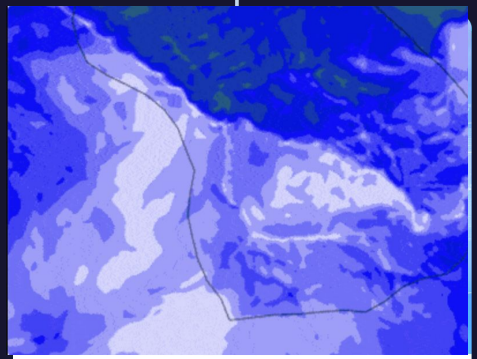
Tomorrow.io

State-of-the-Art **Wind Power Prediction**

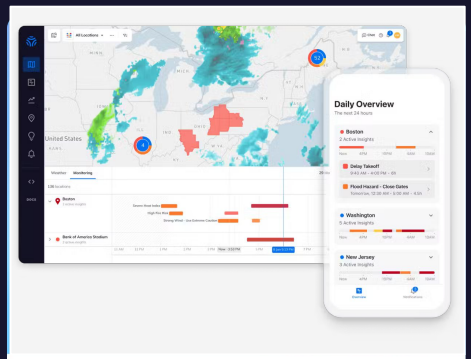
Company & Technology
Snapshot

Differentiated on 3 Fronts

Comprehensive Global Weather Observations & Measurements



Proprietary Weather Modeling. Powered by Physics, Supercharged with AI/ML.



Weather Intelligence SaaS/API

Innovating Across the Entire Weather Value Chain

Public Weather Models

Tomorrow.io Proprietary Models

ML-Powered Forecasting

Weather Models

Air Quality

Hydrology

Lightning Forecast

Fire Potential and Smoke

Ocean surface and currents

Layers Continuously Added

Layered Forecast Products

Public Satellite Data

Tomorrow Satellites (Radars & Sounders)

Weather Balloons

Aircraft

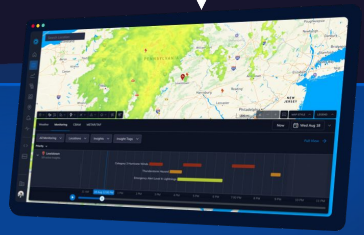
Lightning

Weather Station Observations

Ocean Buoys

Ground Radars

Observations



Weather and Climate Security Platform

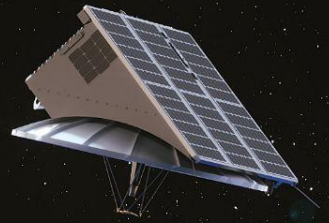
- Single Source of Truth
- Predictive Insights Dashboard
- Dynamic, Actionable Alerting
- **Automated Decision Making at Scale**

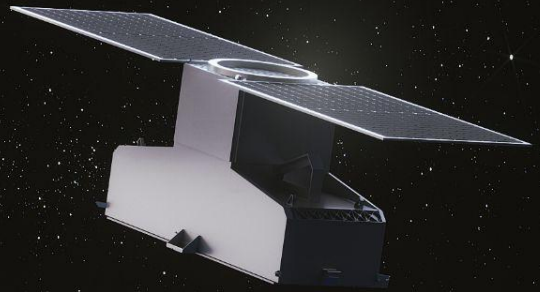
User Workflows

- The power of Tomorrow.io weather direct via API
- The weather conditions that matter to your business or operations
- The weather-dependent actions specific to your business or operations

The Tomorrow.io Constellation

Equipping the World with Global Radar Coverage





Tomorrow.io's constellation of 20 small satellites will provide:

- Full Global Coverage
- <1 hour average revisit rate
- World's first near real-time precipitation measurements and 3D atmospheric profiles
- Dramatic improvement in real-time weather forecasts, tropical cyclone warnings and flood alerts

Hybrid constellation of 20 small satellites in Low Earth Orbit

- 12 Ka-band radars
- 18 MW radiometers

Timeline:

- Launched in Q2/23
- Constellation fully operational by EOY 2024

Wind Power Prediction

Cutting-Edge Day-Ahead Wind Power Prediction

Delivering an unmatched forecast of power production

- High resolution forecasts at the **individual wind farm level** 0-48 hours ahead
- Leverages **11 vertical wind profiles** via proprietary machine-learning algorithms, enhancing inputs and driving accuracy of wind power predictions
- **Advanced machine learning techniques** trained on historical observational power production data, not just theoretical power curves, improving accuracy
- **Thorough QC measures** considering factors like curtailment, downtime, wake, sensor quality issues, mothballing, maintenance work, and general economics
- Provides **calibrated probabilistic forecasts** quantifying uncertainty, enabling enhanced risk management and hedging strategies
- Reliable **accuracy maintained at longer lead times**, with initialization farm-level R^2 of 0.85+ at hourly intervals and 0.97+ system-wide
- Retroactive Comparison for **Matching Historical Day-Ahead Predictions**

Forecast Accuracy Across All Scales

Validated Predictive Power at Farm, System Levels (Results shown for ERCOT)

Resolution	R^2	MAE (Est. Percent Cap.)
Farm-Node/Hour	0.85	0.09
Farm-Node/Day	0.94	0.05
System/Hour	0.97	0.03
System/Day	0.98	0.02

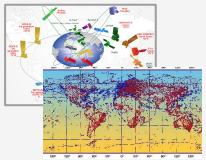
Metrics are reported on estimated initializations aggregated up and evaluated against held out test set over 2022. Periods of curtailment and in-operability have been removed.

Alaska Wind Power Model

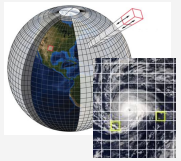
Current Operational Status

Alaska Wind Power Forecasting Model

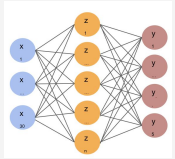
Observations



Models



Machine Learning



Model combines the strengths of Numerical Weather Prediction (HRRR) with Machine Learning (ML) to maximize predictive accuracy

Wind Power Forecast

Hourly predictions out to 48-hours for all wind turbines in US Wind Turbine DB.

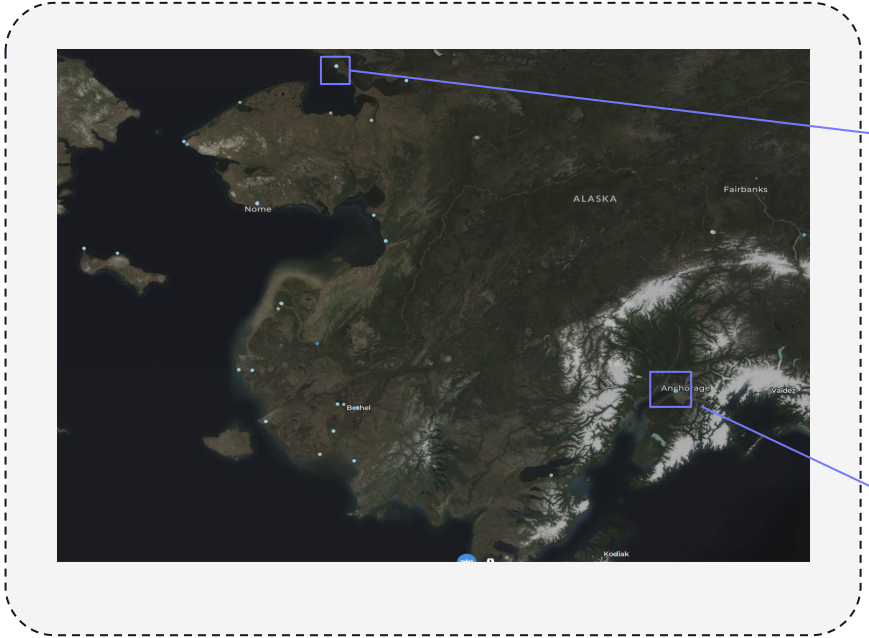
Model trained on similar farms (hub heights, etc) with 4 years of historical generation data

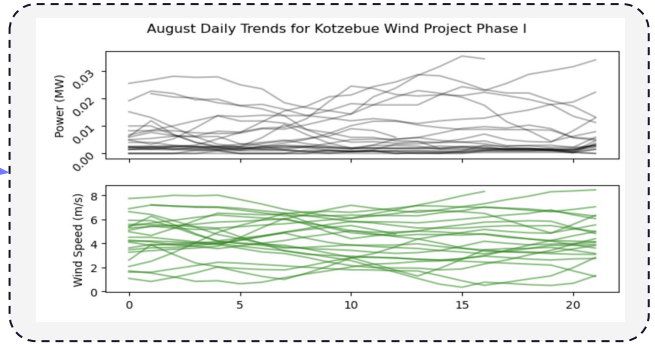
Weather Intelligence™

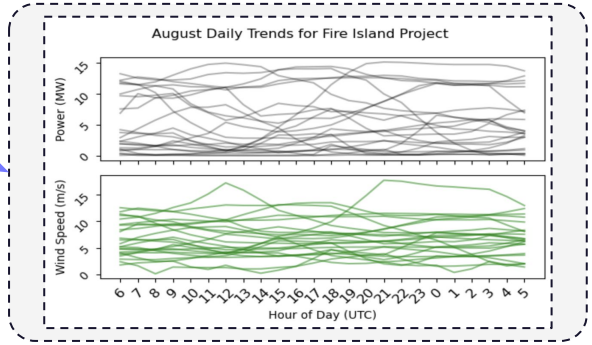
Deterministic and probabilistic forecasts!

Ability to utilize probabilistic forecasts for minimizing costs of spinning reserves

Weather Intelligence™ isn't focused on the weather, it's focused on the predictive **impact of the weather, automated decisioning, and operational optimization.**



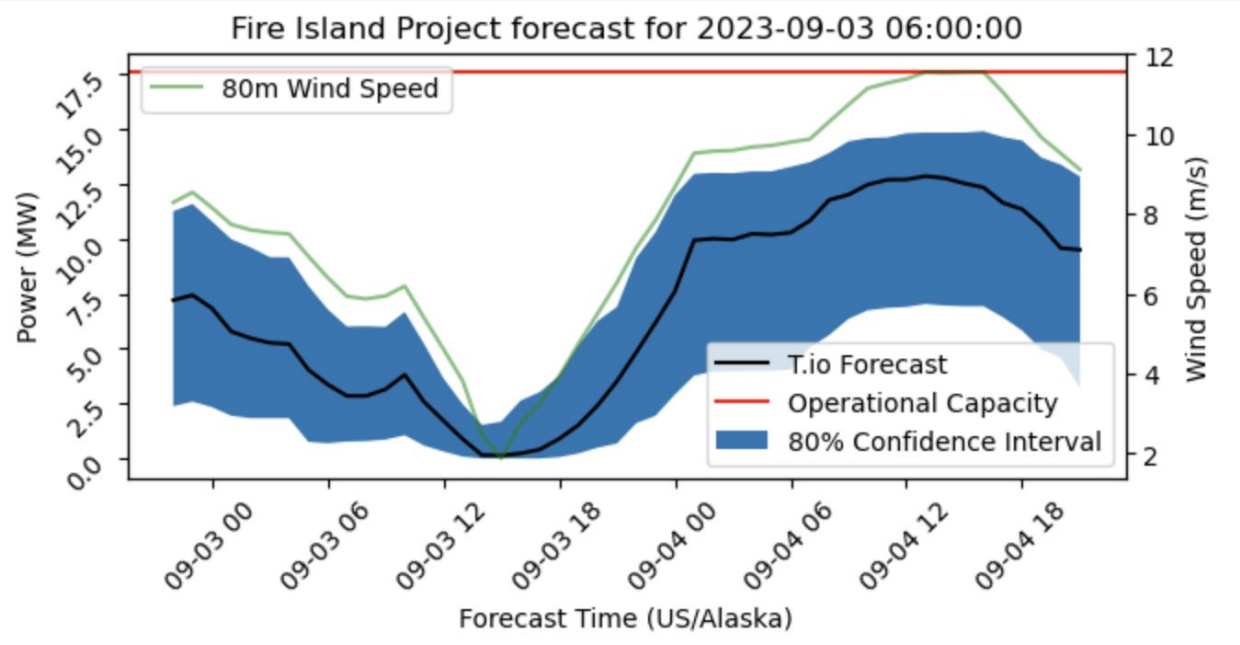




- Forecasting for 33 Alaskan wind farms and repower phases.
- Captures both low level jet wind and coastal wind patterns

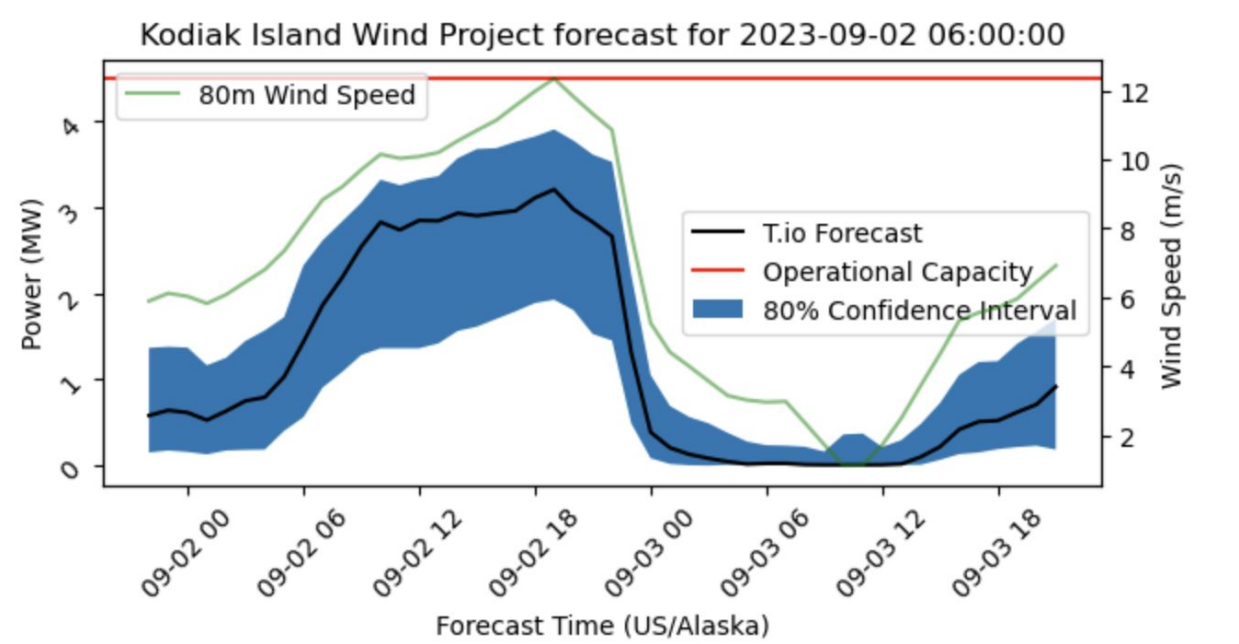
Fire Island Wind Project - Example Forecast August 4th

Probabilistic Forecasting Edge: Leveraging advanced machine learning algorithms, the 80% confidence interval provides range of potential outcomes enabling better decision making



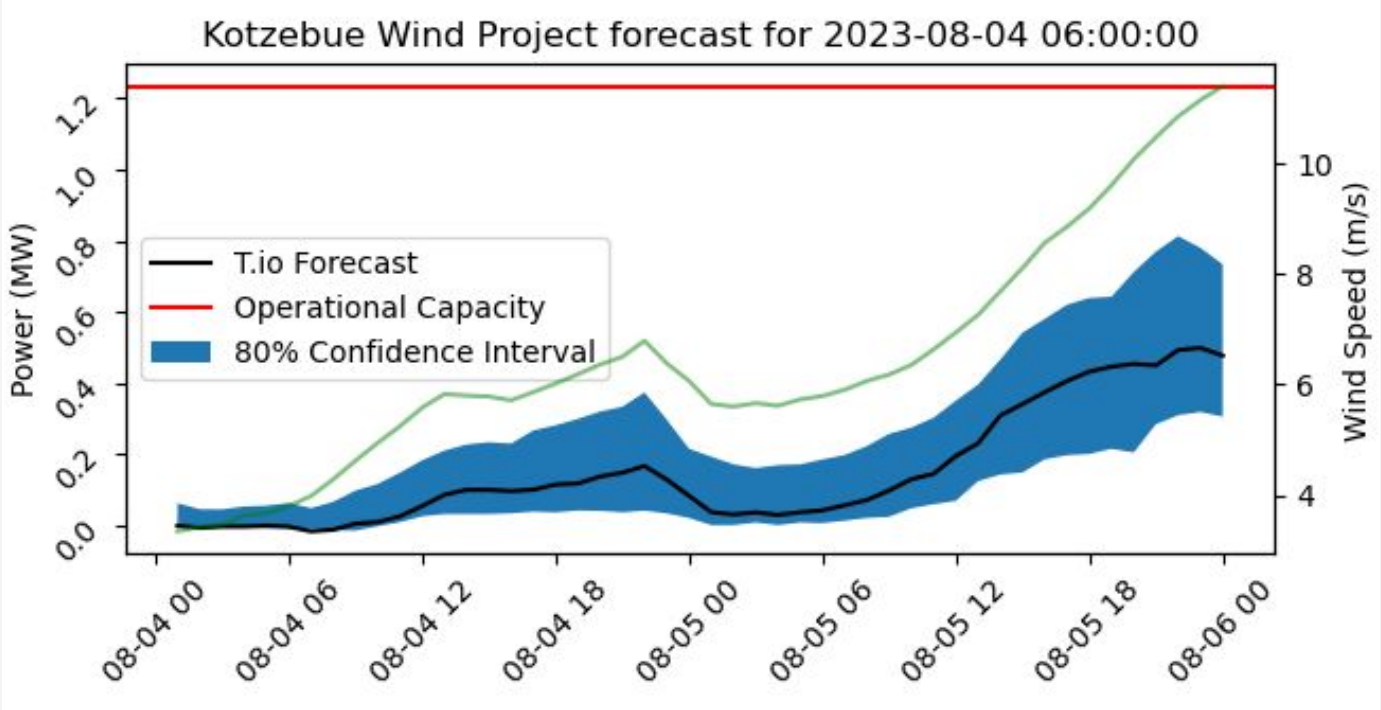
Kodiak Island Wind Project - Example Forecast August 4th

Probabilistic Forecasting Edge: Leveraging advanced machine learning algorithms, the 80% confidence interval provides range of potential outcomes enabling better decision making



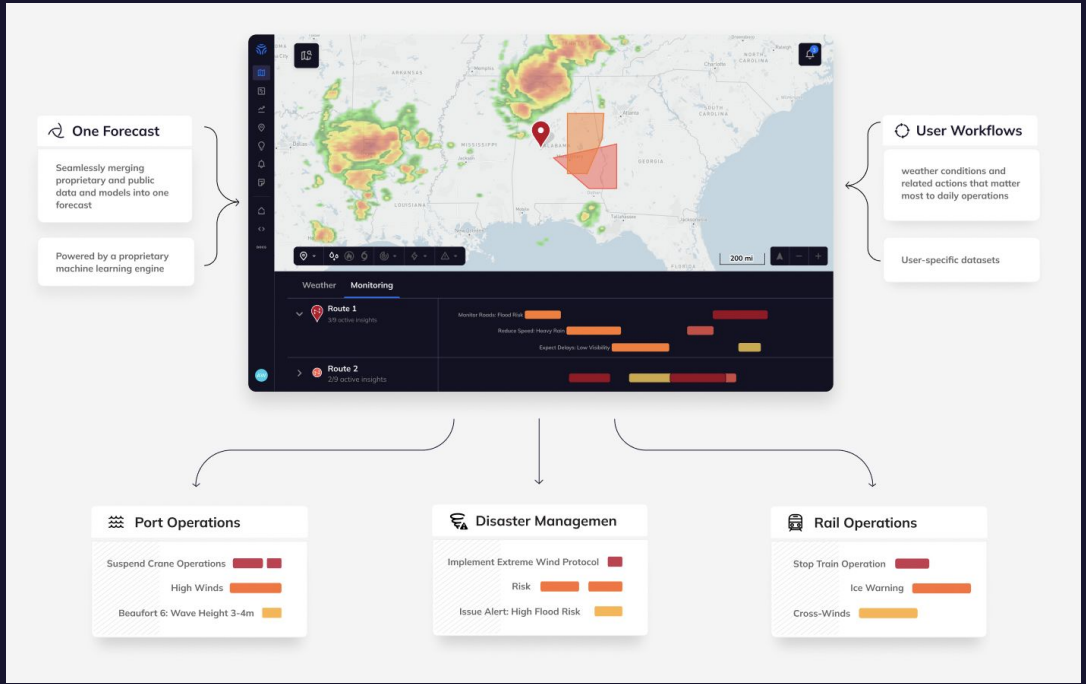
Kodiak Island Wind Project - Example Forecast August 4th

Machine Learning Advantage: Changes in wind speeds at lower values have less impact on generation - capturing effect of cut-in wind speeds



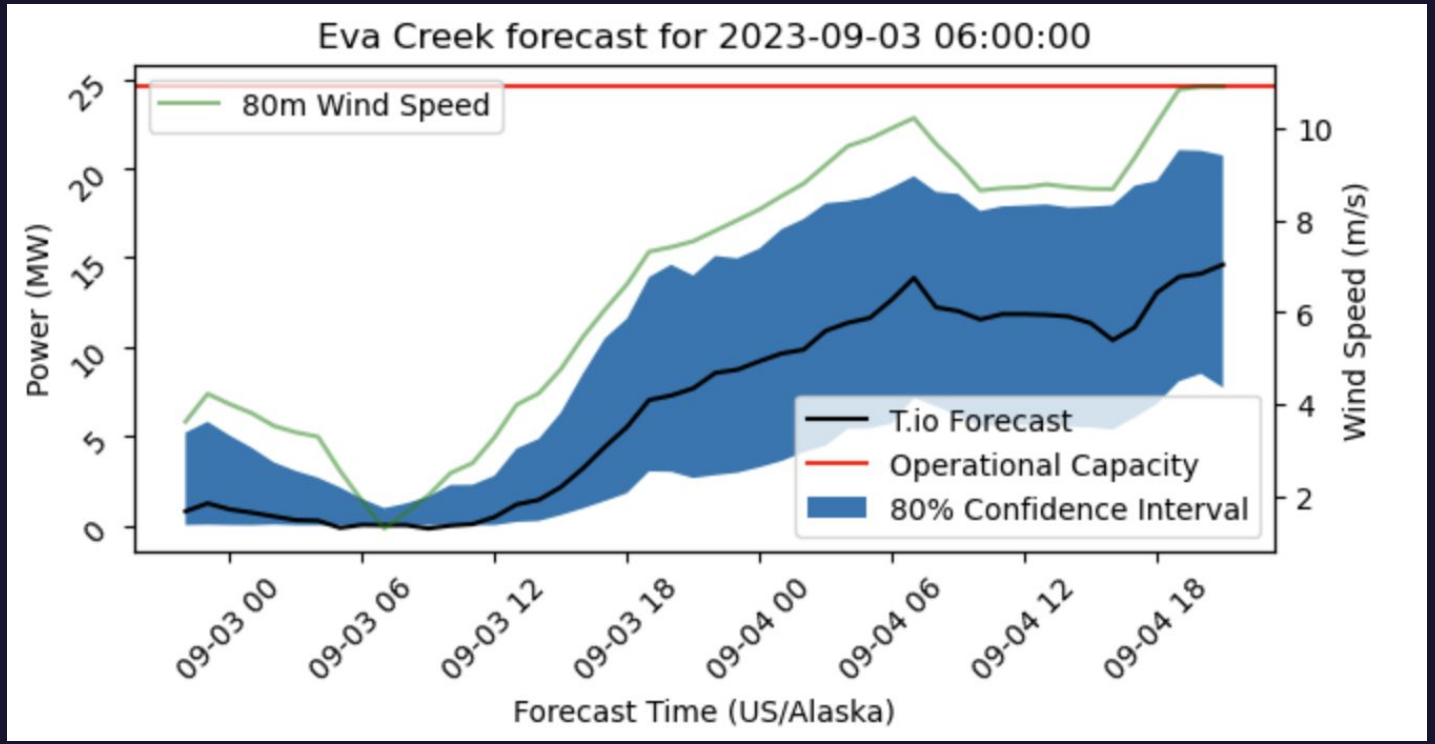
What is coming next?

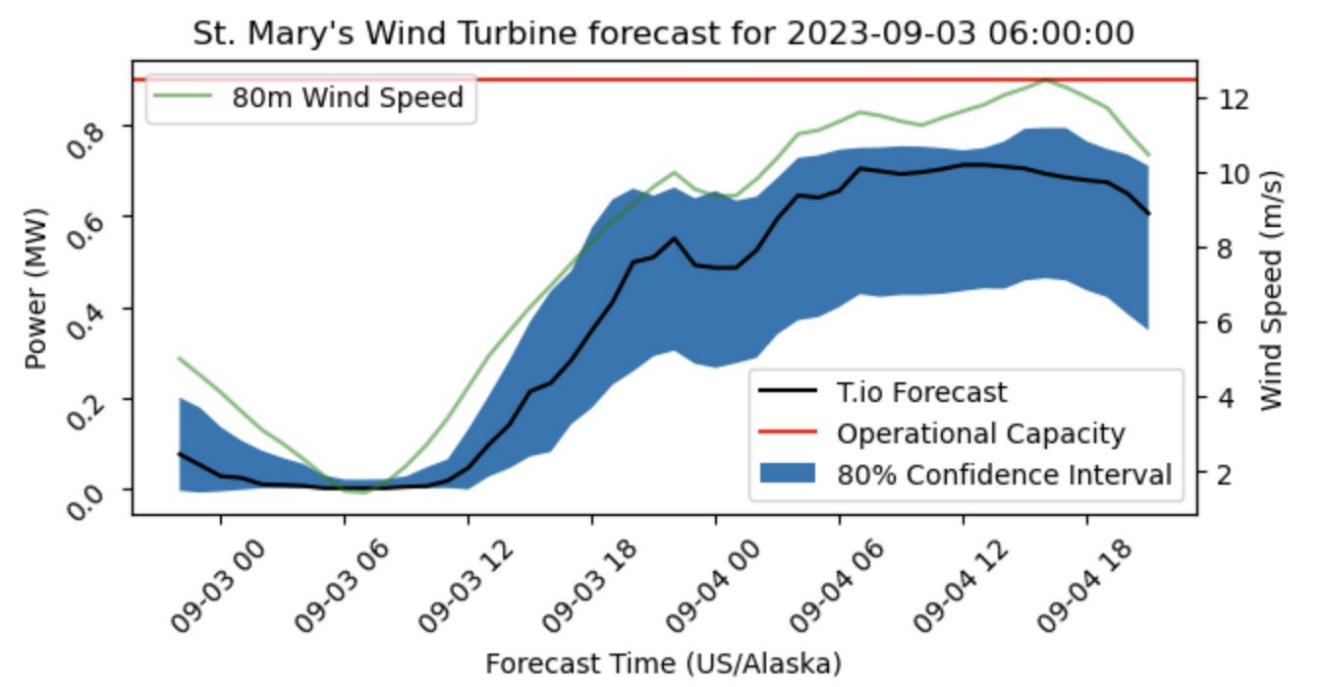
- Increasing the forecast period out to **10-days** at the **individual wind farm level**
- Simulate generation for planned or potential wind farm locations
- Ability to train based on historical generation data
- **Further advancements in machine learning techniques** trained on historical observational power production data
- **Incorporation into Tomorrow.io platform** - currently available via AWS S3 and soon API



Appendix

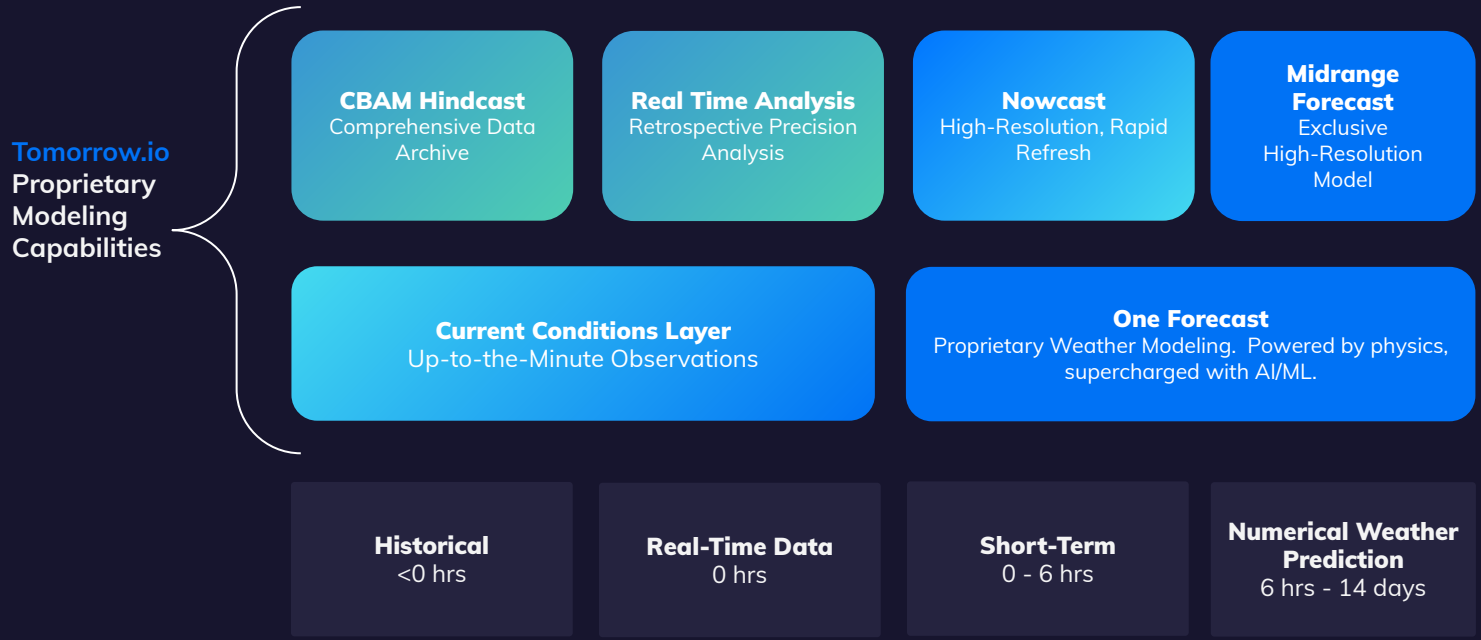
Updated September Wind Power Forecasts




St. Mary's Wind Turbine forecast for 2023-09-03 06:00:00
80m Wind Speed
T.io Forecast
Operational Capacity
80% Confidence Interval
Power (MW)
Wind Speed (m/s)
0.0
0.2
0.4
0.6
0.8
2
4
6
8
10
12
09-03 00
09-03 06
09-03 12
09-03 18
09-04 00
09-04 06
09-04 12
09-04 18
Forecast Time (US/Alaska)

Precision Across all Time Scales

Driven by Private Modeling, Blending, Observations, and Machine Learning



Visualizations and Monitoring Built to Deliver Insights

Interactive map provides real-time situational awareness of approaching weather.

Monitors track incoming weather impact for point locations, polygons and polylines.

Clusters help quickly identify the operational zones expecting the most significant weather impact.

Timeline displays hourly forecast trend, for up to two parameters at a time, up to 14 days out.

Insights based on your weather criteria transform the forecast into recommended actions.

Alerts for expected weather impacts can be sent to staff by email, text or mobile app.

Competitive Advantage

Gartner

COOL VENDOR 2022

FAST COMPANY

WE MADE THE LIST!

WORLD CHANGING IDEAS 2022

The Brands People Rely on, Rely on Tomorrow.io

Trusted by the Top Brass

"Tomorrow.io to Rebuild NOAA's Weather Data Models in the Cloud."

"Tomorrow.io and NOAA Enter Cooperative Research and Development Agreement."

POLITICO

"United States Air Force Awards $19.3M to Tomorrow.io for First Satellites."

CNN

"Tomorrow.io testifies to U.S. Congress on Climate Impact."

PBS

"DIU Selects Tomorrow.io for U.S. Military Weather Modeling Project."

"Tomorrow.io to Support FAA Project for Urban Mobility."

"Tomorrow.io Informs WMO on Cutting-Edge Precipitation Measurements and Applications from Space."

MIT Technology Review