2020 SPRING VIRTUAL LEARNING SERIES
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CMS and Advanced Analytics: Complementary Approaches

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POWER FACTORS

BACKGROUND

Condition Monitoring Systems (CMS) and Advanced Analytics (AA) are industry-standard solutions assisting wind power plants operators and owners in their tasks.

Differing by their requirements, costs and scope they are typically considered separately and not in combination.

However, the two methods are complementary in terms of results and therefore added value can be anticipated from a combined approach.

CMS

Typical CMS encompasses vibration sensors on wind turbines at:

- Main bearing
- Gearbox planetary / intermediate / high-speed stages
- Generator Drive End / Non Drive End side
- Tower

Additional useful monitoring can be achieved using specific in situ sensors such as on-line particle monitoring.

Progress in up-tower repairs and increased turbine size have largely contributed to an enhanced business case for CMS-based preventive maintenance. It is usually argued that combined with smart planning for repairs, significant monetary gains can be achieved.

AA

AA is based on existing data sources – primarily SCADA data. AA can help reduce maintenance costs on major turbine components as well as on Balance of Plant (BOP). More importantly, it has been demonstrated that AA can also increase revenue through improved performance.

Maintenance cost reduction is achieved through the same approach as CMS by monitoring available signals such as:

- Main bearing temperature
- Generator temperature
- Pitch motor temperature/currents

Performance improvement is rather achieved through analysis of trends and intra- or inter-plant benchmarking, with the power curve being the corner stone of all analyses.

CASE STUDIES

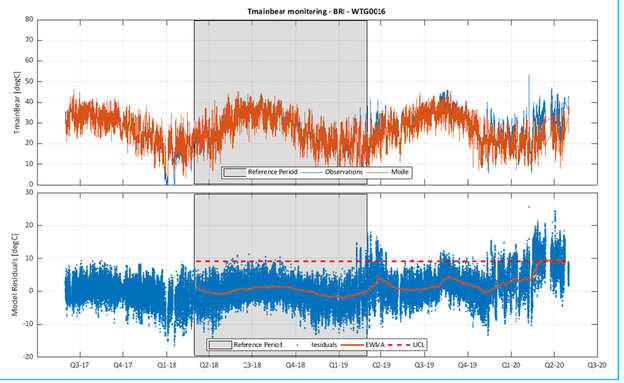
A. AA informing CMS

For rotating components CMS provides advanced warnings as early as 9 months or better. Turbine SCADA typically provides temperature signals for these components.

Various simple or advanced techniques can be used to monitor these signals and raise flags weeks or a few months before the SCADA itself does so. Therefore, one approach could be to carry out advanced O&M planning based on CMS and then relying on more progressive AA flags to fine-tune on-site repairs or replacement schedule.

Fig. 1 AA model (orange) and measured (blue) main bearing temperature.

Fig. 2 AA model residuals. Residual rolling-average hitting the predefined threshold is used as an advanced warning.



B. CMS informing AA

SCADA data monitoring using AA allows efficient, continuous and scalable assessment of turbine general health and performance. On the down side, root-causes cannot typically be pinned down with AA.

For major components where CMS is available an efficient root-cause analysis (RCA) can be devised as a follow-up to preliminary AA findings.

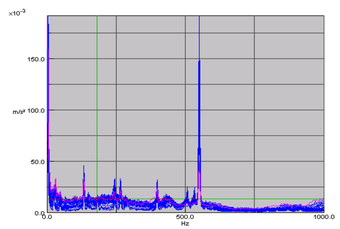


Fig. 3 CMS main bearing spectral analysis. Higher spectral floor (magenta) indicates defect. Source: [1].

C. Compounding cumulative benefits of CMS & AA

The main advantage of AA resides in optimizing turbine performance while CMS primarily focuses on major components. The former targets small but continuously cumulative losses while the latter targets big-ticket but rare repairs and/or replacements.

A study over a fleet of 900 utility-scale turbines [1] showed that the use of CMS and AA in combination could result in significant savings. Fig. 4 shows the relative weight of savings through reduced O&M costs thanks to CMS and AA advanced warning vs. those generated by AA-directed performance optimization.

The relative shares of CMS and AA savings are not to be generalized from this one study. Indeed, the breakdown depends on specificities of each portfolio.

Instead, CMS and AA should be considered as complementary approaches whose benefits can be compounded.
The fleetwide annual savings reported in [1] were about 1.5%.

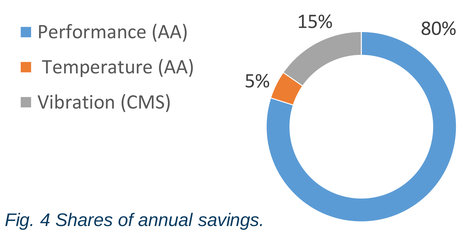


Fig. 4 Shares of annual savings. Adapted from [1].

CONCLUSIONS

CMS:

- Focuses on reducing maintenance costs
- Relies on specific signals and hardware
- Is accurate, precise but also specific
- Allows advanced warnings (9+ months for specific components)
- Allows RCA (specific components)

AA:

- Focuses on performance improvement
- Leverages readily available SCADA data
- Is not precise but is scalable and efficient
- Allows progressive advanced warnings of weeks to few months

Combined CMS & AA:

- Enhances the efficiency of O&M planning
- Leverages wider scope of AA with CMS' in-depth RCA possibilities
- Benefits from
  - CMS' infrequent but large savings (major components), and
  - AA's more modest but cumulative gains (minimized losses)

REFERENCES

[1] TransAlta, 2016 (CanWEA).

CONTACT INFORMATION

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