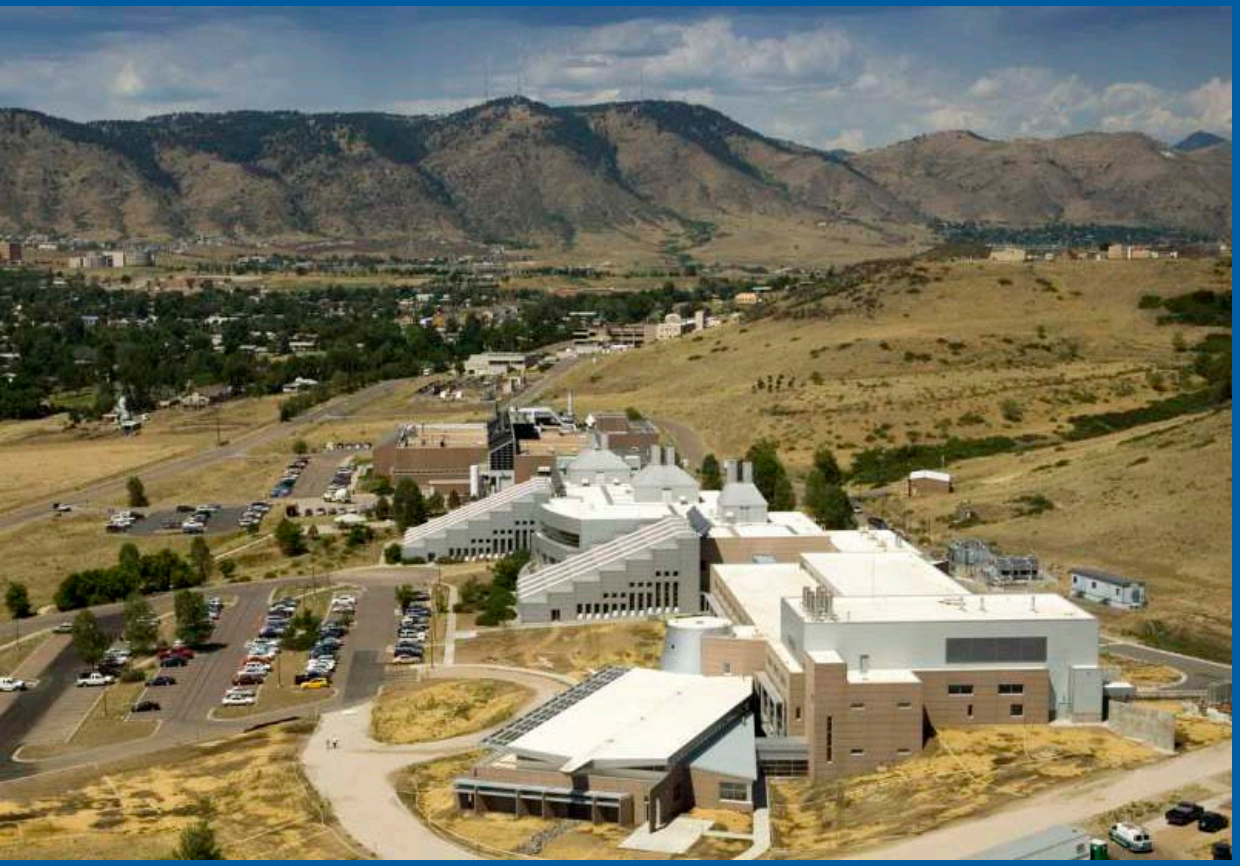
National Renewable Energy Laboratory
Innovation for Our Energy Future

Insights and Opportunities: Technologies, Policies, and Markets for Clean Energy Solutions



NREL Industry Growth Forum

Dr. Douglas J. Arent
Director, Analysis Center

November 2009
Denver, CO

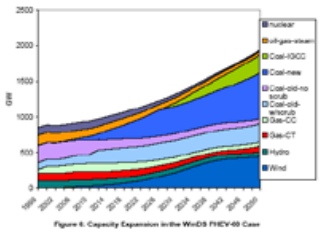
NREL/PR-6A2-47122

Strategic Energy Analysis

Integrated technical and economic analyses that advance the understanding of the value of technology in the context of dynamic global, national, and local markets, policies, energy resources and loads, and infrastructure.

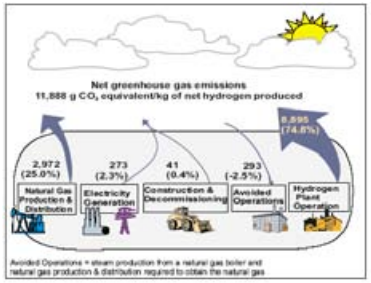
Energy-Economic Market Characterization

Analyze benefits and impacts of programs, portfolios, and policy options



System

Analyze system performance and technology interfaces in the context of the overall system



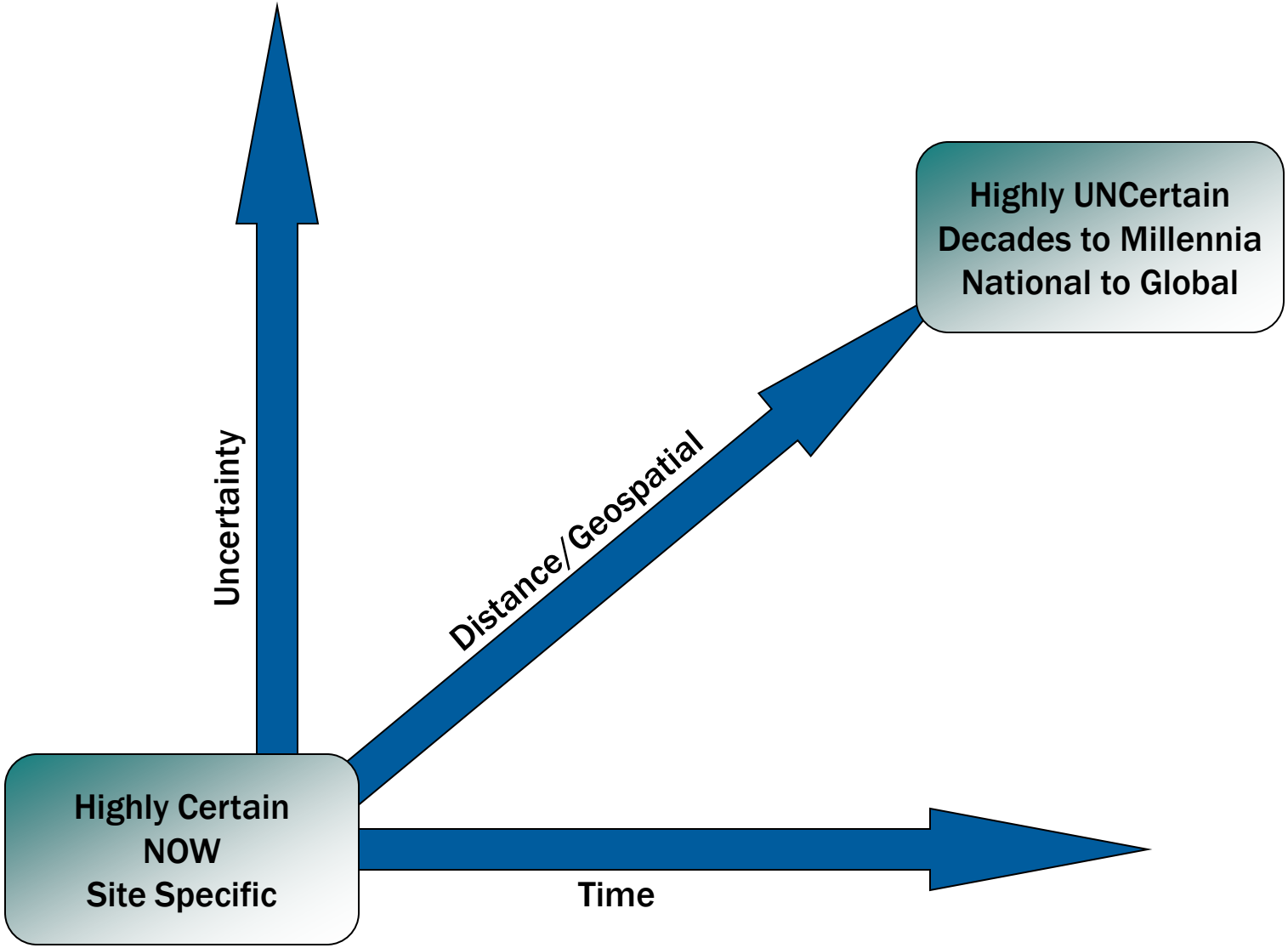
Technology/Component

Analyze technology and component performance, cost, and other attributes

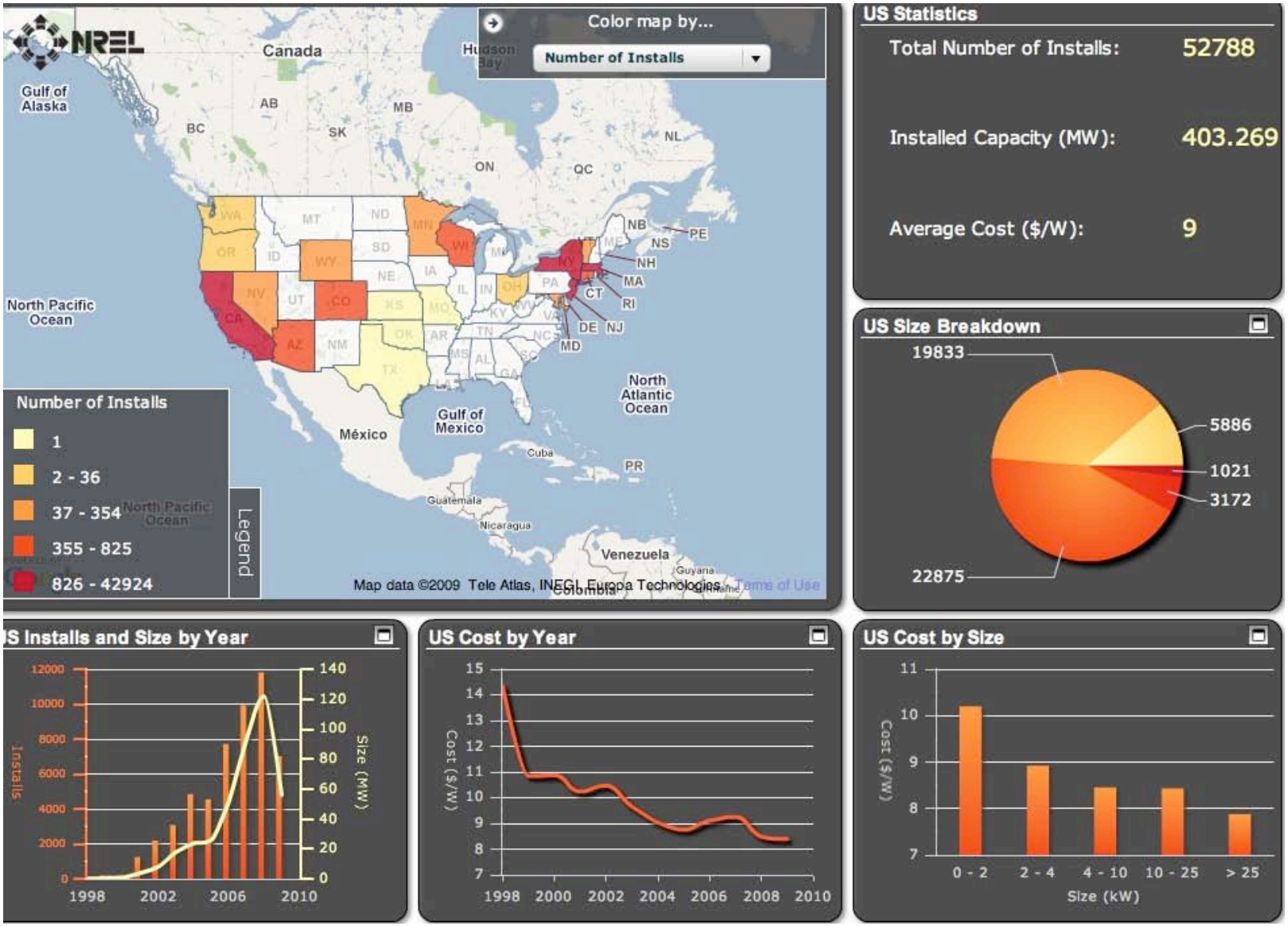
Resource

Assess resource availability and characteristics

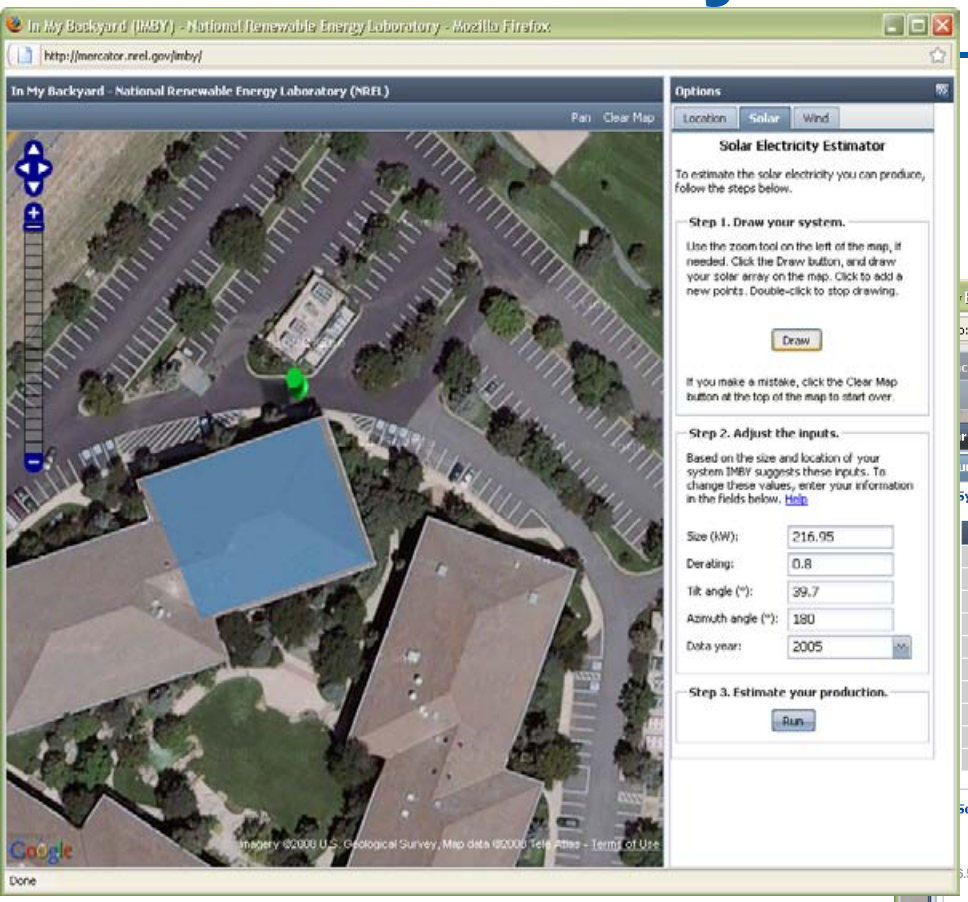
Driving Innovation In Energy Analysis



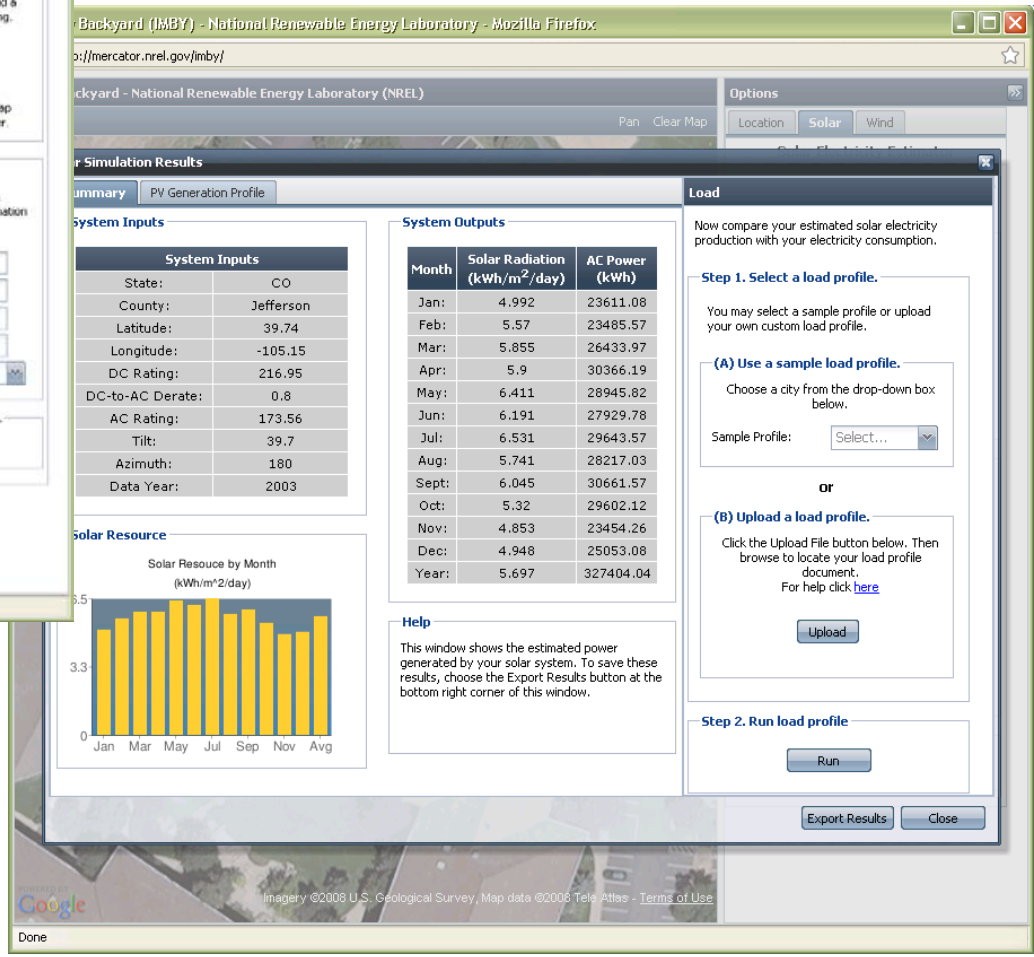
OpenPV – PV Market Information



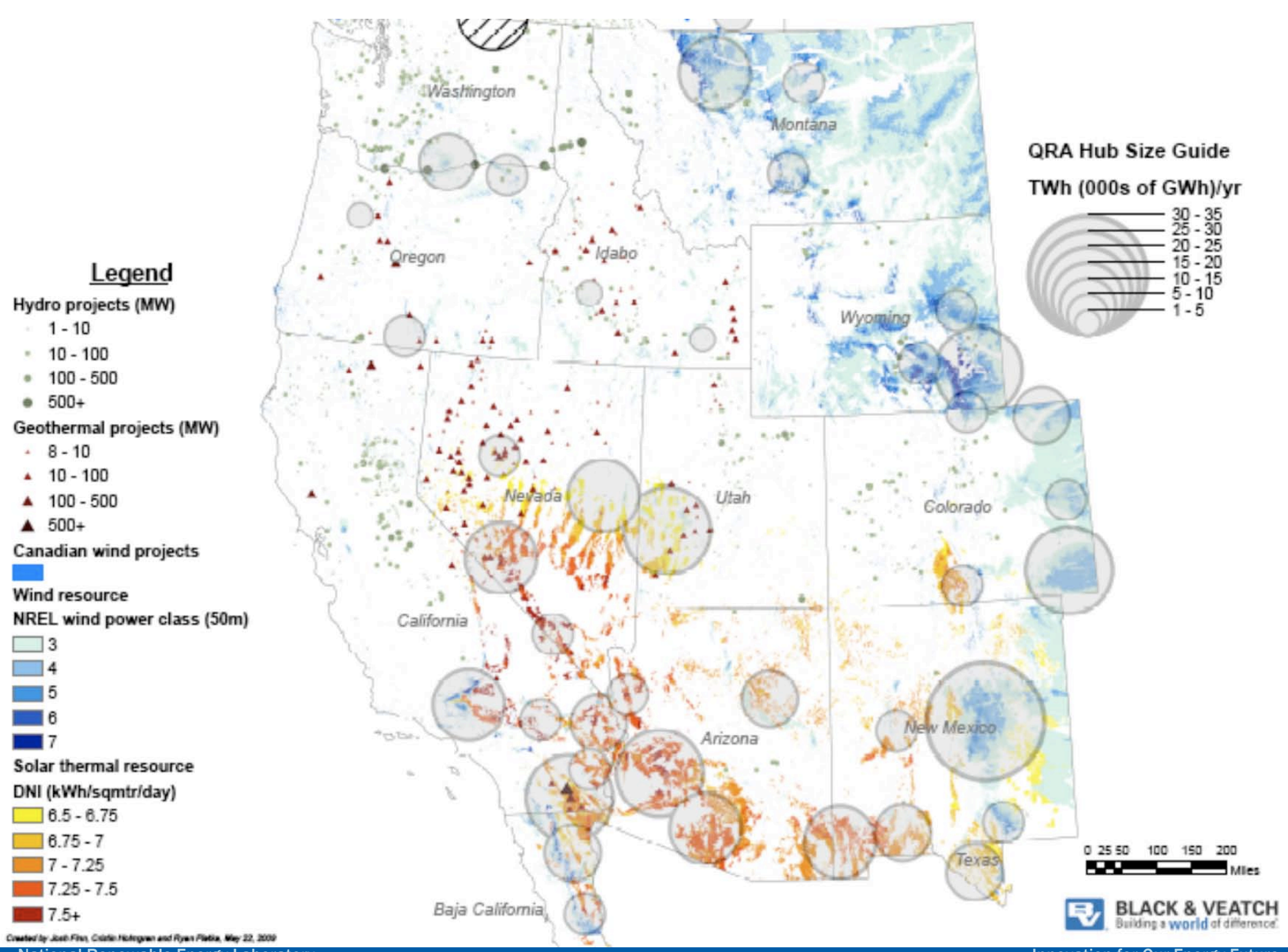
IMBY – In My Back Yard



Rooftop PV or Small Wind System
For Feasibility Analysis



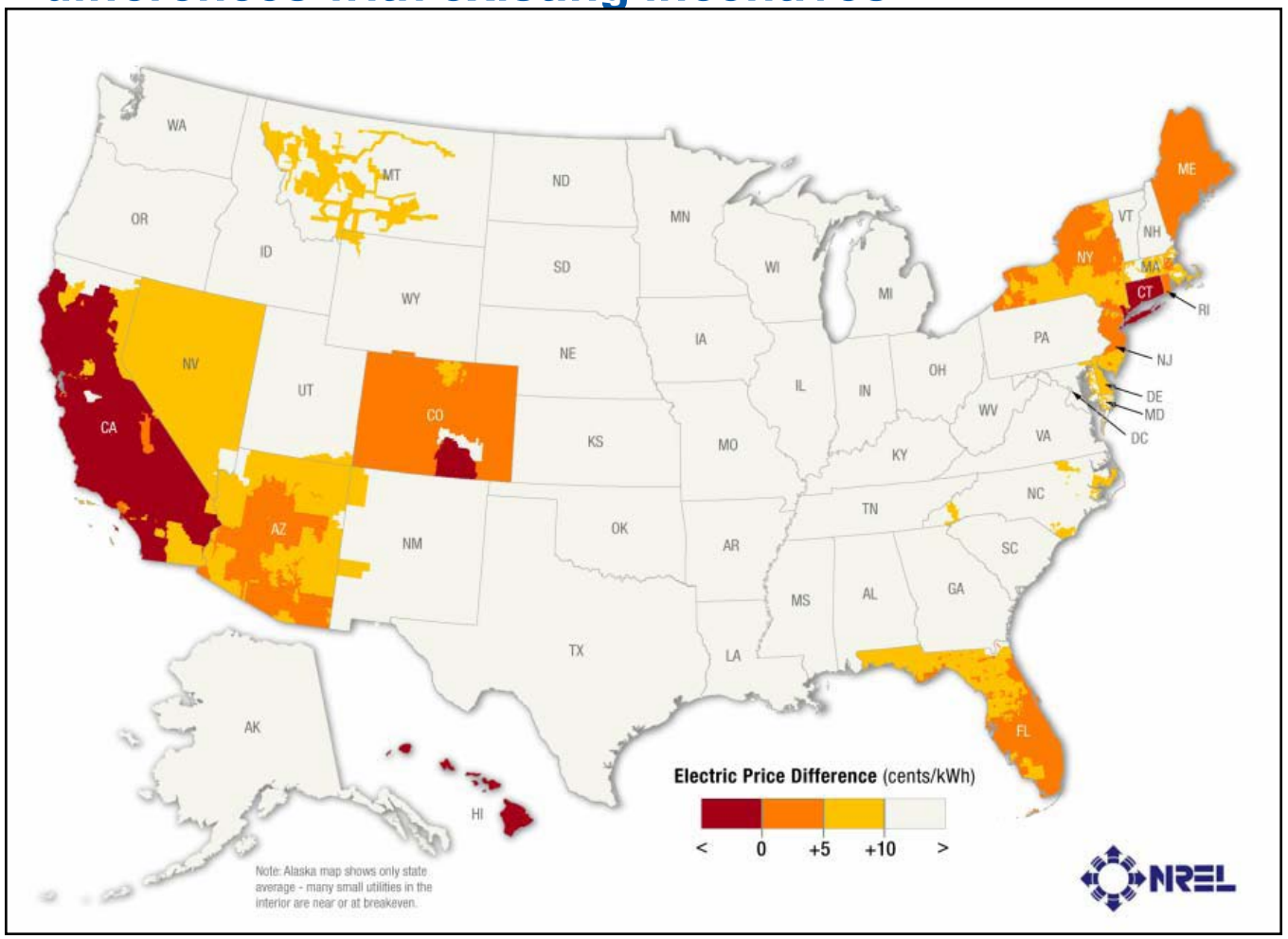
Segmentation and Geospatial Insights


Legend
Hydro projects (MW)
1 - 10
10 - 100
100 - 500
500+
Geothermal projects (MW)
8 - 10
10 - 100
100 - 500
500+
Canadian wind projects
Wind resource
NREL wind power class (50m)
3
4
5
6
7
Solar thermal resource
DNI (kWh/sqmtr/day)
6.5 - 6.75
6.75 - 7
7 - 7.25
7.25 - 7.5
7.5+
Created by Josh Flor, Cristin Holmgren and Ryan Fiebig, May 22, 2009
Washington
Montana
Oregon
Idaho
Wyoming
Nevada
Utah
Colorado
California
Arizona
New Mexico
Texas
Baja California
QRA Hub Size Guide
TWh (000s of GWh)/yr
30 - 35
25 - 30
20 - 25
15 - 20
10 - 15
5 - 10
1 - 5
0 25 50 100 150 200
Miles
BLACK & VEATCH
Building a world of difference.

Policy analysis example: PV grid-parity analysis

- Analysis for 1000 largest utilities in the U.S.
- Currently PV is only attractive where there is a combination of high electricity prices and incentives.

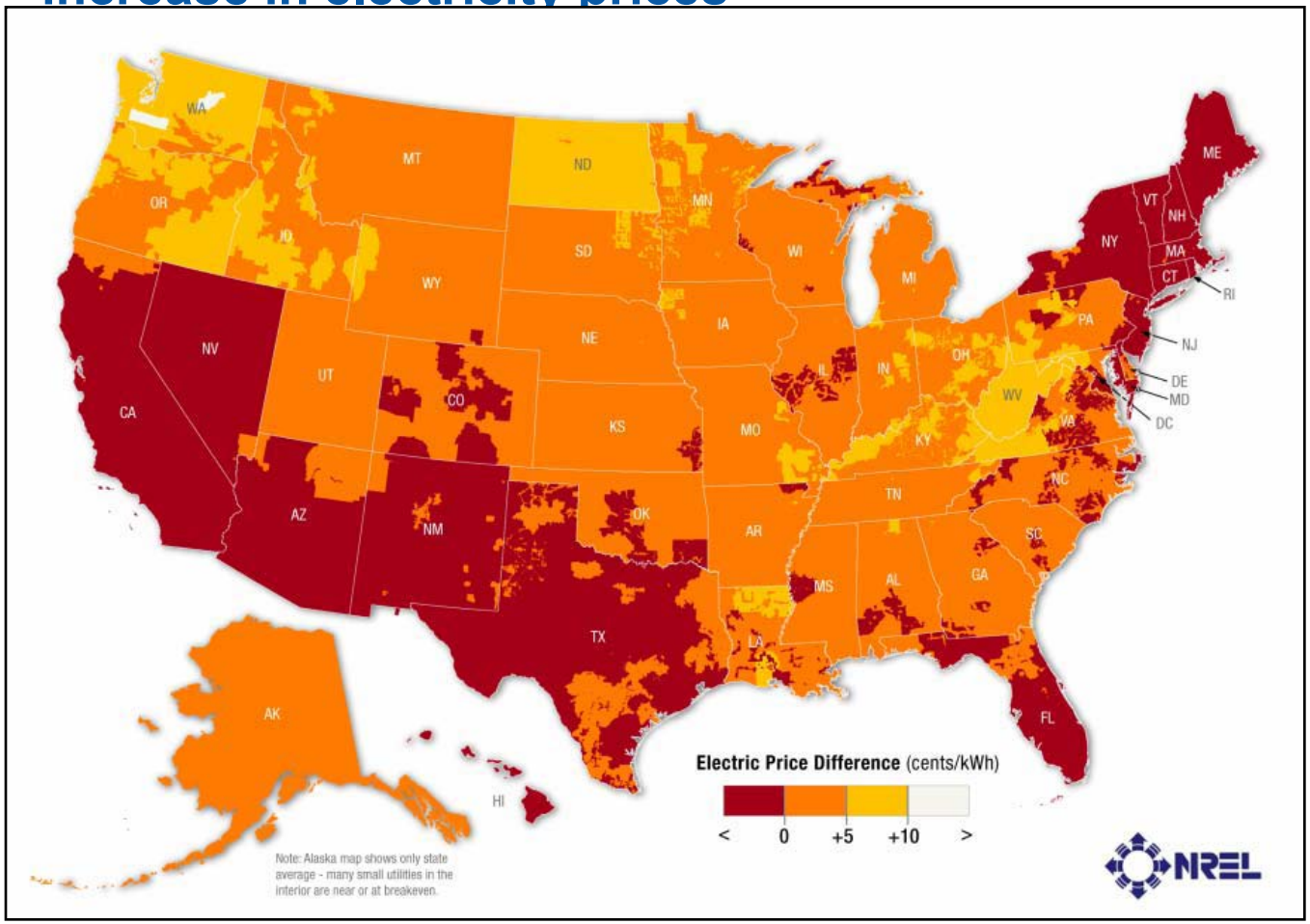
2007 residential PV and electricity price differences with existing incentives



Policy analysis example: PV grid-parity analysis, 2015

- Attractive in about 250 of 1,000 largest utilities, which provide ~37% of U.S. residential electricity sales.
- 85% of sales (in nearly 870 utilities) are projected to have a price difference of less than 5 ¢/kWh.

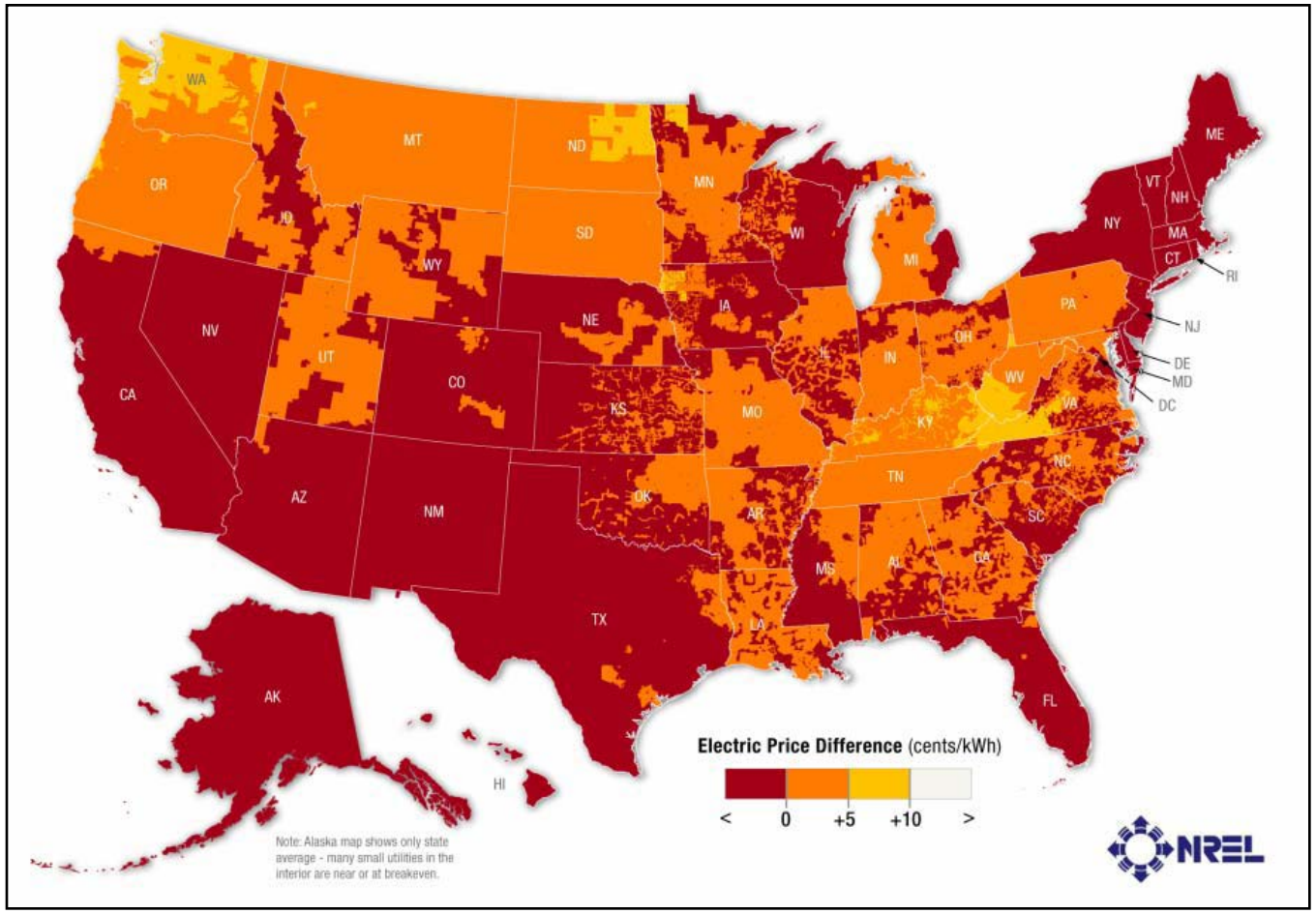
2015 residential without incentives and moderate increase in electricity prices



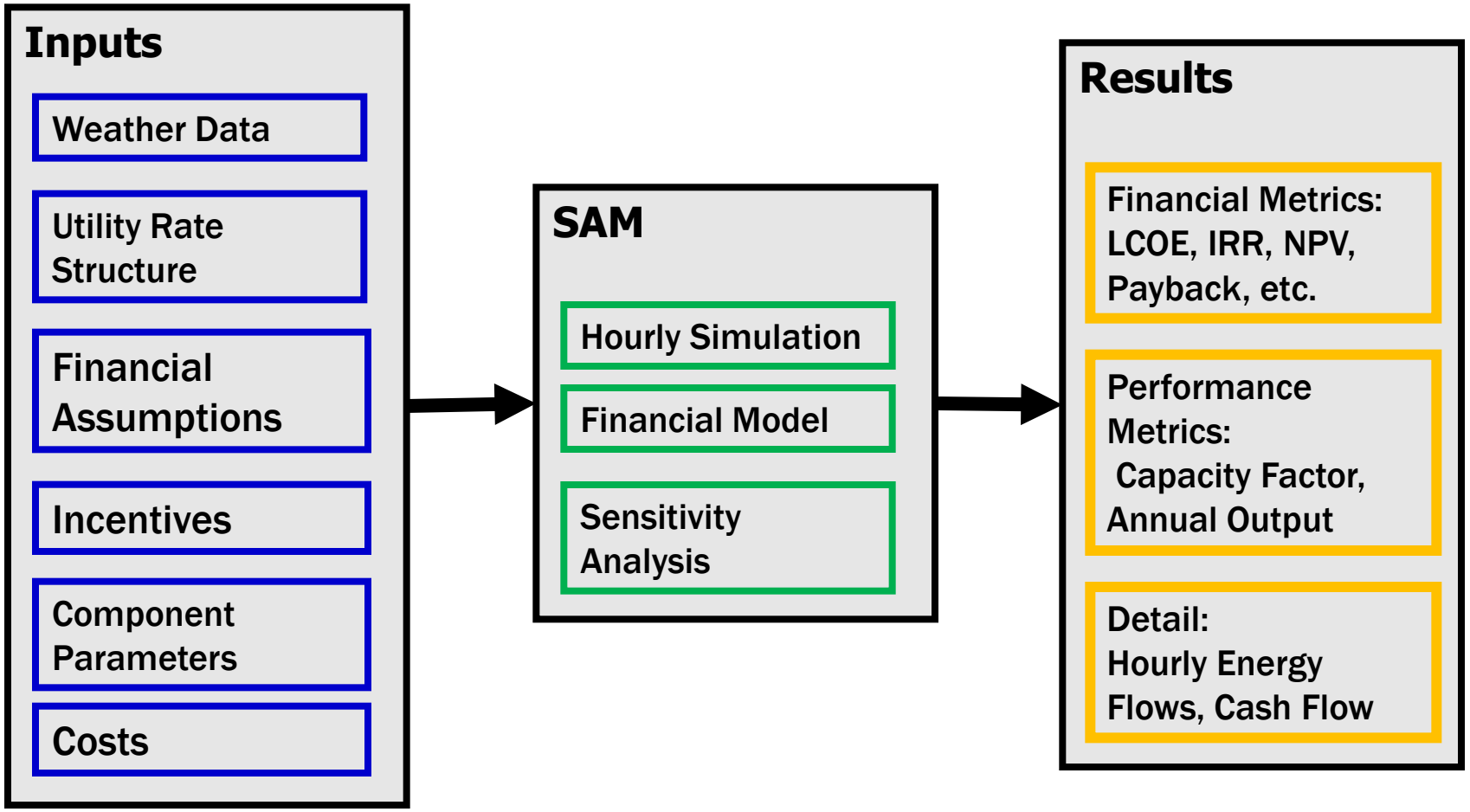
Policy analysis example: PV grid-parity analysis; Alternative Scenario

2015 residential without incentives and aggressive increase in electricity prices

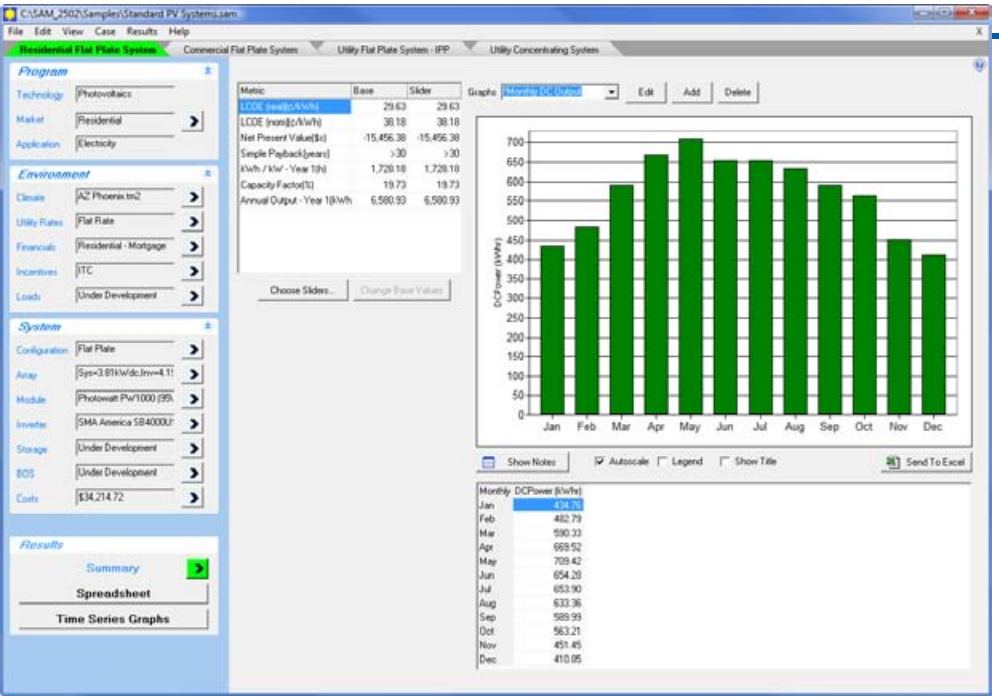
- Attractive in about 450 of 1,000 largest utilities, which provide ~50% of U.S. residential electricity sales.
- 91% of sales (in nearly 950 utilities) are projected to have a price difference of less than 5 ¢/kWh.

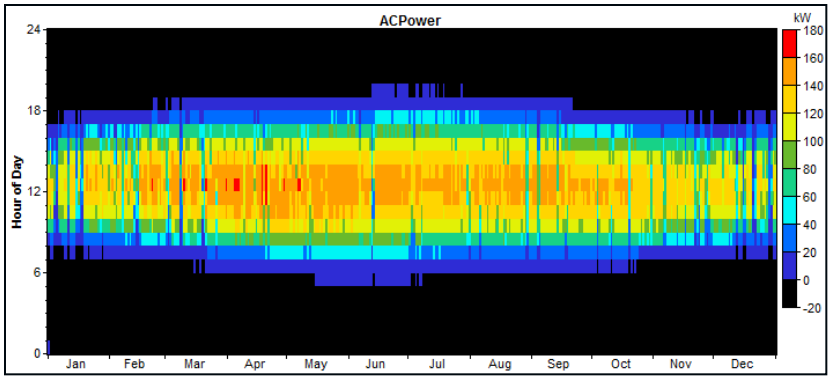


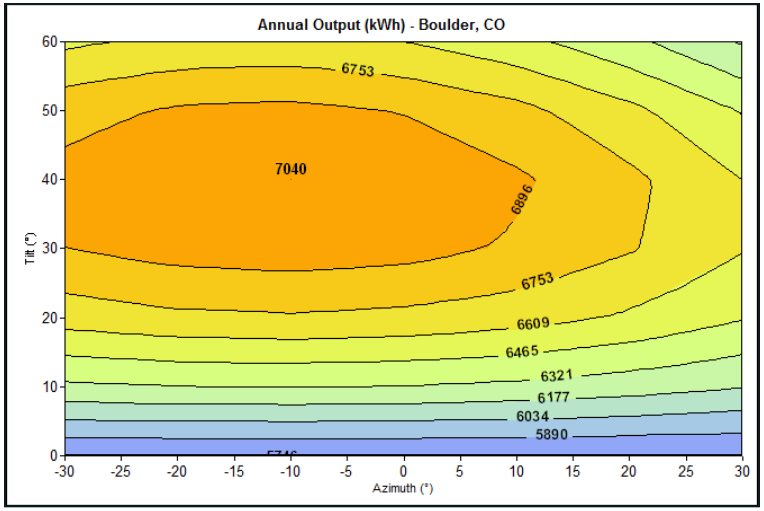
Value Differentiation:
Systems and LCOE Example: Solar Advisor Model

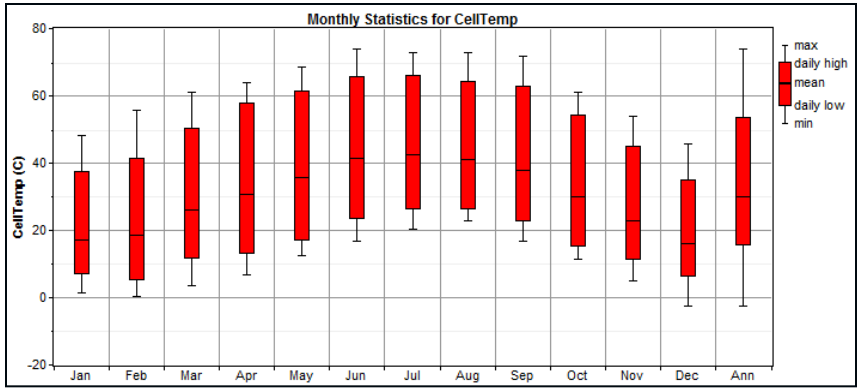


Sample Outputs

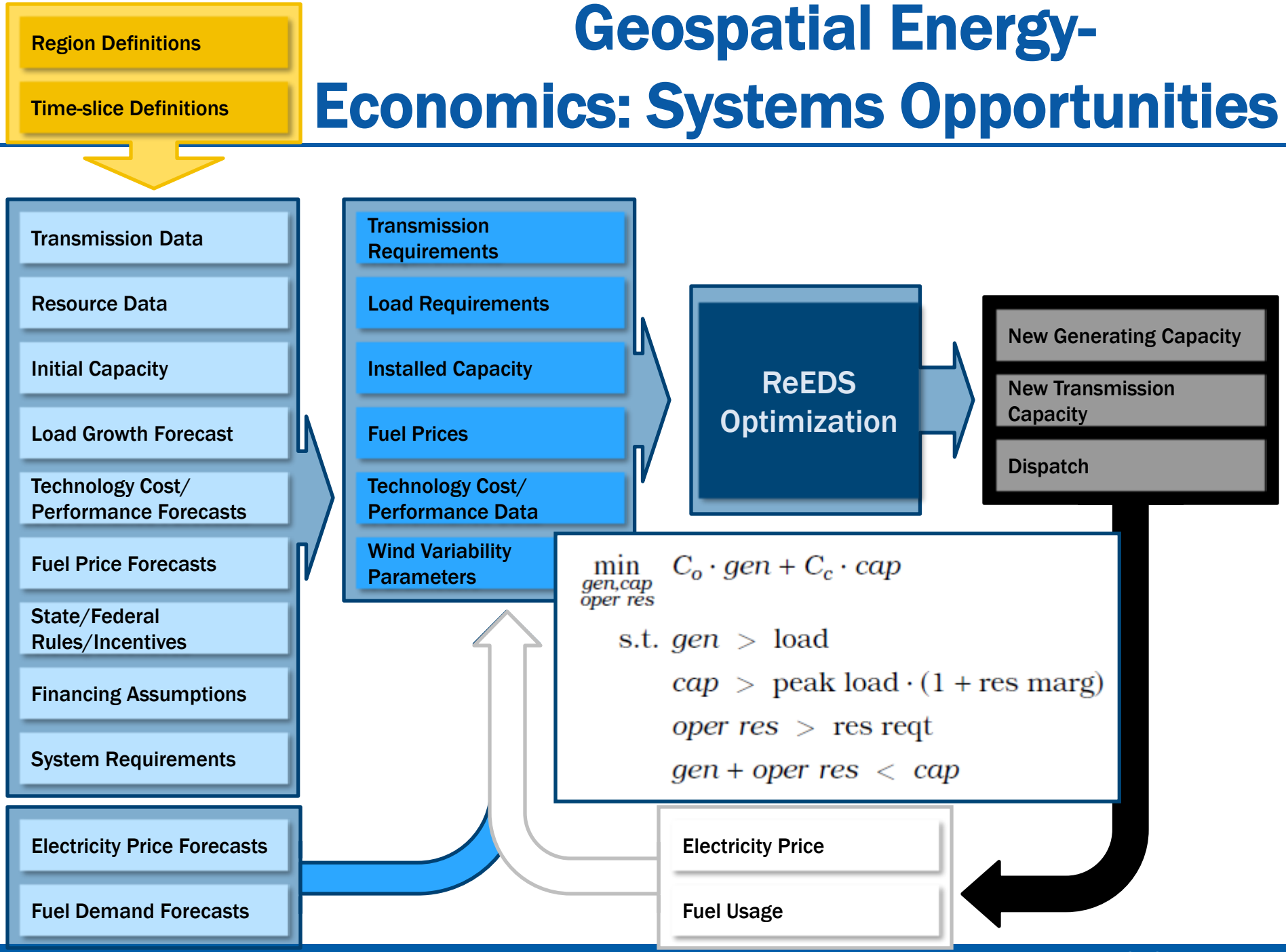




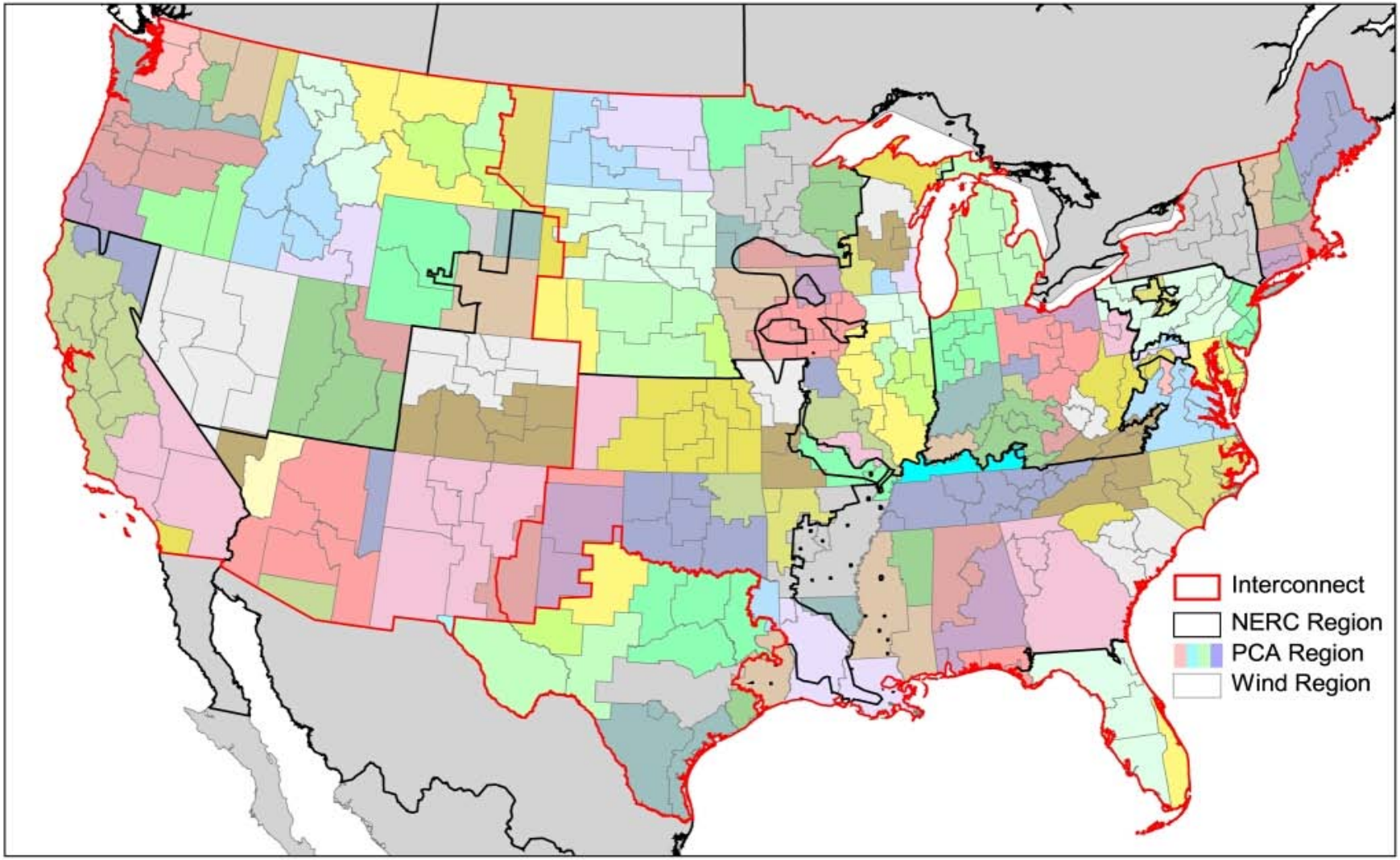




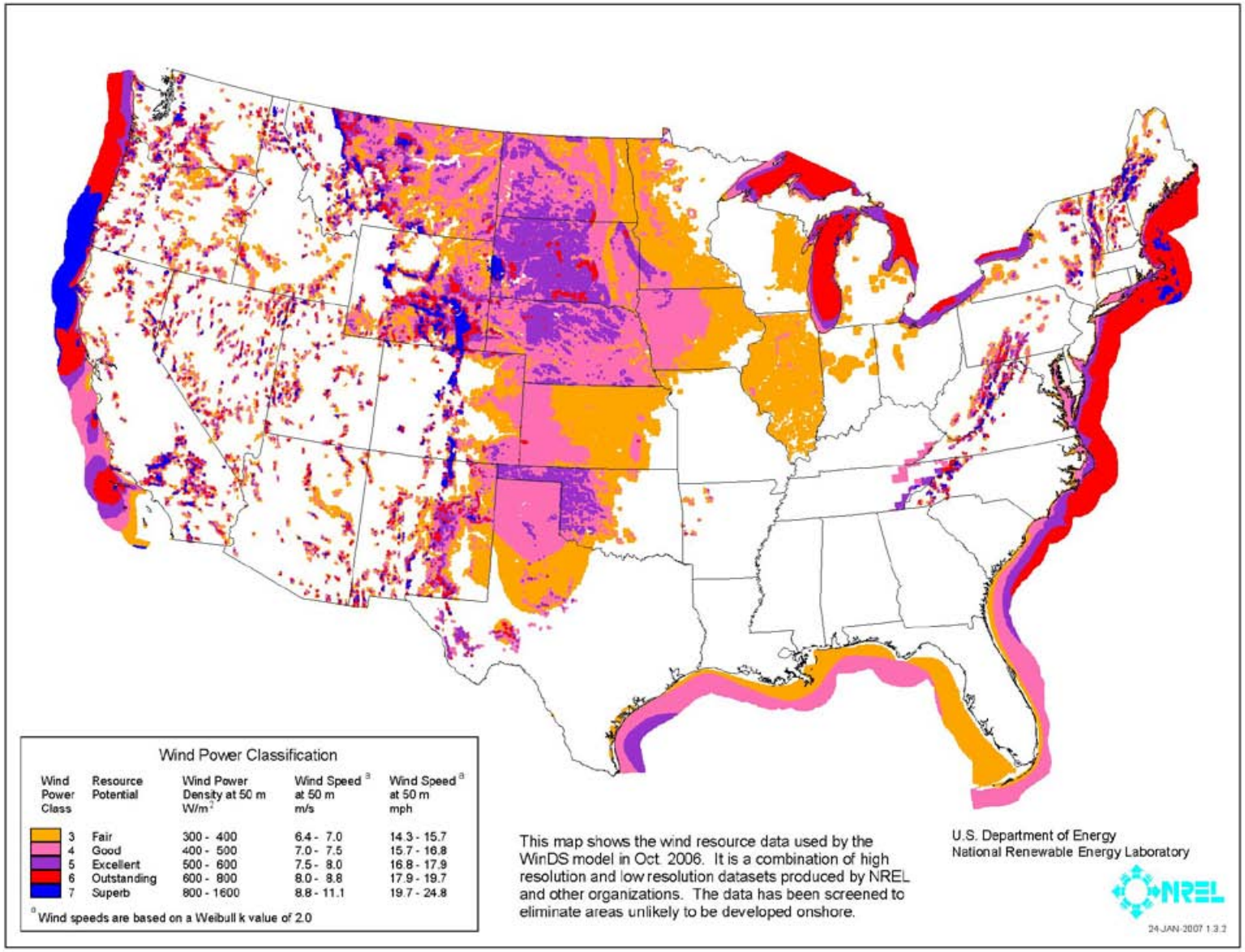
Geospatial Energy-Economics: Systems Opportunities

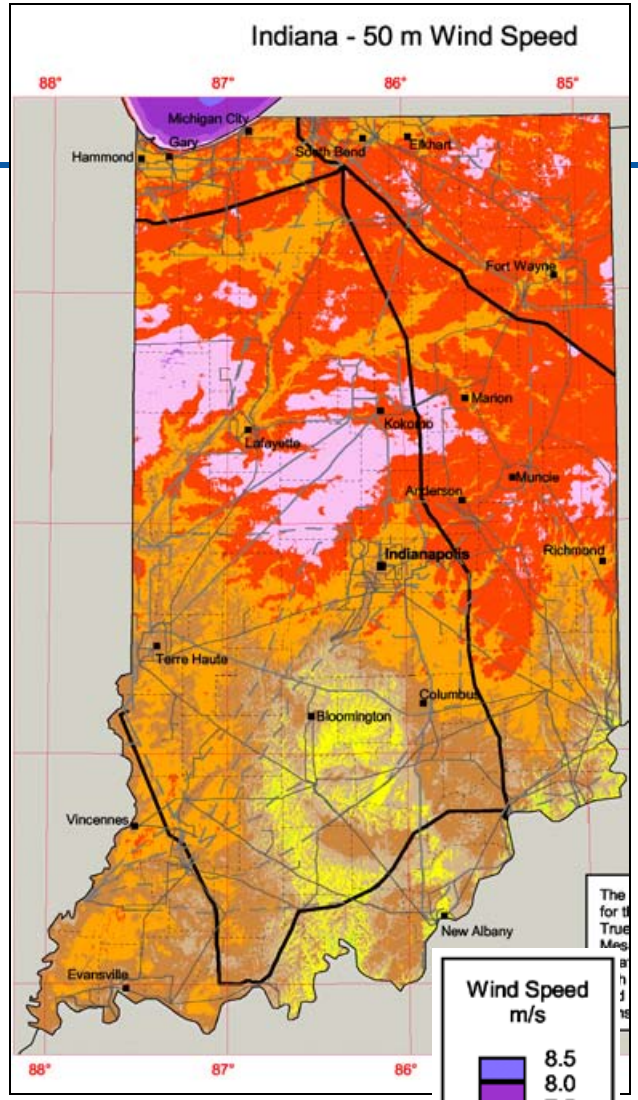


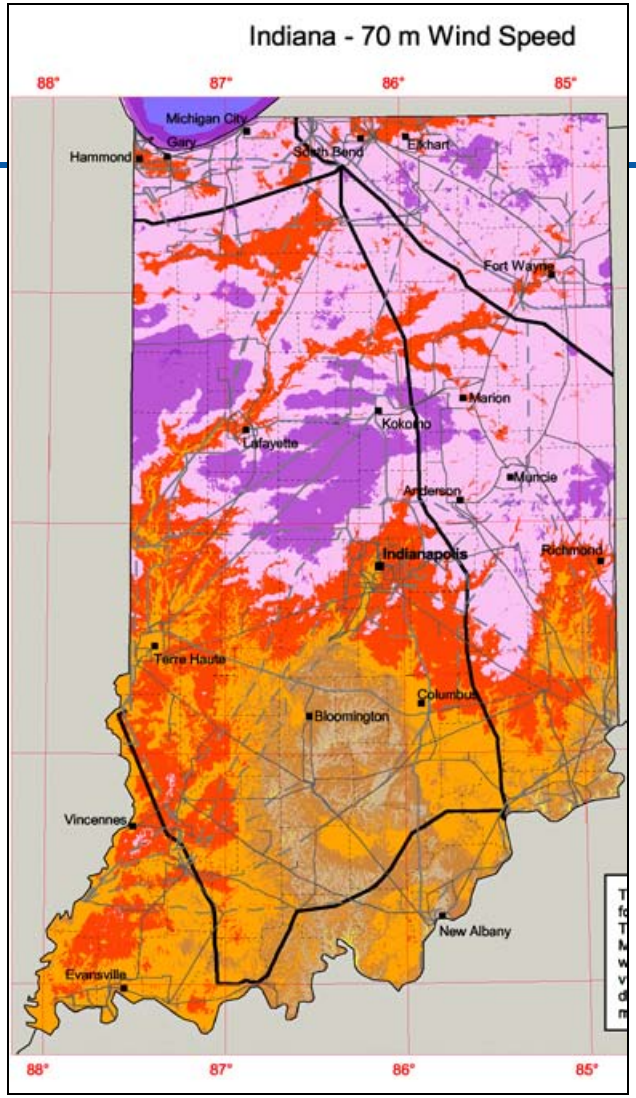
ReEDS Regions

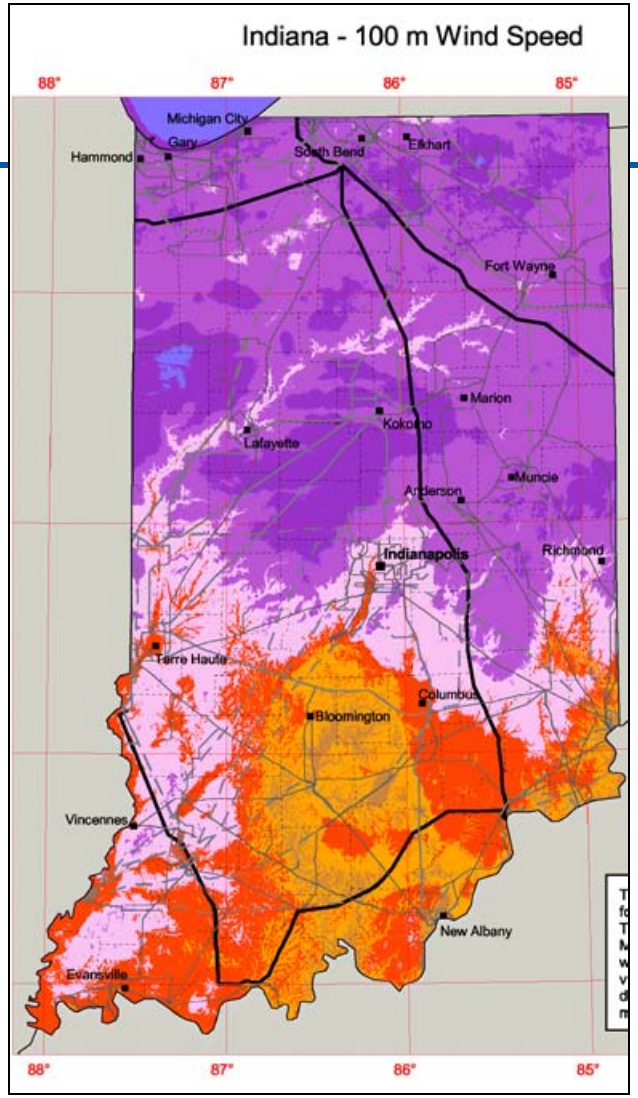


Wind Resource in ReEDS





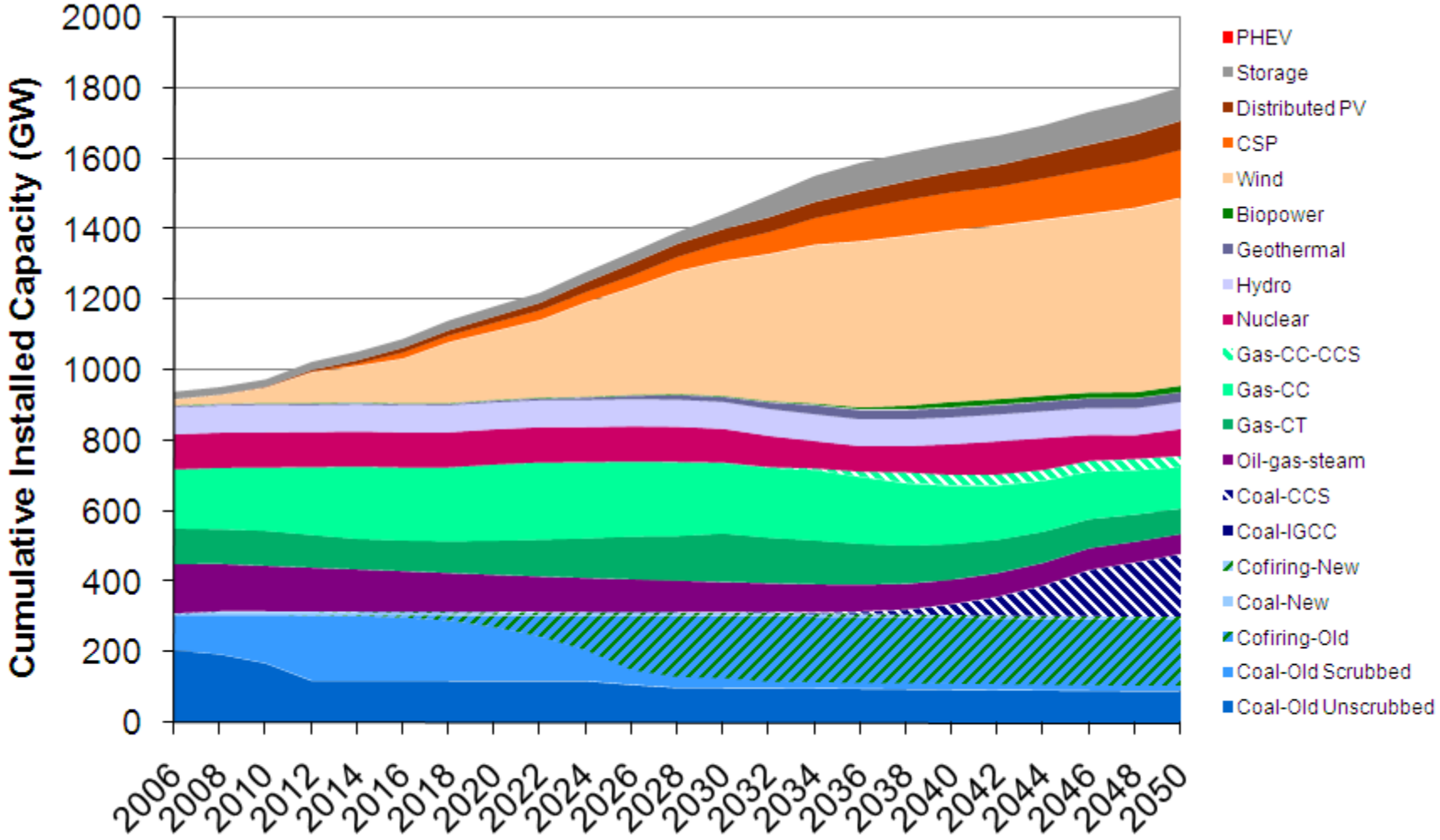




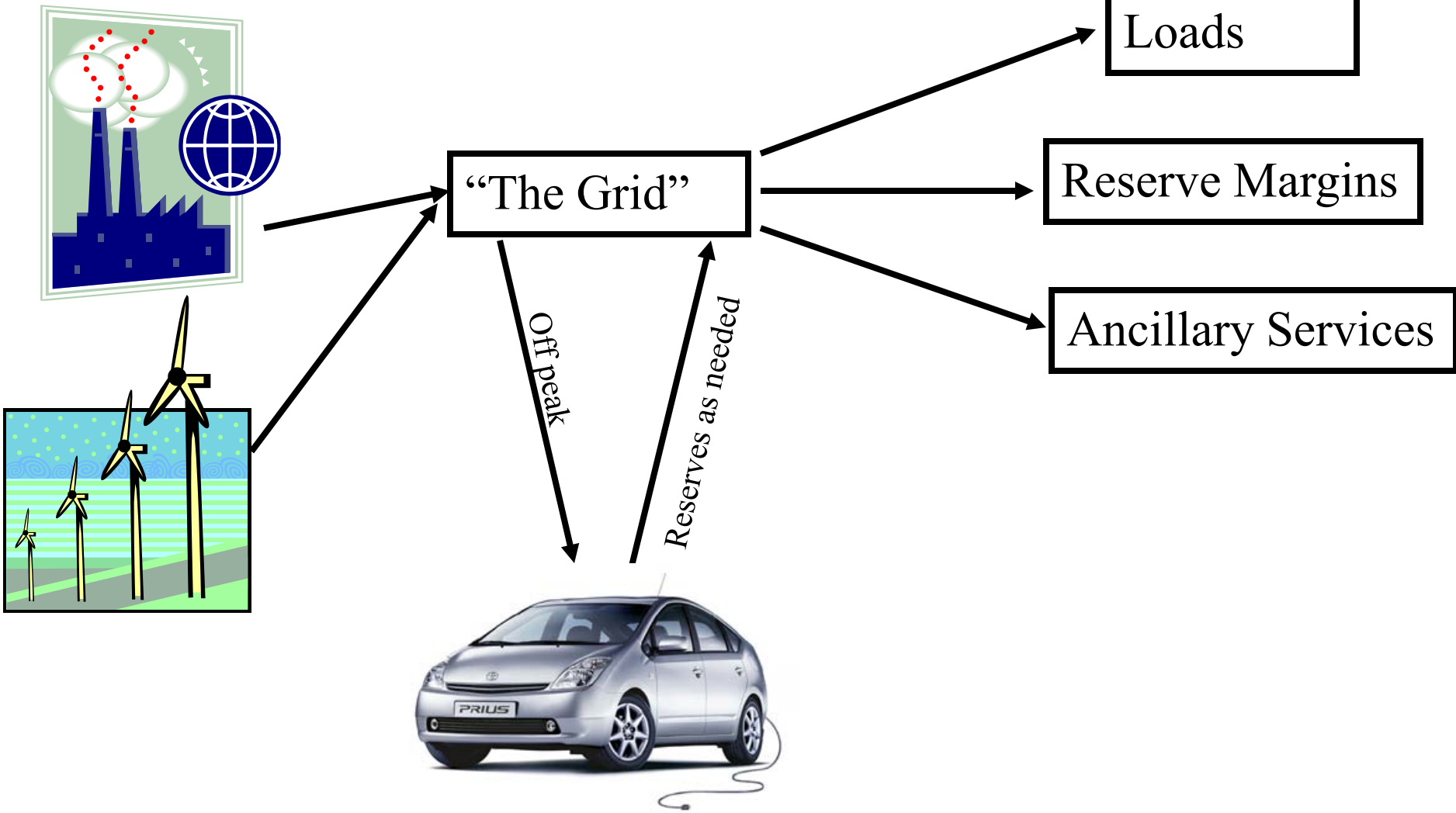
Wind Potential (8-12% Losses)
30-36% Capacity Factor: 100 – 42 GW
36-41% Capacity Factor: 2 – 0 GW
Total: 102 – 42 GW

Wind Potential (8-12% Losses)
30-36% Capacity Factor: 123 – 161 GW
36-41% Capacity Factor: 99 – 37 GW
42-46% Capacity Factor: 1 – 0 GW
Total: 223 – 198 GW

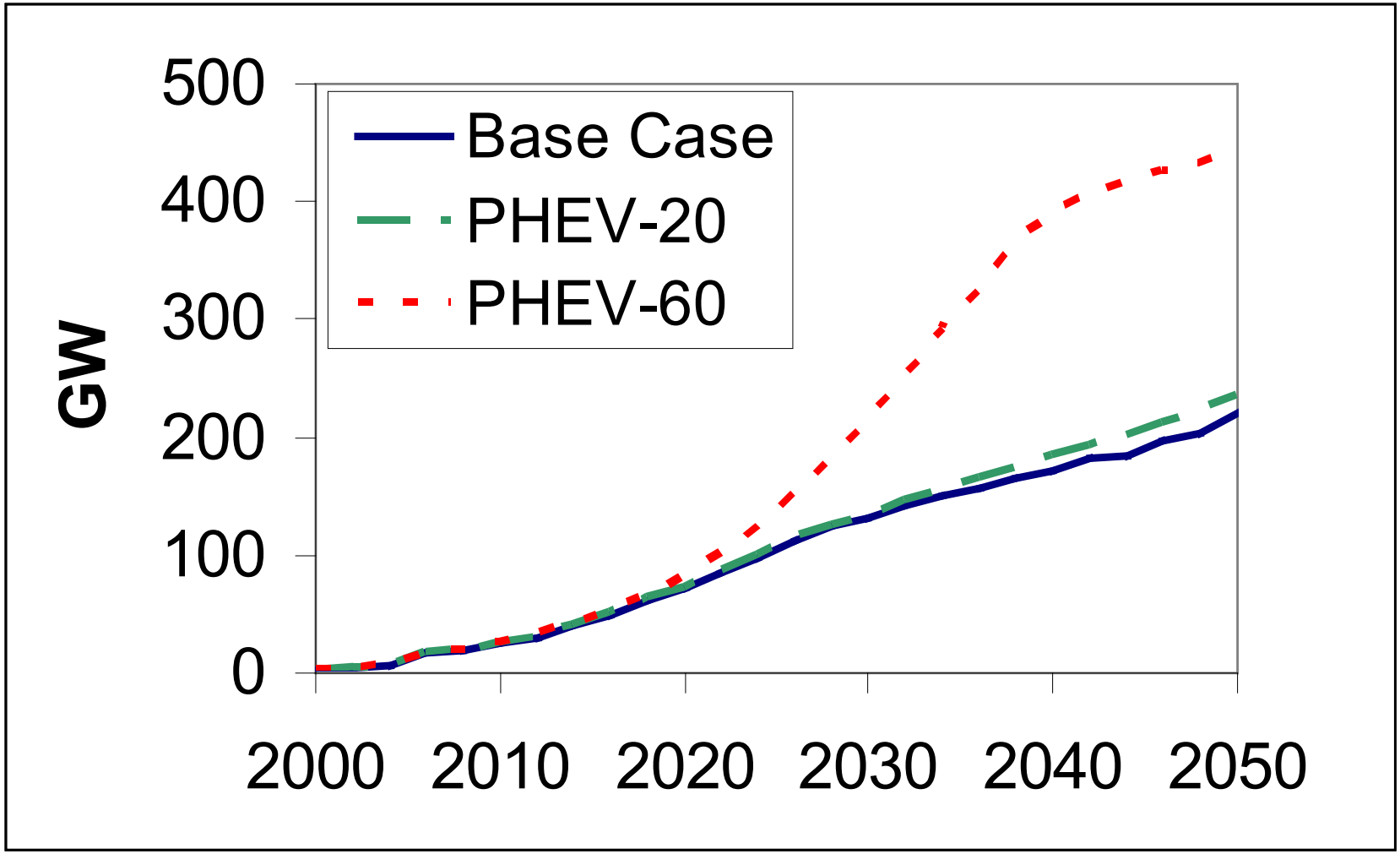
Evolution of Electric Generation under Carbon Constraint



Plug-in Hybrid Electric Vehicle Modeling

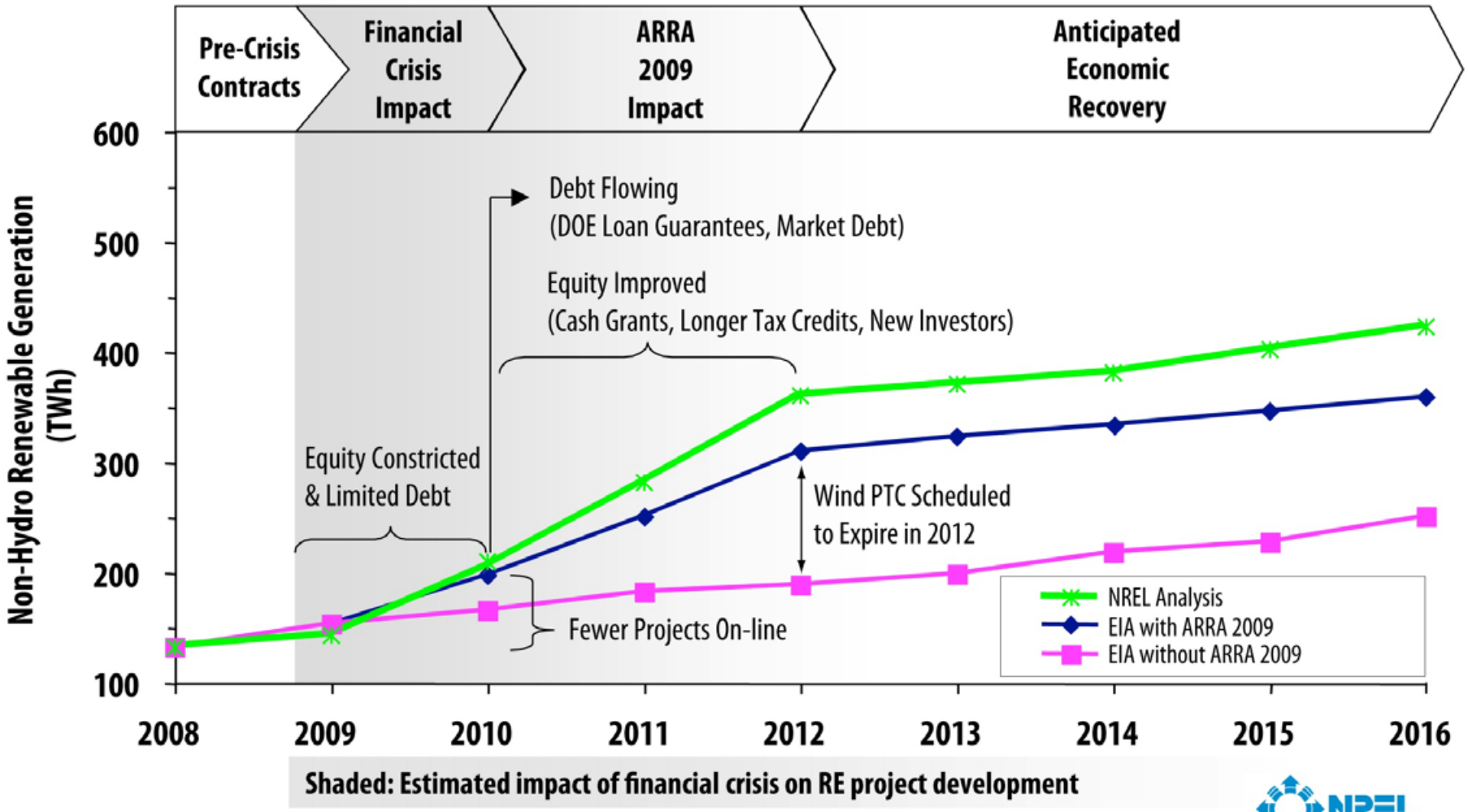


PHEVs* Can Increase Wind Penetration



* Assumes 50% PHEV-V2G penetration by 2050

Federal Stimulus Impact on Renewables



Source: **EIA** - 2009 Updated Annual Energy Outlook Reference Case
NREL - Comparative Analysis of Three Proposed Renewable Electricity Standards

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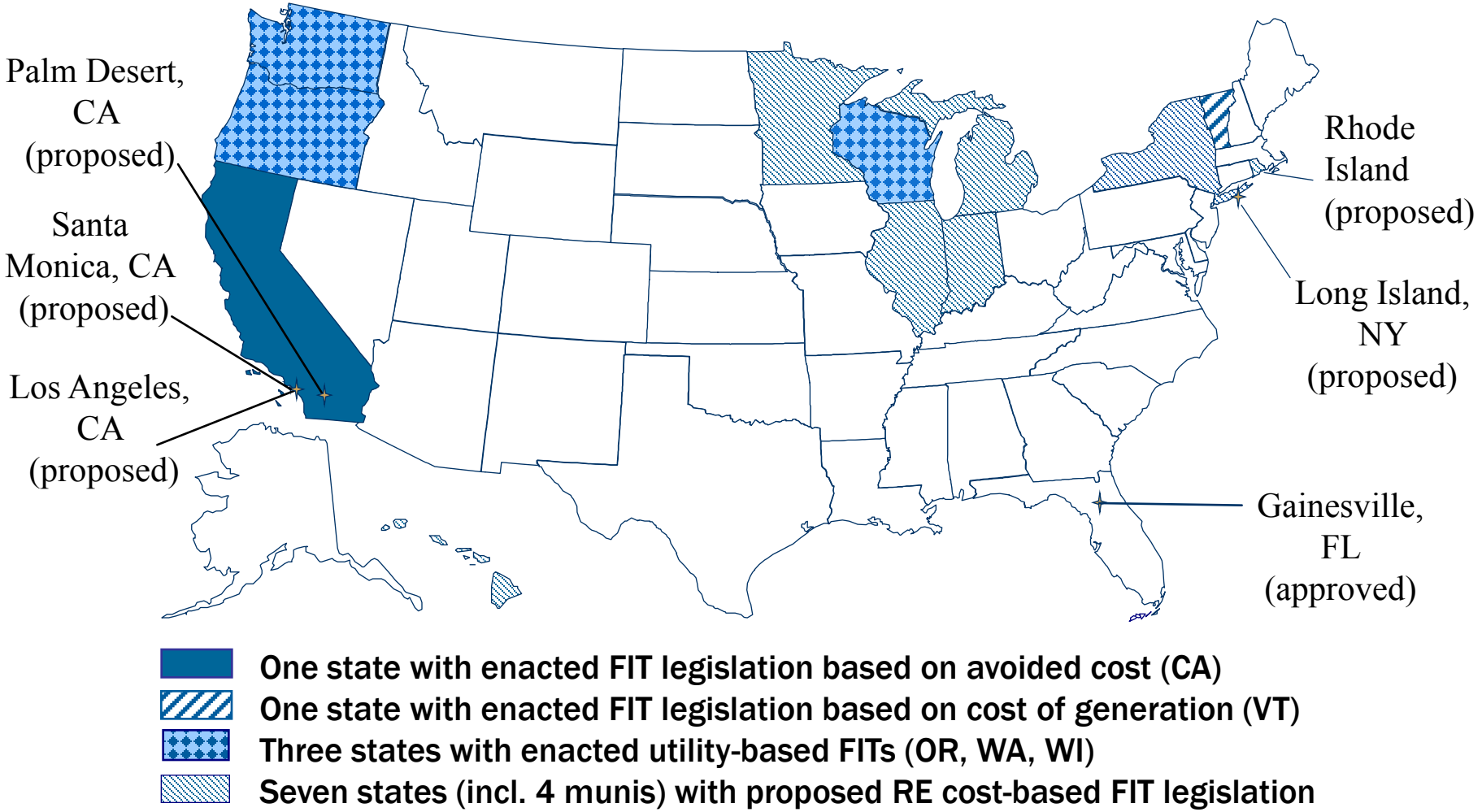
Innovation for Our Energy Future

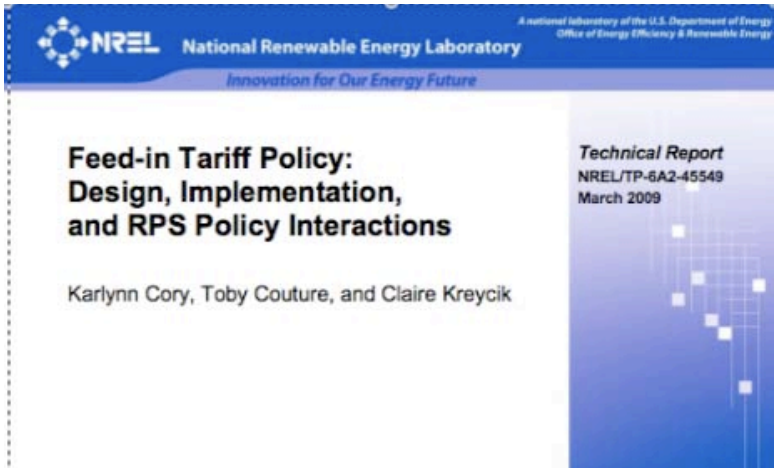
Feed-in Tariffs in the U.S.

Note: Gainesville Regional Utilities, has approved the first U.S. cost-based FIT for solar PV.
In May 2009, Vermont enacted the first statewide FIT policy based on the RE project cost.



Source: NREL June 2009

Recent Publications



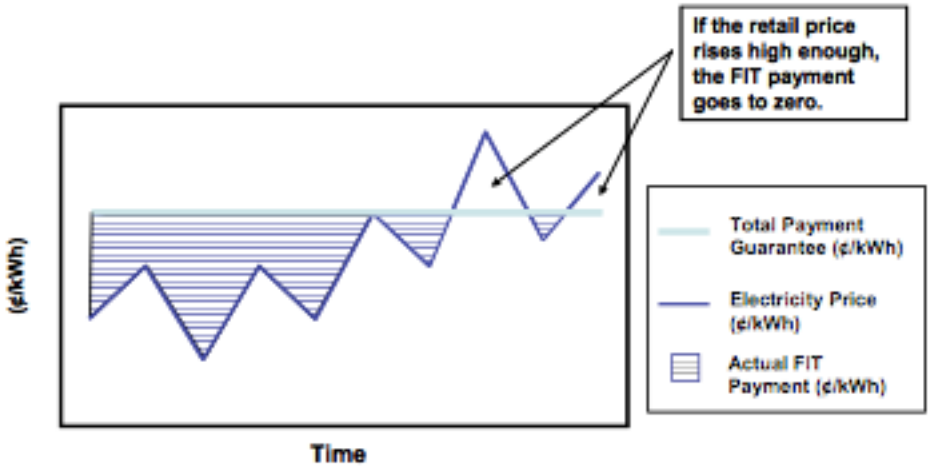
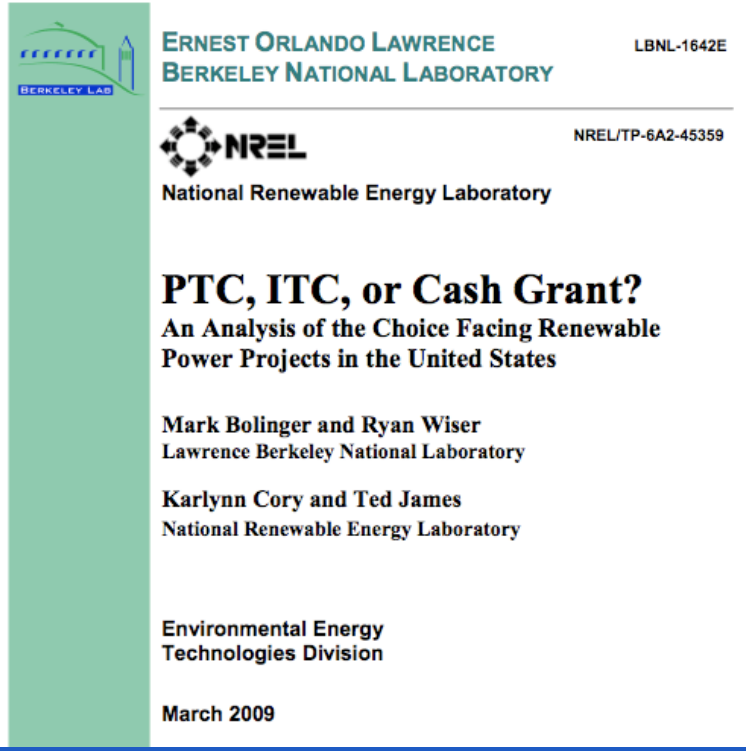
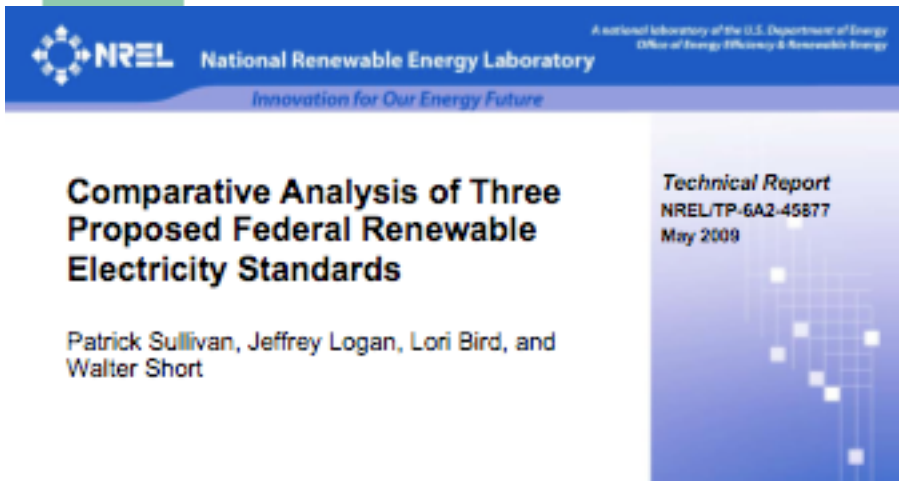


Figure 3. The Netherlands' premium-price FIT (Spot-Market Gap Model)





Insights & Opportunities

- Technology, Policy and Business Model Innovations will drive opportunity
- System Solutions hold high promise.
  - IT Enabled: Smart Grid…
  - Geospatial Diversity
  - Interactions of Technologies
  - Cross Sector Opportunities: Transport & Power
  - Load Shifting & Storage