Modeling High-Penetration Wind Scenarios: WinDS Model Results

Presentation to
Wind Powering America Summit
June 8, 2006

Walter Short, Nate Blair, Paul Denholm,
Donna Heimiller

Contents

- Brief Description of the WinDS Model (5)
- Base Case results (3)
- 3 High-Penetration Cases (7)
  - Carbon Tax
  - PTC extension
  - High Gas prices

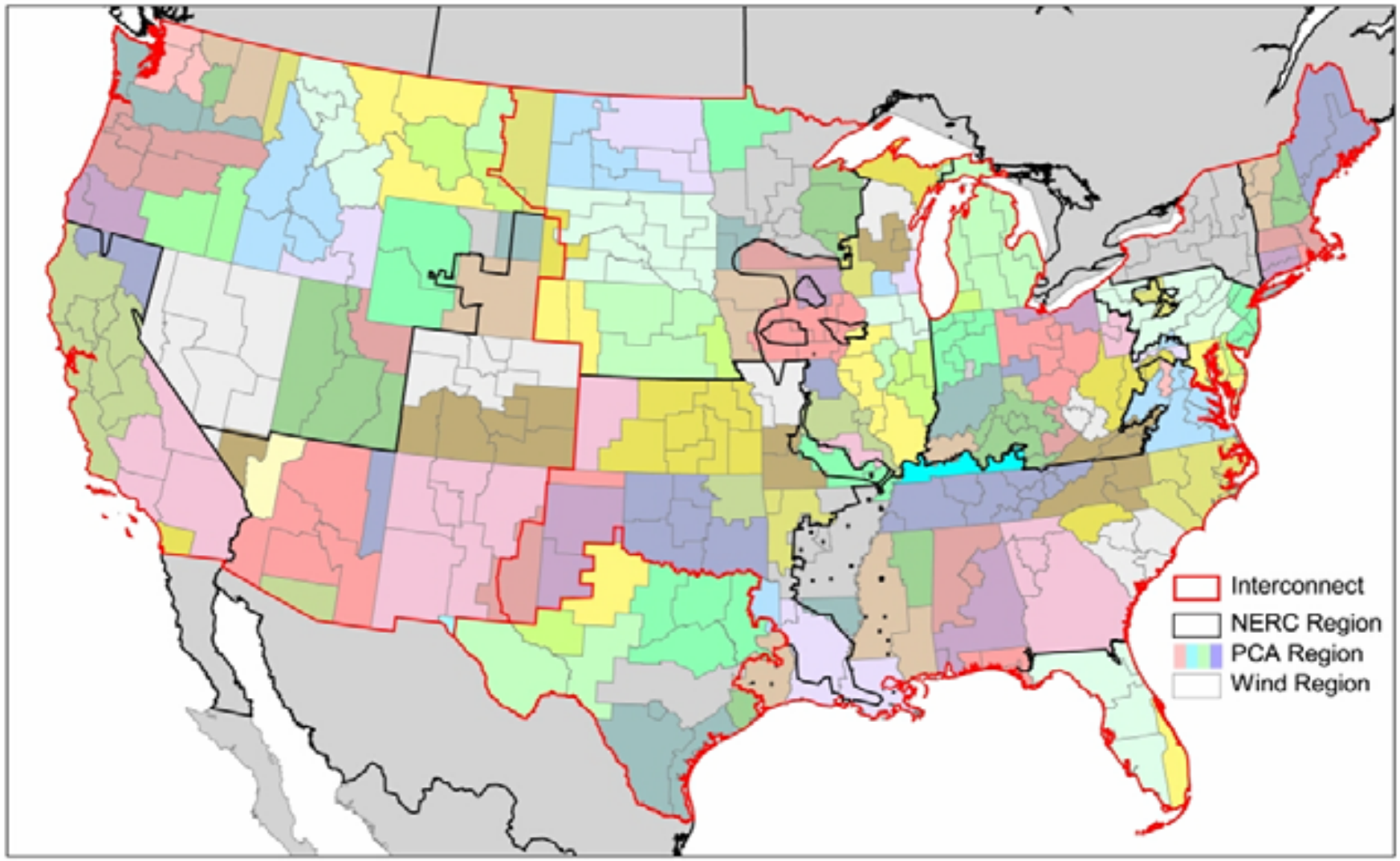
WinDS Model

(**Win**d **D**eployment **S**ystems Model)

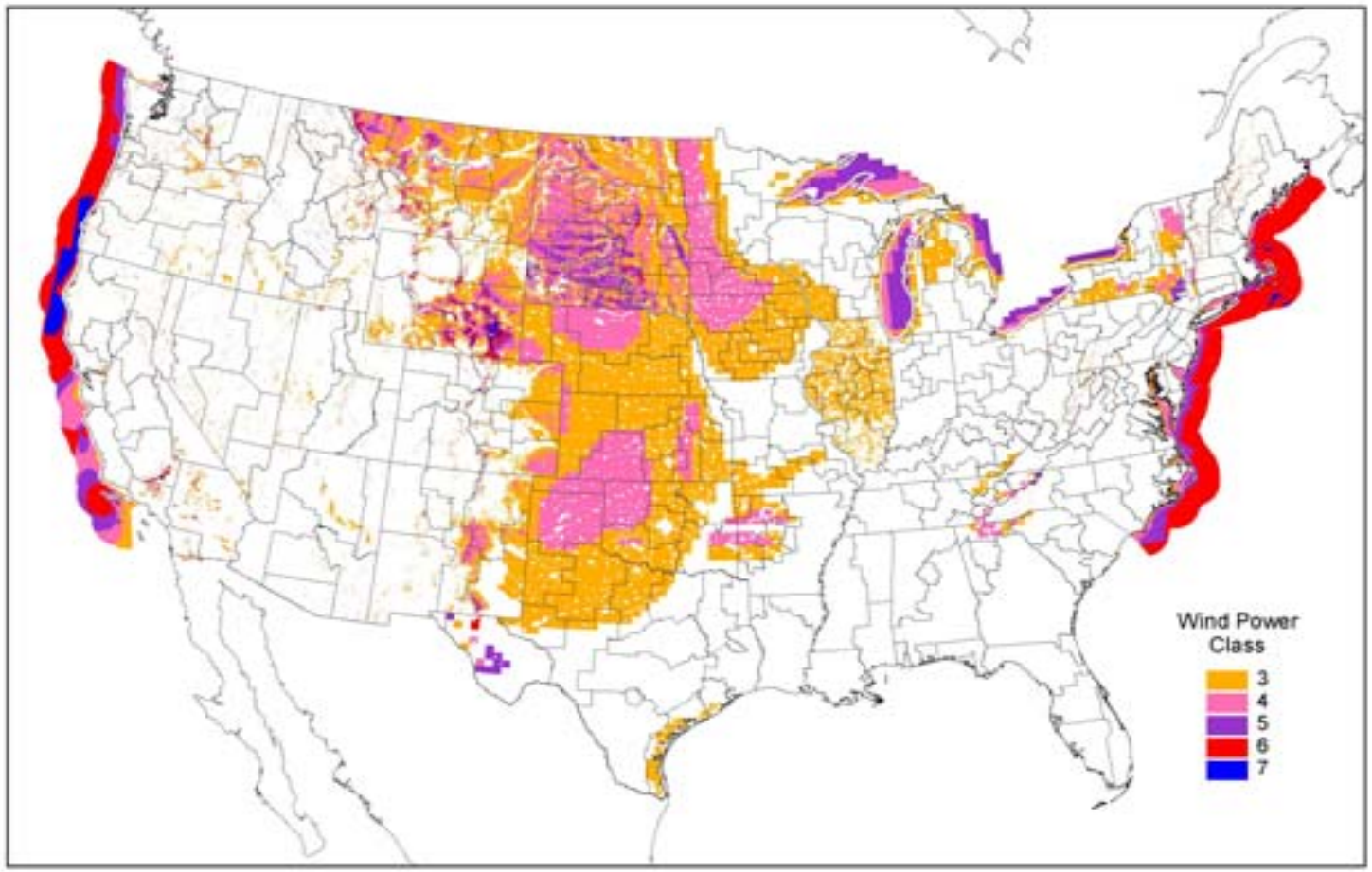
A multi-regional, multi-time-period model of capacity expansion in the electric sector of the U.S.

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

WinDS Regions



Wind Resources in WinDS



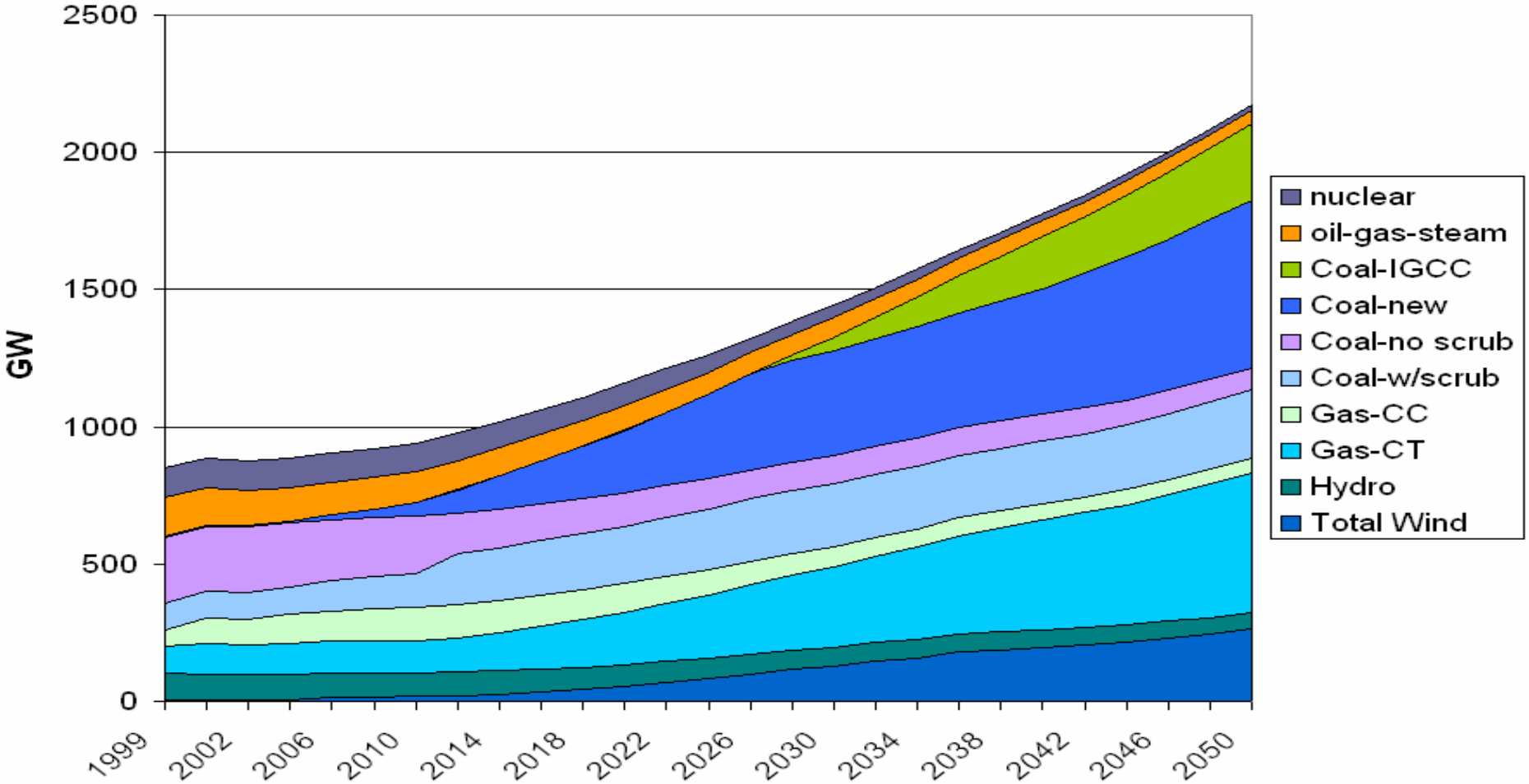
WinDS is Designed to Address the Principal Market Issues for Wind

- Access to and cost of transmission
  - Class 4 close to the load or class 6 far away?
  - How much wind can be transmitted on existing lines?
  - Will wind penetrate the market if it must cover the cost of new transmission lines?
  - Will offshore wind close to seaboard loads penetrate?
- Resource Variability
  - How does wind capacity credit change with penetration?
  - How do ancillary service requirements increase with wind market penetration
  - How much would dispersal of wind sites help?
  - Is on-site storage cost effective?

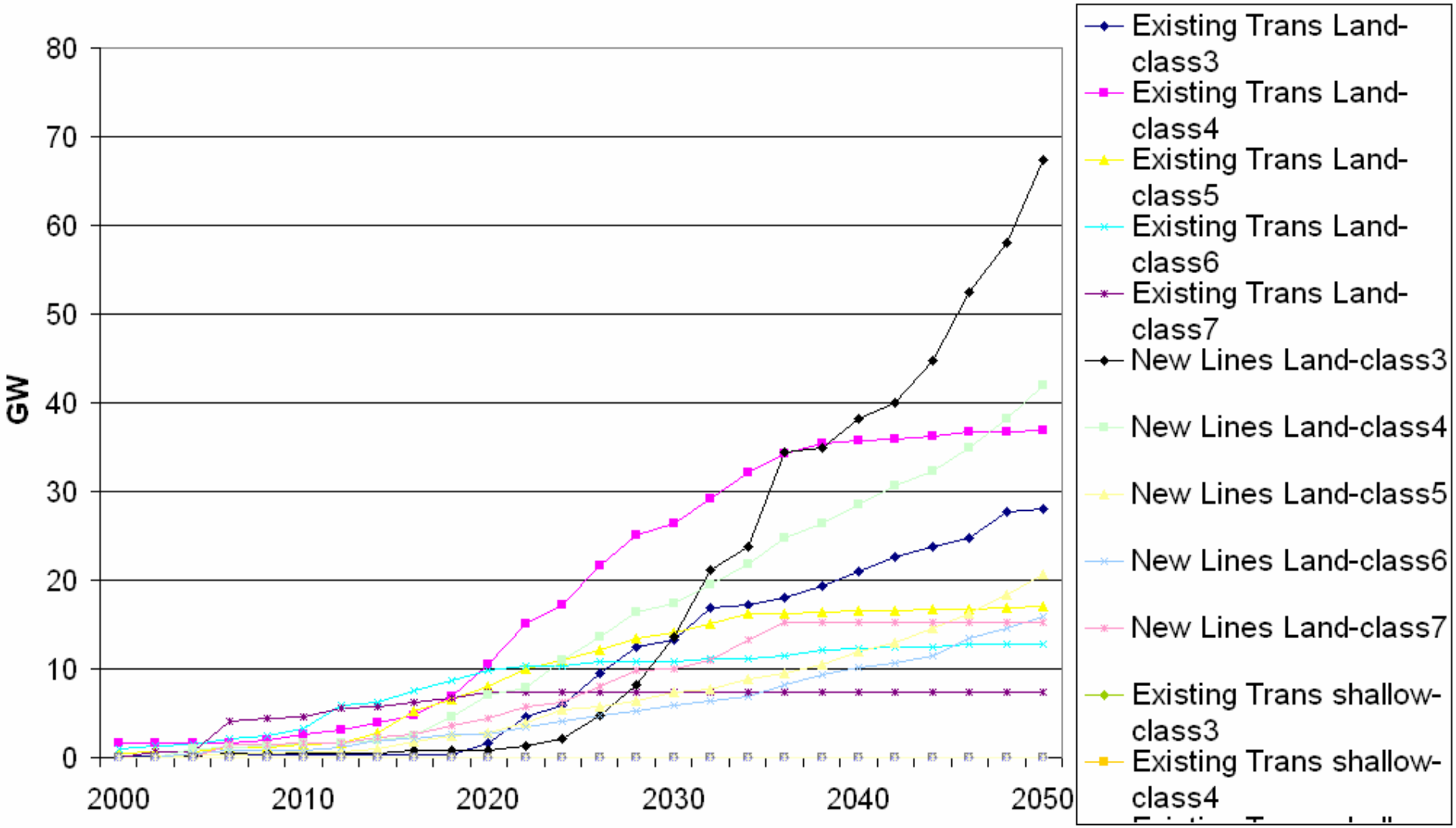
General Characteristics of WinDS

- Linear program cost minimization for each of 26 two-year periods from 2000 to 2050
- Sixteen time slices in each year: 4 daily and 4 seasons
- 4 levels of regions – wind supply/demand, power control areas, NERC areas, Interconnection areas
- Existing and new transmission lines
- 5 wind classes (3-7), onshore and offshore shallow and deep
- All major power technologies – hydro, gas CT, gas CC, 4 coal technologies, nuclear, gas/oil steam
- State-level incentives and RPS
- Stochastic treatment of wind resource variability – planning reserves, operating reserves, surplus wind

Base Case Electricity Capacity

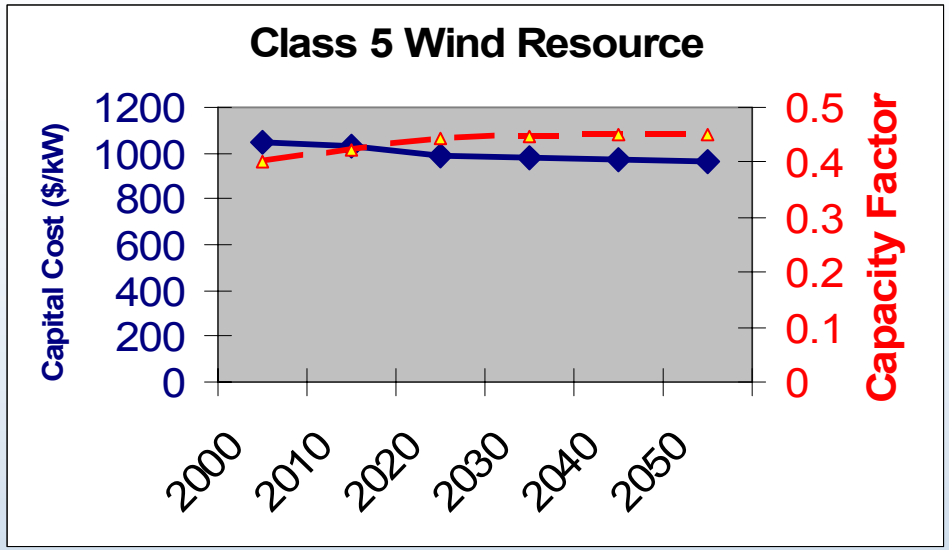


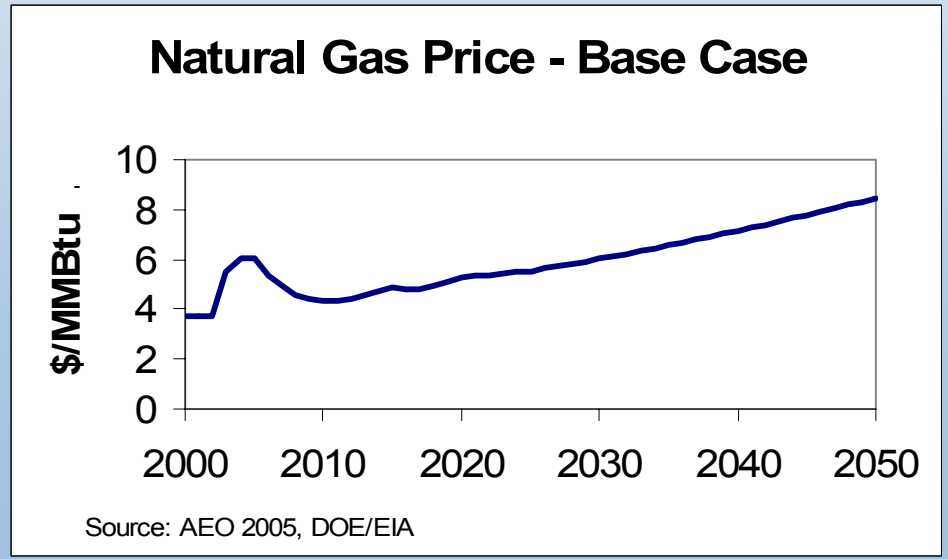
Base Case Capacity by Wind Class



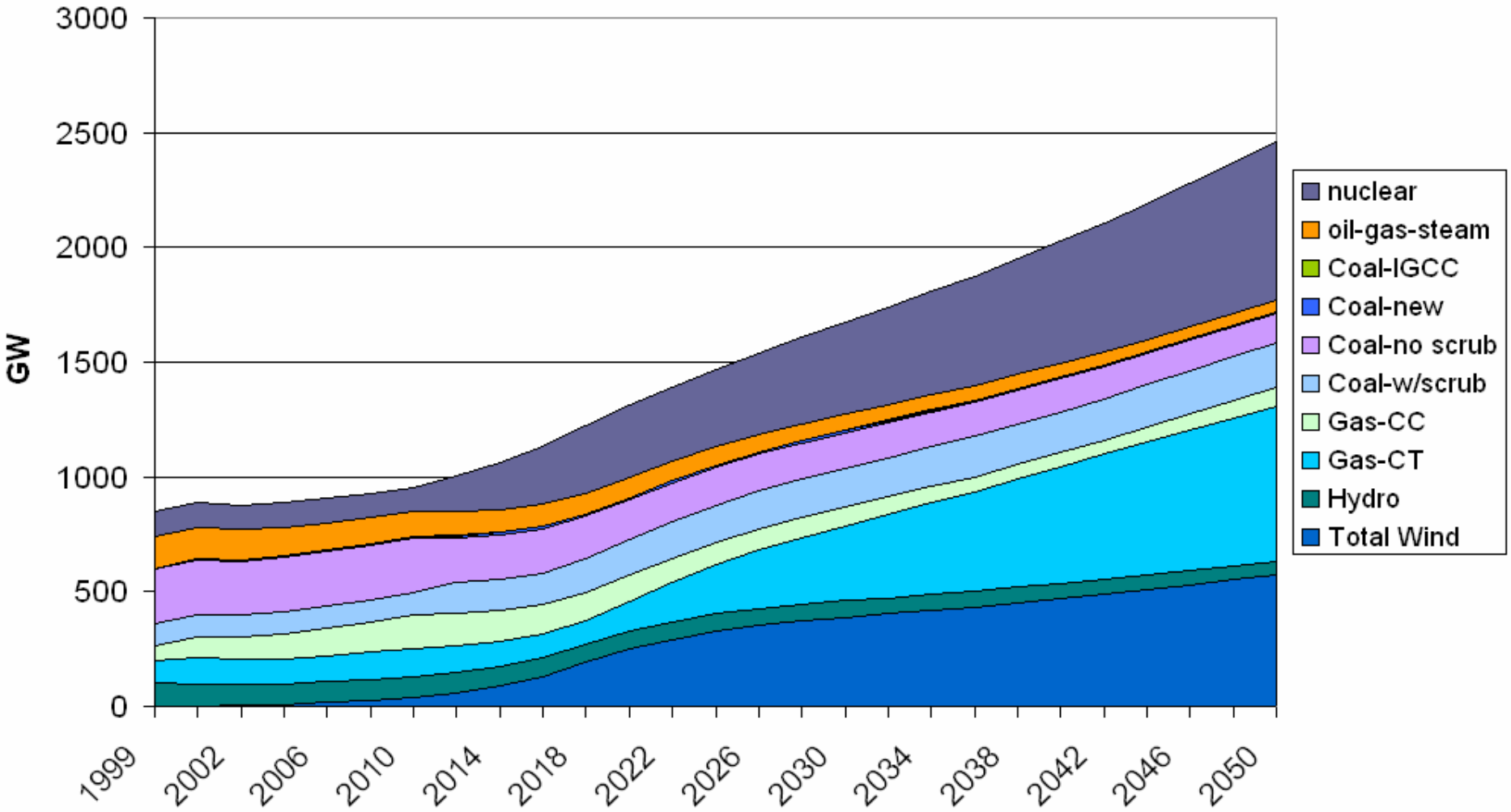
Base Case Key Inputs

- Wind R&D-driven Cost/Performance improvements
- 8% wind learning rate
- 1.9 cent/kWh PTC through 2007
- No carbon caps/tax
- Gas prices

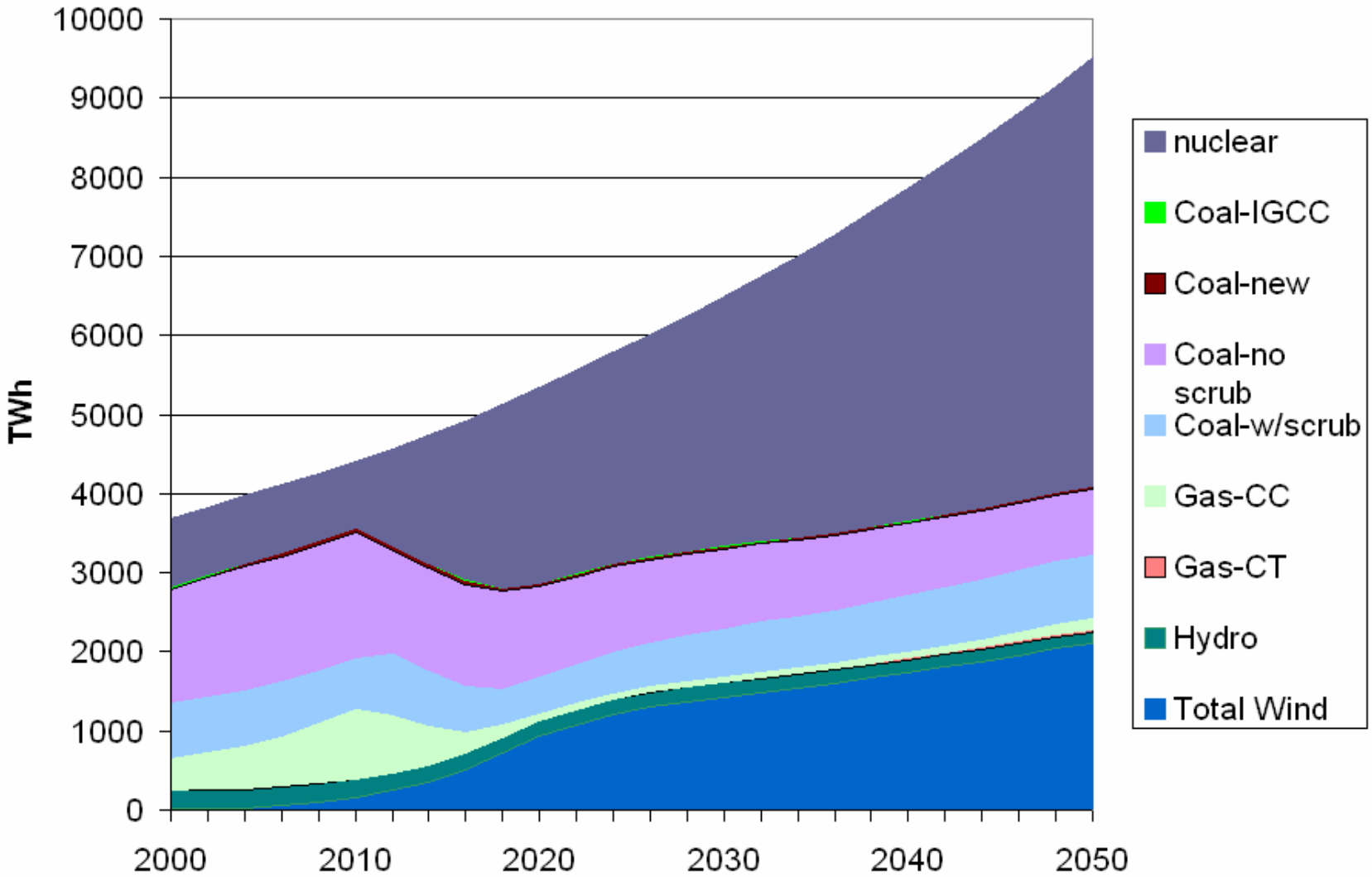




$100/ton Carbon Case - Capacity

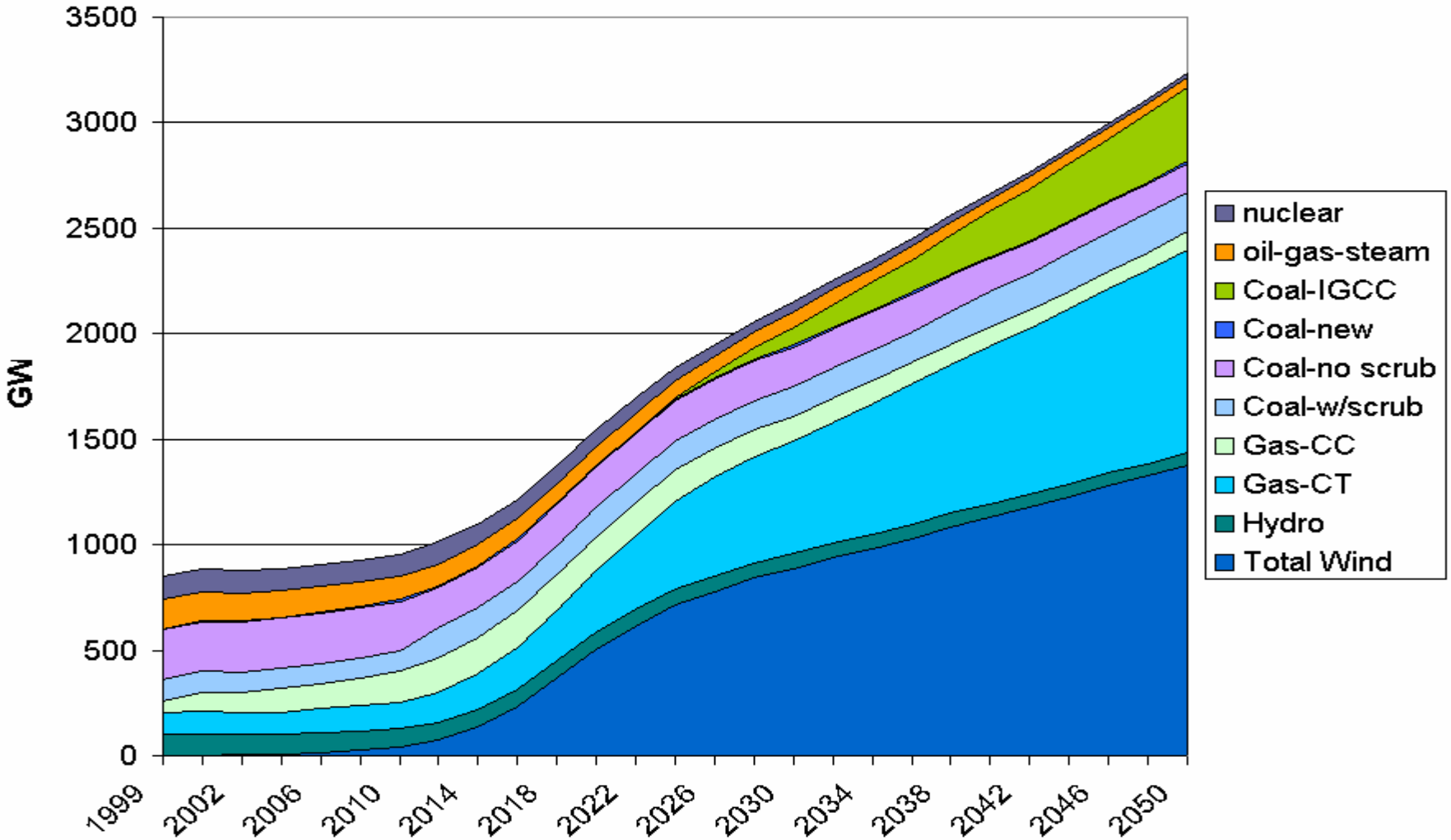


$100/ton Carbon Case - Generation

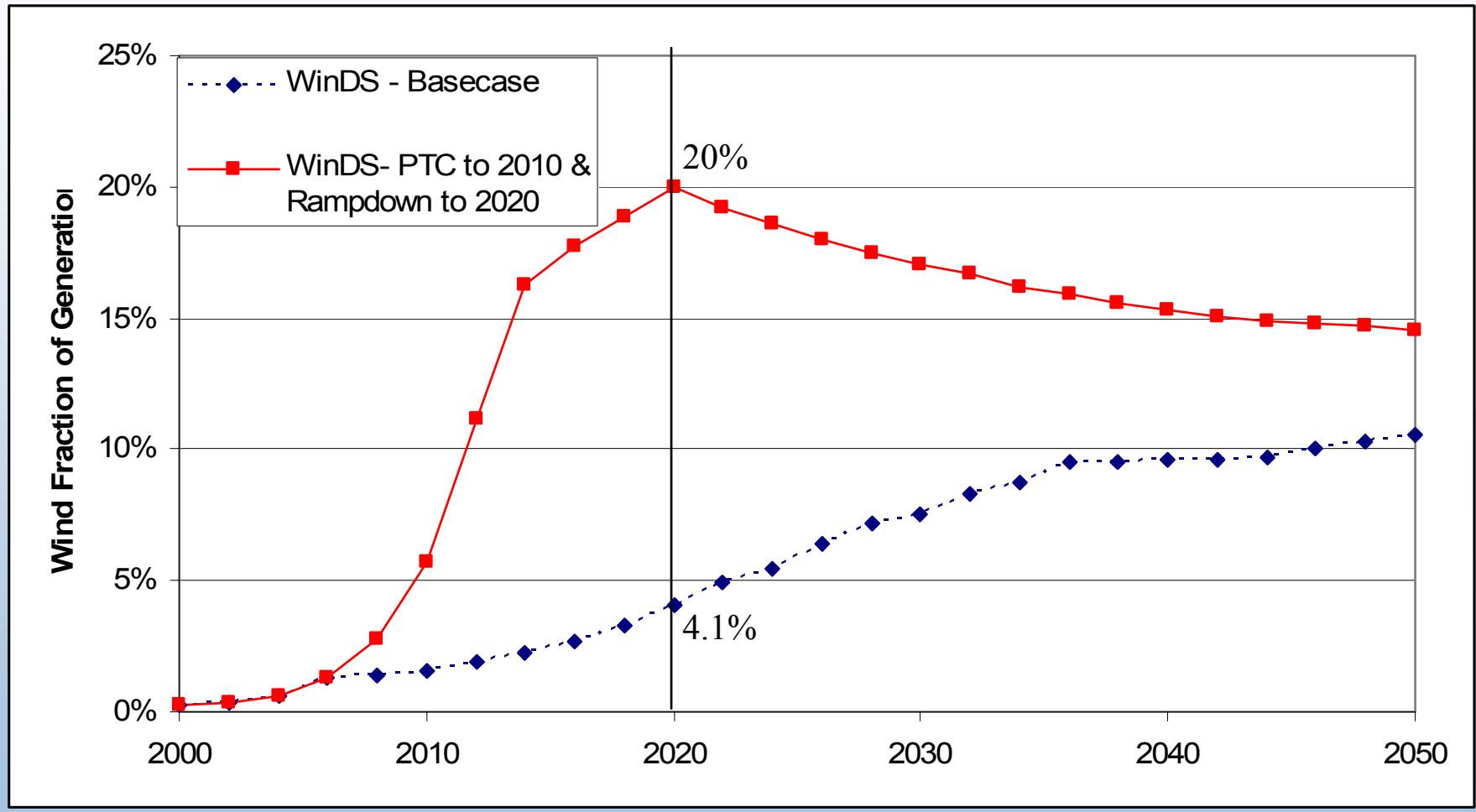


$100/ton Carbon – No New Nukes

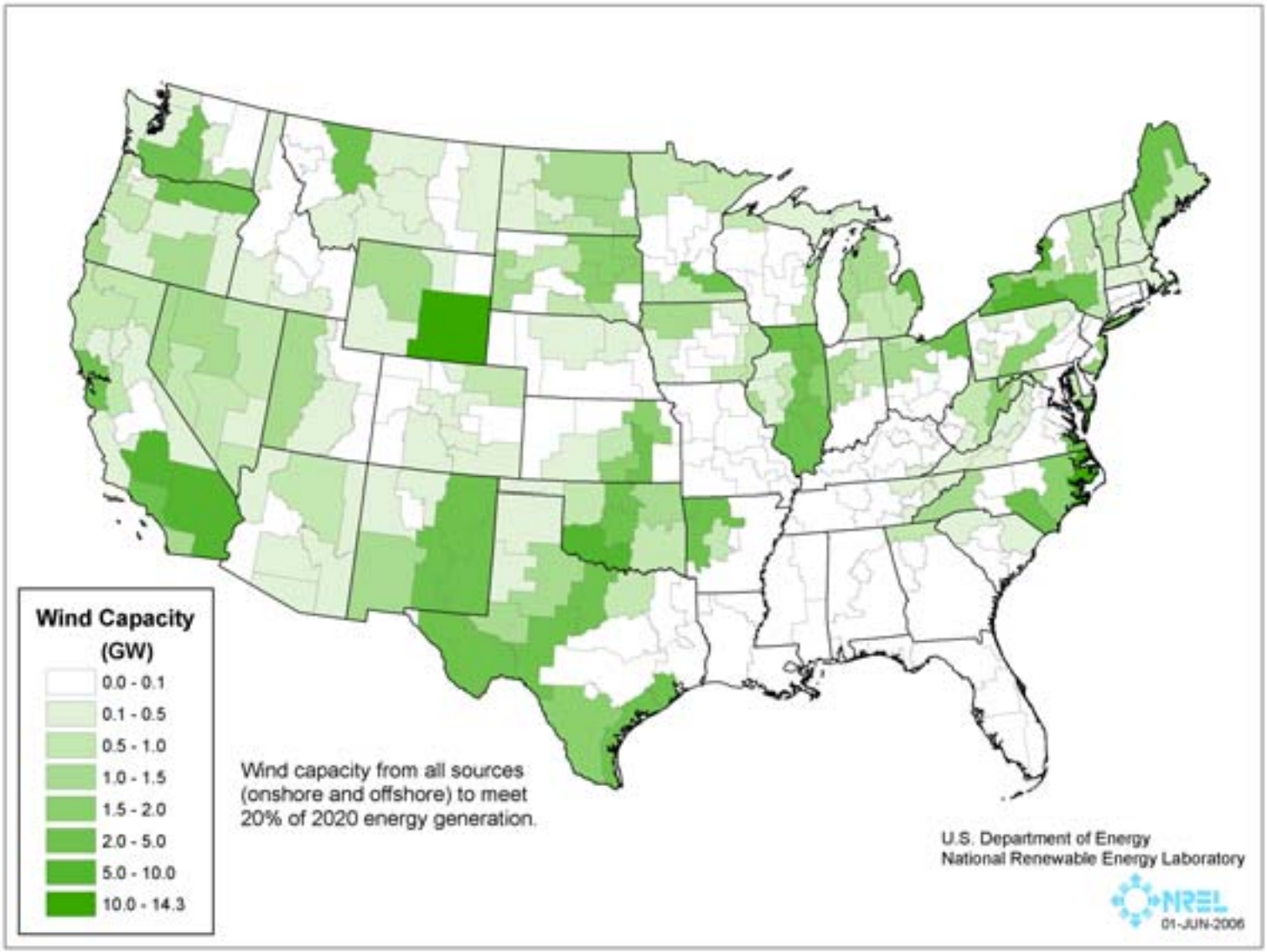
Capacity



A PTC Extension to 2020 Could Result in 20% of Generation from Wind by 2020

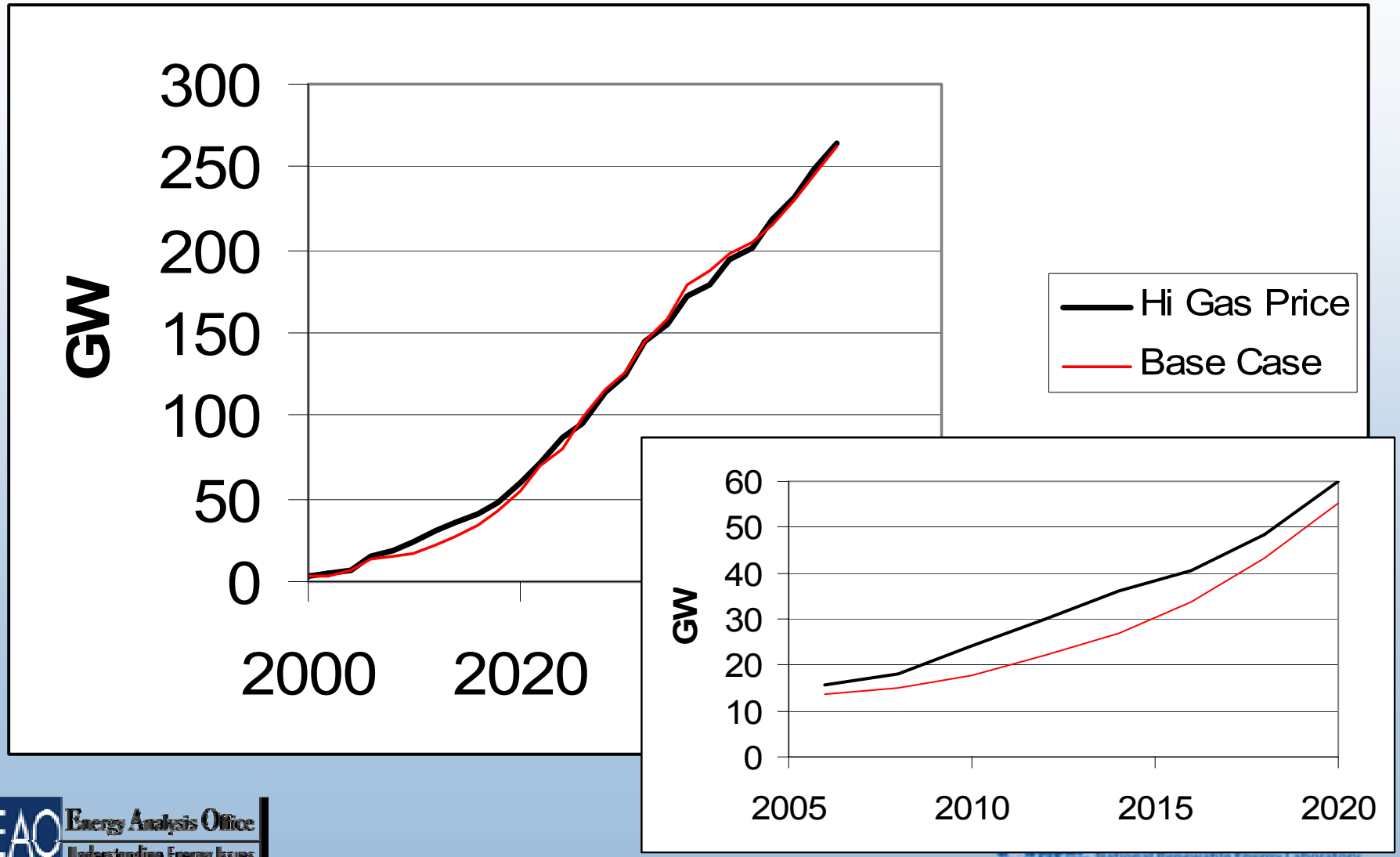


Regional Wind Installations by 2020 with PTC*



* PTC to 2010 with ramp down by 2020

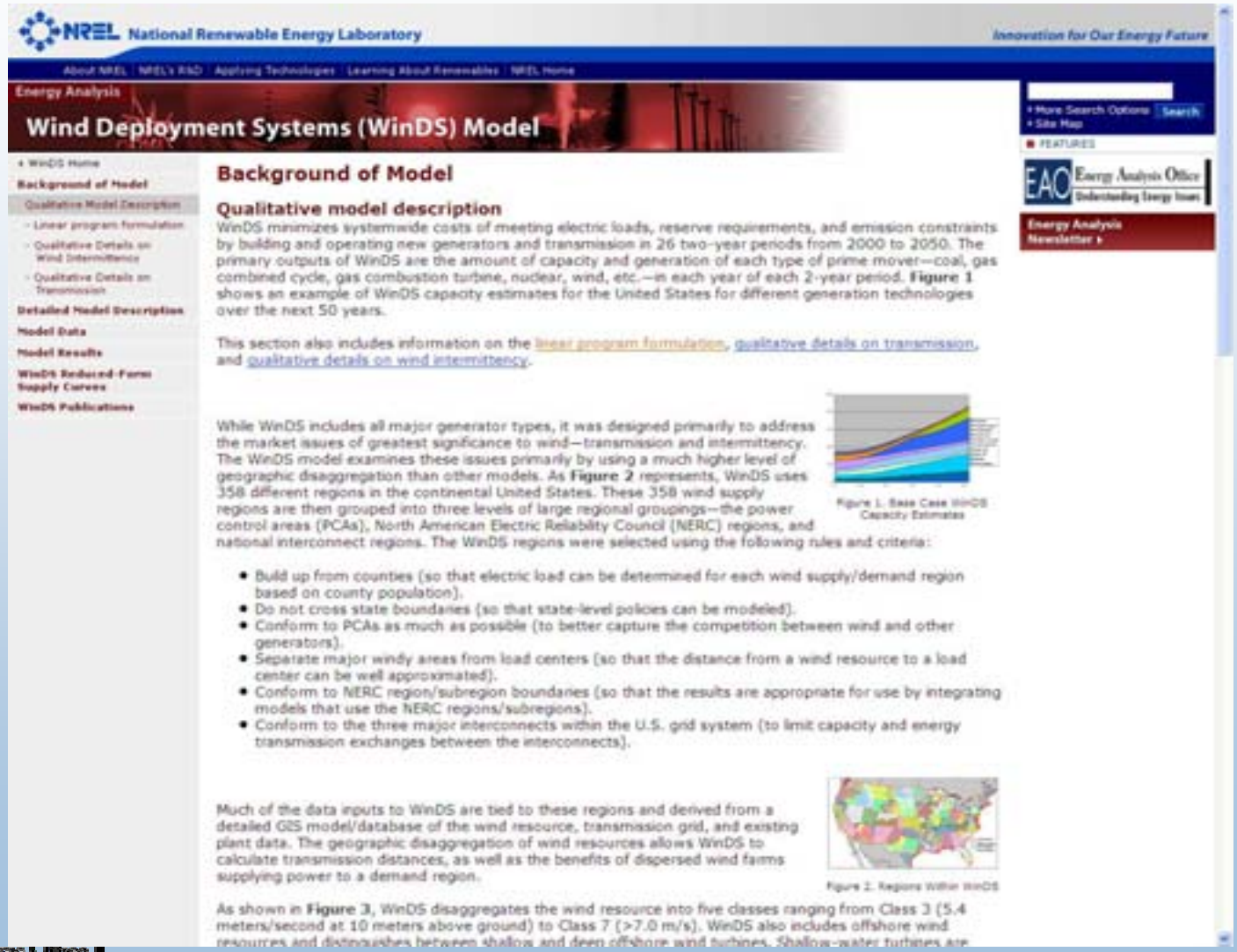
High Gas Prices Do Not Increase Wind Penetration in the Long Term



Energy Analysis Office
Understanding Energy Issues

NREL National Renewable Energy Laboratory

New Website (documentation and results) at: http://www.nrel.gov/analysis/winds



Backup slides follow

Wind Capacity in the National Energy Modeling System (U.S. DOE Energy Information Administration)

- 13 large electric regions
- No new transmission
- No cost or limits on use of transmission within regions
- Wind considered a mature technology (1% learning rate on capital costs and capacity factors)
- Eliminates 91% of U.S. wind resource base
- Wind capacity factor < 20%
- Can't accurately capture wind correlation within NERC regions