Digital Transformation of Energy Systems

A holistic approach to digitization of utility system operations through effective data management
DNV GL: Global classification, certification, technical assurance and advisory company

Mission: ‘To safeguard life, property and the environment’
Global service portfolio

**Service areas:**
- Power testing, inspections and certification
- Advisory services spanning the energy value chain:
  - Transmission and Distribution
  - Renewable integration
  - Energy efficiency

**Strategic topics:**
- Smart grids, Smart green cities
- Energy storage
- Future transmission grids
- Solar & Wind
- Digital Transformation of Energy systems
Intelligent Networks and Communications Service overview

- SCADA/EMS/ADMS advisory services (>100 projects)
  - Requirement specification
  - Project management
  - QA & test management
- Utility Telecommunication consultancy
- Utility data communication conformance testing (CS 101/104, 61850, DLMS, CIM).
  - DNV GL is market leader and has a UCA accredited Level A testlab (> 400 products certified)
  - Provider of test tools & protocol analyzer tools
- Cyber Security advisory and testing
Digital transformation in Energy -> Digital Disruption?

Google's DeepMind is in talks with National Grid to apply artificial intelligence to energy use

Disruptive technologies: Advances that will transform life, business, and the global economy

How will the digital revolution transform the energy sector?

"90% of companies will be using data-driven business insight by 2020"

There’s Big Money In Energy Big Data
Utility forecasted spending on Big data analytics

Forecasted cumulative global spending on power utility digitalisation will grow up to an annual spend of $3.8 billion globally by 2020
Emerging data sources in the system operation landscape

- Sensor data: RTU, IED, PMU, PD, Fault indicators
- DER: Wind, Solar, EV, Storage
- External data: PFI analysis, Oil lab reports
- Network model schema: GIS, long term network planning
- Geographic map for fault localization
- Switching plan generation: planned outages
- OMS crew management: unplanned outages
- MV, LV Call centre data
- Historic data for (e.g. post mortem) analysis
- ERP Maintenance data
- Customer data for demand response and load shedding
- Smart meter data
- Getting proactive with weather data, social media
- Other data: HR, Finance, drawings, permits, etc.
Uses cases related to Energy Data Analytics

- Operation decision support
- System situational awareness
- Predictive asset maintenance analytics
- Asset health assessment analytics
- Fault location and root cause analysis
- System oscillations detection (using PMU data)
- Real-time voltage stability monitoring
- Alarm processing and filtering
- Renewable energy generation forecasting analytics
- Weather caused damage prediction
- Outage restoration analytics
- Power quality analytics
- Peak load management analytics
- Load research analytics
- Vegetation management analytics
- Non-technical loss analytics
- Cyber security assessment analytics
“Big data” typically applies when technical limitations of traditional used computer systems and software are encountered and when the available toolset limits what you can do with the data. Usage of new types of hardware, software, and/or algorithms is required to solve the problem.
Data Science - definition
Machine Learning - definition

Build model

\[ y = \hat{f}(x) \]

Initial observations \((X, y)\)

Data Algorithm Model

Use model in operation

\[ \hat{y} = \hat{f}(x^*) \]

New observations \(x^*\)

Predicted outcome \(y^* \approx \hat{y}\)

Build predictive models from historical data for use on new data
Digital Transformation - definition

Digital Transformation of Energy Systems will allow utilities to improve:

- How they serve their customers → Improved engagement
- How they run their operations → Using their data and applying big data analytics
- The products and services that they offer → Smart, cloud, social media, mobile, web
Data is the new raw material of business …. but, how to manage it?
Data Quality is important for data scientists/analysts?
Garbage in = Garbage out
Typical Project execution

- Preparation: 30% used, 10% Sustainable target
- Execution: 60% used
- Reporting: 10% used

% Time used
Sustainable target
Time spent in a data driven project

In Data Driven projects 70 % of the time is spent in import, data preparation, quality management and data improvement.
Data reality in Utilities

<table>
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<tr>
<th>Siloed data</th>
<th>Data governance</th>
<th>Poor info provisioning</th>
<th>Manual processing</th>
<th>Efficiency</th>
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| • Master asset data in different systems  
  • No unique Asset ID  
  • No enterprise wide datamodel  
  • Meaning no integrated view on assets capability  
  • No automated interfaces  
  • Not future proof for interrelation static and dynamic data | • Poor data governance  
  • No master data management  
  • Insufficient availability  
  • Data quality issues  
  • Insufficient data integrity control  
  • Limited data awareness  
  • System awareness, no person for enterprise data responsibility | • Reporting, analysis, planning, engineering, inspection & maintenance based on siloed data.  
  • Data generated in many systems  
  • Integrated information is not accessible  
  • Poor process support | • Many manual process steps required.  
  • Use of temporary datasets (excel, access)  
  • Manual processing leads to errors.  
  • Manual processing is labour intensive.  
  • Leads to suboptimal decisions. | • No end to end insight, leading to poor decision making on assets life cycle.  
  • Poor insight in total cost of ownership and end to end process costs.  
  • Not flexible and predictable.  
  • Not future proof, no basis for condition based maintenance. |

Poor Data → Poor Decisions
Corporate Data Governance takes a long term focus

Data Governance

- ‘Enterprise-Oriented’
- Strategic Long Term Focus

- ‘Project-Oriented’
- Tactical Short Term Focus

Project Teams

- System Vendors
- System Integrators
- Project Consultants

Internal Systems Experts

- Data Governance

System Experts

- Project

Vendors

- Consultant

Integrators

- System

Experts

- Project

Teams

- Data Governance
Common Information Model & Enterprise Service Bus

- The CIM is an international IEC standard that models the information exchanges required in electric utilities.
- It is independent of any individual application, middleware, or message protocols used for data exchange.
- The interoperability enabled by the CIM standards is a key factor for achieving the Smart Grid vision.

Point-to-point communication

Centralised communication
Holistic Data management for Electric Utilities
How to focus on reducing the ‘70%’ and improve data quality

- **Data modeling**
  - Remove data silos by adoption of a standardized (CIM based) enterprise logical datamodel

- **Data quality assessment**
  - Assess and manage the quality and ‘truthfullness’ of the data

- **Enterprise architecture for analytics**
  - Solution for capturing of large datasets from different sources
  - Ability to work with a variety of types of data
    - data warehouses vs data lakes
    - cloud vs on-premise
  - Solution for handling streaming data (analyze close to the source)
  - Create Proof-of-Concepts in a ‘Data development and discovery lab’
  - Digital Twin concept
  - Hardware in the loop testing
Partial Discharge in a 10 kV cable

PD pulse  Synchronization pulse

defect

Raw data  Warning level

Server

up to 16 km

DNV GL applications: Smart Cable Guard: Predictive analytics solution for cable failures
Just launched: DNV GL’s Veracity industry data platform
... reducing friction between data sets and stakeholders...

Data Management Services

Veracity

HRS
Viewer and builder for the HRS dataset
more dataset info
- Viewer
- Builder
- Sensor browser

Energy Statnett demo
Frequency and weather data
more dataset info
- Viewer
- Builder
- Sensor browser

Statoil WHF demo
Wellhead fatigue visualization
more dataset info
- Viewer
- Builder

PMU Nordic power grid
Gothia Power
more dataset info
- DQD (External link on Azure)
PMU data analytics project with data from the Nordic grid
Preliminary Results

Histogram DFreq

Deviation from 50Hz
(=0)

Frequency deviation - sub

Count

Frequency value

Scale ID

Accepted interval

-0.1Hz
+0.1Hz

Deviation from 50Hz

-0.155 - 0.135 - 0.115 - 0.095 - 0.075 - 0.055 - 0.035 - 0.015
-0.005 0.005 0.025 0.045 0.065 0.085 0.105

Counts

0 20 40 60

0.048 0.050 0.052 0.054 0.056

Deviation (Hz)
PMU data analytics project

- Synchrophasor measurement data
  - 5 sensors: Covering the Swedish and Finish power grid
  - Time span: 2005-2016
  - Resolution: 50 measurements each second
  - Size: 900 Gigabytes binary, 6.5 Terrabytes in CSV format.

- Approach:
  - Look at sequences of events, patterns that occur before, during and after system disturbances as they may lead to (real-time) data analysis which may predict system disturbances before they occur
  - Look at frequency anomalies (deviations of more than 0.2 Hz) and correlate to other events (e.g. interconnection cable failures, generator trips)
  - Based on PMU measurements, we can determine the asset (interconnector, load or generator) that has caused a frequency excursion, within a few seconds after it has tripped.
Summary:
Holistic Data management is an enabler for Digital Transformation in Energy

Project manager of a data-driven project in a utility that is taking its data governance serious
DNV GL can help in unlock the power of Digital Transformation in Energy
Come visit us at our booth or contact us

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