The AES Corporation

Asset Management Strategy for Renewable Assets using IoT and AI/MI
About Me

Gavin Linderman, CMRP

• 11 years in multiple operations, maintenance, & reliability engineering roles within the automotive, steel, and utility industries

• 7 years as the Global Performance & Reliability Leader for a large chemical (plastic) manufacturer

• 2 years with a consulting firm as a Senior Business Consultant (Power & Oil/Gas)

• 3 years with AES leading the Global Center for Performance Monitoring & Analytics (PMAC)
AES Company Overview

30,308
Gross MW in operation*

6,909 MW
Renewable generation under construction or with signed PPAs

$9.78 billion
Total 2020 revenues

$34.6 billion
Total assets owned & managed

2.5 million
Customers served

Recognized for our commitment to sustainability

8,200 people
Our global workforce

4 Continents

14 Countries

5 Generation Technologies

6 Utility companies

* 20,397 proportional MW (gross MW multiplied by AES' equity ownership percentage).
Generation & Utility
AES PMAC

- Multiple Remote-Operations Control Centers Per Multi-Location Country
- One Global PMAC (Dayton, OH)
- Two Regional PMAC’s (Panama & Chile)
- PMAC Staff Includes:
  - Performance Engineers
  - Reliability Engineers
  - Capital Planners
  - Analysts
  - Subject Matter Experts
Our Digital Asset Management Strategy

Let the asset tell us what it needs...

Get data in the hands of the right person at the right time...

Risk based maintenance and not fear based maintenance...

The effective marriage of people and processes...

Leverage digital tools to get the robot out of the human...

Living Asset Strategy

All Together

Data Driven Decisions

Resource Efficiency

Risk Management

PMAC
SAS Viya System / Data Lineage

AES Applications & Data Sources

AES Data Lake (Google Cloud)
- Data Twins
- Curated Datasets

SAS Event Streaming / AIoT
- Live data flows
  - Time Series
  - Use Case Specific

SAS Viya (V4)
- Data Management
- Data Preparation
- Visual Analytics
- Visual Statistics
- Visual Data Mining & Machine Learning
- AI/ML Model Development
- Intelligent Decisioning
- Streaming Analytics

...and many more!
Wind Turbine Generator Challenges

Keep in mind this is one region, with different operating contexts, NOT including thermal, solar, battery energy storage, hydro, and T&D assets.
## AES PMAC Analytic Solution Options

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Features</th>
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<tbody>
<tr>
<td>Anomaly Detection Models</td>
<td>• Least complex, quick to deploy, and quick to scale</td>
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<td></td>
<td>• Ensemble approaches may detect issues sooner</td>
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<tr>
<td>Forecasting Models</td>
<td>• More complex, relatively scalable, and objective</td>
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<td>• Data needs to be cleansed and of good quality to deliver value</td>
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<tr>
<td>Prediction Models</td>
<td>• Most complex, rigorous, specialized, and unique-prone to bias</td>
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<td>• Hard to translate probabilities to actionable recommendations</td>
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<td>Visual Analytics</td>
<td>• More than dashboards-includes statistical analysis</td>
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<td>• Ad-hoc analytics to solve a problem enables actionable value</td>
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<tr>
<td>Automation</td>
<td>• Very use case specific</td>
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<td>• Brings high-perceived value to users and operations team</td>
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</tbody>
</table>
Anomaly Detection - Wind MWPCA
Forecasting – Wind Turbine Power Curve
Prediction - Reliability Growth
Automation - Transformer Health
Lessons Learned

- One team, one plan, one target
- Business case and technical feasibility first
- Clear vision from top management
- All stakeholders co-designing the solution
- Agile approach and iterative roadmap
- Change management plan
Leading the renewable transition