Open-Source Wind Power Plant Database – U.S.

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Overview

- Data Needs for Power System Models and Forecasts

- U.S. National Intra-Hour Wind Power Database

- Extending the Wind Power Database

Data Needs for Power System Models and Forecasts

High-resolution wind power time series are needed across all energy applications.

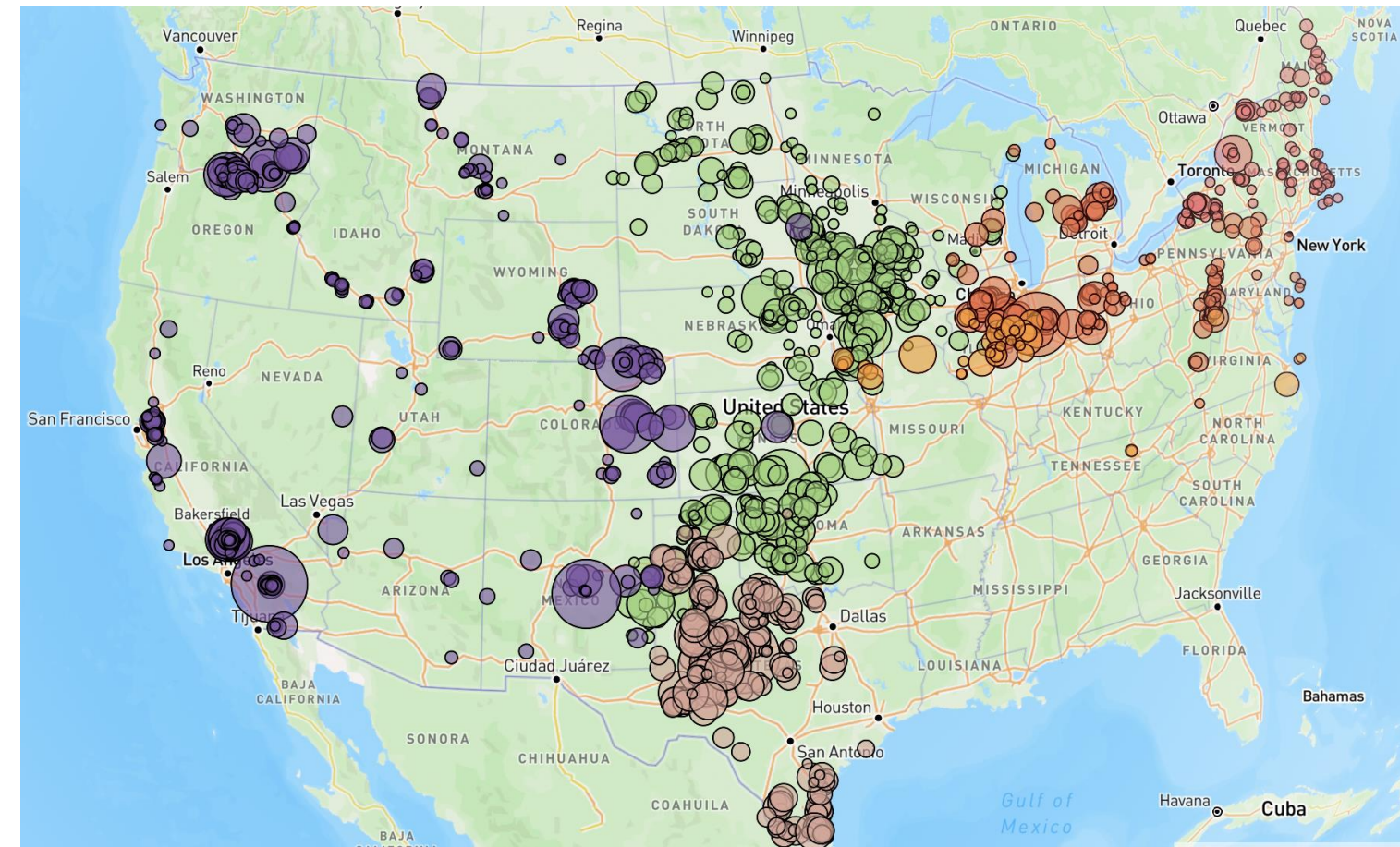| Application	Temporal Res	Spatial Res
Production Cost Model	Hourly	Plant-level
Optimal Power Flow	1-minute	Plant-level
Imbalance Reserves	1-minute	Plant-level
Operational Forecasts	5-minute, Hourly	Plant-level
S2S Forecasts	Hourly	Plant-level, Balancing-level
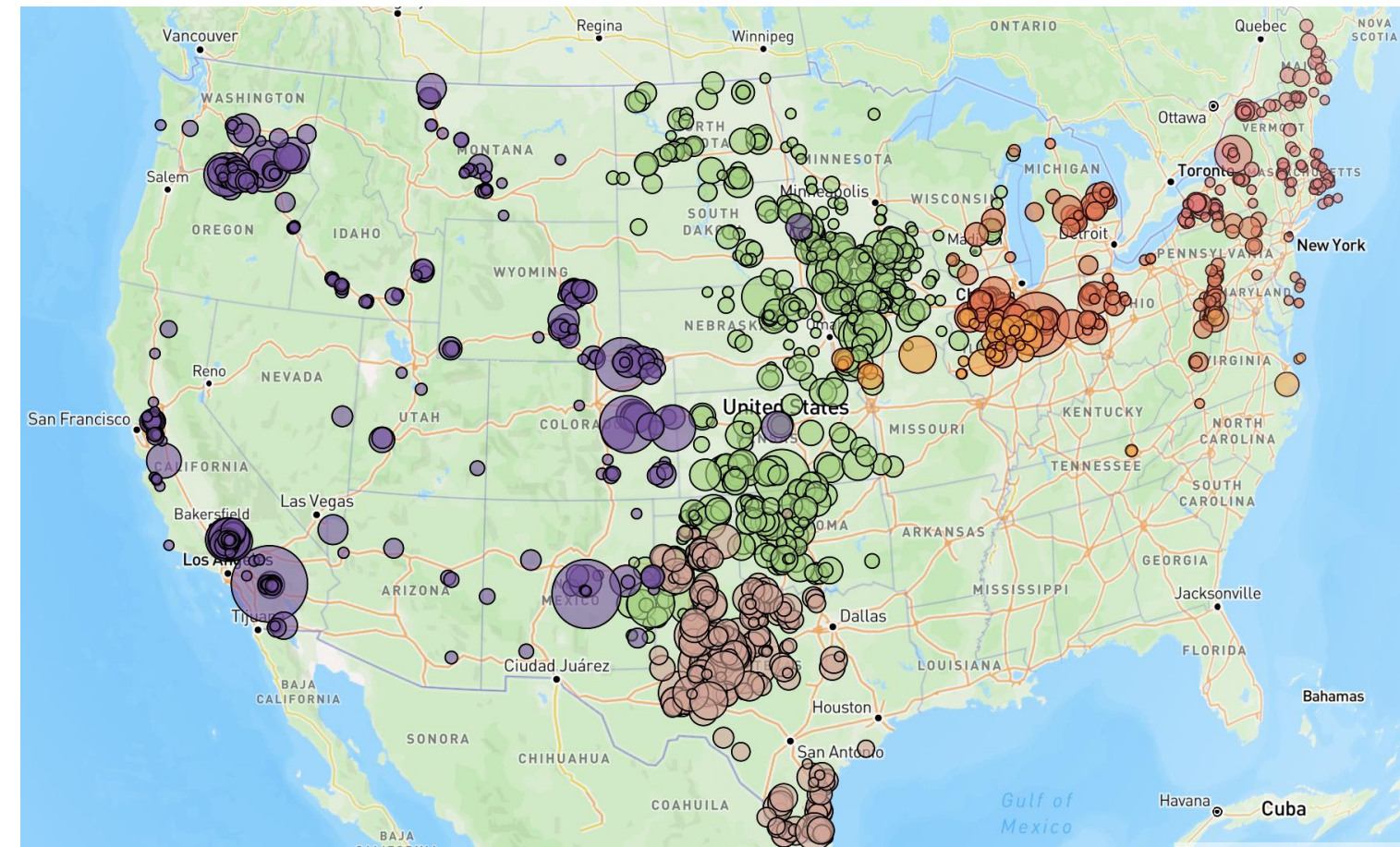
DOE Wind Data Portal Interactive Tool (in development) 3

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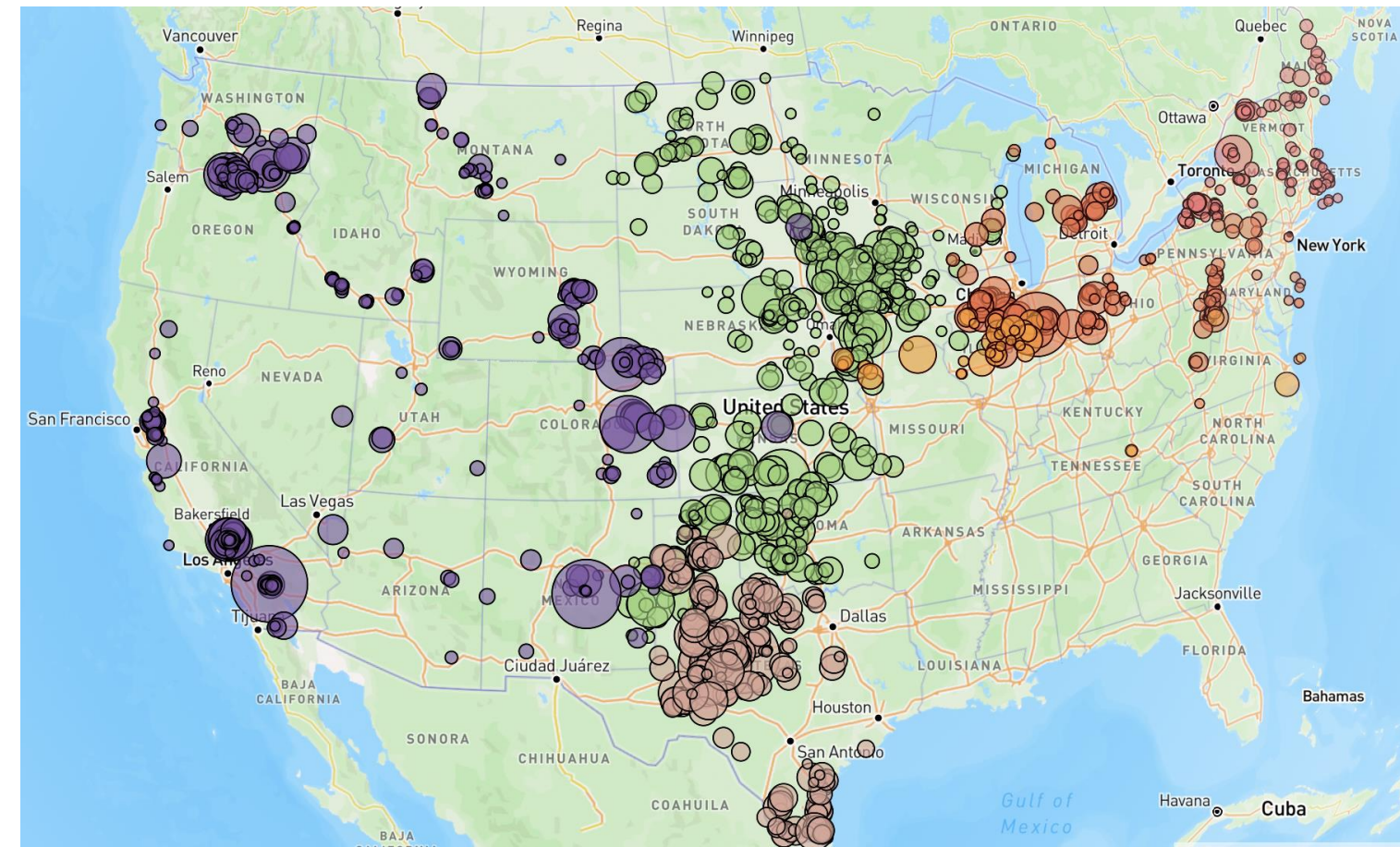*DOE Wind Data Portal Interactive Tool (in development)*

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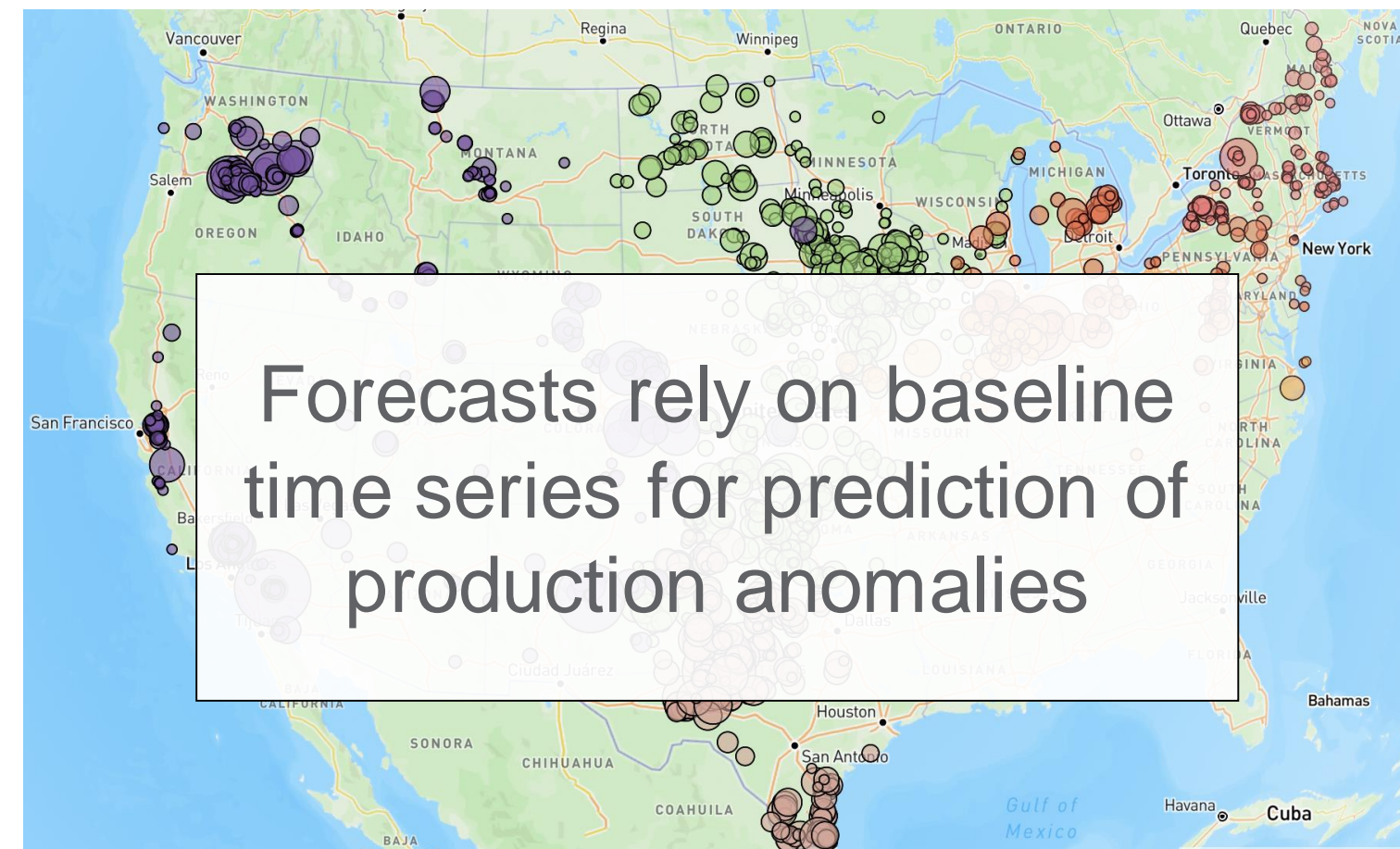*DOE Wind Data Portal Interactive Tool (in development)*

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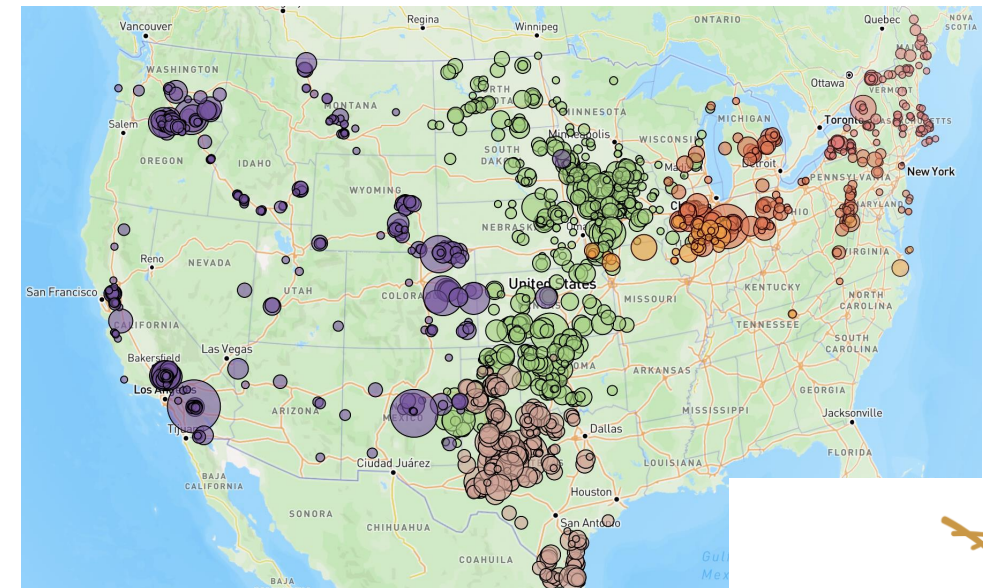Forecasts rely on baseline time series for prediction of production anomalies

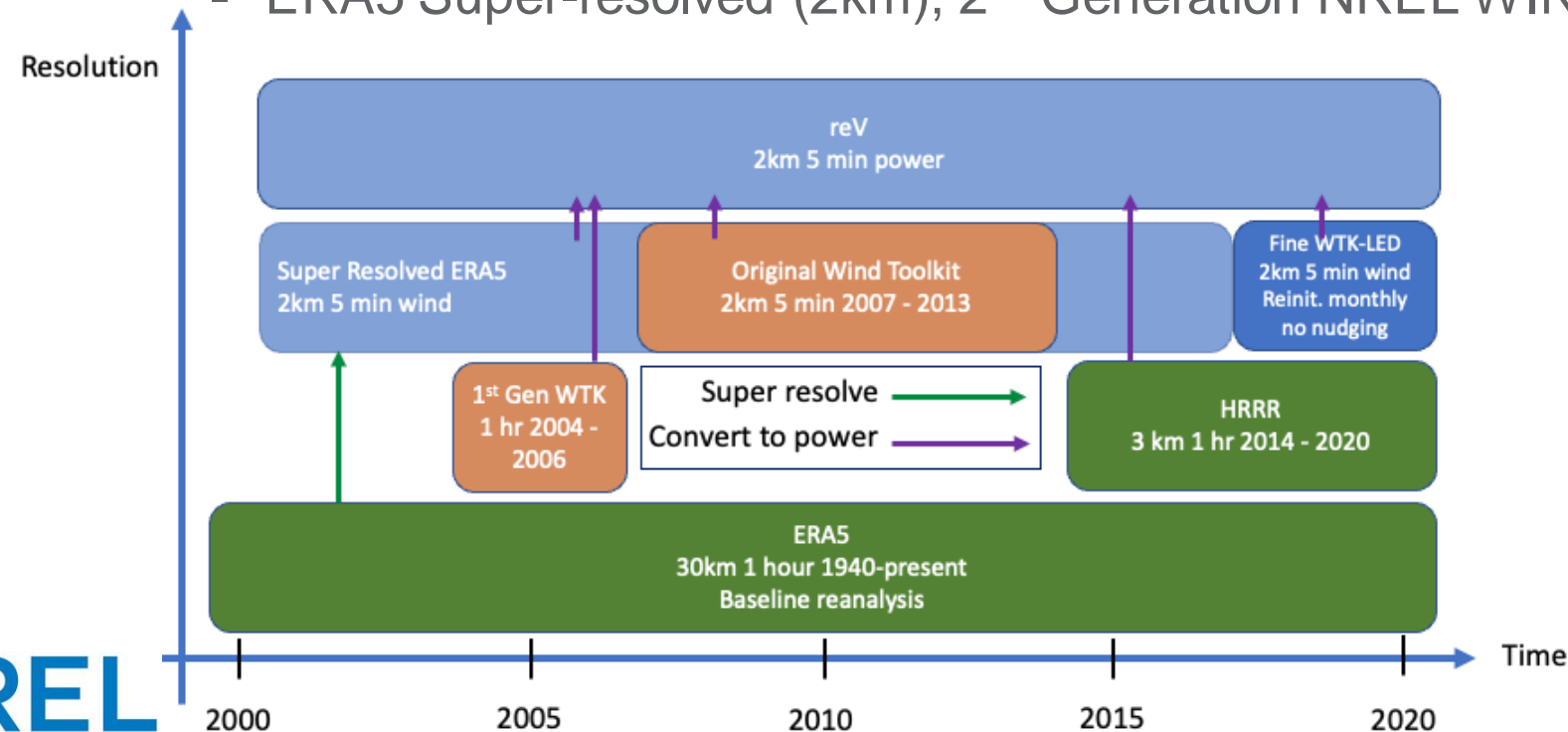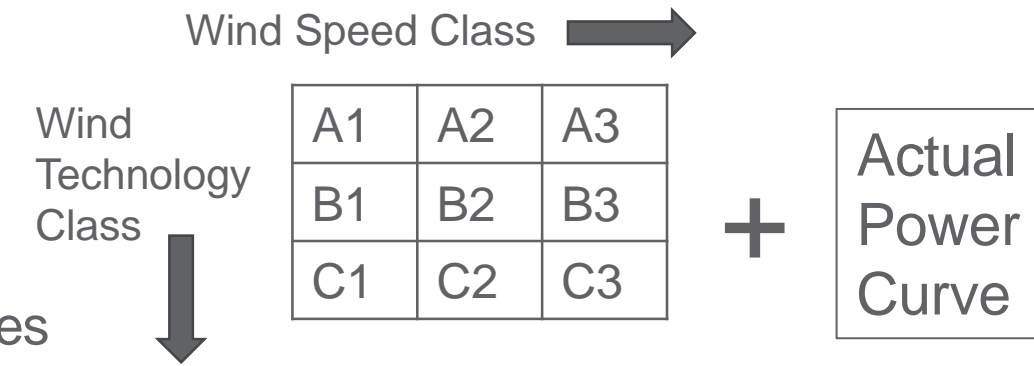*DOE Wind Data Portal Interactive Tool (in development)*
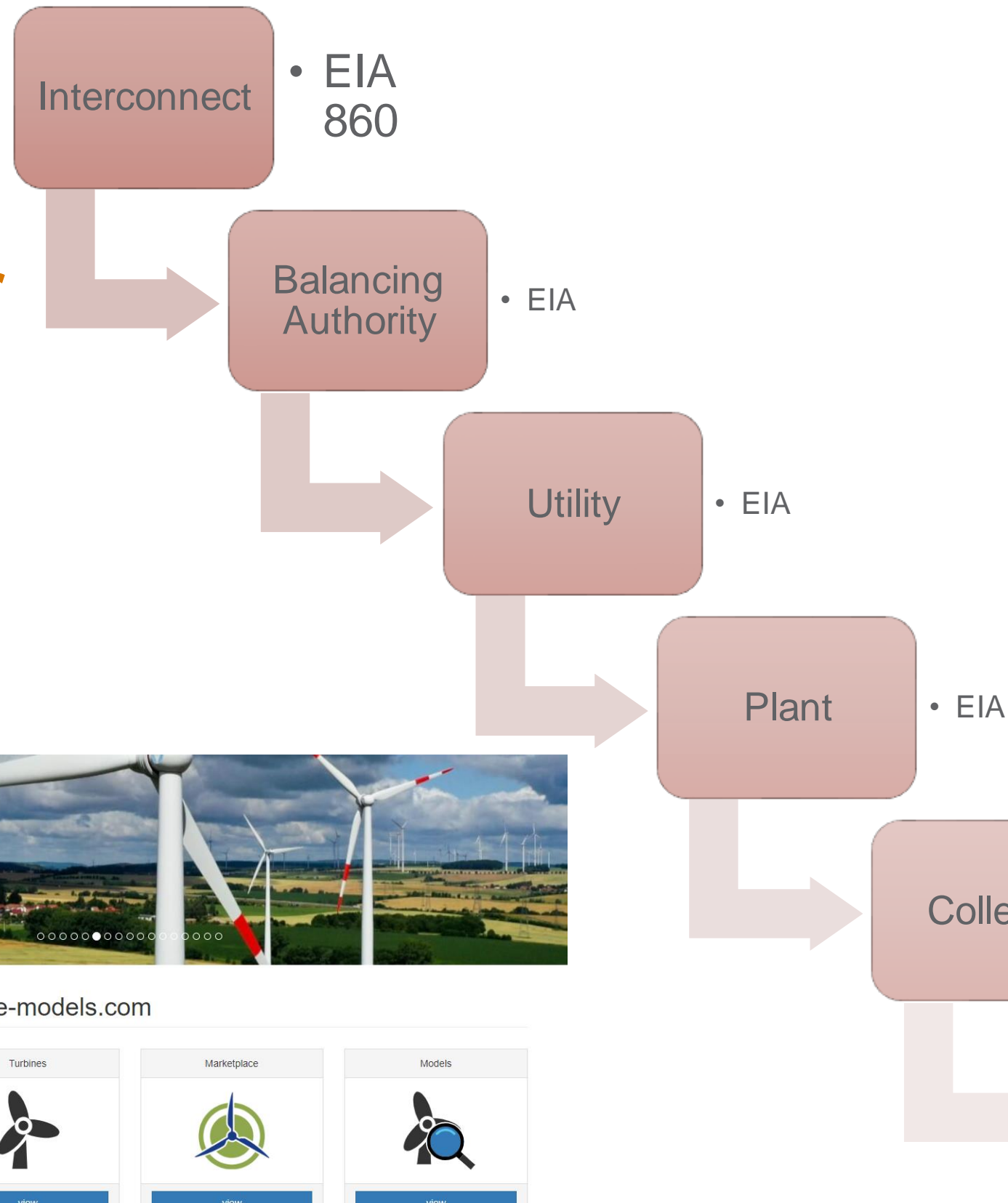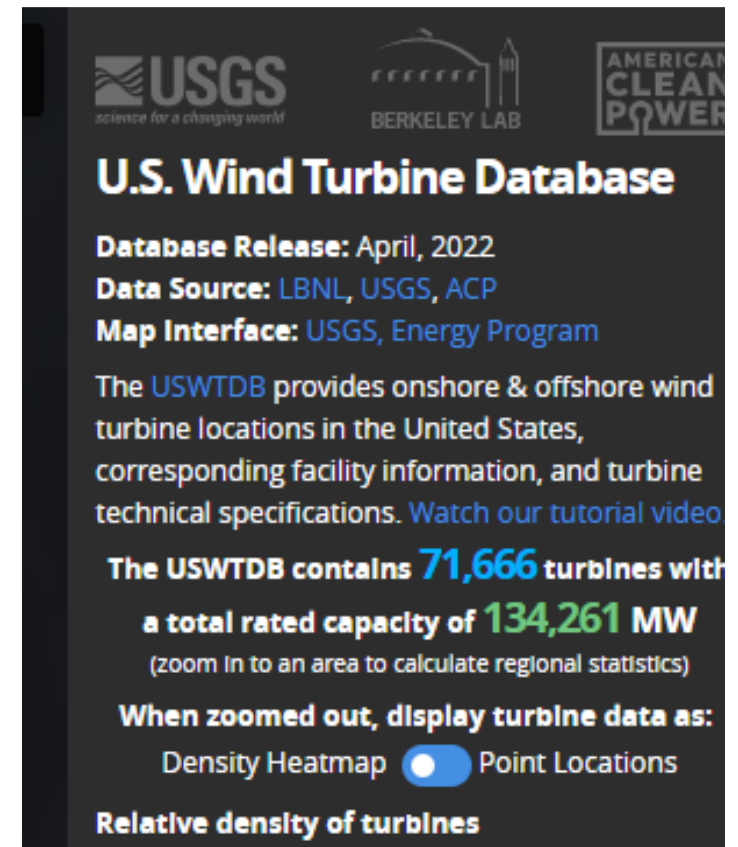
Data Needs: Open-Source Datasets

- Open-source benchmark datasets have been accumulated through the IEA Wind Task 36:

    - RE-Europe (2012 – 2014):
        - ✓ Nodal-aggregated capacities (uniform and proportional to wind energy potential), hourly
        - ✓ Single power curve
        - ✓ Not created for specific plant-level characteristics nor anticipated installations
    - NREL WIND Toolkit (2004 – 2007):
        - ✓ 2km gridded (126,000 U.S. sites), 5-10 min
        - ✓ Composite power curves created for 3 onshore average wind speed classes, 1 offshore class
        - ✓ Not created for specific plant-level characteristics nor anticipated installations

U.S. National Intra-Hour Wind Power Database

- Plant-specific turbine characteristics:
  - Existing U.S. Energy Information Administration (EIA) recorded power plants – 9 default power curves + 1 actual power curve
  - Planned on-shore, off-shore power plants – 9 default power curves

- Hourly meteorology from:
  - ERA5 (2000 – 2020), 1st Generation NREL WIND Toolkit (2004 – 2006), HRRR (2014 – 2020)

- 5-minute meteorology from:
  - ERA5 Super-resolved (2km), 2nd Generation NREL WIND Toolkit, 3rd Generation NREL WIND Toolkit

Wind Speed Class →

Wind Technology Class

A1	A2	A3
B1	B2	B3
C1	C2	C3

+ Actual Power Curve

Wind Power Plant Information Sources

Interconnect
- EIA 860

Balancing Authority
- EIA

Utility
- EIA

Plant
- EIA

Collector
- EIA
- USGS

Turbine
- USGS
- Turbine model data sheets

U.S. Wind Turbine Database

Database Release: April, 2022
Data Source: LBNL, USGS, ACP
Map Interface: USGS, Energy Program

The USWTDB provides onshore & offshore wind turbine locations in the United States, corresponding facility information, and turbine technical specifications. Watch our tutorial video.

The USWTDB contains **71,666** turbines with a total rated capacity of **134,261** MW (zoom in to an area to calculate regional statistics)
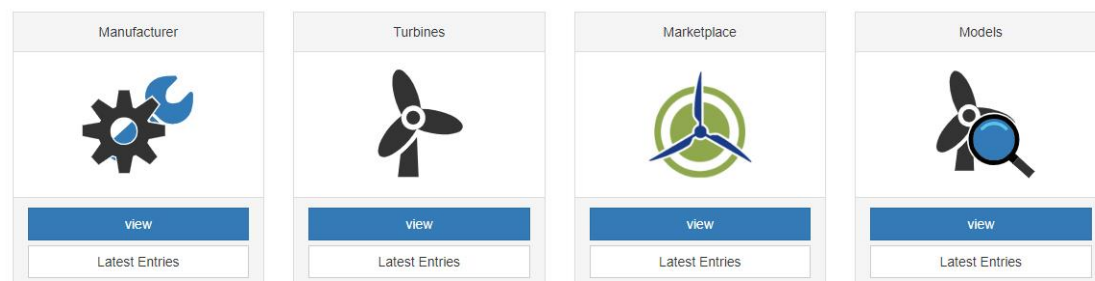
When zoomed out, display turbine data as:
Density Heatmap ⬤ Point Locations

Relative density of turbines

https://eerscmap.usgs.gov/uswtdb/

Welcome to wind-turbine-models.com

| Manufacturer | Turbines | Marketplace | Models |

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Wind generating asset data detail

Plant (EIA)

- EIA Plant Code
- Plant name
- Location:
  - Street address
  - County
  - Lat./Long.
- Technology (Prime Mover)
  - Offshore Wind (WS)
  - Onshore Wind (WT)
- Capacity
  - Nameplate capacity (MW)
  - Nameplate power factor
  - Summer capacity (MW)
  - Winter capacity (MW)
  - Minimum load (MW)
- Operational status
  - Status changes
- Grid voltage

Collector (EIA)

- EIA Generator ID
- Lat./Long. of collector/ PCC
- Technology (Prime Mover)
  - Offshore Wind (WS)
  - Onshore Wind (WT)
- Capacity
  - Nameplate capacity (MW)
  - Summer capacity (MW)
  - Winter capacity (MW)
- Number of turbines
- EIA Predominant Turbine Manufacturer
- EIA Predominant Turbine Model Number
- EIA Design Wind Speed (mph)
- EIA Wind Quality Class
- EIA Turbine Hub Height (Feet)
- Operational status
  - Status changes
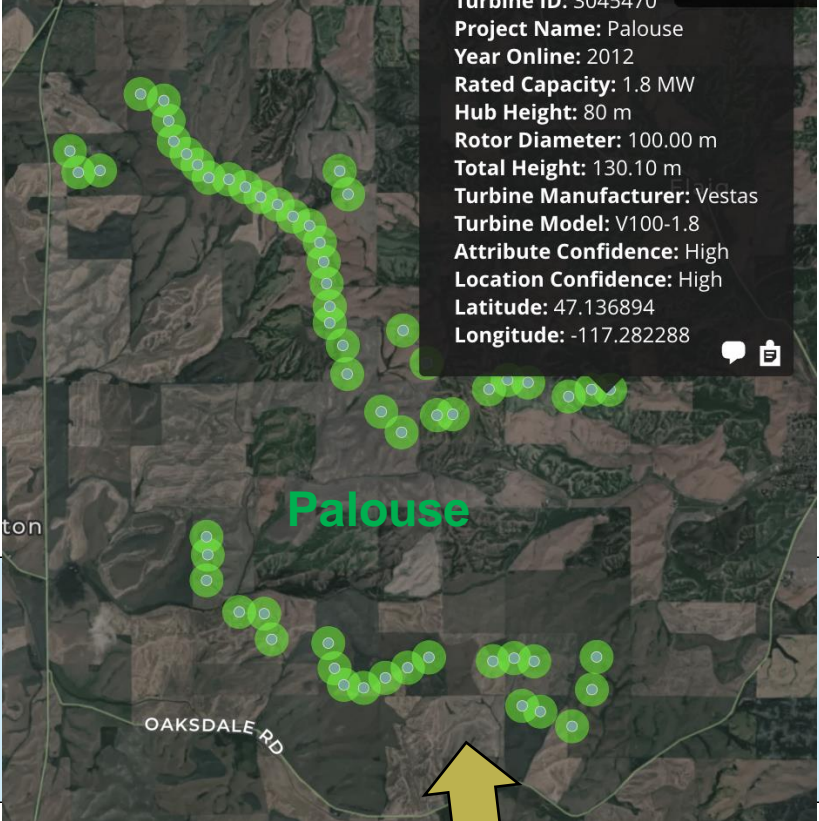
Turbine (USGS, Data sheets)

- USGS Turbine ID
- USGS Project name
- Lat./Long. of turbine
- Turbine Manufacturer
- Turbine Model
- Rated capacity (MW)
- Hub Height (m)
- Rotor Diameter (m)
- Swept area (m^2)
- Number of blades
- Total Height (m)
- Cut-in wind speed (m/s)
- Rated wind speed (m/s)
- Cut-out wind speed (m/s)
- Wind Class (IEC)
- Power Curve (kw) (for a range of 0-25 m/s)
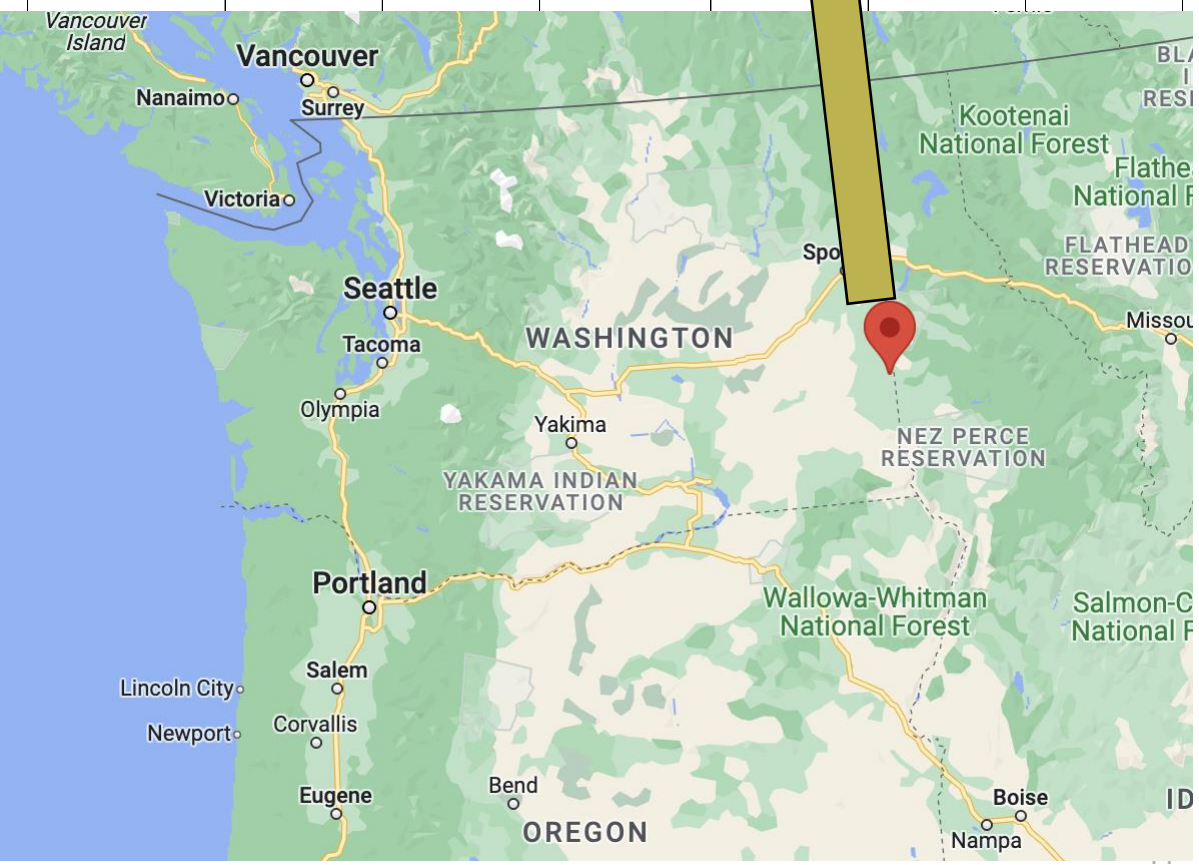
Palouse wind plant example EIA 860 Plant Table data

Pacific Northwest NATIONAL LABORATORY

Turbine ID: 3045470
Project Name: Palouse
Year Online: 2012
Rated Capacity: 1.8 MW
Hub Height: 80 m
Rotor Diameter: 100.00 m
Total Height: 130.10 m
Turbine Manufacturer: Vestas
Turbine Model: V100-1.8
Attribute Confidence: High
Location Confidence: High
Latitude: 47.136894
Longitude: -117.282288

Palouse

2019 Form EIA-860 Data - Schedule 2, 'Plant Data'

Utility ID	Utility Name	Plant Code	Plant Name	Street Address	City	State	Zip	County	Latitude	Longitude	NERC Region
60453	Novatus Energy	57530	Palouse	1171 Baird Road	Oakesdale	WA	99170	Whitman	47.15583		

Sector	Sector Name	FERC Cogeneration Status	FERC Cogeneration Docket Number	FERC Small Power Producer Status	FERC Small Power Producer Docket Number	FERC Exempt Wholesale Generator Status	Exempt Wholesale Generator Docket Number	Transmission or Distribution System Owner	Transmission or Distribution System Owner ID	
2	IPP Non-CHP	N		N		Y	12-45	Avista Corp	20169	

Palouse wind plant example EIA 860 Generator Table data

2019 Form EIA-860 Data - Schedule 3, 'Generator Data' (Operable Units Only)

Utility ID	Utility Name	Plant Code	Plant Name	State	County	Generator ID	Technology	Prime Mover	Unit Code	Ownership	Duct Burners	Can Bypass Heat Recovery Steam Generator?	Nameplate Capacity (MW)	Nameplate Power Factor	Summer Capacity (MW)	Winter Capacity (MW)
60453	Novatus Energy	57530	Palouse	WA	Whitman	1	Onshore Wind Turbine	WT		S	X	X	105.3		105.3	105.3

Minimum Load (MW)	Uprate or Derate Completed During Year	Month Uprate or Derate Completed	Year Uprate or Derate Completed	Status	Synchronized to Transmission Grid	Operating Month	Operating Year	Planned Retirement Month	Planned Retirement Year	Associated with Combined Heat and Power System	Sector Name	Sector	Topping or Bottoming	Energy Source 1	Solid Fuel Gasification System?	Carbon Capture Technology?	Turbines or Hydrokinetic Buoys	Multiple Fuels?
0.0	N			OP	X	12	2012			N	IPP Non-CHP	2	X	WND	N	N	58	N

- This table contains fields for any type of generating asset – the Wind Table contains additional fields specific to wind generating assets
- The plant is listed as a single "generator" of 58 turbines. Some wind plants may be specified as multiple generators.

Palouse wind plant example EIA 860 Wind Table data

2019 Form EIA-860 Data - Schedule 3, 'Wind Technology Data' (Operable Units Only)

Utility ID	Utility Name	Plant Code	Plant Name	State	County	Generator ID	Status	Technology	Prime Mover	Sector Name	Sector
60453	Novatus Energy	57530	Palouse	WA	Whitman	1	OP	Onshore Wind Turbine	WT	IPP Non-CHP	2

Nameplate Capacity (MW)	Summer Capacity (MW)	Winter Capacity (MW)	Operating Month	Operating Year	Number of Turbines	Predominant Turbine Manufacturer	Predominant Turbine Model Number	Design Wind Speed (mph)	Wind Quality Class	Turbine Hub Height (Feet)
105.3	105.3	105.3	12	2012	58	Vestas	V100-1.8	17.0	3	262.0

- Information for each turbine is not given, only characteristics of the predominant turbine type

The U.S. Wind Turbine Database (USWTDB)

- Used for Turbine Layout (The creation of this database was jointly funded by the U.S. Department of Energy (DOE) Wind Energy Technologies Office (WETO) via the Lawrence Berkeley National Laboratory (LBNL) Electricity Markets and Policy Group, the U.S. Geological Survey (USGS) Energy Resources Program, and the American Clean Power Association (ACP).
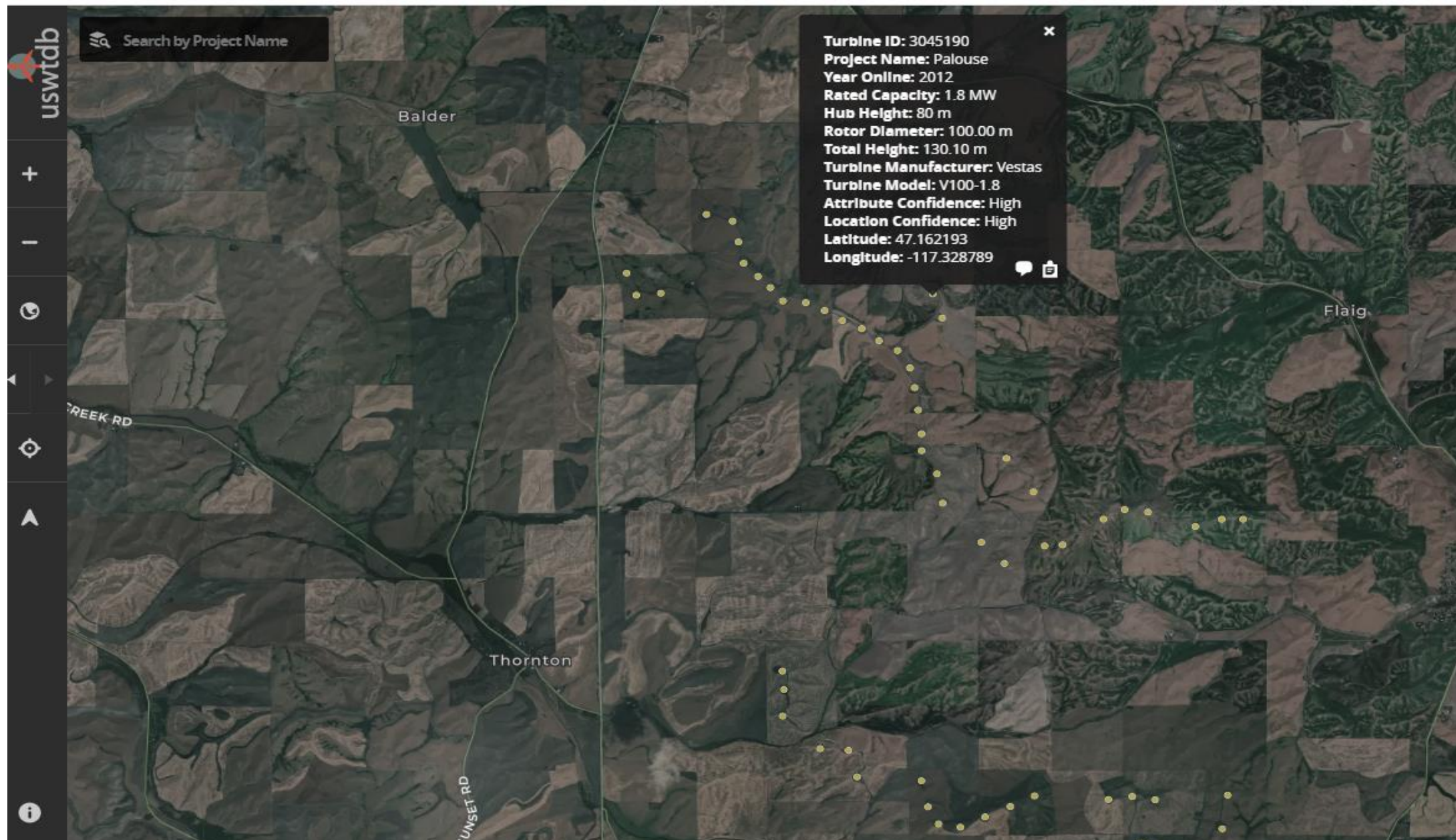
Turbine Type Database
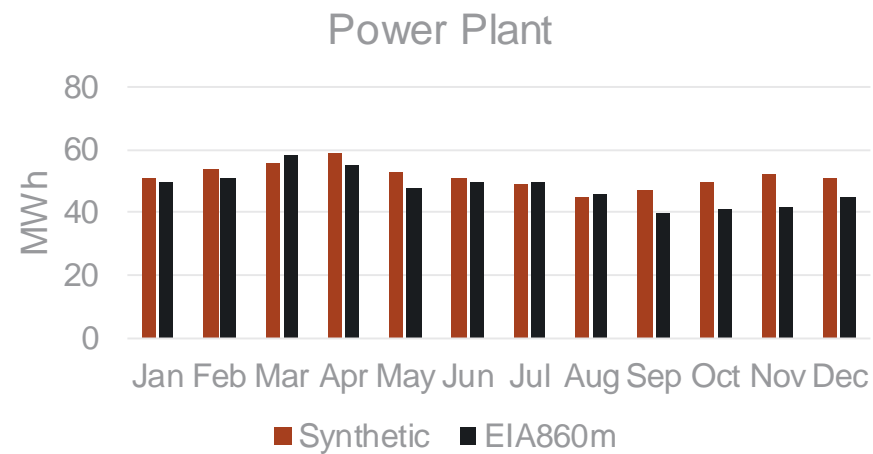
- Used for Wind Turbine Power Curve
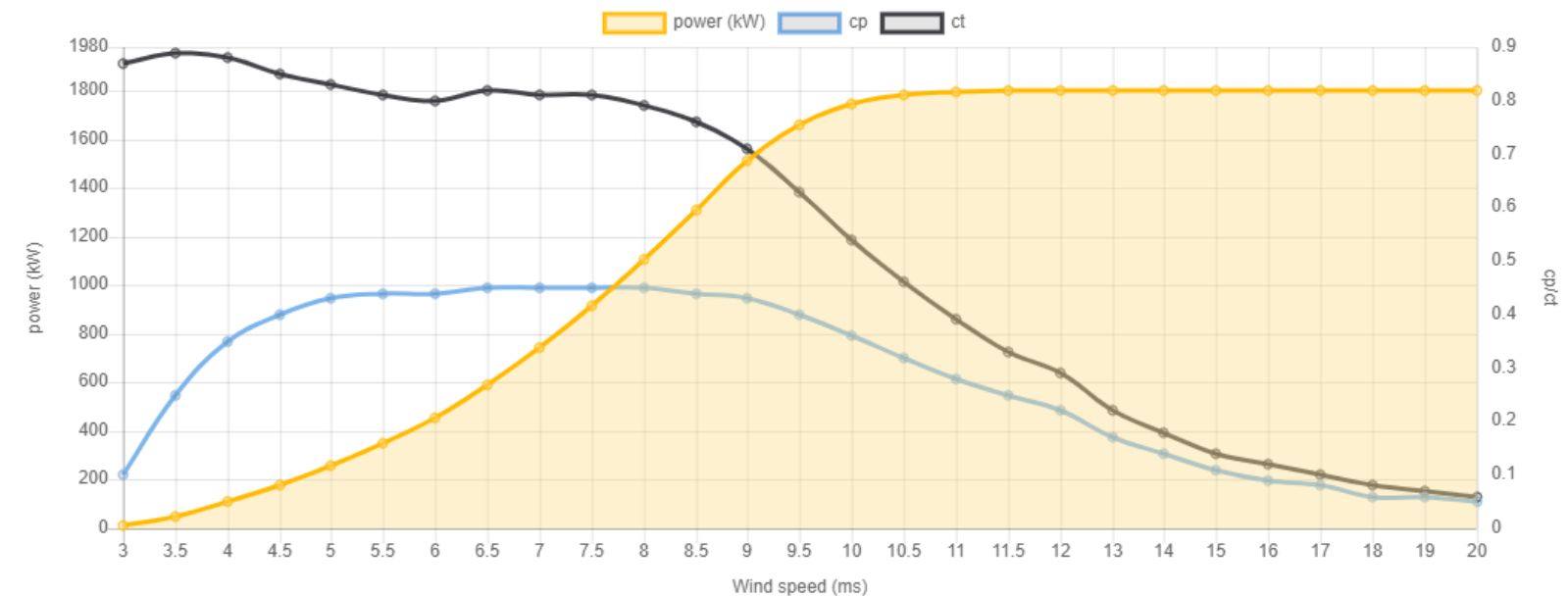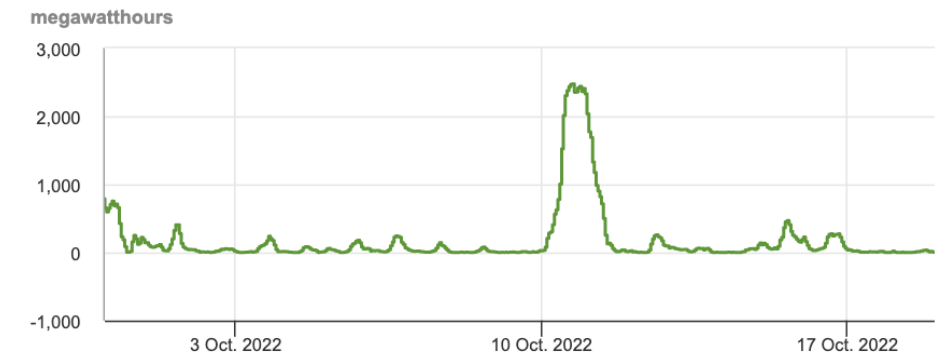
Wind Power Validation

EIA860m: Monthly MWh produced at the power plant
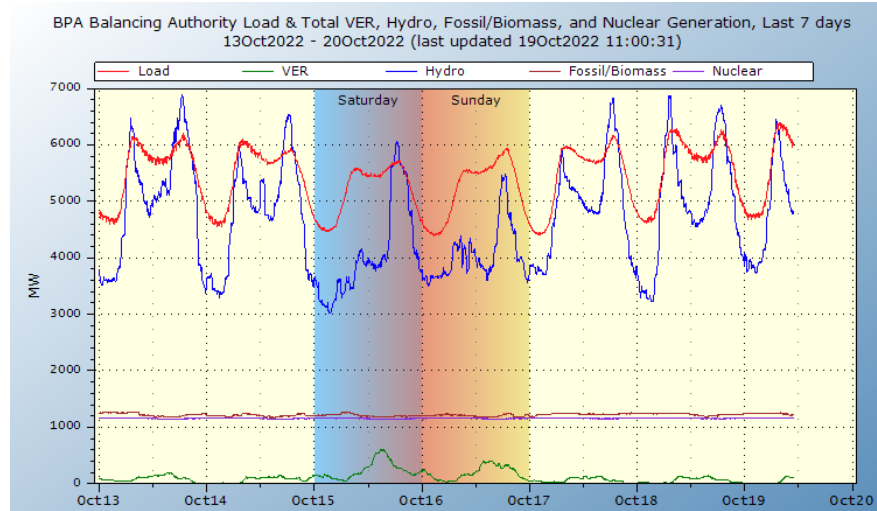

Power Plant

BPA 2022

EIA930: Hourly MW produced at the balancing authority

Bonneville Power Administration (BPAT) electricity generation by energy source 9/30/2022 – 10/18/2022, Pacific Time

megawatthours

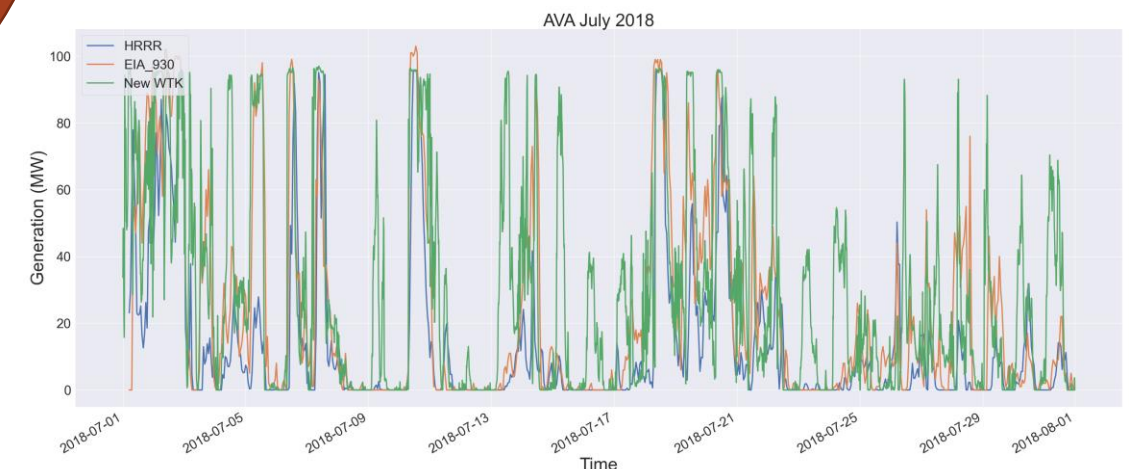BPA, CAISO: 5 minute system production at the balancing authority
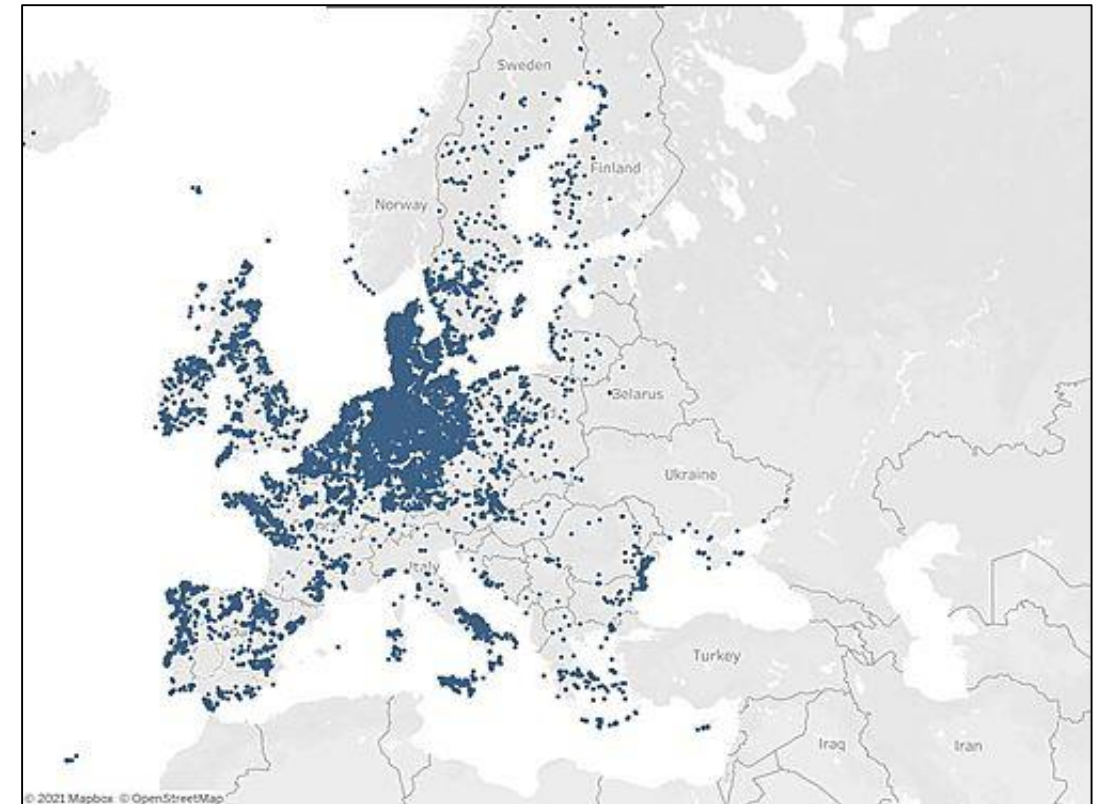

Different aggregation levels

EIA930: Hourly MW produced at the balancing authority, *only one power plant*

AVA 2018

Extending the Wind Power Database

- Meteorology
  - ERA5 hourly
  - Super-resolved* to 5 min, 2km

- Power plant characteristics inventory
  - Number of turbines
  - Predominant turbine manufacturer
  - (Power curve – wind-turbine-models.com)
  - Hub height, rotor diameter, rated wind speed
  - Plant layout

- Plant-/region-level historical production for validation
  - ENTSOE-e,
    - ✓ 30min, hourly, since 2011
    - ✓ Inconsistent availability
  - Open source wind/wind-power datasets (Effenberger 2022):
    - ✓ For use in comparison against forecasts
    - ✓ Inconsistent availability

https://windeurope.org/intelligence-platform/interactive-data-and-maps/

*Super-resolution developed at NREL:
https://doi.org/10.1073/pnas.1918964117

ENTSOE-e: https://transparency.entsoe.eu

Effenberger 2022: https://doi.org/10.1002/we.2766

Thank you

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