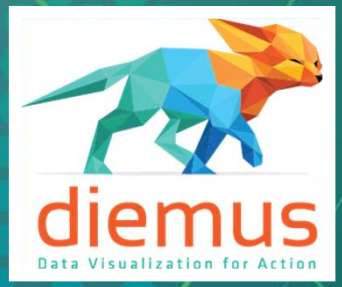
When Turbines Go Bump in the Night – Shedding Light on Lost Revenue

David Rodriguez and Lonnie A. Bowling



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EDF Renewables North America

- Provides Grid-Scale Power, Distributed Solutions, and Asset Optimization
- 16 GW of renewable energy installed
- 26 GW planned or in construction

Problem – Turbines Go Bump

- Common reasons turbine fault
  - Gearbox oil temperature too high
  - Excessive vibrations
  - Equipment voltage spikes

- Typical solutions
  - Operation Control Center remote reset
  - Site personnel remote reset
  - Climb turbine

But what if turbines go down on nights/weekends?

- Site crew work typical hours
- Operation Control Center (OCC) monitors 24/7/365
- OCC can notify the site and have a repair team come in for after-hours repairs
- Each site had its own criteria

Site Callout Criteria

4.3 Call Out Chart 24/7 - 365

Wind Speed	1 wtg off line	2 wtg off line	3 wtg off line	4 wtg off line	5 wtg off line
5	DNC	DNC	DNC	Call Out	Call Out
6	DNC	DNC	Call Out	Call Out	Call Out
7	DNC	Call Out	Call Out	Call Out	Call Out
8	Call Out	Call Out	Call Out	Call Out	Call Out
9	Call Out	Call Out	Call Out	Call Out	Call Out
10	Call Out	Call Out	Call Out	Call Out	Call Out
11	Call Out	Call Out	Call Out	Call Out	Call Out
12	Call Out	Call Out	Call Out	Call Out	Call Out

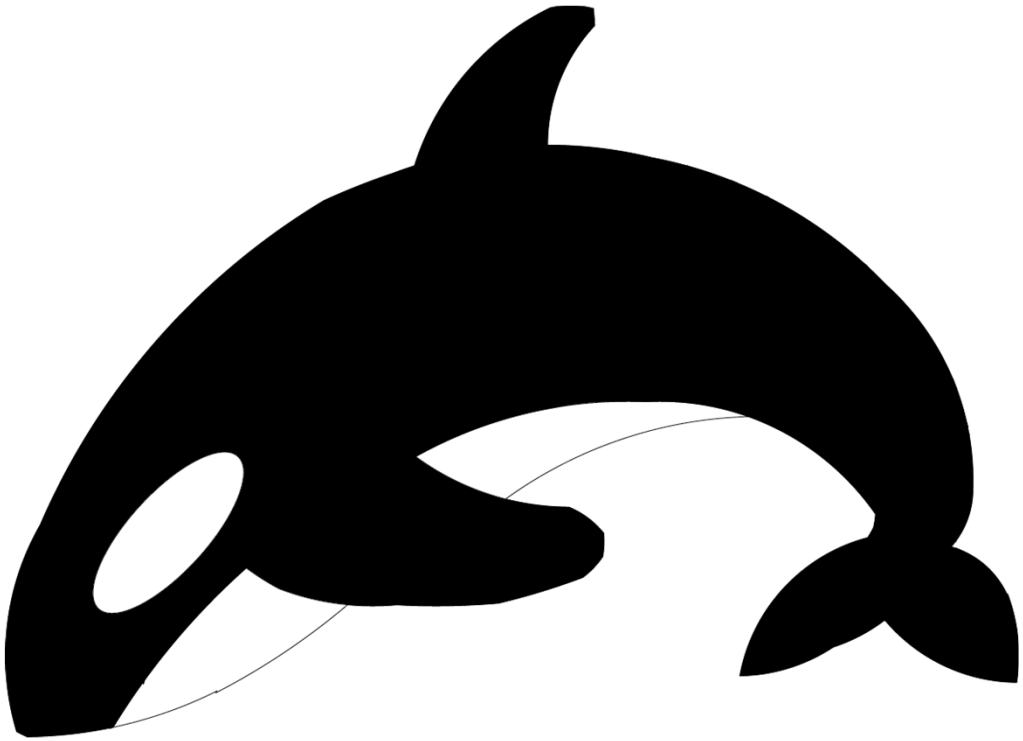
There must be a better way!

1. Take into account future state – wind speed forecasts
2. Describe callout criteria in dollars, for simple and consistent decision making
3. Capture history to assess effectiveness

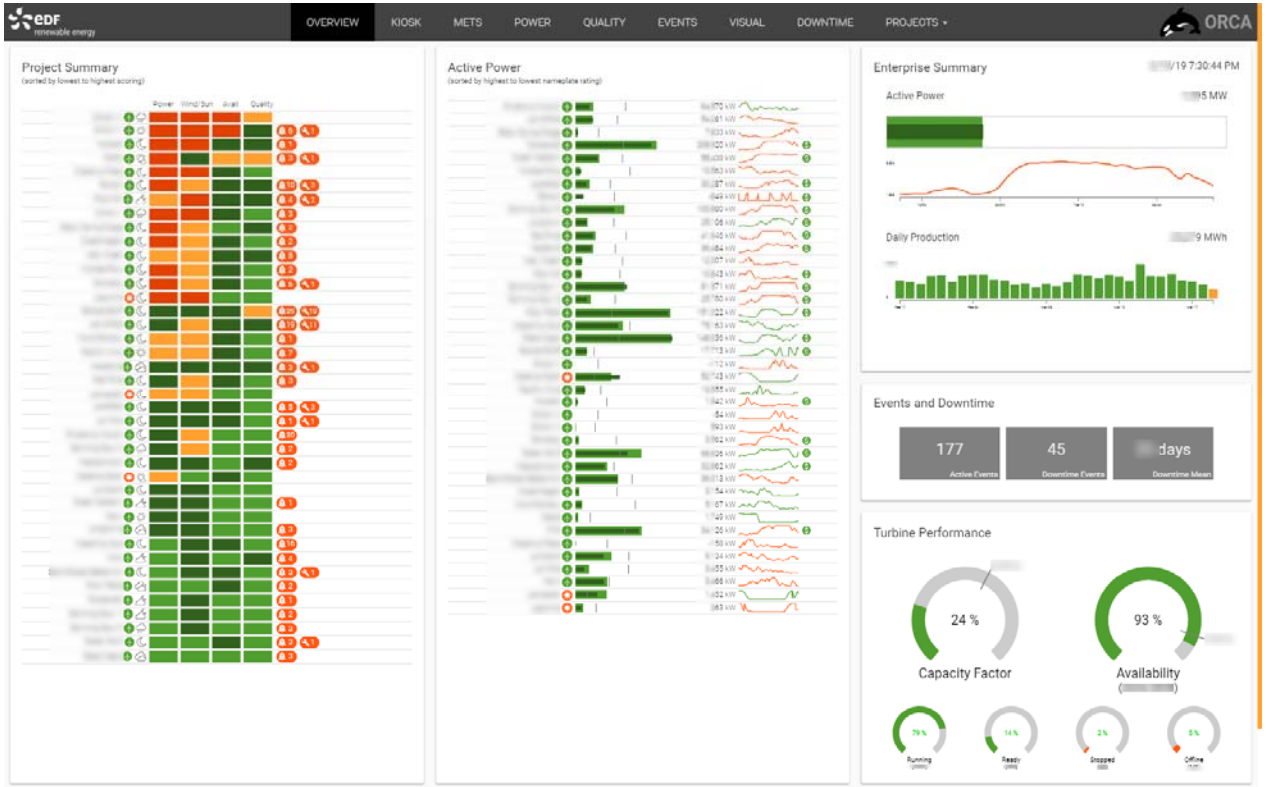
Outline the solution

- Provide real-time monitoring
- Forecast lost revenue of down turbines
- Integrate rules for when to do a callout
- Provide notifications and store events

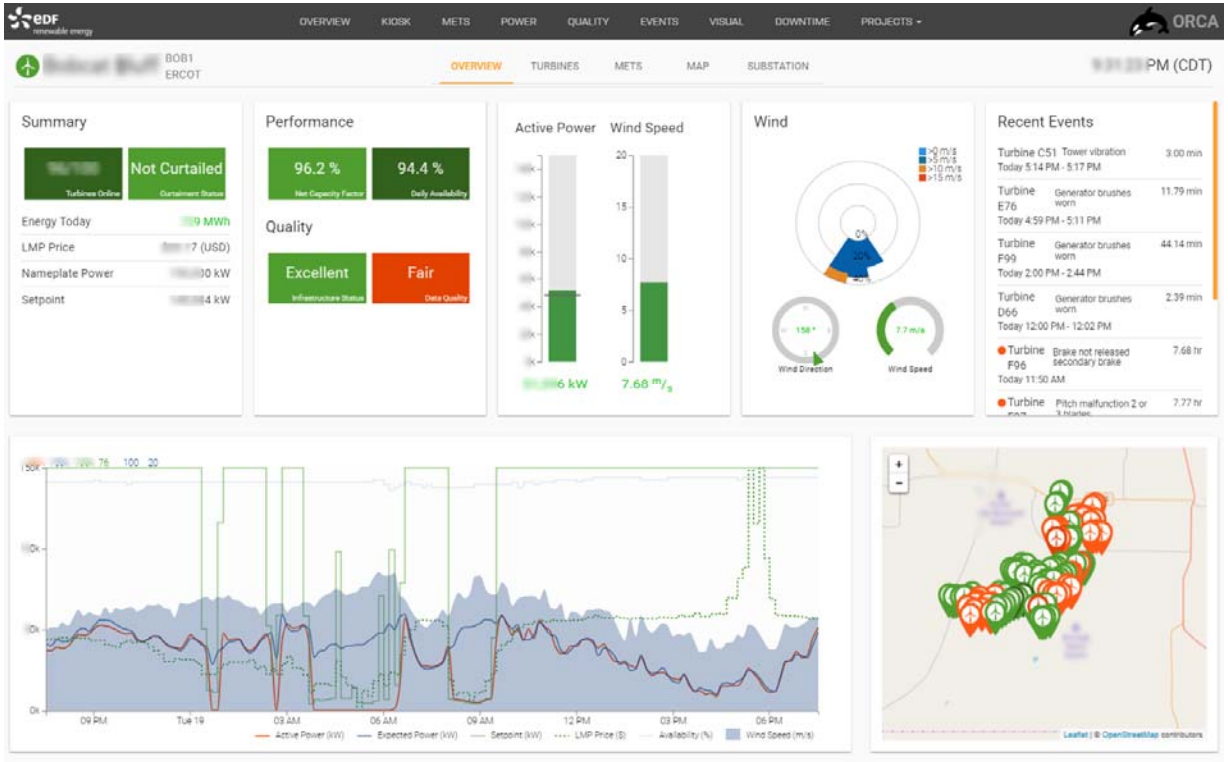
ORCA
Operational Readiness and Contextual Awareness



ORCA – Enterprise Level

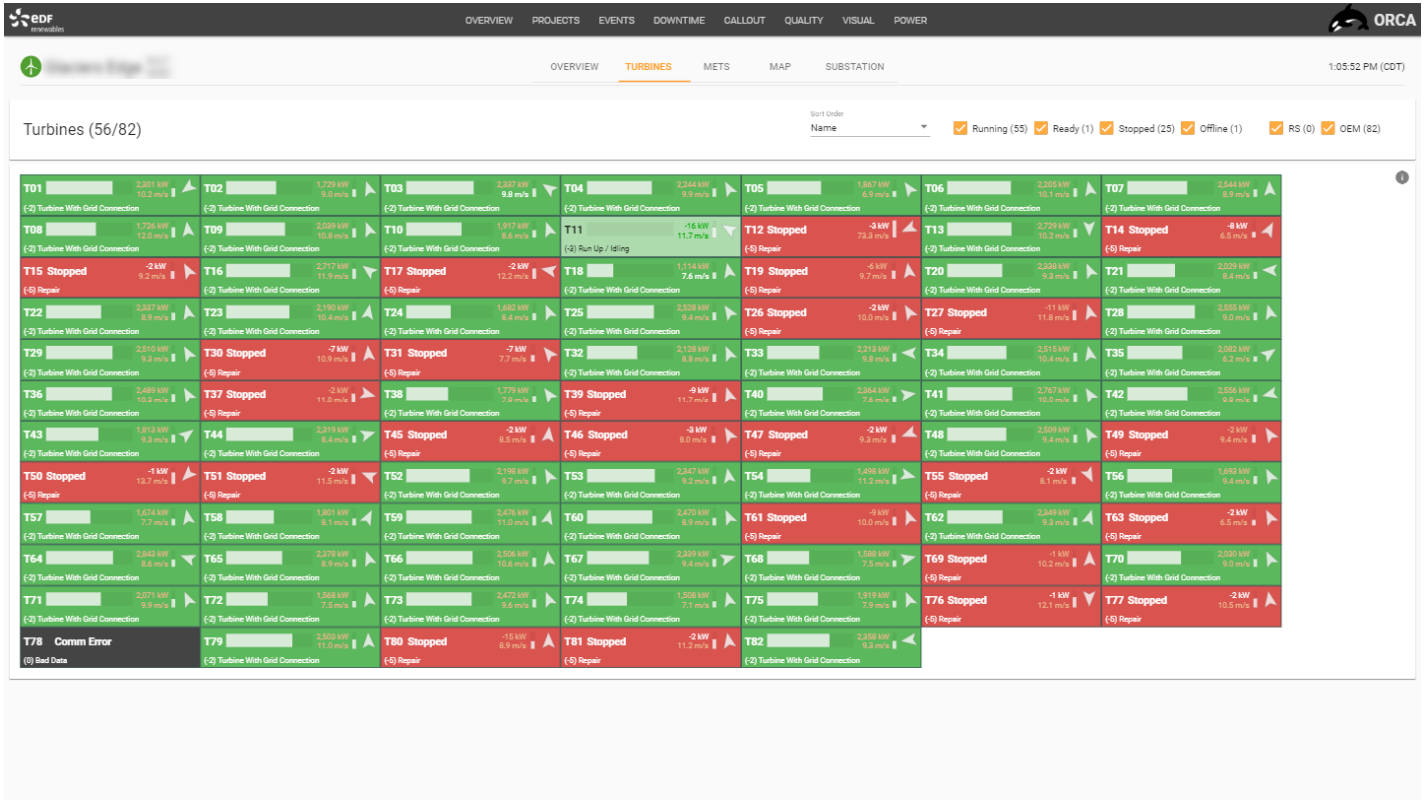


ORCA – Project Level

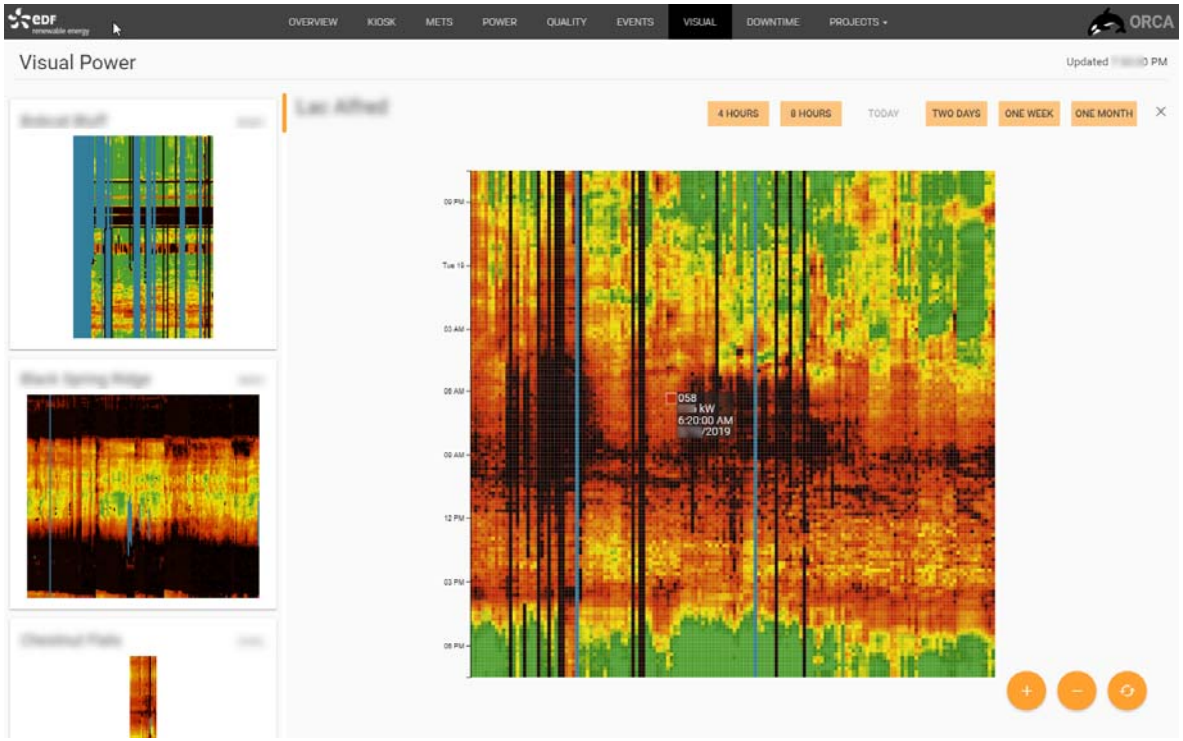


ORCA – Asset Detail Level

ORCA – Other Visualizations



ORCA – Other Visualizations



The Ingredients

Forecasted Energy

+

Energy Price

+

Schedule

+

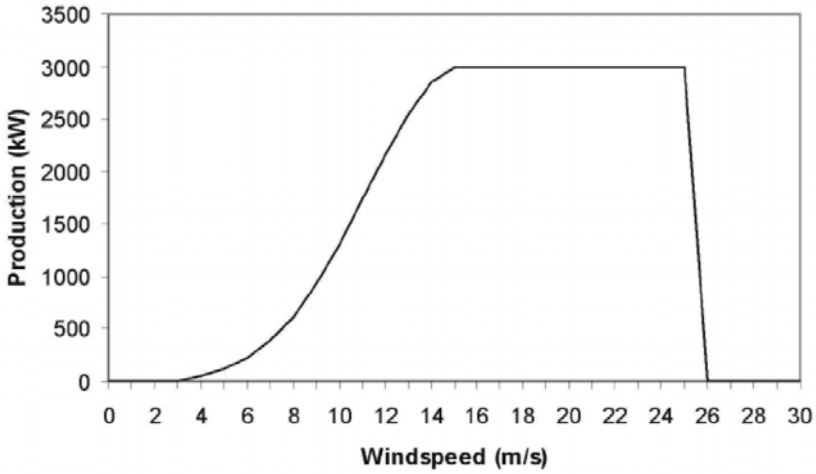
Operational Status

The Ingredients - Forecast

Create a power forecast for each turbine

- Weather forecast data via the Dark Sky API
- Convert wind speed to hub height
- Manufacturer power curve

DARK SKY



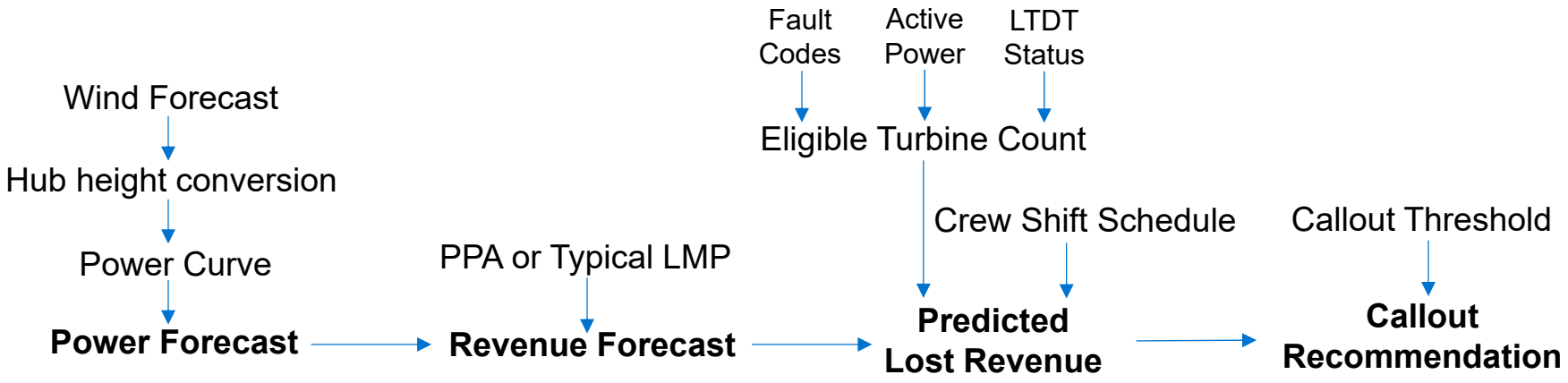
The Ingredients – Business Data

- Fixed Price (PPA) or Market Price (LMP)
  - Turn turbine forecast power into revenue
- Crew shift times
  - Know how long until crew comes back to the site
- Callout threshold
  - How much revenue loss is worth sending crew out?

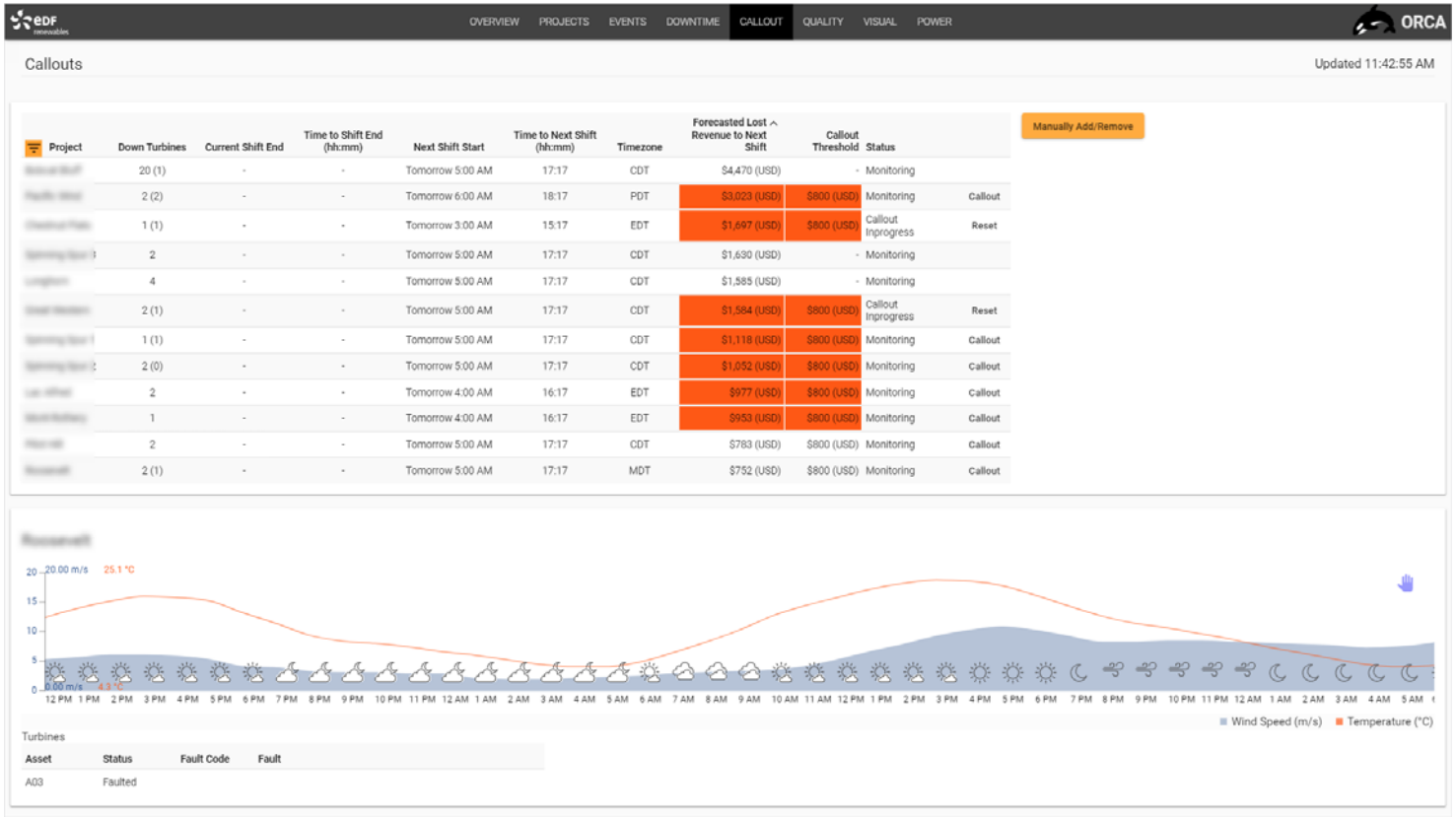
The Ingredients – Turbine Eligibility

- Active Power
  - Must be 0 or negative
- Turbine State
  - Must be a code that's considered a fault – for at least 15 minutes
- Long Term Downtime Status
  - Must not already be tracked in our Long Term Downtime Tracker (LTDT)

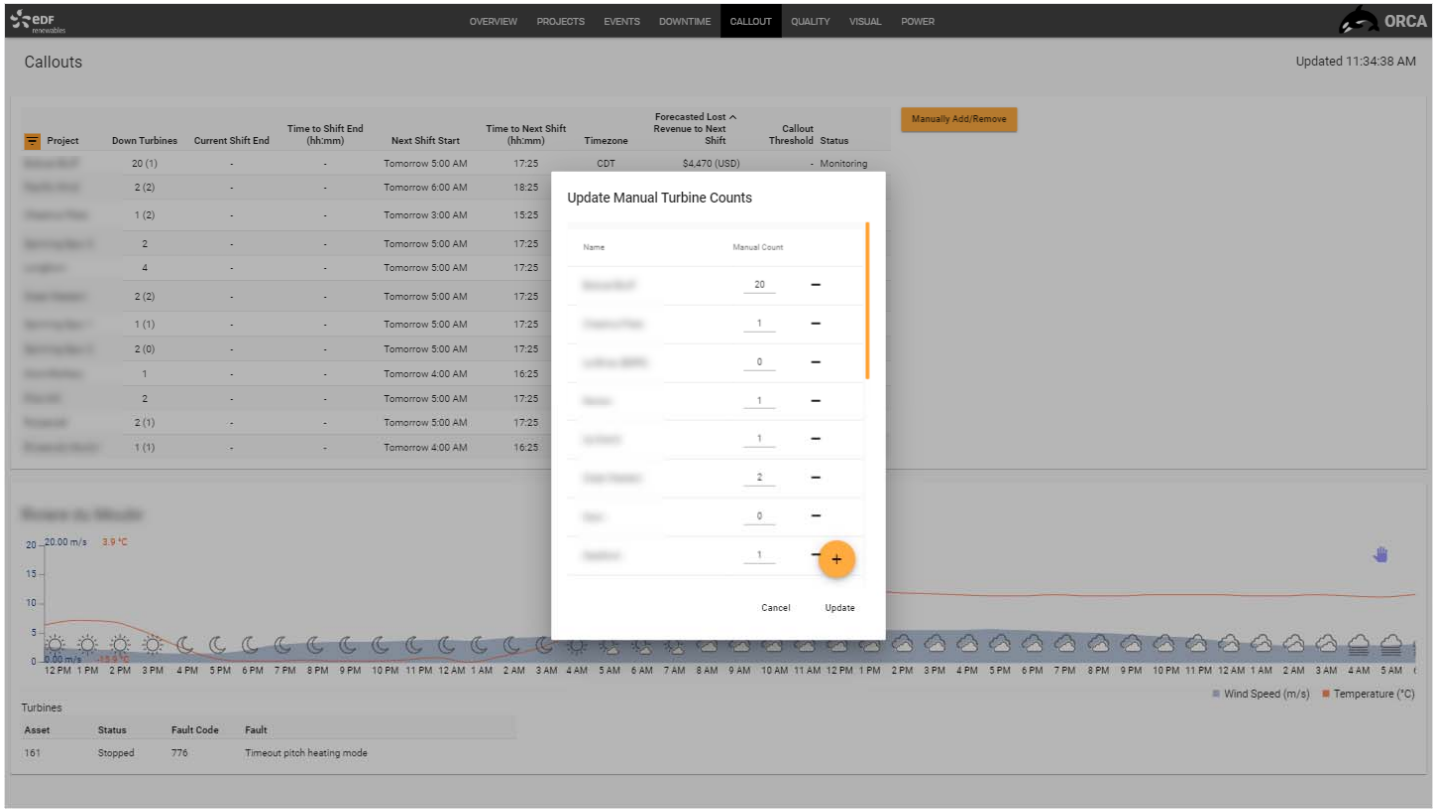
The Recipe



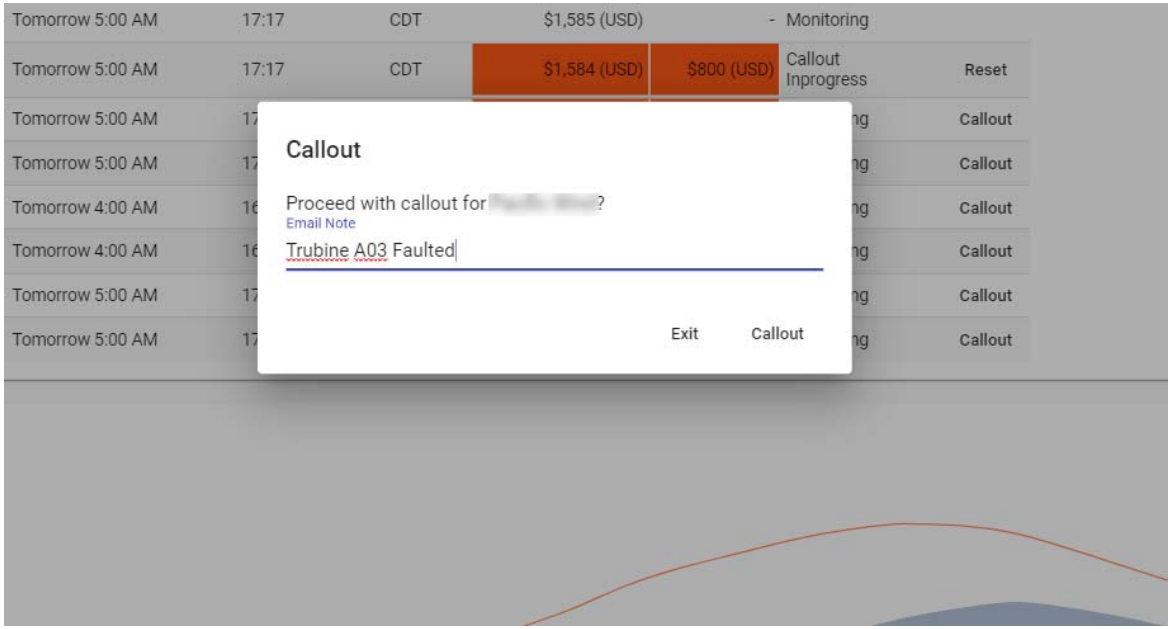
Callout Dashboard



User Input Still Needed



Initiating a Callout



Callout Notification

From: OCC <[redacted]>
Sent: Saturday, March 21, 2020 7:14 PM
To: [redacted] Notifications <[redacted]>
Subject: OCC has made an ORCA callout [redacted] down turbine(s)

OCC has made an ORCA callout for [redacted] down turbine(s) due to forecasted lost revenue of $2212 with a callout threshold of $800.

Additional Notes:

Informed site of two down turbines; D24/D13

Please go to ORCA Callouts to view additional information.

Insights

- About $5 million in revenue lost annually
  - Not great to see, but exciting to have room for improvement
- Taxing on site crews
  - Callouts increased by 50%
  - Decided to increase threshold to $3200 if within 7 hours of next shift
  - Unnecessary callouts more easily avoided
- Down turbine auto detection not 100% accurate
  - Still need humans in the loop

Results thus far

700 callouts to date

Estimated savings of $2 million per year

Talk of hiring more site personnel

"We are now able to track callouts and know the value we are gaining, which allows us to further refine our callout criteria to capture additional value. Our most significant callout to-date resulted in just over $30,000 in saved revenue."

- Bob Sullivan, OCC Projects Manager

What's next?

- Planned improvements
  - Change to industry-specific weather forecast service
  - Day ahead pricing for market sites
  - Improve callout threshold logic, based on corrective action
  - Improve down turbine auto-detection with better fault classification
  - Unsupervised monitoring and operators notified as needed

- Reuse real-time and forecasted revenue for better decision making in other areas

Thanks for Listening!

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Questions?

Please wait for
the **microphone**

State your
name & company

Save the Date...

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