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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 CO₂/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 CO₂ 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 CO₂/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 Dollars²		
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



Schedule - Overall Project

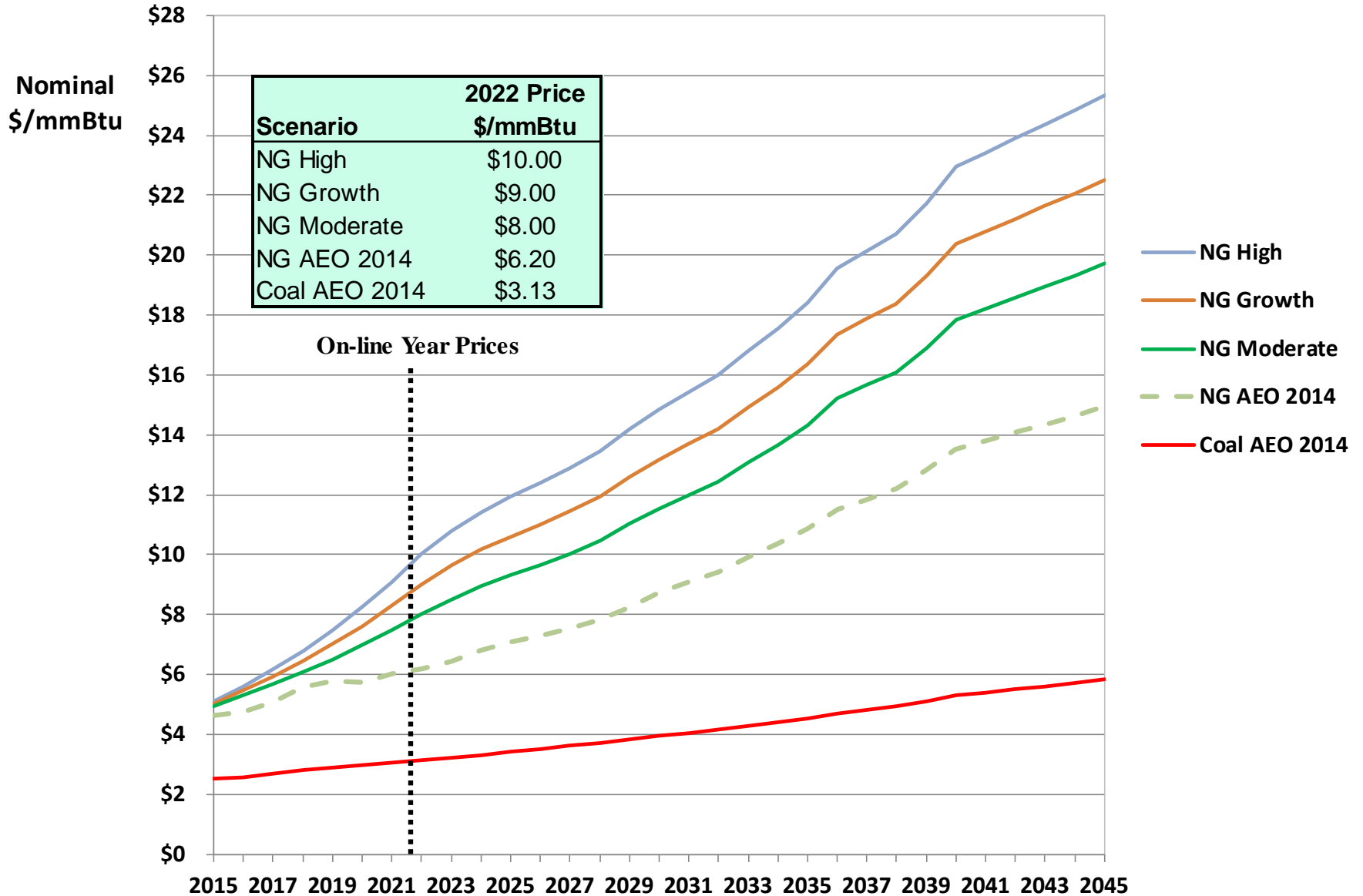


Source: Schedule and costs based on estimates in quarterly report through May 2014.

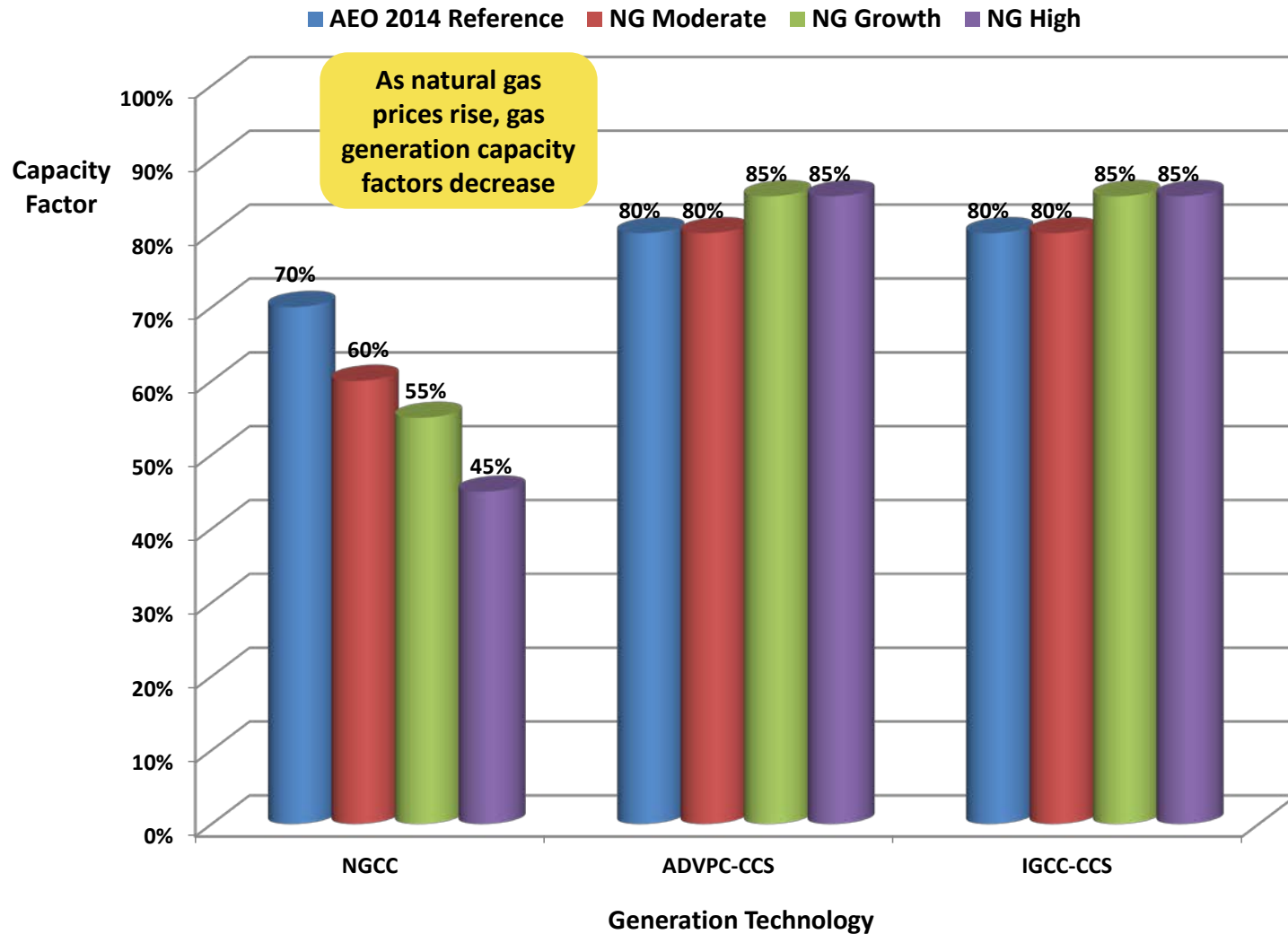
Coal and NGCC Capital Cost Scenarios

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

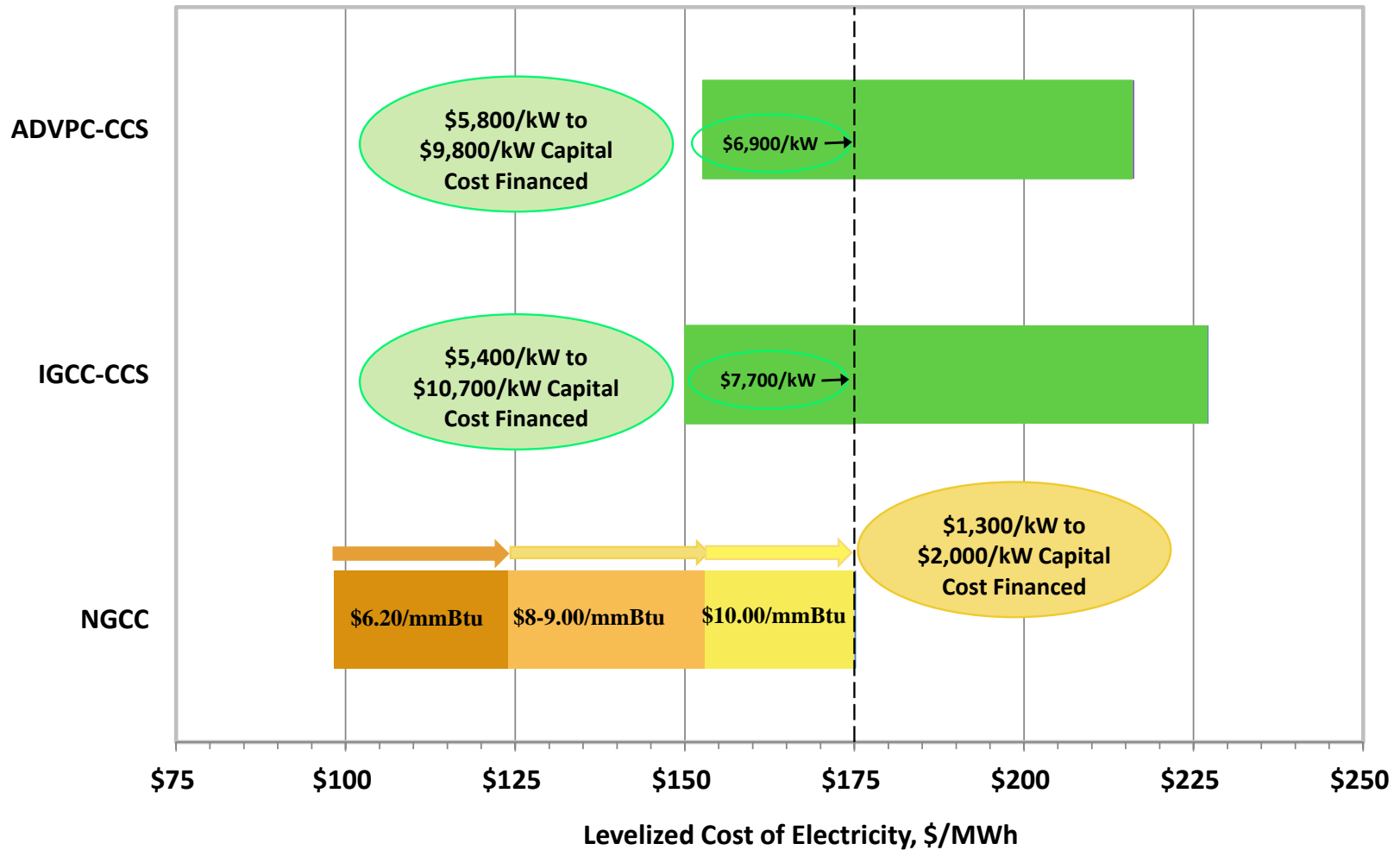


Natural Gas Price Scenarios and Capacity Factors



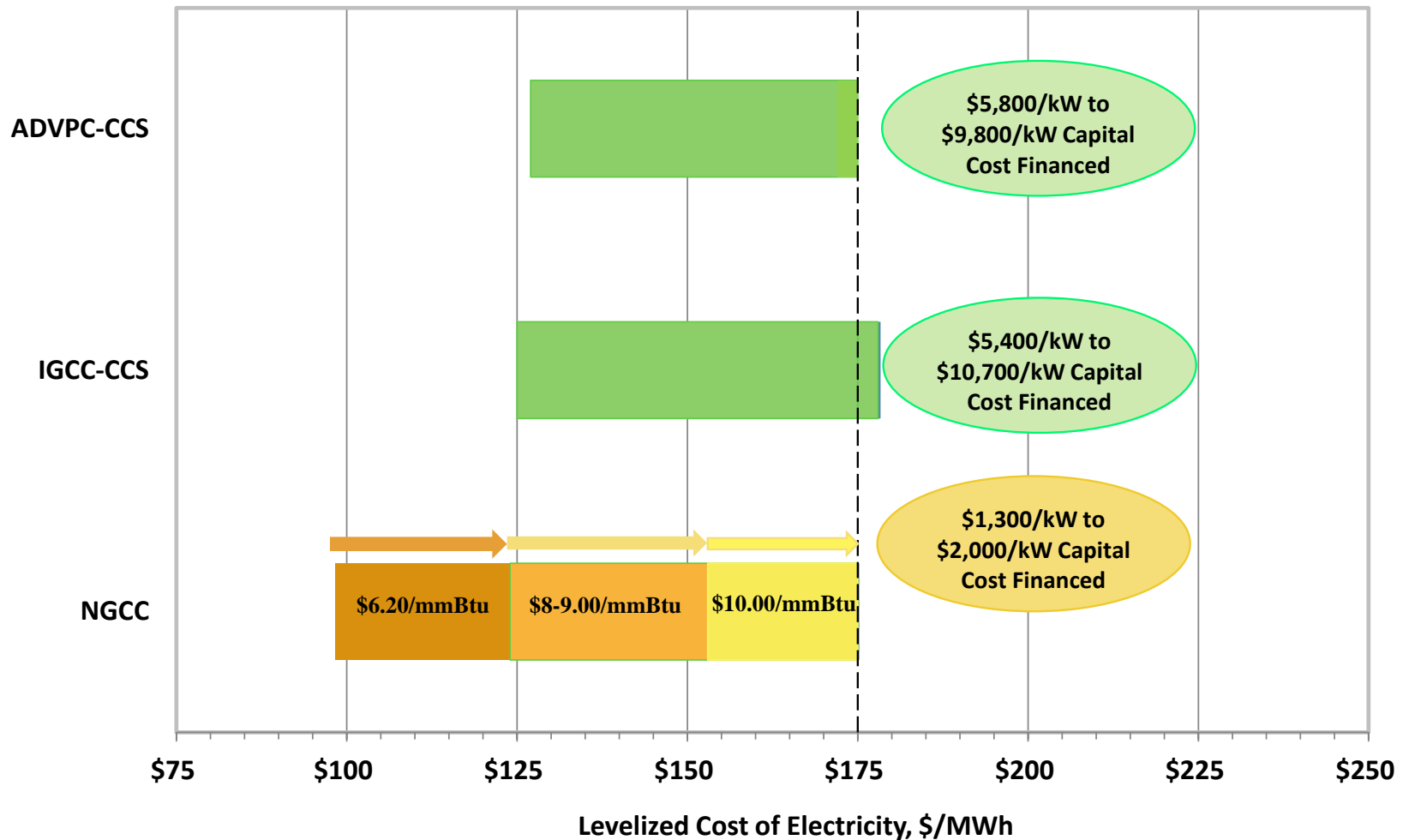
Modeling Results for 2022

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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