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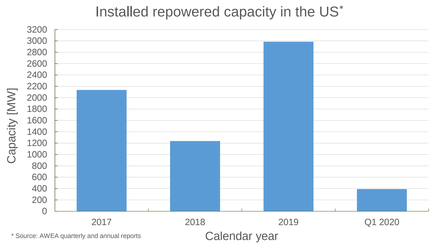
Partial repowering of wind asset: technical considerations and financial return

A. GHORASHI, P. BRODEUR, H. NGUYEN, N. NITSCHE, and K-H. CHEW

DNV·GL

BACKGROUND

- Partial repowering involves decommissioning/removal of selected equipment/parts in a wind asset and replacing with new parts of recent technology to attain higher performance and financial benefits out of the asset;
- Partial repowering has notably accelerated in US over the past 3 - 4 years with increasing diversification of sponsors/investors, turbine technologies and geography (states) involved;



- Key market drivers:
  - More than 21 GW of capacity in North America is in excess of 10 years old;
  - Renewed Production Tax Credit (PTC) qualification;
  - Improved energy production and capacity factor;
  - Reduced OPEX through re-negotiated contracts and newer equipment;
  - Improved energy sales structure through re-negotiated PPA; and
  - Improved asset value for M&A transactions.

OBJECTIVES

- Understand the key valuation drivers for partial repowering activities in the industry;
- Understand the technological and engineering challenges and considerations associated with partial repowering of wind assets;
- Evaluate the trade-off between CAPEX and future revenue; and
- Evaluate the impact of the PTC sunset on partial repowering of wind assets and the possible future scenarios of such practice.

METHODOLOGY

Key valuation drivers for repowered projects (vs greenfield projects):

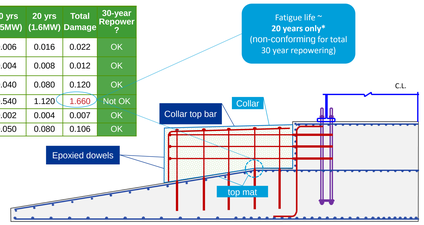
- Energy assessment based on historical operational data and modelling
- Trade off between CAPEX and OPEX/production/revenue
- Go-forward revenue mechanism, e.g. with negative bidding
- Interface risks for new contracts and physical components with existing ones
- Performance and reliability of re-used equipment

RESULTS

Key technology risks – Reused foundations:

- Fatigue performance
  - Typical weak links include pull-out fatigue, top mat fatigue, pedestal bearing/bursting fatigue.
- Case study: 10-year baseline + 20-year repowered damage
  - Existing foundation: octagonal spread footing, inadequate fatigue strength on top mat steel; and
  - Retrofitted foundation: reinforced concrete collar on top of existing foundation.

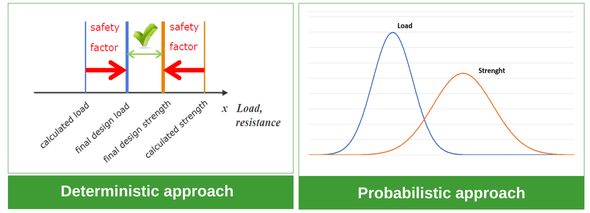
	Fatigue location	10 yrs (1.5MW)	20 yrs (1.6MW)	Total Damage	30-year Repower ?
1	Concrete bearing	0.006	0.016	0.022	OK
2	Pullout of vertical steel	0.004	0.008	0.012	OK
3	Concrete shear fatigue	0.040	0.080	0.120	OK
4	Bottom and top mat steel	0.540	1.120	1.660	Not OK
5	Grout	0.002	0.004	0.007	OK
6	Anchor bolts	0.050	0.080	0.106	OK



- Recommendations & mitigations:
  - Inspection/monitoring programs (to manage the risk), e.g. Section 8 of DNV OS C502; and
  - Structural retrofit (to achieve the target reliability).

Key technology risks – Turbines:

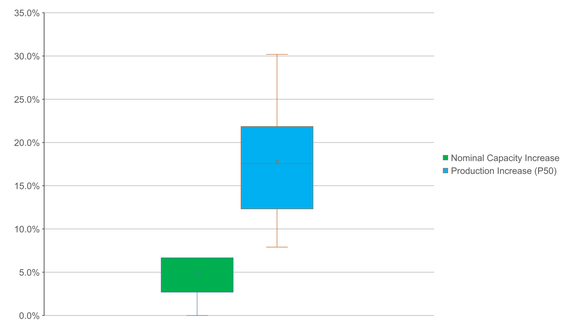
- Failure probability and design;



- Major wind turbine components to replace (may vary): Blades/hub, drivetrain (gearbox, main bearing), electrical system, tower;
- Interface challenge (e.g. adapter pieces)
- Recommendations & mitigations:
  - Certification of the repowered configuration;
  - Inspect/refurbish reused components and define the contractual responsibilities for the reused components;
  - Regular inspection/condition monitoring and good O&M practices; and
  - Good quality SCADA data for future evaluation.

Financing considerations:

- PTC benefits - Repowered projects can qualify for PTCs (and are impacted by the PTC sunset) in generally the same way as greenfield project, subject to the “80/20” rule;
- Increase in production*;



*Source: DNV GL database. Nominal capacity increase is based on total nominal project rating pre and post repowering, without any limitation of curtailment.

- Long-term maintenance costs may improve but with higher uncertainty regarding remaining components;
- Trade off between CAPEX and OPEX/production/revenue:
  - PTCs play a major role in financial feasibility of partial repowering, however, it is not notably different from that of a greenfield project;
  - In the absence of PTCs, the additional CAPEX may be compensated for by the reduction in OPEX as well as increase in production/revenue. However, data shows that at current offtake pricing in the mainland US market, this may not be sufficient on its own to compensate for the additional CAPEX;
  - An increase in the offtake pricing may therefore be also required to make repowering financially feasible in the absence of the PTCs;
  - Feasibility of the practice also heavily depends on project specifics, e.g. the age, technology, contractual arrangements, etc.
  - This may make the practice more appealing for markets with feed-in tariffs and/or higher offtake pricing.

CONCLUSIONS

- Partial repowering could bring high financial and performance benefits to existing wind assets;
- Key technology risks in repowered projects typically focus on the foundations and wind turbine components;
- Assessment of remaining useful life of foundation and turbine components should be performed in a probabilistic approach;
- Fatigue failure is the major failure mode of concern for re-used foundation in repowered projects;
- Interface risks exist between new and old/ re-used physical components and contracts; responsibilities of suppliers and contractors on new and old components should be clearly defined;
- OPEX reduction and production/revenue increase through software optimization and use of recent technology could make additional CAPEX for repowering economical. However, this on its own may not be sufficient to make the practice financially feasible in the absence of PTCs, and therefore markets with higher offtake pricing, e.g. feed-in tariffs, may be more appealing for partial repowering in the absence of the PTCs;
- Recommendations & mitigation of technical & financial risks:
  - Good quality SCADA data for future evaluation of feasibility in partially repowering;
  - Maintain regular inspection/condition monitoring and good O&M practices; and
  - Maintain sufficient reserve for inspections and repairs.

REFERENCES

- AWEA, Webinar *The age of partial repowering of wind assets*, https://webinars.awea.org/products/the-age-of-partial-repowering-of-wind-assets-sponsored-by-dnv-gl, 18 November 2019.
- Norton Rose Fulbright, Currents Podcast *EP63: The business of repowering*, https://www.projectfinance.law/podcasts/2019/may/ep63-the-business-of-repowering/, 29 May 2019.
- DNV GL White Paper on *Technical and contractual considerations in partial repowering of wind turbines*, EAA-WP-07, 19 Aug 2016.

CONTACT INFORMATION

Ali Ghorashi, Director, Wind Independent Engineering

Ali.Ghorashi@dnvgl.com