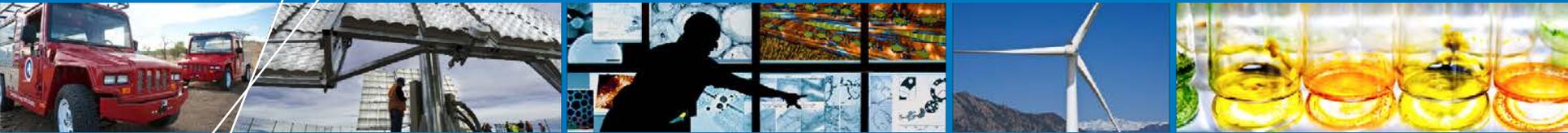


# Review of the dWindDS Model Initial Results



**Ian Baring-Gould**

**Michael Gleason**

**Robert Preus**

**Ben Sigrin**

**Small Wind Conference**

**June 17, 2015**

**Stevens Point, Wisconsin**

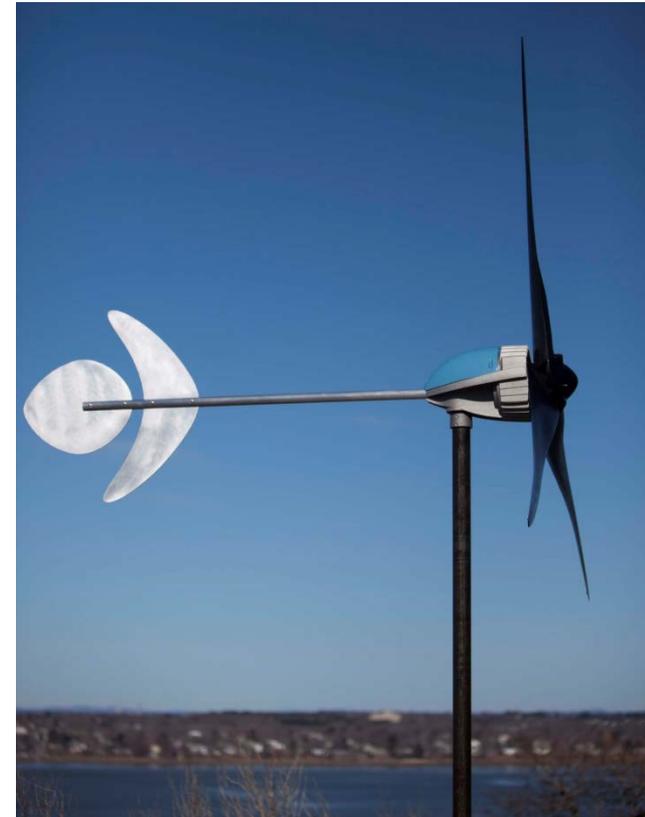
**NREL/PR-5000-64517**

# What Is This Model?

- **This model simulates consumer purchase decisions based on economics and consumer behavior**
- **It models large populations of consumers on a statistical basis applied to high resolution wind data**
- **It is not a siting tool and covers only distributed wind (DW) associated with a customer load**
  - Community wind is not covered
  - Wind gardens are not covered
  - Of 842 MW of DW 45% is behind the meter
- **Permitting and zoning barriers are not directly modeled**
  - Population density is used as a proxy for siting exclusions and height restrictions

# Purpose/Background

- **Simulate DW market growth through 2050**
  - Simulates customer purchase decision
- **Explore market impacts of**
  - Price changes
  - R&D improvements
  - Available incentives and Net Energy Metering policies
  - Electricity rates and rate structure
  - Customer behavior
- **Create a strategy for the future of DW**



*Photo by Pika Energy, Inc., NREL 31729*

# Status

Work to date has been focused on model verification and defining the Base Case, not on scenario analysis. **We feel the model is doing what we expect** but we are still working to understand how changes in the input data are reflected in model output.

Recent improvements:

- Incorporated utility rate structures and expanded siting considerations
- Updated financing assumptions based on industry solicited input
- Aligned payback period and cash flow calculations with solar model
- Updated wind turbine performance curves
- Detailed overview of specific model components underway
- Identified initial sensitivities simulations
  - Cost, financing, performance, and parcel size limits
- Completed **initial** business as usual and sensitivity studies



# Draft Reference Case Assessment and Results



*Photo by Evan Osler, NREL 14660*

# Preliminary Results

- **Draft results primarily for model validation**
- **Reference case not final**
  - Final draft in July followed by industry review
- **Primary open issues for reference case:**
  - Future installed cost (needs detailed industry input)
  - Future performance (ready for industry review)
  - Current and future maintenance cost (needs more industry input)

# Reference Case Assumptions

## Contiguous U.S. for Residential, Commercial, and Industrial markets

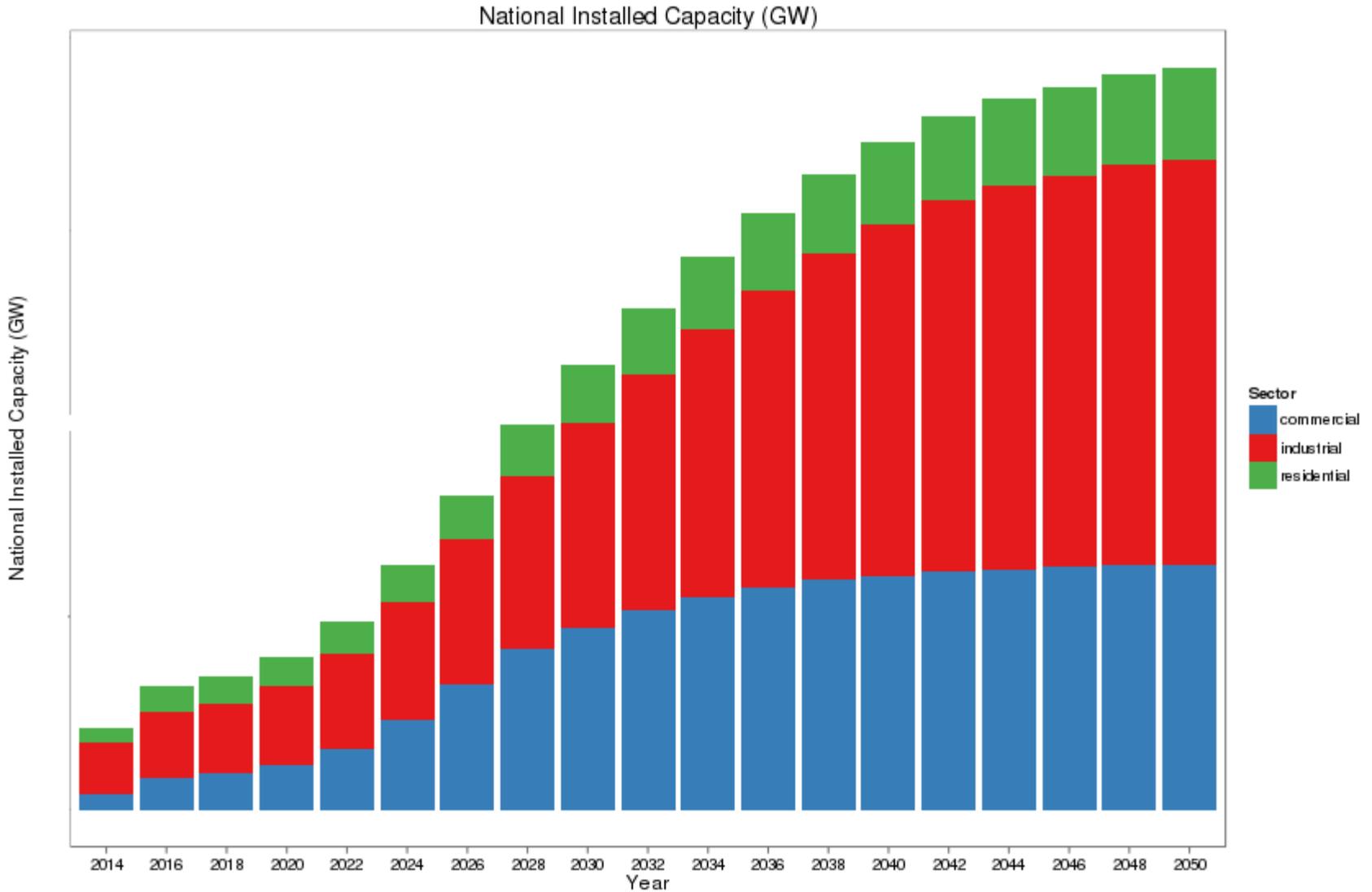
- Installed costs: Adapted from Distributed Wind Market Report, other PNNL data, and detailed feedback from industry partners
- Load Growth: AEO2013 Reference Case
- Rate Structures: Complex rates based on URDB
- Rate escalations: AEO2014
- Net Metering: Current policy – incorporated in most states with generally low limits
- Incentives: Based on 2013 DSIRE data; **ITC expires in 2016**
- Carbon Price: None
- Siting: High resolution tree cover, population density, and lot size data incorporated
- Performance Improvement: Projected BAU improvements, being vetted with industry
- Finance: Fairly liberal, based on solar base assumptions; Host-Owned & Third Party Ownership allowed

## Notes:

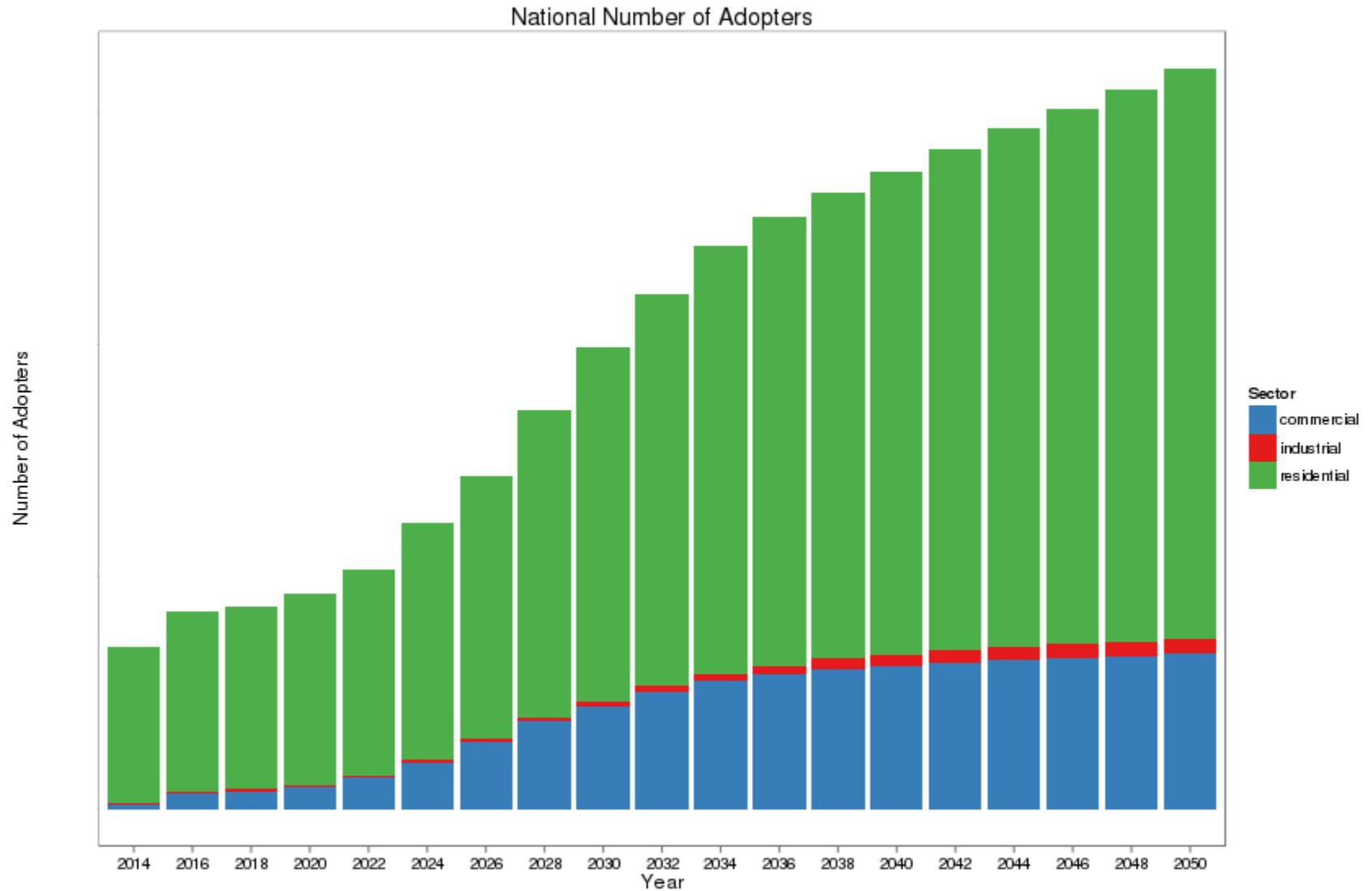
Utility rate escalations do not include EPA Climate Plan impact

Reference model information for Alaska and Hawaii have not been developed

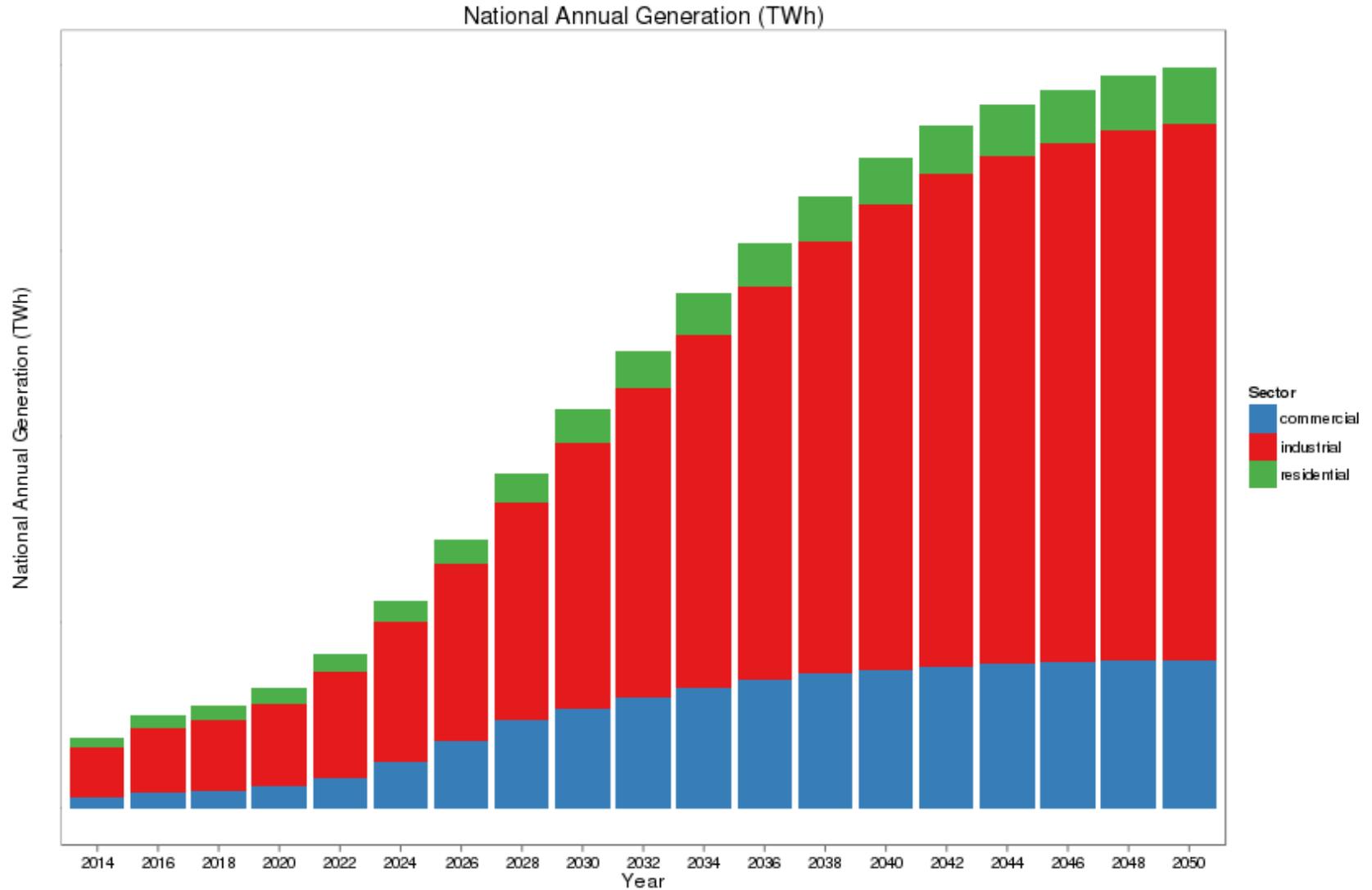
# Installed Capacity (GW)



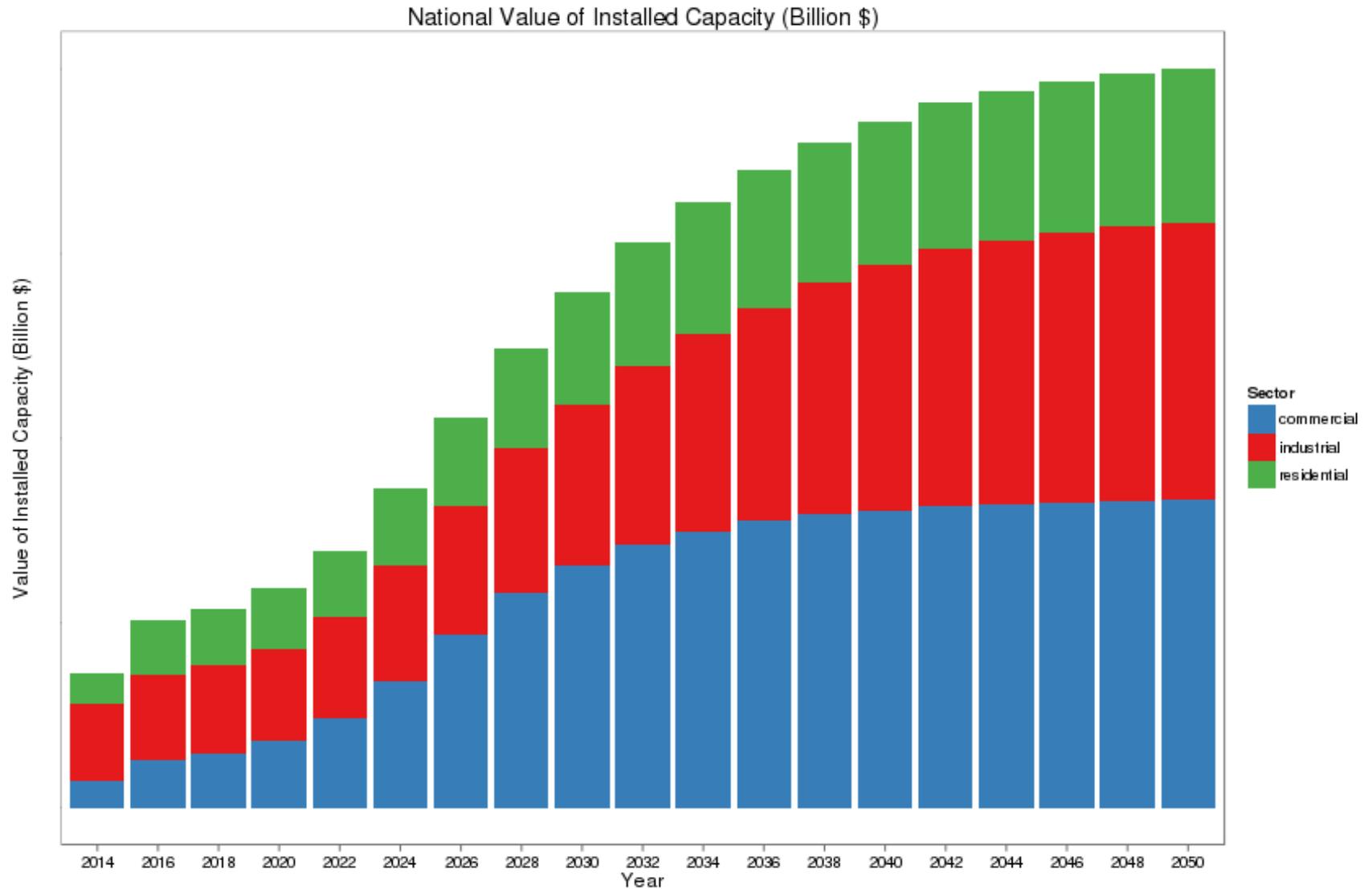
# Number of Systems Installed (Adopters)



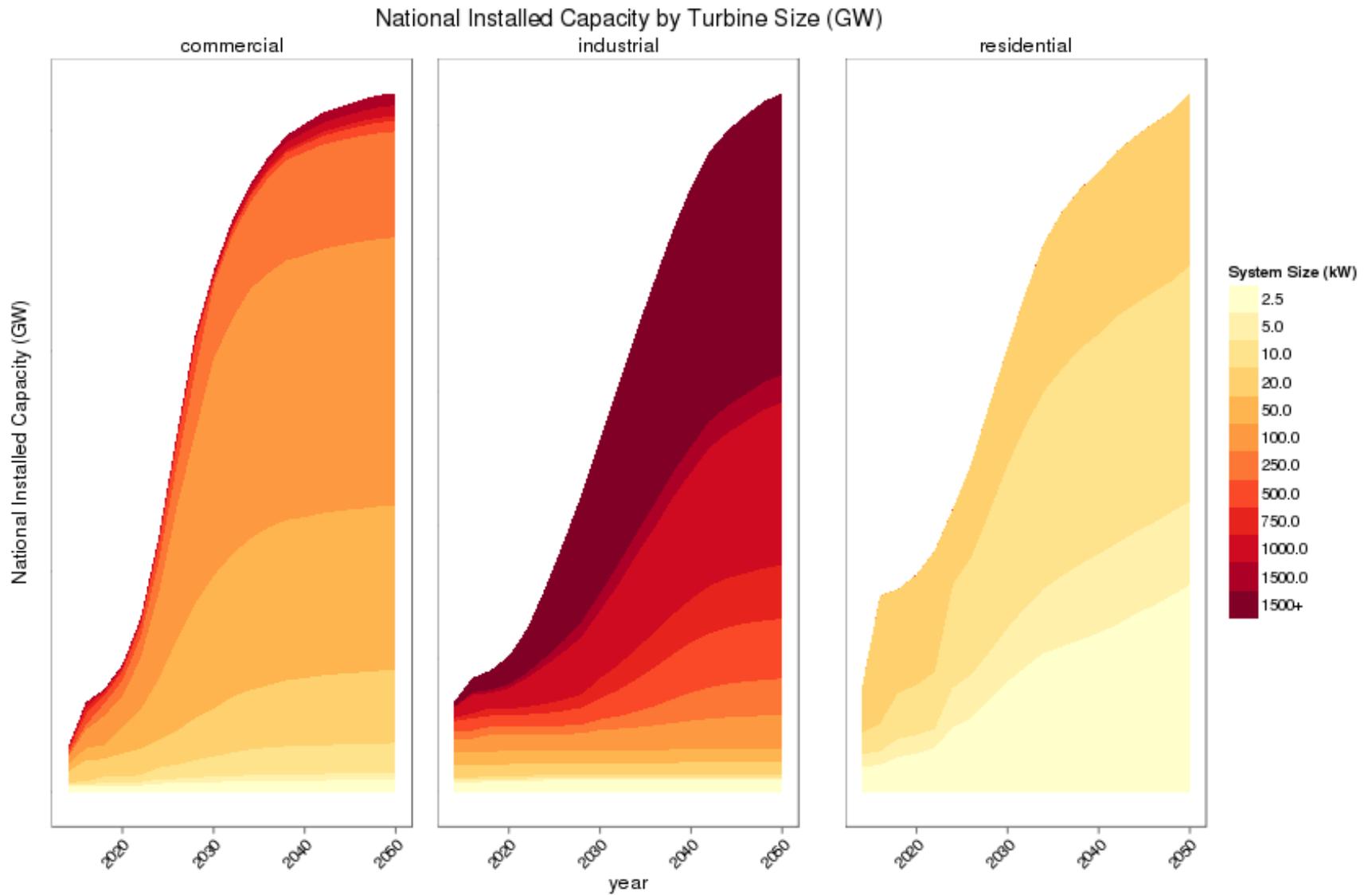
# Annual Generation (TWh)



# Market Value (Billion \$)

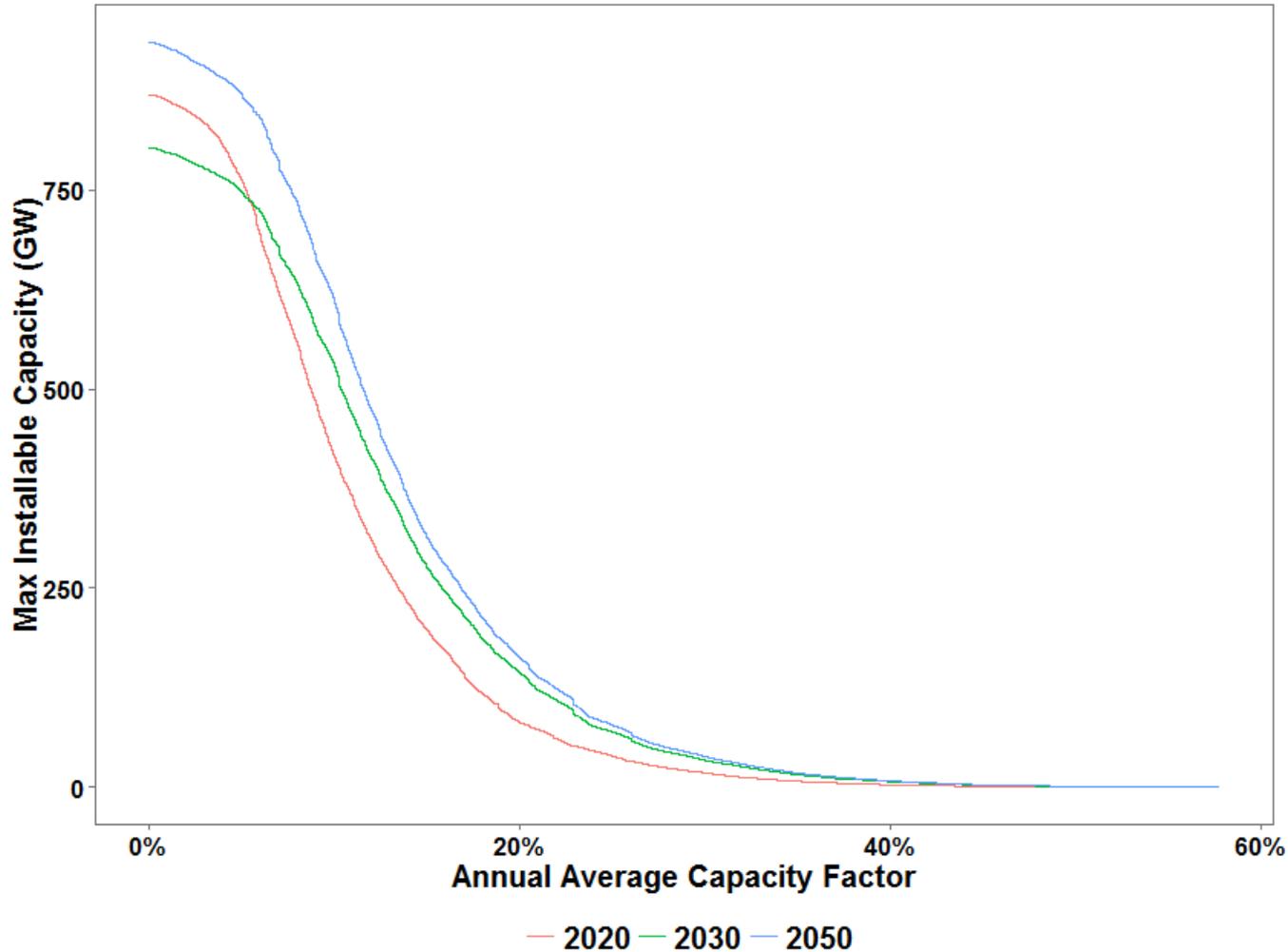


# Cumulative Installed Capacity by System Size



# Base Case: Technology Limits

## Maximum capacity given every customer site adopted



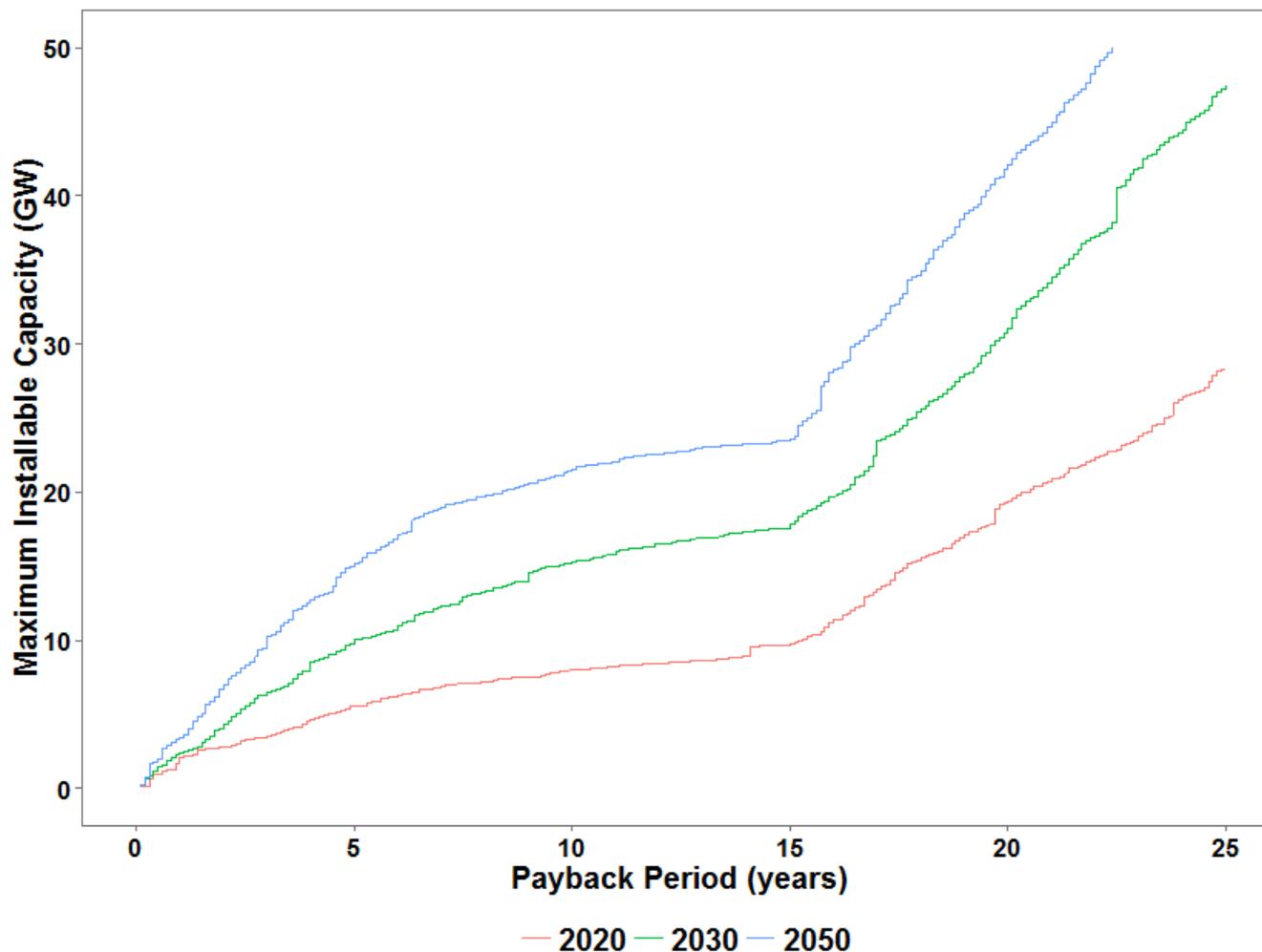
Provides a reference for the total potential market based on available resource and base case technology assumptions.

### Points of Note:

- Large market potential, but most below 20% CF
- As technology improves, more area is opened to potential development

# Base Case: Financial Limits

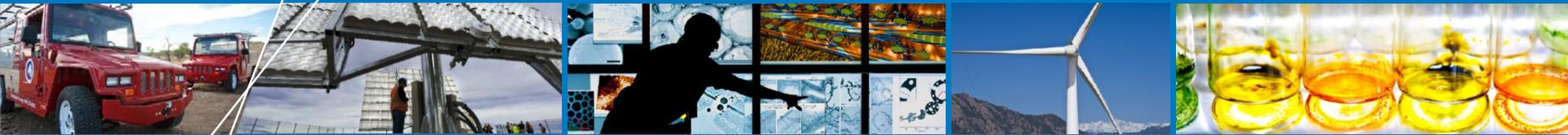
## Maximum capacity given every customer site adopted



Provides a reference for the total potential market based on base case payback calculation

### Points of Note:

- Given current power prices, most don't achieve short-term payback
- As power costs increase over time, more economically viable wind is identified



# What's Next

# What's Next

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- **Define reference case**
- **Conduct sensitivity analysis**
- **Define scenarios**
- **Run scenarios**
- **Review with industry**
- **Develop DW strategy with industry and DOE**

# What We Need From You (manufacturers)

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- **Help in forecasting future costs**
- **Validation on future performance**
- **Validation for base or reference case**

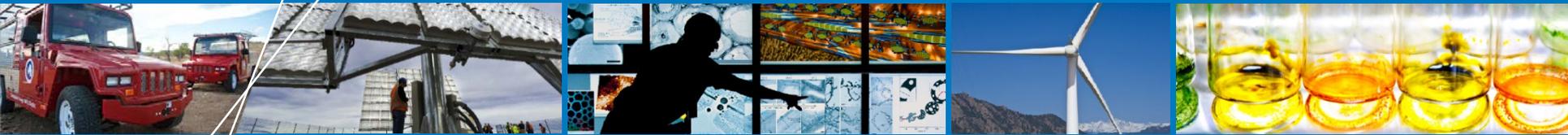
# Thank You

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The authors are solely responsible for any omissions or errors contained herein.

# Questions



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# Summary of data sets used

Description	Source	Spatial Resolution
<b>Modeled Turbine Annual Energy Production</b>	AWS TruePower	200 m by 200 m
<b>Potential Customer Locations (Land Use Mask)</b>	HSIP, ORNL	200 m by 200 m
<b>Siting Criteria (Turbine Height Restrictions)</b>	Derived from nighttime population densities (HSIP) and landscan masks (ORNL)	200 m by 200 m
<b>Electricity Rates</b>	NREL Utility Rate Database (USDB)	Utility Service Territories
<b>Incentives</b>	DSIRE database (or manually input)	Variable: Electric Service Territories, Counties, State, Nation
<b>Net Metering Availability</b>	DSIRE database & IREC (or manually input)	State
<b>Electrical load/consumption</b>	Ventyx Velocity Suite used to constrain county-level load & number of households; RECS/CBECS (EIA) used to generate variations in household-level consumption	County
<b>Load Growth Projections</b>	EIA 2014	Census division (multi-state regions)
<b>Electricity Rate Projections (EIA 2014a or User Input)</b>	EIA 2014 (or manually input)	Nation
<b>Financing Parameters (User Input)</b>	NREL (or manually input)	Nation
<b>Turbine Cost Projections (User Input)</b>	NREL (or manually input)	Nation
<b>Wind Performance Improvements</b>	NREL (or manually input)	Nation