Lowering Wind Turbine maintenance cost in Brazil by implementation of a SCADA-based data analysis mechanism

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Abstract

Due to its geographical size, recourses and ecological structure, Brazil is presented as an important contributor to global climate goals. With the expansion of wind turbines in the national energy matrix, operational efficiency and reliability become significant issues to provide secure energy supply. Especially in the northeastern region, strong winds and high capacity factors lead to high O&M cost in case of unexpected component breakdown

The cost of energy (COE) will have to be lowered in order to make wind turbines more competitive with conventional generation methods. To avoid long downtimes, predictive maintenance strategies will have to be complied in order to organize maintenance actions and order spare parts.

The broad collection and benchmarking of SADA data enables predictive maintenance approaches, which reduces downtimes and lost revenues and increases overall turbine availability. European programs (e.g. WMEP) serve as examples how broad operational data collection help make wind turbines more competitive.

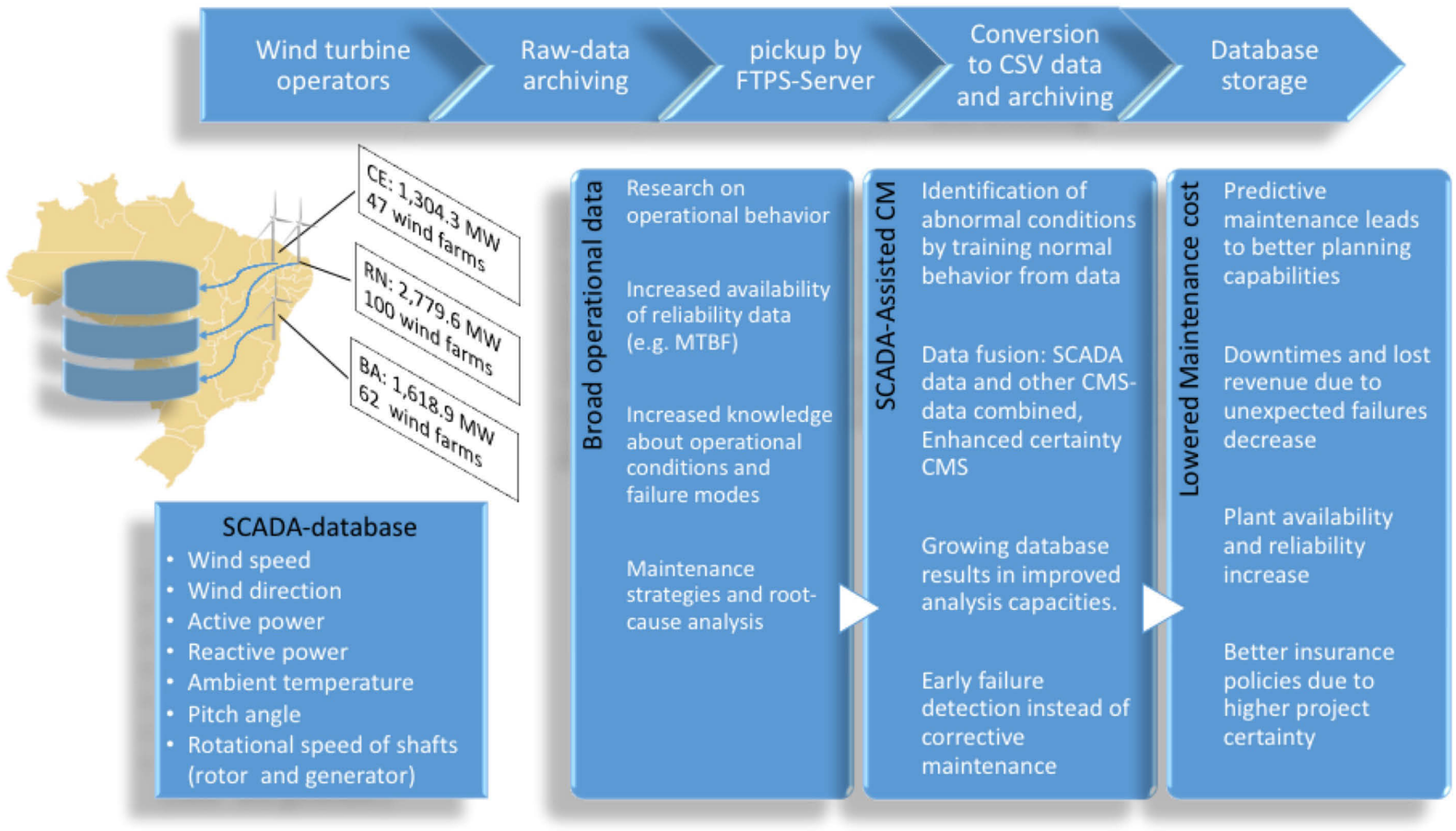

Figure 1: Broad SCADA-Data collection in Brazil [1,4,5]

Objectives

Active condition monitoring is not yet conducted on wind turbine assets in Brazil. Unexpected failures and downtimes push the electricity generation cost. The objective of this poster is to present an approach to lower the COE of wind turbines in the northeastern region of Brazil by lowering O&M cost and increasing overall turbine availability, the following bullet points give an overview of the main objectives:

- Establish efficient wind turbine maintenance in Brazil
- Avoid unexpected failures by predictive maintenance
- Broad and central collection of SCADA data, to perform statistical analysis
- Increase knowledge about reliability parameters under local conditions
- Lower COE as a result of lowered leveled replacement cost over asset life cycles

Methods

Publications by the Fraunhofer Institute for Wind Energy and Energy Systems (IWES) on SCADA-based condition monitoring (CM) have been adapted on the Brazilian wind market (see figure 1). The northeastern states Rio Grande do Norte (RN), Ceará (CE) and Bahía (BA) have the highest quantity of installed wind turbines and reach continuously high average capacity factors due to the consistent equator winds. Original Equipment Manufacturers (OEM) are located in the south and industrial services are still being consolidated. To avoid excessive downtimes in case of component breakdown, spare part lead time is important. The proposed mechanism helps gain more knowledge about reliability parameters and, as a result, plant availability and maintenance action can be accurately planned.

In a calculation (Table 1) derived from Yang [6], the application of CM and a predictive maintenance approach is being justified. With input data from the Brazilian wind market derived from [7], it is discovered, that approximately 97 condition monitoring systems (CMS) are paid for by early detecting a gearbox fault resulting in bearing replacement and avoiding of excessive downtime.

Results

Brazil's wind market in a nutshell [1,2,3]:

- Highest number of installed turbines in Latin America and the Caribbean by end of 2015
- With 9.6 GW installed under the top 10 leading wind markets globally
- Latest energy auctions plan substantial growth in the northeastern states with average capacity factors of over 50%, up to 4000 full load hours per year
- Long distances, poor roads, unconsolidated supply-chain

Future wind market development needs:

- Lowering COE, become more competitive
- Predictability of plant condition, conduct more cost efficient maintenance
- Lower failure caused downtime
- Increase plant availability & reliability

To meet this requirements, a SCADA data based analysis mechanism inspired by a German approach is proposed. The research institute Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) recently developed the WInD-Pool, a mechanism, that collects operating and maintenance data of wind turbines across several companies who participate the program. In order to optimize maintenance cost, the collected dataset is being analyzed with RAMS-LCC techniques (reliability, availability, maintainability and safety life cycle costing) [4].

With further development of the wind market, industrial services such as condition monitoring become more available to operators. Historic and broad operational data, collected over a large period of time helps the prediction of future plant conditions. In a study covering 472 wind turbine operational years of SCADA-data, 24 out of 36 gearbox and generator bearing failures have been detected with majority within 6 months before failure. By data fusion of SCADA-data and other CMS-data, enhanced certainty CM can be achieved [5].

Table 1: cost justification for Predictive Maintenance

Turbine capacity	2	MW
Number of turbines in study	3958	-
Capacity Factor	0.5	-
Price of saleable energy	180	BRL/MWh
Gearbox failure rate	0.2	faults/turbine/year
Downtime per failure	30	Days
Failures per year	792	-
Annual downtime	23748	Days
Annual cost of maintenance, *A*	BRL 4,939,584.00	BRL
Annual cost of lost Energy, *B*	BRL 102,591,360.00	BRL
Annual cost of gearbox replacement, *C*	BRL 699,774,400.00	BRL
Annual cost of failure, $T = A + B + C$	BRL 807,305,344.00	BRL
Annual cost of replacement bearings assuming failure is avoided	BRL 10,290,800.00	BRL
Approximate number or CMS paid for by early detecting of a gearbox fault including bearing replacement, $(T-D)/CMS_{cost}$	97	-

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