Panacea Technologies Inc.
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CONTROL ENGINEERING System Integrator HALL OF FAME

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OpenPWR - Improving Wind Farm Operational Control and Intelligence

Introduction

With an increasing demand for renewable energy, Wind Energy has seen massive growth in line with other renewable energy sectors. The consolidation of wind farms has led to the rapid growth of wind farm portfolios, leaving many owners with a new set of challenges. With operators directing wind farms across the country or even the world, improving operations is at the forefront of corporate priorities [1].

Operating wind farms remotely can present a problem, especially when dealing with a wide range of turbine manufacturers with varying control and visualization platforms. These platforms can vary between sites or even between areas at the same site. Different visualization systems have different data standards and instrument naming, making data consolidation and analysis cumbersome. However, this sort of data analysis is vital to energy generation forecasts and other key economic markers. Consolidating these to a single platform is often an expensive and engineering intensive task.

Panacea Technologies has worked with their renewable energy clients to deploy a multi-site cross-functional visualization platform, named OpenPWR, that provides uniform control and reporting regardless of turbine vendor or current visualization platform. When effectively deployed, OpenPWR consolidates cross-county and transnational sites on to a single platform allowing standardized company-wide monitoring and control of windfarms and associated turbines. The platform's Unlimited Licensing Model drastically reduces licensing costs and allows seamless scaleup and consolidation. Our current deployments have resulted in improved financial and performance metrics while vastly reducing annual licensing fees. Our deployments have also empowered companies to have greater access and visibility into their important assets. Panacea's OpenPWR is designed using Inductive Automation's Ignition, a powerful off-the-shelf software.

Consolidated Control

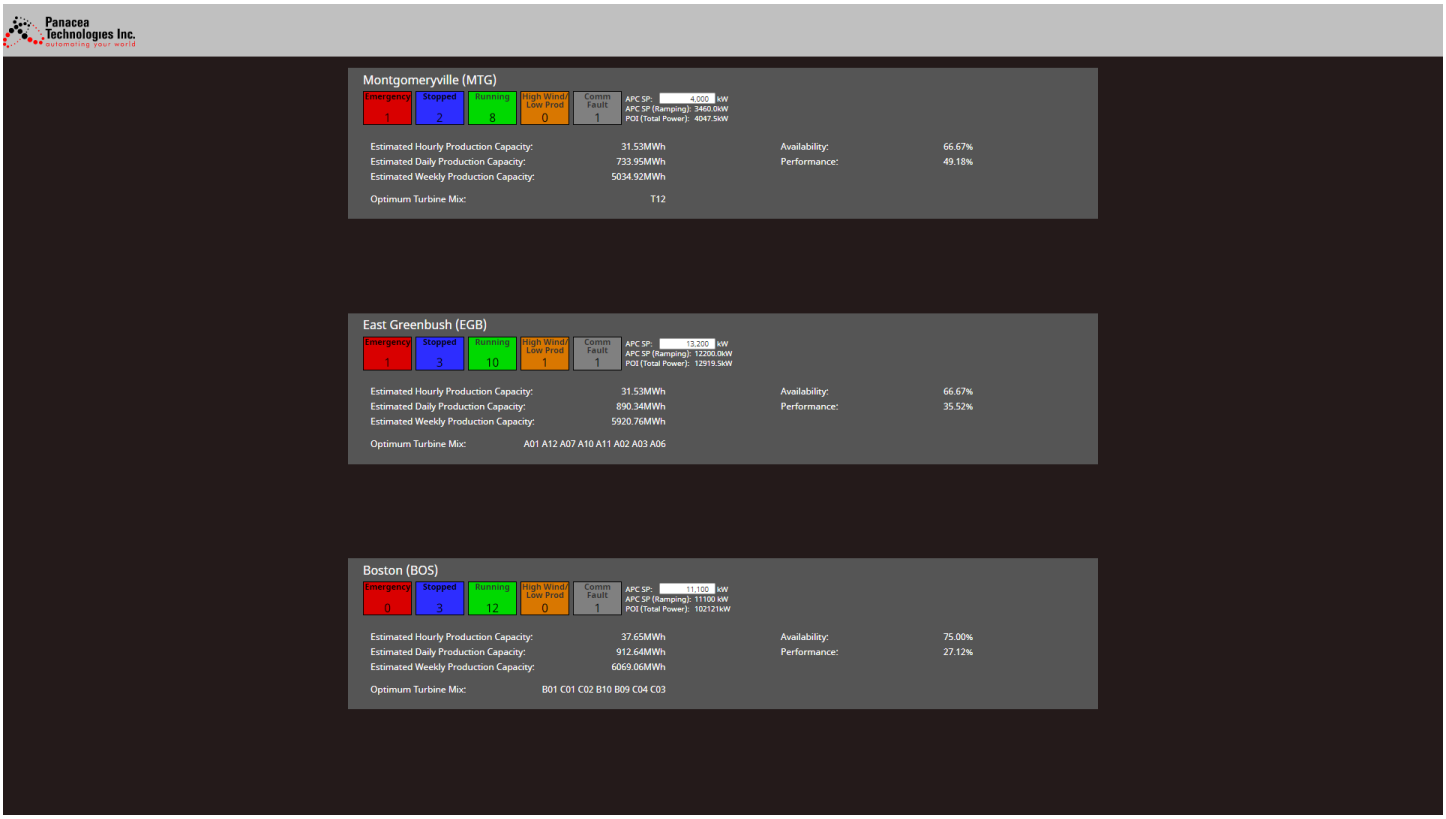
For many wind energy operators, operating turbines from multiple vendors across multiple sites can be a challenge. Individual turbine vendors may have different data standards and instrument naming, complicating data consolidation. Furthermore, remote access to the turbines can range from cumbersome or in the case of certain older turbines, impossible. Migrating multiple systems to a single platform can provide simple control, data consolidation, and remote access capabilities.

Corporate Level

At the highest level, OpenPWR's corporate view (**Figure 1**) aggregates site data to provide performance and financial metrics. These metrics can be used to determine key predictive and operational drivers including:

- Instantaneous production capability
- Hourly, daily and weekly production capability
- Optimum turbine mix
- Correlation between reliability and maintenance

Figure 1: Corporate View



Site Level

Moving from the corporate view to a site-specific view, OpenPWR's robust interface allows for customized and tailored monitoring solutions to meet operational needs. In **Figure 2A** (page 3), the Site Level View provides a quick summary of the conditions and output of every turbine at a site as well as active alarms. All alarms are also archived in Alarm History as shown in **Figure 2B** (page 3). In **Figure 2C** (page 4), a graphical display of the communications fiber line within the site is shown. This helps to provide insight into the substation or fiber line related issues.

Figure 2A: Site Level View

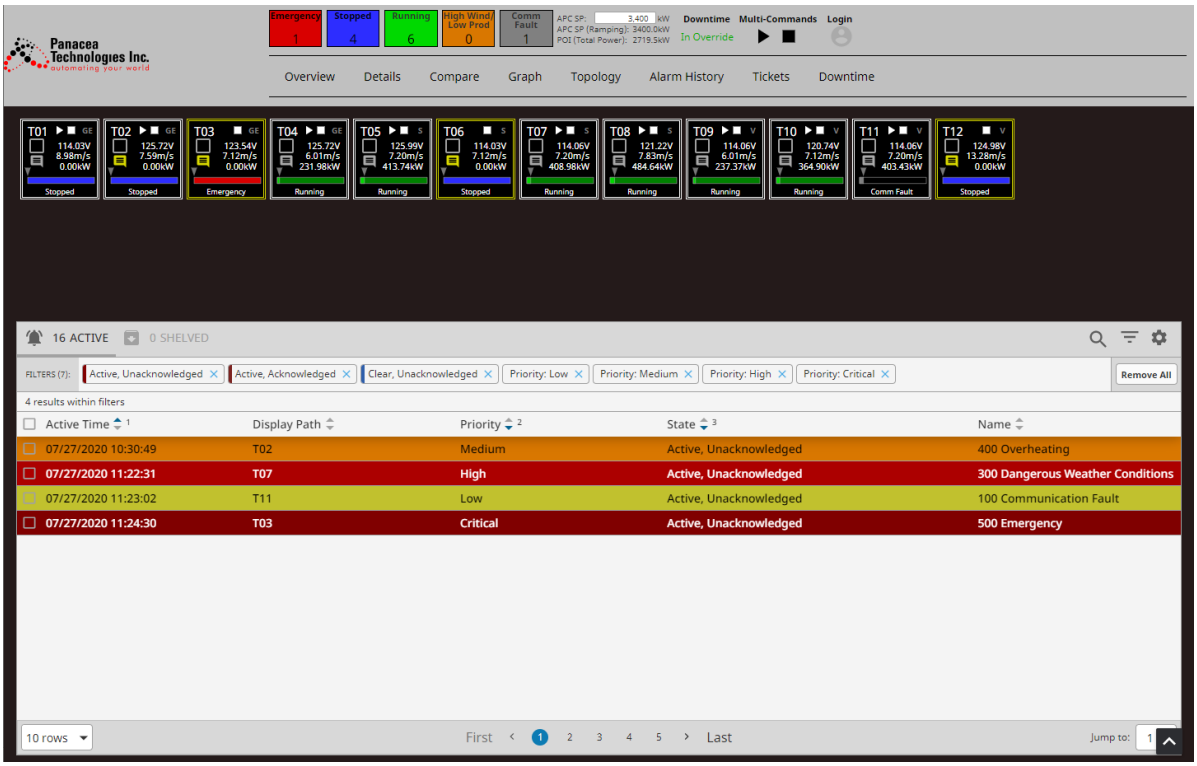


Figure 2B: Alarm History

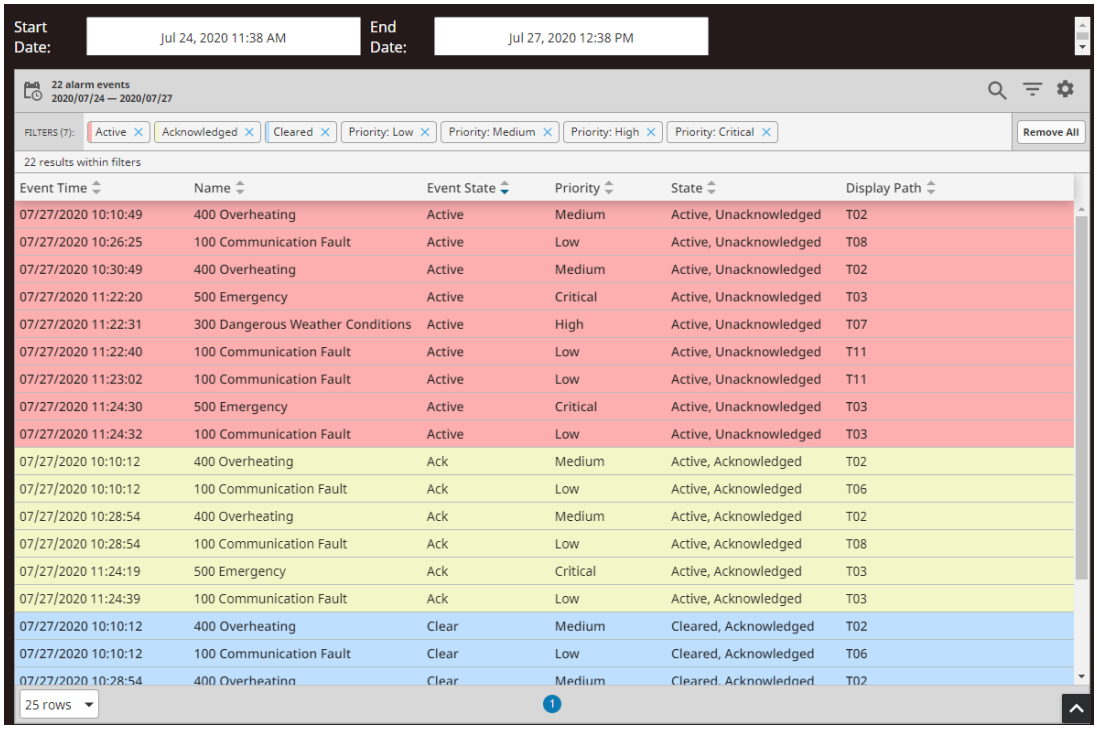
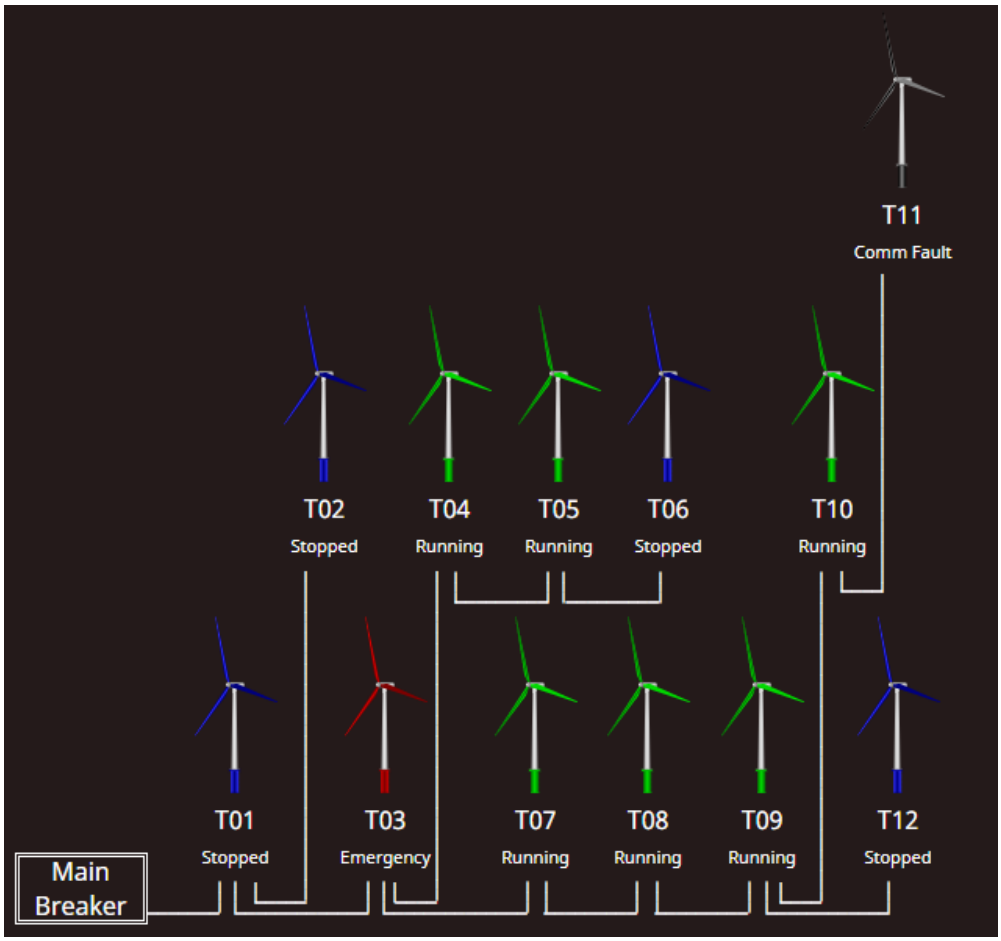


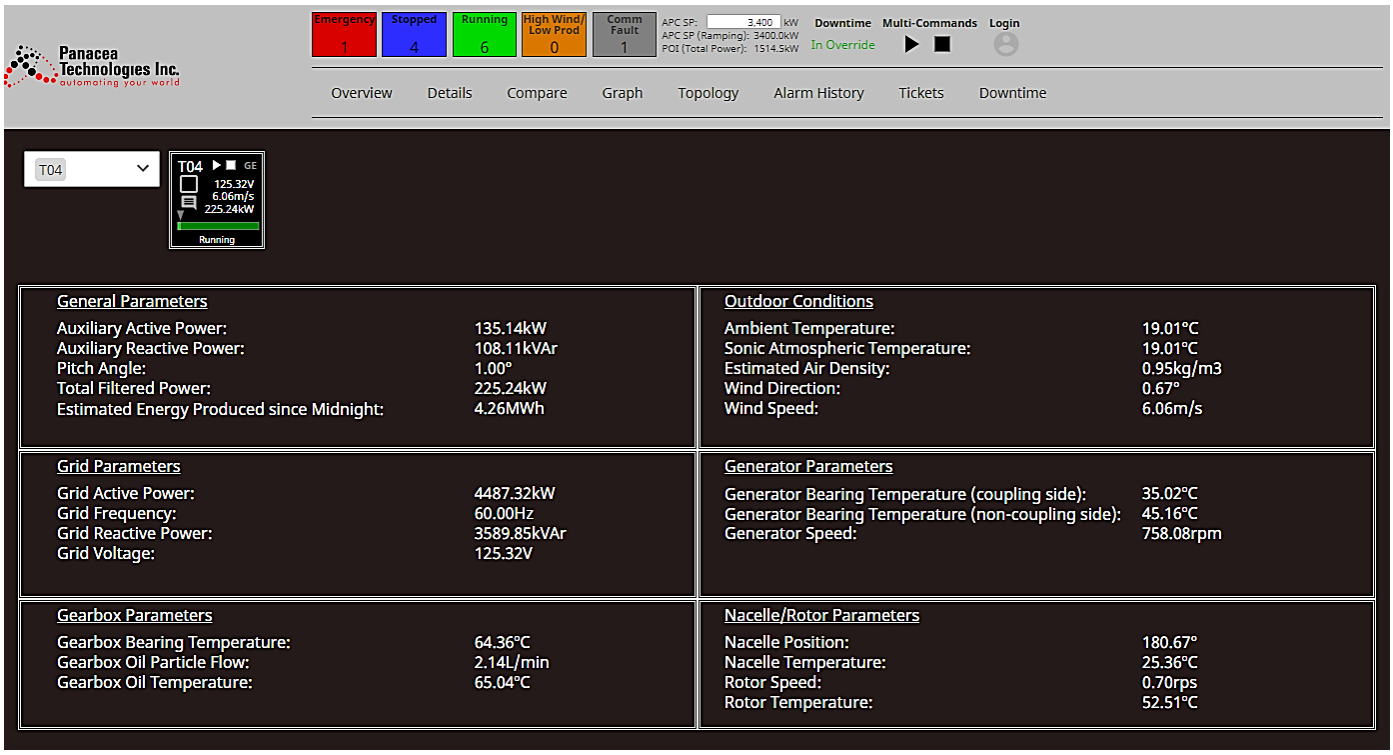
Figure 2C: Topography View



Turbine Level

Digging deeper at the site turbine level, OpenPWR provides real-time remote monitoring of a specific turbine and it's related metrics and environmental data. At this level, the individual performance of each turbine can be monitored, shown in **Figure 3** (Page 5). General, grid, generator, gear box, and nacelle & rotor parameters for a specific turbine as well as related outdoor conditions can be quickly evaluated from this view.

Figure 3: Site Level Turbine View

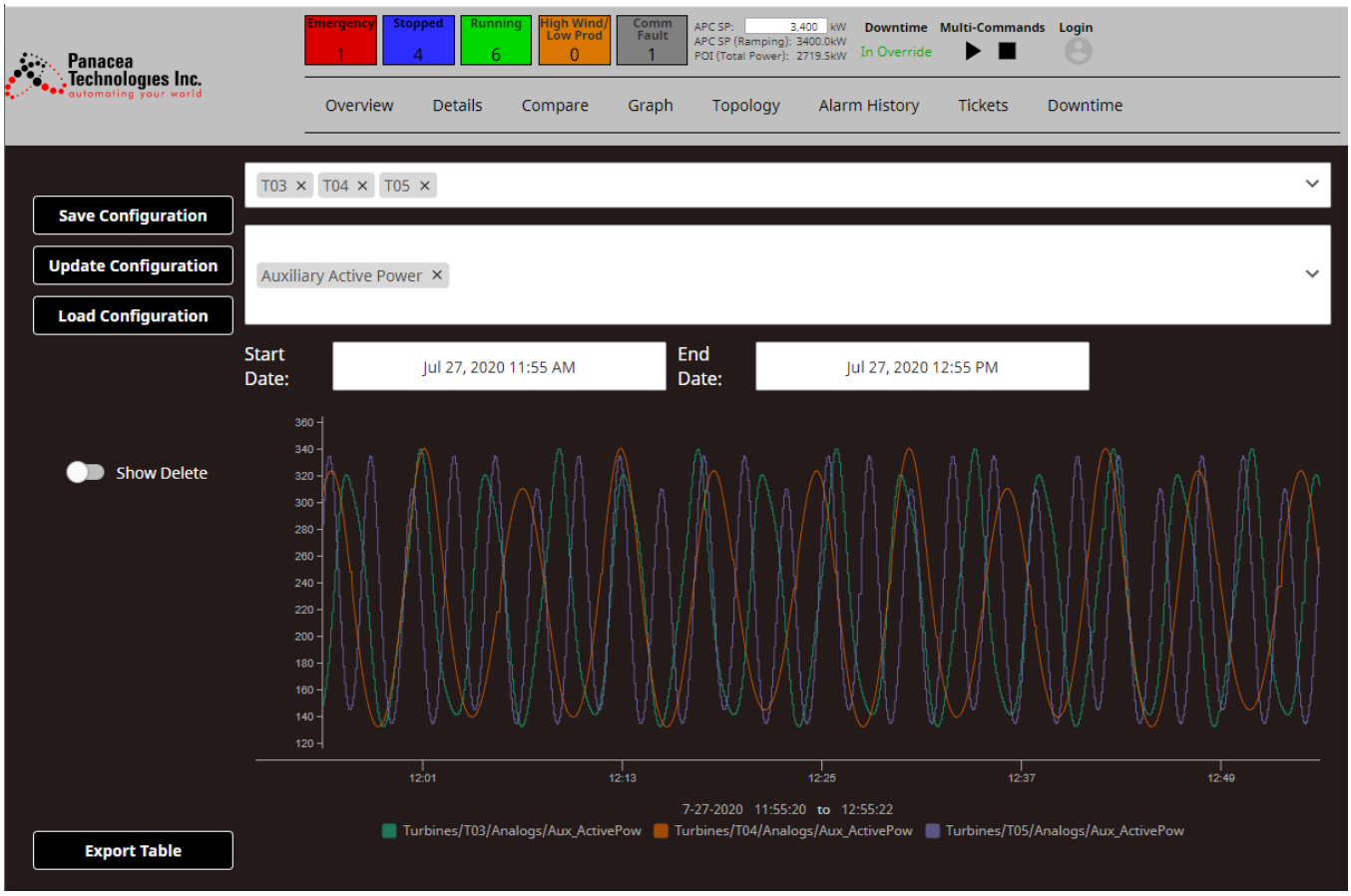


Analytics and Data Management

Data management is vital to operations as site analytics generate millions of data points annually. OpenPWR is highly adaptable and can be configured to provide average data on 10-minute intervals, rolling averages, or continuously generated graphical displays. This data can be exported in various file formats including .pdf reports. These reports provide information tailored to stakeholders at the corporate or site level at defined time intervals.

The graph generator in **Figure 4** (page 6) allows for different configurations to be created, customized and saved.

Figure 4: Example of Customized Graph of Continuous Data



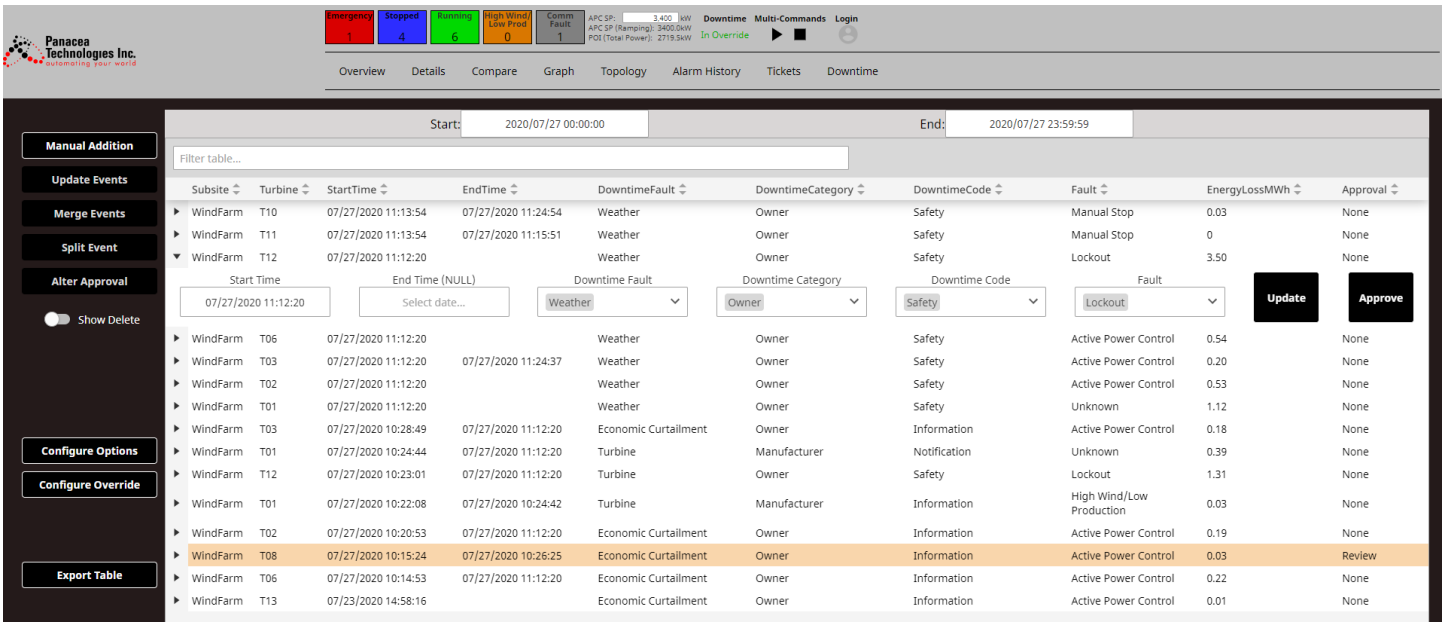
Downtime Analysis

Manually recorded downtime logs are labor intensive and prone to error. There is no guarantee the record is accurate nor that every outage was recorded [2]. By automating the downtime recording, OpenPWR's logs can provide a more robust analysis of the breadth and impact of both internal and external events. Detailed downtime logs provide information on the length, cause, and result of a downtime event. Each event is assigned to an Owner with crucial details, including:

- Curtailment
- Utility
- Turbine manufacturer
- Fault code

As seen in **Figure 5** (page 7), individual Downtime logs can be manually edited and changed. Multiple events can be selected and edited simultaneously or merged. Events can be split to divide the assignment of fault. Logs can also be manually added to the record.

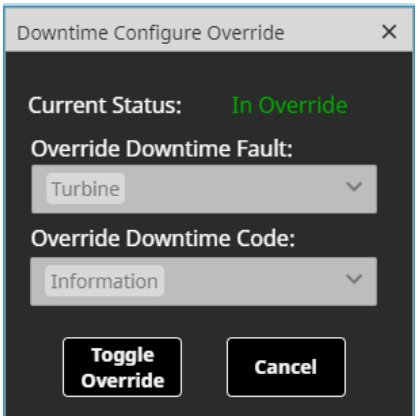
Figure 5: Downtime Log



Sorting these events by the Fault Owner generates detailed summaries, describing the energy lost due to each event. This can provide insight into the key causes and costs of the different downtime events, allowing the users to improve turbine availability and determine if an incident is part of a trend and if corrective procedures were followed.

The downtime log also allows for an Override Downtime Event. An Override Downtime Event automatically allocates every event during a set period to the selected fault – often weather for extreme weather events or utility for curtailment. **Figure 6** shows an example interface for setting up an Override Downtime Event.

Figure 6: Example Override Downtime Event Setup



Licensing Model

OpenPWR's licensing model drastically reduces costs compared to other visualization packages. Licenses are designed to be a onetime cost and include deployment and integration of the platform, moving away from costly annual software subscription services. Instead of complicated pricing plans, licenses are based on site size and number of turbine technologies. As an example, a small site with less than 25 turbines of a single technology will have a deployment/license cost of $90,000. A large site with more than 100 turbines consisting of three different turbine technologies will have a deployment/license cost of $140,000. In both cases the

deployment/license cost includes setup, testing, licensing, and integration. Additional sites can be added for a fraction of the original cost as well. Optional service contracts provide access to updates and patches as well as software improvement deployment reducing annual service costs. Annual service contracts range between ten to fifteen percent of the deployment cost.

One license gives you an unlimited number of data points, and users, enabling it to be cost-effectively deployed on large systems, which is crucial in the competitive energy space. With an unlimited number of users, every person on every team can get access to the data and information that they need. With unlimited data points, there are no license-based limits to your data collection, allowing you to collect all required data to improve your operational success. Unlimited number of turbines enables your system to change size and adapt to your companies changing requirements. OpenPWR is streamlined for optimum performance to reduce the number of servers required for the system and can also be hosted on commercially available cloud servers.

Product Roadmap

Panacea is committed to continuous improvement and feature development of the OpenPWR platform. This includes operational, visualization, and functional improvements that will deployed to clients once tested and approved by Panacea's Quality team. An example of that is a Machine Learning module for OpenPWR's exiting Active Power Control module that is currently included. The Active Power Control module utilizes data on optimal power output from individual turbines to achieve power output setpoint in the most cost effective manner. We are developing a Machine Learning module to incorporate weather and power forecasting to better plan downtime and maintenance events in addition to a more agile method of automated turbine selection.

OpenPWR is compatible with Gemesa, Siemens, GE, Mitsubishi (MHI), and Vestas turbines. Our team can investigate adding additional manufacturers upon request.

Summary

OpenPWR provides a consolidated system that generates improved data that can be more quickly and easily translated into advanced analytics and key predictions. This helps to reduce operating costs, maximize energy production and revenue, improve predictability, and mitigate potential incidents. Automating alarming and downtime analysis provides a more consistent and accurate report, providing better indicators of problematic trends. OpenPWR empowers users to accomplish this and enables the cost-effective deployment of a consolidated visualization platform on even the largest of systems.

References

[1] Farren, Des. *Operational Intelligence for Renewable Energy*. ServusNet. https://www.ucd.ie/t4cms/ti12_d.farren_servusnet_11jun10.pdf

[2] Singh, Preetcharan. *Analytical Techniques of SCADA Data to Assess Operational wind Turbine Performance.* Department of Mechanical and Aerospace Engineering, University of Strathclyde, Faculty of Engineering. http://www.esru.strath.ac.uk/Documen

About Panacea Technologies

Panacea Technologies Inc. is a Process Control and Automation solutions company headquartered in Montgomeryville, PA with offices in East Greenbush, NY, Boston, MA, and Gaithersburg, MD. Panacea has been delivering cutting edge software solutions and services to our clients since 1996.

It is our mission at Panacea Technologies Inc. to provide our customers a competitive advantage by providing superior design, implementation, software, and management strategies to best leverage their automation and validation investments. Panacea Technologies' success is attributed to the confidence clients have in our technical know-how, diligence, and dependability.

Contact Panacea Technologies Headquarters at (267) 421-5300 or at sales@panaceatech.com to order or request an invitation to the next OpenPWR web demo, or to schedule a personalized product overview.