Agenda

Introduction
Key renewables industry trends – and the implication for O&M
The top 2 renewables monitoring & controls challenges
Re-gaining control: HAPG’s offering for real-time and prognostic O&M
Mission-critical solutions for mission-critical assets: Communication, safety & security systems
References
Key Renewables Industry Trends
Implications for Asset Management beyond O&M

01. Auctions & cost pressure
   - Auctions as key means for allocating new build-outs dominate global markets in both ONS and OFS wind
   - ~30% price decrease for USD / Wind MWh in ONS wind over last 10 yrs (1)
   - OPEX with 9-20% of Total Cost of Ownership (TCO) a key determinator of bid price, thus winning or losing new projects, thus impacting chance of growth / survival for larger, vertically integrated IPPs (developing, owning, operating)
   - As a result, expenses for O&M must be minimized whilst yields must be maximized.

02. Curtailments and less attractive sites
   - 75% of days in UK see partial wind power curtailment through system operator ensuring grid stability
   - 7-8% of theoretically possible power sales goes lost uncompensated in OFS Wind (example: DE)
   - Increased deployment of attractive sites leading to more unattractive sites inland with weaker, less stable winds
   - As a result, maintenance and repair timings must be timed for expected periods of curtailments or low winds.

03. Asset operational life extensions
   - 78 GW wind globally will have reached 20 years «end-of-design-life» by 2028
   - Experience shows, real asset life can be expanded to 25+ years. Key attraction: Avoidance of asset repowering often requiring re-permitting (height) and grid connection upgrades (capacity)
   - Insurances an increasingly demanding stakeholder requesting proof for predictive maintenance esp. in older assets.
   - As a result, maintenance must be conducted with foresight, allowing maximum component life-time.

04. Digitalization
   - From real-time monitoring (SCADA) ever since to learning from analyzing historic data (diagnostics) to predictive and prognostic maintenance tools (Enterprise Software) since ca. 5 years
   - Large universe of emerging players in predictive maintenance software allow for selection of boutiques according to owner / operator’s favor. However, experience thus far not convincing most owners + operators
   - As a result, solutions with successful references are key.

Sources:
(1) Wood Mackenzie, Global Onshore Wind O&M Report, 12/2019
(2) Renewe.biz, 01/2021
(3) Renewe.biz / Northland Power, 05/2020
Real-time monitoring + controls challenge No 1: The unintended effects of growth: High O&M costs

Growing fleets

Fast and unsustainable expansion

• Modernize the power generation fleet: From conventional assets & substations to Renewables & substations to BESS & substations

• Mistakenly “saving costs” (“CAPEX ONLY” perspective)
  • “Got PV monitoring for free from PV inverter manufacturer”
  • “Got Wind controls & monitoring from Wind OEM”
  • “Tried Monitoring + Controls as a pilot from a start-up”

• Different systems + teams built or acquired:
  • PV Monitoring + Controls
  • Wind Monitoring + Controls
  • BESS Monitoring + Controls
  • Substation Monitoring + Controls

• Teams pursuing different goals, e.g.:
  • PV output maximization
  • CO2 savings
  • Lifetime extensions

Growing complexity

From single plants to “fleet jungle”

Growing inefficiencies

Unintended effects

• Unexpectedly high O&M costs
• Frustration between “expert teams” talking different languages, using different systems and KPIs
• Conflicting controls / commands
• Operational risks of unsynchronized management of various assets
• Lack of legacy for inverter monitoring + controls w bankrupt OEMs leading to “blind eyes”
• Need a “re-set” in Renewables Monitoring + Controls for the future
## Real-time monitoring + controls challenge No 2:
From “basic” O&M to “digital” O&M: Saving revenues

### Example

<table>
<thead>
<tr>
<th>Location</th>
<th>Project Highlight</th>
<th>Saving Estimates (25 yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middlemount, AU</td>
<td>Fix-build (non tracking) 20 degrees Central inverters (&gt;250kw/each)</td>
<td>$0.5 M USD</td>
</tr>
<tr>
<td>Toledo, ES</td>
<td>Fix-build (non tracking) 20 degrees Central inverters (&gt;250kw/each)</td>
<td>$2.7 M USD</td>
</tr>
<tr>
<td>Lonborg Hede, DK</td>
<td>10xV117-3.45 (Power optimized mode: 10 x 3.6 MW)</td>
<td>$2 M USD</td>
</tr>
<tr>
<td>Tonstad, NO</td>
<td>51 x SWT – DD – 142</td>
<td>$8 M USD</td>
</tr>
</tbody>
</table>

### Underlying Assumptions:
- Reduction of availability losses: 25%
- Reduction of operations and maintenance work time: 40%
- Reduction of component exchange costs: 20%

#### Annual revenues
- **WITH** digital O&M
- **WITHOUT** digital O&M

© Hitachi Energy 2022. All rights reserved
Digital Renewables Integration
We increase Renewables ROI* through digital synergies

From planning & designing to trading, from field to boardroom

1. Energy markets forecasting & planning
2. Grid edge advisory services
3. Communication networks & CCTV solutions
4. Substation & plant automation systems (protection, controls, monitoring)
5. Battery energy storage systems (BESS) & Hydrogen Solutions
6. Power plant controls
7. Remote monitoring & control solutions
8. Asset lifecycle management solutions & services
9. Market operations software

Serving Renewables strategists, originators, planning engineers, operators, service providers, energy and project buyers, sellers and traders from one hand, end-to-end

*ROI = Return on Investment
Digital connections for a reliable power flow
Seamlessly integrated OT-to-IT solutions for efficient, low-risk asset management

Reliable power wherever and whenever it’s needed
Renewables SCADA systems
One view across assets and geographies
Our Network Manager Generator Management System (GMS) integrates large fleets of Wind (and Solar) assets into one SCADA application, providing one single control room across technologies and OEMs:

- **Identification and remote control of issues** and production data
- **Automatic generation control** applications (AGC) compliant with European and North American markets and TSOs.
- **Computation algorithms** are available to compute commercially important data such as availability, power curve analysis, error analysis and performance monitoring
- **Integrates with energy trading, economic dispatch, load forecasting, unit commitment, billing & settlements**
- **Compatible with main generator OEMs:** Wind: Acciona, Enercon, GE, Goldwind, Senvion, Siemens-Gamesa, Vestas, others
  - PV: Acciona, Bonfiglioli, others tba

>3'000 wind turbines integrated to date
Top-level SCADA for Large Renewables Fleet’s Big Data
The right solution from >5'000 I/O points

Real-time control
A uniform monitoring
• Monitoring of actual vs. predicted, contracted production
• Data normalization
Multi time zone
Model-based implementation of the renewable objects
Dispatch (AGC) and TSO communications
Flexible and scalable solution
Support for NERC CIP
Provide or enable reporting and advanced analytics
• Streaming analytics
• Short term historian

Centralized implementation – Wind Turbine, Wind Farm, Substation

© Hitachi Energy 2022. All rights reserved
Top-level SCADA for Large Renewables Fleet’s Big Data
The right solution for integrated workflow lifecycle management
Top-level SCADA for mid-sized Renewables fleets
The right solution for up to 5'000 I/O points, Renewables and BESS only

Highlights

- **Maximum synergies in operations** through integration of multi-tech and multi-OEM fleets into one single remote monitoring + controls solution
  - Wind: Vestas, Siemens, Nordex, GE, Enercon, others configurable
  - PV: Fimer, SMA, Sungrow, Huawei, and most other PV inverter OEMs supporting classical protocols like Modbus, DNP-3, IEC104
  - BESS: Hitachi Energy, others upon discussion
  - Hydro, Bimoass: All major generator manufacturers
- Future-proof, **cybersecure** solution (vs. e.g. in-house xls-based, historically grown solutions)
- Maximizes safety and allows reduction in operator error

Simplify site energy operations & maximize return on investments
Plant SCADA for PV, Wind, Hydro and Hybrid Renewables
Performance monitoring under control down to PV string level

Highlights

• Provides real-time monitoring and open-loop controls of all your plant components into one single plant SCADA, particularly relevant for “Hybrid Power Plants” or “BESS co-location” projects
  • Generation plants (PV, Wind, Hydro, Biomass)
  • Generator substations
  • Supporting components (BESS, STATCOM, GenSets)
  • Auxiliaries (Weather stations etc)
• Compliance with major communication protocols (Modbus, DNP3, IEC, OPC and others)
• Granular view into sub-components, e.g.: PV panels, PV trackers, PV combiner boxes
• Productized libraries simplify application customization for maximum flexibility
• Quickly locates issues in the plant
• Maximizes safety and allows reduction in operator error

Simplify site energy operations & maximize return on investments
EMS for Hybrid plants (BESS, co-located w Renewables)
Automating operations as a function of preferences

Highlights

e-mesh Energy Management System (EMS), an optimizer suite that provides additional features for optimal energy management of distributed energy resources.

- Minimize OPerating EXPenses through day-ahead and intra-day optimal dispatch
- Accurate forecasts of renewables power generation and loads power consumption
- Insightful and handy reports for business executives
- Enhanced visibility into energy saving methods compliant with ISO 50.001
- Enable ancillary services market participation and energy trading

Site energy management optimization
Top-level Remote Offshore Wind Fleet Monitoring
Digital integration across OEMs, WTGs, transmission assets, applications

Our solution enables the following functionalities as a standard:

- **Supervisory Control:**
  - Command execution
  - Command orchestration
  - Command scheduling

- **Monitoring & Supervision:**
  - Production Assets Monitoring
  - Auditing
  - Identity & Access Mgmt
  - Incident Mgmt

- **Integration**
  - Grid Operator Integration
  - Recommendation receiver
  - L1 SCADA data integration
  - Trading integration
  - Activity dispatcher

- **Top-level Remote Offshore Wind Fleet Monitoring**
  - Digital integration across OEMs, WTGs, transmission assets, applications

- **Network Manager SCADA:**
  - Large fleet real-time monitoring & controls

- **Key related applications**
  - Local Archiving
  - Local HMI
  - Asset Performance Mgmt (APM) incl. prognostics
  - Enterprise Asset Mgmt (EAM) incl. CCMS
  - Field Service Management (FSM)
  - Automated Generation Control (AGC)
  - Data Acquisition
  - Protocol Conversion
  - Buffering
  - Scaling and Transformation
  - Alarm Management

- **Communication & IT infrastructure**

- **Market operations**

- **ISO/TSO/DSO SCADA**

- **BESS**

- **PV inverter, combiner boxes, trackers**

- **Conventional Generation**

- **Substation SCADA**

- **Meteo Station**

- **CCTV & smart camera software**

- **Included in typical Offshore Wind Remote Control Centers**

- **Optionally available scope for integrated Renewables Remote Control Center**

- **Not in scope**

- **Future OFS or ONS Wind Parks XX MW**

- **e.g.**
  - SG-14-222 PPC + SCADA
  - OFS Wind Park 1 (4 blocks) 2200 MW
  - OFS Wind Park 2 1304 MW
  - e.g. GE Haliade X PPC + SCADA
  - e.g. V-236-15MW PPC + SCADA
  - OFS Wind Park 3 805 MW
  - e.g. MySE 6.0 MW PPC+SCADA
  - OFS Wind Park 4 120 MW
  - SGRE/Vestas/GE PPC + SCADA
  - Future OFS or ONS Wind Parks XX MW

© Hitachi Energy 2022. All rights reserved
CCTV & Video Analytics

Turning your Renewables projects into smart spaces for safety & security for your teams & assets
Site Monitoring through CCTV & Video Analytics
Ensuring crew safety for commissioning & operations, detecting intruders, preventing theft and hazards

- Integrated System from hardware (smart cameras, LiDAR Sensors) to software (video analytics, alarming)
- Enabling to understand IF people are entering certain areas
- Enabling to understand WHO and HOW MANY are entering certain areas
- Enabling to understand WHERE TO people are moving towards (direction detection)
- Automating the access for the RIGHT people
Automated Intelligent Site Monitoring Alerts
Engineered by Hitachi, enabled by Hitachi Smart Spaces & Video Intelligence (SSVI)

Enabling Crew Safety: Left-Behind Objects and Hazards
- Alerts for left behind objects or potential hazards on offshore wind platforms
- Detect potential fire or other health & safety risks
- Analysis from fixed or drone-based data

Ensuring Asset Security: Intrusion Detection & Geo Fencing
- Real-time alerts for the protection of critical assets, perimeters and buildings
- Warning zone with perspective provides the highest possible level of protection
Digital Video-based Incident and Case Management
Engineered by Hitachi, enabled by Hitachi Visualization Suite (HVS) archives

• Improve evidence management for incidents, maintenance, liability, litigation and insurance for in-house or 3rd party personnel
• Manage all incident footage, PDFs, or data from investigations
• Seamlessly switch between Hitachi Visualization Suite (HVS) Map, Dashboards and Archive view
• Federated management and central access to evidence from incidents at facilities and premises
Health & Safety through Video Analytics and 3D Lidar AI
People management on offshore wind platforms engineered by Hitachi, enabled by Hitachi 3D Lidar AI

3D Lidar AI solution learns and calculates the location of its view
Designed not to capture sensitive identifying information
Alerts and analytics can be created to
• Track the movement of people on site
• Count people in an area
• Detect specific behaviors and interactions using analysis of 3D data
• Define alerts based on required social distancing policies.

HS&E Analytics
Incident Case Management
Online access from remote to various levels in Offshore wind platforms Engineered by Hitachi, enabled by Hitachi Video Systems

Facility – Facility 1 Dudgeon Offshore Wind Platform

Facility - Facility 1 Dawson Creek

Child hierarchy

<table>
<thead>
<tr>
<th>Facility – Facility 1 Dudgeon Offshore Wind Platform</th>
<th>ROOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Plan</td>
<td></td>
</tr>
<tr>
<td>+ Facility 1 Camera 5</td>
<td>CAMERA</td>
</tr>
<tr>
<td>+ Facility 1 Camera 6</td>
<td>CAMERA</td>
</tr>
<tr>
<td>+ Facility 1 Camera 1</td>
<td>CAMERA</td>
</tr>
<tr>
<td>+ Facility 1 Camera 2</td>
<td>CAMERA</td>
</tr>
<tr>
<td>+ Facility 1 Camera 3</td>
<td>CAMERA</td>
</tr>
<tr>
<td>+ Facility 1 Camera 4</td>
<td>CAMERA</td>
</tr>
</tbody>
</table>
Mission-critical solutions for mission-critical assets
Communications, Safety & Security Systems
Communications Applications in Offshore Wind
How HAPG wired & wireless scope offers synergies
# HAPG’s Offering for Offshore Wind Communications

<table>
<thead>
<tr>
<th>Classically required Offshore Wind Communications Scope</th>
<th>HAPG Offering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Identification System (AIS), vessel and personnel tracking system</td>
<td>Hitachi + HAPG Geofencing solutions</td>
</tr>
<tr>
<td>Access intruder system</td>
<td>Hitachi smart cameras, Video Intelligence System + Geofencing solutions</td>
</tr>
<tr>
<td>Telephone solution with integration of Offshore Platform system to the WTG phones</td>
<td>Integrating specialized 3rd party products</td>
</tr>
<tr>
<td>Closed circuit television (CCTV) with integration of Offshore Platform system CCTV</td>
<td>Hitachi smart cameras, Tropos for auxiliary comms</td>
</tr>
<tr>
<td>UHF/VHF Radio communication system</td>
<td>Integrating specialized 3rd party products</td>
</tr>
<tr>
<td>WiFi Wireless network and access points including possible integration of WTG WiFi</td>
<td>Tropos (if wireless), AFS (if wired)</td>
</tr>
<tr>
<td>Data Networks including cabling and backbone network</td>
<td>FOX615, AFS</td>
</tr>
<tr>
<td>Interface to TMS (Telecommunication Management System)</td>
<td>Surpos, Foxmen</td>
</tr>
<tr>
<td>LTE/4G or 5G broadband internet solution</td>
<td>Tropos meshed wireless network as a cost-saving alternative OR Tropos hybrid solution with LTE/4G or 5G network provider</td>
</tr>
<tr>
<td>Temporary data and telecommunication during hook-up and completion phase</td>
<td>Tropos</td>
</tr>
<tr>
<td>Optional: Full cybersecurity + people safety system and services</td>
<td>Hitachi – HAPG blended service offering incl. PGGA CoC</td>
</tr>
<tr>
<td>Optional: Wireless meshed network machine-to-machine telecommunication systems for temporary hook-up &amp; commissioning services in absence of fiber-optic infrastructure, reducing risks of costly commissioning delays through future-proof, cybersecure, plug-and-play private wireless meshed network</td>
<td>Tropos</td>
</tr>
</tbody>
</table>
Prognostics for Wind & Asset Management Solutions for Renewables
Covering wind plants + substations
57% UF

57% of all WTG failures are still unplanned...

Key unplanned component failures by priority:
- Bearings
- Blades
- Electrical components
- Drivetrains
- Others

1.7% LPF

...leading to 1.7% lost production which was unexpected

- In average, US wind owners + operators lost 6.2 days of production p.a. in 2019, caused by unplanned repairs.
- This excludes losses caused by pre-emptive shut-downs or unexpectedly long delivery times for spare parts

34k$/WTG

...and costing 34 k USD / WTG p.a.

For each single Wind Turbine Generator (WTG), 34k$ are lost p.a., of which:
- 16k$ for spares + materials
- 6k$ for major correctives
- 5k$ for minor correctives
- 1k$ for unplanned repair downtime losses
- 6k$ for lost Annual Energy Production (AEP)

Top 3 Reasons for US Wind Owners & Operators to Go Digital(1)

Unplanned Downtime the No 1 distraction from Renewbales O&M success

(1) Source: Wood Mackenzie, 2019: Digital Technologies in Wind O&M
Wind Farm example: Monitoring asset health from fleet to component
Enhancing Real-Time Monitoring and Historic Diagnostics with Prognostics

From MONITORING
• Is our asset still functional?
• Are all parameters in the normal range?
• Are alert and alarm thresholds set correctly?
• Do we observe the right parameters?

To DIAGNOSTICS
• What condition does our asset have?
• Why is this asset condition critical?
• Where is the source of the problem?
• How could we resolve the problem?

And NEXT-LEVEL PROGNOSTICS
• **When** will we reach a critical condition?
• When can we expect a malfunction or failure?
• When will we get an alert or alarm?
• **What** happens if we take a particular action? (eg. curtailment)
Focussing Asset Management on Key Wind Component Failures

Data granularity focussing on key critical components:

- Gearbox
- Generator
- Converter
- Main bearing
- Rotor

Solution Configuration Steps:

1. Specification of fleet, units, components
2. Definition of malfunction modes
3. Prioritization of malfunction modes
4. Review parameter types
5. Assessment of correlations at qualitative level
6. Assessment of correlations at quantitative level
7. Validate the solution
8. Go Live
Enhancing Diagnostics and Prognostics with Customizable Granularity

- View condition diagnostics
- View malfunction diagnostics
- View malfunction prognostics
- Aggregate prognostics
- Cross-check maintenance plan
- Extend condition data sources
- Extend malfunction modes
- Extend prognostic horizon
- Display probabilities
- Switch calendar to op. hrs.
- Set load scenarios
- Set retrospective scenarios
- Navigate solution
- Switch language
Asset Performance Management (APM) for Green Hydrogen Production
Prognosticating Malfunctions in Electrolyzer’s Critical Components

Enhancing Real-Time Monitoring and Historic Diagnostics with Prognostics

From MONITORING
• Is our asset still functional?
• Are all parameters in the normal range?
• Are alert and alarm thresholds set correctly?
• Do we observe the right parameters?

To DIAGNOSTICS
• What condition does our asset have?
• Why is this asset condition critical?
• Where is the source of the problem?
• How could we resolve the problem?

And NEXT-LEVEL PROGNOSTICS
• When will we reach a critical condition?
• When can we expect a malfunction or failure?
• When will we get an alert or alarm?
• What happens if we take a particular action? (eg. curtailment)

APM models currently available for key hydrogen production components

Enhancing Real-Time Monitoring and Historic Diagnostics with Prognostics

From MONITORING
• Is our asset still functional?
• Are all parameters in the normal range?
• Are alert and alarm thresholds set correctly?
• Do we observe the right parameters?

To DIAGNOSTICS
• What condition does our asset have?
• Why is this asset condition critical?
• Where is the source of the problem?
• How could we resolve the problem?

And NEXT-LEVEL PROGNOSTICS
• When will we reach a critical condition?
• When can we expect a malfunction or failure?
• When will we get an alert or alarm?
• What happens if we take a particular action? (eg. curtailment)
Hitachi Energy Lumada for WTGs & Substations & Prognosticating malfunctions from fleet to component

Asset-specific performance models
- Wind turbines
- Electrolyzers
- Batteries
- Transformers
- Capacitor banks
- Cables
- Transmission lines
- Distribution circuits
- MV switchgear
- Capacitor voltage transformers
- Breakers

Integration with existing technology
- SAP ERP
- CMMS
- SCADA
- Asset + Work
- Payroll
- OSIsoft Pi
- HR
- cpmPLUS
- ERP
- ADMS

People tracking
Mobile data gathering
Enhanced geospatial capabilities

Inventory management
- Electronic catalog
- Parts & service store
- Procure-to-pay
- Graphical parts catalog

Business process models that support ISO 55000

Asset Investment Planning (AIP)
Service Offering Portfolio

**Rapid response**
We guarantee fast and flexible response to maximize your equipment uptime.

**Operational excellence**
We work together with you to manage your assets, operations and risk to deliver strategic business results.

**Performance improvement**
We optimize creativity, reliability and efficiency of your assets to increase speed and productivity.

**Lifecycle management**
We employ powerful tools and knowledge to optimize and extend your equipment life.

---

**Service Offering for Renewables**
Maximum flexibility from full peace of mind to essential support only.

---

© Hitachi Energy 2022. All rights reserved
Cyber Security for Renewables Projects
Meeting latest & greatest standards

Ensuring compliance with your insurance’s requirements, from planning to maintenance

- Security assessment & monitoring
- Backup & recovery
- Security updates & hardening
- Malware protection
- Procedures & policies
- Perimeter protection
CUSTOMER CHALLENGES
Access to expertise and technology that allows them to harness the power of people and information to enable grid automation

CUSTOMER OUTCOMES
✓ Continuous collaboration and access to experts
✓ Sound business decisions using detailed data analytics
✓ Increased productivity through improved asset performance
✓ Higher safety and security, reduced risks and lower costs

GLOBAL FOOTPRINT
+40 Engineering and Service Centers worldwide
24/7 Secure remote expert service delivery
6 Collaborative Operations Centers to ‘follow the sun’

VALUE PROPOSITION
Collaborative Operations Centers connect customers, operators and our people to provide mission-critical communication and automation infrastructure for a sustainable energy future
References
How we made a difference
- 12 GW Hydro
- 12 GW Wind
- 1.5 GW Solar
- 0.1 GW BESS with utility-scale Renewables («Hybrid»)
- 0.5 GW BESS + MG systems (often co-located w Renewables)
ENGIE Italy is a major developer, owner and operator of renewable energy plants in Italy. Their portfolio in Italy comprises of 14 wind farms, 6 PV plants, 10 virtual power plants (“UVAM”). The challenge was to update an in-efficient, outdated and non-cybersecure system with a new, cost-effective monitoring + control center integrating both wind, solar and VPP assets into one single solution.

About the project

- **Project name:** ENGIE Renewables Monitoring & Control Center
- **Location:** Italy
- **Customer:** ENGIE
- **Completion date:** 2021

Customer benefits

- Modernization of RCC to MicroSCADA X based RCC and enabling expansion of monitored fleet
- Compliant with customer cyber-security requirements
- Improved reaction time through structuring and visualization of critical data in a high level display
- Reduction in operational cost by managing all assets using a fully integrated automation system
- Automatic power curtailment that allows to perform the curtailment request from TSO via MQTT protocol

Solution

- e-mesh SCADA solution with:
  - Local gate-ways collecting information from the field and making available for top-level monitoring + controls
  - Integrated monitoring + controls center for both Wind, Solar, VPPs
Viesgo is a major Spanish power generation and distribution utility, owning and operating 505 MW of Renewable assets.

Viesgo saw itself with an outdated SCADA and AGC system leading to inefficient monitoring and dispatching of their wind assets across the country.

Also, the AGC solution didn’t allow for efficient integration with existing hydro and thermal assets.

About the project

• **Project name:** Viesgo Wind Monitoring + Control Center
• **Location:** Spain & Portugal
• **Customer:** Viesgo
• **Completion date:** 2017

Customer benefits

• Modern wind power monitoring + control center
• Updated AGC (Automated Generation Control) functionality integrating both conventional and Renewable assets
• Compliance with Spanish regulatory requirements
• Wind park monitoring, dispatch and curtailment functionality

Solution

• Network Manager GMS
• Latest AGC functionalities
• Integration of 400 MW new wind capacity with conventional fleet
Clearway Energy is a major developer, owner and operator of wind and solar assets in the US with assets installed or under development in 23 states.

Key customer challenges were disperse generation in different time-zones, connected to different TSOs without a coherent monitoring + control system, relying on an in-house built solution resulting in inefficient operations. No advanced wind SCADA functions, relying on operators to make decisions.

About the project

- **Project name:** Clearway Energy Wind + Solar Monitoring + Control Center
- **Location:** USA
- **Customer:** Clearway
- **Completion date:** 2018

Customer benefits

- Real-time performance data acquisition from generator level
- Increased operations efficiency
- Increased revenues through increased performance (actual vs. expected)

Solution

- Network Manager GMS with:
  - Model-based implementation of Renewable resources
  - Summary alarms and states and market communications
  - Asset Performance Analytics & integration with Ellipse™ Asset Performance Management
  - Common monitoring and control model across all wind OEMs via IEC 61400-25-2
ENEL Green Power USA is a developer, long-term owner and operator of renewable energy plants including hydroelectric, wind, solar and geothermal. EGPNA has a renewable capacity of more than 8.7GW.

Key challenge was managing a disparate and diversified asset base across the US: Multi-GW fleet in the US, Mexico and Canada and complying with latest cybersecurity requirements.

About the project

• **Project name:** ENEL North America
• **Location:** USA, Canada, Mexico
• **Customer:** ENEL
• **Completion date:** 2017

Customer benefits

• Visibility and control for 100 Renewables plants while performing high speed optimization calculations and reporting real time system health.
• NERC CIP Cybersecurity compliance
• Increased operations efficiency
• Increased revenues through increased performance (actual vs. expected)

Solution

• Network Manager GMS with:
  • Network Manager SCADA System on a virtualized Infrastructure
  • Historian support for both UDW and OSIsoft PI
  • ICCP and OPC-UA protocol support
  • Multiple PCU400 pairs collect data from RTUs
The Angola Solar 1 project, with 7 sites and 370 MWp, is expected to benefit around 1.2 million families, allowing access to cleaner and more economical electricity both in extremely populated regions and rural areas, while reducing the usage of diesel generators, supporting the UN's Sustainable Development Goal 7.

**About the project**
- **Project name:** Angola Solar 1
- **Location:** Angola
- **Customer:** MCA Group & Sun Africa consortium
- **Completion date:** expected 2022

**Customer benefits**
- Intuitive HMI to visualize all relevant process data from the plant, grid connection and weather stations
- Highly granular PV plant monitoring + controls incl. PV inverters, PV solar irradiation sensors, combiner boxes, PV panel strings and Diesel GenSets
- Performance and Production Ratio (PR) at plant, section, transformation center and inverter level

**Solution**
- Solar PV (370 MWp)
- Diesel Generators in 2 of the 7 Sites
- e-mesh PPC
- e-mesh Control system
- e-mesh SCADA
Major European Renewables developer, owner, operator monitoring & controlling both onshore and offshore wind fleets.

The challenge was to prognosticate offshore wind asset performance, based on Siemens offshore wind turbines, and inform strategies for both operating and maintaining offshore wind assets.

About the project

- **Project name:** Asset Performance Management for Wind
- **Location:** Germany
- **Customer:** Undisclosed
- **Completion date:** 2019

Customer benefits

- Bridged the gap between existing in-house intelligence and potential improvement through industry best practice, software and AI-based
- Use learnings from related industries (e.g. conventional power generators) in new industries (e.g. Renewables)
- Decrease dependence on OEM-led analytics and recommendations

Solution

- APM for Wind: Wind performance prongostics software, cloud-based, using expert interviews to create – IP-protected algorithms
- Prognostic (beyond predictive) analysis defining when component or system failures are to be expected
- Scenario planning: Impact of voluntary curtailment on component failures and system unit remaining useful lifetime (RUL)
- Flexible integration of APM into existing customer asset management enterprise environments
Various owners and operators of substation fleets with or without Renewables assets connected.

Key challenges to overcome through a asset work management solution classically are:

- Ageing work-force requiring efficient management of O&M and in-field support
- Stringent health & safety requirements driving the need for software supporting the requirements
- Trend to digitalization and company requirements to benefit

About the project

- **Project name:** Various substation owners + operators
- **Location:** Global
- **Customer:** Various
- **Completion date:** Ongoing

Customer benefits

- **American Electric Power:** APM contributed to the prevention of at least three EHV transformer failures that could have cost AEP 15-20 M$
- **Inner Mongolia Power Company:** Saved nearly $8.7M USD million, much higher than the initial cost of investment in the software
- **Ameren Illinois:** More than 2,000 transformers were loaded into the Ellipse APM system within 90 days of implementation

Solution

- **APM for substations:** Cloud-based (MS Azure) SaaS solution to prognosticate substation failures before they occur
- **Integration with Enterprise Asset Management (EAM)** to prioritize malfunctions and connect to required inventory / spareparts
- **Field Service Management (FSM)** to dispatch work orders to in-field crew and accompany repair works through remote support
Your name

Your job title and organizational unit

Your e-mail

Gian Schelling
Global Business Development Manager Renewables Segment Grid Automation

gian.schelling@hitachienergy.com

+ 15 years in Renewables
+ 10 years in Wind
+ 7 years
+ 5 years in Energy Storage