WinDS-H2 Model and Analysis

2004 DOE Hydrogen, Fuel Cells & Infrastructure Technologies Program Review

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May 25, 2004

This presentation does not contain any proprietary or confidential information.

Project Objectives

- Identify the scenarios, time frames and regions of the U.S. in which wind turbines that generate both electricity and hydrogen are likely to become economical
- From a market perspective, optimize wind system concepts that produce both electricity and hydrogen, both today and in the future

Budget

- Funded as a part of the NREL Hydrogen Analysis task

- Total FY04 Funding: $230 K

Technical Barriers and Targets

- Hydrogen Generation by Water Electrolysis Barriers
  - T. Renewable Integration
- Targets
  - Verify renewable integrated electrolytic hydrogen production at $2.50/kg

Approach

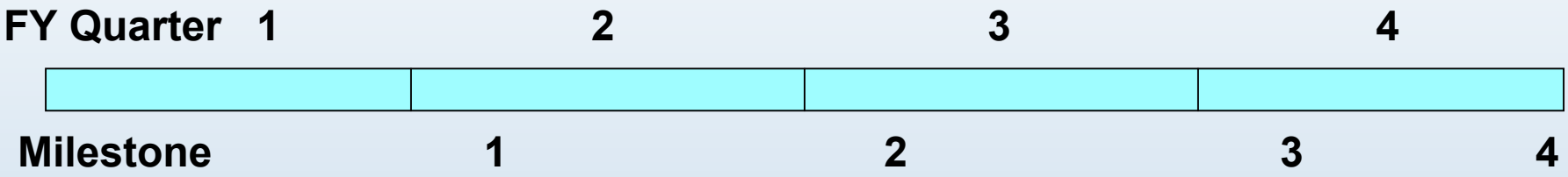
- Add hydrogen production from wind to NREL's WinDS model
  - WinDS-H2 is a multi-regional, multi-time-period model of capacity expansion in the electric sector and H2 production from wind in the U.S.

- Evaluate the market potential for hydrogen from wind under different scenarios using WinDS-H2

Project Safety

- Inasmuch as this project is a computer-based analysis effort, there are no safety issues

Project Timeline



Project started in June 2003

Milestones/Deliverables (* completed):

1) Base case analysis report *

2) Report on the addition of steam methane reforming to WinDS-H2*

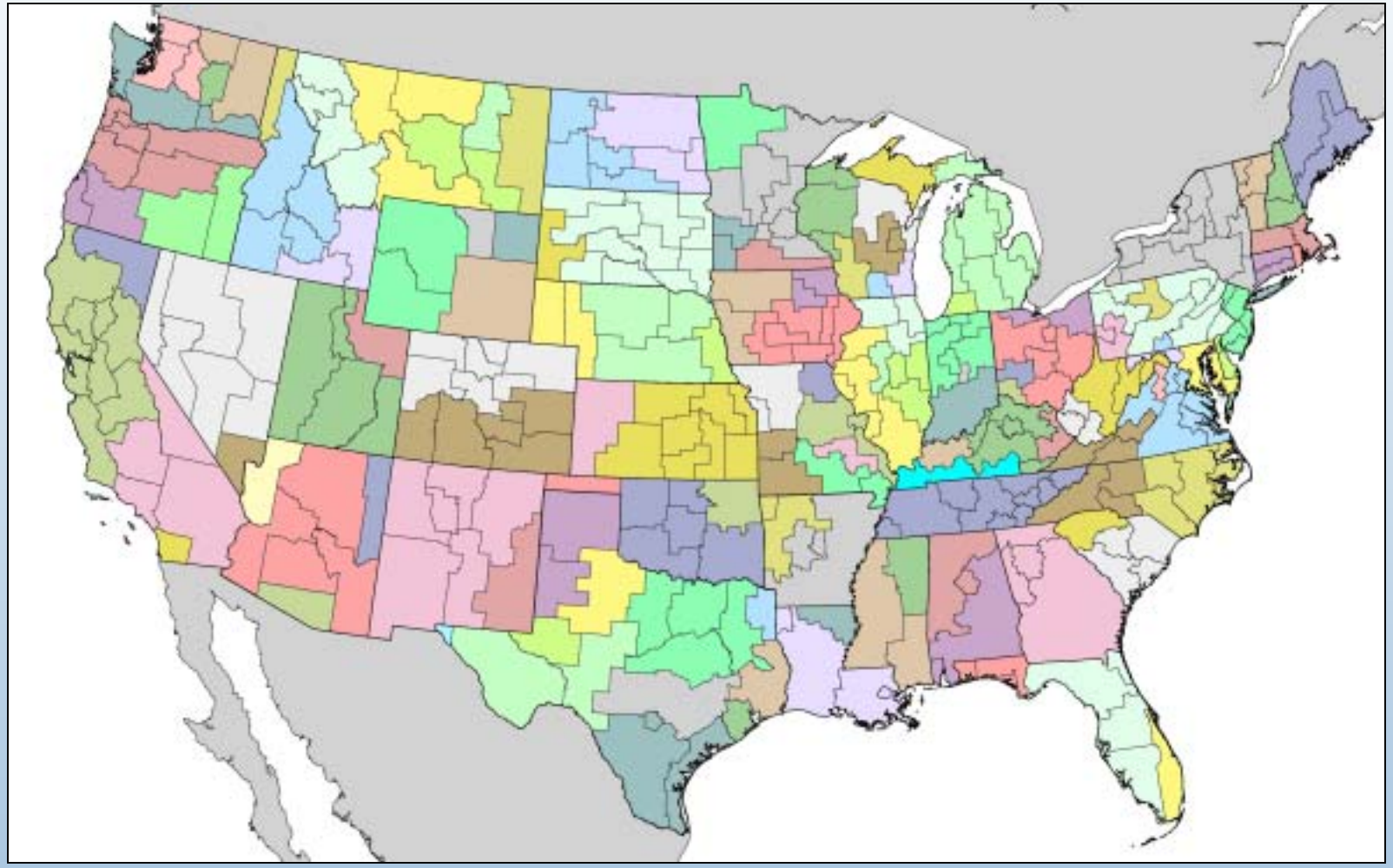
3) Report on the addition of other renewable technologies to WinDS-H2

4) Summary of analysis to answer project questions for wind/H2 analysis

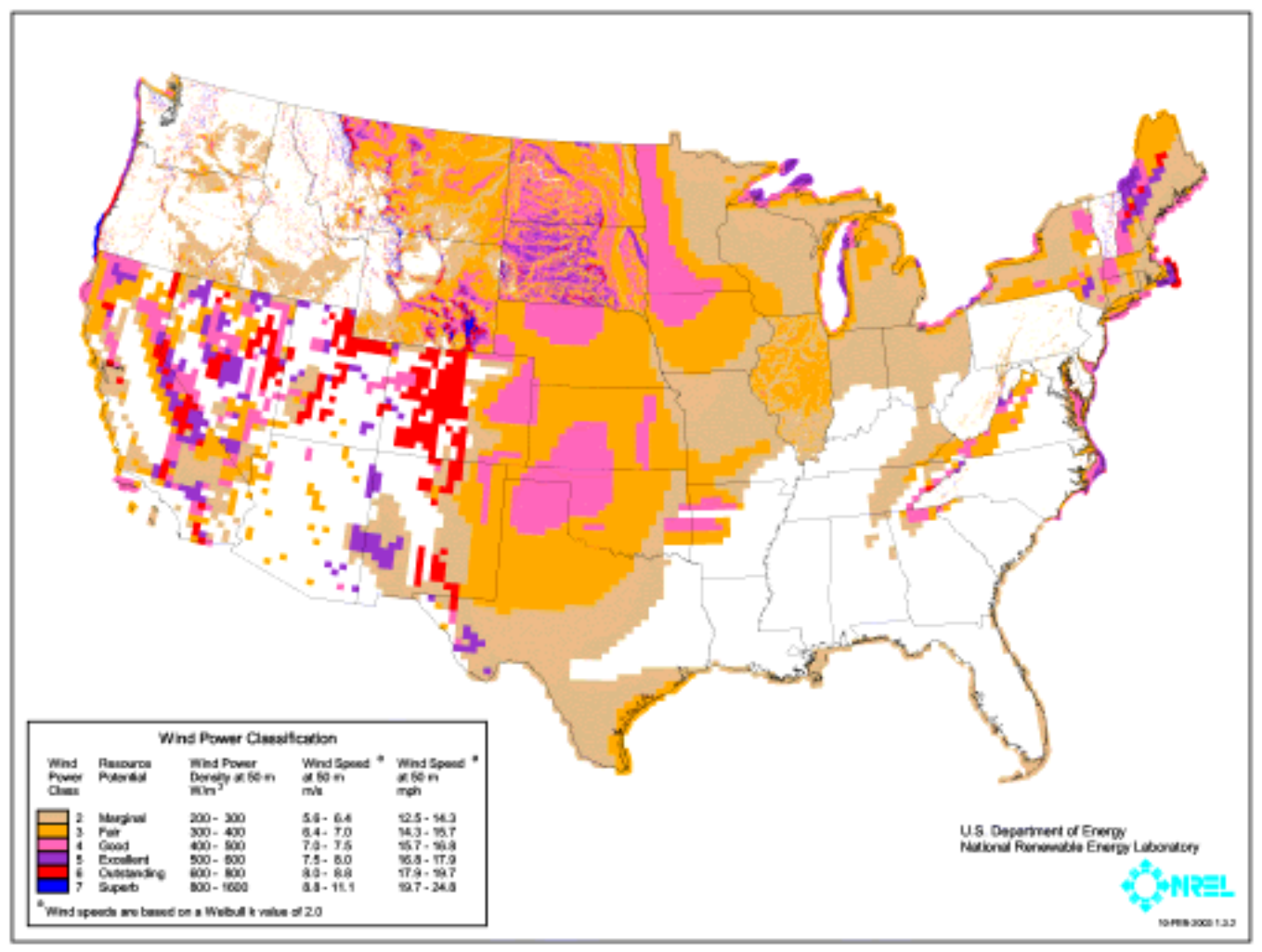
Accomplishments

- WinDS-H2 Model: A brief description
- Base Case results
- A sensitivity case

WinDS Regions

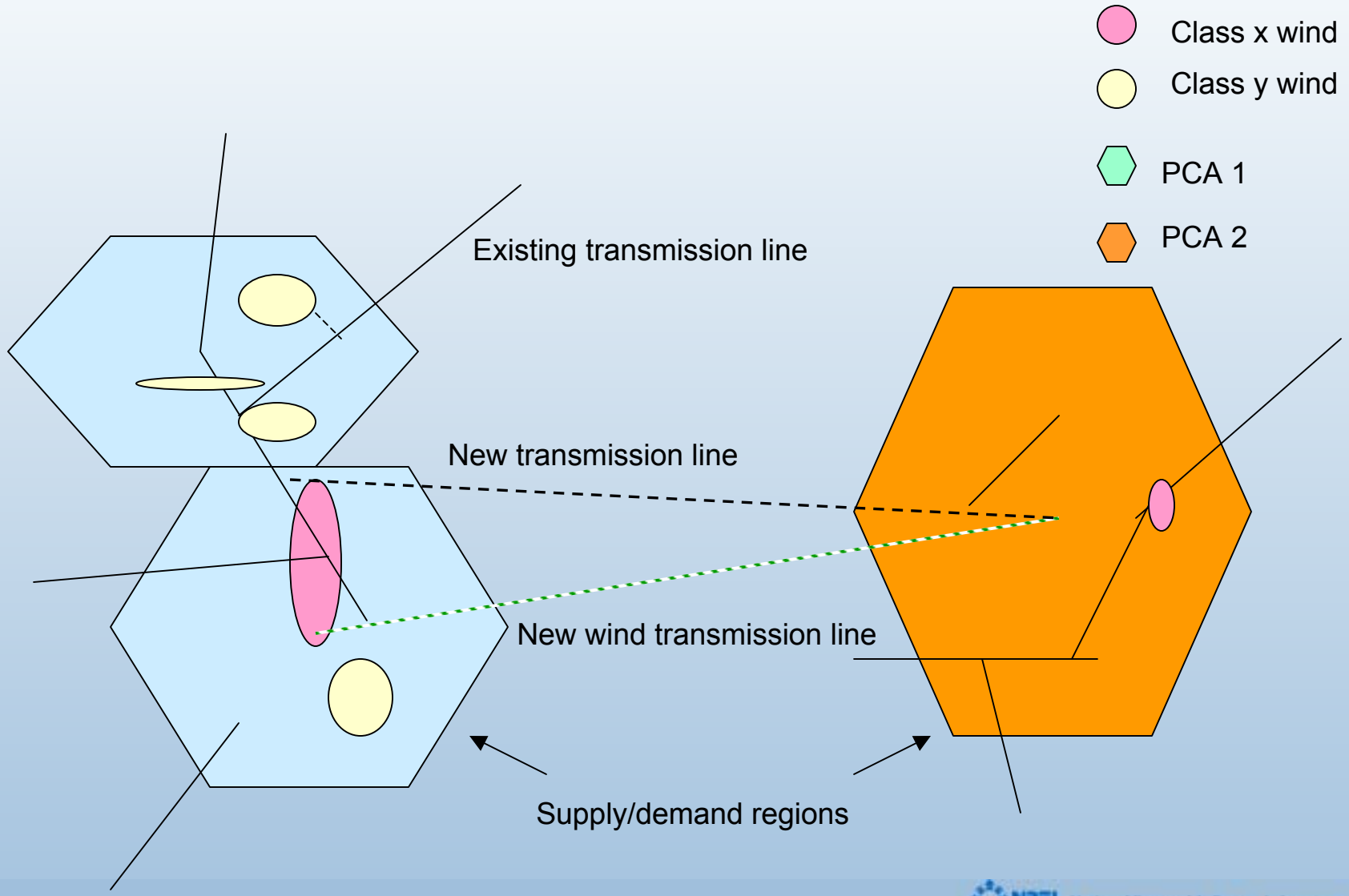


Wind Resources

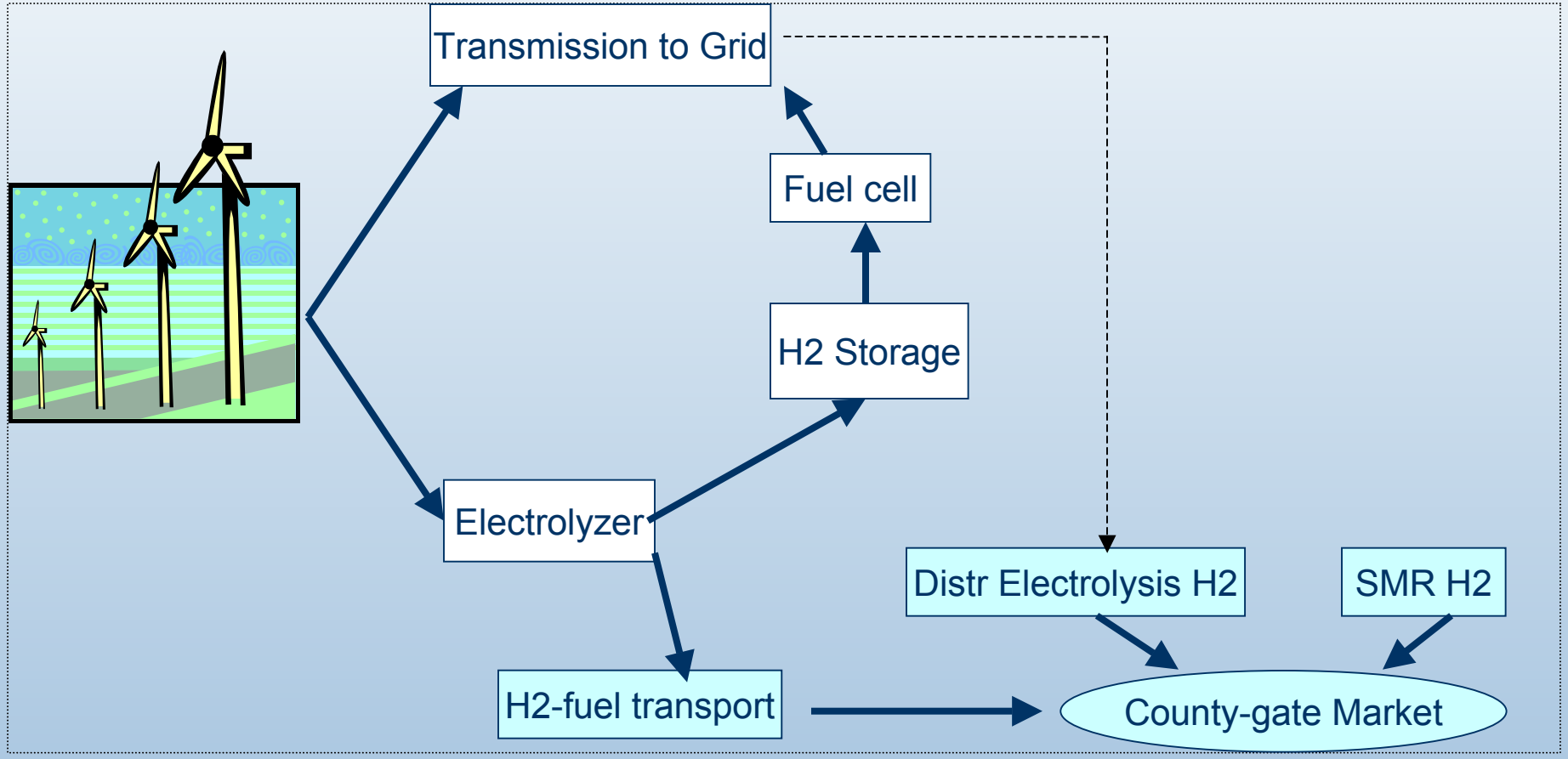


Transmission in WinDS

Constraints on Wind Transmission



Hydrogen in WinDS-H2



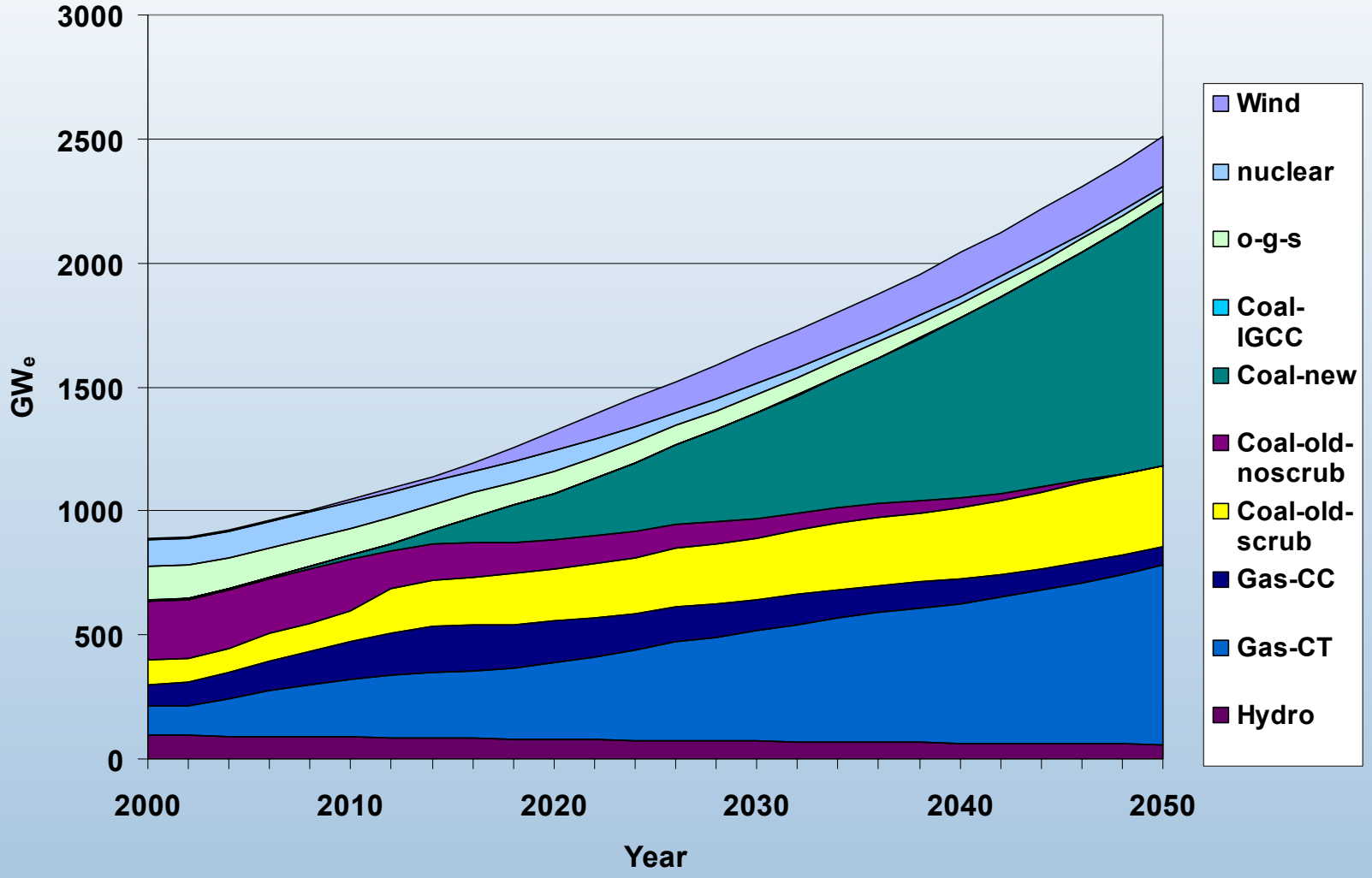
Cost/Performance for Class 6 Wind Resources

Year	Capital Cost ($/kW)	Capacity Factor
2000	942	0.4
2010	754	0.5
2020	706	0.54

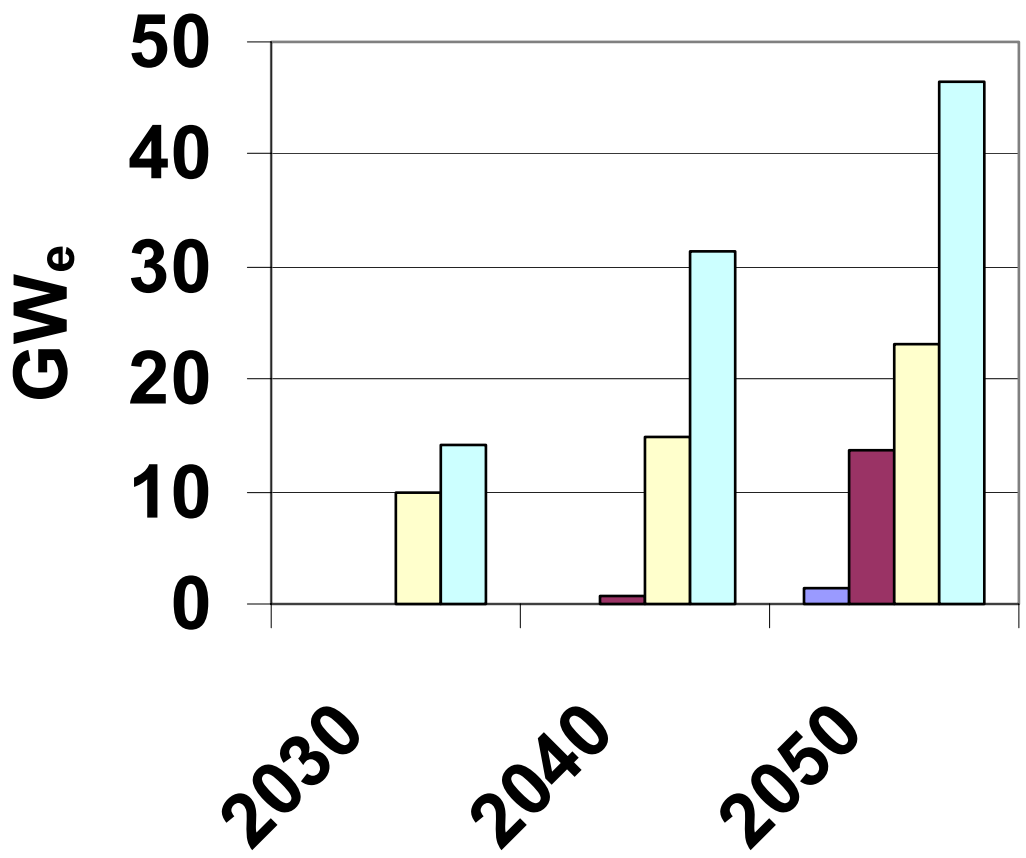
2010 H2 Technologies Cost/Performance Scenario

Technology	Capital Cost	Efficiency %
Electrolyzer	$150/kWe	80
Fuel Cell	$400/kWe	50
Steam Methane Reformer	$4/kg-yr	70

Base Case Results

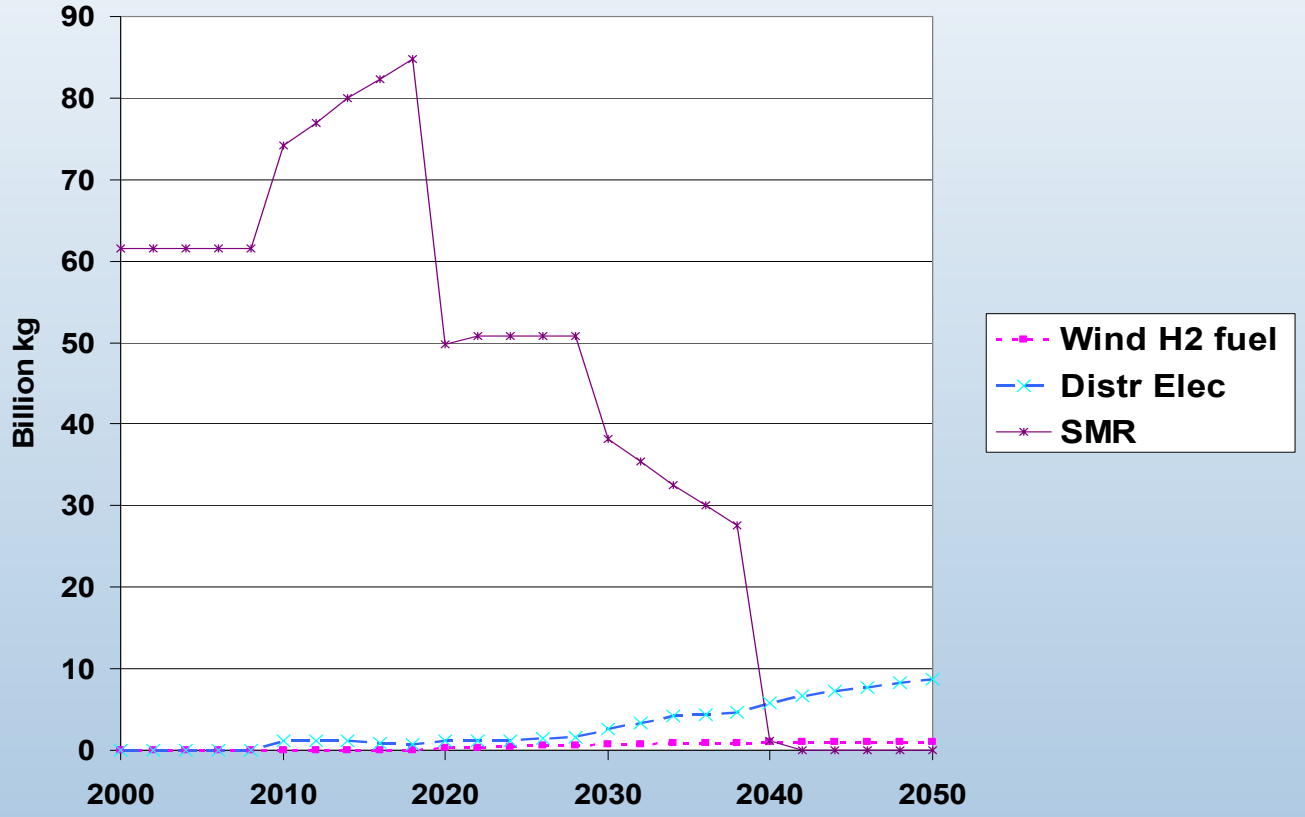


Capacities in the Base Case

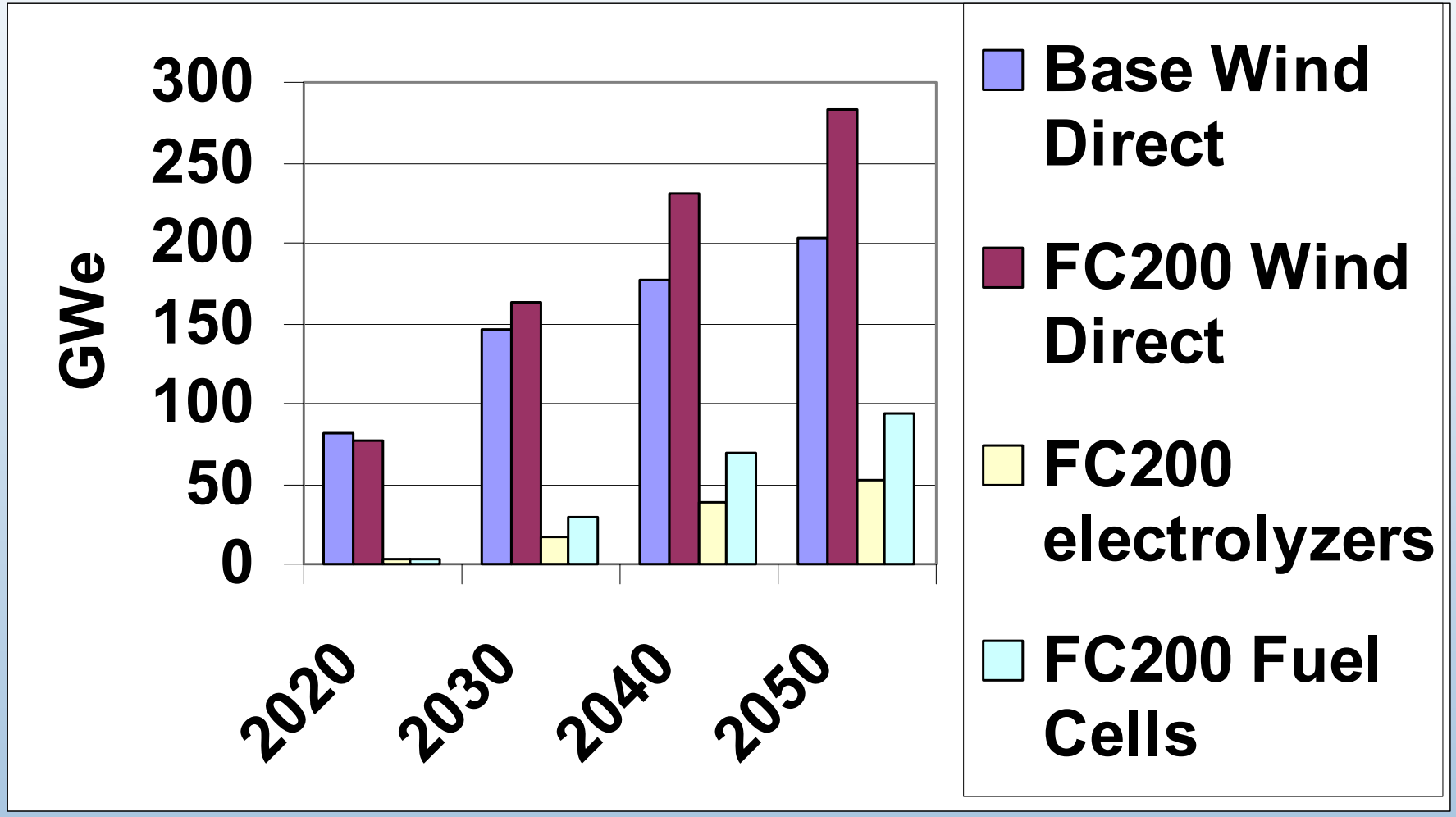


- Fuel cells at wind farms
- Wind to electrolyzers at wind farms
- Add'l Wind direct to grid
- Distributed electrolyzers at load centers

Hydrogen Production in the Base Case



A Sensitivity Case: Reduced Fuel Cell Costs



Conclusions

- The use of electrolyzers and fuel cells at wind sites to store/shift wind generation from off-peak to on-peak periods is unlikely due to round-trip efficiencies and costs.
- Where wind resources are close to transportation fuel demand centers, electrolyzers at wind farms may be preferred to electrolyzers distributed close to the demand center.
- Wind's most substantial contribution may be as power to the grid needed for the additional demand for power required by distributed electrolyzers.

Interactions and Collaborations

- Interaction with DOE and NREL Hydrogen Programs Analysis staff for hydrogen system configuration and data inputs.
  - Mark Paster
  - Maggie Mann
  - Johanna Ivy
- Interaction with NREL Wind Program staff for wind system costs
  - Alan Laxson
  - Lee Jay Fingersh

Responses to Previous Year's Comments

- This is a new project
- There has been no prior review

Future Work

- Complete FY2004 deliverables
  - Add biomass as a source of H2
  - Document methodology and analyses
- Assess different scenarios of markets and costs
- Continue to refine model and data inputs