, as outlined in Figure 4. Here, the solutions in Levels 1, 2 & 4 are well developed. The balance of this section will focus on the application needs for Level 3 – Operations Management & Intelligence. The individual modules are grouped into subsystems under the headings of "Generation," "Maintenance," "Health & Safety," "Accounting & Reporting," "Performance Management," and "Technology." The proposed solution map calls for a common data structure, and for integration between all of the modules. This is accomplished through the use of a common set of foundation modules.

FOUNDATION MODULES

The foundation modules include the basic building blocks to configure the system for use, and include: Asset Hierarchy; Event Manager; Performance Criteria; Electronic Logs; Alarms and Notifications; and KPI (key performance indicator) Manager.

- Asset Hierarchy—This module allows the user to manage overall asset hierarchy, from organizational units

(company, geographical unit, division, plant, etc.) down to equipment, sub-assemblies, and components. There is no limit to the number of levels the user can create in the hierarchy. The asset hierarchy module is the backbone of the software solution—against which all performance criteria, events, and activities are structured. This solution seamlessly integrates with other standard industry solutions [ERP, computerized maintenance management systems (CMMS) and data historians] to provide the information on asset availability to all foundation modules and application modules

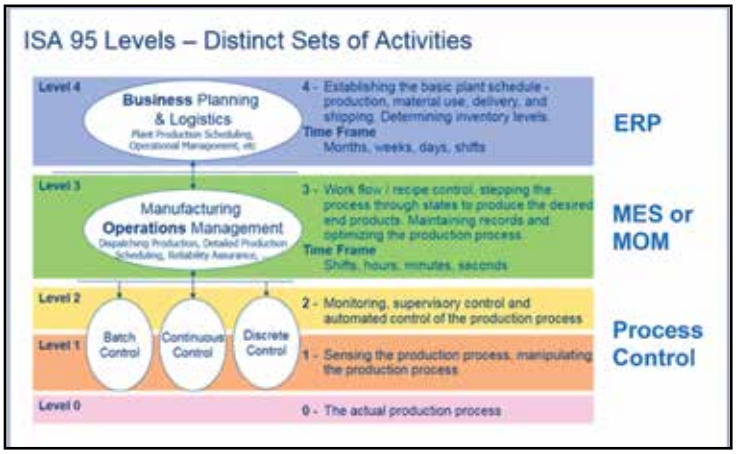


Figure 1: ISA 95 manufacturing standards.

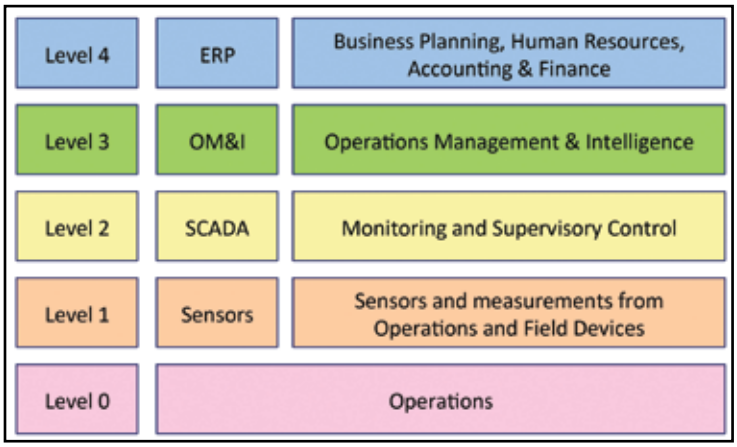


Figure 2: Layered structure of proposed wind energy solution map.

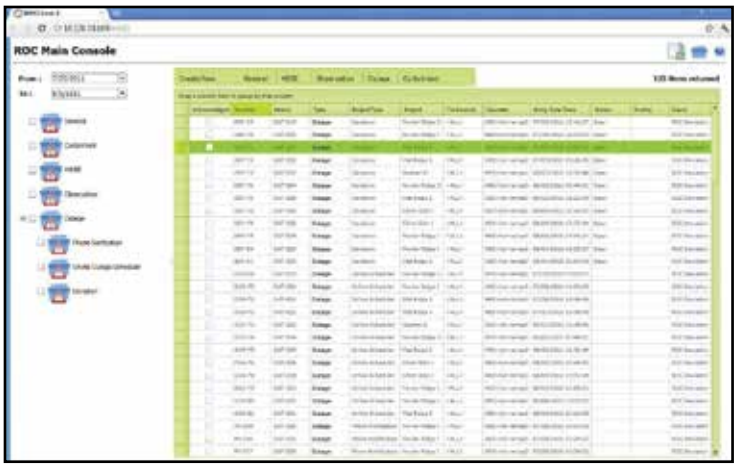


Figure 3: Screenshot–Electronic Logs.

- Event Manager—Operating and non-operating events within the organization are detected, recorded, and communicated through the Event Manager Module. This module (Figure 10) is suited for monitoring operating events that cannot be tracked manually or with traditional system alarms. It can also capture events either electronically or manually. This module automates and highlights unusual conditions, and notifies the user when these events occur. As a result, the user is able to reduce operating costs and improve yields with fast, effective follow-up, while improving regulatory compliance, reducing incidents, and analyzing events.
- Performance Criteria—Once the Asset Hierarchy has been established and attention switches to collecting data for analyzing performance, the targets, standards, or metrics for the different events (performance criteria), must be established. Examples include: the rated output of the wind turbine for different wind speeds; expected operating temperature for wind turbine gearbox oil; and the schedule for preventive maintenance tasks. Performance Criteria can also be established for the business—for expected daily generation; target for real-time energy prices; and other daily, weekly, monthly, or annual statistics.
- Electronic Logs—This module provides an electronic log framework (Figure 3) to allow users to make log entries under predefined categories such as safety, environment, and operating procedures, among others. The log entries should be supportable with any digital media (voice, pictures, videos).
- Alarms and Notifications—The Alarms and Notifications engine is intended to notify users that any predefined situation may be developing or occurring. Notifications can be sent via email or text message. The

Figure 4: Screenshot–Generation.

software includes an escalation function should there be no response within a predefined time frame.

- KPI Manager—This module provides a real-time solution framework for the collection, analysis, and calculation of key performance indicators. The KPI Manager delivers accurate and timely information the user needs in order to enhance visibility into operations and increase the efficiency and effectiveness of resources. It provides accurate key performance indicator data throughout the organization, allowing everyone to drive performance improvement initiatives. The KPI Manager rolls up low-level performance indicators (such as unit-specific production generation) to high-level business objectives (e.g. site productivity or asset utilization). Users can quickly drill down to view actual performance measures and respond appropriately.

GENERATION MANAGEMENT MODULES

The modules in Generation Management are related to tracking electricity generation and downtime and include: Generation, Downtime, Outage Management, Generation Forecast, and Lost Generation Analysis.

- Generation—Generation data—collected from SCADA systems through the data historian or other central collective—is tracked by individual asset, summarized, and presented in real-time display (Figure 4). This data can be used for comparisons to specifications, or comparisons between equivalent units.
- Downtime—This module pro-

vides tracks all downtime events—planned or unplanned, imposed or self-induced. These events are captured either manually or automatically, and include the capability to code events by different fault codes (e.g. manufacturer, O&M, NERC, PPM). The user should be able to review and modify all events captured in the system. Displays (Figure 5) to review event logs, as well as charts to analyze downtime by turbine, component, fault code, etc., should be included.

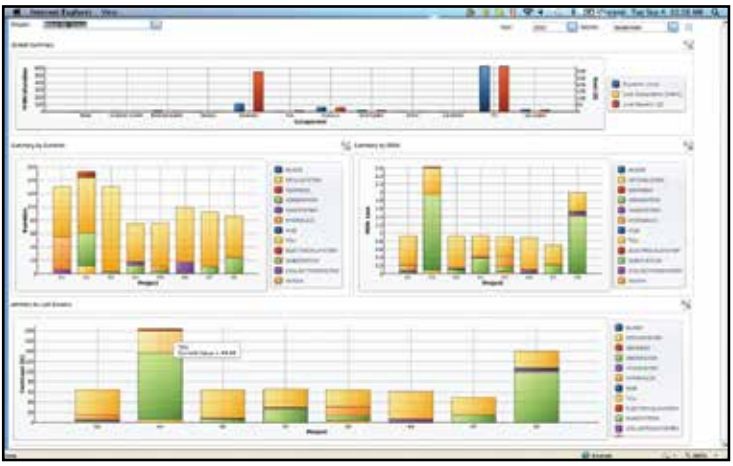


Figure 5: Screenshot–Downtime Analysis.

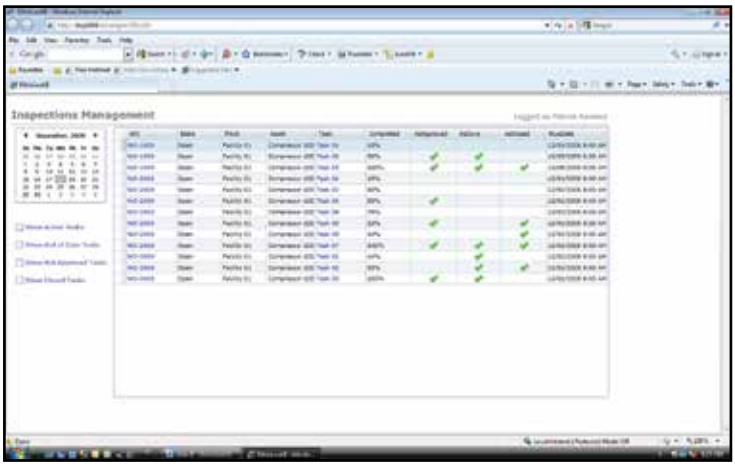


Figure 6: Screenshot–Inspection Tours.

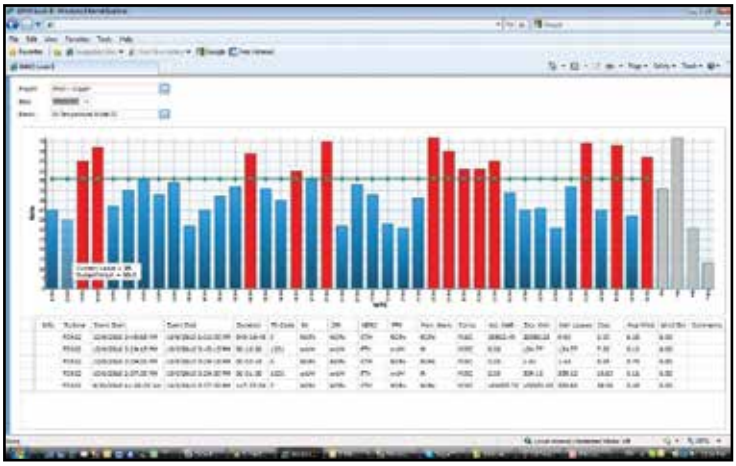


Figure 7: Screenshot–Condition Monitoring.

- Outage Management—This application supports logging and tracking of site outages—planned and unplanned—and captures generation and resource availability at the time of the outage, while triggering required notifications or work orders. This increases visibility of outage information across the organization; ensures that key personnel are notified of outages; captures critical information associated with an outage; and ensures the required procedures are followed for bringing a unit back online.
- Generation Forecast—An environmental forecast is brought into the system from a third-party provider. This information is used to calculate the expected generation from each asset, considering known outages for maintenance or curtailment. The generation forecast can also be converted to a financial forecast based on market or contact prices.
- Lost Generation Analysis—This module allows the user to analyze and categorize all lost generation, both in terms of lost production and lost revenue. Standard reporting categories in the industry are: generation, gross availability, contract availability, project availability, and commercial availability. The solution must also consider downtime related to curtailment or maintenance. The loss analysis should use pricing from contract actual agreements, or real-time pricing from the Web. (Figure 9)

MAINTENANCE MODULES

The modules for maintenance functionality are those related to planning, coordinating, and tracking maintenance activity, and include: Equipment Records, Maintenance Information, Work Orders, Inspection Tours, Condition Monitoring, and Spares Inventory.

- Equipment Records—This module allows the user to maintain a

complete hierarchical record of all operating equipment. There should be no limit to the number of levels in the hierarchy, and the asset hierarchy should include all subcomponents (e.g. sub-assemblies and parts). Ideally, the Equipment Records module also points to digital records of the equipment such as engineering drawings, pictures, and operating manuals.

- Maintenance Information—Detailed information should be associated with the equipment records, specifying the maintenance work to be done, the interval between service, the job skill requirements, and the spare parts and tooling required for the work.
- Work Orders—The system should support work orders for different types of activity, such as inspection tours, corrective maintenance, and preventive maintenance. The work orders should clearly identify the following: equipment involved; safety procedures to be followed; repairs to be made; parts and tools required; and the expected start and completion date of the work.
- Inspection Tours—This function (Figure 6) allows the user to use printed reports or mobile devices to specify safety or maintenance inspection requirements to field personnel. With mobile devices, the user can easily communicate maintenance tasks (safety procedures, job steps, drawings, etc) to field personnel, who in turn can use the device to indicate task completion, record verbal comments, or take photographs and videos of the situation.
- Condition Monitoring—This mod-

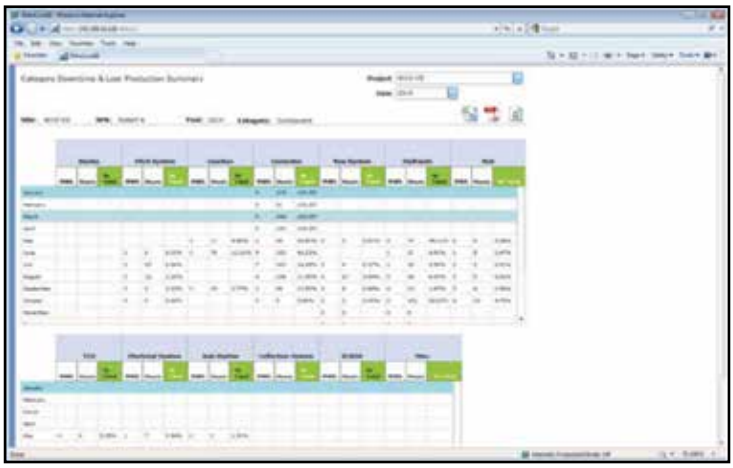


Figure 8: Screenshot–NERC GADS Reporting.

ule (Figure 7) allows the user to collect condition data from the operating units, comparing this data standard or expected values. It also triggers any necessary alarms, alerts, notifications, or work orders. The system should handle any type of condition measures, including vibration analysis, oil sample analysis, bore hole photography, and dynamic loads, while coordinating this information with other system data (e.g. weather conditions, generation data).

- Spares Inventory—Here, the user can track the quantity and location of all spare parts, subassemblies, or tools, along with the associated information for procurement. The module should also allow for tracking equivalent parts or allowable substitutions. In the case of repairable or re-usable parts, the module should also allow for tracking usage history of such parts.

Figure 9: Lost Generation Analysis.

Figure 10: Screenshot– Event Viewer.

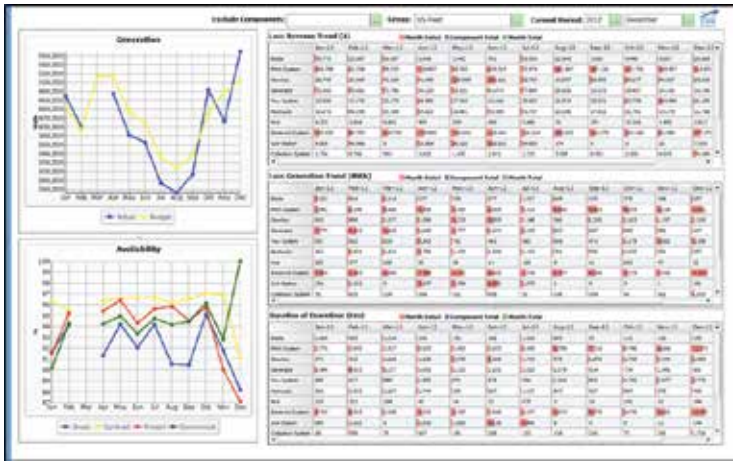


Figure 11: Screenshot–Management Dashboard.

HEALTH AND SAFETY MODULES

- Incident Tracking—Our incident tracking application allows you to enter new incidents and assign them to the right personnel for investigation and resolution. It classifies incidents in a variety of categories enabling powerful search capabilities and flexible reporting.
- Work Place Hazards—This application assists workplace safety professionals in documenting workplace and material hazards, and in recording a complete history of the hazard investigations and assessments. It covers job safety analysis, ergonomic analysis, lockout/tagout, and risk assessment. It also allows the user to record any events and analyze them using the root cause analysis application.
- Compliance Management—Provides the user the ability to make compliance programs repeatable, sustainable, and cost-effective. Compliance Management provides a common framework and an integrated approach to manage all compliance requirements faced by an organization. It enables companies to manage cross-industry mandates and regulations such as SOX, OSHA, EH&S, and FCPA, as well as industry-focused regulatory guidelines from FDA, FERC, FAA, HACCP, AML, Basel II, and Data Retention laws.
- OSHA Reporting—This application allows the user to track all health and safety issues, material and workplace hazards, and risk assessments, and has the capability to generate all OSHA standard

reports. The module can easily track safety investigations and audits, while also providing the ability to record the costs associated with safety incidents. In addition to standard reports, this module lets the user create personalized dashboards and analytical reports to optimize reporting.

- Environmental Issues—This module provides users a means to track all issues related to the environment in one central system. It allows you issues related to land use, track oil spills and waste disposal, and track issues related to wildlife and birdlife. The software can also track the noise created by wind turbines operating in different wind conditions.

ACCOUNTING AND REPORTING MODULES

The modules in Accounting and Reporting are those related to executing accounting tasks, as well as providing in-house and statutory reporting about operations, above and beyond the functionality ERP solutions provide, and include: Energy Settlements, Lease and Royalty Payments, NERC GADS Reporting, Revenue Forecasting, Day Ahead Training, and Warranty Management.

- Energy Settlements—All Generation and downtime information is paired with metered data and pricing information to calculate Energy Settlements. Pricing data can be taken from contracts or from real-time pricing on the Web, and can also be used to value losses from downtime events.
- Land Lease & Royalty Payments—This application tracks all of the agreements for the user's operating assets. It manages contracts for land lease and royalty payments, automatically triggering payments for any period and/or frequency. It also allows the user to preview the complete output to ensure accuracy and completeness prior to transferring the data into an accounting system.
- NERC GADS Reporting—The application should be programmed to generate the reporting requirements specified by the North American Electric Reliability Corporation (NERC) Generating Availability Data System (GADS). It allows users to gather and verify event and performance data, as well as analyze (Figure 8) current and historical event and performance data, including energy availability, outages, and demand factors.
- Revenue Forecasting—The revenue forecast application allows the user to import weather condition forecasts, and then calculate a generation forecast

using the historical performance of each asset (taking into consideration all planned maintenance outages, curtailment, or other planned outages). It also translates data into revenue forecast by accessing contract pricing stored in the system, or by accessing real-time pricing data on the web.

- Day-Ahead Trading—Comparing forecasting module information with customer power commitments, the software can predict anticipated surplus generation for a future time period. This surplus can then be offered on the day-ahead trading market at asking price.
- Warranty Management—This module allows the user to monitor all assets under warranty, tracking work performed and replacements made during the warranty period. This includes tracking parts or sub-assemblies that have been removed, repaired and put back into service as warrantied parts on other turbines. This system should be put in place well before the equipment comes out of warranty, so equipment records are established and the maintenance tracking procedures are in place.

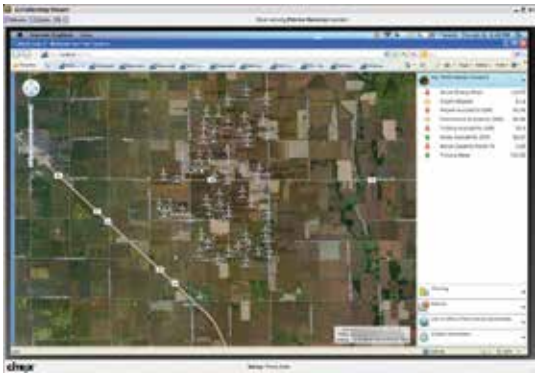


Figure 12: Screenshot–Visualization.

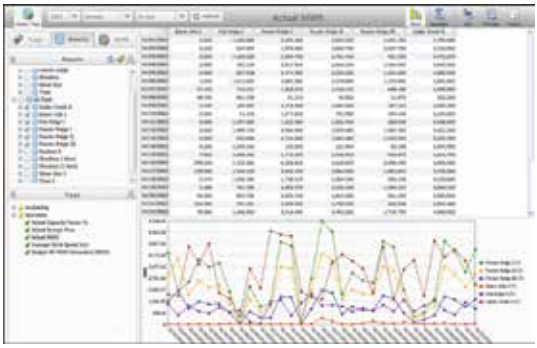


Figure 13: Screenshot–Data Mining and Analysis.

PERFORMANCE MANAGEMENT

The modules for Performance Management are those related to collecting, analyzing, and reporting on all data across the organization, and include: Operational Planning, Capacity Analysis, Performance Analytics, Comparative Reporting, Root Cause Analysis, and Activity Tracking.

- Operational Planning—This enables improvement of operational planning capability through increased visibility of key site-related data. It consolidates critical operations data into a single, centralized location for visualization and analysis. Planned and unplanned downtime events, scheduled and unscheduled outages, and weather forecast data are all centralized into a single, consolidated system that can provide the insight needed to enhance operational planning.
- Capacity Analysis—Gaining insight into project capacity can dramatically increase the profitability of renewable asset(s). Whether it is individual wind turbine power curve or an entire wind farm's peak power, the capacity analysis application provides the operator with the ability to understand how well assets are performing in relation to their rated capacity.
- Performance Analytics—Allows the user to create performance summaries for all operating assets, including measures such as gross, contract, and commercial availability, performance to manufacturer's standards,

SOFTWARE FUNCTIONALITY FOR OPERATIONS MANAGEMENT & INTELLIGENCE FOR WIND FAMRS						
Performance Management	Operational Planning	Capacity Analysis	Performance Analysis	Comparative Reporting	Root Cause Analysis	Activity Tracking
Accounting & Reporting	Energy Settlements	Land Lease & Royalty Payments	NERC GADS Reporting	Revenue Forecasting	Day Ahead Trading	Warranty Management
Health & Safety	Incident Tracking	Work Place Hazards	Compliance Management	OSHA reporting	Safety Inspections	Environmental Issues
Maintenance	Equipment Records	Maintenance Information	Work Orders	Inspection Tours	Condition Monitoring	Spares Inventory
Generation	Generation Data Capture	Downtime	Power Curve Analysis	Outage Management	Lost Generation Analysis	Generation Forecast

Table 1: Completed solution map for Operations Management.

UNDERLYING TOOLS AND TECHNOLOGY						
Visualization	Design Studio	Map Overlays	Summary KPI's	Drill Down Capability	Configurable Dashboards & Reports	Mobile Support
Foundation Modules	Asset Hierarchy	Attribute Definition	Event Manager	Performance Criteria	Electronic Logs	KPI Manager
Underlying Technology	Interface to SCADA	Interface to Data Historian	Interface to Business Systems	Interface to the Web	Messaging Network	Mobile Technology

Table 2: Intelligence for wind farm management.

and comparative performance. The software should support hundreds of thousands of data calculations, generating actionable intelligence to support performance improvement initiatives and the pursuit of increased ROI.

- Comparative Reporting—One of the key benefits of an information system independent from a particular vendor's SCADA system is that it allows the user to consolidate and compare data from different units. This can be accomplished by establishing codes for normalizing data from different sources. Examples include using fault codes from multiple vendors, and comparing performance of similar turbines in different areas versus the prevailing wind speeds in those areas.
- Root Cause Analysis—The root cause application should serve an accountability function. It enables the user to analyze structures, prioritize corrective actions, and track progress. This ensures that resources are focused, to avoid performance losses. Root Cause Analysis improves problem resolution with automatic and precise downtime logging, tracks implementation of recommendations, and allows the user to assesses effectiveness of recommendations.
- Activity Tracking—Projects are defined and broken down into specific tasks, including responsibility, start/end dates, priority, targeted results, and risk evaluation. Daily updates can be viewed both on a per project basis as well as in schedule performance charts. Hierarchical management of data allows authorized viewing up the organizational ladder. Impact of change activities can be measured over time.

Software supports drill down to source data.

ADDITIONAL FEATURES

- Design Studio—The Design Studio allows for creation and/or modification of displays and reports within the system. The user can also configure customized KPI's, as well as create custom modules within the software.
- Visualization—The software should provide tools for visualization (Figure 12), including map overlays, a dashboard object library, dashboard/report templates, and a library of pre-defined KPI's.
- Import/Export—The software should allow the user to import data from external systems (e.g. bulk loading specific turbine fault codes, or importing regional wind forecasts). The software should also allow exporting of data to related systems, as well as the export of on-screen content to Excel or PDF formats.
- Interfaces—This includes the software required for interfacing with other related business systems, SCADA systems, data historians, or the Web.
- Mobile Technology—With the exponential growth of mobility and due to the distributed nature of the wind energy assets, it is imperative that the system solution utilize mobile technology. Alerts and notifications should be transmitted to mobile devices. Dashboards, performance summaries, and KPI's should be visible on smartphones and tablet computers.
- Messaging Network—This module allows users to have better interaction with the platform's data flow. By providing a push-and-pull mechanism, users are able to experience enhanced interaction with module applications and faster notifications from any computer, or device connected to the Messaging Network.
- Data Mining & Analysis—The software should allow for ad hoc data mining and querying of the data, making selections by asset, event type, tag status, or tag information. Results should be presentable in tabular form or in charts (Figure 13), and the user should be able to perform "what if" analyses or causal analyses on the resultant data.

THE END PRODUCT

If we summarize all of the preceding information into a single model, we end up with the solution map for Operations Management and Intelligence for wind farm management, outlined in Tables 1 and 2.

Hopefully this will be viewed as a viable first step in the creation of an overall model for Wind Farm Information Systems. Ekho for Wind, from Ekhosoft, has been developed in accordance with this proposed standard model. The author welcomes feedback and suggestions on the proposed model, and is open to inquiries about Ekho for Wind.

POTENTIAL ECONOMIC IMPACTS FROM OFFSHORE WIND IN THE UNITED STATES – THE SOUTHEAST REGION

Applying the offshore JEDI model to estimate economic impacts of potential offshore wind farms along the South Atlantic coast.

By Dane Zammit and Jonathan Miles

Dane Zammit is the data manager for the Virginia Center for Wind Energy at James Madison University. Jonathan Miles, Ph.D. is a Professor of Integrated Science and Technology and Director of the Virginia Center for Wind Energy at James Madison University. For more information, call (540) 568-8770 or visit wind.jmu.edu.

ABSTRACT

The Virginia Center for Wind Energy at James Madison University, supported by the National Renewable Energy Laboratory (NREL) and the U.S. Department of Energy (DOE), performed a study that applied the new offshore Jobs and Economic Development Impacts (JEDI) model to estimate the economic impacts associated with potential offshore wind power development off the coasts of Virginia, North Carolina, South Carolina, and Georgia. The Southeast region presents an ample wind resource in waters beyond 12 miles from the coast. According to the American Wind Energy Association, the region currently employs an estimated 11 percent of the total U.S. wind workforce. This analysis finds that construction costs for offshore wind within the region are among the lowest in the nation, suggesting a competitive advantage for this industry.

The major attributes associated with the region were identified and analyzed in order to define likely scenarios for offshore wind development in the region. Relevant data and justifiable assumptions were made to develop five scenarios for JEDI analysis.

1. INTRODUCTION

The offshore wind industry represents a major opportunity to provide clean, stable-priced energy

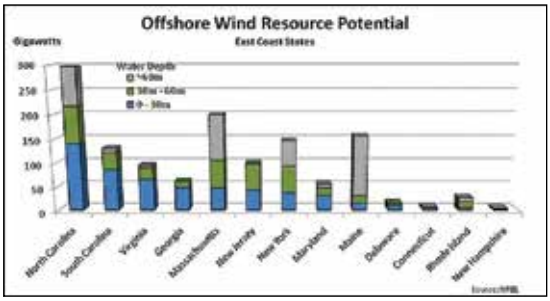


Figure 1: The Southeast region represents 45% of the total offshore wind resource and 82% of the resource in shallow water and more than 12 miles offshore.

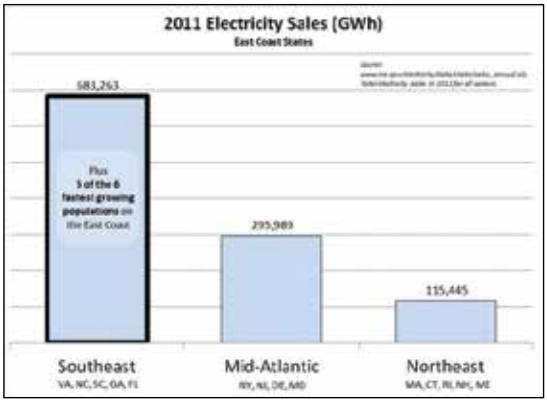


Figure 2: The Southeast region represents more than half of the total electricity sales on the East Coast.

using a domestic renewable resource, while promoting significant job growth and economic development. The industry is currently being driven by individual state policies, with Mid-Atlantic and Northeastern states all competing to become the "hub" of this new industry. While state-by-state competition can drive down costs, a regional approach would realize the full potential of the industry. Some of the benefits of a coordinated regional approach include:

- reduction of ratepayer impacts by spreading costs over a wider base
- the ability to spread costs and share lessons learned
- coordination of research, resource assessment and environmental studies
- expansion of the scope of transmission integration analyses
- allocation of economic development resources based on comparative strengths
- aggregated or collaborative procurement could result in lower energy costs

In this study, a regional approach was adopted in the development of scenarios for application to the Jobs and Economic Development Impacts (JEDI) model, to investigate the potential economic impacts of offshore wind in the Southeast. A regional overview highlighting the comparative strengths of the Southeast region—Virginia, North Carolina, South Carolina and Georgia—is provided in Section 2. The JEDI model is described in Section 3. In Section 4, the development of three distinct, justifiable offshore wind energy scenarios for the Southeast is discussed. Finally, in Sections 5 and 6, the results of JEDI model runs are presented followed by conclusions.

2. REGIONAL OVERVIEW

In order to be able to develop reasonable justifiable assumptions for the offshore wind industry in the Southeast—defined in this study to be Virginia (1) (2) (3) (4), North Carolina (5), South Carolina (6) (7) and Georgia

	Virginia		North Carolina		South Carolina		Georgia		Totals	
Year	Capacity	Growth	Capacity	Growth	Capacity	Growth	Capacity	Growth	Capacity	Growth
1990	16,155	N/A	22,075	N/A	16,721	N/A	22,302	N/A	77,253	N/A
1991	16,644	489	22,120	44	17,963	1,242	23,947	1,646	80,674	3,421
1992	18,095	1,451	22,175	55	17,969	6	24,277	329	82,516	1,842
1993	18,466	370	22,172	-3	17,832	-137	24,228	-49	82,697	181
1994	18,647	181	22,309	138	18,449	617	25,144	915	84,548	1,852
1995	19,111	464	23,475	1,165	18,443	-6	25,949	805	86,978	2,429
1996	19,858	747	23,918	443	18,845	402	25,693	-256	88,315	1,337
1997	20,217	359	23,866	-52	19,221	375	26,492	799	89,796	1,481
1998	20,064	-153	23,949	83	19,255	34	26,487	-5	89,755	-41
1999	20,041	-23	24,129	179	19,332	77	26,666	179	90,168	413
2000	20,854	813	25,986	1,857	19,925	593	29,427	2,761	96,192	6,024
2001	22,047	1,193	27,780	1,794	20,914	989	31,605	2,178	102,346	6,154
2002	21,919	-128	28,538	758	21,761	847	37,176	5,571	109,394	7,048
2003	23,041	1,122	29,342	804	22,258	497	37,626	450	112,267	2,873
2004	24,497	1,456	29,023	-319	24,117	1,859	38,498	872	116,135	3,868
2005	24,431	-66	29,013	-10	24,155	38	39,792	1,294	117,391	1,256
2006	24,415	-16	29,022	9	24,500	345	39,758	-34	117,695	304
2007	25,270	855	29,654	632	25,078	578	39,767	9	119,769	2,074
2008	25,642	372	29,647	-7	25,698	620	39,641	-126	120,628	859
2009	25,833	191	30,103	456	25,790	92	39,639	-2	121,365	737
2010	25,912	79	30,197	94	25,878	88	39,665	26	121,652	287
Total		9,757		8,122		9,157		17,363		44,399
Average		488		406		458		868		2,220

Table 1: Historical electricity capacity data (1990-2010) for the Southeast.

(8) (9), the major characteristics of the region must be understood. These include Federal and State activities, the wind resource, transmission infrastructure, ports and the existing supply chain in the region. Each state was researched thoroughly, through reliable sources as well as collaboration with local and regional experts in the region.

Federal and State Activities

The Bureau of Ocean Energy Management (BOEM) manages the exploration and development of the nation's offshore resources. BOEM runs a number of offshore Renewable Energy Programs and it grants leases, easements, and rights-of-way for orderly, safe, and environmentally responsible renewable energy development activities.

To assist the development of offshore wind energy in the region, BOEM established Renewable Energy Task Forces in Virginia, North Carolina and South Carolina, to facilitate intergovernmental communications regarding outer continental shelf renewable energy activities.

Wind Resource

According to the National Renewable Energy Laboratory (NREL), the Southeast region represent 45 percent of the total East Coast offshore wind resource and 82 percent of the resource in shallow water and more than 12 miles offshore, as shown in Figure 1. (10) NREL resource maps show that average wind speeds are slightly lower in the southern states. However, the most important metric is ultimately the Levelized Cost of Energy (LCOE), and the Southeast has numerous advantages that should result in lower LCOE in the region.

Market Size

The Southeastern states represent five of the six largest electricity markets on the East Coast with high per-capita electricity consumption and five of the six fastest growing

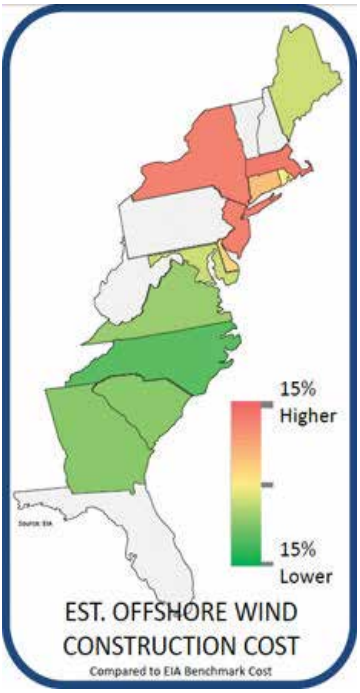


Figure 3: The Southeast is expected to enjoy significantly lower constructions costs for offshore wind energy than other regions on the East Coast.

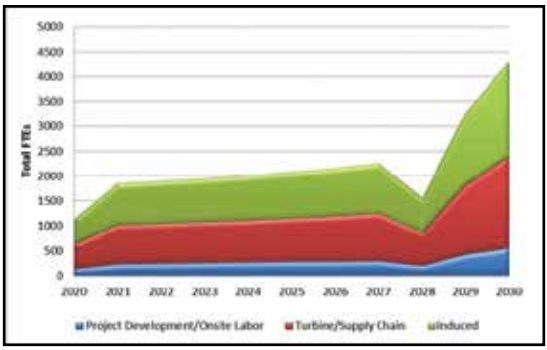


Figure 4: Total FTEs projected during construction from 2020 to 2030 for Scenario A.

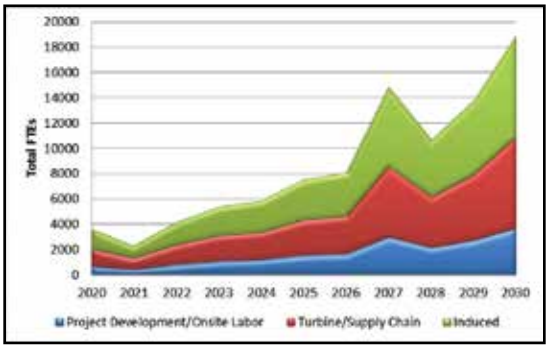


Figure 5: Total FTEs projected during construction from 2020 to 2030 for Scenario B.

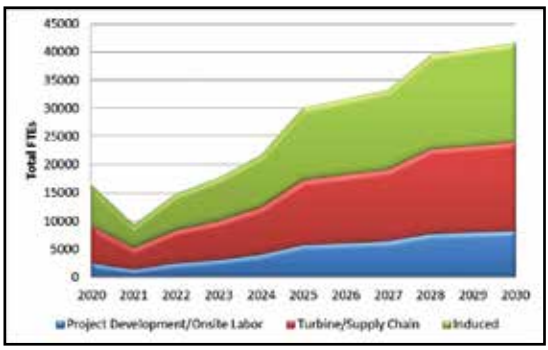


Figure 6: Total FTEs projected during construction from 2020 to 2030 for Scenario C.

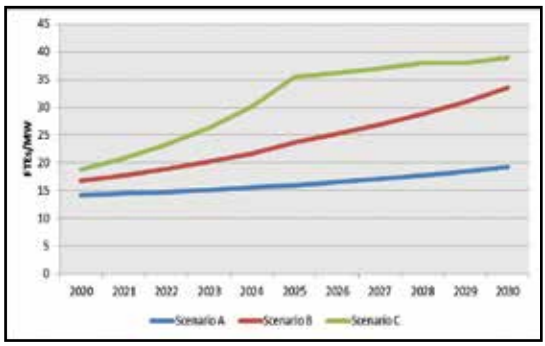


Figure 7: Total FTEs projected during the O&M phase for Scenario A from 2020 to 2030.

Year	Virginia		North Carolina		South Carolina		Georgia		Total	
	Market	Total	Market	Total	Market	Total	Market	Total	Market	Total
2018	36	36	0	0	0	0	0	0	36	36
2019	0	36	9	9	0	0	0	0	9	45
2020	0	36	0	9	40	40	10	10	50	95
2021	150	186	0	9	0	40	0	10	150	245
2022	50	236	100	109	0	40	0	10	150	395
2023	0	236	150	259	0	40	0	10	150	545
2024	0	236	0	259	150	190	0	10	150	695
2025	0	236	0	259	0	190	150	160	150	845
2026	0	236	150	409	0	190	0	160	150	995
2027	0	236	150	559	0	190	0	160	150	1145
2028	0	236	100	659	0	190	0	160	100	1245
2029	100	336	100	759	0	190	0	160	200	1445
2030	250	586	0	759	0	190	0	160	250	1695

Table 2: Low Market and Deployment path for the Southeast.

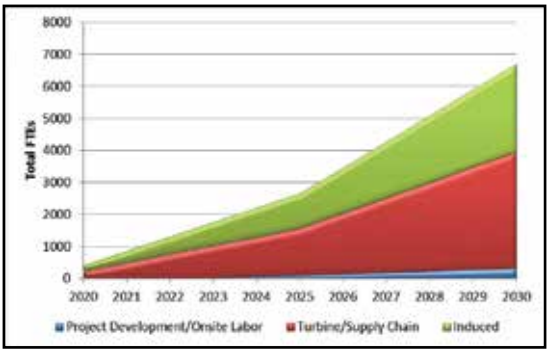


Figure 8: Total FTEs projected during the O&M phase for Scenario A from 2020 to 2030.

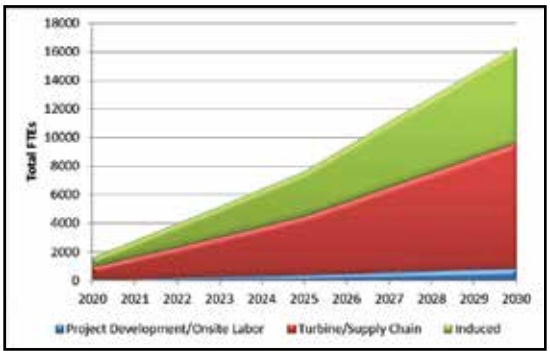


Figure 9: Total FTEs projected during the O&M phase for Scenario A from 2020 to 2030.

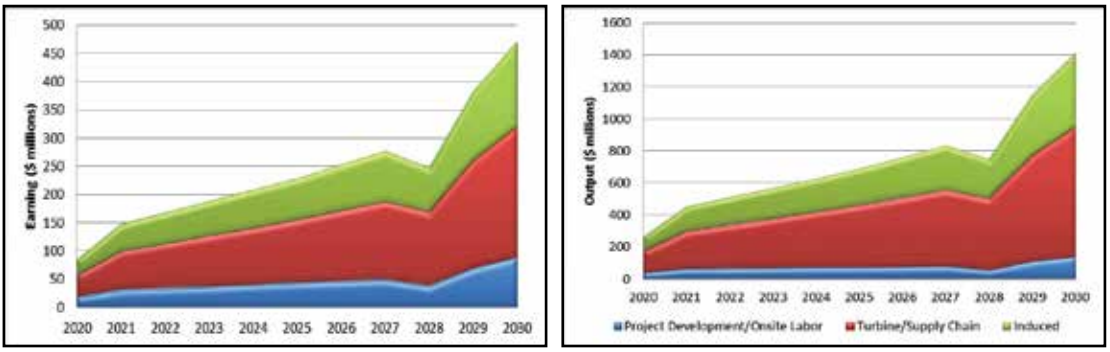


Figure 10: Comparison of Earnings (left) against Output (right) for Scenario A show similar growth patterns from 2020 to 2030, but the ETP ratio increases over time.

populations (see Figure 2) (11). The low electricity rates in the region attract energy-intensive industries, which points to a high demand growth rate and the ability to accommodate long-term, large-scale offshore wind energy development.

Cost

The U.S. Energy Information Administration (EIA) estimates that the Southeast region offers the lowest construction costs for offshore wind energy among East Coast states, as shown in Figure 3 (12). This advantage

would result in lower capital and expenditures (CAPEX) and energy costs from offshore wind and a competitive advantage for manufacturers that locate facilities in the region.

Currently, electricity supplied in the Southeast primarily comes from coal, nuclear and natural gas (11)—all technologies that are susceptible to fuel price volatility and large-scale outages. Dispatchable generating technologies, such as coal, gas-combined-cycle and nuclear can be controlled by the systems operator and can be switched on and off based on their economic attractiveness to supply electricity and to supply network reliability services. Electricity rates can change quickly as the demand for electricity changes throughout the day, while power generation must continuously be adjusted to match electrical load to avoid outages. Non-dispatchable generating technologies such as wind energy would diversify the region's electricity supply and provide long-term, stable-priced energy by putting less demand on conventional technologies to match the electrical load.

Infrastructure and Workforce

The Southeast is home to some of the largest and industrious ports and logistics infrastructure in the United States, including ports at Norfolk Harbor (VA), Newport News (VA), Morehead City (NC), Wilmington (NC), Charleston (SC), and Savannah (GA) (13). The region has a highly skilled manufacturing and maritime workforce and employs thousands of people in the land-based wind industry, despite having no large-scale wind plants. (14) (15)

3. THE OFFSHORE WIND JEDI MODEL

The Offshore Wind Jobs and Economic Development Impact Model (JEDI) was developed by the National Renewable Energy Laboratory (NREL) in order to demonstrate the magnitude of economic impacts associated with developing and operating offshore wind power plants in the United States. (16)

The JEDI model uses input-output analysis to estimate the number of jobs, income (wages and salary), and economic activity that may be supported in the state (or region) from the project (1). Three separate impacts are examined,

- Project Development and Onsite Labor Impacts
- Turbine and Supply Chain Impacts
- Induced Impacts

Year	Virginia		North Carolina		South Carolina		Georgia		Total	
	Market	Total	Market	Total	Market	Total	Market	Total	Market	Total
2018	32	32	15	15	0	0	0	0	47	47
2019	0	32	0	15	80	80	25	25	105	152
2020	100	132	0	15	0	80	0	25	100	252
2021	150	282	0	15	0	80	0	25	150	402
2022	0	282	100	115	150	230	0	25	250	652
2023	0	282	200	315	100	330	0	25	300	952
2024	150	432	150	465	0	330	0	25	300	1252
2025	150	582	200	665	0	330	0	25	350	1602
2026	200	782	0	665	150	480	0	25	350	1952
2027	200	982	250	915	150	630	0	25	600	2552
2028	0	982	250	1165	150	780	0	25	400	2952
2029	0	982	250	1415	150	930	75	100	475	3427
2030	0	982	200	1615	200	1,130	200	300	600	4027

Table 3: Medium Market and Deployment path for the Southeast.

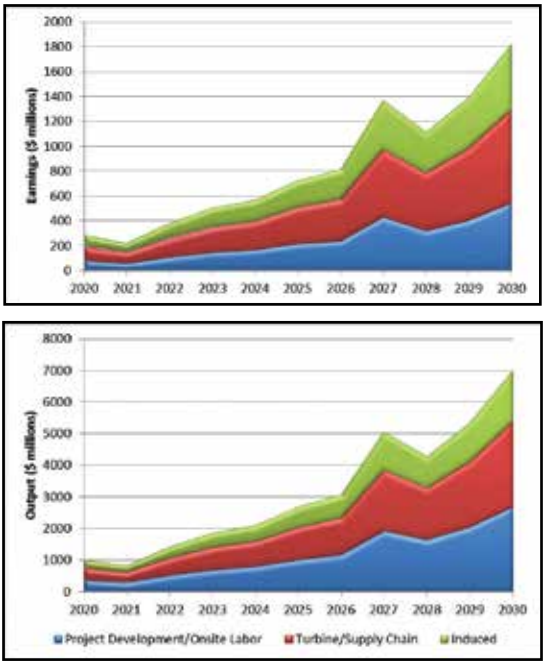


Figure 11: Comparison of Earnings (above) against Output (below) for Scenario B show similar growth patterns from 2020 to 2030, but the ETP ratio increases over time.

In order to accomplish this analysis, multipliers and expenditure patterns were used to derive these results. These regional multipliers for employment, earnings, and output and personal expenditure patterns were derived from the Impact Analysis for Planning (IMPLAN) model 3.0 (17).

Model Input

JEDI utilizes either default or user-supplied construction cost data, operating cost data as well as data pertaining to the percentage of goods and services acquired in the region to produce outputs. From a broad perspective, JEDI input variables can be classified into three main categories

- Market and Deployment—The number and size of wind turbines deployed each year.
- Regional Investment—The percentage, for each component or service, which is being acquired or produced regionally.
- Cost—The cost (per MW capacity) of an offshore wind project.

Model Output

JEDI provides information to understand the magnitude of the gross economic impacts within the region being analyzed, including construction-related spending and operations and maintenance, as well as the portion of the spending that could occur regionally. JEDI reports the local jobs in Full-Time Equivalents (FTEs), earnings and output supported as a result of the project for the construction phase and for the ongoing operations phase. Construction phase impacts are assumed to occur of the equivalent of one year, while O&M impacts are assumed to be ongoing for the life of the facility.

Caveats

First, the offshore wind JEDI model is intended to construct a reasonable profile of expenditures and demonstrates the magnitude of gross economic impacts, and is an estimate, not a prediction.

Second, the JEDI is a static model that relies on inter-industry relationships and personal consumption patterns and does not account for supply-side changes such as inflation, changes in technology, taxes, or subsidies. Additionally, the model does not consider constraints on labor, goods or money.

Third, the model was not designed to provide cash flow projections or for use as a cash flow analysis tool and

Year	Virginia		North Carolina		South Carolina		Georgia		Total	
	Market	Total	Market	Total	Market	Total	Market	Total	Market	Total
2018	64	64	30	30	0	0	0	0	94	94
2019	136	200	150	180	80	80	25	25	391	485
2020	150	350	150	330	200	280	0	25	500	985
2021	150	500	150	480	200	480	0	25	500	1,485
2022	150	650	300	780	250	730	0	25	700	2,185
2023	150	800	325	1,105	250	980	0	25	725	2,910
2024	150	950	325	1,430	300	1,280	0	25	775	3,685
2025	150	1,100	350	1,780	300	1,580	100	125	900	4,585
2026	150	1,250	350	2,130	300	1,880	125	250	925	5,510
2027	150	1,400	350	2,480	300	2,180	150	400	950	6,460
2028	200	1,600	400	2,880	300	2,480	200	600	1,100	7,560
2029	200	1,800	400	3,280	300	2,780	200	800	1,100	8,660
2030	200	2,000	400	3,680	300	3,080	200	1000	1,100	9,760

Table 4: High Market and Deployment path for the Southeast.

results do not measure of project viability or profitability.

Finally, the analysis assumes that sufficient revenues are generated for equity and debt repayment and annual operating expenditures. (1)

4. SCENARIO DEVELOPMENT

As discussed in Section 3, the JEDI model is built around three major variables – Market and Deployment, Regional Investment, and Cost, based on information gathered and other similar studies. (18) For each, three distinct 'paths' with varying rates for how these variables change over time were developed. Three distinct scenarios, running from 2020-2030 for offshore wind energy in the Southeast were generated, and JEDI was run for each year.

Market and Deployment

For Market and Deployment, a conservative, a moderate and an aggressive approach to the deployment of offshore wind turbines in the Southeast region were created. An analysis of the historical growth rates for electricity capacity, as shown in Table 1, indicates that this is around 2.2GW/year. It was assumed that the Southeast could support a maximum build-in rate of around 1.1GW/year.

For Low Market and Deployment, as shown in Table 2, investment in the offshore wind industry was assumed to be very conservative, defined by pilot projects and small wind farms. For Medium Market and Deployment, as in Table 3, a moderate level of investment in the industry was assumed. Initially, this path is similar to that of the low growth path, with a more consistent level of growth being observed in the later years of the model run. For High Market and Deployment, as in Table 4, an aggressive level of offshore wind turbine deployment was assumed, and assumed a large percentage or new power-generating plants derived from offshore wind facilities.

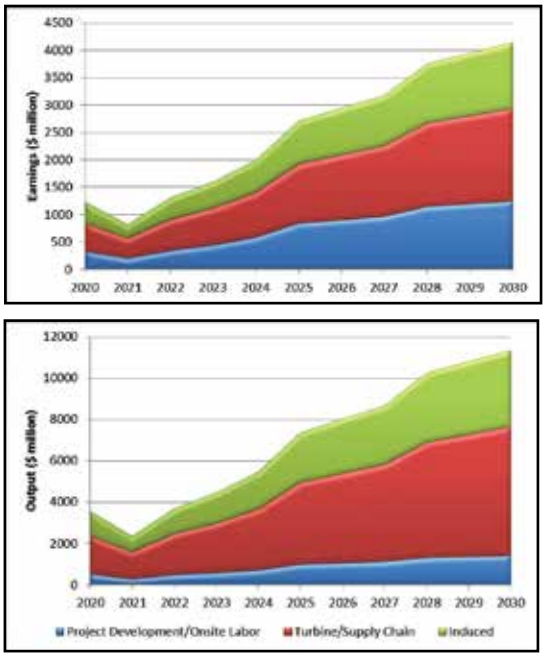


Figure 12: Comparison of Earnings (above) against Output (below) for Scenario C show similar growth patterns from 2020 to 2030, but the ETP ratio decreases over time, indicating that the size of the industry is too large for optimal labor.

Regional Investment

As in the case of Market and Deployment, three different paths for how the regional supply chain could develop were built. The higher the regional share percentage in a specific line item, say wind turbine blades, the more money is being circulated into the regional economy, thereby creating more regional jobs.

Each individual component was examined separately when determining its potential for regional sourcing.

Component	Regional	Justification
Construction		
Materials and Other Equipment		
Basic Construction (concrete, rebar, gravel, etc.)	100%	All basic construction materials are produced locally and are therefore assumed to be sourced locally
Labor Costs		
Management/Supervision	100%	It is assumed that a wind project in the region would leverage local management and supervision
Development Services/Other Costs		
Engineering (project and interconnection facility design)	100%	This requires local knowledge and the region has engineering firms that can design and plan offshore wind projects
Legal Services	100%	This requires local knowledge for many items, and for general legal support. There are a number of law firms with offices in the Southeast that specialize in projects of this nature.
Public Relations	100%	This is typically done by local firms that have relations with local media and decision-makers
Ports and Staging	100%	The Southeast region has a number of suitable ports for offshore wind development, and it is assumed that a regional wind project would be built out of the nearest suitable port
Site Certificate/Permitting	100%	This requires local knowledge of laws, regulations, and agencies, and therefore it is assumed that all related work would be sourced locally
Air Transportation	100%	These services would be more cost effective if they were provided for by local companies
Marine Transportation	100%	
Operation and Maintenance		
Labor		
Technician Salaries	100%	It is assumed that local land-based staff service the facility
Monitoring and Daily Operations Staff and Other Craft Labor	100%	
Administrative	100%	
Materials and Services		
Water Transport	100%	These services will primarily be provided from the servicing port and the surrounding area.
Site Facilities	100%	
Machinery and Equipment	100%	
Subcontractors	100%	
Corrective Maintenance Parts	100%	Assuming no catastrophic failures (ex. Blade failure), the majority of maintenance parts will be sourced locally
Financing		
Equity Financing/Repayment		
Individual Investors	0%	All equity is expected to come from corporations
Tax Parameters		
Property Tax	100%	These are local taxes by definition
Sales Tax	100%	
Other Local Taxes	100%	

Table 5: Summary of regional share percentages for static components with justifications.

The regional share of many of these components and services were not expected to change over time, called static components and services. A list of these, with regional share percentages and justifications are given in Table 5. Components and services of which the regional share is expected to vary over time are called dynamic components and services, and are discussed in the next section.

Dynamic Components and Services

For the Low Regional Investment path, it was assumed that the development of the regional supply chain is minimal due to uncertainties in the industry. However, due to the presence of manufacturers and developers already in the region, some regional contributions are expected, but development of supply chain is slow.

Initially, the Medium Regional Investment path was assumed to be similar to the low path, but higher growth rates are applied, as more of the larger components are manufactured regionally, and as expertise is gained. Approximately half of manufacturing and services are assumed to be regional by 2030.

The High Regional Investment path assumed immediate and significant regional investment into the off-

	Low Investment			Medium Investment			High Investment		
Component	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**	**2020**	**2025**	**2030**
Nacelle/Drivetrain	10%	15%	25%	10%	25%	50%	20%	50%	70%
Blades and Towers	10%	15%	25%	10%	30%	45%	20%	50%	70%
Substructures and Foundation	10%	15%	20%	25%	50%	75%	35%	85%	95%
Substructure and Foundation Labor	10%	15%	20%	25%	50%	75%	25%	80%	95%
Project Collection, HV Cable, Convertor Stations, Substation	15%	20%	30%	15%	35%	50%	30%	60%	80%
Construction Financing	0%	0%	0%	0%	10%	20%	0%	30%	75%
Management of Operating Plants	50%	60%	70%	50%	65%	80%	45%	95%	95%
Erection and Installation Services	50%	50%	65%	50%	65%	80%	50%	75%	95%

Table 6: Low, Medium, and High Regional Investment paths for the dynamic components for offshore wind in the Southeast.

	Cost in 2015 (per kW)	Cost in 2020 (per kW)	Cost in 2025 (per kW)	Cost in 2030 (per kW)
High	$5,600	$5,407	$5,220	$5,040
Medium	$5,600	$5,119	$4,826	$4,480
Low	$5,600	$4,972	$4,415	$3,920

Table 7: High, Medium and Low cost reduction paths for the Southeast are consistent with Department of Energy estimates. (Source: http://en.openei.org/apps/TCDB/).

Year		2020	2025	2030
Market and Deployment	Market (MW)	50	150	250
	Total (MW)	95	845	1,695
Regional Investment	**Nacelle/Drivetrain**	10%	15%	25%
	Blades and Towers	10%	15%	25%
	Substructures and Foundation	10%	15%	20%
	Substructure and Foundation Labor	10%	15%	20%
	Project Collection, HV Cable, Convertor Stations, Substation	15%	20%	30%
	Construction Financing	0%	0%	0%
	Management of Operating Plants	50%	60%	70%
	Erection and Installation Services	50%	50%	65%
Cost ($/kW)		5,407	5,220	5,040

Table 9: Summary statistics for Scenario B.

Year		2020	2025	2030
Market Growth	Market (MW)	100	350	600
	Total (MW)	252	1,602	4,027
Regional Investment	**Nacelle/Drivetrain**	10%	25%	50%
	Blades and Towers	10%	30%	45%
	Substructures and Foundation	25%	50%	75%
	Substructure and Foundation Labor	25%	50%	75%
	Project Collection, HV Cable, Convertor Stations, Substation	15%	35%	50%
	Construction Financing	0%	10%	20%
	Management of Operating Plants	50%	65%	80%
	Erection and Installation Services	50%	65%	80%
Cost ($/kW)		5,119	4,826	3,920

Table 9: Summary statistics for Scenario B.

shore wind industry, resulting in a rapid development of the supply chain. Nearly all components and services are regionally sourced by 2030. A summary of all three Regional Investment paths are given is Table 6.

Cost

Three simple Cost reduction models were established for application to the JEDI model, which may occur due to technological advancements, economies of scale, and other factors. These paths, establish upper and lower bounds for cost reduction in the Southeast. A baseline Cost of $5,600/MW in 2015 was established based on 2010 Energy Information Administration (EIA) estimates for the industry in the region (12).

For the High Cost path, there is limited development in offshore wind energy technologies, and a cost reduction of 3.5% every 5 years was applied, resulting in an overall cost reduction of around 10%. For the Medium Cost path, a more aggressive cost reduction model was applied, representing more significant technological advances. A cost reduction of 7.2% every 5 years was applied, resulting in an overall cost reduction of around 20%. For the Low Cost path, the most aggressive cost reduction model was applied, representing optimal improvements in the technology. The average cost of offshore wind is assumed to decrease by 11.2% every 5 years, for an overall cost reduction of around 30%. A summary of the cost reduction models are given in Table 7.

Scenario Compilation

Using this method, three combinations of these variables were combined that best represented all the combinations and to reduce redundancy. Scenario A, shown in Table 8, is the most conservative of the three scenarios, representing a small industry with limited regional investment due to uncertainties. As such, much of the labor and capital is outsourced and the high cost reduction model was adapted. Scenario B, as shown in Table 9, represents an 'average case' marked by moderate and steady growth in both Market and Deployment and Regional Investment. This growth helps spurn advancements and efficiencies and the Medium Cost reduction model was applied. The details of Scenario C are given in Table 10 and represent the 'best case' scenario for the offshore wind industry. Therefore, a high Market and Deployment and Regional Investment paths were selected, presenting a situation where the industry grows very quickly, resulting in a Low Cost reduction model being selected for this scenario.

Year		2020	2025	2030
Market Growth	Market (MW)	500	900	1,100
	Total (MW)	985	4,585	9,760
Regional Investment	Nacelle/Drivetrain	20%	50%	70%
	Blades and Towers	20%	50%	70%
	Substructures and Foundation	35%	85%	95%
	Substructure and Foundation Labor	25%	80%	95%
	Project Collection, HV Cable, Convertor Stations, Substation	30%	60%	80%
	Construction Financing	0%	30%	75%
	Management of Operating Plants	45%	95%	95%
	Erection and Installation Services	50%	75%	95%
Cost ($/kW)		4,972	4,415	3,920

Table 10: Summary statistics for Scenario C.

5. RESULTS

Jobs–Construction

Construction is highly labor intensive, requiring a large number of workers to complete a project, supporting thousands of jobs. However, unless the offshore wind market is robust with multiple projects in the pipeline, these jobs may cease to exist after construction.

For Scenario A, the offshore wind industry is projected to support around 1,000 FTEs, increasing to over 4,000 FTEs in 2030, as shown in Figure 4. In other words, the industry is expected to require four times more labor after 10 years, despite conservative increases in Market and Deployment and Regional Investment. Many of the total jobs created are from supply chain and induced impacts.

Scenario B, as shown in Figure 5, shows significantly higher projected jobs throughout the modeling period, increasing from under 4,000 FTEs in 2020 to over 18,000 FTEs in 2030. Scenario C, as shown in Figure 6, projects the most FTEs by a significant margin, with the 2020 estimate of 15,000 FTEs being very close to the 2030 value of Scenario B. By 2030, if all the assumptions made hold, this Scenario projects over 40,000 FTEs.

An important metric to consider in order to be able to directly compare jobs supported by each scenario is the normalized FTEs per MW. As seen in Figure 7, this will show how more Regional Investment into the offshore wind supply chain will support more jobs per MW installed than if the supply chain were developed outside the region. For instance, in 2020, where the percentage investment during the construction phase is comparable for all three scenarios, the normalized FTEs/MW values are similar, ranging from around 14 FTEs/MW in Scenario A to around 19 FTEs/MW in Scenario C.

Since the three scenarios follow different regional investment growth patterns, the rate at which the normalized FTEs/MW grow accordingly. Scenario A assumes marginal increases in regional investment - therefore the model suggests that around 19 FTEs/MW would be supported by 2030. On the other hand, Scenario C assumed an aggressive investment growth pattern, and this is reflected in the FTEs/MW value over time, which increases very sharply to over 35 FTEs/MW by 2025. During the next five years, the rate of growth tapers off because much of the supply chain is already regional, with a normalized value of around 39 FTEs/MW by 2030.

Jobs–Operations and Maintenance

For operations and maintenance, the total number of FTEs projected is significantly less than for construction. However, these jobs last for 20 to 25 years, the typical lifetime of an offshore wind project, and are therefore permanent, career-length opportunities. Construction jobs, as reported by JEDI, are the equivalent of one year (job-years or person-years).

The results for FTEs supported under Scenarios A, B, and C are given in Figure 8, 9 and 10 respectively and show very similar patterns as for construction. The majority of jobs would be in supply chain and induced impacts – this trend is even more prevalent during the operations and maintenance phase.

Similarly to the analysis in the previous section, Scenario A projected the least FTEs, with around 2,700 FTEs over 1,695MW total generating capacity by 2030. On the other hand, Scenario B supports around 7,000 FTEs over 4,027MW generating capacity, and the expected total for Scenario C is over 16,000 FTEs over 9,760MW capacity by 2030.

For operations and maintenance, the normalized FTEs/MW increases at a much slower rate from around 1.64 FTE/MW to around 1.67 FTEs/MW for all three scenarios. This is because it is assumed that the majority of services and materials would already be regionally sourced for this phase of a project, therefore this metric stays relatively consistent from 2020 through 2030.

Earnings and Output

As explained previously, earnings refer to wages and salaries paid to workers and employer-provided supplements, while output refers to the total economic activity supported by the scenario of analysis. As expected, as the indus-

try grows the model projects higher earnings and outputs for all three scenarios. The earnings and output charts for Scenarios A, B and C can be seen in Figures 11, 12 and 13 respectively. All three sets of charts show similarities - (1) the growth patterns for earnings/outputs are very similar for each scenario; (2) Turbine and Supply Chain has the highest portion of earnings and output across all scenarios, typically over half the total; (3) conversely, Project Development and Onsite Labor has by far the smallest portion of earnings and output, particularly for scenario A; and (4) there is a greater discrepancy in these proportions for the output rather than the earnings.

6. CONCLUSIONS

The Southeast has the capacity to become a long-term leader in offshore wind energy, with ample resources for the industry to thrive. A very good shallow wind resource, low manufacturing costs, manufacturing expertise and access to some of the largest and most industrious ports on the East Coast are all very attractive features of this region.

The JEDI model was used to provide estimates of the magnitude of economic impacts for the region using three distinct scenarios. Scenario A projected the least economic activity and is considered to be too small to encourage industry growth. Scenario C projects the largest gross economic impacts, but it requires the regional supply chain to develop at a extremely fast rate. Finally, Scenario B is a moderate and offers sufficient economic returns to encourage growth.

As described previously, the results of this study are only estimates intended to provide a reasonable profile of what the offshore wind industry could look like in the Southeast region. Since a mature offshore wind industry does not currently exist in the United States, revisions of this model would be required in the future, as the impacts of the industry are better understood.

KEYWORDS

Economic impacts; supply chain; Southeast region; JEDI; offshore wind

ACKNOWLEDGMENTS

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FOOTNOTES

1. See www.secoastalwind.org for more information on how a regional approach can benefit the Southeast
2. www.boem.gov/Renewable-Energy-Program/index.aspx
3. http://www.boem.gov/Renewable-Energy-Program/State-Activities/Virginia.aspx
4. http://www.boem.gov/Renewable-Energy-Program/State-Activities/North-Carolina.aspx
5. http://www.boem.gov/Renewable-Energy-Program/State-Activities/South-Carolina.aspx
6. Input-output analysis is a method of evaluating and summing the impacts of a series of effects generated by expenditure.
7. A 'User Add-in Location' feature was added to allow users to derive the necessary data to complete analysis for specific regions. The necessary inputs include direct, indirect, and induced multipliers for employment, earnings and output, and personal consumption expenditure patterns – calculated as a percentage for each industry, for the 14 aggregated industries and the IMPLAN 432 industry sectors
8. A FTE is equivalent to 2,080 hours of work, and could also mean 2 part-time jobs of 1,040 hours each.
9. Economic activity in the region
10. Note that nearly half of this capacity growth occurred between 2000 and 2004.
11. Generally, these are components and services which are easily produced regionally, such as concrete and legal services
12. These are components and services which require expertise in offshore wind industry, such as foundations and project financing.
13. A linear scaling system was applied for Regional Investment percentages between 2021 and 2024, and 2026 to 2029.
14. $100 million against $200 million
15. $450 million against $1.4 billion
16. $300 million against $1 billion
17. $1.8 billion against $7 billion
18. $1.25 billion vs. $3.75 billion
19. $4.25 billion vs. $11 billion

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SampleSafe Eliminates Entry into Wind Farm Transformer Cabinets for Oil Sampling

Recent studies on cabinet-style wind farm transformers show a high occurrence of elevated combustible gas levels, particularly hydrogen.

Tallmadge, Ohio-based SD Myers Inc. is not only leading in the research of the ever-growing problem of wind farm transformer gassing, but also recently introduced the SampleSafe™ system for installation on cabinet-style wind farm transformers.

Designed to allow safe sampling of the dielectric fluids on energized wind farm electrical transformers, SampleSafe aids in detecting gas build-up. The sample valves, pressure gauges and relief valves are located remote to the electrical hazards inside the cabinet to the outside of the cabinet in separate, isolated stainless steel weather-resistant enclosure.

Eliminating the need to enter the transformer cabinet for routine oil sampling or processing, SampleSafe allows technicians access to valves and instruments inside of the transformer without dangerous exposure to energized equipment. A window kit may be installed in the cabinet door to allow the other important inspections that are a part of a responsible maintenance program, including liquid level, temperature and leaks.

Features:
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For more information, contact SD Myers at 330-630-7000 or go to sdmyers.com/EP-samplesafe.html.

Companies wishing to submit materials for inclusion in this section should contact Stephen Sisk at editor@windsystemsmag.com. Releases accompanied by color images will be given first consideration.

MetalSCAN 3000 Boasts Reliability in a Wind Energy-Specific Design

GasTOPS provides products and services to the wind industry to monitor gearbox health using its flagship MetalSCAN product. MetalSCAN is the leading sensor product available today for on-line detection and quantification of metallic debris in wind turbine gearboxes. MetalSCAN's advanced in-line, full-flow technology detects both ferromagnetic and non-ferromagnetic metal particles and provides a reliable, early indication of impending failure.

MetalSCAN's reliability lies in its simple, maintenance free design. The sensing element uses non-obtrusive magnetic coils, which surround the oil line and detect the passage of metallic debris. All of the particles above a minimum size threshold are detected and counted.

With thousands of installations worldwide on equipment ranging from advanced jet engines to industrial gearboxes, MetalSCAN has proven its

effectiveness, meaning expensive failures can be avoided and maintenance personnel can plan repairs during convenient and cost-effective periods.

The newest member of the MetalSCAN product family, MetalSCAN Series 3000, was developed specifically for application to modern wind turbines and addresses an industry wide need for reliable, advanced warning of gearbox damage. Fitted directly into the gearbox lubrication system, MetalSCAN 3000 has demonstrated its ability to detect metallic debris generated by bearing and gear damage many months in advance of impending failure and to track the progression of damage so that turbine repairs can be performed before costly failure occurs.

The MetalSCAN 3000 sensor system provides a simple and reliable particle count output, which can be compared to pre-defined limits to provide:

- On-line damage detection for gearbox bearings and gears;
- Damage level quantification; and,
- Automatic warning and alarm alerts.

MetalSCAN 3000 offers an effective solution to the unique condition monitoring needs of wind energy.

- Improved turbine availability;
- Reduced of unplanned downtime; and,
- Reduced repair costs.

The product has already been applied to a wide range of turbine models from most major OEM's.

For more information, visit www.gastops.com or call 800-363-8658.

MARKETPLACE

ADINDEX

Ajay Swamy
Senior Director of Wind Turbine Sales, ACCIONA Windpower

TELL US ABOUT ACCIONA'S UNIQUE PERSPECTIVE IN DESIGNING ITS WIND TURBINES.

ACCIONA Windpower has a unique ability to understand what our customers need because we have been and will always be in their shoes. ACCIONA is one of the world's leading renewable energy operators. We own over 8,400 MW of renewable energy facilities around the globe, including over 7,000 MW of wind power. Our 20 years of experience as an owner and operator has helped us design wind turbines that deliver benefits over the lifetime of a project. As an owner and operator, two important criteria are reliability and performance. Accordingly, we developed a robust design that has resulted in extremely low failure rates for critical components and over 98 percent availability across our global fleet.

ACCIONA'S NEWEST TURBINE IS THE AW3000. HOW WAS IT DEVELOPED?

ACCIONA Windpower was one of the first OEMs to design a 3MW machine. We began design work on the AW3000 in 2006 because we understood a larger nameplate created economies of scale that could drive down a project's cost of energy. If you can build a project with fewer turbines, there is less land to be developed, fewer foundations, and fewer roads to build. Also, higher nameplate capacity means fewer turbines to maintain, which lowers lifetime O&M labor costs. Finally, a higher nameplate means developers can focus on the best-producing turbine positions. These differences can add up to lower the COE by 10 percent or more compared with a 1.5MW or 2MW nameplate.

WHAT'S INSIDE? TELL US ABOUT THE TECHNOLOGY OF THE AW3000.

The AW3000 has double bearing support for the main shaft. Additionally, it uses a six-pole, doubly-fed induction generator that allows the generator to rotate at lower RPM than many of our competitors. These two features, when combined with other elements of the design, significantly isolate and reduce the load on the gearbox. This reduces maintenance costs and ensures a long life for the WTG. We are the only OEM that generates electricity at 12kV (i.e. at the generator terminals). This enables the turbine to be connected directly to a 12kV collection system without using a step-up transformer. Eliminating costly pad-mount transformers and reducting energy losses results in significant savings on the order of $50,000-$150,000 per MW, depending on the layout.

WHAT ARE THE KEY BENEFITS OF CHOOSING THE AW3000?

The choice of four different rotor sizes (100m, 109m, 116m, and 125m) and four different tower heights (hub heights of 92m 95.5m, 100m, and 120m) allows the AW3000 to be configured to meet the requirements of various wind classes and site conditions. The availability of concrete towers for 100m and 120m hub height further enhances its versatility. The variety of options from a single platform enables a developer whose site has multiple wind class locations to use the same platform and configure each wind turbine for its specific location.

Furthermore, the large diameter rotor and high performance blades will lead to a significant increase in net capacity factor. Using wind and site data, we have seen that the AW3000 can deliver an NCF of over 50 percent at some projects currently in development. The other design features I mentioned earler enable the turbine to have a high availability. For developers, this means a very competitive LCOE resulting in a high IRR and/or high probability of success in the procurement stage.

HOW DO THESE CONFIGURATIONS PAIR UP WITH VARIANCE IN GEOGRAPHY AND WIND RESOURCES?

We offer four rotor diameters and a suite of tower heights in both steel and concrete that can meet the needs of almost any project globally. The 100 meter rotor is ideally suited for high-wind sites, while the 109 and 116 meter rotors give the AW3000 exceptional performance at medium-wind speed sites. Recently, we introduced a 125 meter rotor that competes in low-wind environments.

ACCIONA also has a robust suite of options, including: a cold weather package, condition monitoring, automatic lubrication, medium voltage inside the tower, and shadow flicker mitigation, to name a few. A service lift inside the tower is standard with every wind turbine.

For the complete Q&A with Ajay Swamy, visit windsystemsmag.com.

For more information about Acciona Windpower turbines, visit AW3000.com or email sales@acciona-na.com. Also, the company's commercial team is regularly present at major industry events like CanWEA to meet with developers and answer questions.

You name it, we've forged it.

In an industry where reliability matters most, we possess the knowledge, infrastructure, and passion to deliver outstanding forging solutions that ensure product success.

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