

# OVERVIEW OF THE MISO MARKET

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# Who is MISO?

- Midwest Independent Transmission System Operator, Inc.
  - Changing name to the Midcontinent Independent System Operator, Inc. as of June 2013
- A Regional Transmission Operator (RTO) entity with exclusive responsibility for grid operations, short-term reliability and transmission service within a specific U.S. region. A RTO also acts as a market operator in wholesale power.

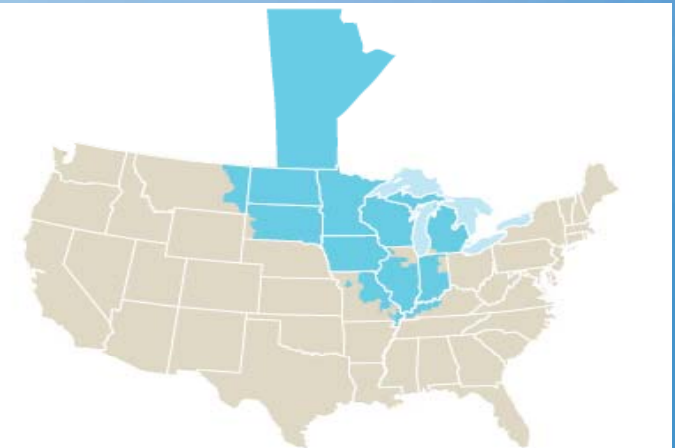
# MISO Scope of Operations as of July 2012

- Generation Capacity
  - 131, 581 MW (market)
  - 143, 765 MW (reliability)
- Historic Peak Load (July 23, 2012)
  - 98,576 MW (market)
  - 104, 669 MW (reliability)
- 11 States
- 1 Province (Manitoba)
  - Manitoba Load and Generation are External to the MISO Market Footprint but corporation is a market participant
- Region serves 39 million people

*MISO Market & Reliability  
Area Footprint*



MARKET AREA

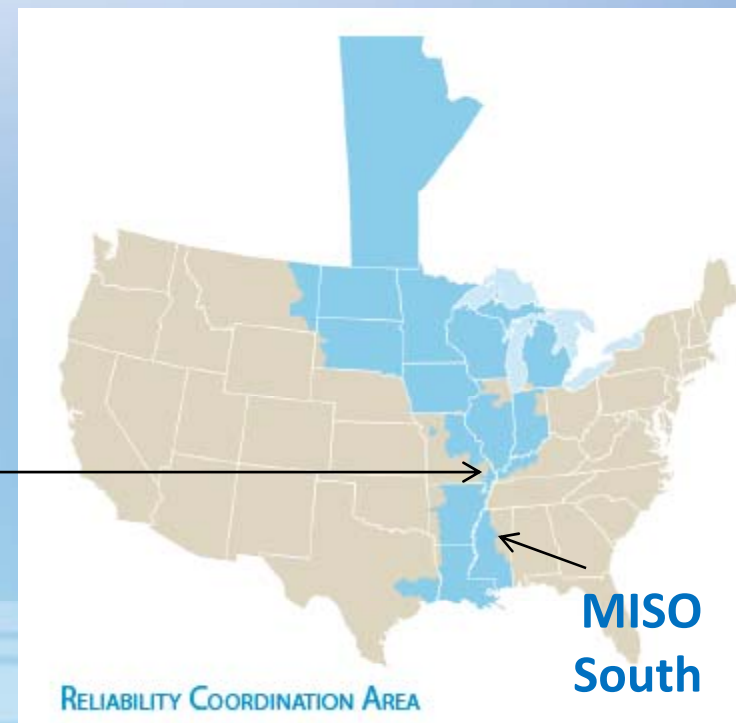


RELIABILITY COORDINATION AREA

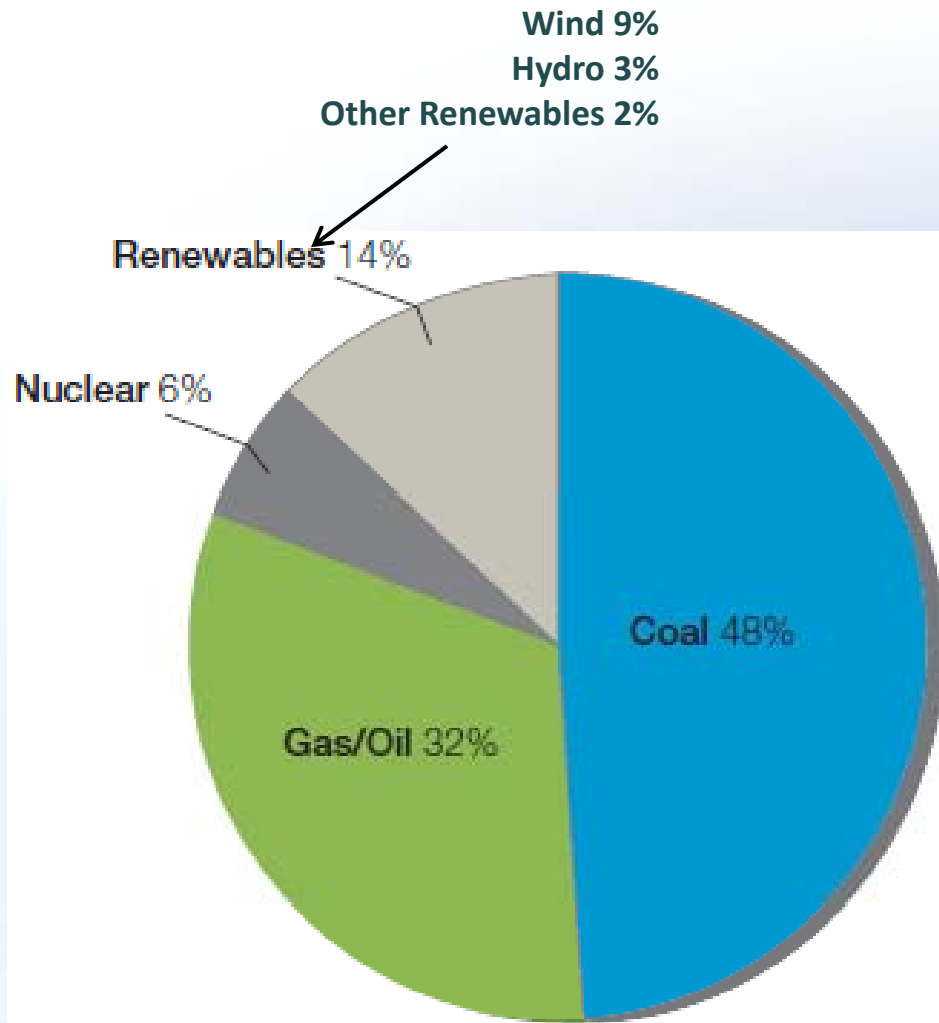
# MISO South Integration

- Integration will add 15,500 miles of transmission and 30,000 MW of generation capacity into MISO
- Full integration to be completed by December 2013
- Small interconnection (1000 MW) with historical MISO market area
  - Limiting impact of MISO south integration on northern market participants such as Manitoba Hydro

**Connection between historical MISO & MISO South region**



# Installed Generation Capacity in MISO Market Footprint as of July 2012



Unit Type	Capacity (MW)
Renewables	18,400
Coal	63,200
Gas/ Oil	42,100
Nuclear	7,900

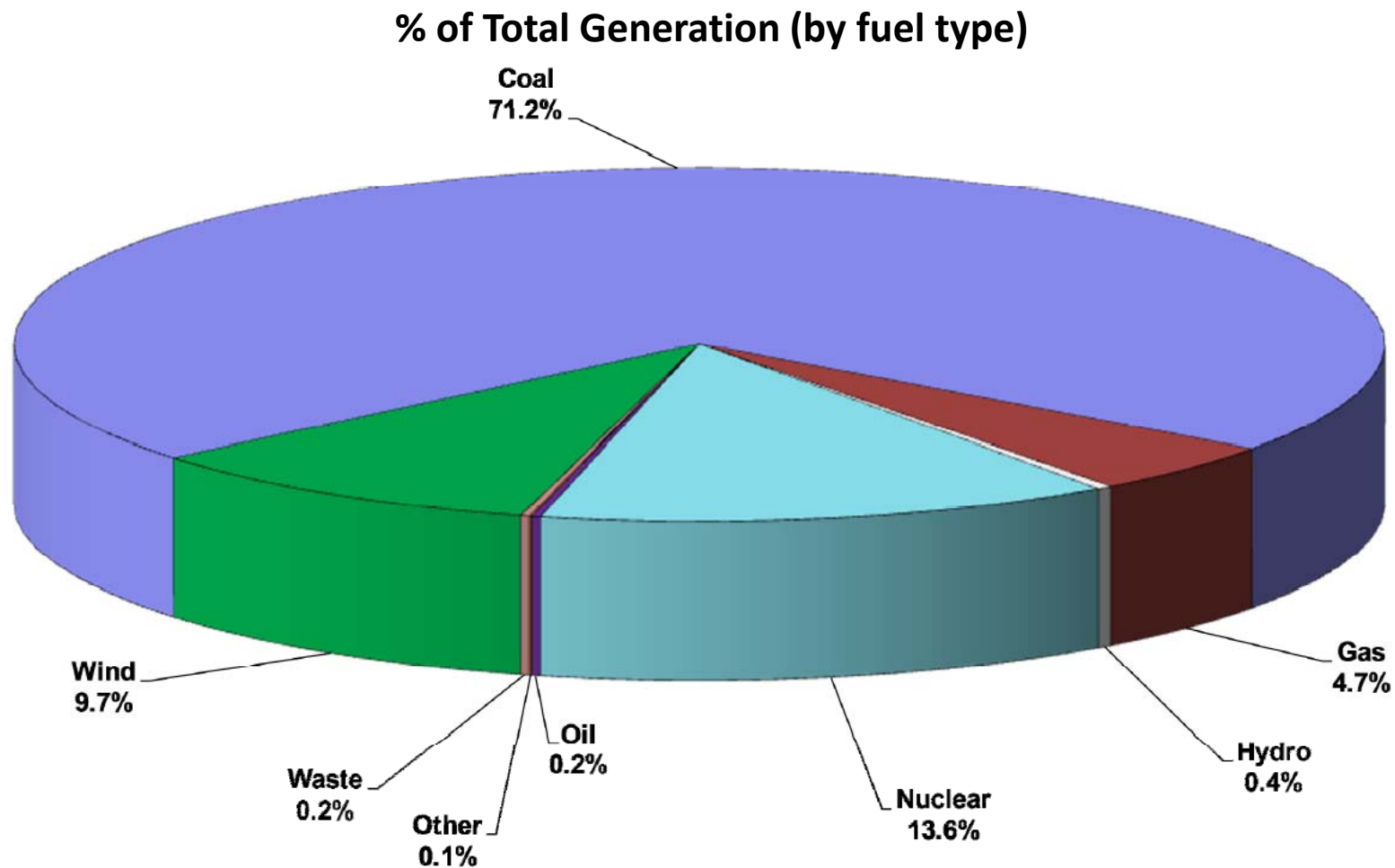
*Excludes Manitoba Hydro generation; based on 131,581 MW in market footprint*

# 2011 Energy Supplied by Region and Technology

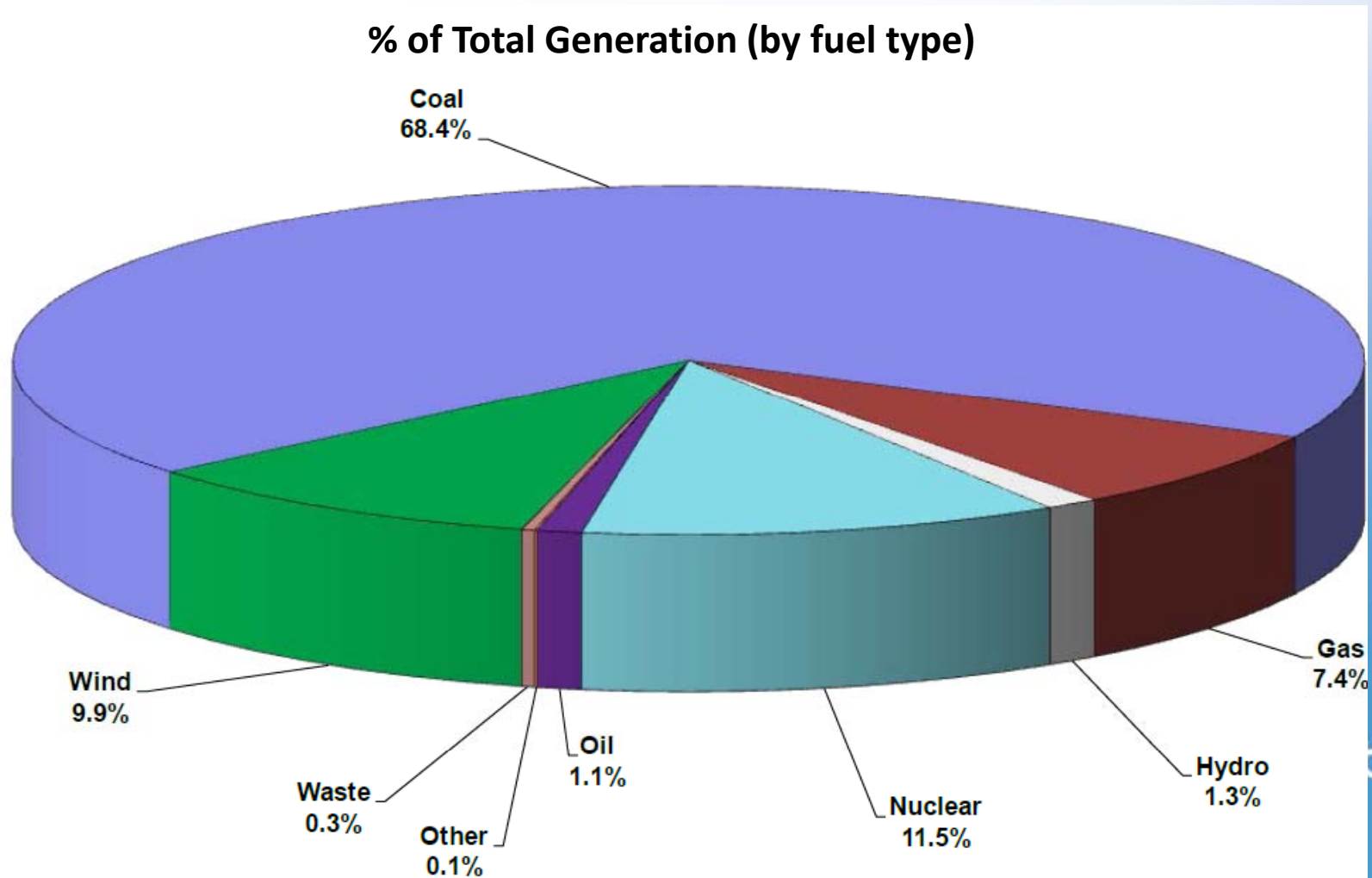
Fuel Type	NE-ISO	MISO	CAISO	PJM	NY-ISO	ONTARIO	US (Total)
Coal	6%	<b>75%</b>	1%	47%	7%	3%	<b>42%</b>
Natural Gas/Oil	52%	<b>5%</b>	46%	15%	37%	15%	<b>26%</b>
Hydro	8%	<b>1%</b>	21%	2%	20%	22%	<b>8%</b>
Nuclear	28%	<b>13%</b>	18%	34%	31%	57%	<b>19%</b>
Solar	0%	<b>0%</b>	0%	0%	0%	0%	<b>0%</b>
Wind	1%	<b>5%</b>	4%	2%	2%	3%	<b>3%</b>
Geothermal	0%	<b>0%</b>	6%	0%	0%	0%	<b>0%</b>
Other	5%	<b>0%</b>	3%	1%	3%	1%	<b>2%</b>

*Figures are based on percentage of actual energy generated in 2011 and not installed capacity*

# MISO Energy Supplied by Fuel Type – January 2013



# MISO Energy Supplied by Fuel Type- April 2013





# MISO Market Construct

- High percentage (~95%) of generation in MISO owned by vertically integrated utilities
- Utility has the obligation to serve load
  - When new resources are required, direct acquisition of resources through bilateral PPAs or construction of new capacity resources
  - Not a large reliance on market to provide resource needs
- MISO responsible for dispatch of regional resources and optimizing market operations (i.e. maximizing efficiency of interconnected system)
  - Effectively a “balancing market” to ensure resource adequacy to meet regional load requirements

# Components of Electricity Market Prices

- ***Bundled Electricity Price =***

- Variable Production Cost for Energy + Capacity Charge**

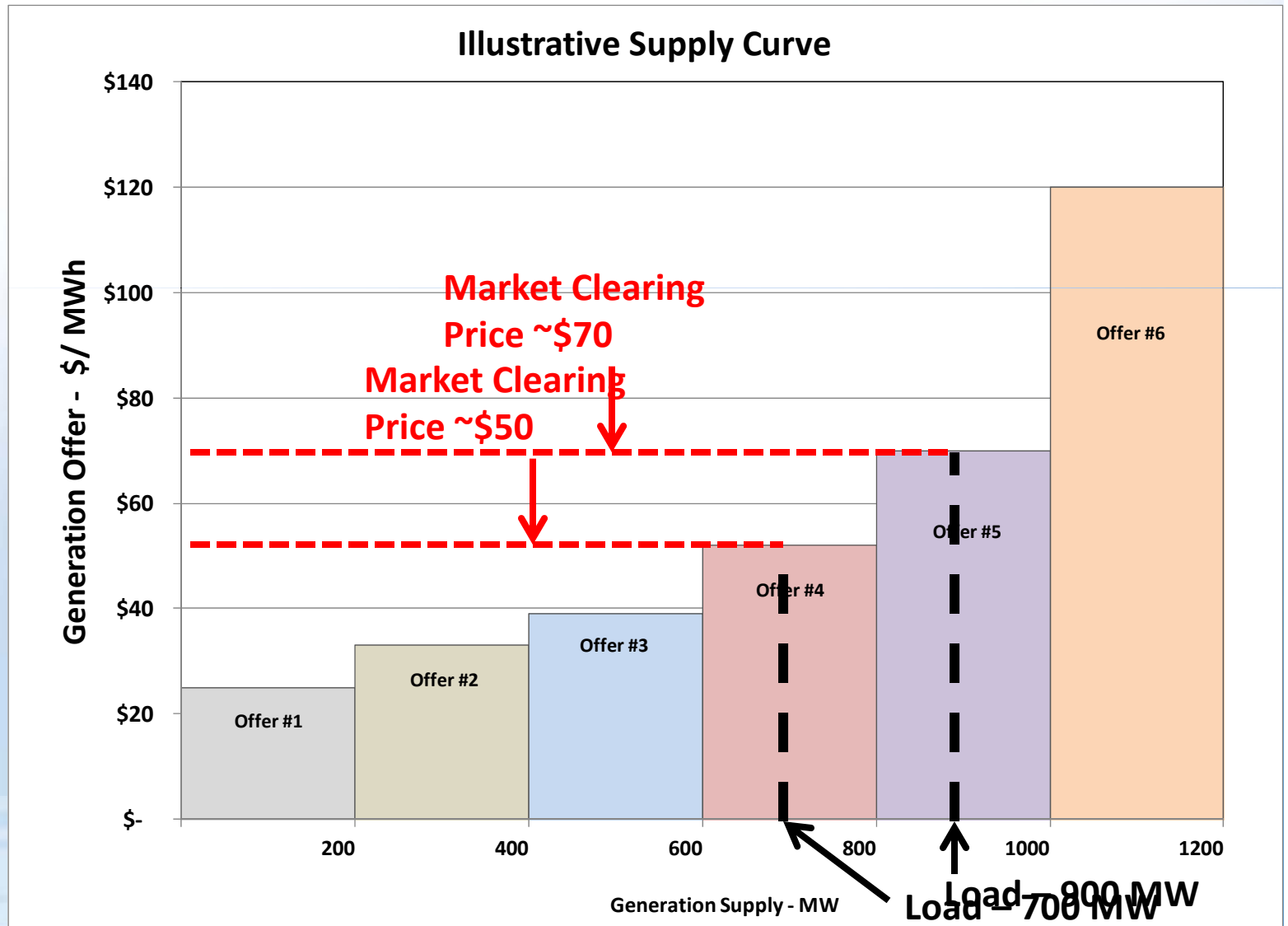
- *Variable Production Cost* - Cost of producing the energy and is the market clearing price in a power market. In a thermal system – this is largely fuel (gas or coal) cost, and in the future will include the cost of carbon credits
  - In the U.S. costs flows through to consumers through fuel cost rate adjustments
  - ***The cost of energy is captured in the MISO Day Ahead & Real-time energy market price***
- *Capacity Charge* (also called fixed or capital) costs represents fixed costs to have a plant available for generation – but before producing any energy
  - In the U.S , annualized cost plus a rate of return flows through to end use consumers through the annual general rate applications, separate from the energy costs
  - ***The cost of capacity is captured through bilateral sale agreements or Planning Reserve (Capacity) auction revenues.***
    - ***The cost of capacity is not incorporated in the Day-Ahead & Realtime market prices***

# Determining the Market Clearing Price (Energy)

- Generators electronically offer the potential output of their units into the market based on their variable cost of producing a unit of energy
  - Variable costs include fuel costs, variable O&M, emission permits
- The market operator uses security constrained economic dispatch to stack all the offers from lowest to highest, and selects the offers (or dispatches the generators) as required to meet the current load, while respecting any system limits such as transmission line capacities
- Each generator who runs gets paid the market clearing price for that hour- which is the variable (or marginal) cost of the most expensive unit operating during that hour

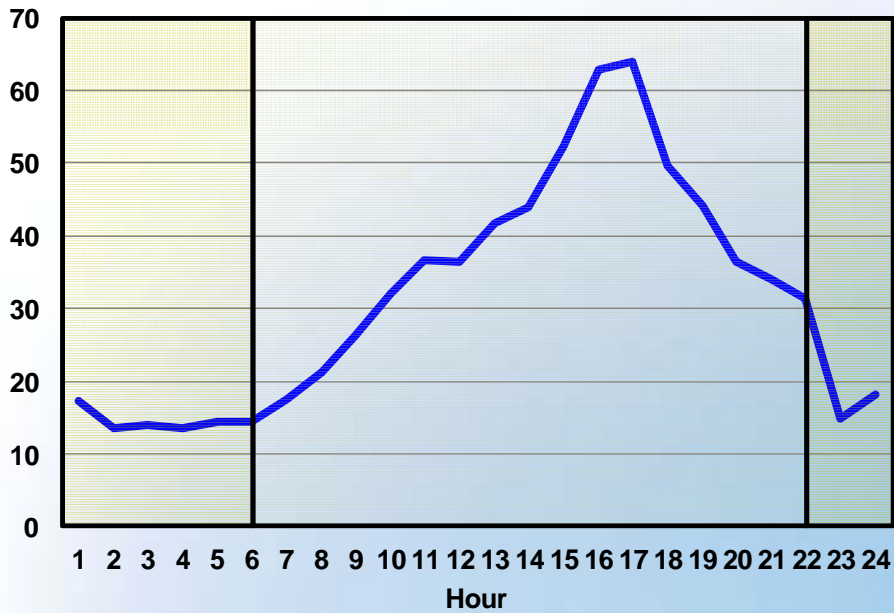
# Illustrative Supply Curve

**Example  
#2:  
900 MW  
load**

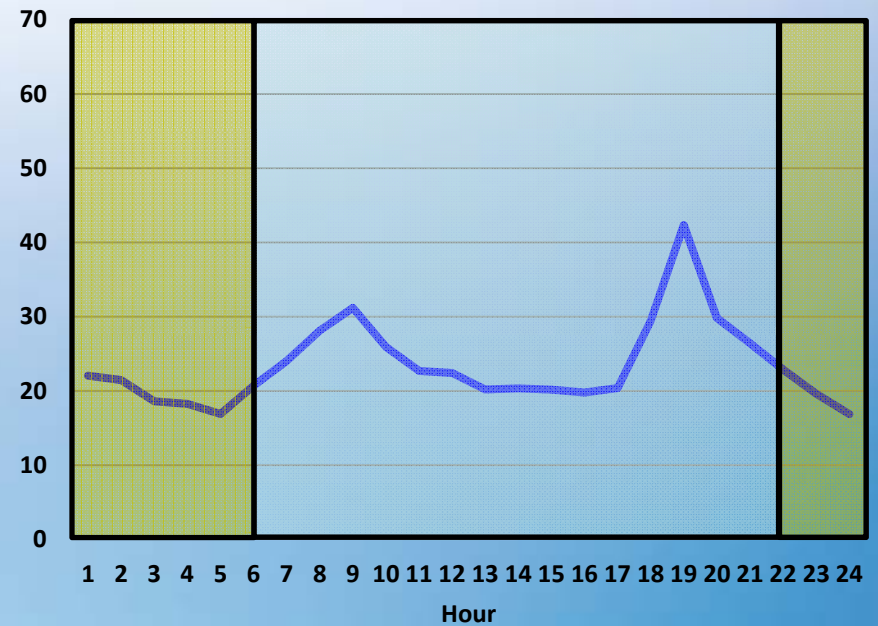


# Typical Energy Price Variation 2012 \$/MW.h

### Summer Day

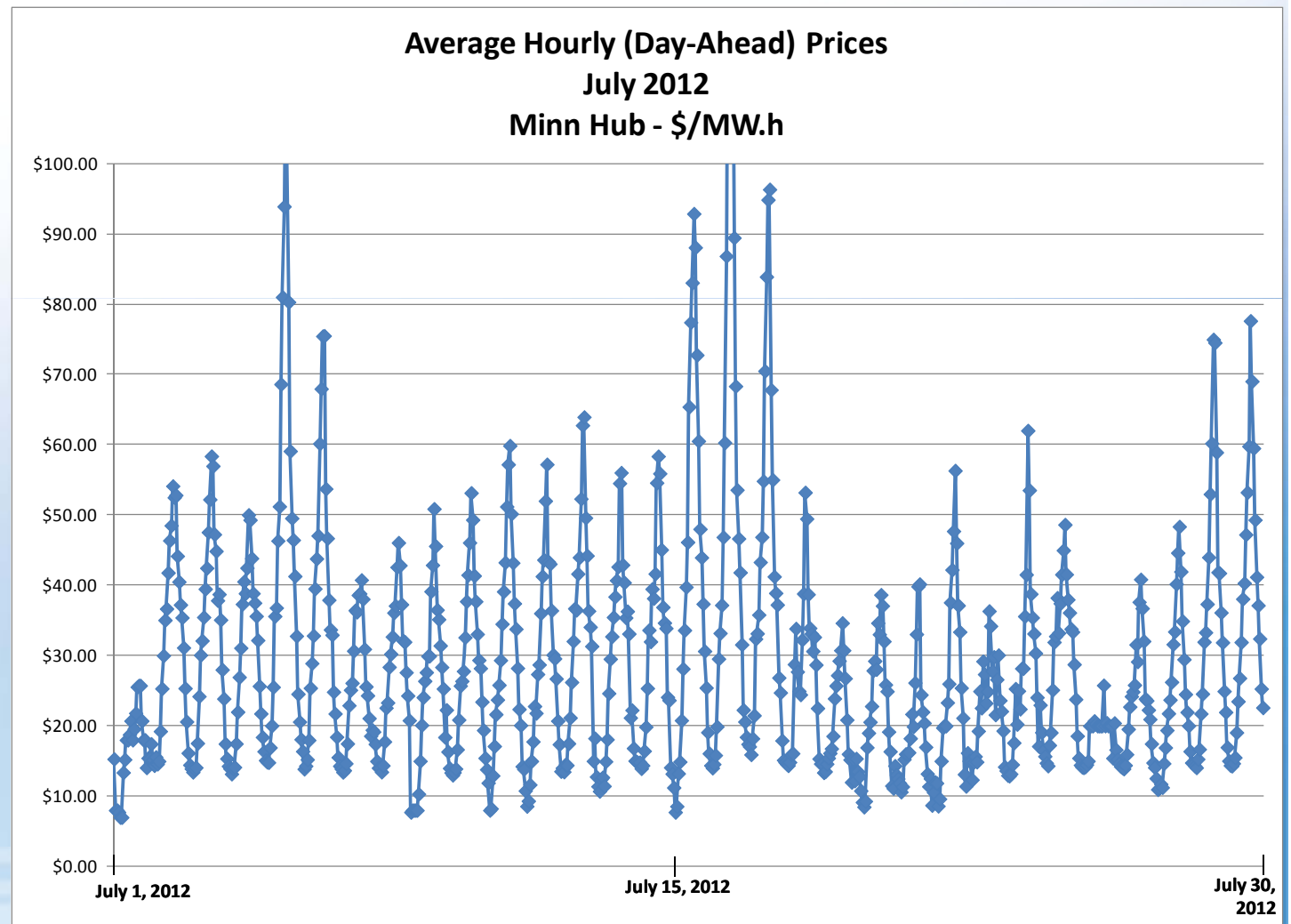


### Winter Day



# Monthly Variability

- Hourly Day Ahead prices (in chronological order) for July 2012
- July 2012 All-Hours Avg price - \$29.27
- Average hourly prices range from \$7-\$168/MWh
  - 23% - 580% of monthly avg price



# Costs by Decision Horizon

- **Operating Horizon:**

- Very short term horizon
- Capacity (also called fixed or capital) costs are sunk and are not considered
- Embedded capital costs not in energy price and recovered via other rate base mechanisms
- Thermal generators offer into market at variable cost of production
- Variable production cost normally sets a floor on the market price

- **Long Term Planning Horizon:**

- Capacity costs are not yet incurred and are considered along with variable production costs
- Consideration of expected capacity factor of plant:
  - low capacity factor requirements often select a gas peaker with high operating but low capital costs
  - High capacity factor requirements previously selected a baseload coal plant (before CO2 consideration); now CCTs considered (moderate capital and operating costs)
- Cost of transmission
- Cost of firm fuel supply

# Illustrative Variable Production Costs from Existing Generation

Plant Characteristics	Coal Plant	Combined Cycle Gas Turbine	Simple Cycle Gas Turbine
Typical Heat Rate (Btu/KWh)	10,000 - 12,000	7,500 - 10,000	9,000 - 13,500
Approximate Non-Fuel O&M (\$/MWh)	\$4.00	\$7.00	\$10.00
Typical Emissions Rates (Tons CO2/MWh)	1.17 - 1.41	0.43 - 0.59	0.52 - 0.82

*Note: Information in the above table and following charts are provided for illustrative purposes only and are not meant to represent specific market forecast/assumptions related to fuel prices, technology efficiencies or O&M costs.*



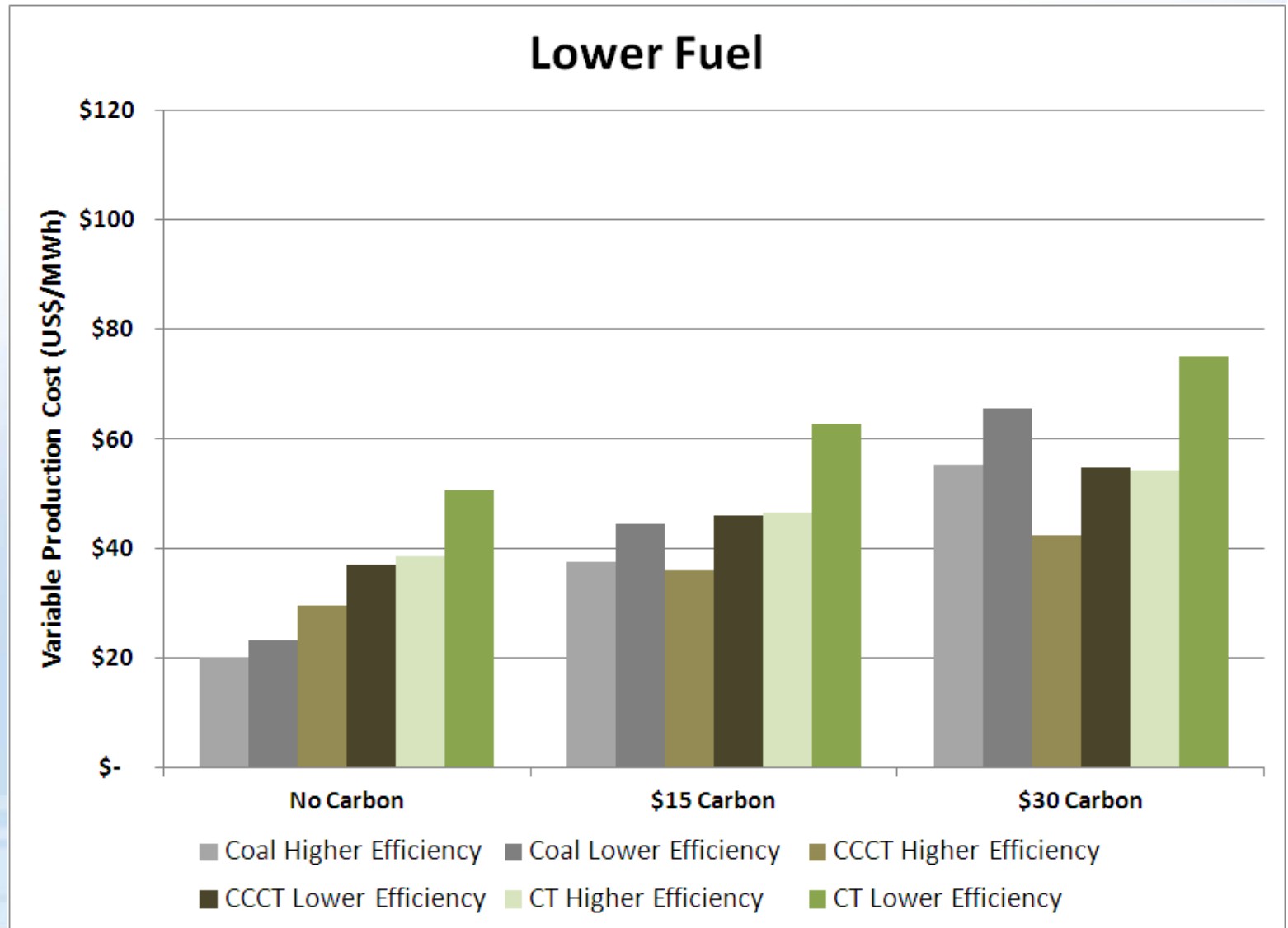


# Lower Fuel Price Scenario Example

Fuel Prices in "Lower bound" example:

- Natural gas - \$3/MMBtu
- Coal (Delivered) - \$1.60/MMBtu

Note: Pricing and efficiencies in the chart are for illustrative purposes only and do not necessarily represent actual market forecasts or expectations

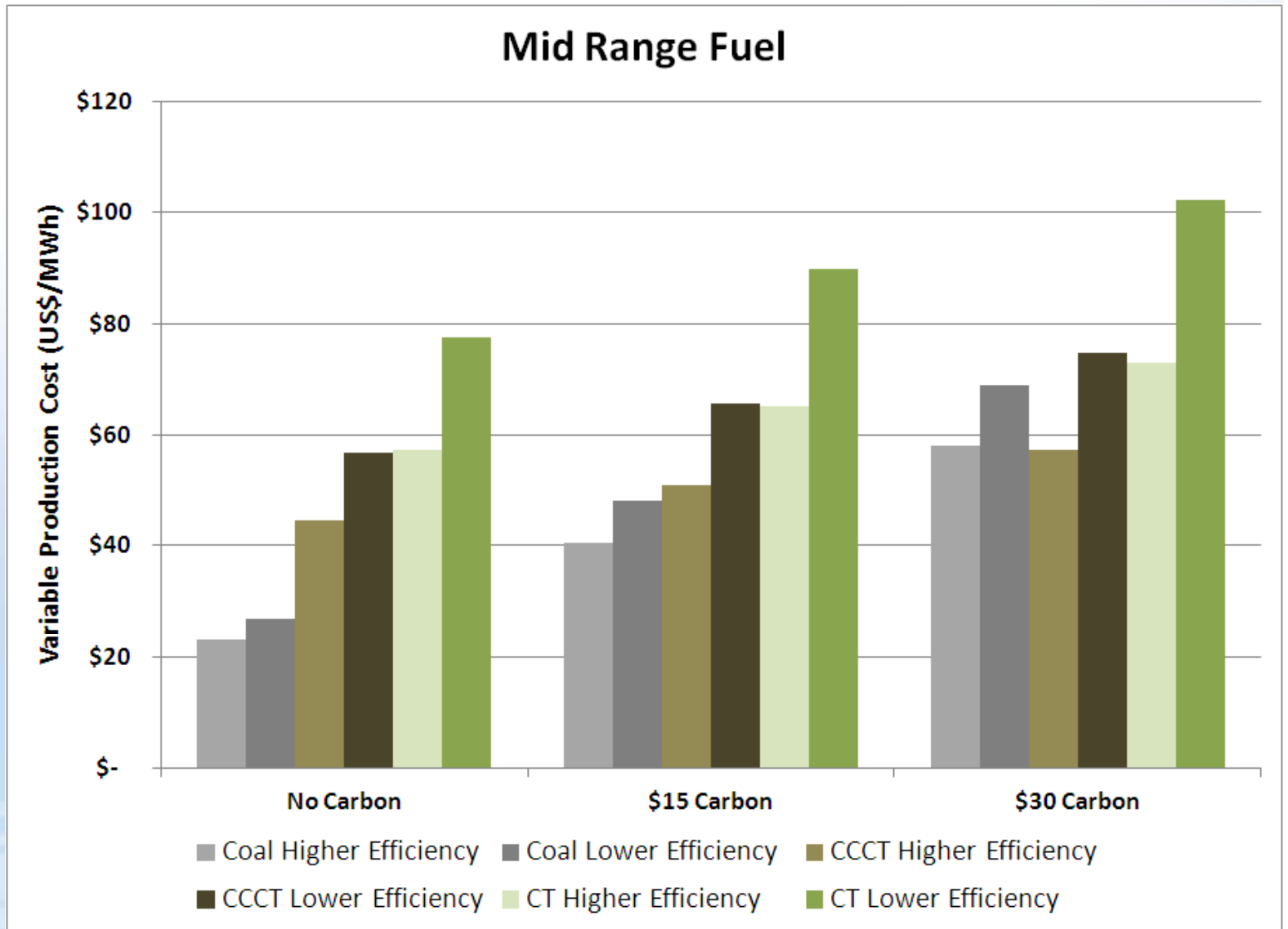


# Midrange Fuel Price Scenario Example

Fuel Prices in "Midrange" example:

- Natural gas - \$5/MMBtu
- Coal (Delivered) - \$1.90/MMBtu

Note: Pricing and efficiencies in the chart above are for illustrative purposes only and do not necessarily represent actual market forecasts or expectations

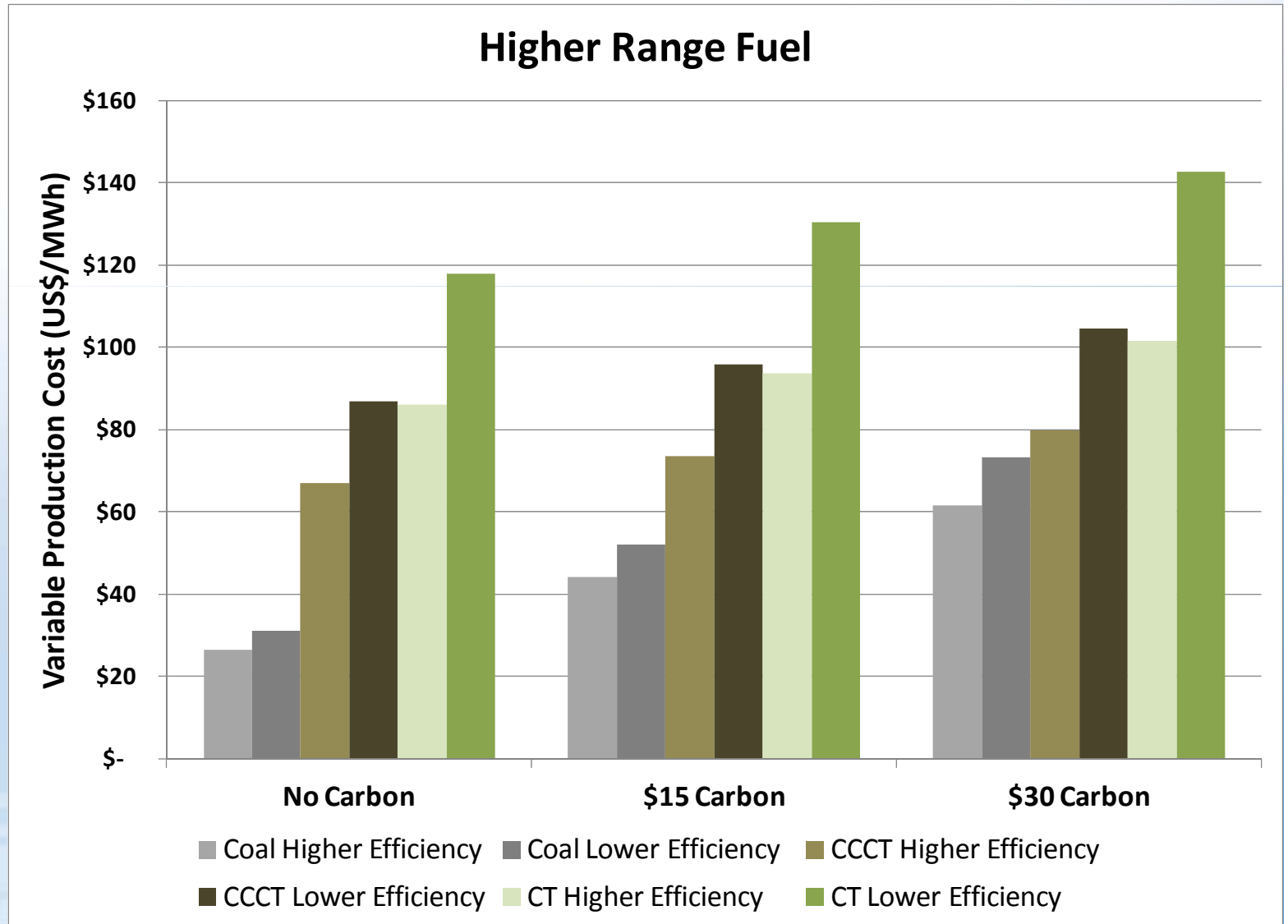


# Higher Fuel Price Scenario Example

Fuel Prices in "Higher bound" example:

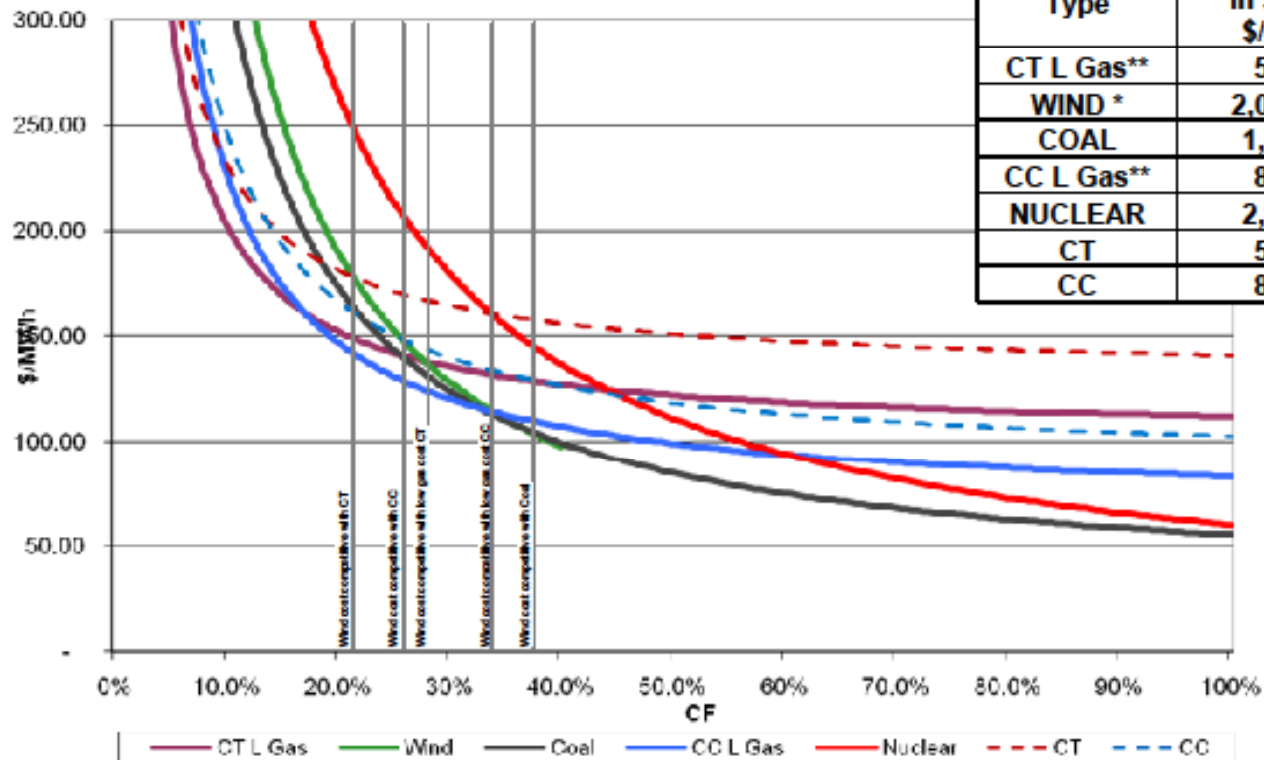
- Natural gas - \$8/MMBtu
- Coal (Delivered) - \$2.25/MMBtu

Note: Pricing and efficiencies in the chart above are for illustrative purposes only and do not necessarily represent actual market forecasts or expectations



# Cost of Generation

Costs in \$/MWh Comparison



Generator Type	Capital Cost	Fuel
	In \$2008 \$/KW	In \$2008 \$/MMBtu
CT L Gas**	597	6.5
WIND *	2,000**	0
COAL	1,833	2.14
CC L Gas**	857	6.5
NUCLEAR	2,928	0.77
CT	597	8.45
CC	857	8.45



\*Wind cost does not include Production Tax Credit; does include cost of associated CTs  
 \*\* All values from MTEP 2009 analysis (Jan 2008) except: wind capital cost, and L gas price scenarios

# Other Considerations for US Utilities

- Numerous EPA Regulations affecting (primarily) coal generation
  - MATS, Cooling Water, Coal Ash etc.
  - GHG (NSPS) still to come
- Aging Generation Fleet
  - Almost 50% of capacity approaching 40 years of age
- Diversification
  - Maintaining price stability through diverse generation mix
  - Coordination challenges utilizing more gas generation due to coal retirements
- IOU interest in investing in capital projects for shareholder return
  - Inherent incentives to construct new transmission (12% fixed rate of return)

**Thank You**

