SPO Planning Analysis

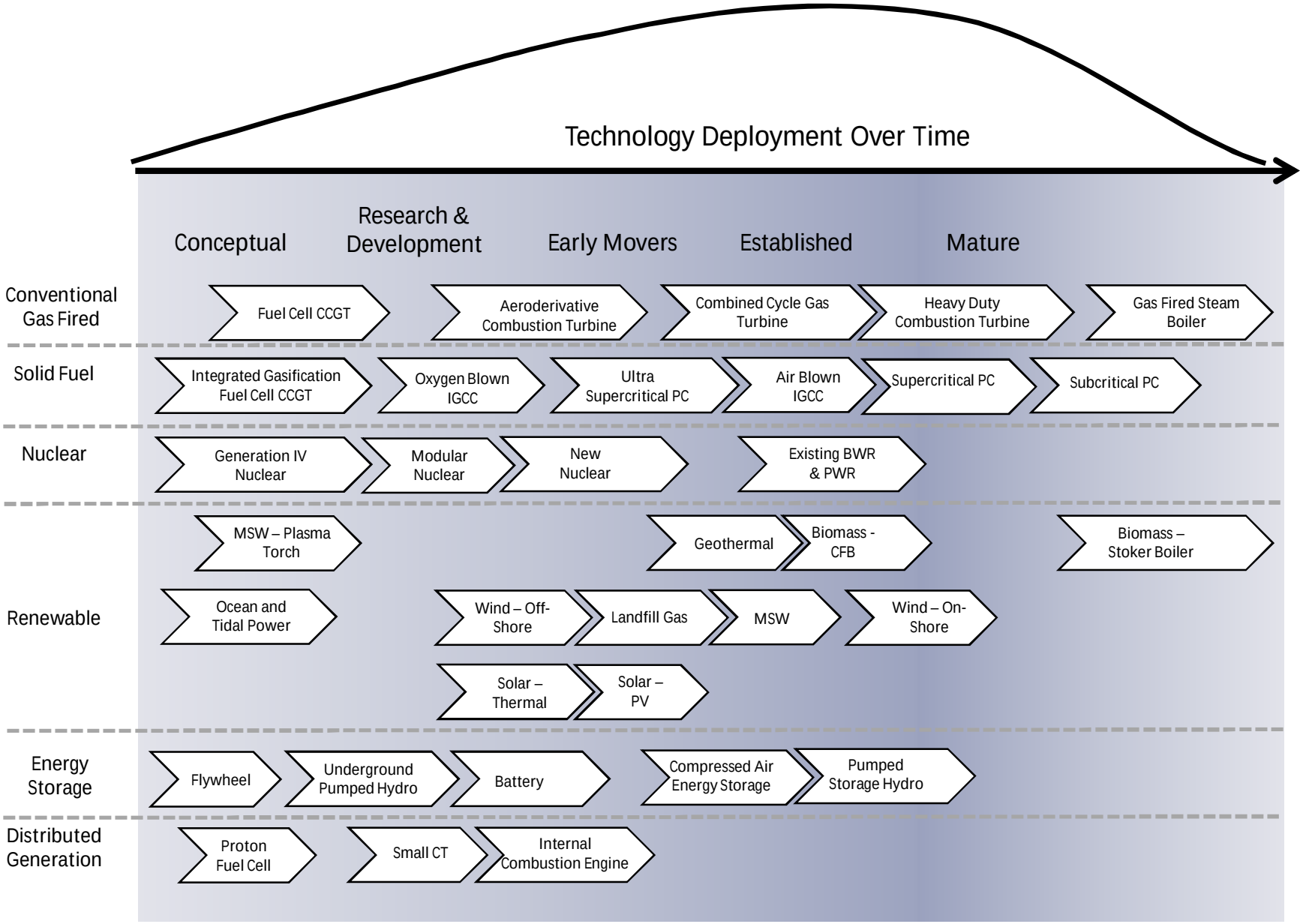
Generation Technology Assessment & Production Cost Analysis

EAI Stakeholder Meeting

July 31, 2012

Entergy®

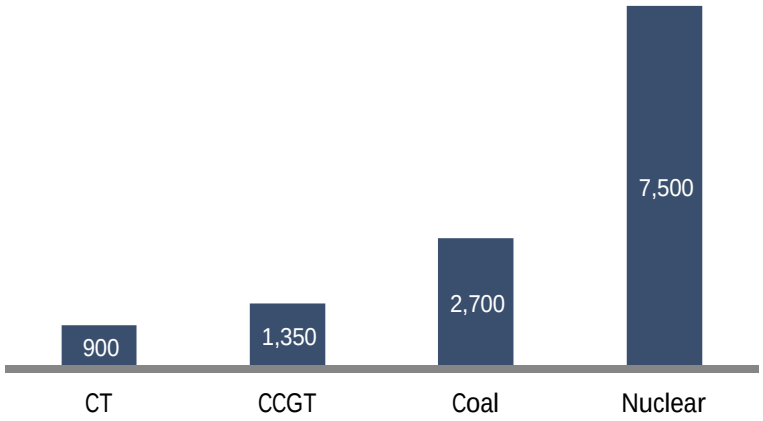
Technology Life Cycle



Conventional Alternatives

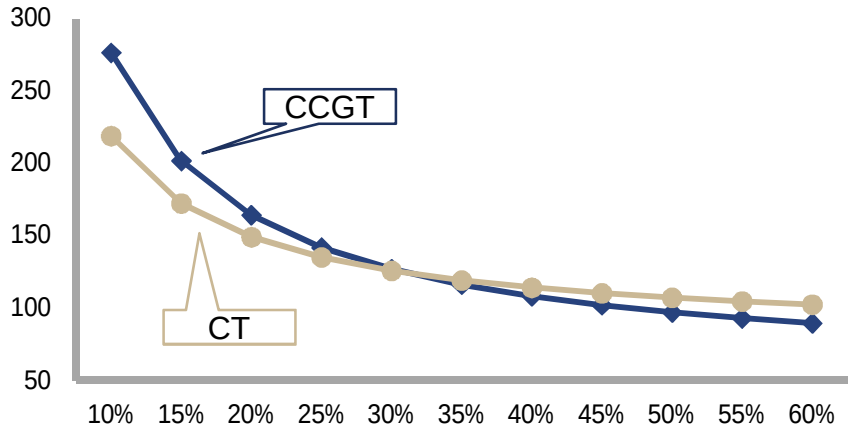
Gas Fired CT / CCGT offers Lowest Capital Cost

Installed Cost (2011$/kW)



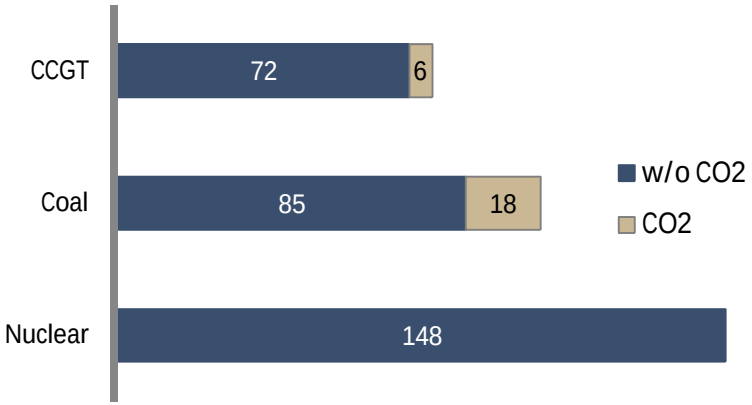
CT is preferred over CCGT below about 30% Capacity Factor

$/MWh (2012 Installation)*



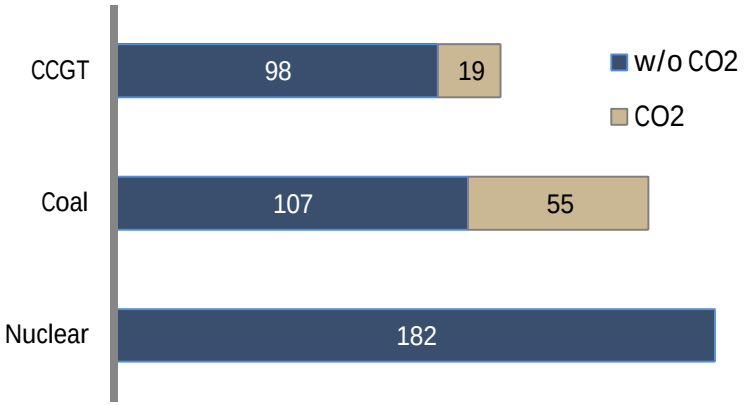
For base load CCGT is low cost alternative in 2012 . . .

Bus Bar Cost/MWh (90% Capacity Factor)*



And in 2022

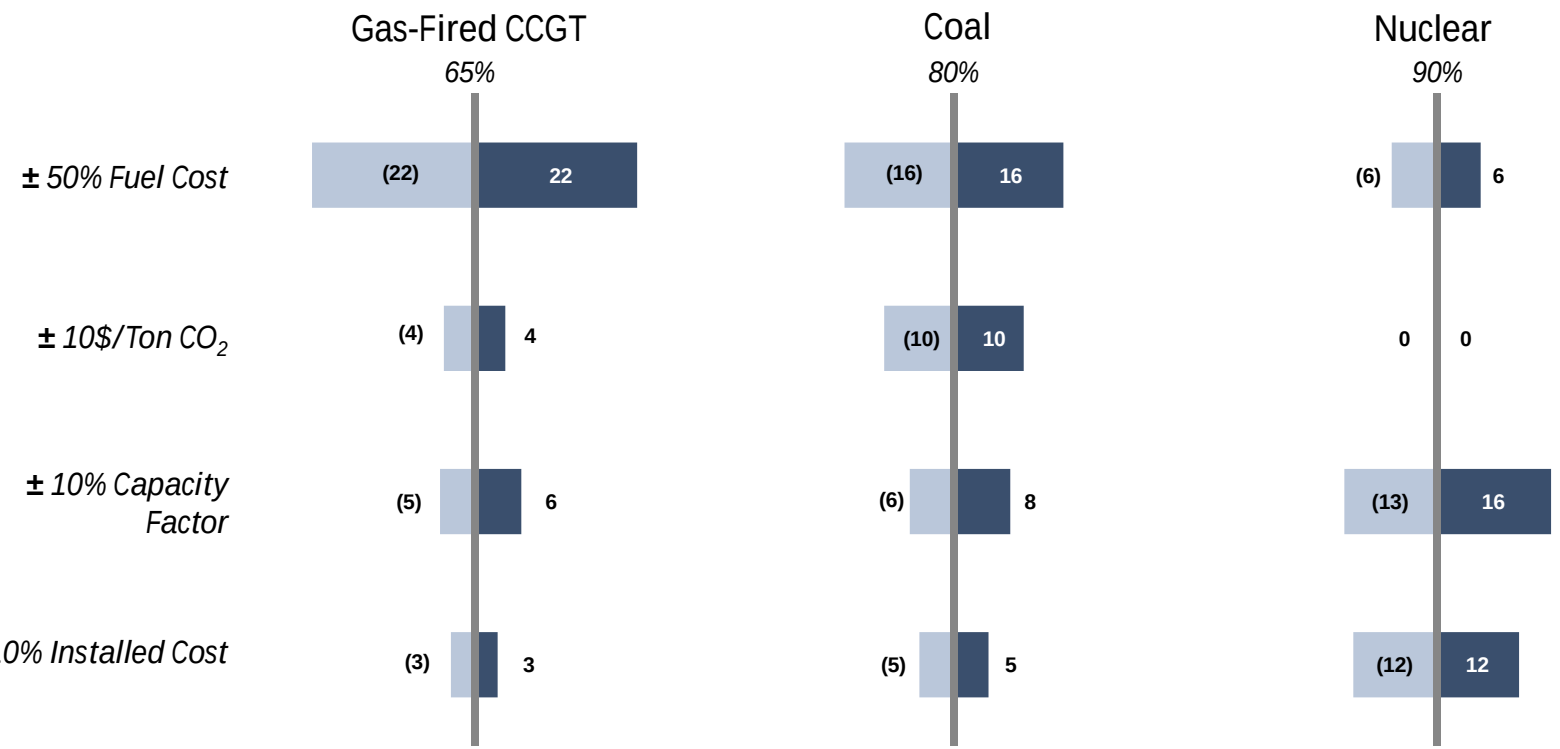
Bus Bar Cost $/MWh (90% Capacity Factor)*



*Bus bar cost levelized in nominal $/MWh over expected life of resource (30 years CCGT & CT, 40 years coal and nuclear). CO_2 compliance cost begins in 2023 and escalates over time.

Sensitivities

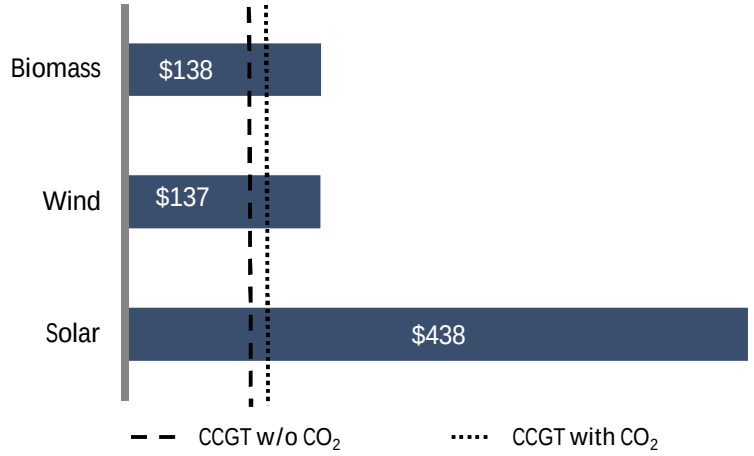
*Gas-fired CCGT economics remain favorable across range of assumptions**



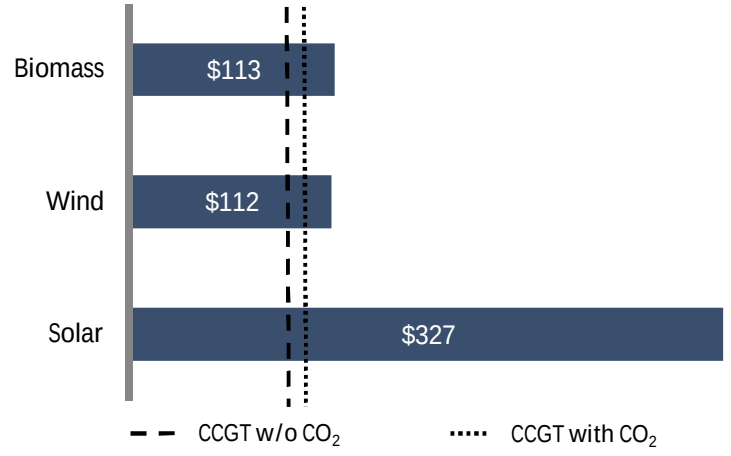
*Bus bar cost levelized in nominal $/MWh over expected life of resource (30 years CCGT & CT, 40 years coal and nuclear). CO_2 compliance cost begins in 2023 at $24.12/U.S. and escalates over time at about 7% per year. Cost based on 2012 COD.

Renewable Alternatives

$/MWh Without Incentives*

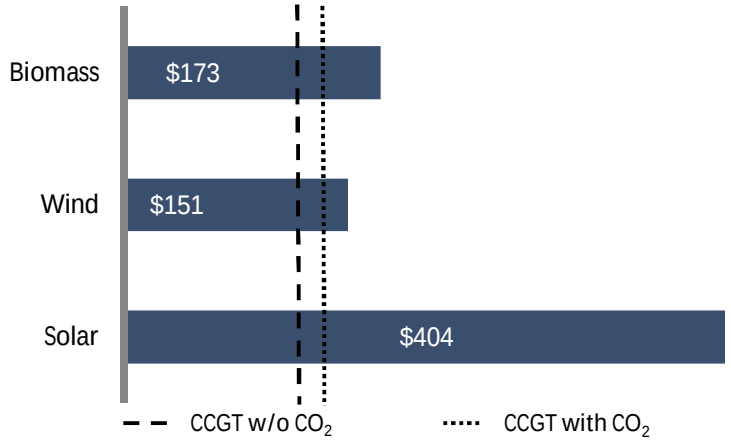


$/MWh With Incentives*

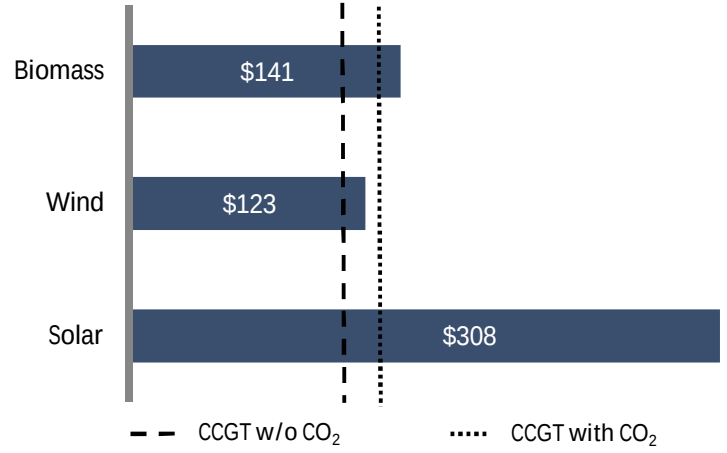


2022 In Service Date

$/MWh Without Incentives*



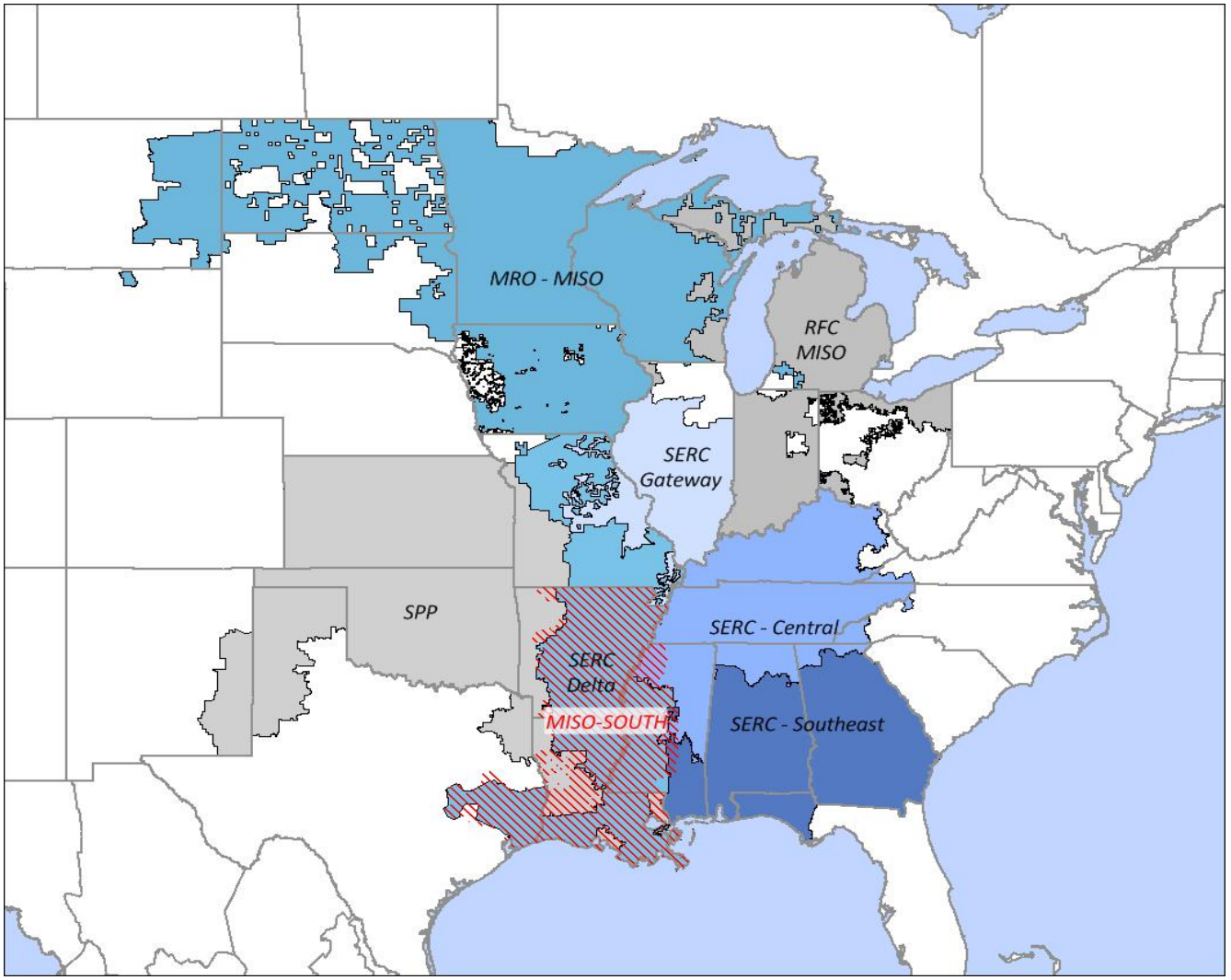
$/MWh With Incentives*



*Bus bar cost levelized in nominal $/MWh over expected life of resource (30 years CCGT & CT, 40 years coal and nuclear). CO_2 compliance cost begins in 2023 and escalates over time.

Scope of Aurora Market Modeling For IRP

Entergy Region and surrounding regions were modeled . . .



Supply Cost Assessment Overview

Aurora Production Cost Model

AURORA is used to simulate the hourly operation of the MISO and 1st tier power markets over the study period 2014 – 2023.

Includes a zonal representation that reflects transmission transfer capability limitations.

Includes a load forecast for each modeled entity and each generating unit is modeled individually.

Additional constraints are modeled to reflect operational limitations and requirements, including:

- Balancing Authority reserve requirements;
- Zonal reserve requirements;
- Generating unit forced outage rates; and
- Generator unit maintenance

All of the generators are committed and dispatched to serve the combined load at the lowest variable cost subject to the constraints.

Results in hourly power prices that are representative of the Locational Marginal Prices (LMP) for each zone.

Supply Cost Assessment

Variable production cost is measured as:

Cost of Service = Load Payment
+ Generation Cost
– Generation Revenue

To assess the total supply cost of each portfolio of resources, the incremental fixed cost of the resources that comprise the portfolio is added to the variable production cost of service.

Market Modeling Overview

IRP analytics will rely on four scenarios to assess alternative portfolio strategies under varying market conditions. Additional information regarding the scope of and assumptions used in the market modeling are provided in other slides. The four scenarios are:

- Scenario 1 (Assumes Reference Load, Reference Gas, and no CO_2 cost)
- Scenario 2 (Economic Rebound)
- Scenario 3 (Green Growth)
- Scenario 4 (Austerity Reigns)

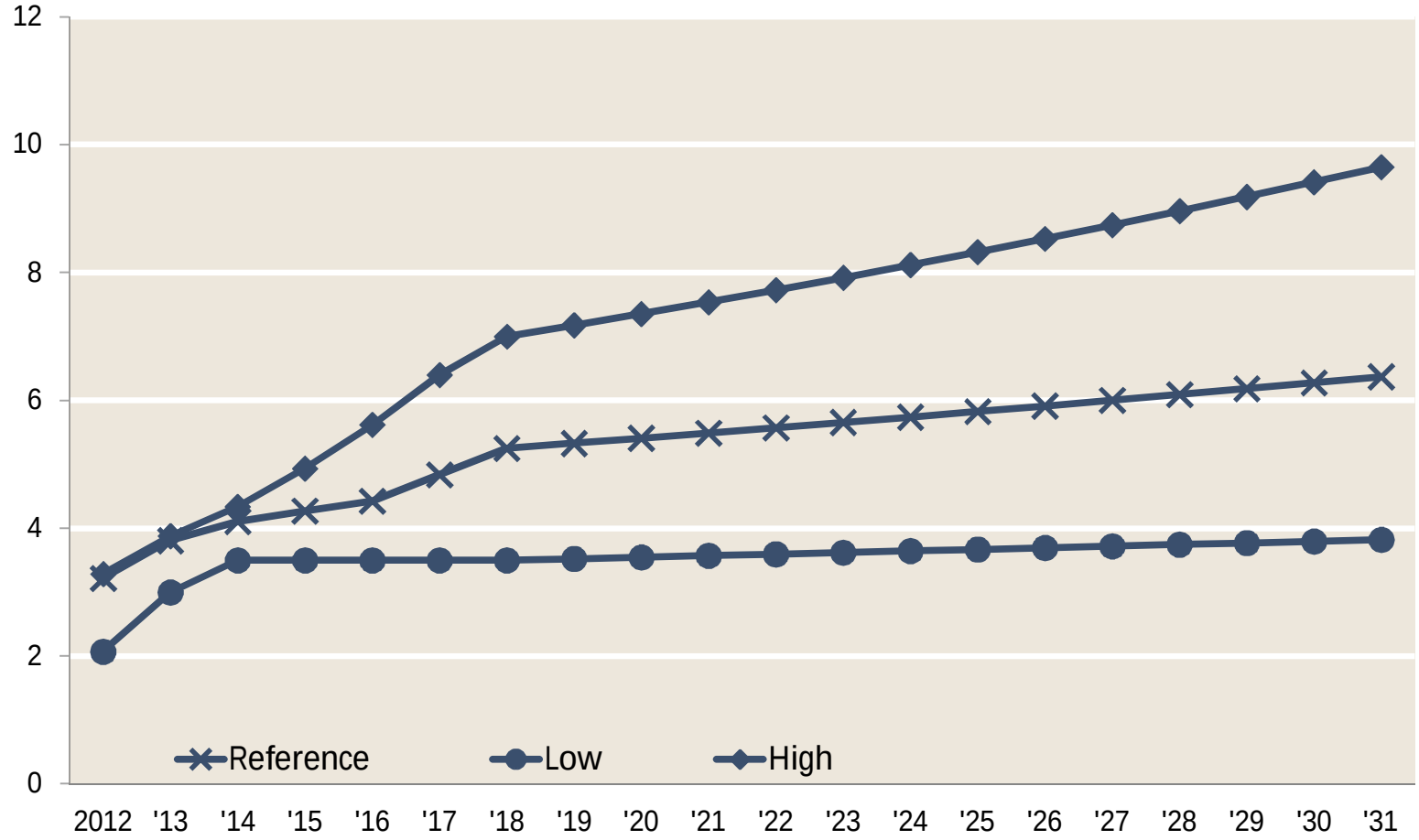
- More information of Scenarios 2-4 are found on the following page.

Scenario Storylines

	Scenario 2 Economic Rebound	Scenario 3 Green Growth	Scenario 4 Austerity Reigns
General Themes	• U.S. economy recovers and resumes expansion at relatively high rates. Improved domestic energy supply and productivity improvements keep current manufacturing/industrial base competitive.	• Government policy and public interest drive a "green agenda" marked by government subsidies for renewable generation; regulatory support for energy efficiency; and consumer acceptance of higher cost for "green." • Overall economic conditions are good with moderate GDP growth which enables investment in energy infrastructure.	• Sustained poor economic conditions in U.S. – low GDP. • Economic issues trump environmental concerns in public policy and consumer attitude.
Power Sales	• Economic growth and new uses for electric power drive power sales. New power uses more than offset energy efficiency gains. Technology improvements drive electric demand and vehicles grow at a steady pace. EVs are about an 12% of the light duty fleet by 2031.	• Moderate economic growth stimulates power demand. • However, decline in electricity intensity resulting from energy efficiency measures provides a countervailing force. • Consistent with green agenda, electric vehicles represent about a quarter of the light vehicle fleet by 2031, slightly muting de-electrification.	• Poor economic conditions result in low growth in demand for power. Electric vehicles don't catch on. Due to low power prices, relaxation of some efficiency standards and consumer's unwillingness to invest in energy efficiency, electricity intensity and therefore KWh sales growth and peak demand is higher than expected.
Climate Policy	• Carbon capture & storage required when commercially available for all new power generation. • Mild cap and trade for power in 2023.	• Cap & trade for carbon (power sector only) starting in 2018. • New coal must have CCS.	• Neither Congress nor EPA regulate CO_2. (no carbon cost).
Energy Policy	• Primarily market solutions. Slow but steady move toward a cleaner environment driven by innovation.	• Clean energy standard enacted. • Government subsidies for renewable generation , new nuclear & EVs.	• Renewable subsidies end. Government has little appetite for new policy. No new state RPSs.
Fuels	• Although demand is strong, technology allows supply to keep pace. Fuel prices stay in reasonable check.	• Natural gas prices are driven higher by EPA regulation of fracking & local opposition. Coal and oil prices also high.	• Low fuel prices, but natural gas and coal still plentiful as E&P cost are also lower.

Henry Hub Natural Gas Forecast

SPO Henry Hub Natural Gas Price Forecasts (2011$/MMBtu)



Natural Gas Assumptions

System Planning & Analysis has produced three gas price curves which are proposed for use in the development of the 2012 IRP. The curves are summarized in the following tables.

2012- 2031 Nominal $ per MMBtu			
	Low	Reference	High
Levelized*	$3.97	$5.79	$7.58
Average	$4.38	$6.66	$9.15
19 Yr. CAGR	5.37%	5.75%	7.96%

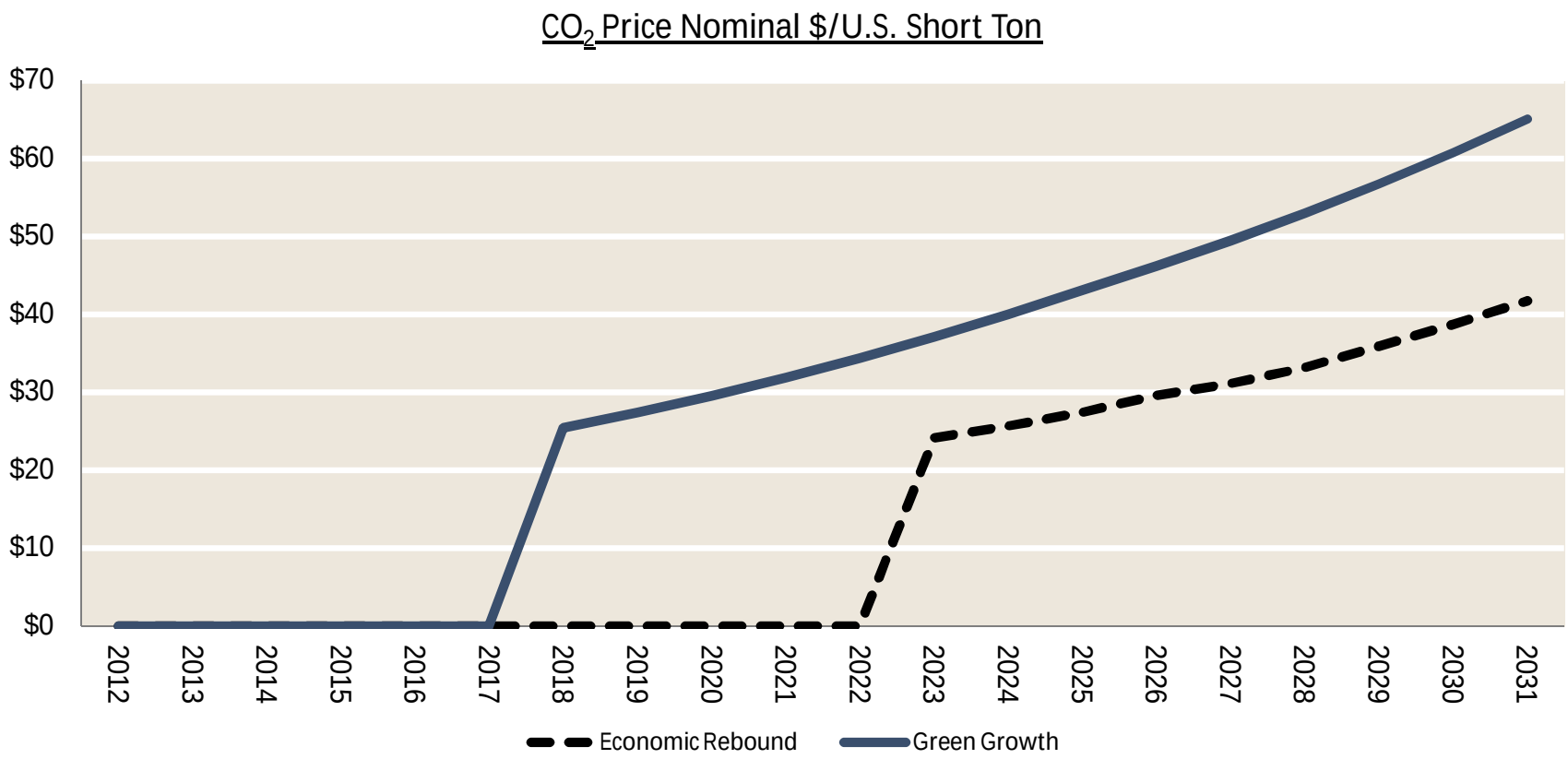
2012- 2031 Real 2011$ per MMBtu			
	Low	Reference	High
Levelized*	$3.41	$4.95	$6.47
Average	$3.51	$5.29	$7.20
19 Yr. CAGR	3.29%	3.67%	5.84%

**Real prices levelized at 7.25% discount rate*

Forecast based on January 13 Market Close.

2012 IRP Carbon Assumptions

Reference Case and Austerity Reigns scenarios assume no direct CO_2 regulation. The Economic Rebound and Green Growth Scenarios assume cap and trade programs beginning in 2023 and 2018, respectively.



Market Model Inputs (2012-2031)

	Scenario 1	Economic Rebound	Green Growth	Austerity Reigns
Electricity CAGR (Energy GWh)	~0.8%	~1.5%	~0.3%	~1.1%
Energy CAGR (w/o Elec. Vehicles)	Not materially different	~1.4%	~0.1%	Not materially different
Peak Load Growth CAGR	~0.8%	~1.4%	~0.2%	~1.1%
Henry Hub Natural Gas Prices ($/MMBtu)	$4.96 levelized 2011$	Same as Reference $4.96 levelized 2011$	High Case ($6.48 levelized 2011S	Low Case ($3.40 levelized 200x)
WTI Crude Oil ($/Barrel)	$93 levelized 2011$	$127 levelized 2011$	High Case $209 levelized 2011$	Low Case $53 levelized 2011$
CO_2 ($/short ton)	None	Cap and trade starts in 2023 $6.56 levelized 2011$	Cap and trade starts in 2018 $16.65 levelized 2011$	None
Conventional Emissions Allowance Markets	CAIR	CSAPR starts 2013	CSAPR starts 2013	CAIR
Delivered Coal Prices – Entergy Owned Plants (Plant Specific Includes Current Contracts) $/MMBtu	Reference Case (Vol. Weighted Avg. $2.66 levelized 2011$)	Same as Reference Case (Vol. Weighted Avg. $3.40 levelized 2011$)	High Case (Vol. Weighted Avg. $3.40 levelized 2011$)	Low Case (Vol. Weighted Avg. $2.27 levelized 2011$)
Delivered Coal Prices – Non Entergy Plants In Entergy Region	Mapped to similar Entergy Plant	Mapped to Similar Entergy Plant	Mapped to Similar Entergy Plant	Mapped to Similar Entergy Plant
Delivered Coal Prices – Non Entergy Regions	Reference Case - Varies By Region	Same as Reference Case - Varies By Region	High Case – Varies By Region	Low Case – Varies By Region
Coal Retirements Capacity (GW)*	54 GW	54 GW	115 GW	25 GW
New Nuclear Capacity (GW)*	7 GW	8 GW	25 GW	2 GW
New Biomass (GW)*	0.1 GW	0.1 GW	7 GW	0.1 GW
New Wind Capacity (GW)*	57 GW	68 GW	80 GW	22 GW
New Solar Capacity (GW)*	0.9 GW	1 .0 GW	2 GWs	0.3 GW

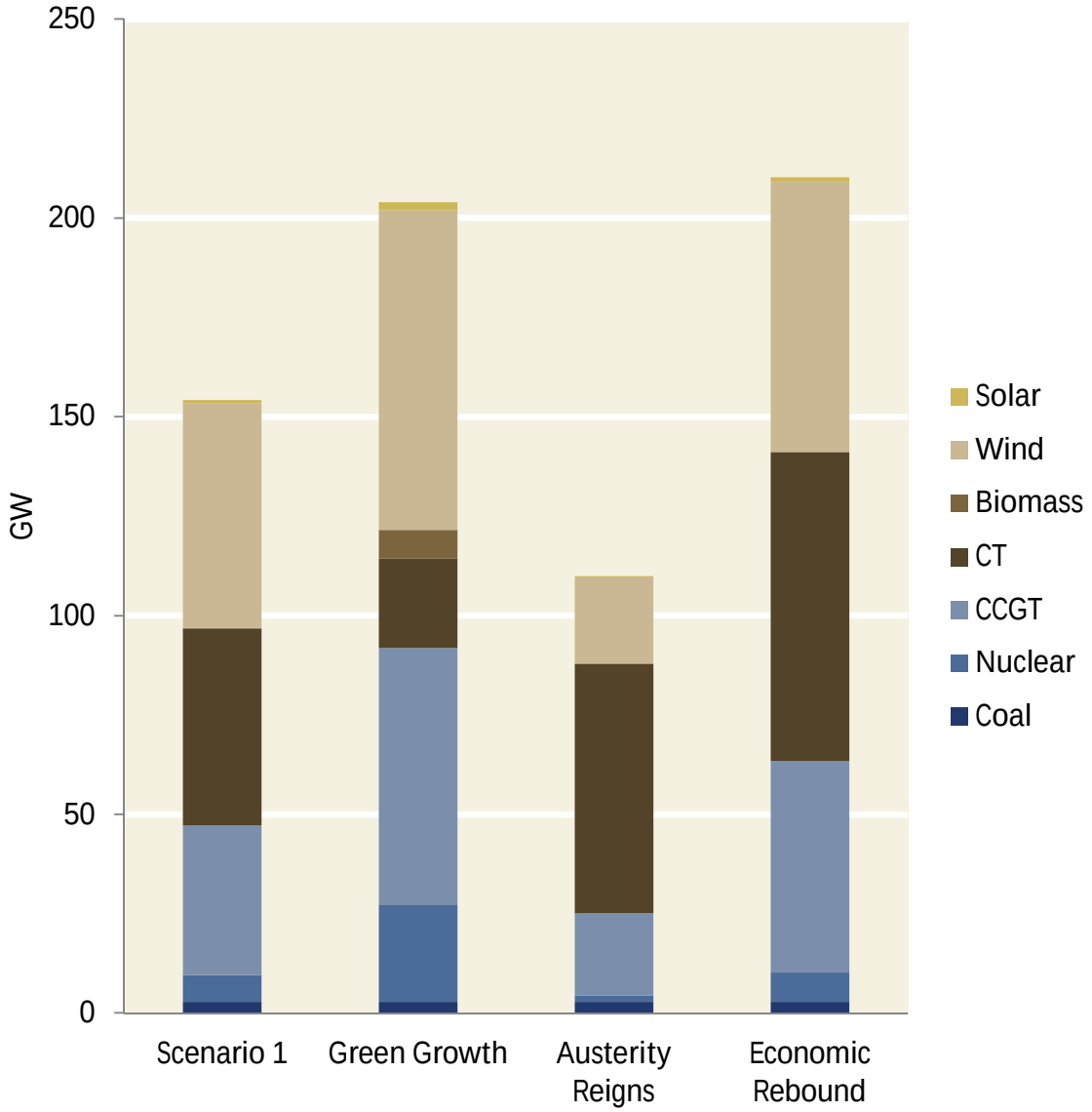
*Figures shown are for the period 2012-2031 covering a sub-set of the Eastern Interconnect which is approximately 34% of total U.S. 2011 TWh electricity sales. Gas and Coal additions other than 5 GW currently under construction handled through the Aurora capacity expansion algorithm. Non coal retirements are assumed to occur when resource reaches 60 years old unless an earlier retirement date has been announced. Entergy regulated plant assumed deactivations based on internal forecasts and do not change by scenario.

Note: Levelized prices refer to the price in 2011 dollars where the NPV of that price grown with inflation over the 2012-2031 period would equal the NPV of levelized nominal prices over the 2012-2031 period when the discount rate is 9.25%.

Capacity Additions In Modeled Market 2012-2031

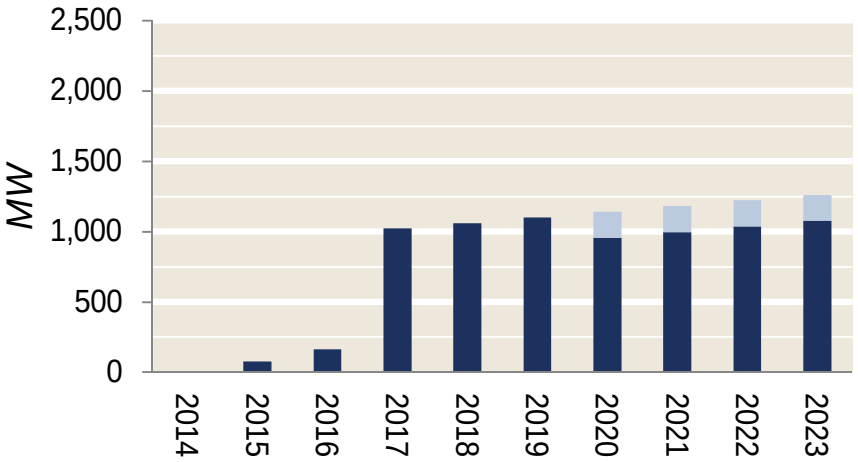
Capacity Expansion

The scenarios differ in regards to the amount and type of capacity added in the market over the planning horizon. The differences reflect specific input assumptions for some technologies (nuclear, biomass, wind, solar) and automatic capacity expansion results, i.e., model-selected additions for others (coal, CCGT and CT). Capacity expansion results shown to the right relate to the overall modeled market (not Entergy Operating Companies specific). The "market" had about one third of U.S. energy sales in 2011.

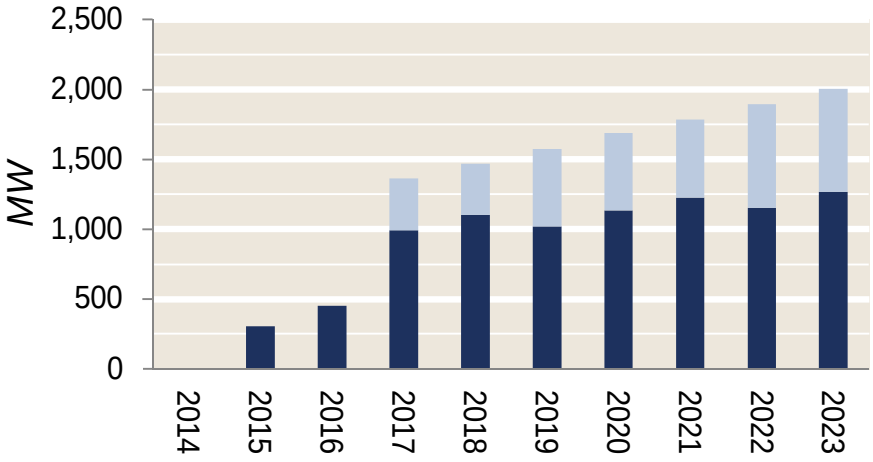


EAI Portfolio 1 – Resource Additions by Scenario

Scenario 1

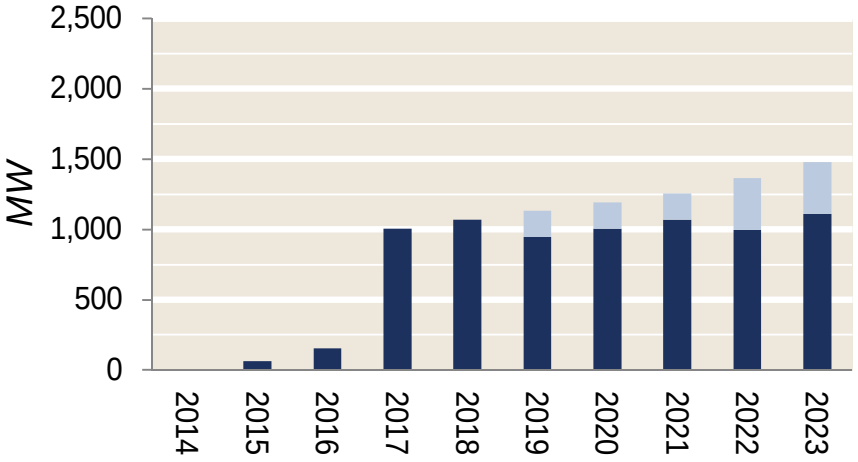


Economic Rebound

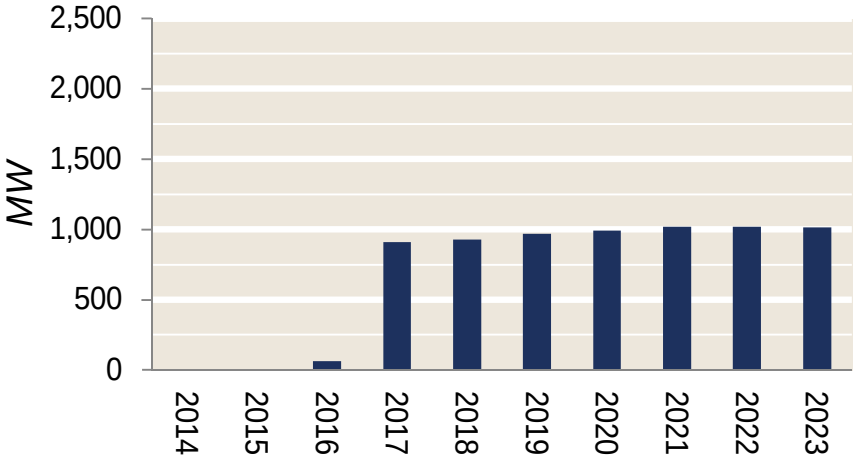


Purchases **CT**

Austerity Reigns

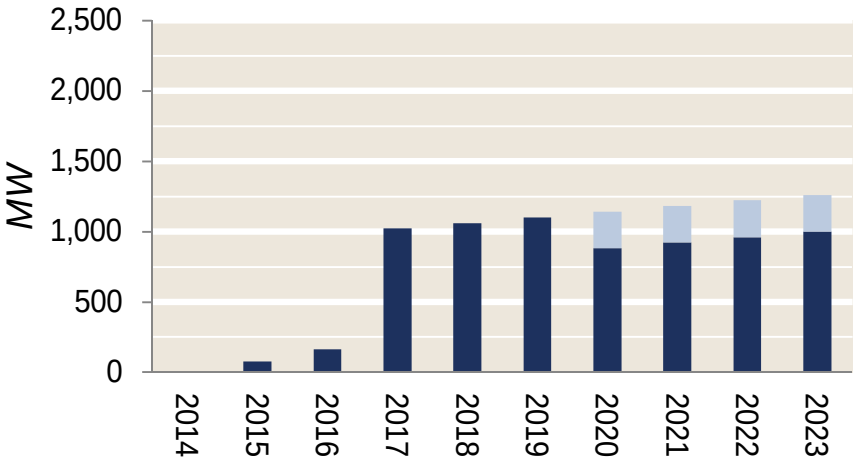


Green Growth

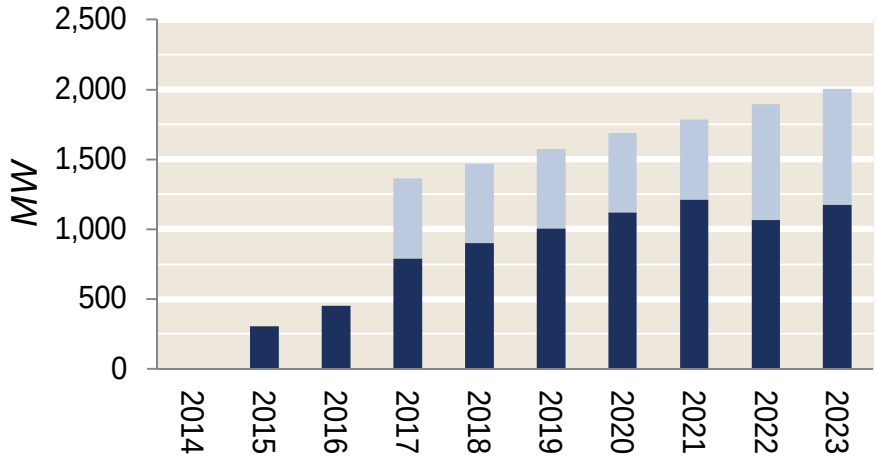


EAI Portfolio 2 – Resource Additions by Scenario

Scenario 1

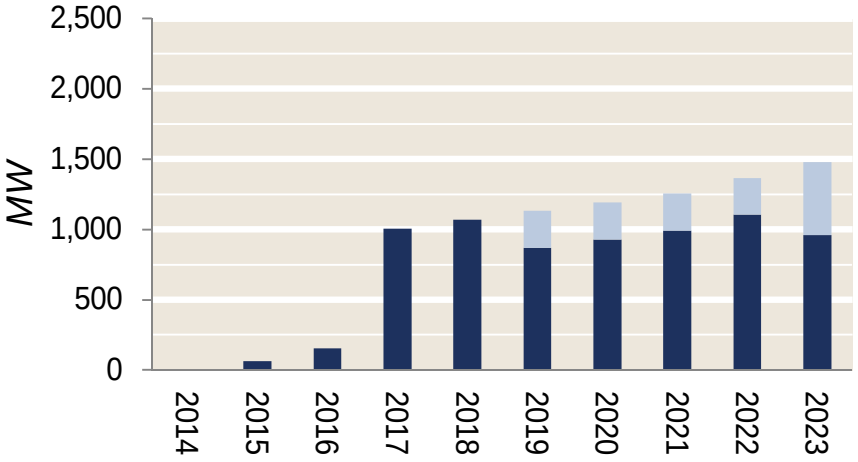


Economic Rebound

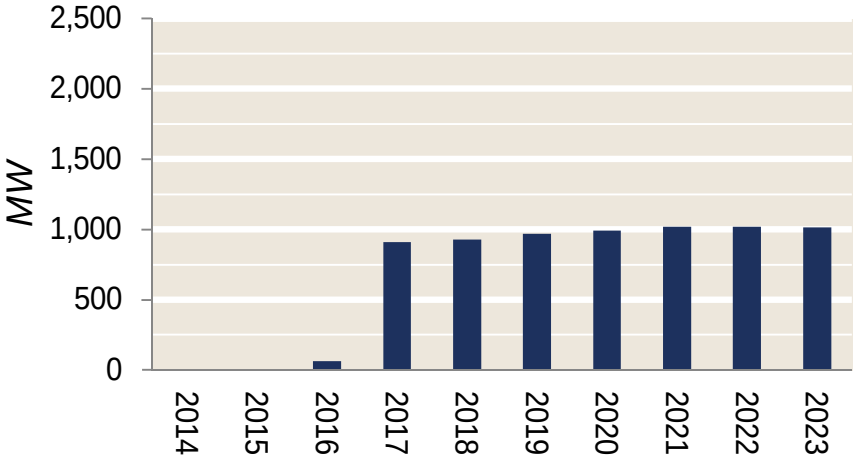


Purchases **CCGT**

Austerity Reigns

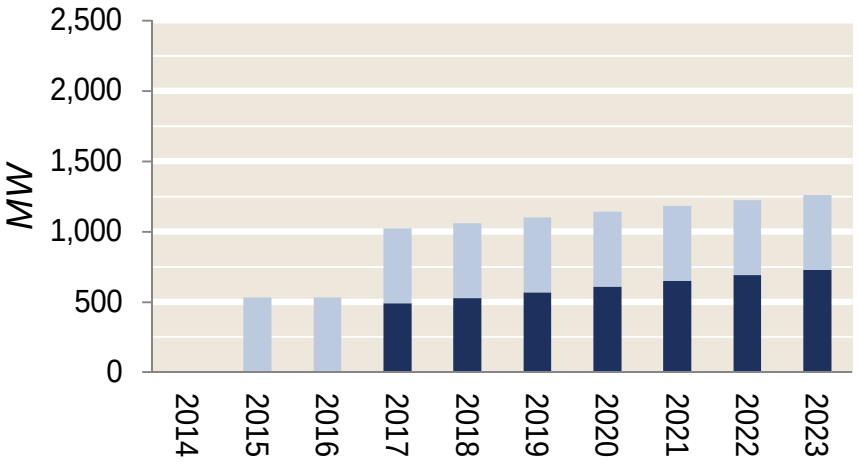


Green Growth

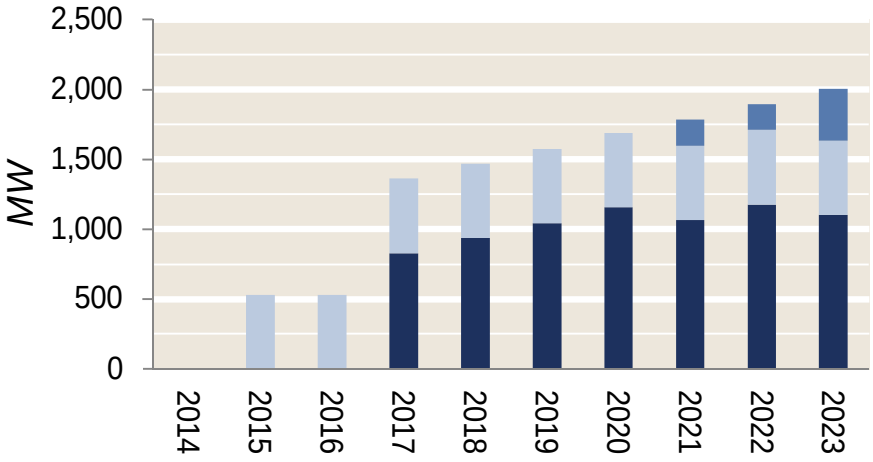


EAI Portfolio 3 – Resource Additions by Scenario

Scenario 1

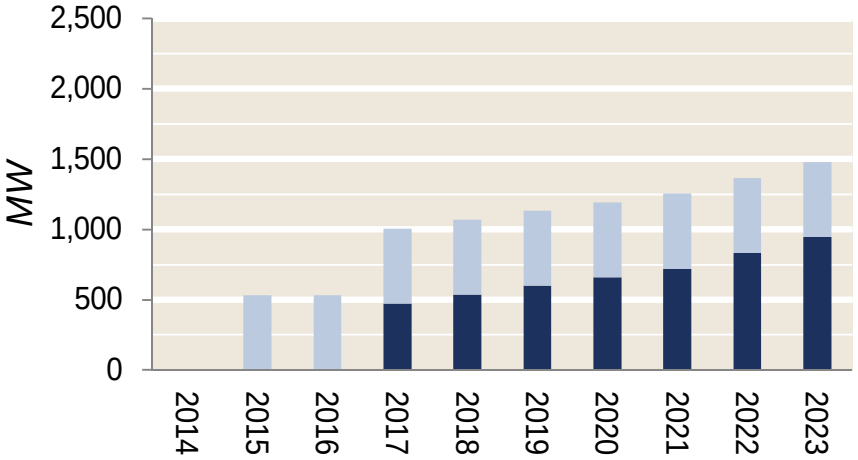


Economic Rebound

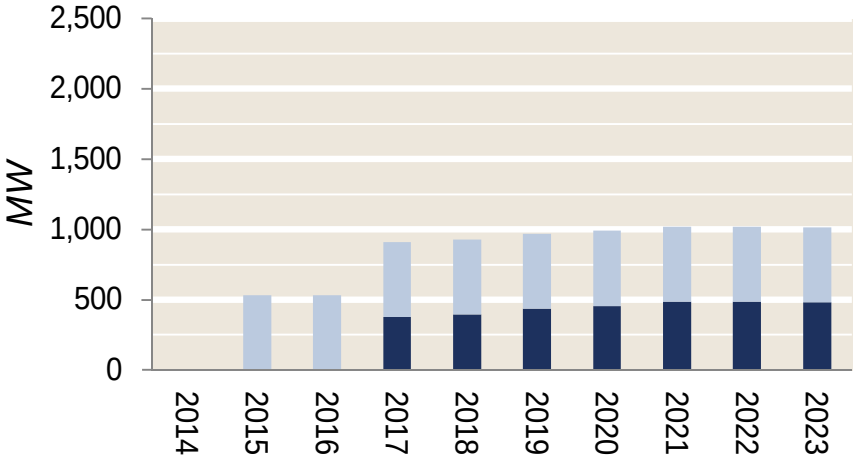


Purchases **Lake Catherine 4** **CT**

Austerity Reigns

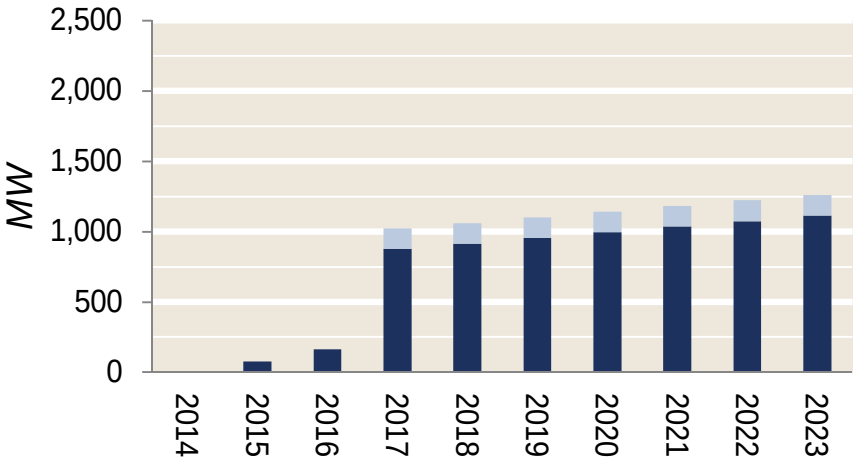


Green Growth

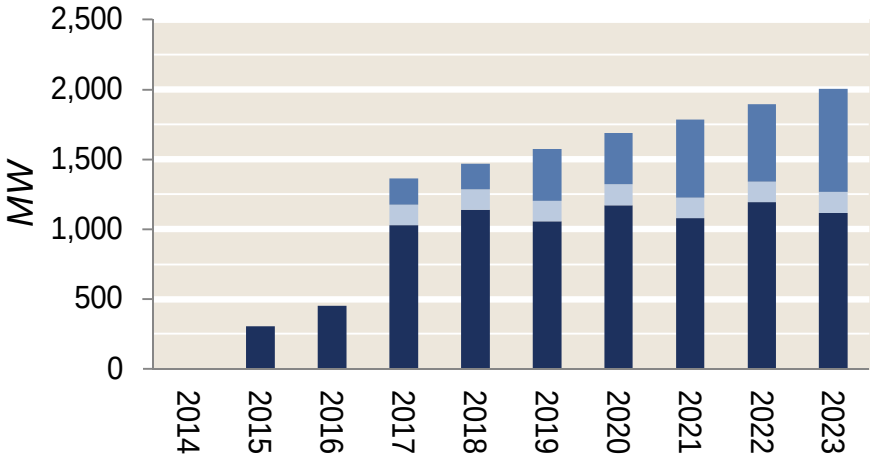


EAI Portfolio 4 – Resource Additions by Scenario

Scenario 1

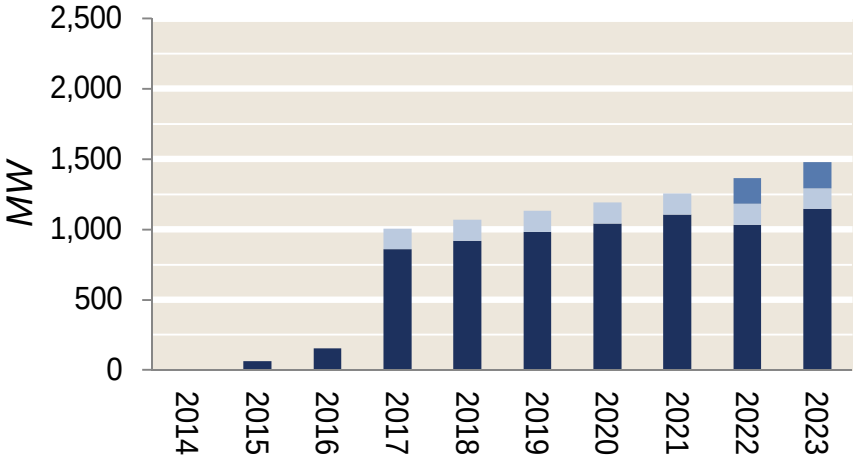


Economic Rebound

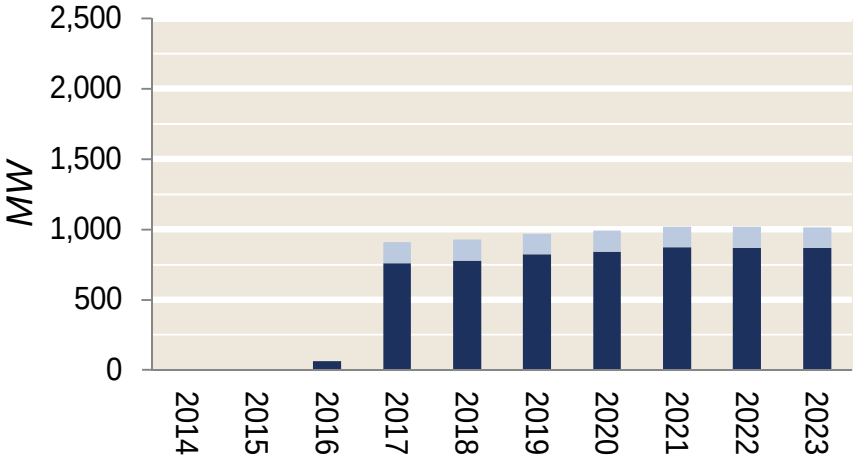


Purchases **Wind @ 14.7% Effective Capacity** **CT**

Austerity Reigns

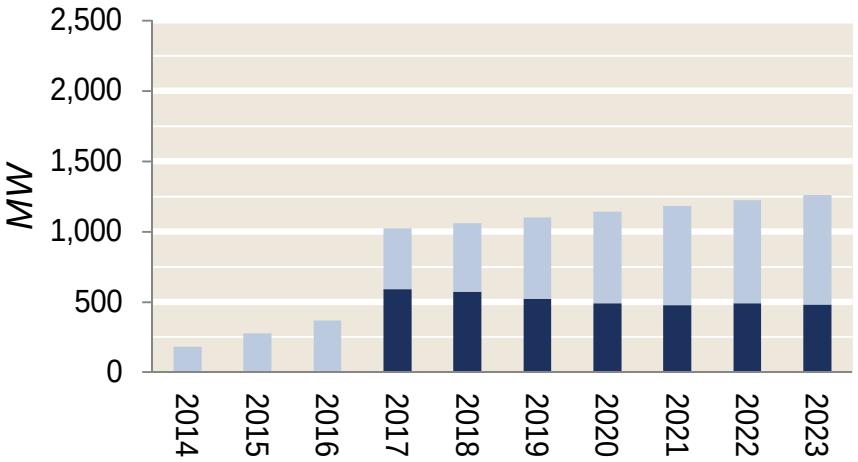


Green Growth

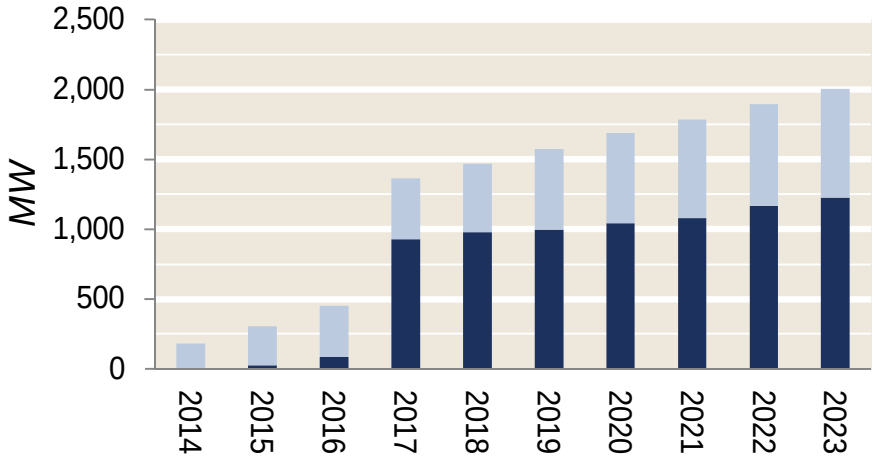


EAI Portfolio 5 – Resource Additions by Scenario

Scenario 1

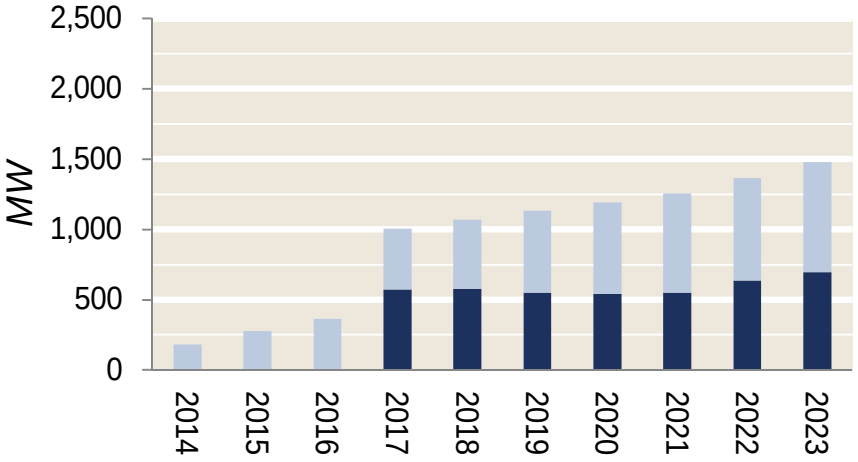


Economic Rebound

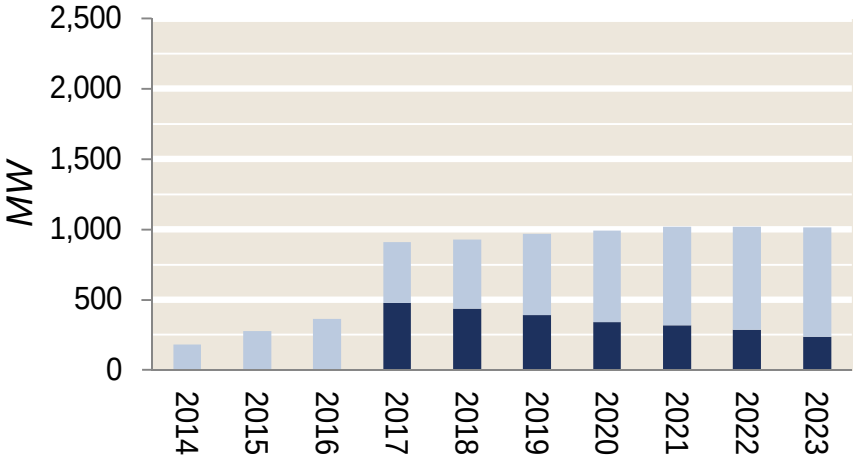


Purchases **DSM**

Austerity Reigns

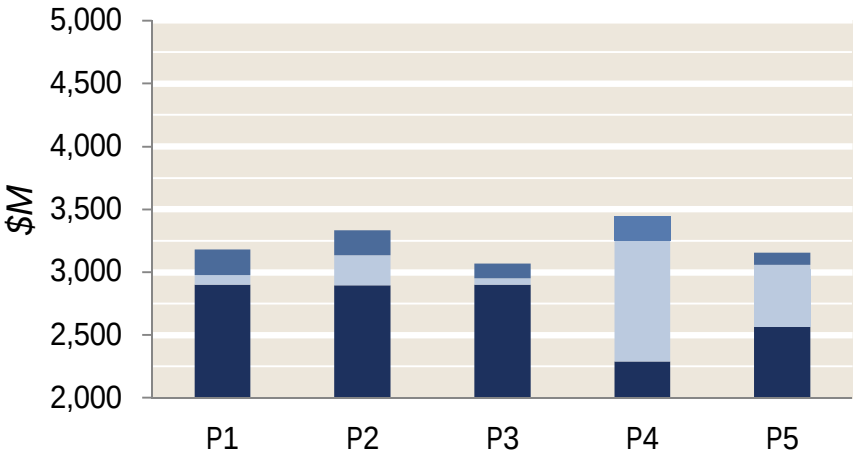


Green Growth

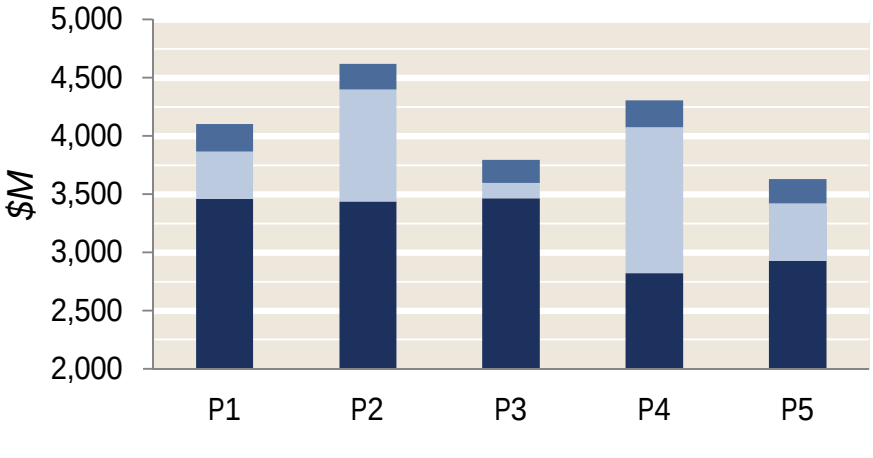


Total Supply Cost 2014 – 2023 (NPV 2012 $M)*

Scenario 1

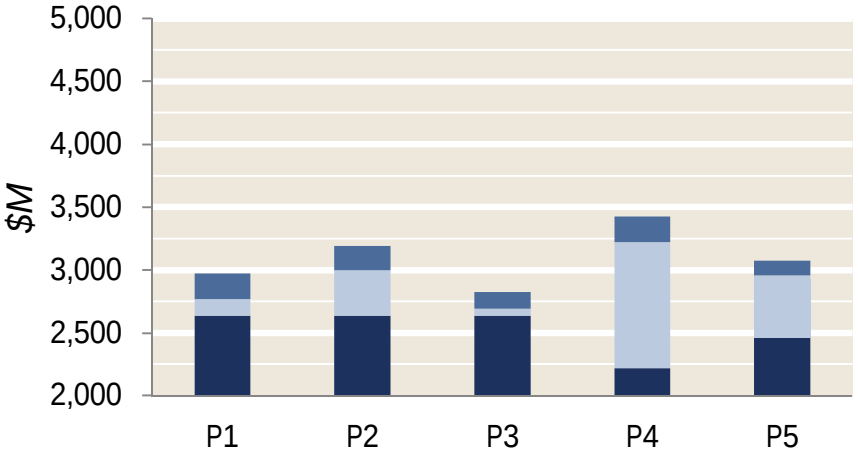


Economic Rebound

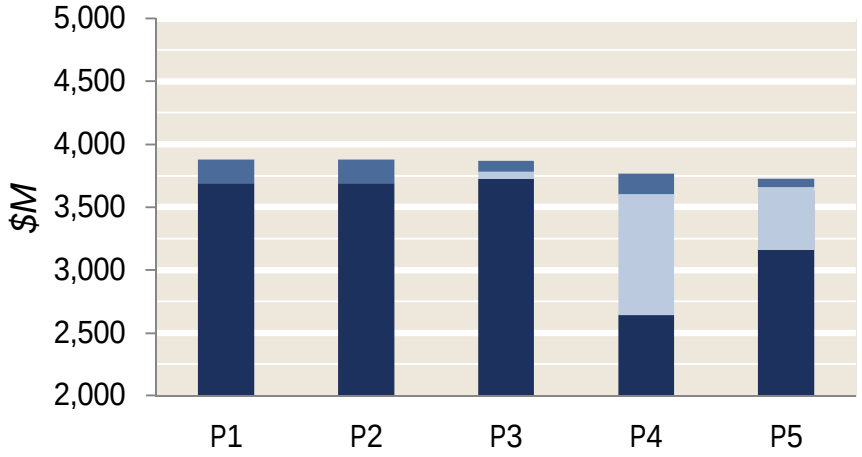


Variable Cost **Fixed Cost** **Purchases**

Austerity Reigns



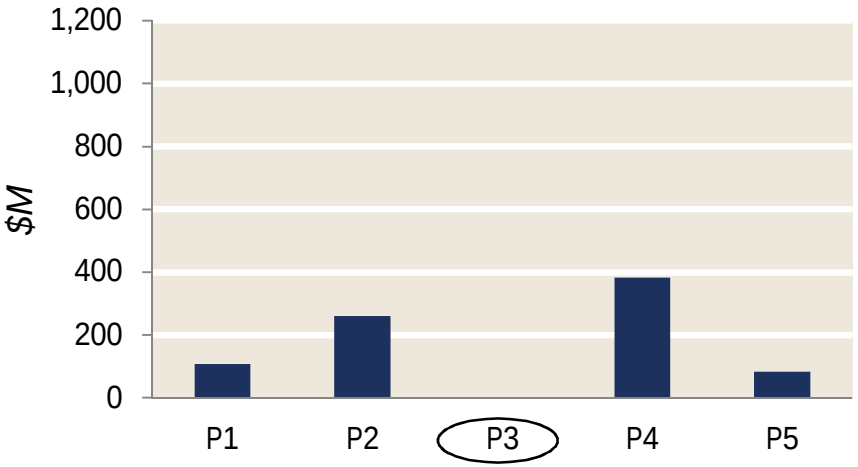
Green Growth



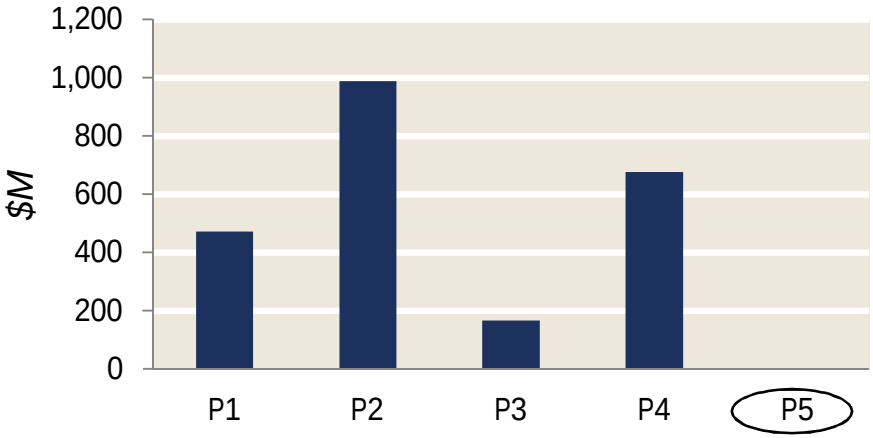
Variable cost refers to total EAI cost of service as modeled in Aurora, fixed cost is incremental resources only

Relative Portfolio Ranking Total Supply Cost

Scenario 1



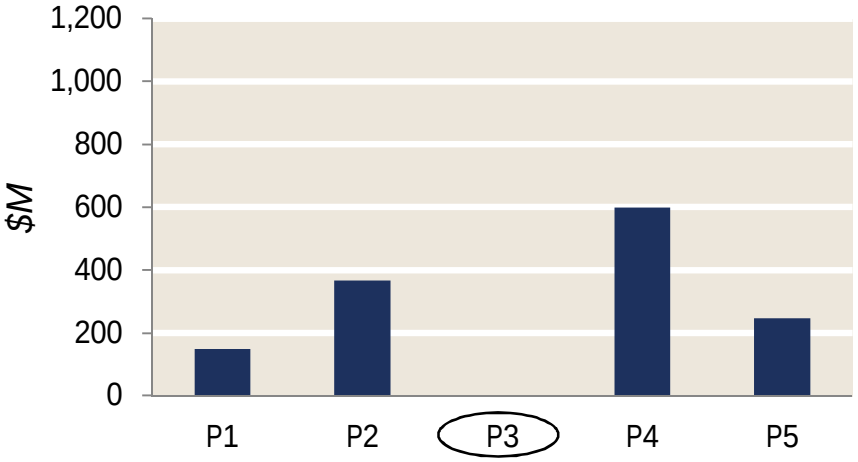
Economic Rebound



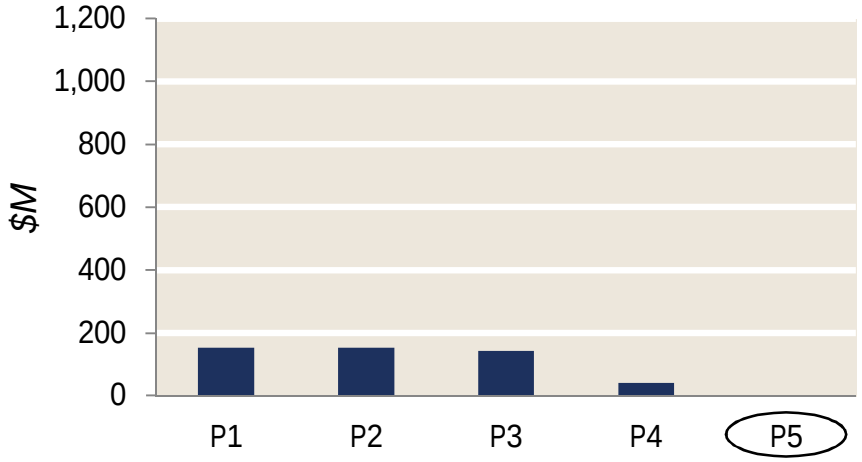
Low Cost Portfolio

Total Supply Cost Relative to Highest Ranked Portfolio 2014 – 2023 (NPV 2012 $M)

Austerity Reigns

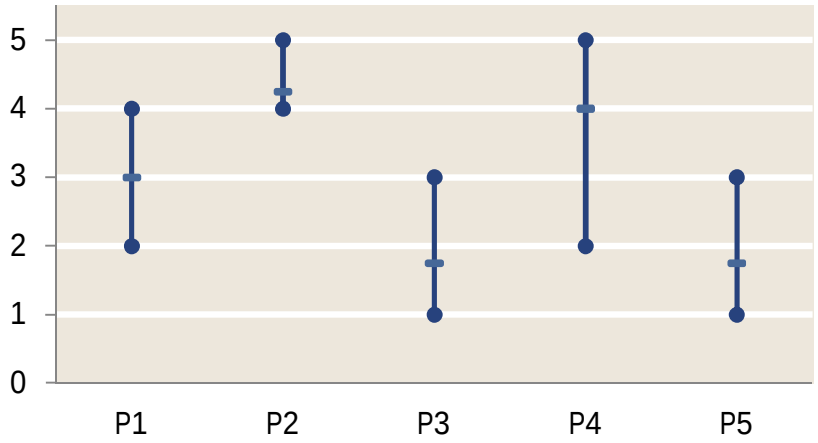


Green Growth

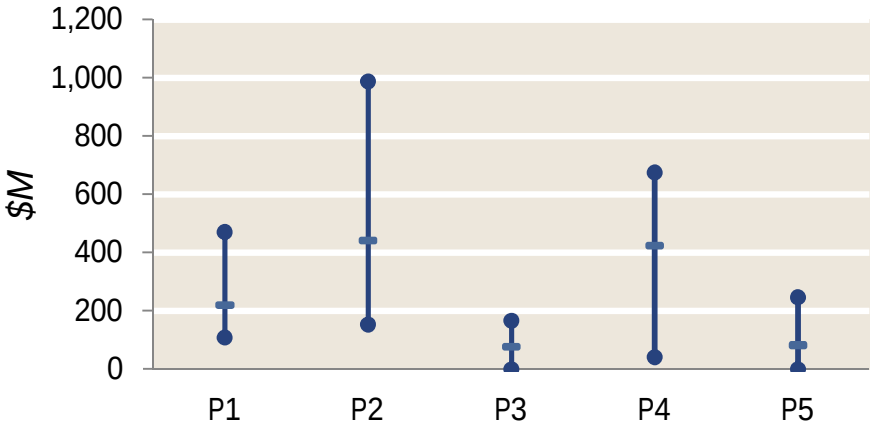


Portfolio Ranking

Ranking



Total Supply Cost Relative to Highest Ranked Portfolio



Total Supply Cost