

NRG4CAST

ENERGY
FORECASTING

EMENDER Workshop

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**Big Data technology for systems monitoring in
Energy – Big Data Europe**

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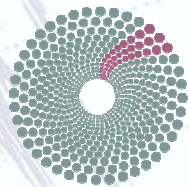


Introduction

- ❖ Big Data is one of the key assets of the future.
- ❖ Big Data evolution will enhance European competitiveness, will result in economic growth and jobs, and will deliver societal benefit.
- ❖ There is need to extract knowledge and insights from large, complex and heterogeneous data collections which is intensifying.
- ❖ The availability of high quality data assets and technologies that are required for acquiring, managing, and exploiting Big Data is of major importance for entities involved in data value chains as well as the wider social environment on which they operate
- ❖ Various application domains exist and each of them bears its own characteristics, and requirements and demands different technological and data assets to be used in order to effectively use the underlying information.

The Big Data Europe project

- **Coordination & Support Action**
 - Horizon 2020, Jan 2015 – Dec 2017
 - Substantial technical work is envisaged
- **Addresses issues encountered when optimizing & extending data value chains across all Horizon Societal challenges:**
 - Introducing Big Data technologies
 - Managing the interoperability & transferability of solutions across different domains
 - Accommodating the adoption of rapidly evolving technologies to established value chains
 - Rendering big data exchange, sharing, integration & joining less cumbersome & resource demanding



BIG DATA EUROPE



Health – Heterogeneous data linking and integration, biomedical semantic indexing



Food & Agriculture – Large-scale distributed data integration



Energy – Real-time monitoring, stream processing, data analytics, decision support



Transport – Streaming sensor network and geo-spatial data integration



Climate – Real-time monitoring, stream processing and data analytics



Social Sciences – Statistical and research data linking and integration



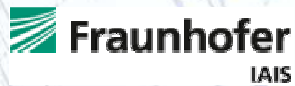
Security – Real-time monitoring, stream processing and data analytics, image data analysis

BDE Participants

12 organizations

9 countries

Duration: 3 years



Big Data Europe project

Planned activities

- Requirement collection from Societal Challenge stakeholders
- Development of the Big Data Aggregator
 - A generic platform for big data management & processing
 - Open source, turn-key, state-of-the-art solution
 - Integrating open source production systems & mature research project prototypes
- Raise awareness regarding the Big Data Europe solution to big data problems
 - Showcases relevant to all Horizon 2020 Societal Challenges



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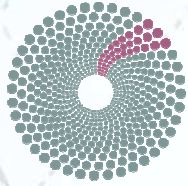
Social Sciences - Statistical and research data linking and integration



Security - Real-time monitoring, stream processing and data analytics, image data analysis



BigDataEurope - Objectives



BIG DATA EUROPE

**CSA
Measures**

COORDINATION
Stakeholder Engagement
(Requirements elicitation)

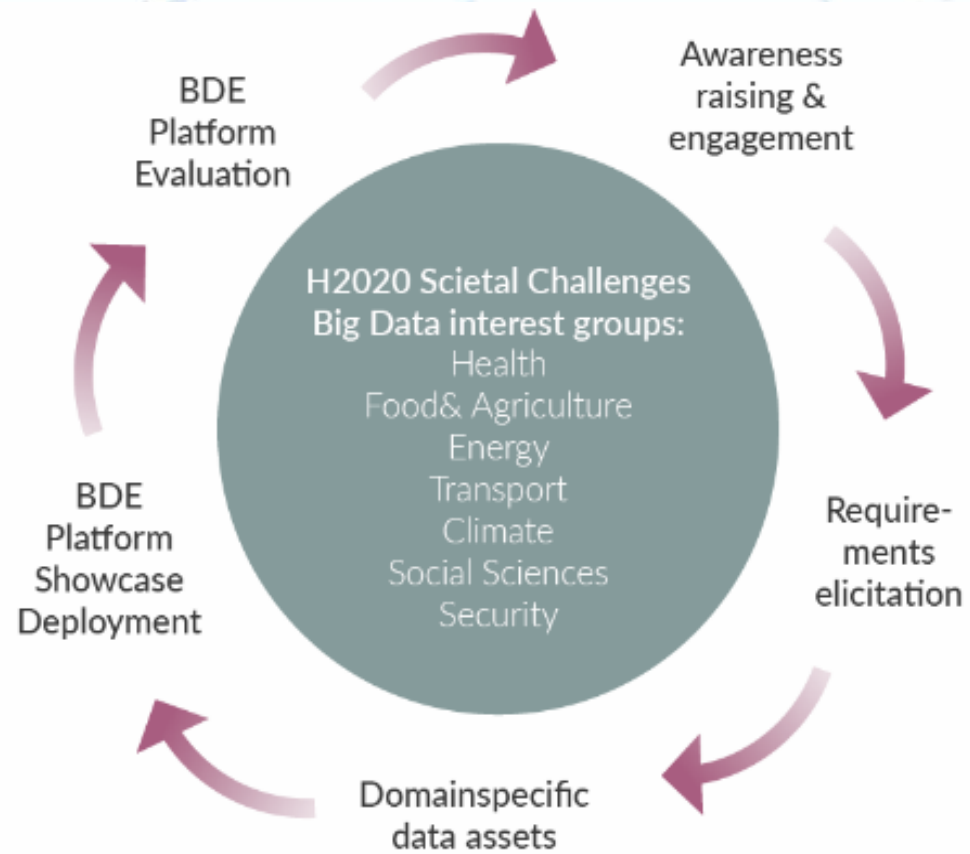
SUPPORT
Design, Realise, Evaluate
Big Data Aggregator
Platform

Results

Create and Manage
Societal Big Data Interest
Groups

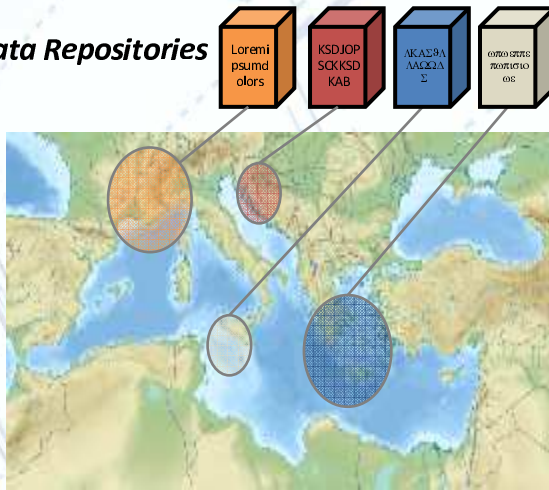
Cloud-deployment ready
Big Data Aggregator
Platform

Stakeholder Engagement Cycle

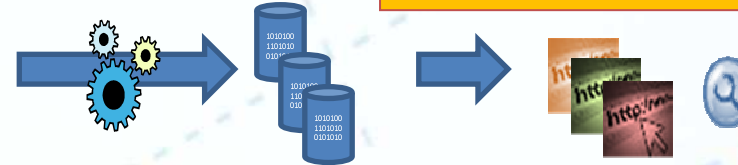


Big Data in Europe: Challenges, Opportunities

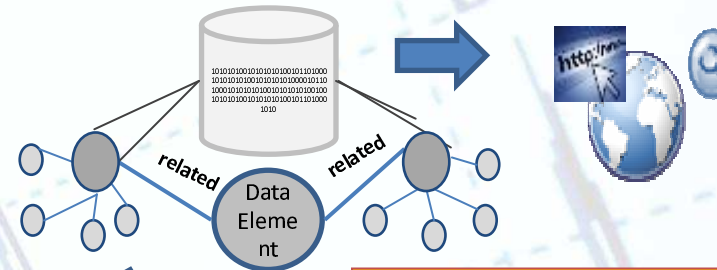
Regional Data Repositories



#1: Compile, Harmonise, Publish



#2: Interlink, Centralise Access, Explore



#4: Mashup, Cross-domain Exploitation



#3: Analyse, Discover, Visualise



[Source: Fraunhofer IAIS]

BDE in Energy Domain

Target fields

- ❖ Electricity production, transmission and distribution
- ❖ Renewable energy production
- ❖ Distributed production and smart grids
- ❖ Energy saving
- ❖ Energy policy planning

Big Data in Energy Domain

Data used in Energy Domain

- ❖ Monitoring complex electro-mechanical systems (O&M, condition and health monitoring CM/SHM, preventive maintenance, optimization based on historic data etc)
- ❖ Monitoring of energy flow on transmission and distribution grids (RTUs, smart metering etc)
- ❖ Forecasting of energy demand and renewable energy production (localized weather, access historic reanalysis data, model optimization etc)
- ❖ Monitoring/optimizing/control of Internet connected distributed systems or components (inverters etc; Internet of Things)
- ❖ Monitoring/optimizing energy management systems (BMS, etc)
- ❖ Market data
- ❖ Socioeconomics/geospatial/resource/legislation etc

Big Data in Energy Domain

Electricity production, transmission and distribution

- Utilities/Operators (system monitoring and control, forecasting)
- Transmission System Operators (grid/substation monitoring, energy flow, smart grids in transmission level, forecasting)
- Distribution System Operators & aggregators (grid/substation monitoring, AMI automated metering infrastructure, historical data management and forecasting)

Renewable energy production

- Manufacturers (fleet monitoring, siting & forecasting)
- Wind Farm operators (system monitoring, resource forecasting/day ahead bidding)

Distributed production and smart grids

- DSOs & aggregators (grid/substation monitoring, energy flow and balancing, smart metering, forecasting, demand side management)

Energy saving

- Industrial sector (energy, large distributed installations)
- Building & commercial sector (building envelope, audit data, user preferences and behavior, etc)

Energy policy planning

- Resource estimation (wind atlases, climate effects etc)
- Exploitation of socioeconomic/geospatial/legislation data from various sources and formats

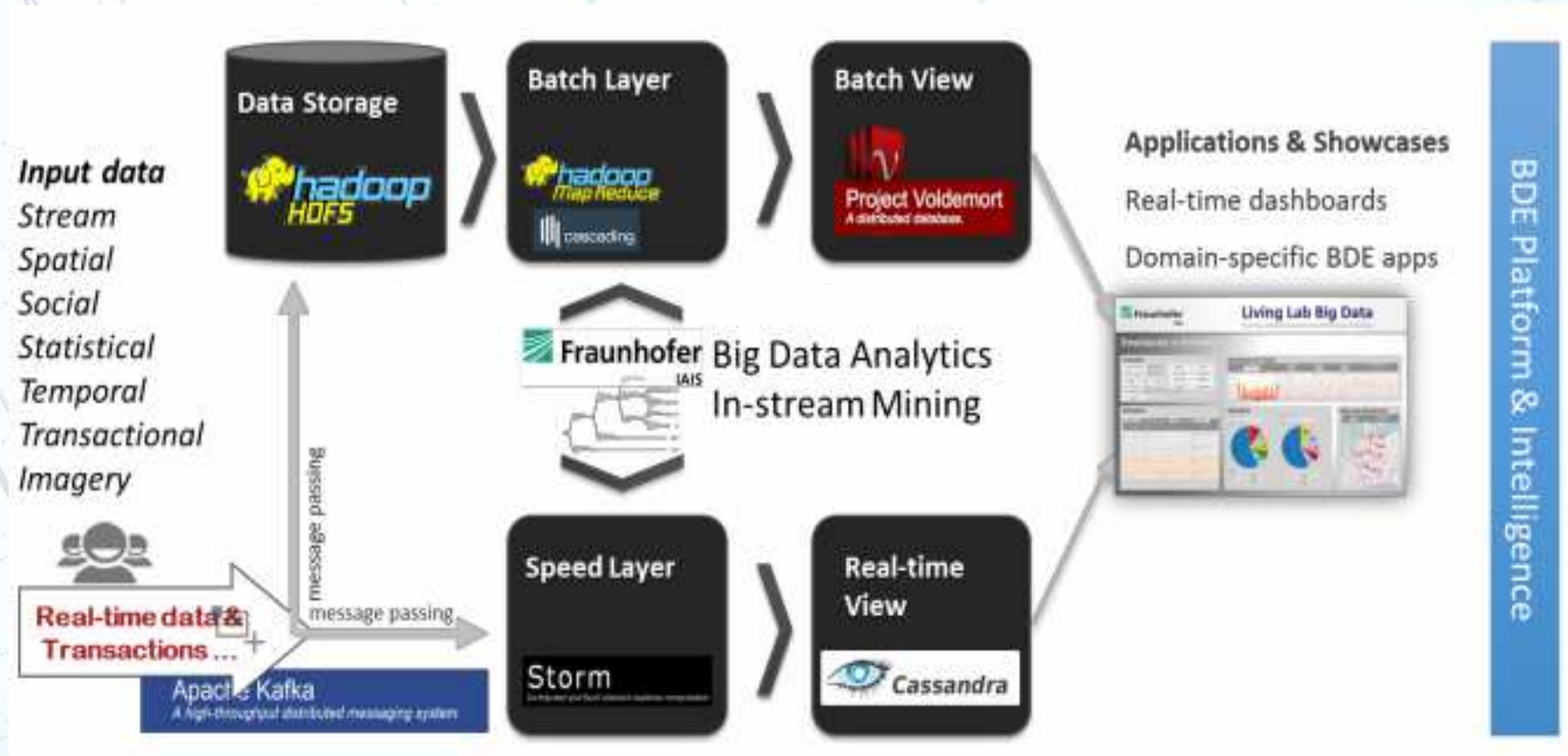
Data Analytics in Energy

- Statistics - baseline analytics (statistical analysis, multivariate analysis etc)
- Modeling (Linear/non linear modeling), CFD (atmospheric boundary layer, mesoscale modeling, environmental parameter modeling etc), FEM (structural modeling)
- Analysis methods: structural analysis (fatigue, fracture etc), dynamic analysis (frequency domain analysis, enveloping, etc)
- Forecasting methods
- Specialized procedures for filtering, pattern recognition, etc

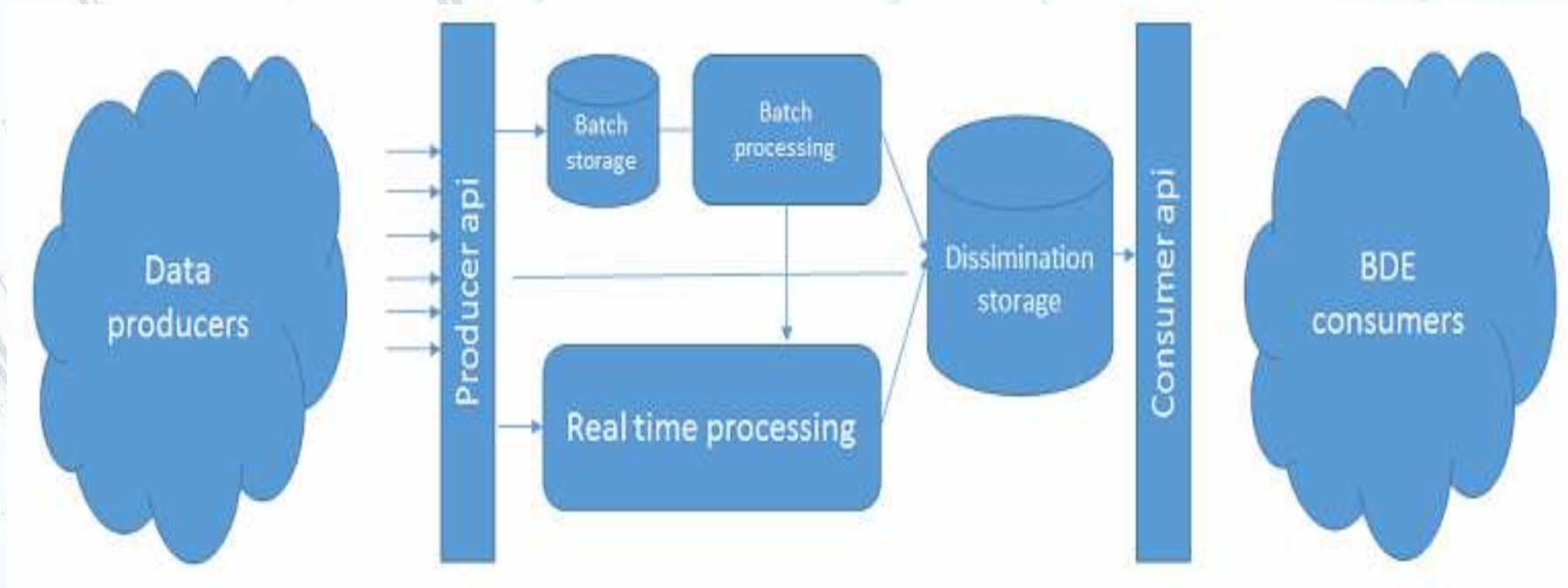
Challenges to be addressed by BDE in Energy

- ❖ Competitive low-cost energy production via lower O&M costs and accurate forecasting and grid management
- ❖ Expansion and optimal operation of smart grids
- ❖ Robust decision making via accessing large data sources
- ❖ Exploitation of latest ICT innovation in BD field

Blueprint of the Big Data Europe Data Aggregator Platform



Big Data Integration Platform Architecture



Building Energy Management Systems

Building Energy Management Systems (BEMS) is an integrated system of software, hardware and services that controls energy use through information and communication technology.

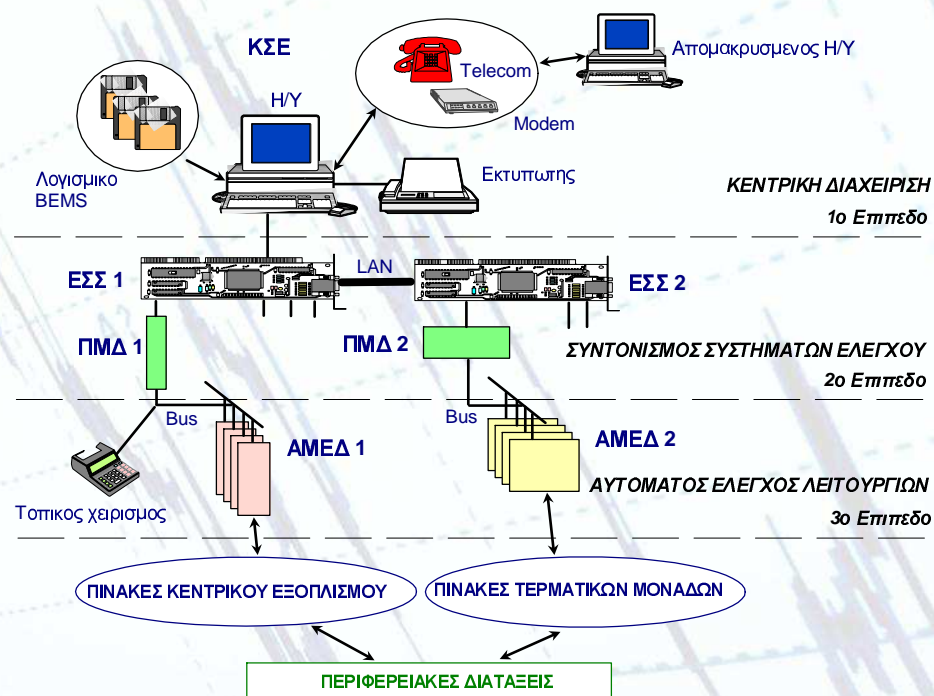
It monitors, automates, and controls building systems such as heating, ventilation, air conditioning, thermostats, and lighting to increase building energy efficiency and improve comfort in a very wide application area.

A BEMS can monitor, control, and use alarm operations regarding energy issues, indoor conditions, power needs on a real time basis data coming from many various sources

The market of BEMS is growing day by day so the need to gather and control, and interpret all the collected data. BEMS revenue is expected to reach \$2.4 billion in 2015 and grow to \$10.8 billion by 2024.

Building Energy Management Systems

The system consists of a Central Station Control unit, which is connected through a system of self regulated controllers, Data Transfer adaptors and a high speed communications network, with a number of de-centralized Data Processing Units, and through those with all terminal controllers, sensors such as temperature, humidity, light, motion, etc.



Condition Monitoring

Monitored WT
Neg-Micon 750kW

CRES Wind Farm

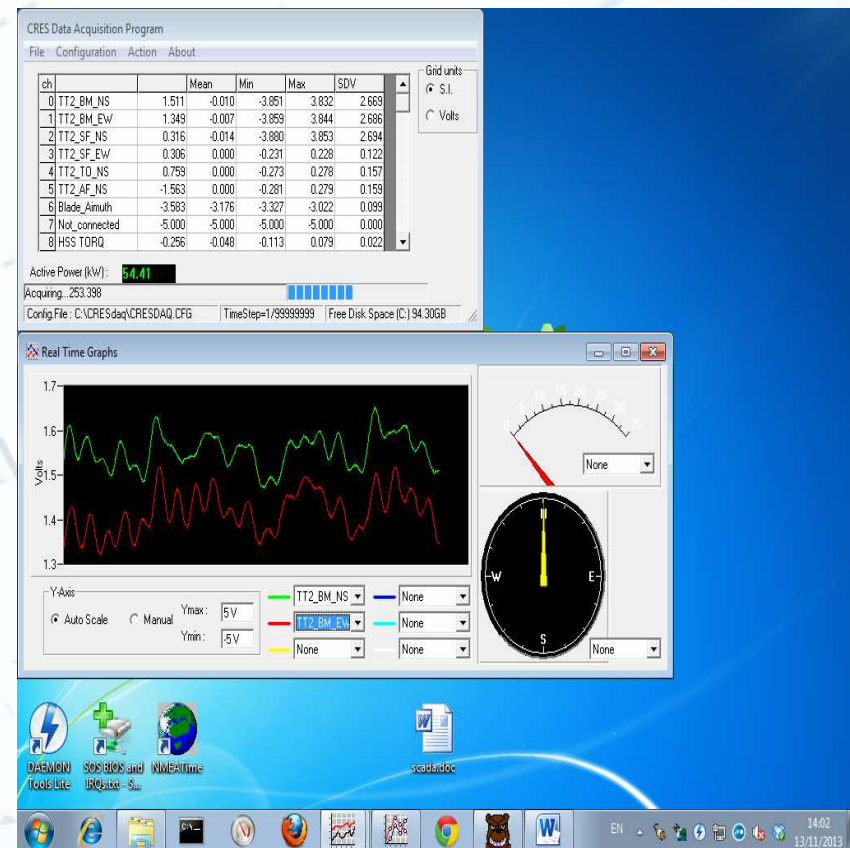


Condition Monitoring

CRES CM system on NegMicon 750kW WT

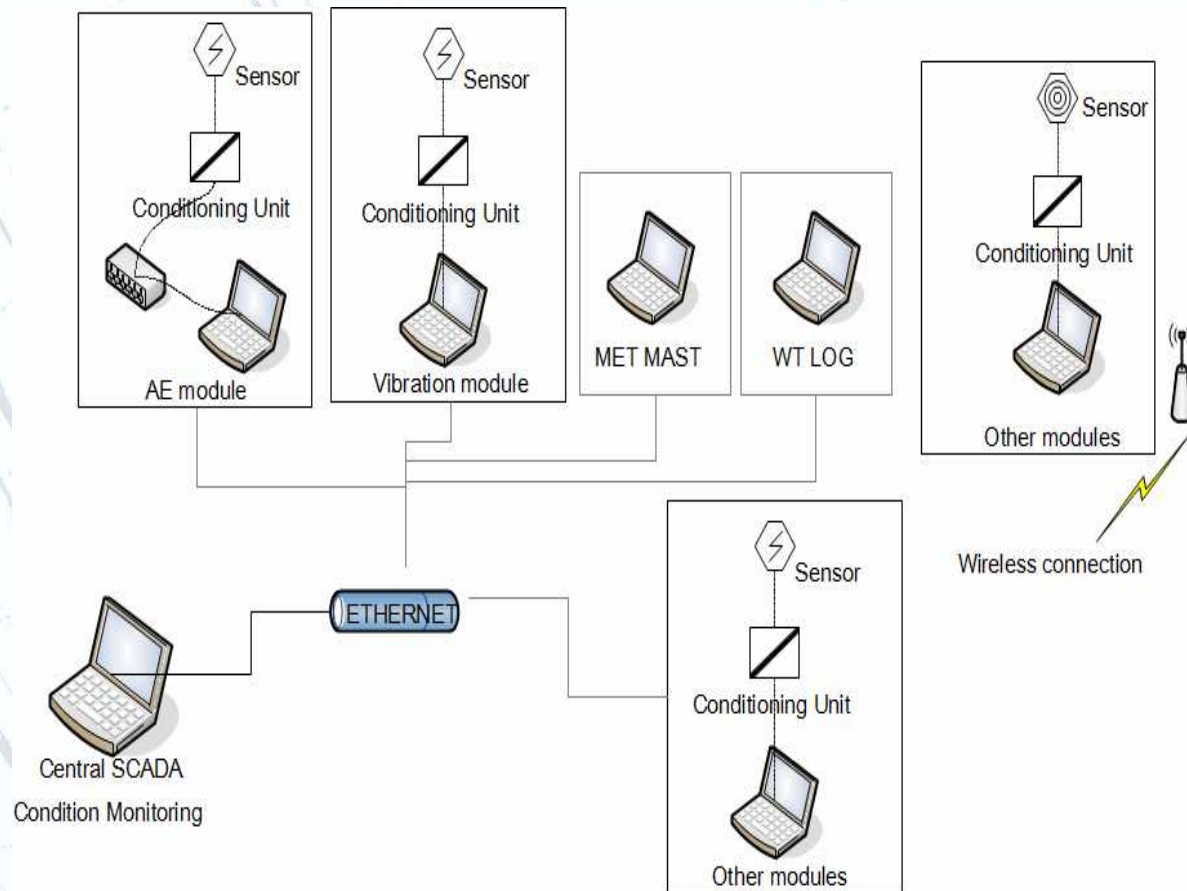
The SCADA software provides indicatively the following data for the condition monitoring system:

- wind turbine output electrical power
- rpm
- nacelle yaw position
- yaw motor electrical power
- wind speed from nacelle anemometer
- mechanical loads on tower top and base cross section
- rotor thrust
- tower torsion
- HSS torque (on shaft coupling the gearbox with the generator)
- vibration velocity at gearbox HSS output shaft and at second intermediate shaft



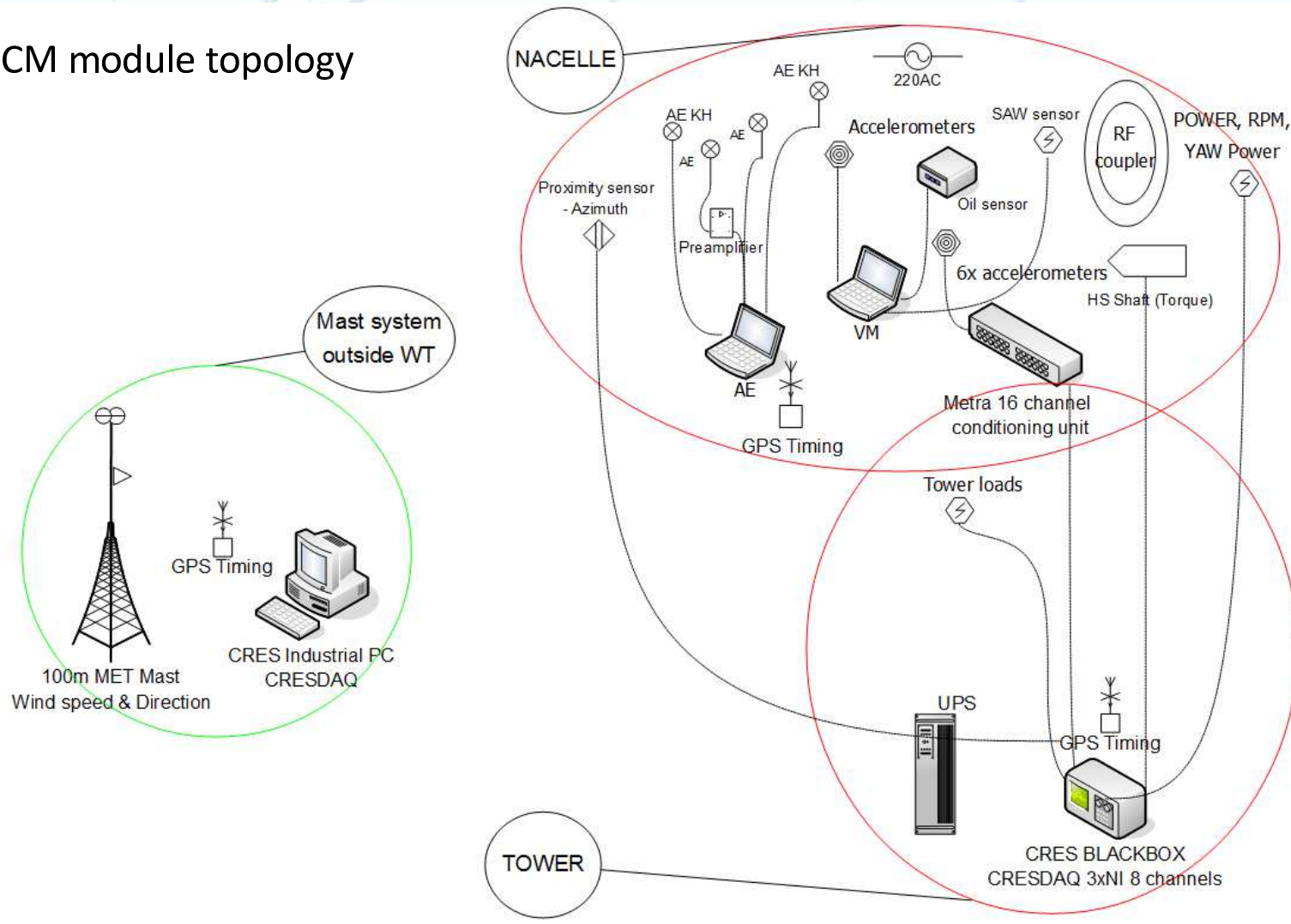
Condition Monitoring

CM module topology



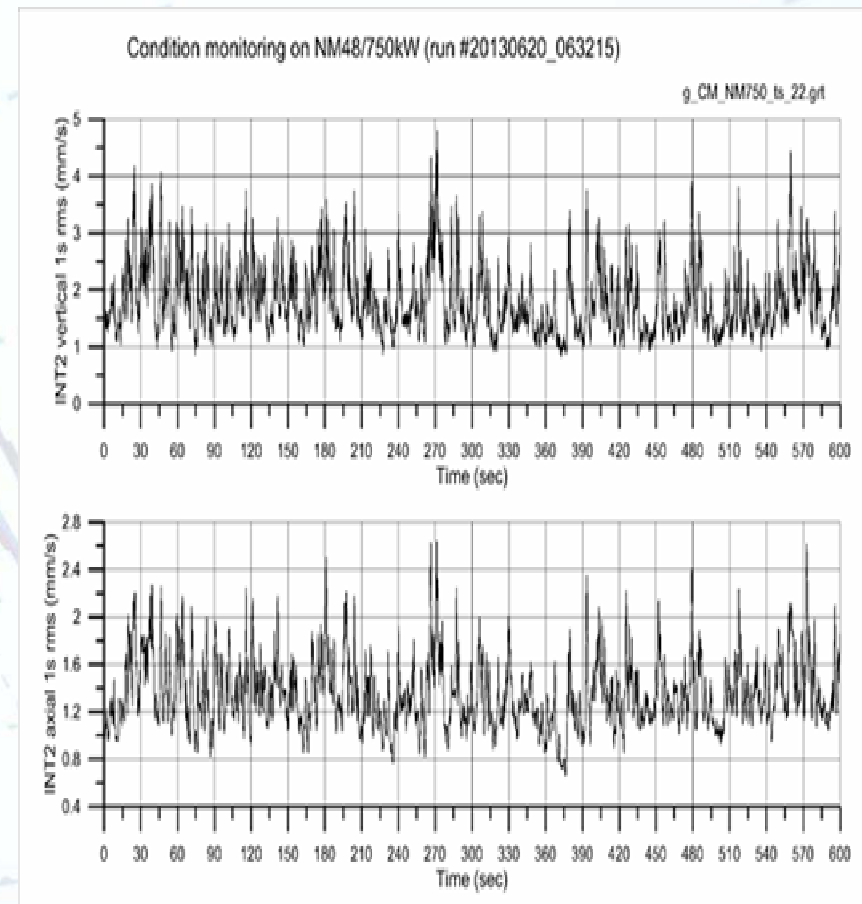
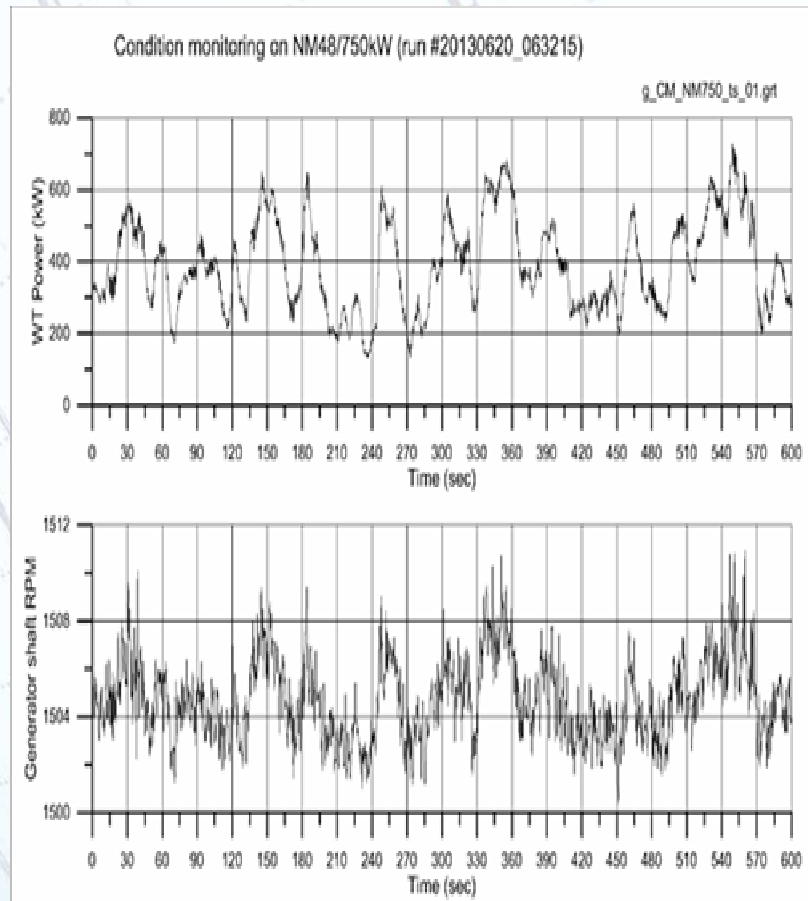
Condition Monitoring

CM module topology



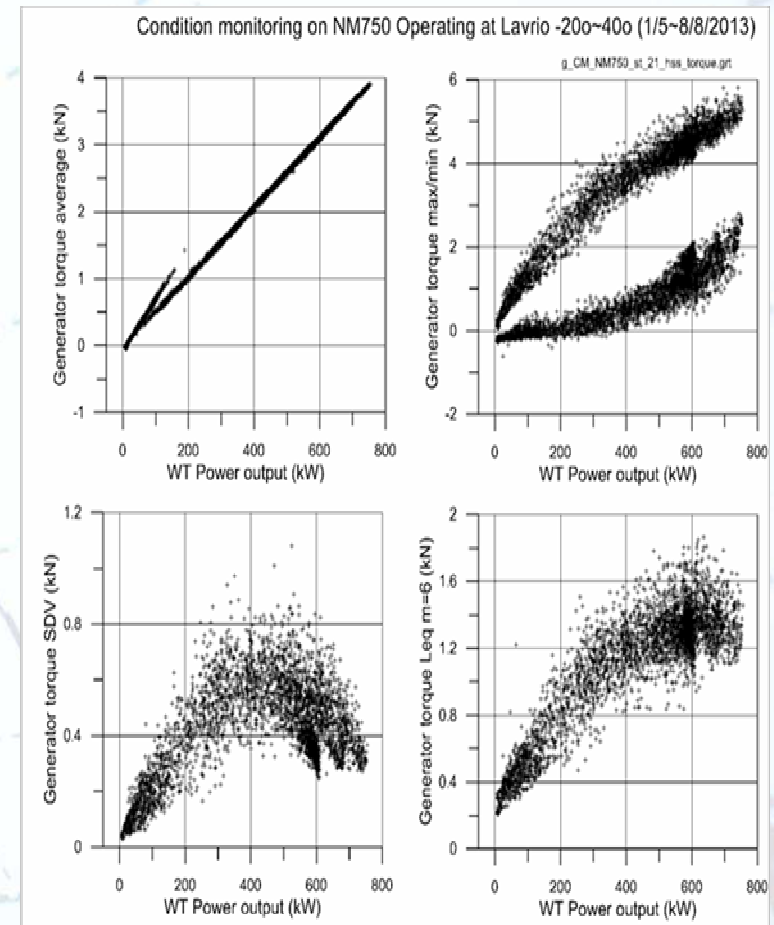
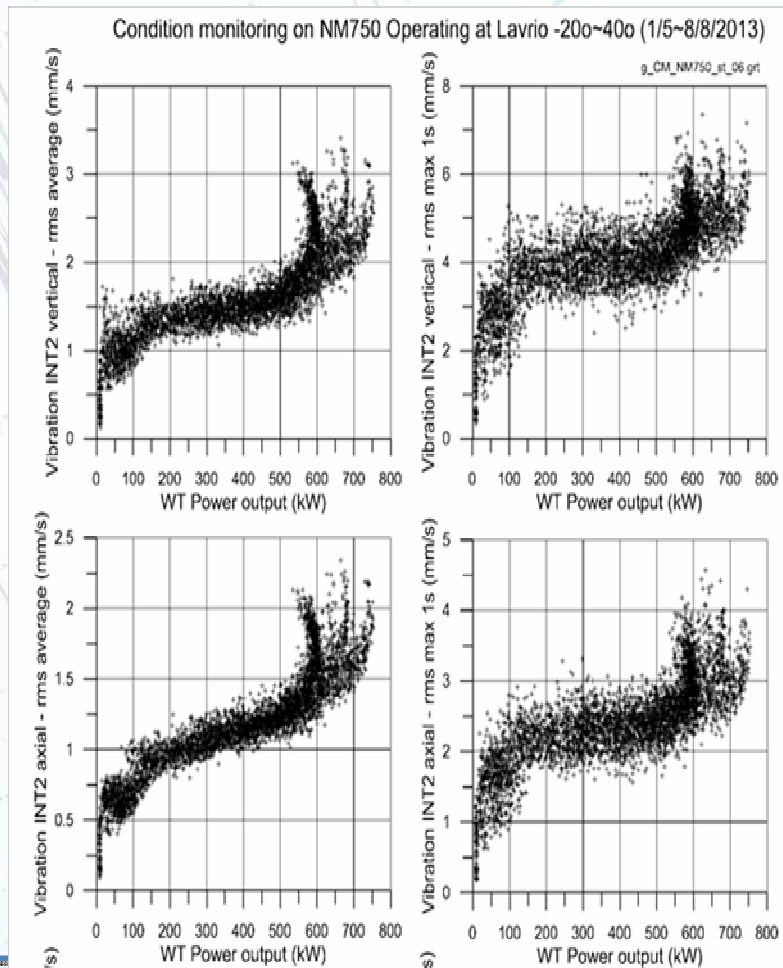
Condition Monitoring

CM raw time series



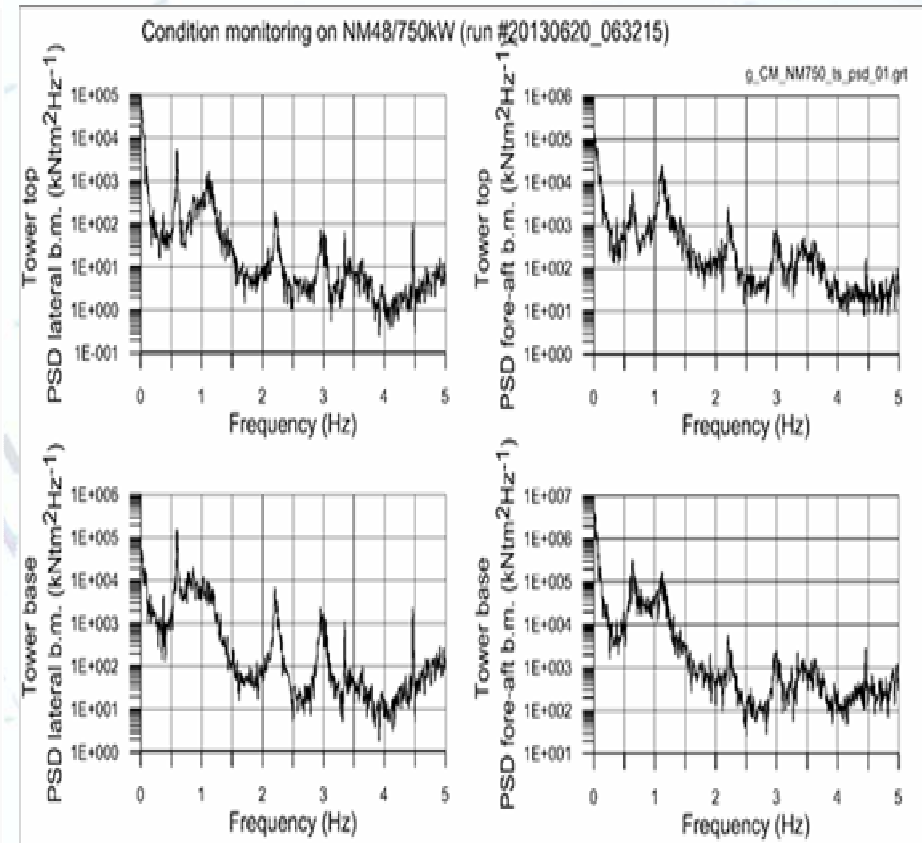
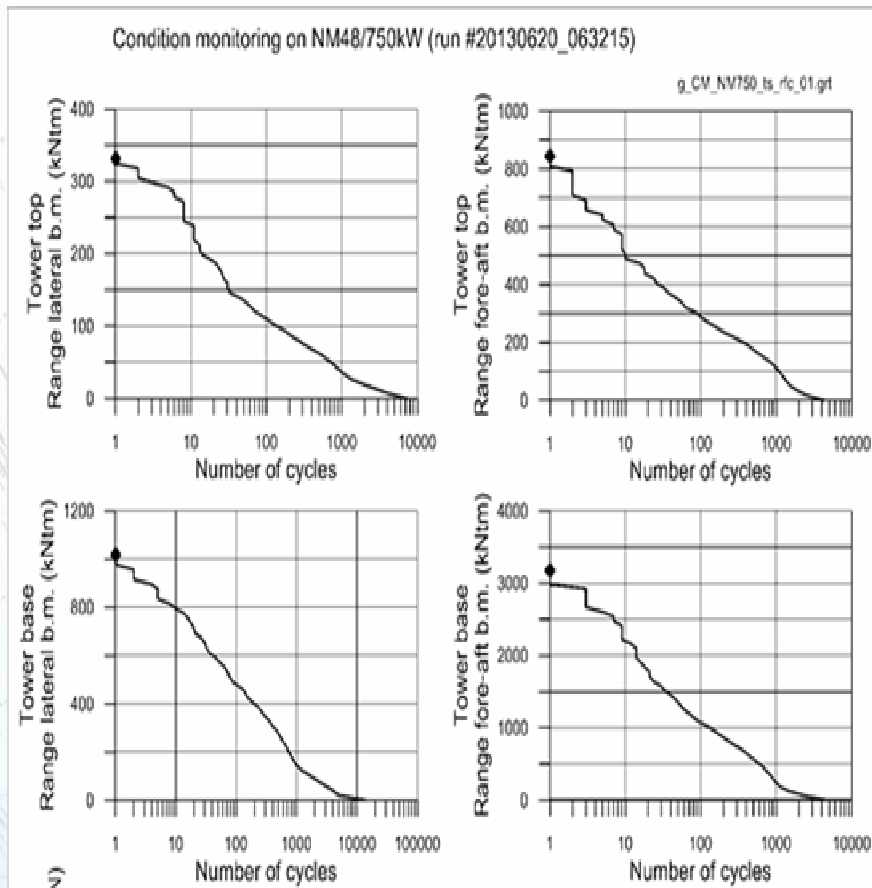
Condition Monitoring

CM Basic analytics: Statistics



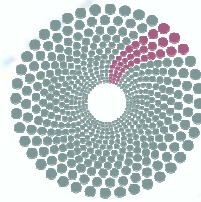
Condition Monitoring

CM Basic analytics: Dynamics and fatigue analysis



Conclusions

- ❖ Big Data technology advances open new prospects and opportunities in numerous data management intensive fields.
- ❖ BigDataEurope is designed to support the communities for meeting their domain challenges via the adoption of the IT advances.
- ❖ The platform features will be defined by the active participation of the stakeholders.
- ❖ Data management challenges can be met with the current technology and facilitate energy saving, renewable power reliability and cost efficiency.



BIG DATA EUROPE

Empowering Communities
with Data Technologies

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