Estimating the Emissions Impacts of Renewable Generators using an Hourly Dispatch Model

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Charting the Path

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Objective

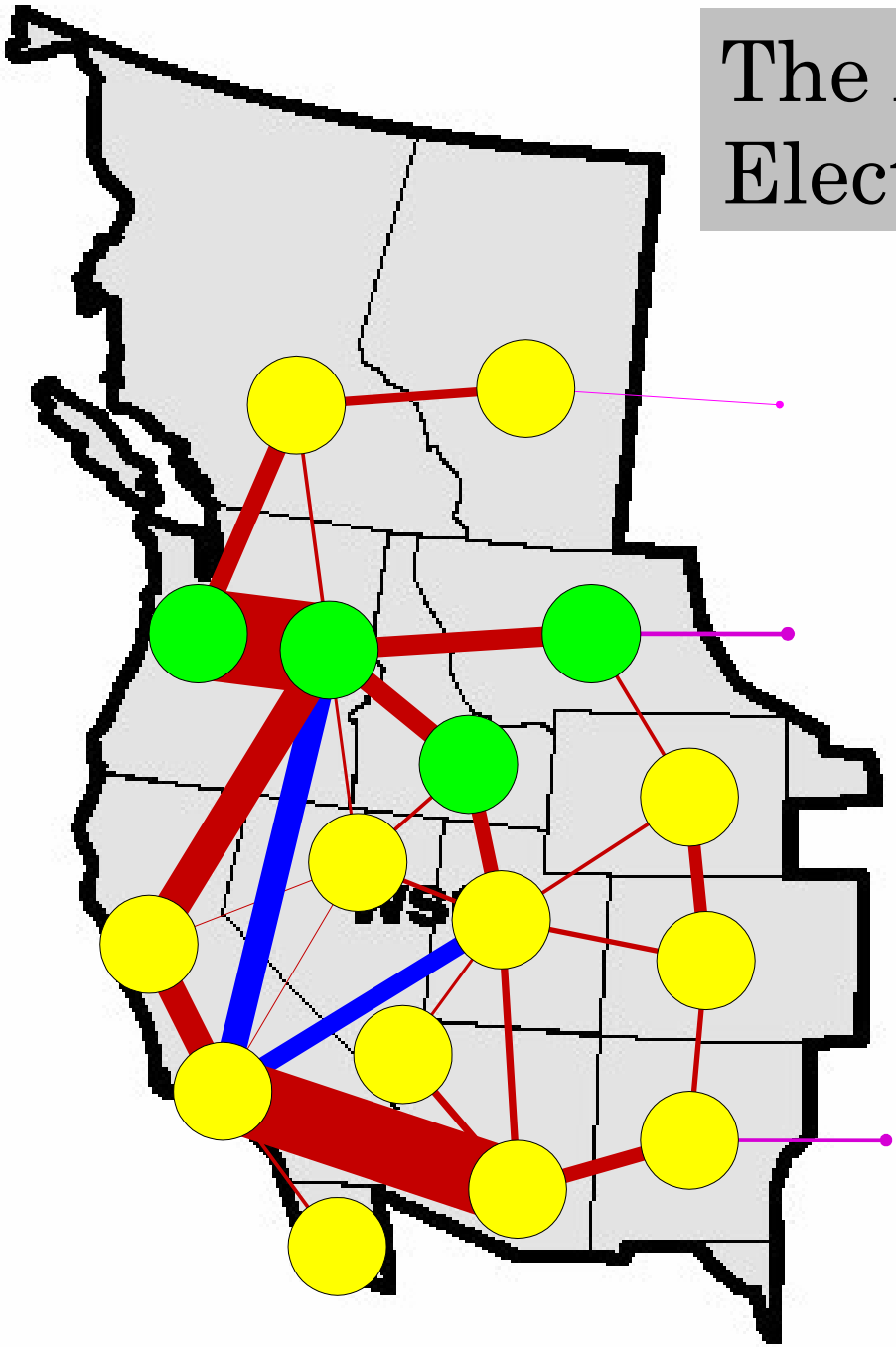
Using an hourly dispatch electricity price forecasting model, forecast the CO2 offset effects of a 100 MW increment of new windpower added in 2006.

Approach is applicable to other air emissions; other types and quantities of resources.

Approach – Two tests

A. Fixed capacity expansion:
   1. Add 100 MW increment of wind to base case 20-year capacity expansion (adds & retirements)
   2. Run 20-year hourly dispatch (2005–24)
   3. Calculate effect on system-wide CO2 production

B. New capacity expansion following forced addition:
   1. Force in 100 MW of wind in 2006
   2. Run new 20-year capacity expansion
   3. Run 20-year hourly dispatch on resulting capacity expansion.
   4. Calculate effect on system-wide CO2 production.



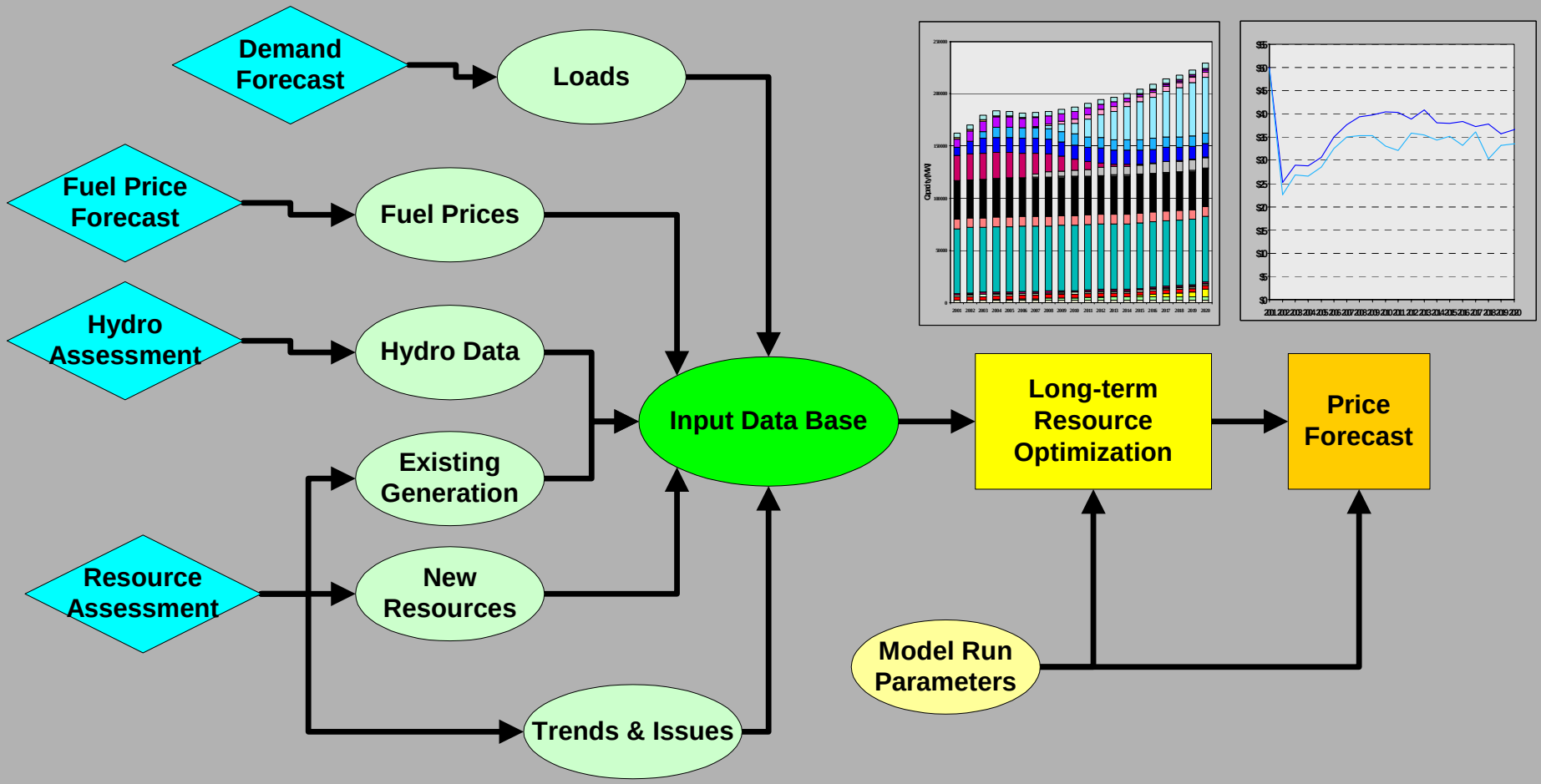
The AURORA^{xmpTM} Electric Market Model

Proprietary hourly dispatch electricity price forecasting model from EPIS, Inc. (www.epis.com)

WECC in scope (NPCC setup)

- 16 load-resource zones defined by transmission
- ~ 3000 generating units
- zonal fuel price forecasts
- zonal load forecasts
- zonal load curtailment blocks
- zonal new resource options

Typical long-term forecasting process



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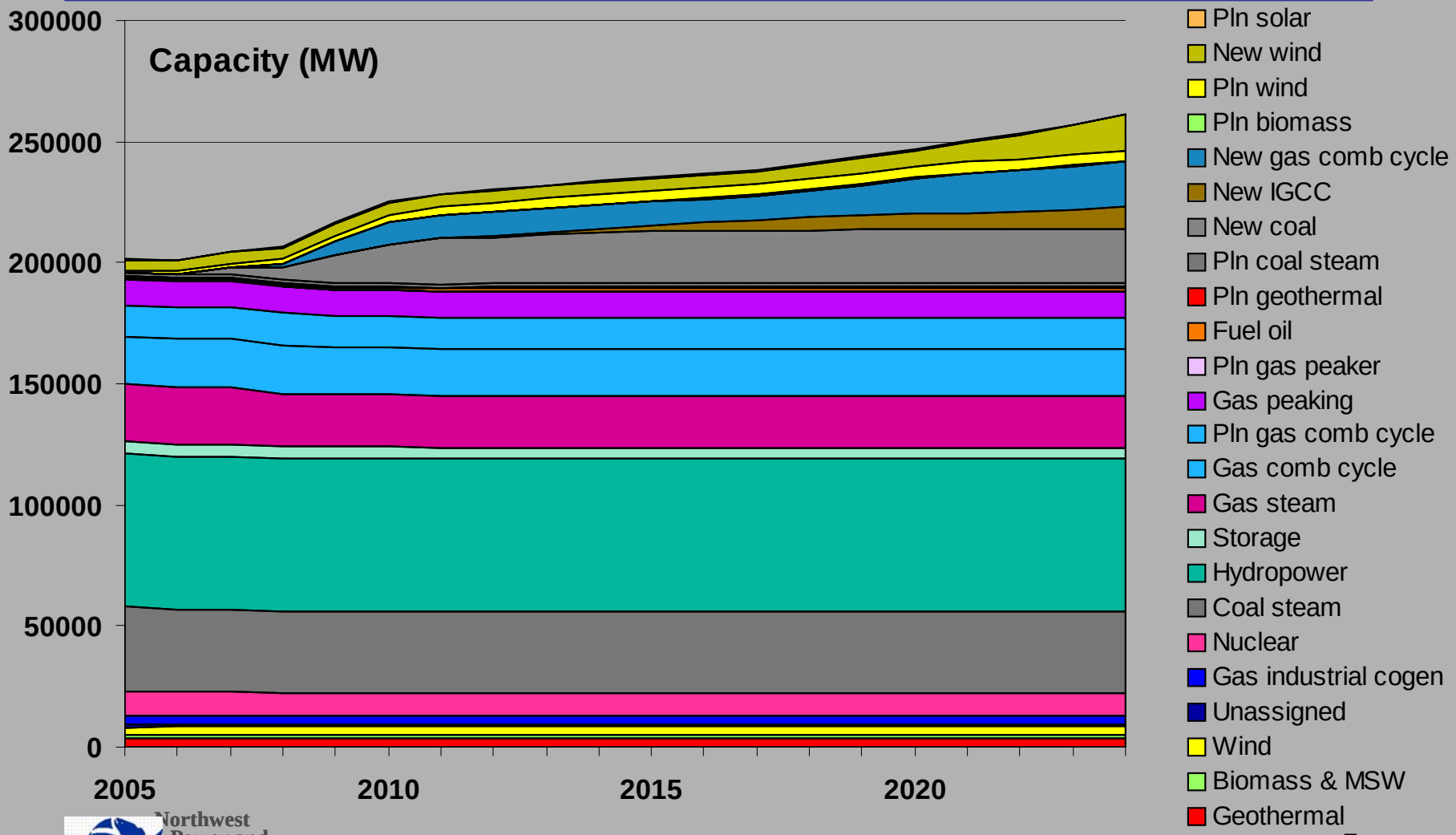
Some assumptions
(Constant 2000 dollar values)

- Natural gas (US wellhead): $5.30/MMBtu in 2005, declining to $4 by 2010, then stable through 2025.
- Coal (Western mine-mouth): $0.51/MMBtu through 2025.
- PTC expires at end of 2005 (Change from NPCC base).
- Green tags: $6/MWh in 2005, declining to $2/MWh in 2024.
- CO2 penalty: zero through 2007, then increasing to ~ $6.70/tonCO2 by 2025.
- Wind modeled with seasonal (monthly) shape but otherwise flat output.
- Average hydro conditions.

Base case WECC capacity expansion



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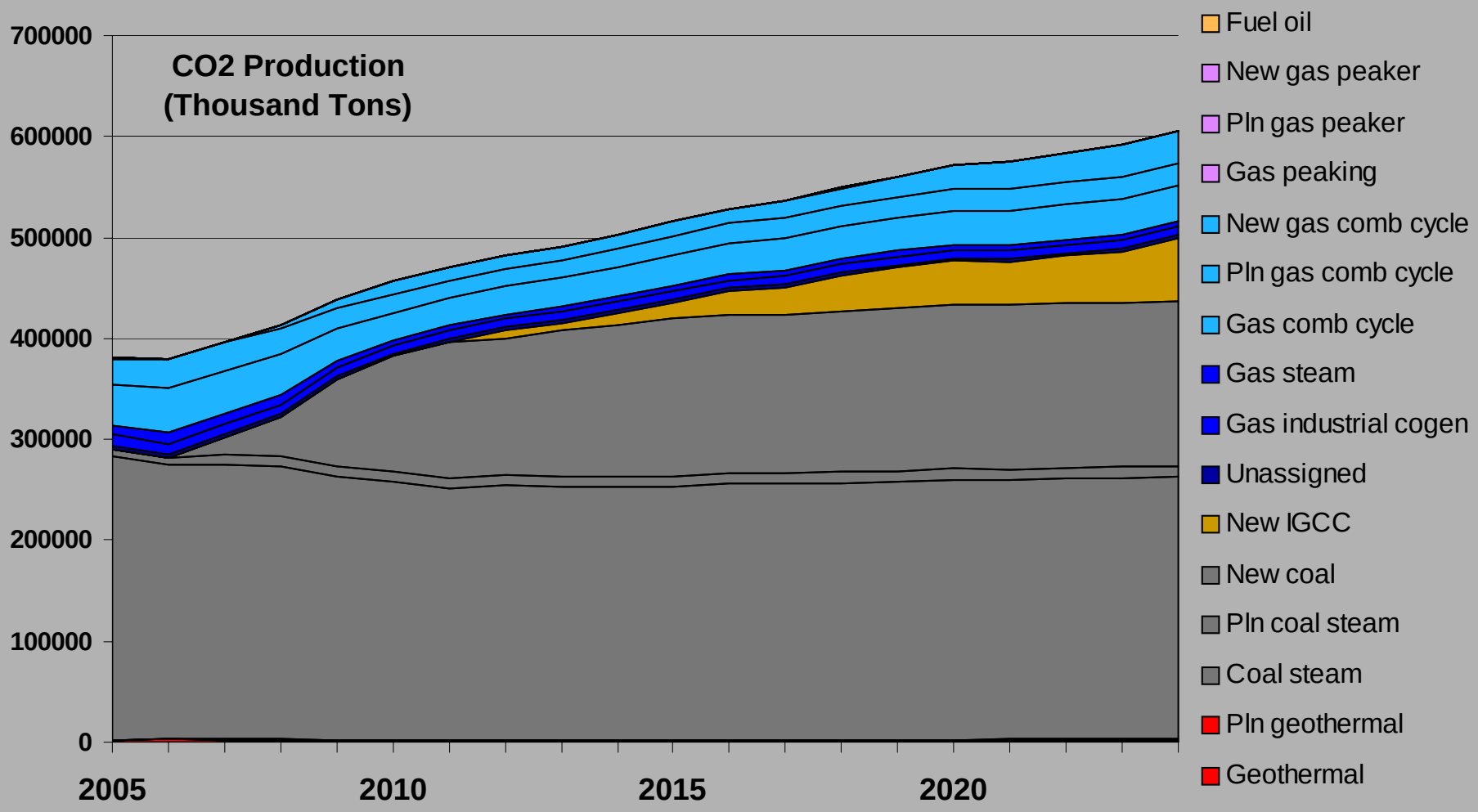
Base case WECC CO2 production



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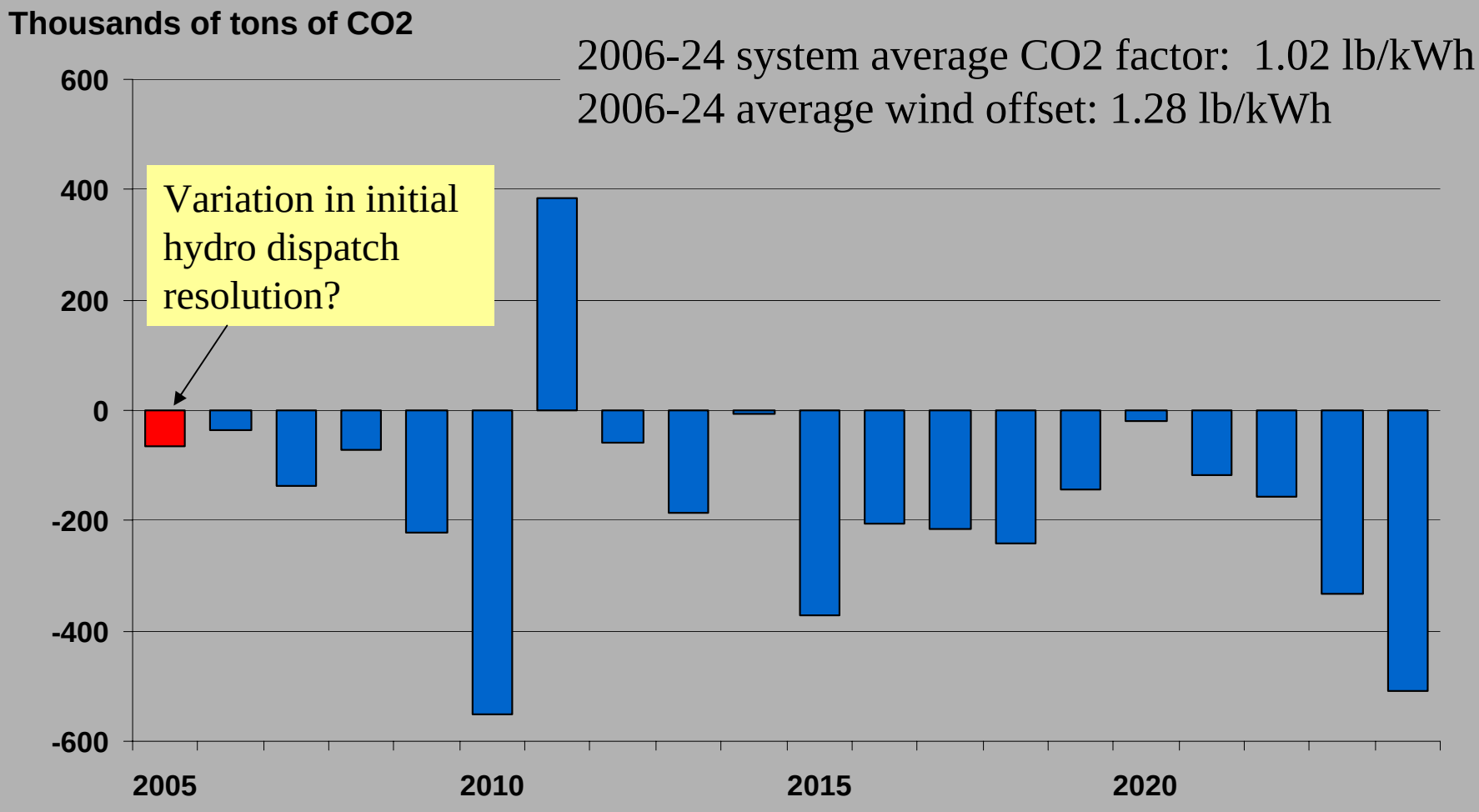
Annual net change in CO2 production 100 MW wind added in 2006



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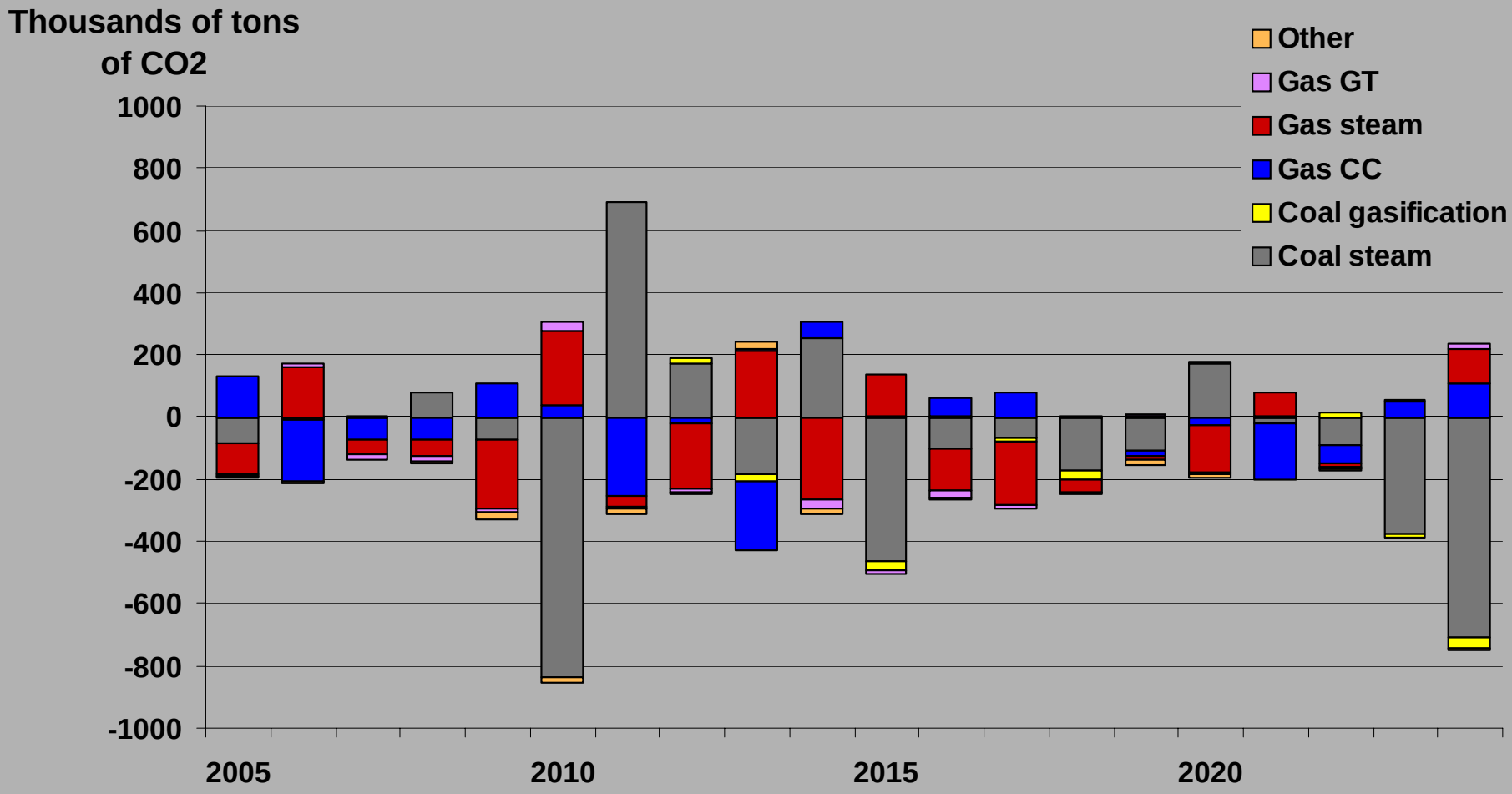
Change in CO2 production by resource 100 MW wind added in 2006



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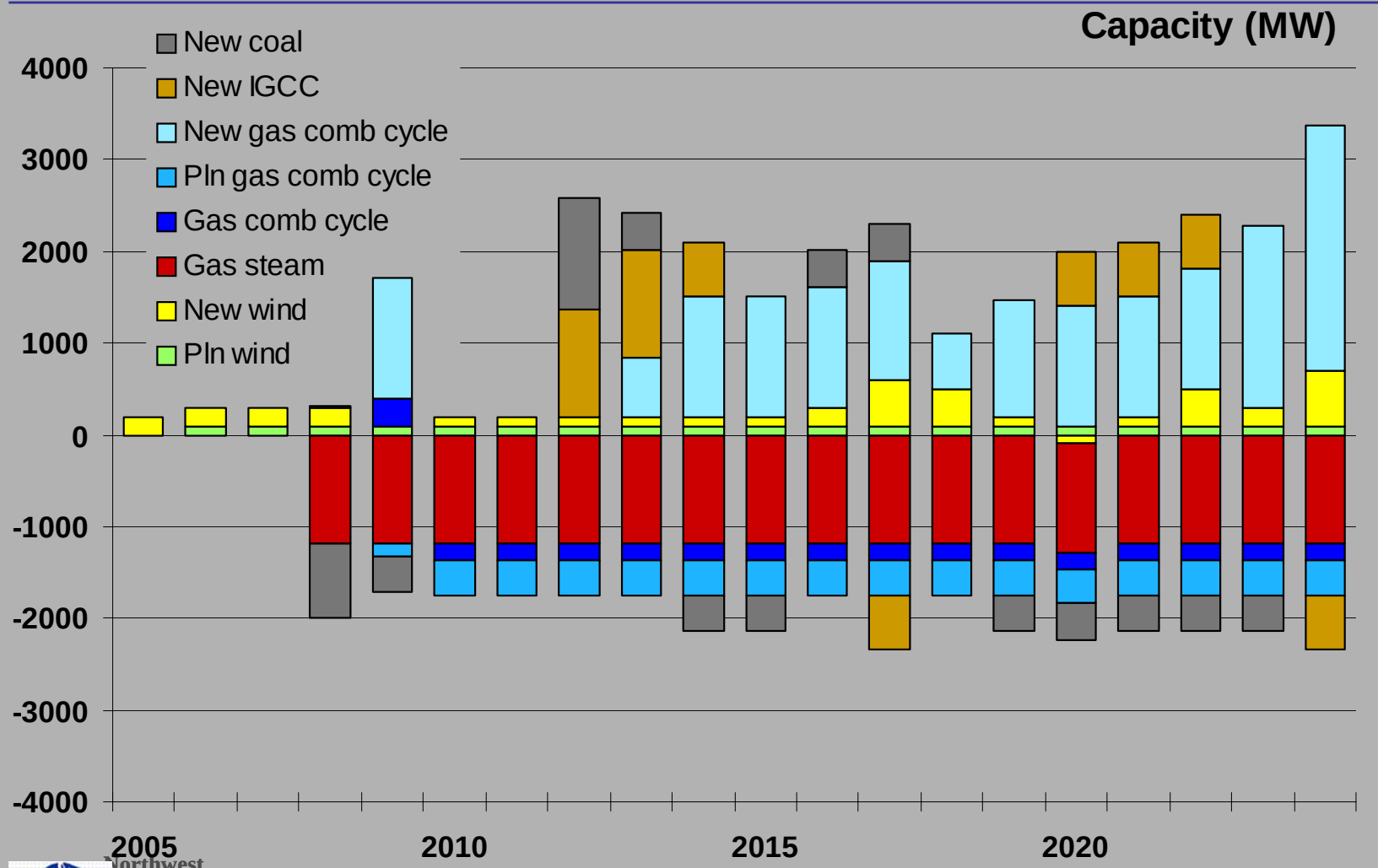
New WECC capacity expansion w/100 MW wind forced in 2006



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Conclusions re: These tests

- Incremental block of wind w/no other change in capacity expansion:
  - Anomalous 2005 dispatch clouds otherwise intuitively satisfying result.
  - Problem may be related to model's difficulty in meeting initial hydro constraints.
  - Worth discussion w/vendor.
  - If initial dispatch issue can be resolved, approach can be used with smaller-scale resource additions.
  - Validity of results will decline in out-years or with larger-scale additions.
  - Possibility of introducing limited stochastic variables, e.g., wind output.
- Incremental block of wind w/new capacity expansion:
  - Unsatisfying results – premature death of butterfly produces new ice age.
  - Possibly related to anomalous initial dispatch observed above.
  - Best approach w/larger scale additions, but would need testing.
  - Alternative would be to develop capacity expansion using portfolio risk modeling, but likely would be limited to smaller system.

Conclusions: Our experience with hourly dispatch models

- Temperamental; often produce unexpected results needing considerable analysis and multiple runs to refine and confirm.
- Data, computing power and computing time hogs.
- Set ups can be complex, helps to build off an existing base case price forecast.
- Compilation and analysis of results can be complex and time-consuming, often require post-processing.
- Simplification of hydro dispatch capability may overestimate benefits in hydro-dominated systems.
- However, remain a promising approach to estimating the effects of resource additions on emissions.