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Making Room for Coal Generation under the NSPS Rule

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Overview

- **What are the cost and market parameters that would help advanced coal generation with carbon capture and storage (ADVPC-CCS) be more viable in the power markets under the new source performance standard* (NSPS)?**
- **Focus on investment tax credit (ITC), scenarios with and without the ITC, and:**
  - ITC approach similar to renewable resources
  - Natural gas prices
  - Capital costs
- **Are capacity markets structured to provide the necessary incentives for investing in high capital cost baseload capacity?**

***Environmental Protection Agency, 40 CFR Parts 60, 70, 71, and 98; [EPA–HQ–OAR–2013–0495; FRL–9839–4] RIN 2060–AQ91, Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units, Federal Register, Vol. 79, No. 5, January 8, 2014, Proposed Rules**

Key NSPS Aspects for this Analysis

- **Best Sources of Emissions Reduction (BSER) for boiler generating units and integrated gasification combined-cycle (IGCC) is partial implementation of carbon capture and storage (CCS) to 1,100 lbs CO_2/MWh, gross output, for boilers and IGCC.**
- **Based on the Regulatory Impact Analysis, EIA analysis and utility announcements*, "few if any" coal plants will be built in foreseeable future, and there is no expected impact on CO_2 emissions to 2022.**
- **EPA suggests that new natural gas combined cycle (NGCC) will meet the standard and be the generation of choice for cost and emission reasons.**

***Environmental Protection Agency, 40 CFR Parts 60, 70, 71, and 98; [EPA–HQ–OAR–2013–0495; FRL–9839–4] RIN 2060–AQ91, Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units, Federal Register, Vol. 79, No. 5, January 8, 2014, Proposed Rules.**

Modeling Assumptions

- **On-line year: 2022, for all technologies, nominal dollars**
- **ITC at 30% of capital cost:**
  - ITC Term is 5-years, credit realized in 2022-2026
  - i.e. $1 Billion capital cost x 30% ITC = $300 Million tax reduction (savings)
- **Financial Parameters:**
  - Cost of debt is 5%, after-tax cost of equity is 9%
  - Assume 60% debt to 40% equity, recognizing that actual costs could be lower or higher due to funding sources
- **Inflation for O&M at 2%**
- **Capital cost range based on available cost estimates**
- **Natural gas price sensitivity cases**
- **Heat rates for ADVPC-CCS and IGCC-CCS**
  - CCS On-and-off to meet 1,100 lbs CO_2/MWh

Capital Cost Comparisons from Key Sources

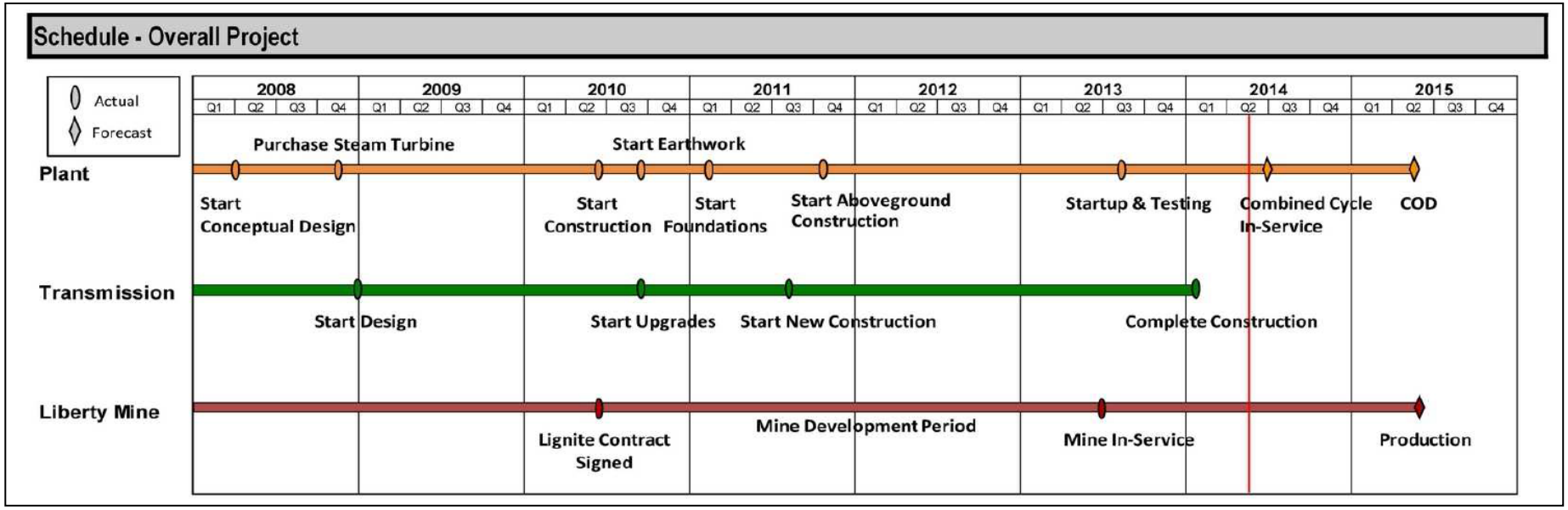
Technology	EPRI 2009 Dollars[1]	NETL Baseline Study,[3] 2011 Dollars	EIA 2014 Update,[4] 2012 Dollars
ADVPC	$2,300 $/kW	$2,452 $/kW	$2,934 $/kW
ADVPC-CCS	$3,408 $/kW	$4,391 $/kW	$5,227 $/kW
	EPRI 2010 Dollars[2]		
IGCC	$3,101 $/kW	$2,969 $/kW	$4,400 $/kW
IGCC-CCS (Illinois #6 Case)	$3,682 $/kW	$4,086 $/kW	$6,600 $/kW
NGCC			$1,023 $/kW

1. An Engineering and Economic Assessment of Post-Combustion CO2 Capture for 1100°F Ultra-Supercritical Pulverized Coal Power Plant, Phase II, Task 3 Final Report. Prepared by Nexant Inc., Bechtel Power Corporation, and Mitsubishi Heavy Industries of America through EPRI. Technical update October 2010.
2. Engineering-Economic Evaluations of Integrated-Gasification–Combined-Cycle Plant Designs with Carbon Dioxide Capture Phase 3: ConocoPhillips E-Gas™ Gasifier-Based Cases Technical Update, September 2011.
3. Updated Costs (June 2011 Basis) for Selected Bituminous Baseline Cases, NETL, August 2012. Costs are for super-critical pulverized coal and IGCC.
4. Costs are for advanced pulverized coal.

Kemper IGCC-CCS Schedule and Costs

- **About 7 years from design to expected on-line date; about 5 years for construction**

Kemper IGCC-CCS	
Installed Gross Capacity	**582** MW
Total Cost	$2,880,000 (000s)
Cost per kW	$4,948 $/kW
Current Total Cost Estimate (through May 2014)	$5,551,600 (000s)
Current Cost Estimate	**$9,539** $/kW

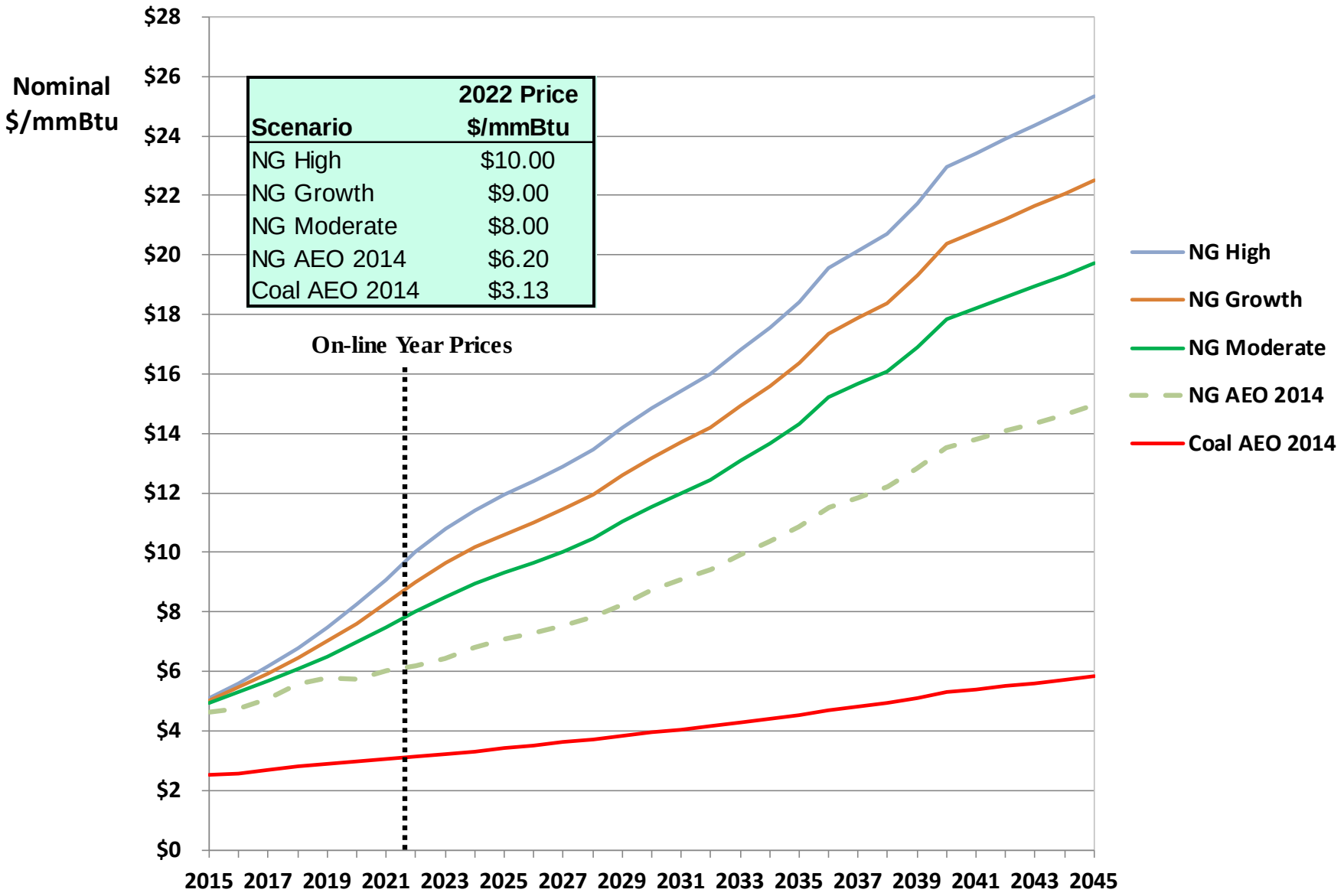


Source: **Schedule and costs based on estimates in quarterly report through May 2014.**

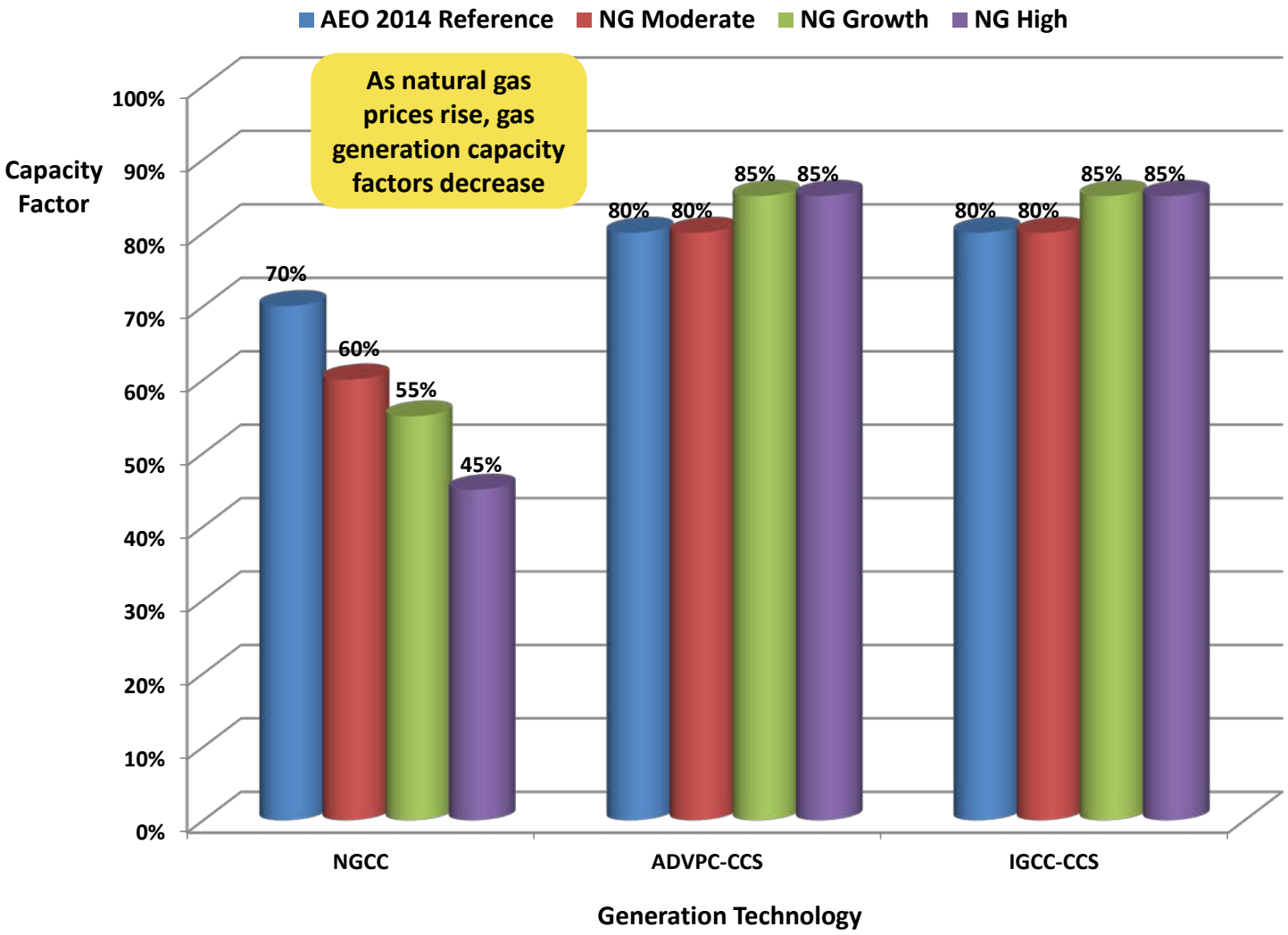
Coal and NGCC Capital Cost Scenarios

Scenario	2012 Cost, $/kW	Cost Esc. To 2022	2022 Total Finance Cost, $/kW
ADVPC w/CCS			
NETL Baseline	$4,391	2.0%	$5,800
EIA 2014	$5,227	2.0%	$6,900
CCS Project Midpoint	$7,400	2.0%	$9,800
IGCC w/CCS			
NETL Baseline	$4,086	2.0%	$5,400
EIA 2014	$6,600	2.0%	$8,700
CCS Project Midpoint	$8,050	2.0%	$10,700
NGCC			
EIA 2014	$1,023	2.0%	$1,300
Growth		5.5%	$1,700
High		7.5%	$2,000

Natural Gas and Coal Fuel Price Scenarios

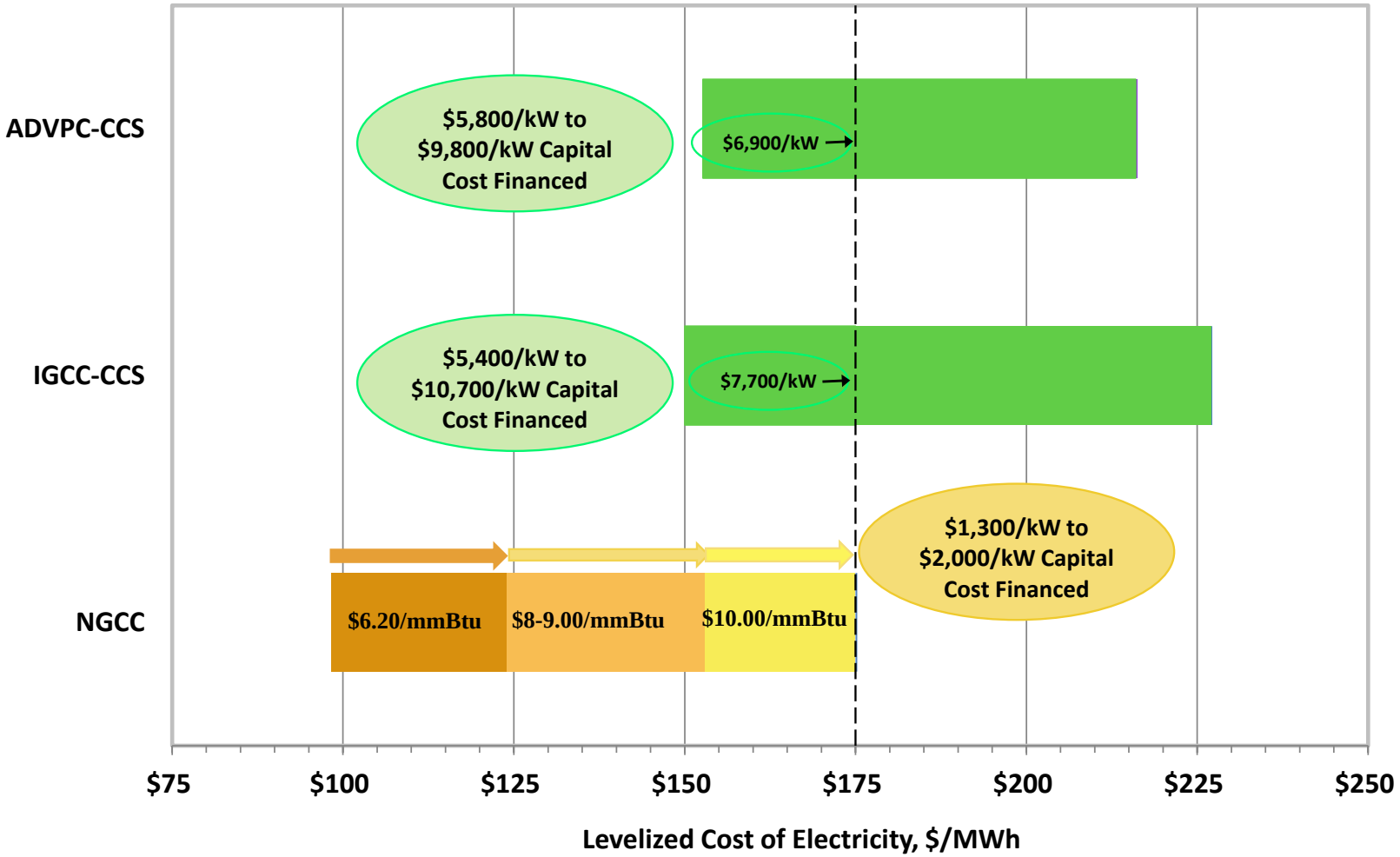


Natural Gas Price Scenarios and Capacity Factors



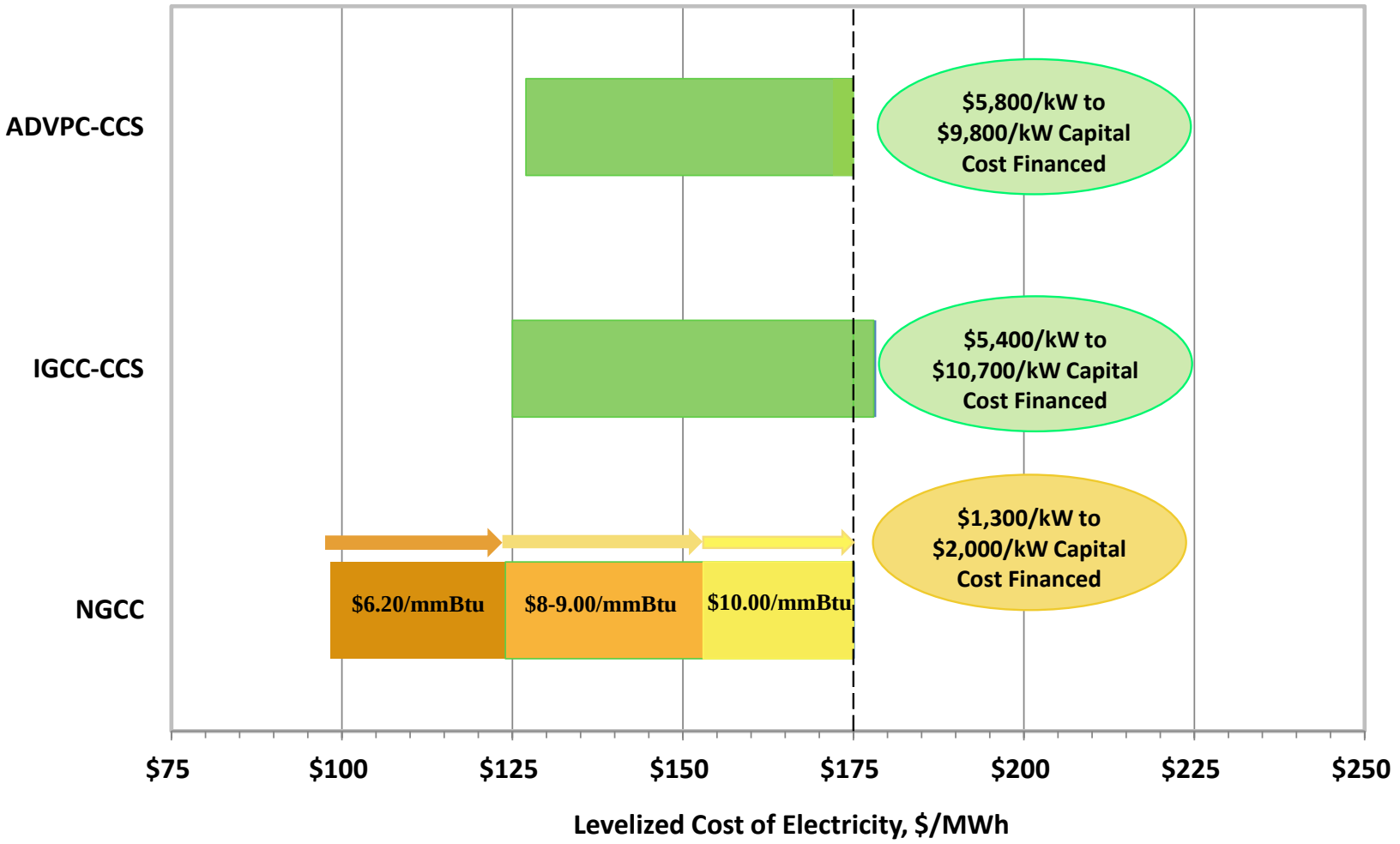
Modeling Results for 2022

Outcomes for 2022 Levelized Cost of Electricity and Power Market Assumptions - No ITC



Modeling Results for 2022

Outcomes for 2022 Levelized Cost of Electricity and Power Market Assumptions - with ITC



Status of RTO Capacity Markets

- **Capacity markets provide a secondary stream of revenue for power plants in RTO markets.**
- **The ERCOT, MISO, PJM, and NE-ISO markets have 75-90 percent of power through self-supply and bilateral contracts:**
  - Capacity markets acquire mostly marginal plants needed for reserves and peaking capacity
  - What happens to this situation when coal plants retire due to new environmental regulations?
- **Predominantly marginal plants needed for reserves and peaking capacity have cleared the markets**
- **Incentives have not been sufficient to induce investors to build baseload (coal and nuclear) generation to enter these markets without contracts or regulated approval of capital costs.**

Are Capacity Markets Structured to Enable Advanced Coal with CCS to Compete?

- **Potential capacity market changes:**
  - 3-year, 10-year, 20-year resource auctions for different purpose resources
  - Multi-lateral contracts as a vehicle that members of RTOs would use to subscribe to capacity commitments and spread risks to all capacity subscribers

- **Would integrated resource planning (IRP) be a means to identify capacity auction generation objectives?**

Additional Reading: "Similarities Between Regulated and Restructured Power Markets Point to Potential Solution to 'Missing Money' Problem", Joel R. Theis. Website: http://papers.ssrn.com/

Summary

- **In addition to CCS being identified as BSER in NSPS, the IPCC and IEA has asserted CCS is needed in order to achieve GHG goals[1,2]**
- **Applying an ITC to coal generation could enable coal generation with CCS to be viable in electric power markets**
- **Competitive forces that could help enable coal with CCS include:**
  - Higher natural gas demand driving NG prices higher
  - Higher demand for new NGCCs could increase capital cost growth more than for IGCC-CCS or ADVPC-CCS with R&D gained efficiencies
- **Identified alternative structures for capacity markets to meet the financial requirements of various resources for resource mix and diversity purposes.**
  - Different capacity auction commitment periods
  - Multi-lateral contracts to spread risks across RTO members

1. **IPCC, 2014: Summary for Policymakers, In: Climate Change 2014, Mitigation of Climate Change.** ***Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*** **, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (See pg. 15).**
2. **"Energy Technology Perspectives 2014, Harnessing Electricity's Potential", International Energy Agency, 2014. OECD/IEA.**

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