Implementing Condition Based Asset Management @ Elia, the Belgian Electricity Transmission System Operator

Diederik Moers
Implementing Condition Based Asset Management @ Elia, the Belgian Electricity TSO
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Content

• Elia Group
• The Pi System at Elia
• Condition Based Asset Management?
• Asset Management Excellence - TFO
• ACC implementation
• Conclusion & Next Steps
Elia Group
Elia Group, a unique location in the heart of Europe

The Elia Group encompasses two leading TSOs in two European regions: Elia in Belgium and 50Hertz in Germany.
The Elia Group is expanding its international activities through Elia Grid International.
TSOs at the heart of the electricity system

**Generation**
Electricity is generated using conventional and renewable energies.

**Transmission system operators**
Ensure that generated electricity reaches consumers via distribution system operators (DSOs).

**Consumers**
Use the generated electricity injected into power grids.
Facts & Figures 2018: Elia Group

A top-5 player in the EU TSO Business

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents covered</td>
<td>30,000,000</td>
</tr>
<tr>
<td>Covered area</td>
<td>140,147 km²</td>
</tr>
<tr>
<td>High-voltage lines in Belgium and Germany</td>
<td>18,990 km</td>
</tr>
<tr>
<td>Interconnections</td>
<td>6</td>
</tr>
<tr>
<td>Experienced engineers and technicians</td>
<td>+800</td>
</tr>
<tr>
<td>Installed capacity of renewable energy</td>
<td>35,000 MW</td>
</tr>
<tr>
<td>Employees</td>
<td>2,441</td>
</tr>
<tr>
<td>Nationalities</td>
<td>24</td>
</tr>
</tbody>
</table>
## Facts & Figures 2018: Elia

A top-5 player in the EU TSO Business

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents covered</td>
<td>11,267,910</td>
</tr>
<tr>
<td>Covered area</td>
<td>30,528 km²</td>
</tr>
<tr>
<td>Length of lines and cables</td>
<td>8,600 km</td>
</tr>
<tr>
<td>Substations</td>
<td>814</td>
</tr>
<tr>
<td>Transmission towers</td>
<td>22,000</td>
</tr>
<tr>
<td>Maximum load</td>
<td>12,870 MW</td>
</tr>
<tr>
<td>Employees</td>
<td>1,366</td>
</tr>
<tr>
<td>Interventions on the grid</td>
<td>18,435</td>
</tr>
</tbody>
</table>
Monitoring the generation/consumption balance in real time, 24 hours a day

The grid needs to be enhanced to respond to changes in the balance between generation and consumption and in the volume and location of generating facilities and centres of consumption.
Key activities

Elia Group

1. Infrastructure management
   Operation, maintenance, planning and expansion of onshore and offshore high-voltage infrastructure.

2. Controlling the system
   Balancing the entire electricity system and ensuring its safe operation 24/7.

3. Developing the EU market
   Being a front runner in the development of the EU electricity market (NWE & CEE regions), to make the EU energy system more competitive, secure and sustainable.
Addressing EU objectives

1. Security of supply
2. Construction of the European market
3. Integration of renewable energies

Competitiveness
Sustainability
Security of supply
The Pi System @ Elia
The Pi System @ Elia

Currently 2 implementations of the Pi System at Elia

1. Visto @ Elia System Operations

The Pi System is used for the visualization of forecasting data at the NCC.

- Cross Border Flows
- Imbalance prices
- Winter Dashboard
- Solar/Wind Forecasting
- Spinning Reserve
- Critical Asset Monitoring
- …

Great project, but not the subject of this presentation
Currently 2 implementations of the Pi System at Elia

2. ACC @ Elia Assets

The Pi system supports in the asset management decision making process, by calculating and visualizing the condition of our assets.

= The subject of this presentation
Facts & Figures for ACC’s PI System

- 560k tags, 2,2M analytics and 16M attributes
- 180k assets (TFO, AIS, Cables, Diesel Generators, OHL)
- 56 element templates and 72 event frame templates
- Daily automatic generation of 10 different reports and 7 more on a weekly schedule
- 19 different types of PI Vision dashboards + 19 event frame dashboards + 5 Process books
- 16 Interfaces with: 11 UFL, 4 RDBMS, 1 Modbus
Condition Based Asset Management @ Elia

Why do we need it for modern Asset Management?
Challenges for Asset Management

Trends

Impact

- New players
  - Household
  - Heat pump
  - Distributed generation
  - Local storage
  - Tertiary sector
  - Electric Vehicle

- Legislation (danger sign)

- High Voltage, Keep Out
Elia’s programs to prepare for the future: House of Assets

Some lever examples to reach the AMEX goals
- Finetuning replacement policy of Circuit Breakers
- Adaptation fleet strategy Current Transformers
- Oil sampling frequency based on asset condition
- Retrofit OLTC (On Load Tap Changer for Voltage Regulation)
- Adapted maintenance of OLTC
- Remote Monitoring and Testing of Diesel Generators
- Monitoring and automatic discharging batteries

Enabled by

By gathering Dynamic Asset Data, one can calculate the Health Index of an asset in order to support the asset manager in decision making for maintenance and replacement

Through new technology, one can remotely access and control an asset, which results in less travel, more simple and frequent monitoring

Focus on “what”

Strive for excellence in Asset Management
- Condition based asset management with high quality data;
- Evolution in maintenance and monitoring

CAPEX plan and OPEX costs
What is ACC

ACC stands for Asset Condition & Control and is as a new department an enabler for smarter Asset Management:
ACC will support the development and implementation of Condition Based Asset Management and Remote Maintenance, enabling Elia to use it’s resources as efficient as possible on CAPEX and OPEX level.
History of ACC

- **2013**
  - Ideas - scope – analyses of potential
  - Market survey – First tests – models

- **2014**
  - Development of POC based on the Pi System
  - Kickoff of POC

- **2015**
  - Continuation of POC

- **2016**
  - End of POC: Feedback + final bus. case
  - Kickoff Final ACC based on the Pi System

- **2017**
  - Implementation Amex Wave 1
  - Procurement historian DB
  - Organisation of ACC within AM

- **2018**
  - Implementation Wave 2
  - Implementation Phase 3

- **2019**
  - ...
Asset Management Excellence – TFO case
Time Based vs Condition Based AM

**Classical** Time Based Asset Management vs **ACC enabled** Condition Based Asset Management

<table>
<thead>
<tr>
<th>55y</th>
<th>55y</th>
<th>Real Age</th>
<th>55y</th>
<th>55y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>Equivalent Age</td>
<td>50y</td>
<td>65y</td>
</tr>
</tbody>
</table>

Only age is used as a criteria. A and B will be replaced in 5 years. Bad condition of B is not taken into account.

A = replacement in 10y → 5y gained
B = replace immediately → avoid run to failure

A and B are both 55 years old with a lifespan of 60 years. Equivalent age is a calculated age based on real age, life span and the physical health condition of the asset.
FMECA approach as driver for improvements

Asset management strategic objectives

Assets primary and secondary functions

Failure modes

Impact

Probability

Mitigation measures

Design / procurement

Maintenance activities

Replacement

End of life

Spare parts management

Incident analysis

Performance

Asset health index

Inspections

Remote monitoring

Asset age
Health analysis of specific fleet

- End of life of sub-fleet 2 = 55 years due to aging
- Retrofit needed on units above reference line
- Extending end-of-life (55 to 60) of assets results in CAPEX savings
- A pilot shell re-clamping has been performed in 2015 moving health index from ~70 to ~30
- Business case retrofit 360 was positive
Results of the Retrofits (1)

After AMEX project need was detected => start-up ACC Asset Condition and Control

Development of ACC : Condition asset translated in Equivalent Age (EA) and Health Index (HI)

- **EA Oil analyses** : DGA (Internal condition) + Oil Quality + Paper degradation
- **EA OLTC** : # operations (~type)
- **EA Bushing** : electrical measurements
- **EA Electrical** : electrical measurements

**EA TFO** = Max of worst EA in EA

**HI** = % of used lifetime ifo expected LT of asset

ACC centralizes all parameters and delivers a day-day refreshed view of the condition
Results Retrofits (2)

ACC : Daily updated report of HI (%)

Impact of retrofits => saving a total of 2 assets in years of life-time
Retrofits
ACC implementation
How does Health Index calculation work at Elia?

- Referential DB tools
- EMS system
- Lab results in XML
- Mobile Data Collection
- Work Order Database
- Fault Analytics DB
- Digital Maint. Reports
- DGA Probes
- IED’s
- Diesels
- Batteries
- Temp/Hum sensors
- SF6 Probes

Analytics

HI/EA calculation

Offline Data

Historian DB

Online Data

Implemented

In Development

2017-2018: Transformers, AIS >70kV (Breakers, CT/VT, Disconnectors), Cables implemented

2019-2020: Diesels, Overhead lines, GIS, Batteries, AIS <70kV, … under development

Daily Report

Dashboard

Recurrent or Specific Report

ACC Validation

Export

Works Program

Investment Tool (Capex & Opex)

RDBMS service
Report uses test data for demonstration use only and does not reflect any real Elia Assets.
Dashboard Example

Dashboard uses test data for demonstration use only and does not reflect any real Elia Assets.
ACC Operation

An implemented software solution doesn't run on its own.

Staffing

4 operational FTE’s are required for daily exploitation of the current scope, under the lead of the ACC Manager who reports to the Head of Asset Management.

1x Data Expert ACC: Governs ACC data and database; Defines which and how data is stored within the ACC environment; Develops the basis for dashboards and reports; Collaborates with the Corporate Data Manager

3x Technician ACC: Implements and exploits ACC data and technical tools; Executes first line analysis on data and communication issues; Creates periodic and specific reporting; Executes certain remote maintenance activities
Benefits ACC

ACC doesn't deliver a direct monetary benefit as a service provider, but delivers services to activities with a positive business case who do:

- Safety
- Reliability
- Availability

ACC will enable Elia to better estimate the health condition of her assets, which means that in certain cases it will be possible to identify a required intervention before a malfunction occurs (avoiding an interruption on the grid and avoiding heavy asset damages and potential safety risks). It is however impossible to quantify this realistically.
Conclusion & Next Steps
Conclusion

First results on health indexes calculated with ACC system are positive and Elia will continue the implementation of other assets.

Some results:

- HI TFO’s used in update business plan
- Input for Works Program generator (switches since last maintenance)
- Dashboards have been profoundly used in the analysis of critical assets
- Used by the Asset Manager for project scoping and replacement policies (=CAPEX)
- Notifications are used to identify unregular activities on transformer voltage regulation (switches per day)
- …
Biggest Challenges on ACC implementation

Concept
• Why do we need an ACC
• How can an ACC help the Asset Manager in the governance of his fleet? What information does the AM need?

Implementation
• Building interfaces with the existing environment
• Creating a data model for each asset: what do we truly need to get started?
• Data Cleaning and Data Quality
Next Steps on ACC

By the end of 2019 we will have developed phase 2:

• Implementing High Voltage Overhead Line systems (1000 circuits, totaling 170,000 assets)
• Implementing additional assets like GIS substations, batteries, …

2020-2021 is reserved for

• Implementing additional assets buildings, cubicles…
• Improving knowledge on CBM (defining actions, alarms and correlating more relevant data)
• Preparing the next step to Predictive Maintenance
• Explore additional opportunities with the Pi System
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• Head Asset Condition & Control
• Elia
• diederik.moers@elia.be
Questions?

Please wait for the microphone

State your name & company

Please remember to…

Complete Survey!

Navigate to this session in mobile agenda for survey

TO DOWNLOAD APP, SEARCH OSISOFT
Thank you