Using NEMS for a Long-Range View (to 2050) of Electricity Markets

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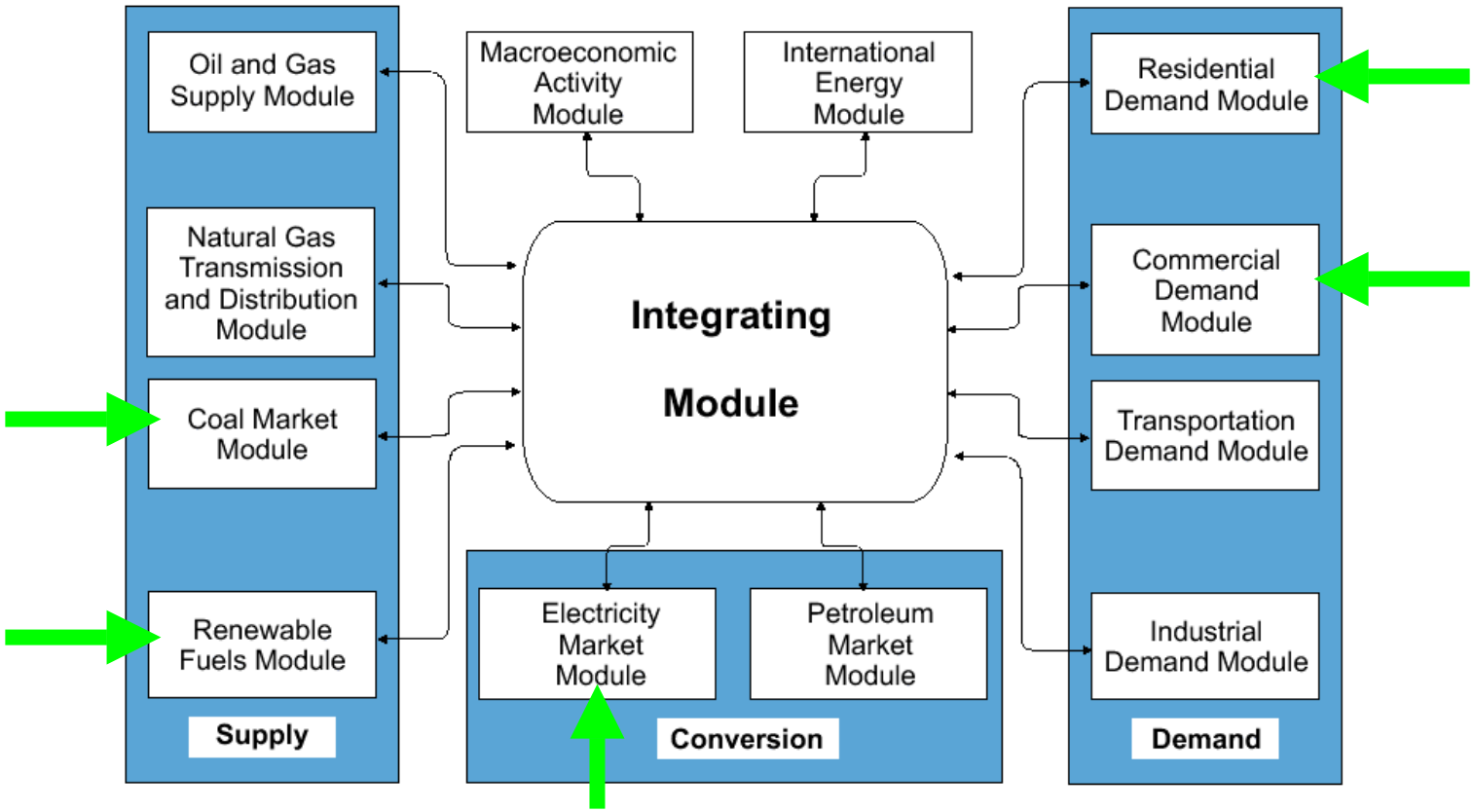
Introduction

- Study Objective: Analyze long-range potential for solar energy markets

- Today's presentation:
  - Methodology of extending NEMS
  - Preliminary Results for two cases
    - Solar Base Case
    - Carbon Value Case

NEMS 2050 Extension

- Only selected NEMS modules were extended, primarily those with solar technology markets.



Assumptions External to NEMS2050

- Inputs usually provided by the non-extended modules become user-specified
- Economic growth, oil and gas prices, and industrial electricity demands are key external drivers
- The 2000 Census Middle Series population projection was used to extend the economic variables

Macroeconomic Activity				10 Year Average Annual Growth Rates		
	Population (millions)	Housing Stock (millions)	Commercial Floorspace (bil sq ft)	Population	Housing Stock	Commercial Floorspace
2000	275.7	105.2	68.5			
2010	300.2	117.2	81.8	0.9%	1.1%	1.8%
2020	325.3	128.9	94.6	0.8%	0.9%	1.5%
2030	351.5	139.8	108.1	0.8%	0.8%	1.3%
2040	377.8	150.2	122.3	0.7%	0.7%	1.2%
2050	404.2	160.6	137.1	0.7%	0.7%	1.1%

Key Financial Assumptions

- The EIA AEO2003 forecast to 2025 was trended to 2050, except natural gas prices which are projected to be roughly $0.50 higher than in AEO2003.

Energy Prices (2001 Dollars)

	2010	2020	2030	2040	2050
World Oil Price ($ per bbl)	24.00	25.48	27.50	29.45	31.52
Gas Wellhead Price($/Mcf)	3.80	4.15	4.49	4.80	5.14
Coal Minemouth Price ($/ton)	14.99	14.57	14.53	14.65	15.35
Gas Delivered to Electric Generators ($/MMBtu)	4.36	4.83	5.26	5.57	5.90

Selected Inflation and Interest Rates

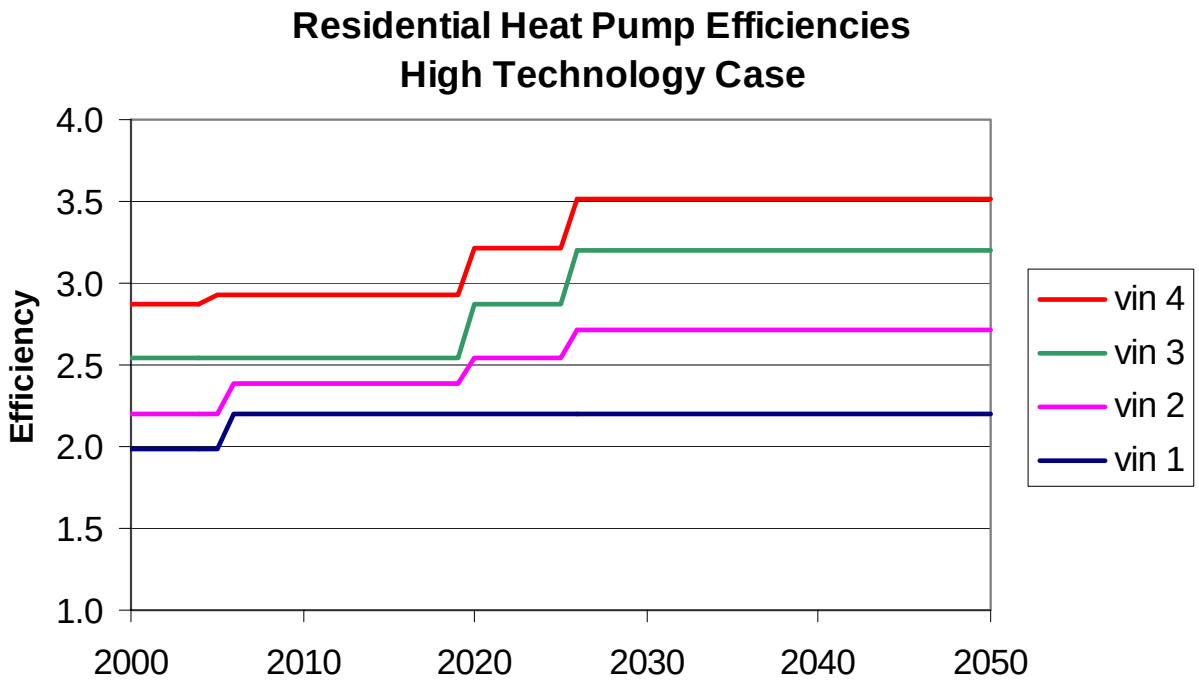
	2000-10	2010-20	2020-30	2030-40	2040-50
Annual Inflation	2.0	2.4	2.9	3.0	3.0
AA Utility, Nominal	7.5	8.2	9.9	10.5	10.5
30 Year Mortgage Rate, Nominal	7.6	8.5	10.1	10.3	10.3
3 Month Treasuries, Nominal	4.1	5.7	6.2	6.2	6.2

Endogenous Assumptions

- Technologies with endogenous learning (primarily central generation) continue to improve based on cumulative installed capacity
- Technologies with specified characteristics were trended out to 2050
- Nuclear plants assumed to retire at age 60 (one re-licensing allowed)
- All generation plants assumed to face an additional $25/kW-year cost at age 60
- Coal mining productivity improvements saturate
- Building end-use applications (e.g. AC shares, growth in office equipment) trended to 2050 with some saturation effects

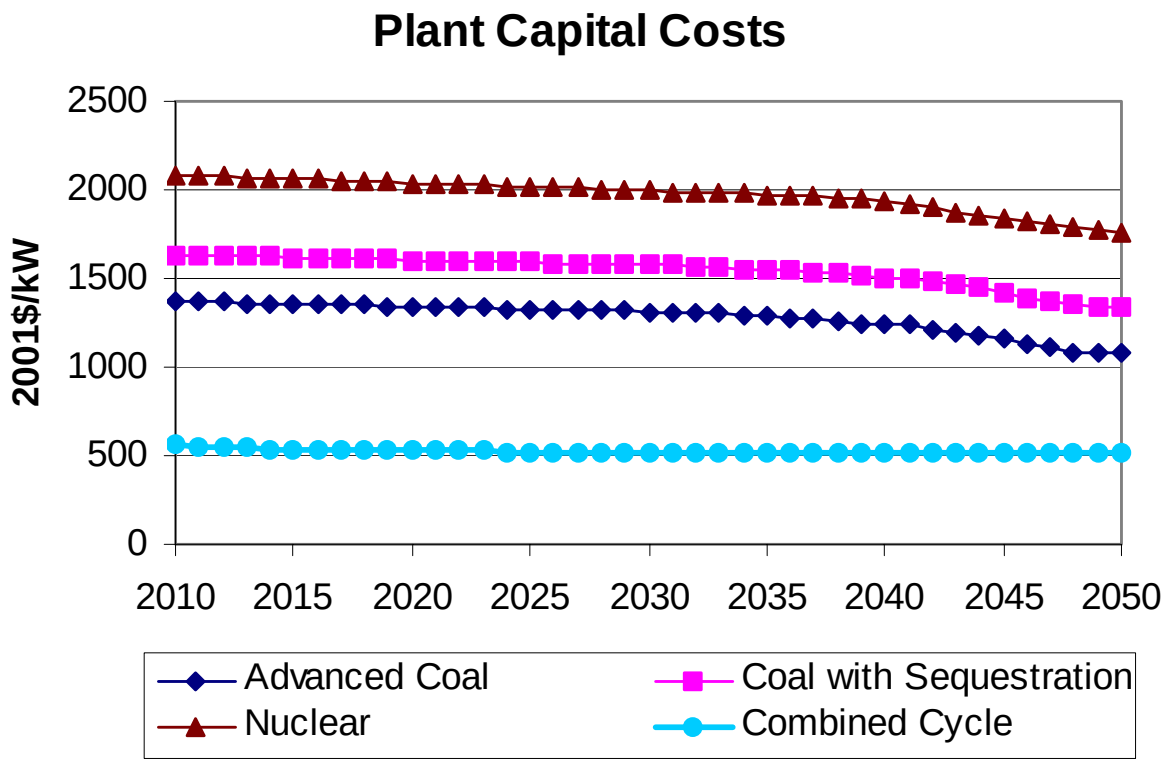
Technology Assumptions

- Within each of the extended modules, assumptions were made regarding continued technology cost and performance.
  - The AEO2003 High Technology Case was used as starting point.
  - In the residential and commercial models, most of the technologies are specified by “vintage.”



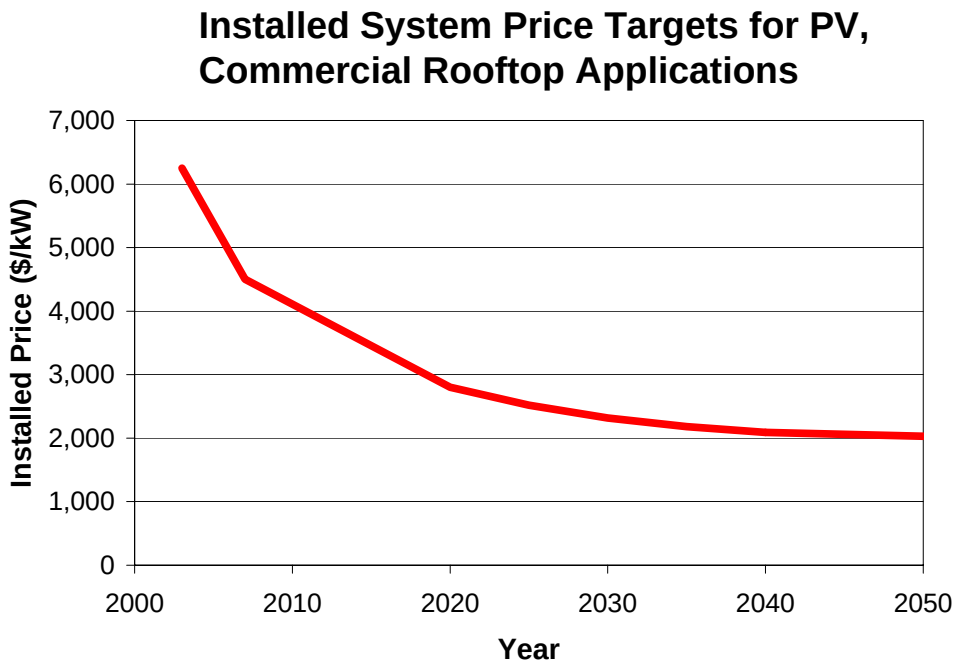
Technology Assumptions (cont.)

- A combination of AEO2003 learning functions (tied to cumulative capacity) and user-specified inputs were used for the central generation technology costs.



Technology Assumptions (cont.)

- Non-solar renewable energy technology characteristics based on AEO2003 High Renewables Case assumptions
- Solar energy technology cost based on the Solar Program's recently published multi-year technical plan and input from multi-lab team of experts

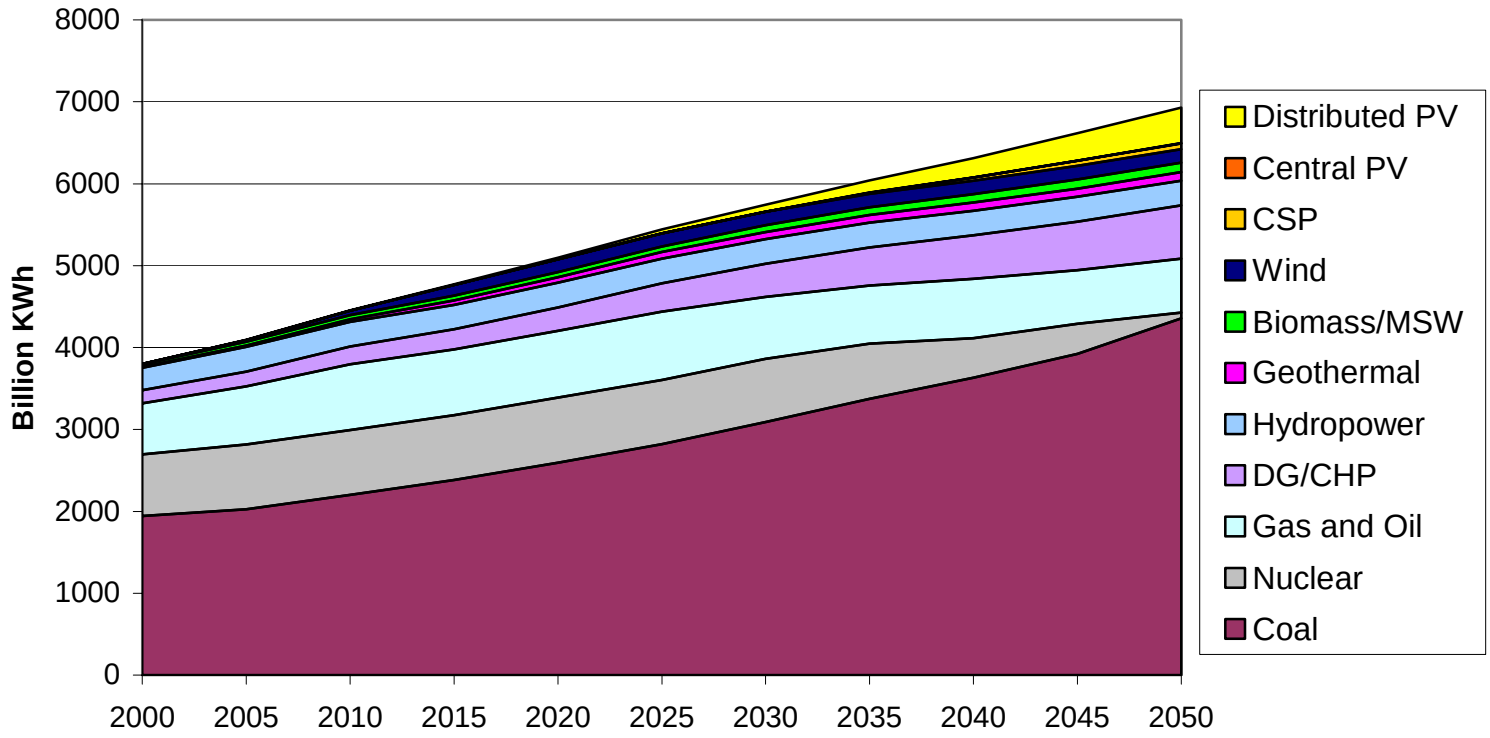


Key NEMS Solar Modifications

- The longer time frame and focus on solar led to several modifications of NEMS
- Distributed PV
  - Added stock accounting with retirements
  - Modified algorithm for adoption rates
  - Increased average system size from 2kW to 4kW for residential and 10 kW to 100 kW for commercial, with a capability for change over forecast period.
  - Increased maximum penetration rates for single family homes and commercial buildings, and added multi-family homes.
- Modifications to Solar Water and Space Heat were also made

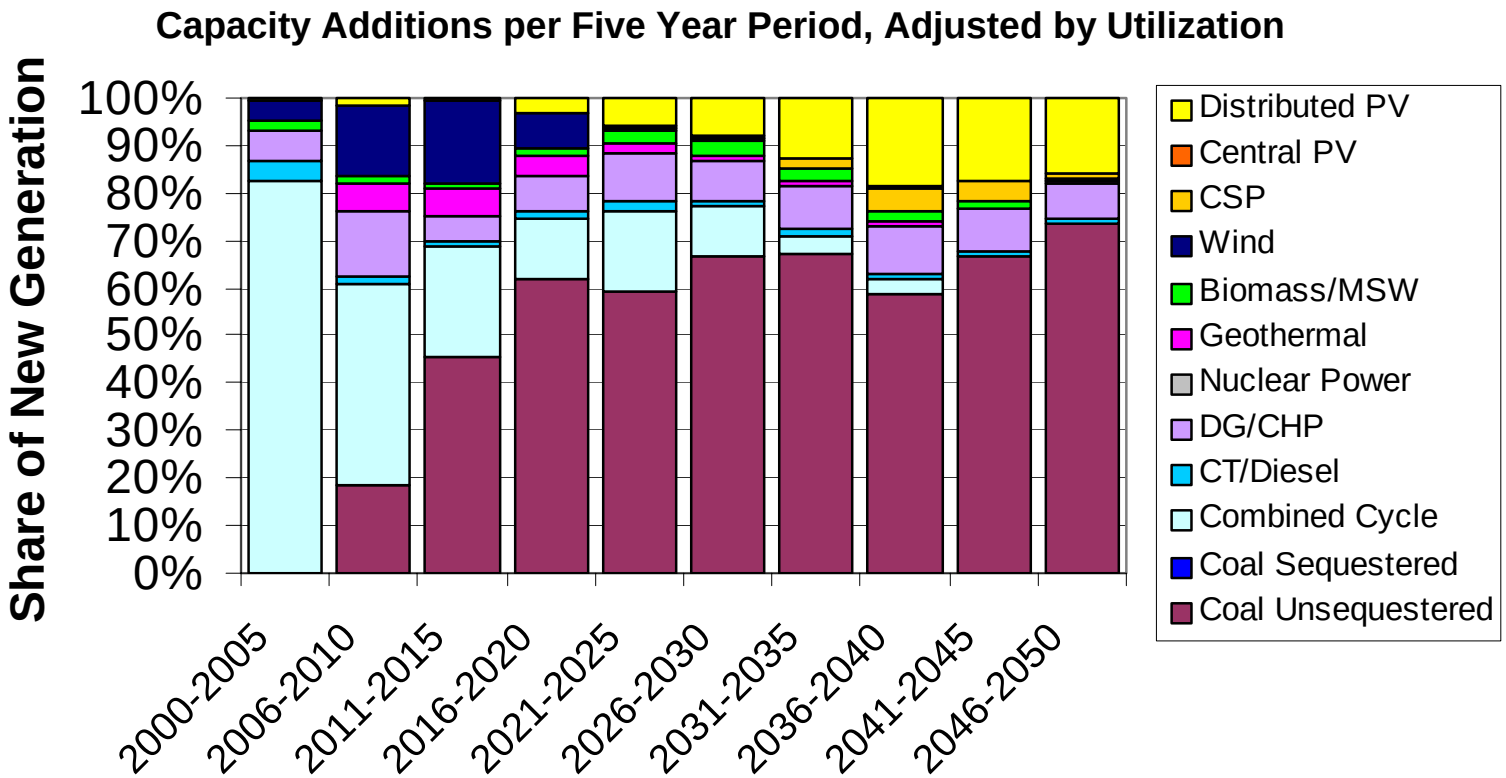
Base Case Generation

- Coal dominates future generation under the High Renewable/High Efficiency Base Case.



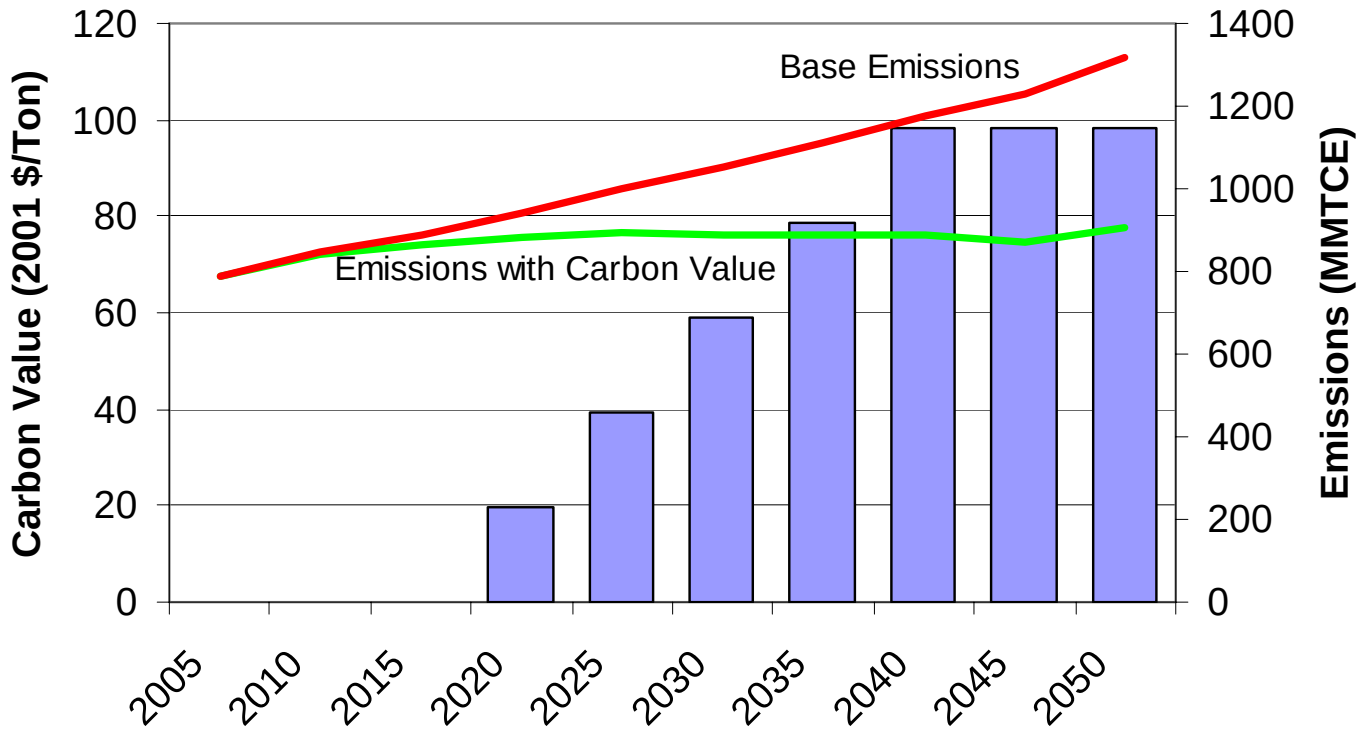
Shares of New Generation in Base

- Coal begins to dominate new additions after 2015, and distributed PV begins to enter after 2020.



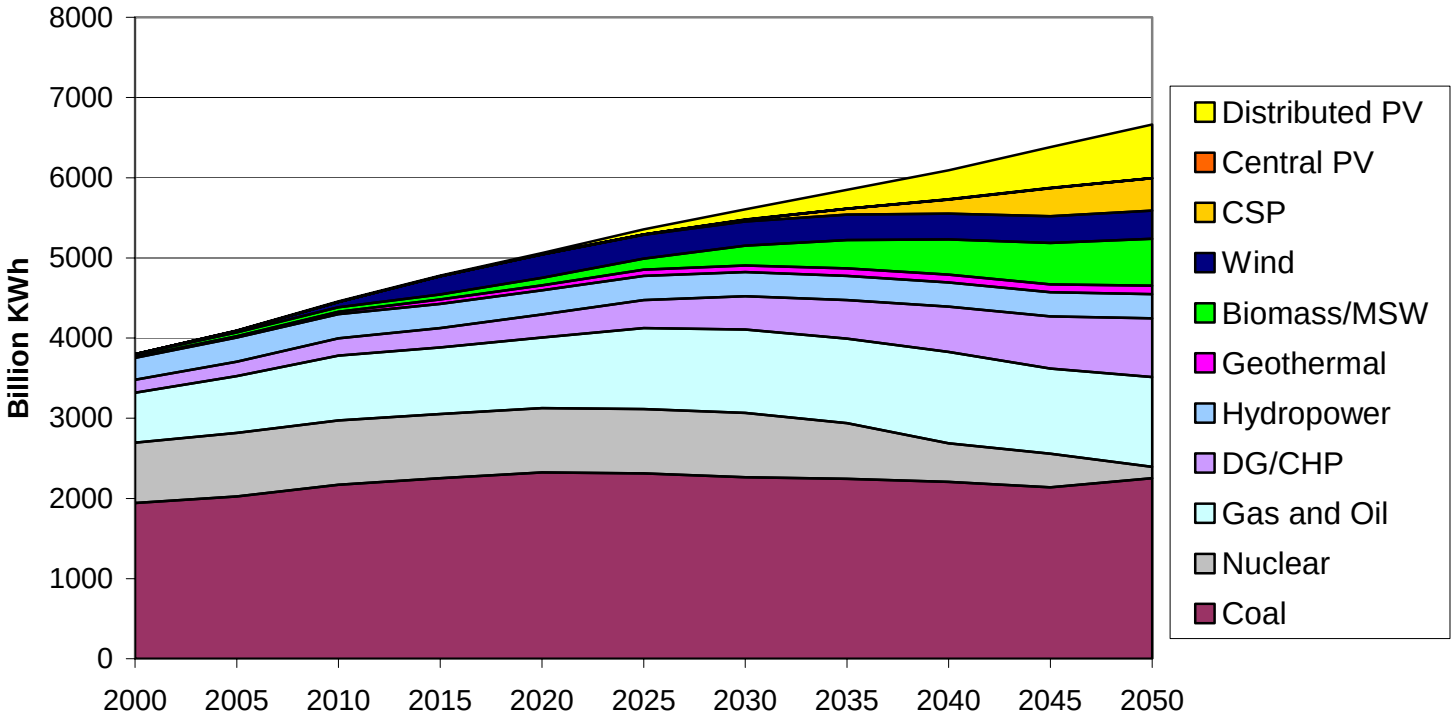
Carbon Value Case

- A case was created to roughly stabilize carbon emissions from the electricity and building sectors.



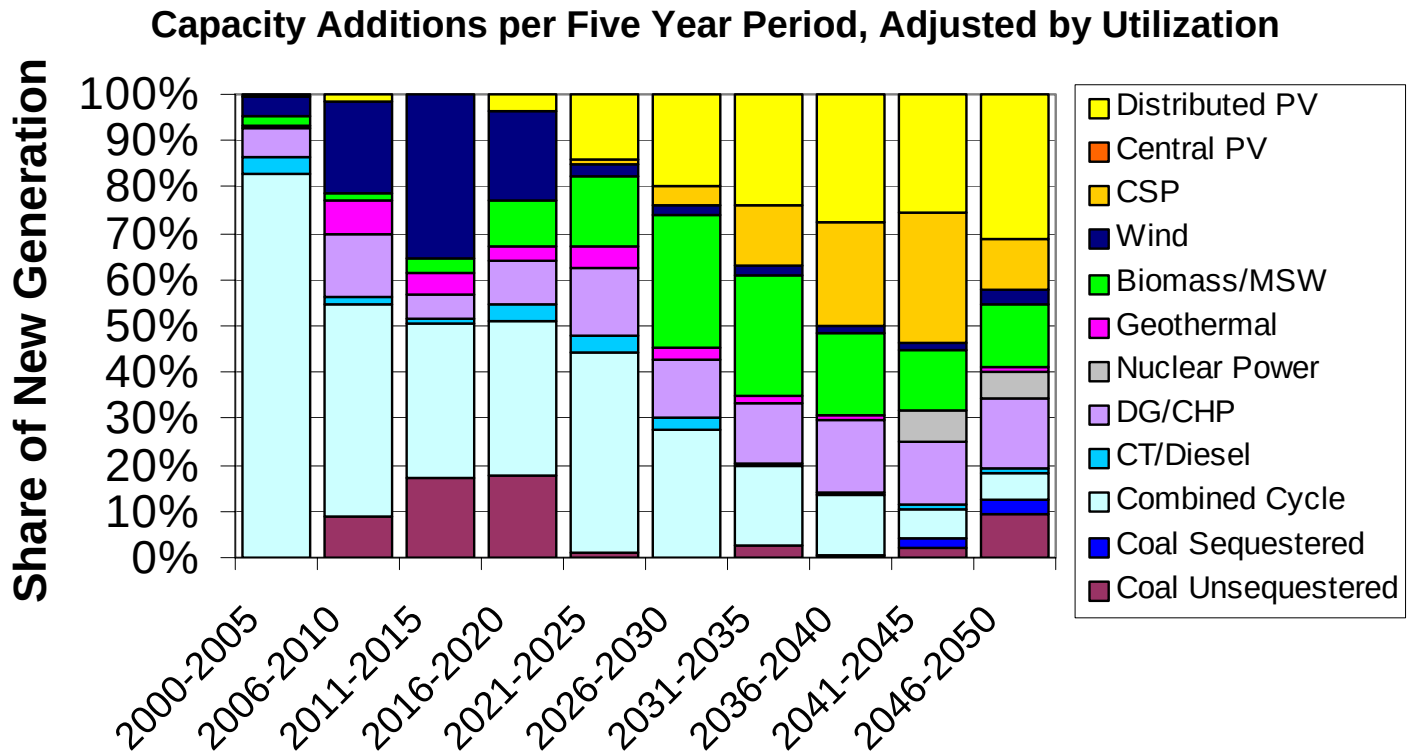
$100 Carbon Value Case

- When a value for carbon is added (ramping up from zero in 2015 to $100 in 2040), coal generation levels off and renewable generation increases substantially.



New Generation Shares with $100 Carbon

- Wind is the dominant new renewable in the early years, while solar and biomass gain additional shares as the technologies become more cost-effective.



Summary

- The mechanics of extending NEMS is relatively straightforward
  - Extending external assumptions (i.e., fuel prices, macroeconomic projections) takes some thought
  - Regional and sectoral detail add complexity
  - A partially integrated model does not capture some important feedback effects (e.g. natural gas price response)
- Important insights gained about how NEMS treats solar and other renewable energy technologies
- Developing meaningful scenarios to 2050 requires consideration of long-term sustainable policies