National Renewable Energy Laboratory

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Strategic Energy Analysis at NREL

November 2007

Douglas J. Arent, Ph.D., MBA
Director
Strategic Energy Analysis & Applications Center

NREL/PR-670-42435
Presented at the 20th NREL Industry Growth Forum held November 6-8, 2007 in Denver, Colorado

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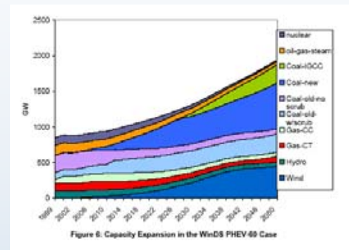
Strategic Energy Analysis

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.

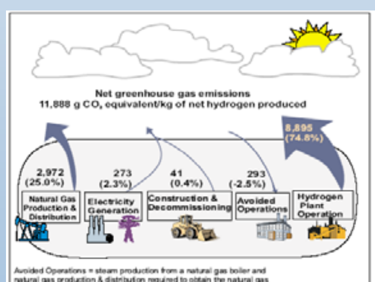
Impact

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 and cost

Resource

Assess resource availability and characteristics

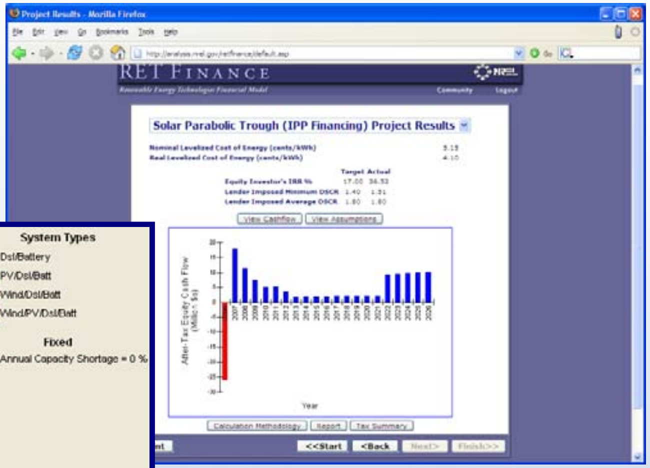
Some Key Themes for Analysis

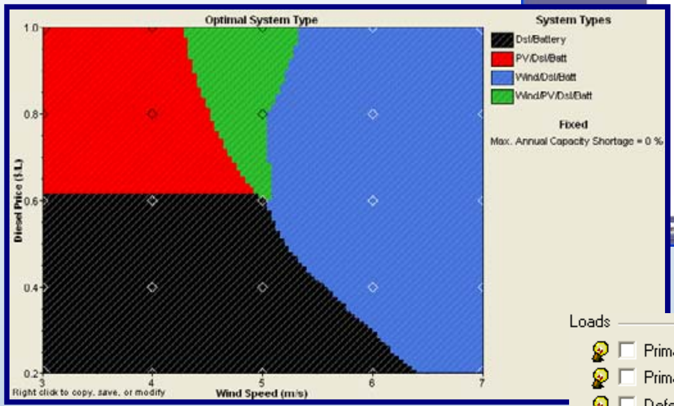
Core Areas:

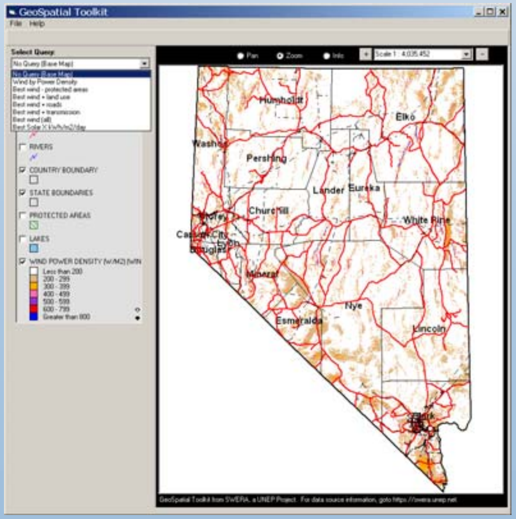
- Market, Technology and Policy Analysis
- Energy Modeling Analysis
  - Renewables, Hydrogen, Alt. Fuels
- Risk, Benefits, and Portfolio Analysis

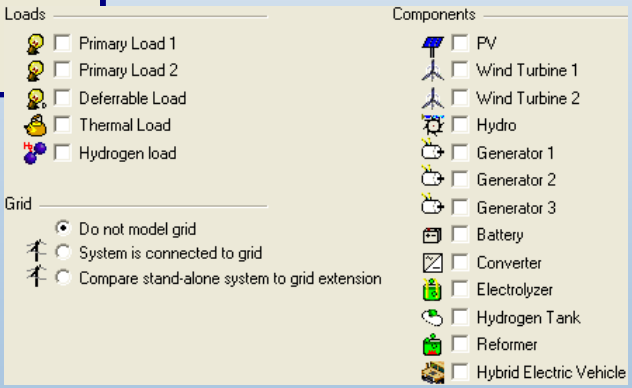
Tools to Inform Decision Making…

- RET Finance
- Real Options
- Hybrid2
- Vipor
- HOMER
- Fresa
- Geospatial
- Tool Kit
- PV Watts
- Advisor
- Energy-10
- Solar Advisor Model
- SUNREL
- JEDI







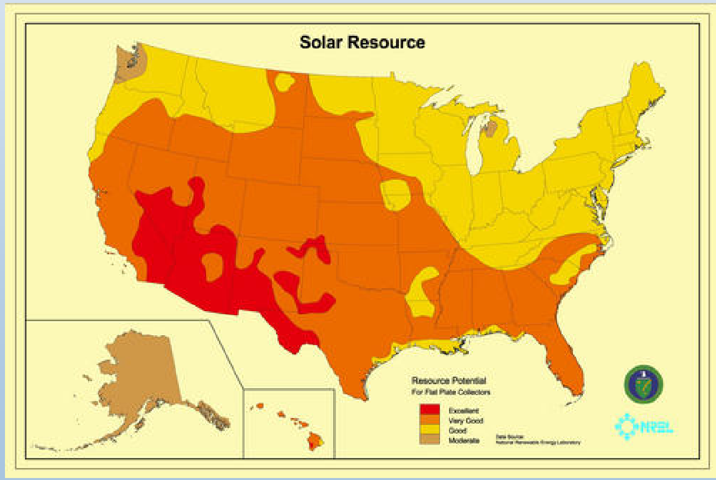


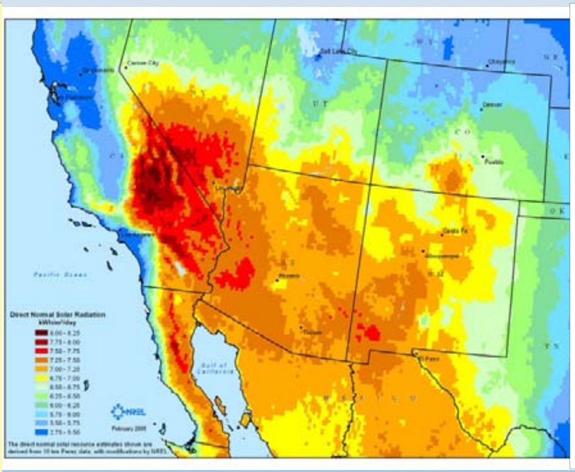
Understanding Energy Resources and potential impact of technology advances on national goals

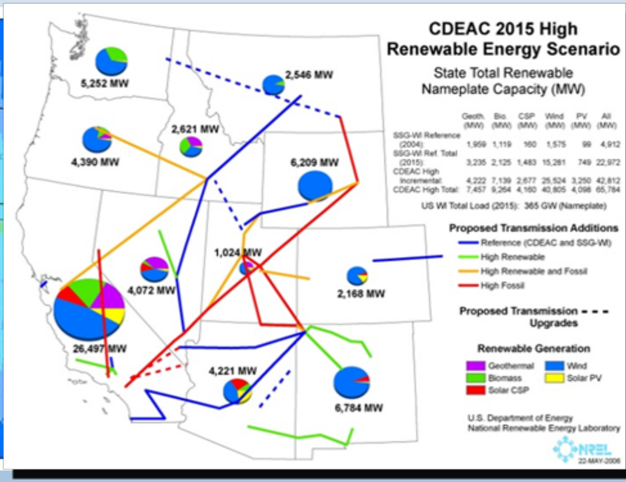
- Example: Solar resources in the Southwest. Resource (technical) potential to “economic” (e.g. commercially feasible) to “accessible” and links to transmission access, markets, pricing, technology adoption (learning) and thus technology advances….

Solar in the SouthWest: More than just photons

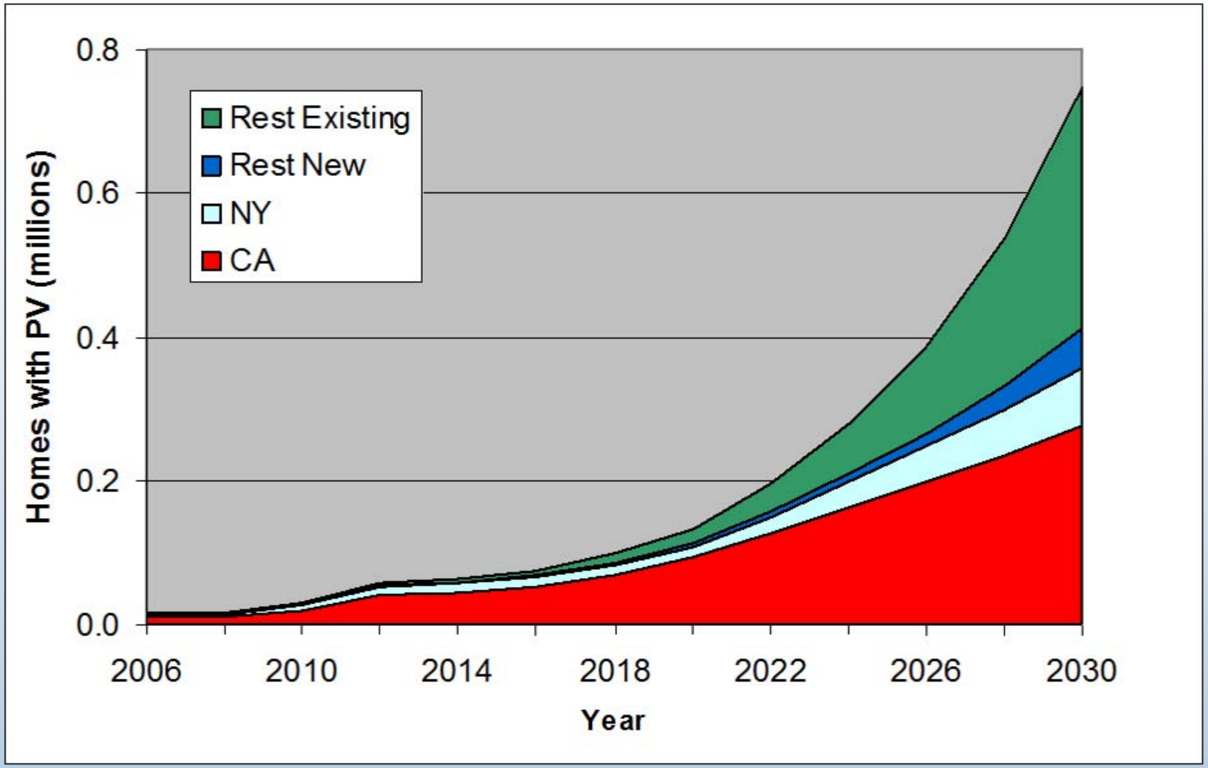
- Gross irradiance is baseline: Analysis to refine to "economic potential" to accessible and linkage to technology adoption, learning and advances in technology.







SOLARDS – PV on Buildings Market Penetration

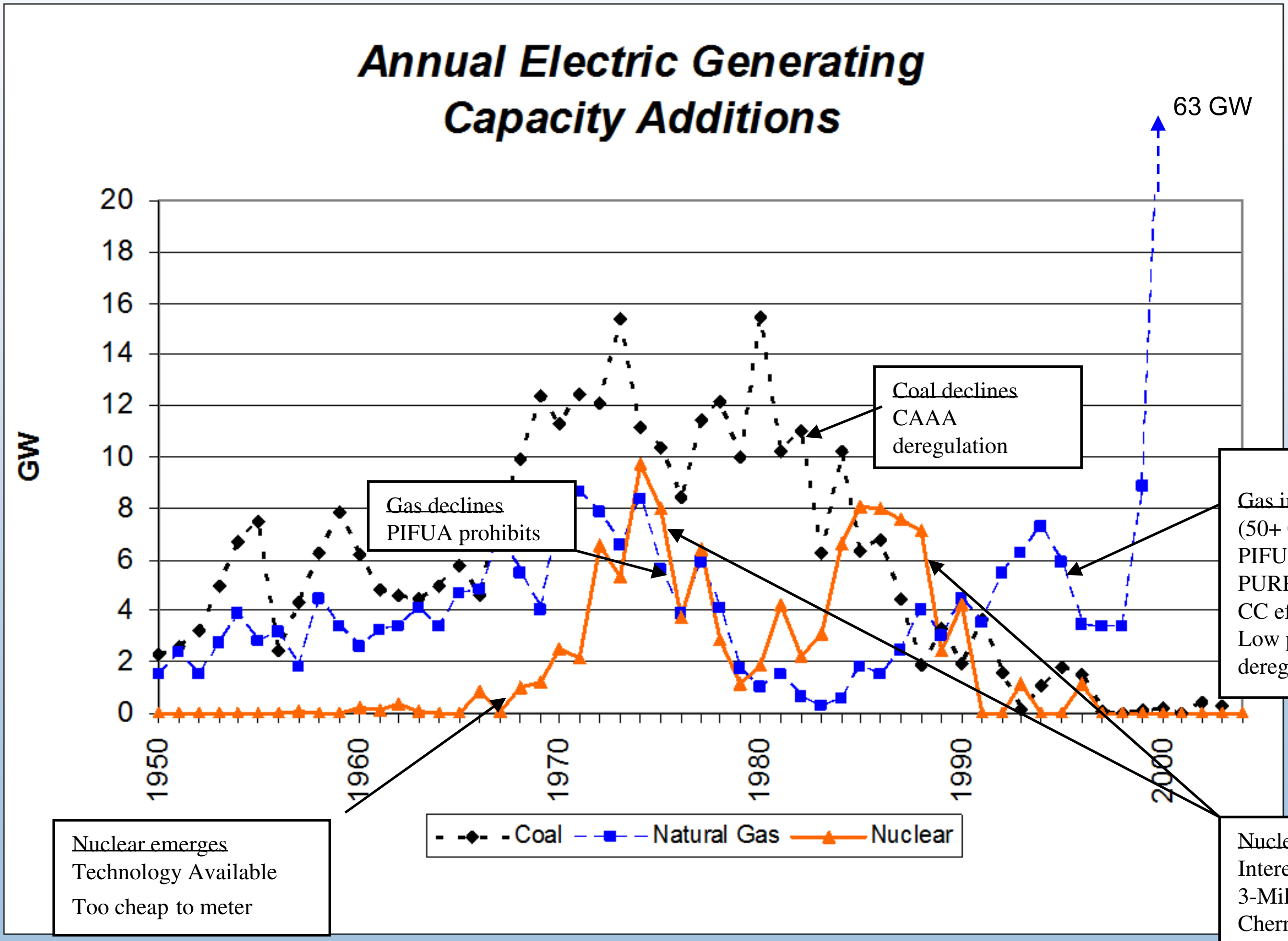


By including rate diversity (especially tiered rates) SOLARDS captures more early adopters, especially in California. Early adoption in niche markets increases learning and penetration in other markets

Decisions “under uncertainty”

- Uncertainty and Translating R&D to Benefits via the applied technology pathway
  - Learning curve impacts; scale and technology advances
  - Technology adoption impacts
  - Assessing multiple pathways
  - Valuing the R&D options
    - Uncertainty, Risk, Real Options

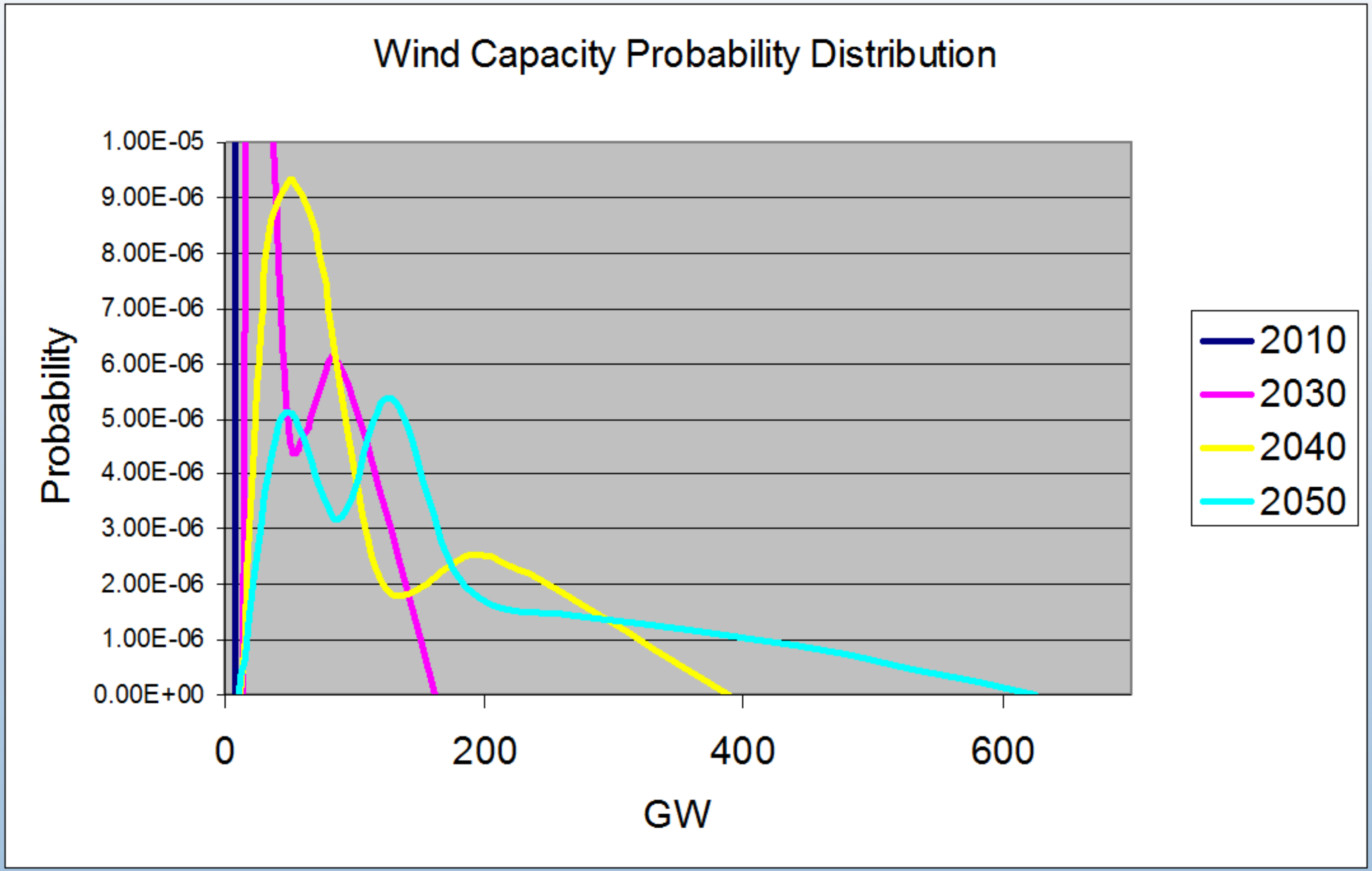
Many (most?) major energy market drivers are highly uncertain and outside the scope of most energy market models



Science & Technology Advances, particularly For Basis Science Are also highly uncertain

What Might a Stochastic Model Show You?

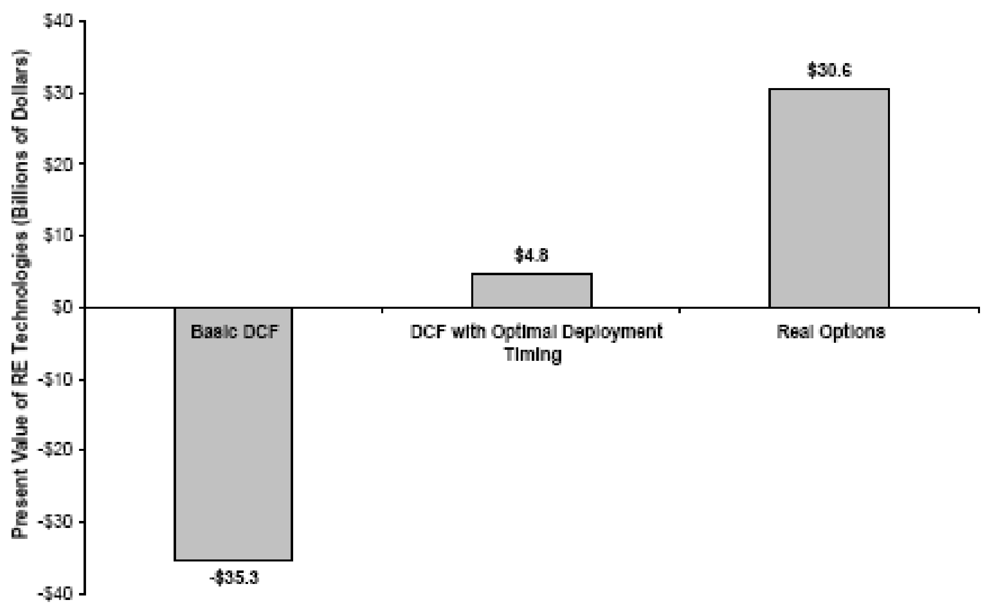
- Incorporating uncertainty into an energy market model conveys significantly more information than a single point estimate



"Valuation" depends on Analytic Approach

- Discounted Cash Flow (DCF) or other "linear" approaches may not be most appropriate.
- Stochastic analysis and options analysis offer alternative insights.

Figure 9: Current Value of the RE Technologies



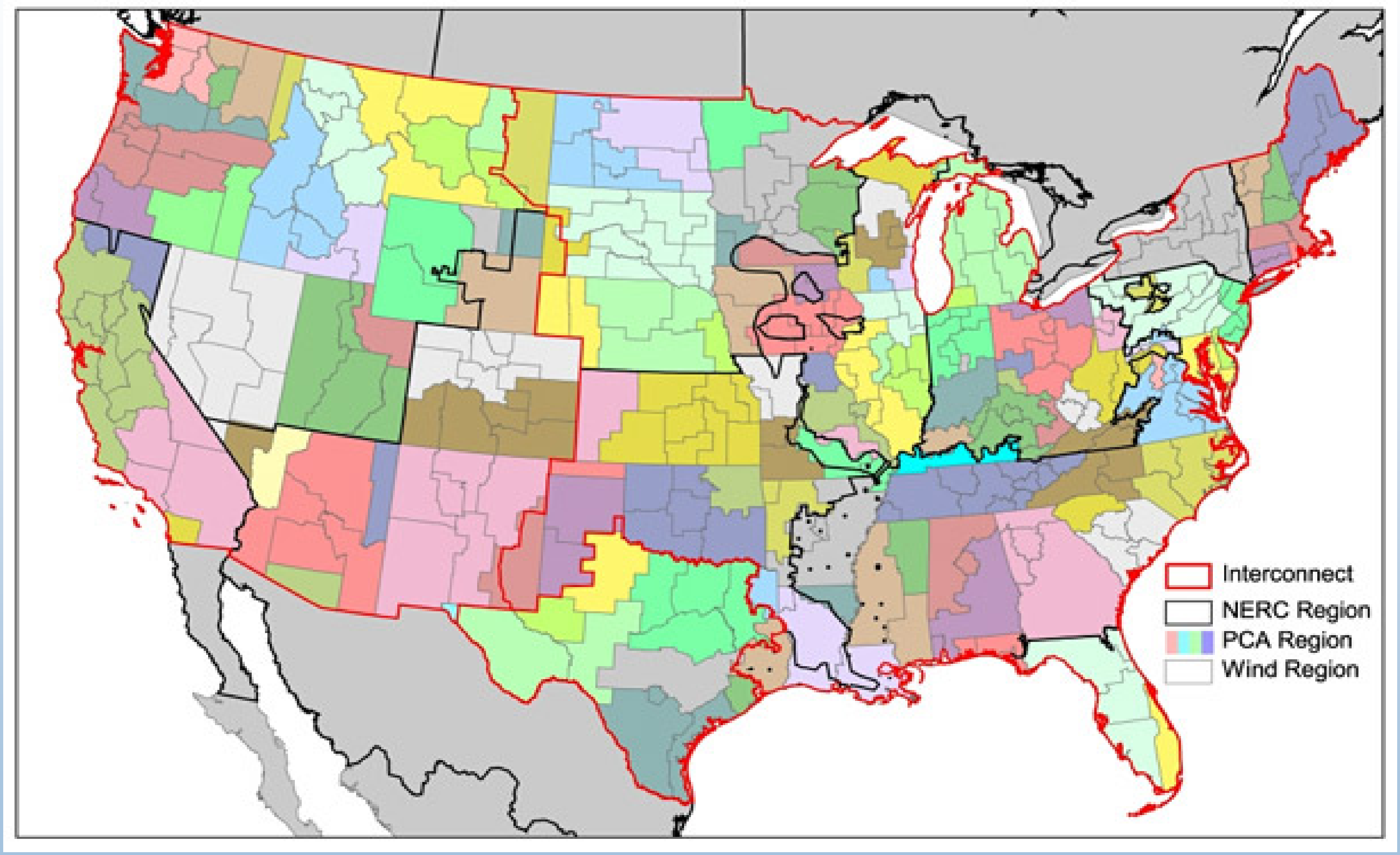
Source: **Optimizing the Level of Renewable Electric R&D Expenditures Using Real Options Analysis**, NREL/TP-620-31221, 2003

Market Development Insights: ReEDS- Regional Energy Deployment Systems Model

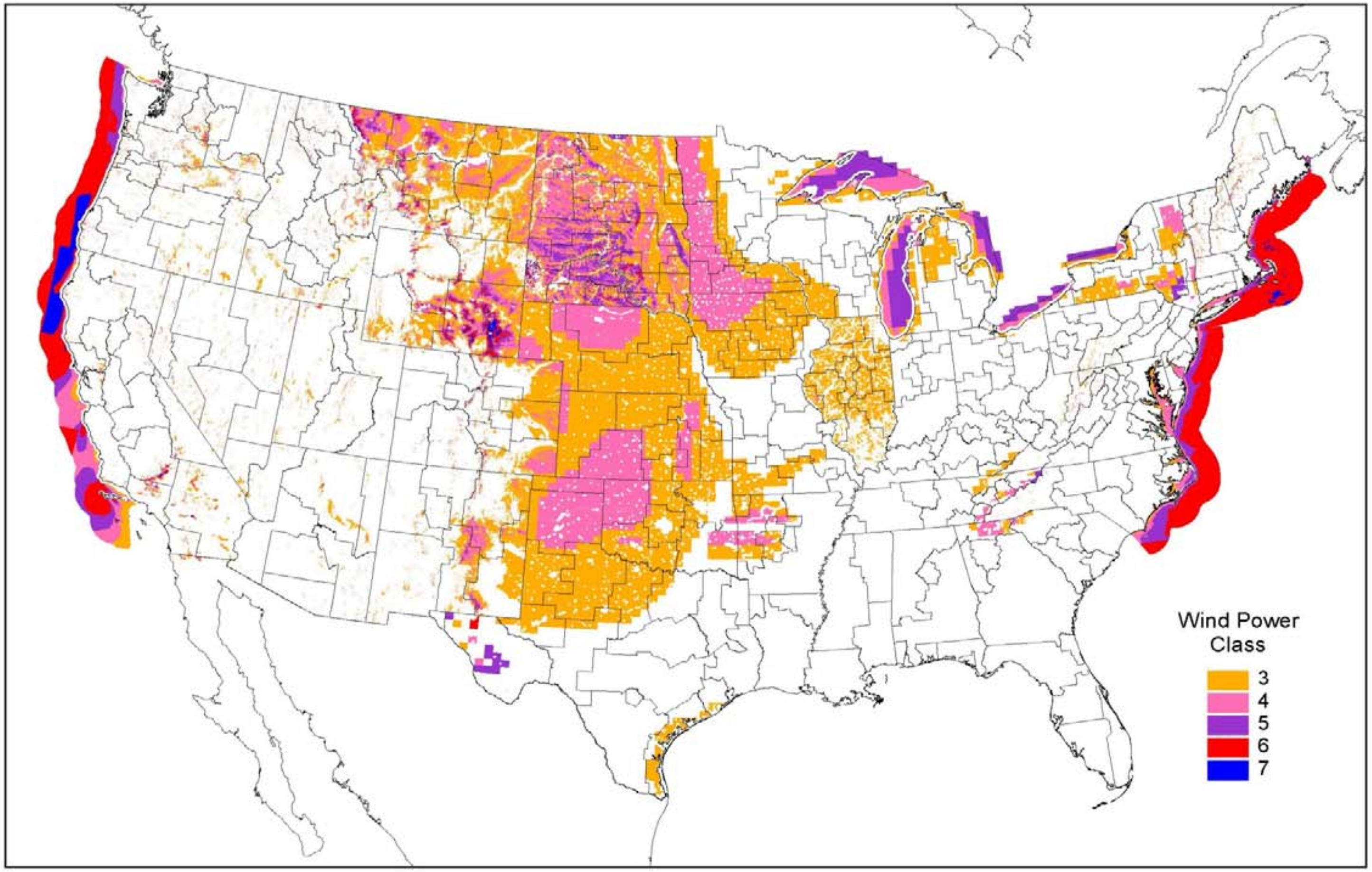
A multi-regional, multi-time-period model of capacity expansion in the electric sector of the U.S.

Designed to estimate market potential of energy technologies in the U.S. for the next 20 – 50 years under different technology development and policy scenarios

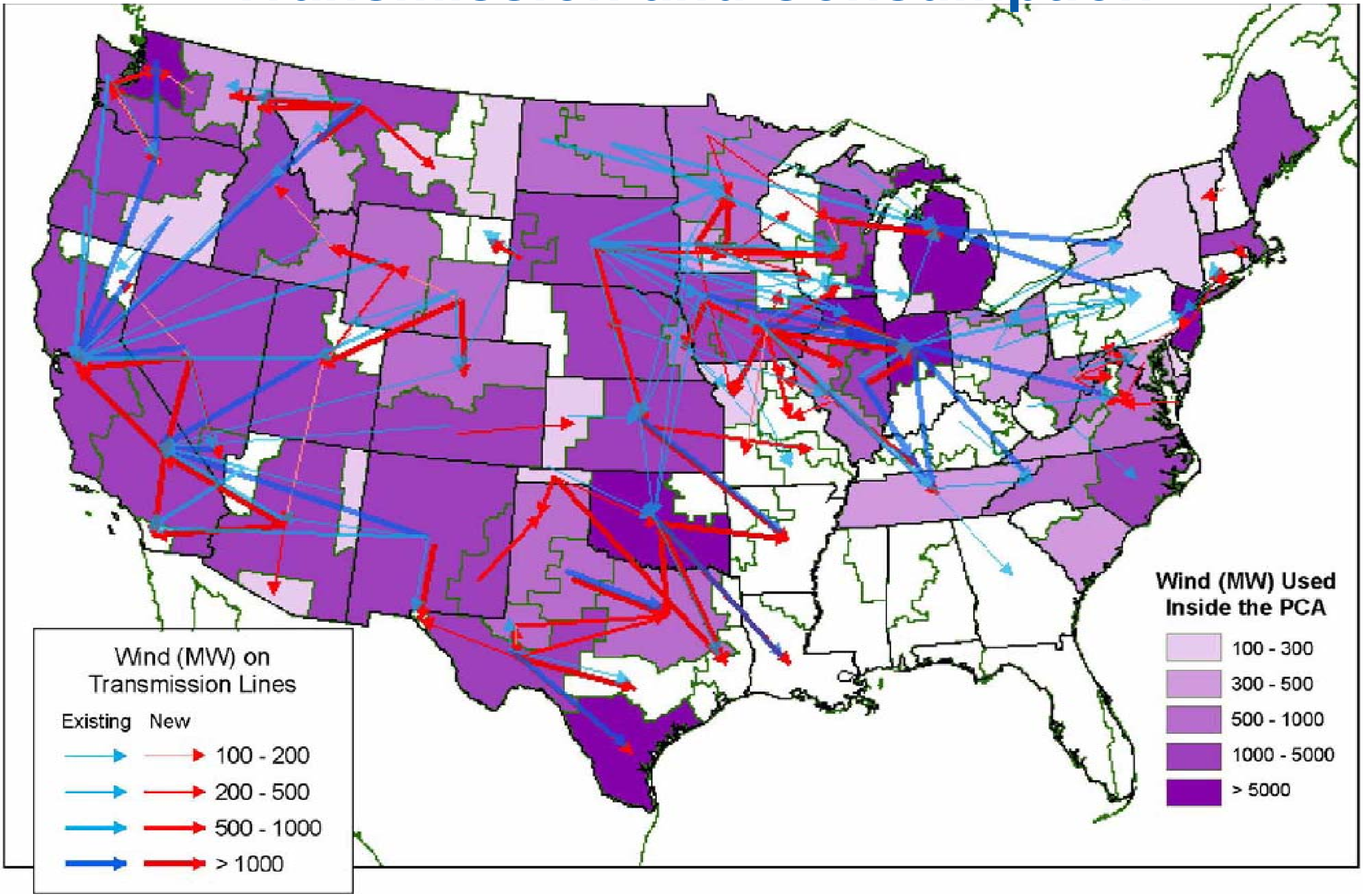
ReEDS Model:
Detailed Treatment of Wind Grid Integration Issues



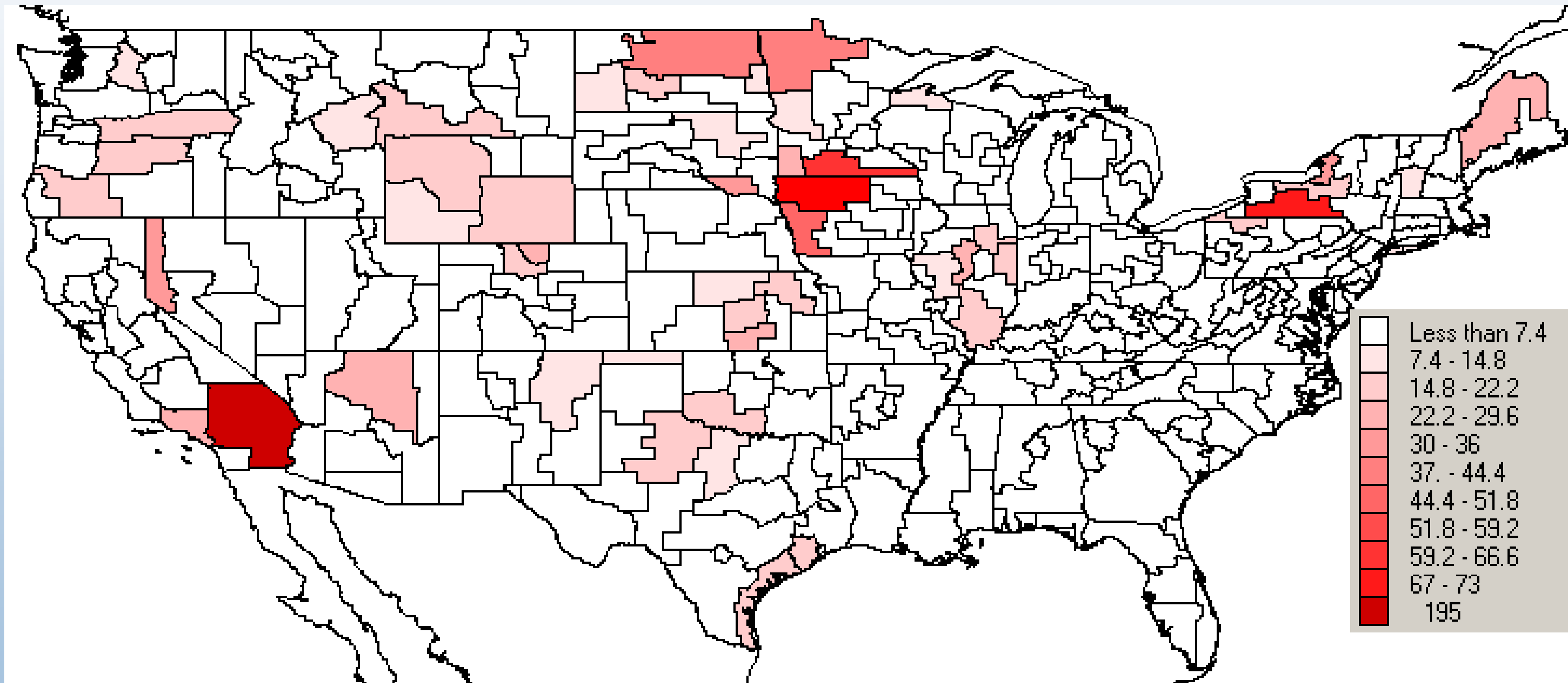
Wind Resources in WinDS



WinDS 2030 RPS: Transmission and Consumption

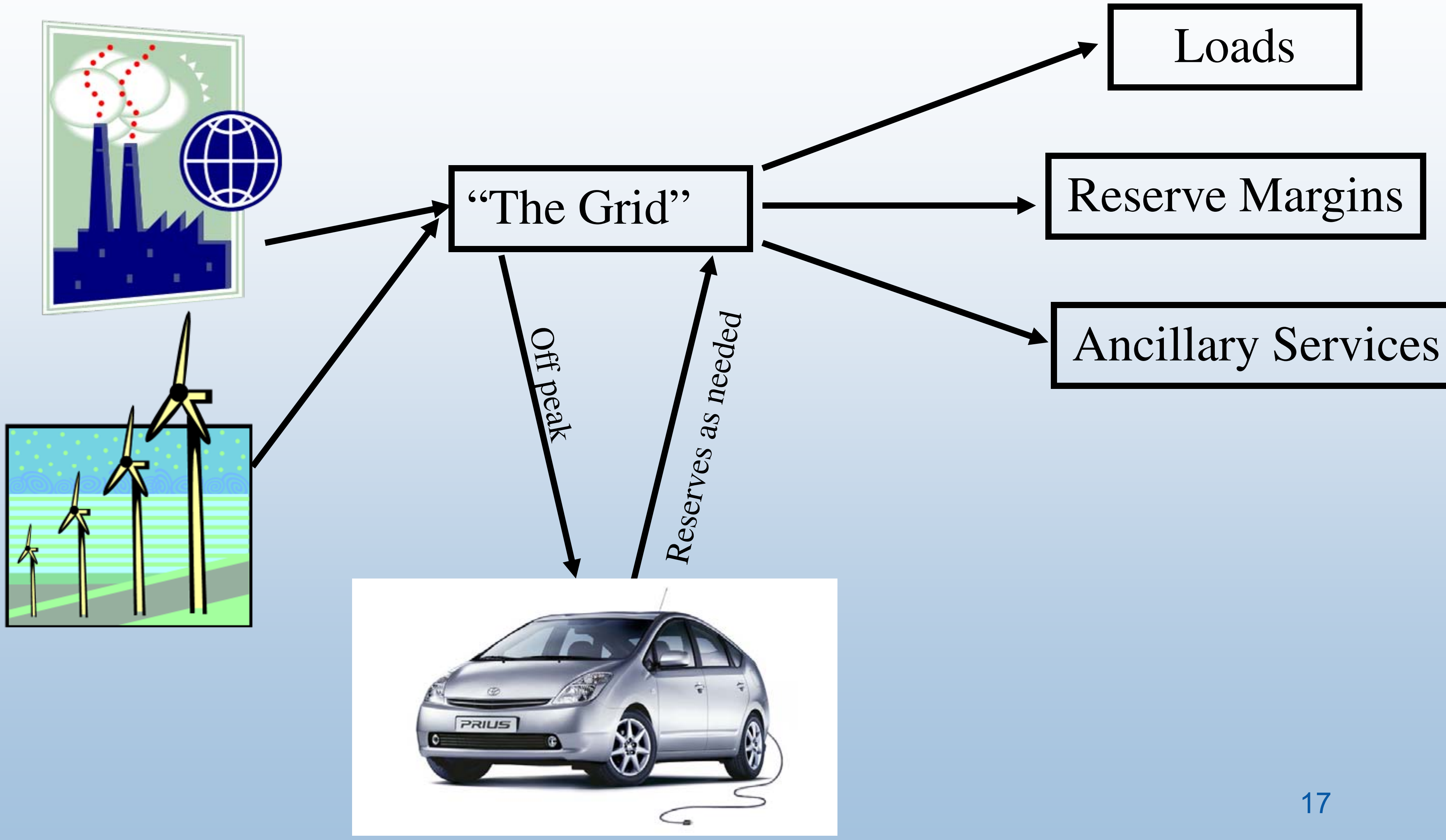


Base Case H_2 Production* from Wind

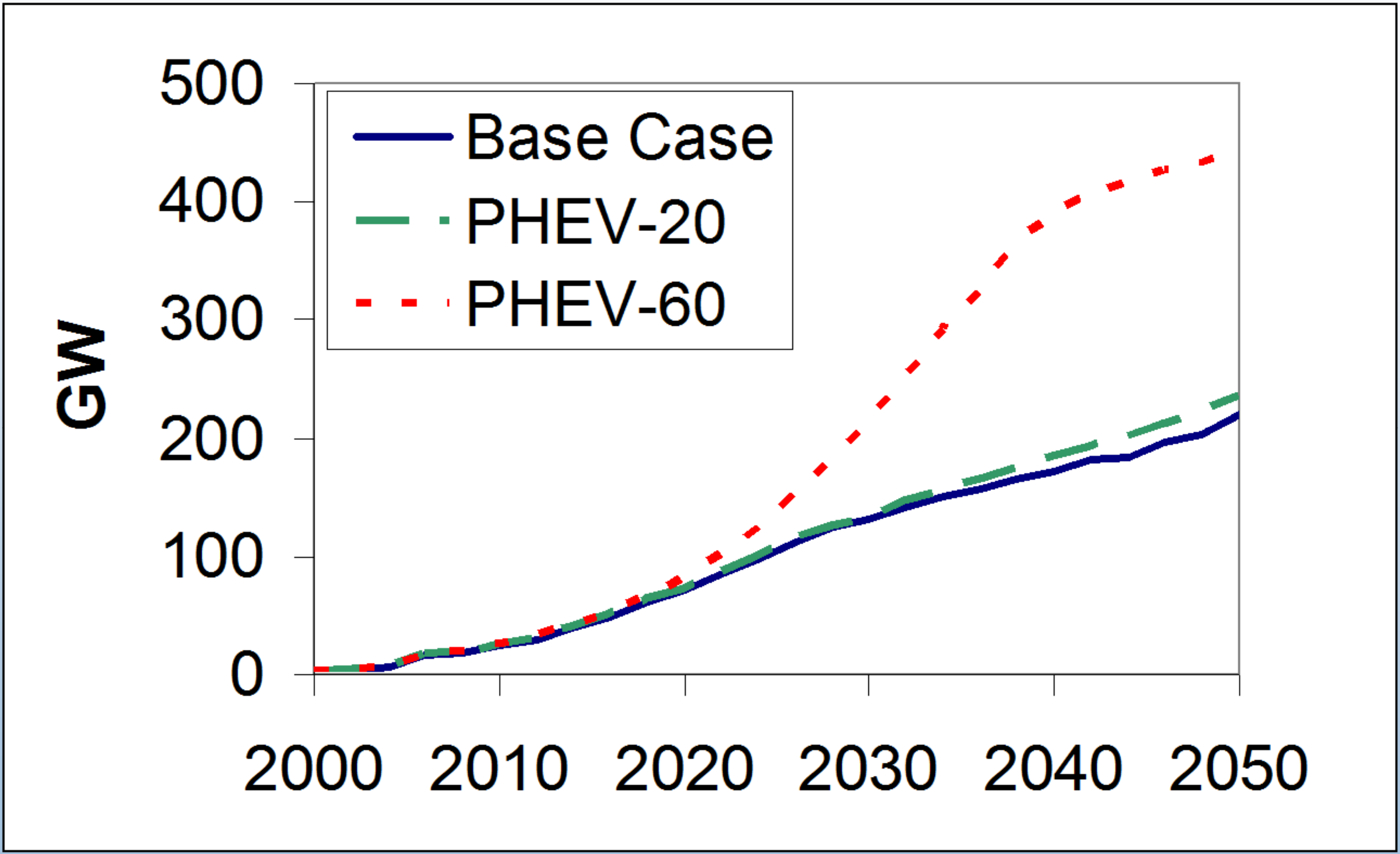


* Kilotons/yr

Plug-in Hybrid Electric Vehicle Modeling

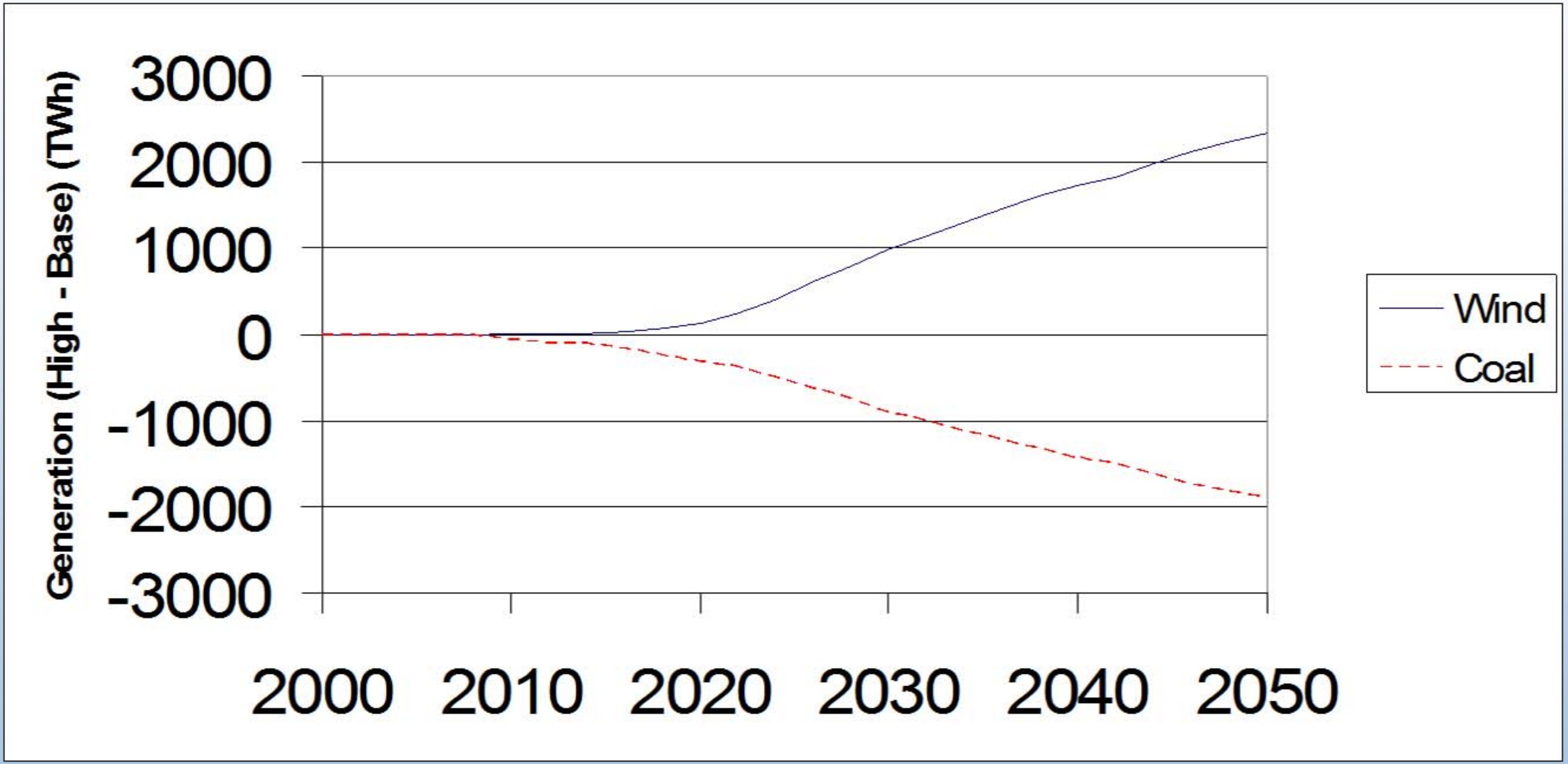


PHEVs* Can Increase Wind Penetration



* Assumes 50% PHEV-V2G penetration by 2050

Coal Generation: PHEV60 – Base Case



Industry Partnerships

- Who:
  - Utilities
  - Corporations
  - Developers
  - Investors

- What:
  - Strategic Planning
  - Market Insights
  - Scenario Modeling & Impacts
  - Expert Review
  - Transformational Applications

PHEVs: What are the Impacts to Xcel Energy*?

- Infrastructure Utilization
- Additional Load

- Production Costs
- Capacity Impacts
- Emissions

UNKNOWN

Can Xcel Energy mitigate adverse impacts with controls or incentives?

Sneak Preview

Time of charging matters…

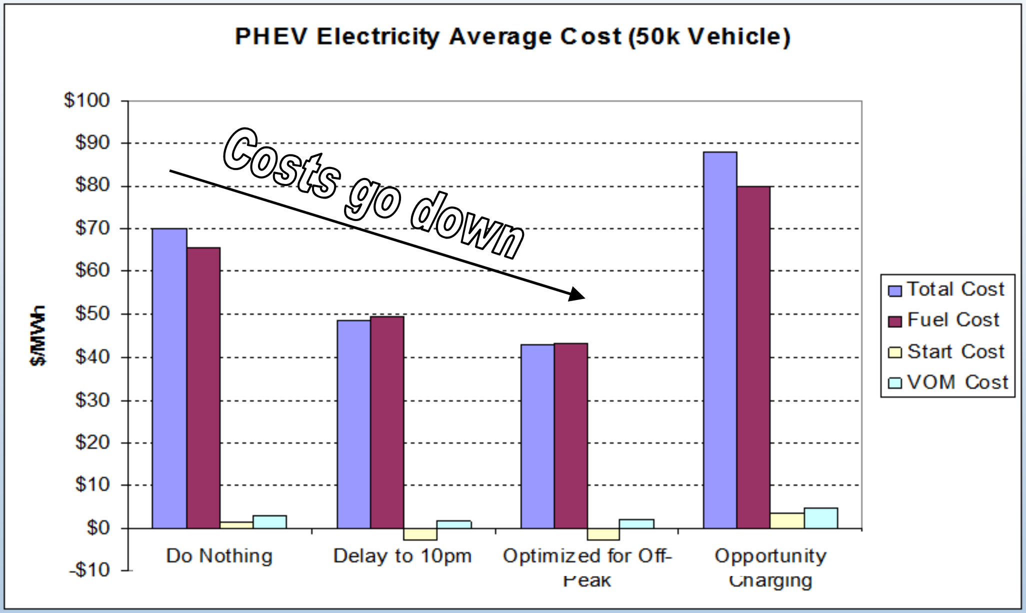
Coincident peak loading matters…

Tailpipe versus upstream emissions matters…

Xcel Energy's Utility Innovations. Other partners: Global Energy Decisions, Hybrids Plus, CO Governor's Office of Energy Management and Conservation

Incremental Cost (Generation Capacity)

- Costs are dominated by fuel cost
- As power is moved to the off-peak period…

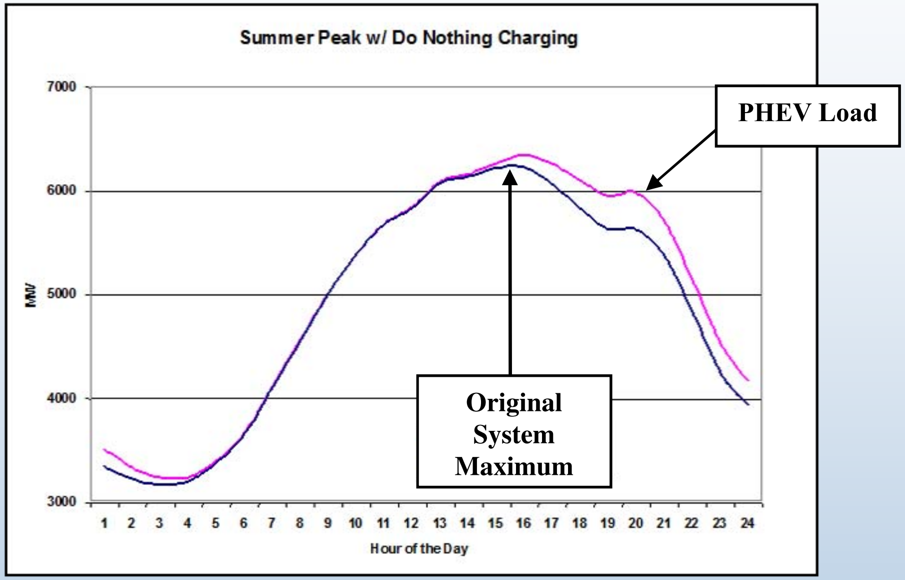


- Opportunity charging is the most costly charging strategy, but utilizes 75% more energy

Incremental Cost (Generation Capacity)

- Coincident peak loading necessitates additional generation capacity

- *Delay to 10pm* and *Optimize to Off-Peak* scenarios avoid capacity expansion costs



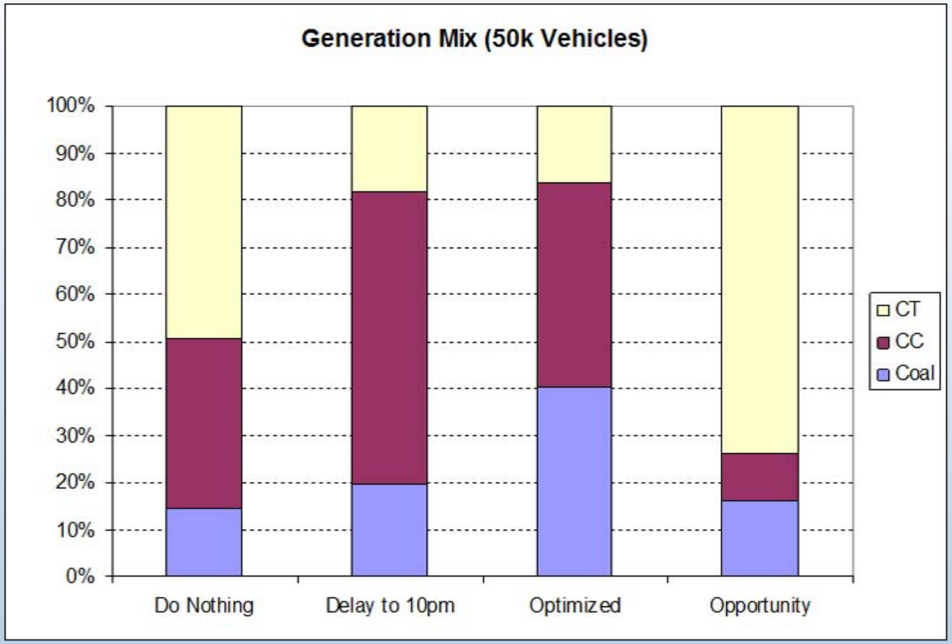
Charging Scenario	Annual Capacity Costs
Do Nothing	$126/kW* @ .238 kW/car = $30/car
Opportunity Charging	$126/kW* @ .548 kW/car = $69/car

*Assumptions: 15% IRR; 20% Capacity Margin; $700/kW overnight cost (combustion turbine)

Incremental Cost (Generation)

- Two significant changes when shifting PHEV load to the off-peak
  - *Delay to 10pm* shifts generation from CT to CC
  - *Optimized to Off-Peak then* shifts generation from CC to coal steam.

- Opportunity charging largely served by CT



*Other generation such as hydro, diesel, and wind are small contributors to incremental generation and are excluded from this graph

Synopsis

- Core Strengths:
  - Technoeconomic Systems Analysis
  - Geospatial Energy Economics
  - US Markets for RE/EE Technology
  - Policy and Technology Options Analysis
  - Uncertainty, Risk, and R&D Portfolio expertise