End-Of-Warranty Guide for Wind Turbines
Asset owners highlighted the need for robust end-of-warranty handover processes at the 3rd Annual Wind Optimization & Maintenance Canada conference in Toronto.

“This is not the place to do short cuts and look to save dollars,” said Alex Couture, director of generation at EDF Energies Nouvelles (EDF EN) Canada, which operates more than 13 GW of wind and 24 M of solar across the country.

And Ian MacRobbie, general manager of Enbridge, a large energy distribution and transmission company which also operates wind farms across North America, said “don't underestimate the time it takes” for basic handover tasks such as turbine walk downs.

MacRobbie said Enbridge faced significant time pressures in coming off warranty with two 99 MW wind projects in Ontario.

In both cases, he said, Enbridge weighed up carrying out a service extension with the original equipment manufacturer (OEM) against contracting an independent service provider or moving to a self-performance operations and maintenance (O&M) regime.

Enbridge chose self-performance for both wind farms, having first carried out a cost evaluation that included internal labor changes and failure frequency analysis.

For the latter, MacRobbie said, it was important for asset owners to draw on the information accrued from machines operating under warranty.

**Volumes of data**

“You should have access to volumes and volumes of data,” he said, relating to gearbox, generator and main bearing borescope readings and inspections.

Using this data, MacRobbie said, Enbridge had been able to make the switch to self-perform without an impact on production. When estimating component failures, “either we've been lucky or we were very conservative,” he said.

As a result, he asserted: “We haven't seen the failure rates we expected.”

In contrast, being able to access this kind of information, along with detailed supervisory control and data acquisition (SCADA) readings, could be problematic once an asset owner has given up its relationship with an OEM.

“Turbine SCADA and software is a really big deal,” MacRobbie claimed. “Don't overlook the headache and aggravation that it may cause.”

Couture confirmed that to get full access to SCADA readings, post warranty, is “always a challenge. It’s a big problem and a big frustration.”

Unlike Enbridge, EDF EN employs a range of O&M arrangements across its Canadian wind assets.

An 898 MW tranche of projects commissioned between 2013 and 2015 has turbine maintenance through the OEM, Senvion, and balance of plant (BOP) O&M through EDF EN’s sister company EDF Renewable Services (EDF RS).
Another 300 MW, commissioned in 2014, has turbine maintenance with a different OEM, Vestas, and BOP O&M through Enbridge. Finally, 129 MW of wind and solar generation, commissioned between 2009 and 2014, has all O&M carried out by EDF RS.

With several sites now coming up to end of warranty, said Couture, EDF EN is following a detailed decision-making process to work out whether O&M should be taken in house.

This includes an exhaustive end-of-warranty inspection to determine the state of the turbines and BOP, put together a punch list, assess the value of all elements needing repair, and claim serial defects and key component failures or degradation.

During this inspection, Couture said: “We are trying to assess the value of all the points on the site. If you are declaring serial defects, you need to see what is the expected delivery of the equipment, to fix the thing.”

Couture also advised asset owners to calculate failure rates for major components up until the end of the project life, taking into account site-specific factors such as the cost of cranes. This could help determine the historical reliability of a given turbine model, he said.

To determine whether self-perform regimes might be advisable, he said, asset owners should question what service elements could be improved, whether they can be done better in house, and at what cost.

Asset owners should also figure out whether they have a supply chain strategy plus an administrative system and staff to carry out procurement of components, as well as being able to cope with on-site staff training and document handling, he said.

Finally, asset owners would need to check to see if self-performance might have an impact on insurance coverage and health and safety matters, he noted.

MacRobbie said a big problem for asset owners is that there is no correct definition of what a turbine should look like after two or five years. “Somewhere in the process you need to come to an agreement with your OEM over what that expectation should be,” he said.
Understanding what an acceptable level of wear and tear should look like is important for critical components including blades, gearboxes, bearings and generators, but also smaller features such as leaks in hoses and seals.

MacRobbie said it was important to agree on a definition of failure, such as ‘a component or an assembly can be considered failed if it is not able to perform its design function.’

And preferably, MacRobbie stated, an asset owner should “set the expectation early on for what that turbine should look like when it gets handed over to you. If end of warranty is the first time you’re actually looking at your blades, you have a real uphill battle.”

He said Enbridge had engaged different third-party end-of-warranty inspection contractors for its wind farms and had submitted 54 claims for the first and 1,283 for the second.

On the second project, “[the OEM] would tell you that we went over the top,” he remarked, although in fact on both projects some of the claims were actually requests for further information.

“You're telling me that wear on the bearing is OK,” MacRobbie recited, but “when does it become a concern?”

Greater control

If applicable, opting to self-perform could lead to greater control of matters including O&M, staffing, health and safety, the quality of assets, annual maintenance schedules and the onsite working environment.

Self-performing could also make it easier to improve site-specific issues and enhance staff satisfaction and empowerment, as well as potentially delivering synergies between turbine and BOP O&M work.

Against this, asset owners would have to accept more limited access to OEM technical documentation and SCADA and software improvements, and greater involvement in operational cost control, staff training and asset management.

Cutting ties with an OEM might also make it more difficult to proceed with highly technical retrofits, while limiting an asset owner’s bargaining power with component manufacturers and relinquishing availability and other non-performance guarantees.

At Enbridge, the decision to move to a self-perform regime at the company’s Talbot and Greenwich projects created scheduling problems even though the asset owner was using Vestas platforms that only needed servicing once a year.

“In terms of timing, we did have challenges in hiring staff,” admitted MacRobbie.

Lauge Nielsen, regional manager at Pattern Energy, said this could be a challenge for other asset owners in Canada. “In Ontario there’s a good pool of technicians [but] it’s really area dependent," he commented.

Finally, said MacRobbie, even though many end-of-warranty processes might lead to a parting of ways with the turbine maker, this did not mean there was not potentially a future role for OEMs. “It’s there,” he said. “It’s not a divorce, it’s a separation.”
3RD ANNUAL
WIND OPTIMIZATION & MAINTENANCE
CANADA 2016 CONFERENCE

UTILITY SCALE SELF PERFORMANCE POST
WARRANTY

ALEX COUTURE
DIRECTOR, GENERATION CANADA
EDF EN CANADA

TORONTO
NOVEMBER 2016
CANADIAN OPERATION OVERVIEW

✓ 1303 MW of wind in Operation

✓ 24 MW of solar in Operation

• 224.2 MW wind PPA in Construction in Québec + 2 solar sites (12+10 MW) + 1 wind site of 60 MW with PPA under development in Ontario

✓ Generation activities in 3 Provinces (QC-ON-AB)
INPUTS REQUIRED TO BASE YOUR DECISION TO GO IN-HOUSE (1 of 3)

End of Warranty Inspection:
✓ Among the most important elements to base your decision.
✓ What is the state of your project (BOP + WEC)?
✓ Proceed with an exhaustive EOW inspection. This is not the place to do short cut and looking to save $$$. 
✓ Obtain a clear EOW punch list by WEC/BOP.
✓ From the punch list... please assess the value of all the elements to repair.
✓ Have you claimed a serial defect or notice a key component failure or a sign of degradation?

Projected failure rate by components:
✓ Assess your major components failure rate until the end of the project life.
✓ Determine the risk and uncertainty associated with your assessment.
✓ Establish a cost of repair by type of major components and the associated downtime to repair.
✓ What is the historical reliability of the WEC model?
INPUTS REQUIRED TO BASE YOUR DECISION TO GO IN-HOUSE (2 of 3)

End of the OEM initial service:
✓ What are the service elements that you are looking to improve?
✓ Are you sure that you can do better?
✓ Better, at the same cost?

Components procurement:
✓ What is your strategy to establish your supply chain?
✓ Are you ready to put in place the administrative system (and associated staff) to ensure a proper cost/inventory tracking?

On site staff training and documentation:
✓ Are you geared to organize all the working procedure documentation and prepare the training session for?
**INPUTS REQUIRED TO BASE YOUR DECISION TO GO IN-HOUSE (3 of 3)**

**Others:**
- What is expected impact on your insurance coverage and potential reclamation?
- HSE – Ok for a better control but you’ll need to be more way more involved in the day to day operation.
## PROS & CONS TO SELF PERFORM

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td><strong>Cost</strong></td>
</tr>
<tr>
<td>Reduce profit margin on the service side</td>
<td>Limited access to OEM SCADA and software improvements</td>
</tr>
<tr>
<td>Greater control on the operation and maintenance and the associated overall quality of your asset</td>
<td>Limited access to OEM technical documentation</td>
</tr>
<tr>
<td>More control on the staffing and on the quality of the onsite working environment</td>
<td>Sometime more difficult to proceed with a highly technical retrofit (documentation, special tools and expertise)</td>
</tr>
<tr>
<td>Better control on HSE</td>
<td>Greater involvement in the operational cost control</td>
</tr>
<tr>
<td>Easier to develop and improve some site specific issue solutions</td>
<td>Limited access to updated technical documentation on the WEC design and also, the customer bulletin</td>
</tr>
<tr>
<td>Improvement of staff satisfaction and empowerment</td>
<td>More time required on staff training</td>
</tr>
<tr>
<td>Some limited synergies b/w BOP and WEC operations</td>
<td>Greater involvement for the Asset Manager (purchasing process, more authorization to go forward, etc.)</td>
</tr>
<tr>
<td>Better quality control of the work</td>
<td>Limited bargaining power with components manufacturer</td>
</tr>
<tr>
<td>Better control on the annual maintenance schedule</td>
<td>No availability guarantee or other non performance guarantee</td>
</tr>
</tbody>
</table>
THANK YOU FOR YOUR ATTENTION.
Wind Energy Update
Enbridge Service Decision and End of Warranty Experiences

– Ian MacRobbie
General Manager, Eastern Region Operations
The following presentation has been prepared by Enbridge Inc. (“Enbridge”). This presentation has been prepared for informational use only and should not be copied or distributed to any other party without Enbridge’s express written consent. Enbridge makes no representations or warranties whatsoever as to the accuracy or completeness of this presentation and Enbridge expressly disclaims any liability whatsoever as a result of any person’s reliance upon statements or information set out below.
Over the past 65 years, Enbridge has become a leader in the safe and reliable delivery of energy in North America.

**We Transport Energy** – operating the world’s longest, most sophisticated crude oil and liquids transportation system, Enbridge moves 15 percent of daily U.S. crude imports.

**We Distribute Energy** – owning and operating one of North America’s largest natural gas utilities, Enbridge serves more than two million customers in Ontario, Quebec and New York State.

**We Generate Energy** – one of the largest wind and solar producers in Canada, with a growing renewables base in the U.S., Enbridge has invested nearly $5 billion in green power assets since 2002.
Why Renewables at Enbridge?

• Our role is to ensure we meet society’s need for secure energy supply—while, at the same time, reducing emissions and protecting the environment.
• Climate change is a global issue.
• As the world transitions to more low-carbon energy sources, we believe that Enbridge is uniquely positioned, as North America’s leading distributor of oil and natural gas, and as a major player in the renewable energy business.
• As global demand for energy continues to grow and society shifts the supply mix towards more renewables and natural gas, we believe in playing our part in that bigger picture by investing in lower-impact solutions that will be of benefit to everyone.

“…We can find common ground to protect our environment while ensuring we meet our collective need for energy in a sustainable way.”

Al Monaco
President and CEO, Enbridge
Enbridge in Ontario

Wind Assets in Ontario

– Underwood and Cruickshank
  • Enbridge Ontario Wind is comprised of two projects, the 182 MW Underwood facility and the 8 MW Cruickshank facility.
  • 115 Vestas V82 Turbines in total between the two projects
  • Both projects are located on the west coast of Lake Huron, in the Municipality of Kincardine, Ontario.

– Talbot
  • Located on the north shore of Lake Erie, near Chatham-Kent, Ontario.
  • Operational since 2011, the 99 MW Talbot Wind generates enough energy to serve the needs of approx. 36,000 homes.

– Greenwich
  • The 99 MW Greenwich project is the first wind power facility to be wholly located on crown land in Ontario.
  • Comprised of 43 turbines, the project generates enough energy to serve about 34,000 homes.
Turbine Services at Enbridge; Talbot and Greenwich

- Talbot; End of Service Agreement in December 2015
- Greenwich; End of Service Agreement in October 2016

Option evaluation;
- OEM extension
- Self Performance
- Independent Service Provider

Self Performance Evaluation
- Cost evaluation, including internal labour charges
- Failure frequency data – Major Components / Minor Correctives
  - Predictive and actual history
  - Majors; Gearboxes, generators, Yaw/pitch system, main bearings, blades
  - Failure frequency changes over time
- Corporate Preference?
- Risk Tolerance
  - Corporate Risk Tolerance
  - Financing Obligations
Turbine Services - Other Considerations

- Health and Safety
  - Programs, development and rollout
  - Training

- Engineering / Backoffice Support
  - Composites, major components, turbine IT

- Contracts and Relationships
  - Suppliers
  - Vendors
  - Service Providers

- Turbine SCADA and Software

- Vendors; parts and services

- Ongoing OEM relationship – how does it change?
Turbine Services at Enbridge; Talbot and Greenwich

- **Talbot**
  - Decision to self perform taken in early September 2015
  - Decision factors: economics, pro-forma, risk tolerance and acceptance
  - Experiences:
    - Fortunate to hire experienced technicians on our turbine platform
    - Timing challenges, hiring staff, parts acquisition, consumables
    - Advantage of once-annual service schedule
    - Availability
    - HSE program readiness, needed to be better

- **Greenwich**
  - Decision to self perform taken in June 2016
  - Decision factors: economics, pro-forma, risk tolerance and acceptance
  - Experiences:
    - Timing was better than Talbot, but should still start earlier
    - Advantage in timing of service schedule, have some time to catch up before service starts again
End of Warranty Process

- End of Warranty process is separate from Service Options, timing may differ depending on contracts
- Self Perform EOW process or Contract services
- End of Warranty Process
  - Condition Monitoring Data Evaluation
  - SCADA Data evaluation
  - Gearbox, Generator and Main bearing boroscopes and inspections
  - Turbine Walkdowns
  - Fluid Samples
  - Blade Inspections

- Contract Language around EOW?
  - Serial Defect Definition
End of Warranty Experiences

What is the “right” expectation of the condition of a turbine after 2 or 5 years?
- Agreement with the OEM
- Set out in original agreements?
- Differing opinions of what wear and tear should be.
- Cleanliness Standards; Owners will hold service providers to a high standard

Normal Wear and Tear??
- Blades
- Gearboxes
- Bearings
- Generators
- Leaks; hoses, seals….is it normal or signs of a greater issue?

What defines a failure?
- Eg. “A component (or an assembly) can be considered failed if it is not able to perform its design function”

Housekeeping and cleanliness standards and expectations
EOW timing vs service schedule
End of Warranty Experiences

- Talbot;
  - Third Party EOW contractors performed CMOS review, Turbine walkdowns and Blade inspections (separate contractor)
    - Walkdowns took ~ 1 month to complete
    - Access to CMOS / SCADA Data issues
  - Claim submission
  - Timing to review before submitting to OEM to “vet” the submissions…we needed to do a better job here
  - 54 significant claims…does not include snags, minor items or retrofit. Some claims seen on multiple turbines
  - Not all claimable items

- Greenwich;
  - Third Party EOW contractors; different than Talbot’s but similar scope
  - Same Blade inspection contractor as Talbot
  - Contracting delays, this delayed start of inspections
  - Claim Submission – 1283 Claims submitted in total, includes all of the snags
Enbridge EOW Learnings

- Work with the OEM on the process, find ways to serialize submissions to keep track of claims
- OEM involvement in turbine walkdowns….reduce the number of claims
- How detailed do you need to be in the turbine walkdowns?
- What is the cost / benefit of being heavily detailed?
  - Number of claims to process, follow, follow-up on, etc. for both OEM and owner
- Need to do QA/QC during the Service Agreement
  - Don’t wait until the End of Warranty to deal with smaller items, it is easier to clean these up along the way
  - Set and agree to the standard / expectations early on
  - Need the OEM engagement and involvement in these processes….set the stage early for EOW expectations
Enbridge Learnings

- Don’t underestimate the time involved in completing the EOW walkdowns, submissions, resolution and settlement process
- Once the Service Agreement has expired for the OEM to do work on site, what contract are you using to perform work?
- Need to have early agreement on normal “wear and tear”, especially on blades
- A number of claims were seeking information on issues in addition to or rather than something needing to be remedied….we don’t have as much experience or knowledge as the OEM
  • Is there a better way to handle this than the EOW process?
- Start and file warranty claims as soon as possible during the service and maintenance contract period.
- Documentation sharing….lots of photos, inspection records, etc…how best to submit and file….work with the manufacturer
Key points; Service Decision and End of Warranty

- Self perform vs. service extension needs to be made early
- Don’t underestimate the efforts to prepare for self performance
- End of Warranty
  - Start the QA / QC process during the service agreement period – set the expectation
  - Come to agreement on “normal wear and tear?”
  - Start the EOW process early if possible….dependant on service schedule
  - Have the turbine manufacturer be a part of the walk down process

- All of these items will take more time than you are expecting
Thank You.

Q&A
Join us at Wind Operations & Maintenance Canada 2017 for a ground-breaking, and business insights driven analysis of what’s required to truly capture every MWh and enhance overall project AEP at all wind sites.

5 key reasons why attending Wind O&M Canada will allow you to truly optimize and perfect your wind O&M strategy:

1. Master O&M contract planning & management for better warranty ROI: Make the most profitable decisions about warranty contract planning, asset management and contract renewal - based on your appetite for risk, company size and WTG characteristics

2. WTG component failure, servicing and repair case studies delivered by operators, OEM’s and ISP’s will demonstrate why major components fail and how to carry out cost effective repairs, so you can improve your ability to manage unscheduled failures and non-scheduled repairs

3. The very latest predictive and preventative maintenance strategies that will help you improve maintenance scheduling and resource management to increase MWh and profitability against your budget

4. Build a Data-Driven Wind O&M Strategy – Learn how to 1) Identify, combine, and manage multiple sources of data (CMS, SCADA, and on-site inspection data), 2) build advanced-analytics models to extract what is relevant for predicting and optimizing turbine performance monitoring and power forecasting; and 3) manage corporate digital transformation

5. Optimize O&M resources to improve your bottom line: Receive the asset manager’s perspective on how to technically and financially enhance asset management

For more details about getting involved at the conference, contact adam@newenergyupdate.com or visit events.newenergyupdate.com/wind-operations-maintenance-canada