

Existing Fleet and Representative Plant Analysis

PRESENTED BY

BRATTLE AND S&L TEAM

PRESENTED TO

PJM MARKET IMPLEMENTATION
COMMITTEE

NOVEMBER 11, 2022



Goals and Contents of Today's Presentation

Goals of Today's Presentation

🌀 Solicit stakeholder feedback on initial analysis

Contents

🌀 Representative plant characteristics for selected types

🌀 Initial avoidable cost ranges for listed types



Proposed Resource Types for Existing Generation

Proposed types cover ~94% of the entire PJM fleet (in ICAP terms)

Technology Type	Total MW (Summer ICAP)	Percent of PJM Fleet Capacity	Recommendation
Natural gas CC	55,828	28%	Include
Coal	41,554	21%	Include
Single-unit nuclear	32,556	17%	Include
Multi-unit nuclear			
Simple-cycle CT	28,496	14%	Include
Onshore wind	9,911	5%	Include
Steam oil & gas	9,240	5%	Add
Large-scale solar PV	7,790	4%	Include
Pumped storage	5,243	3%	Unit Specific
Other	3,427	2%	Unit Specific
Hydro	3,319	2%	Unit Specific

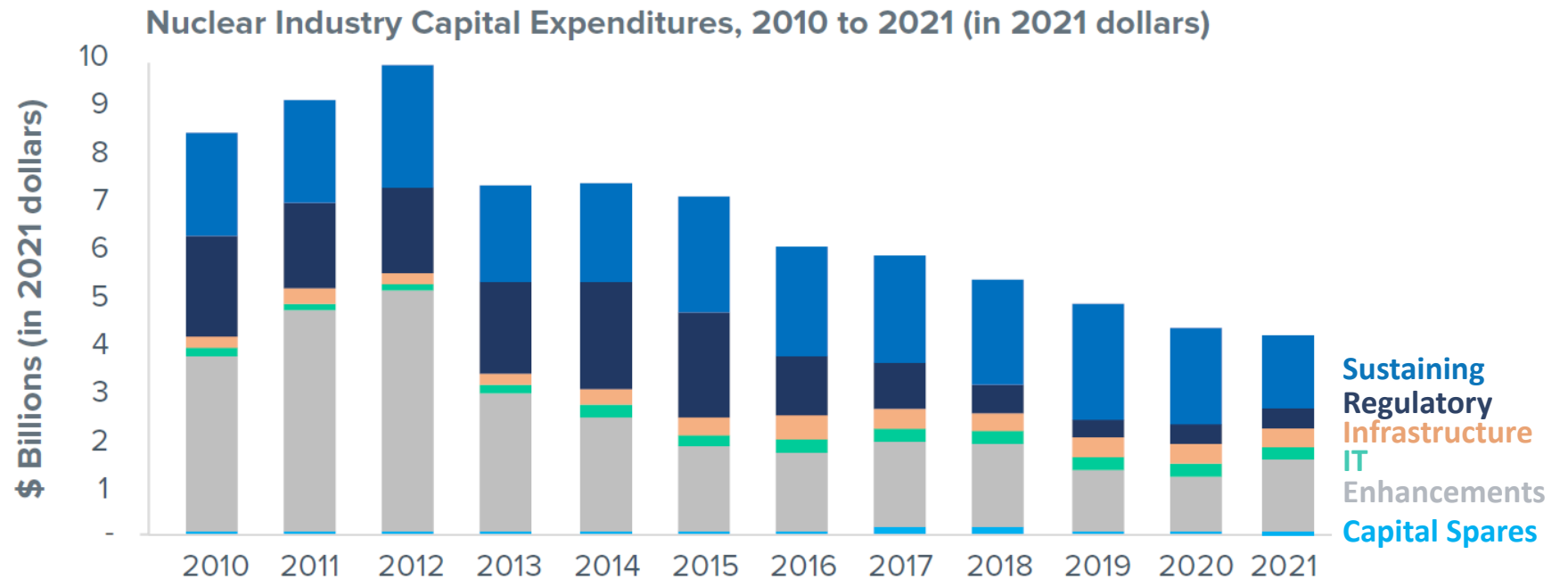
Revision to Nuclear Plant CapEx Inclusions

Nuclear Gross ACR = Fixed O&M + **Fixed CapEx*** + Property Taxes

Fixed CapEx: In 2020, gross ACR included **Regulatory**, **Infrastructure** and **IT** costs, with **Sustaining** costs in VOM, but excluded Enhancements altogether (**Capital Spares** were small and were not counted in 2020 study; the tariff allows including them in VOM adders)

Including **Enhancements** adds ~\$2.17/MWh (\$48/MW-day) to Gross ACR for single- and multi-unit nuclear plants

Nuclear CAPEX



Existing Multi-Unit Nuclear Plants

Population characteristics

- ☞ Most plants are 1,900 – 2,800 MW
- ☞ Most capacity in IL and PA
- ☞ 34 – 52 years of operations

Primary drivers of cost variability

- ☞ Market revenue structure: wholesale vs cost of service
- ☞ Reactor type: pressurized water or boiling water
- ☞ Operator’s fleet size: single or multiple plants

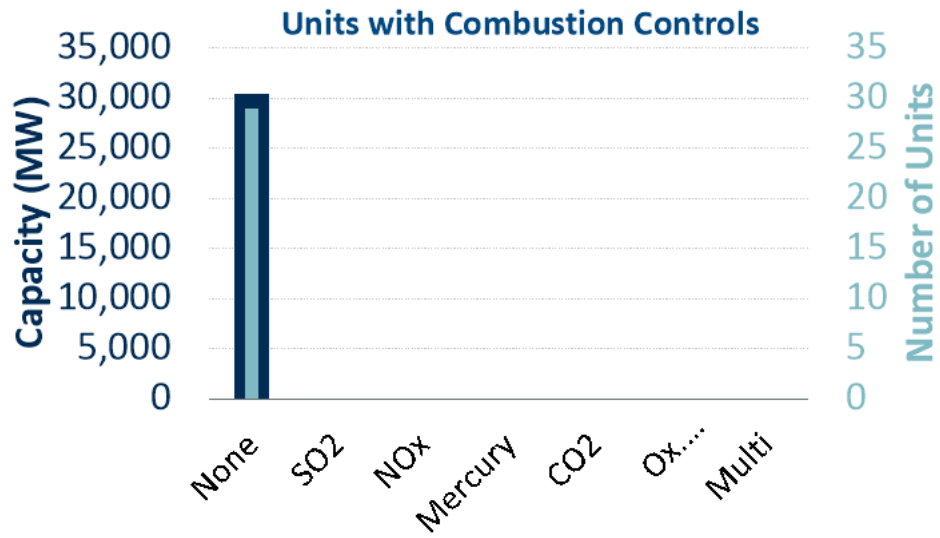
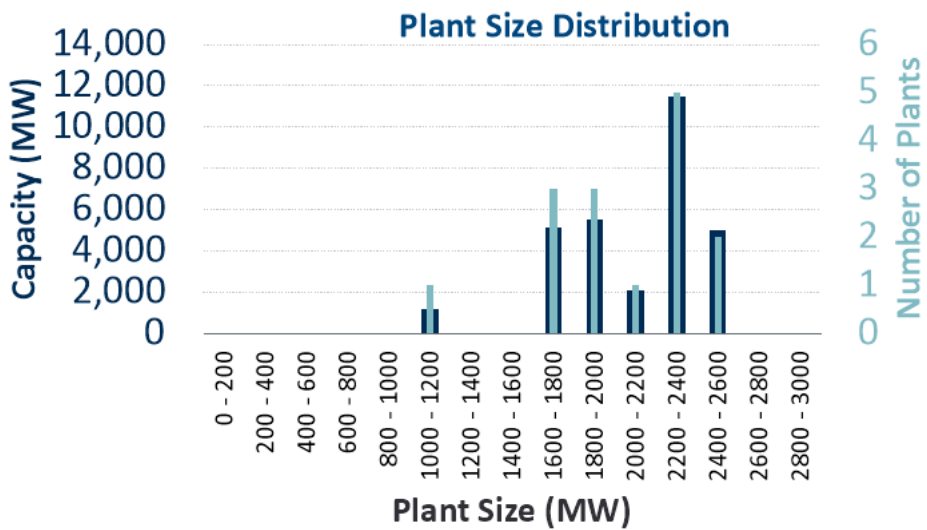
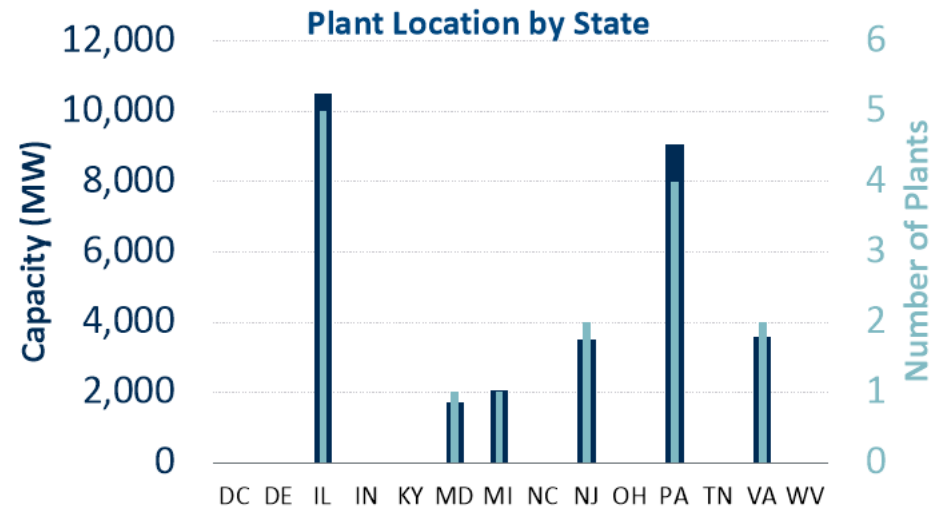
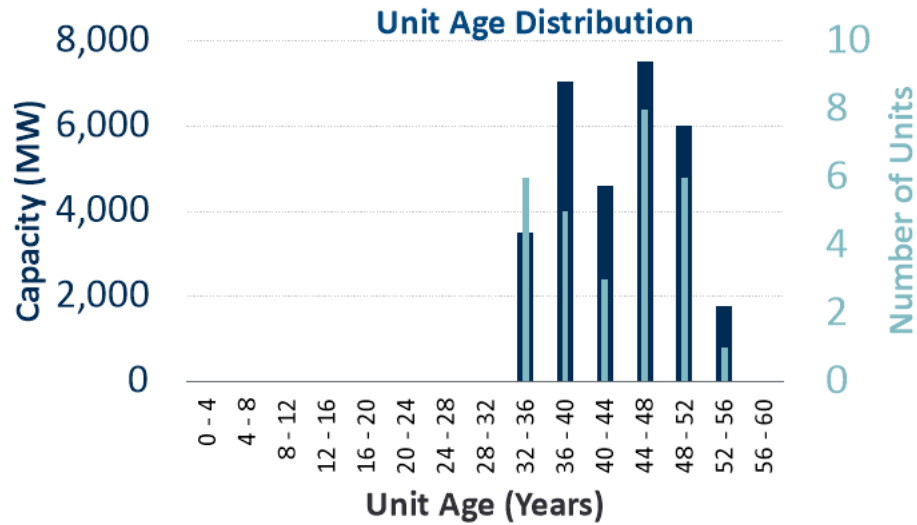
Multi-Unit Nuclear Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$413 - \$513/MW-day (\$18.50-\$23/MWh)* <i>compare to \$445/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • 2,400 MW (2 x 1,200 MW) • Pressurized Water Reactor • Virginia • 47 years old • Operator with multiple plants 	<ul style="list-style-type: none"> • 2,400 MW (2 x 1,200 MW) • Boiling Water Reactor • Illinois • 44 years old • Operator with multiple plants 	<ul style="list-style-type: none"> • 2,400 MW (2 x 1,200 MW) • Boiling Water Reactor • Illinois • 44 years old • Operator with single plant

*This is before adding property taxes of approx. \$17/MW-day (\$0.77/MWh)

We will also provide alternative Gross ACRs including Major Maintenance costs, which will add approx. \$46/MW-day (\$2.06/MWh) of “Sustaining CapEx” and \$1.3/MW-day (\$0.06/MWh) of “Capital Spares”

Multi-Unit Nuclear Fleet



Existing Single-Unit Nuclear Plants

Population characteristics

- ☞ Only 2 in PJM, both in Ohio
- ☞ 1,000 – 1,300 MW
- ☞ 34 – 44 years of operations

Primary drivers of cost variability

- ☞ Market revenue structure: wholesale vs cost of service
- ☞ Reactor type: pressurized water or boiling water
- ☞ Operator’s fleet size: single or multiple plants

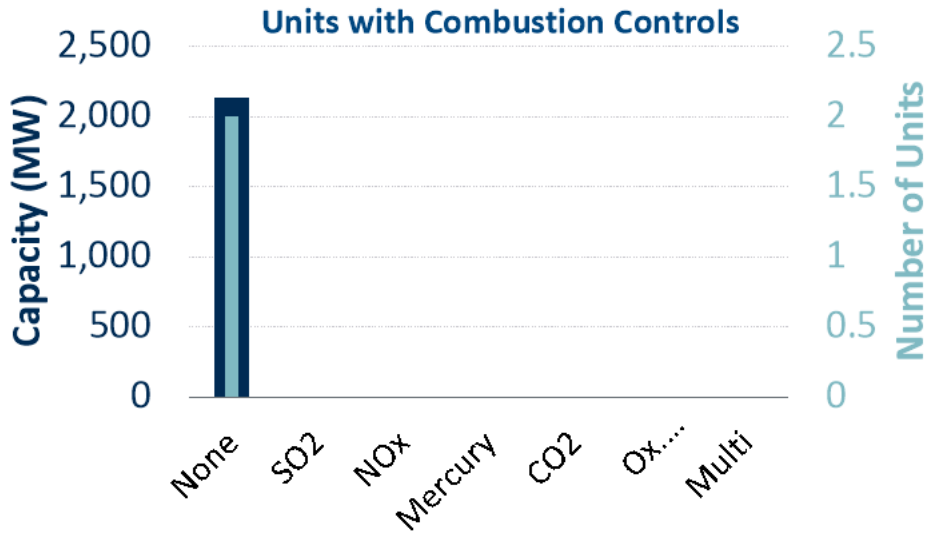
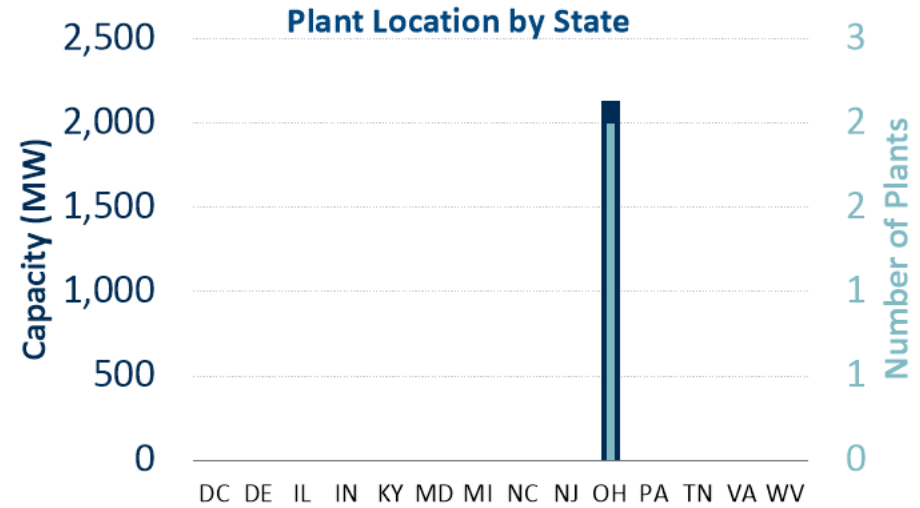
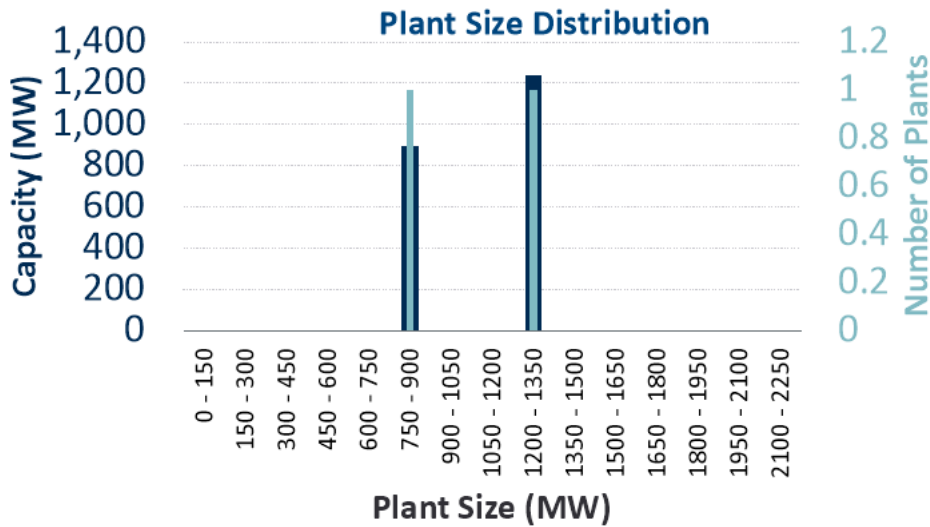
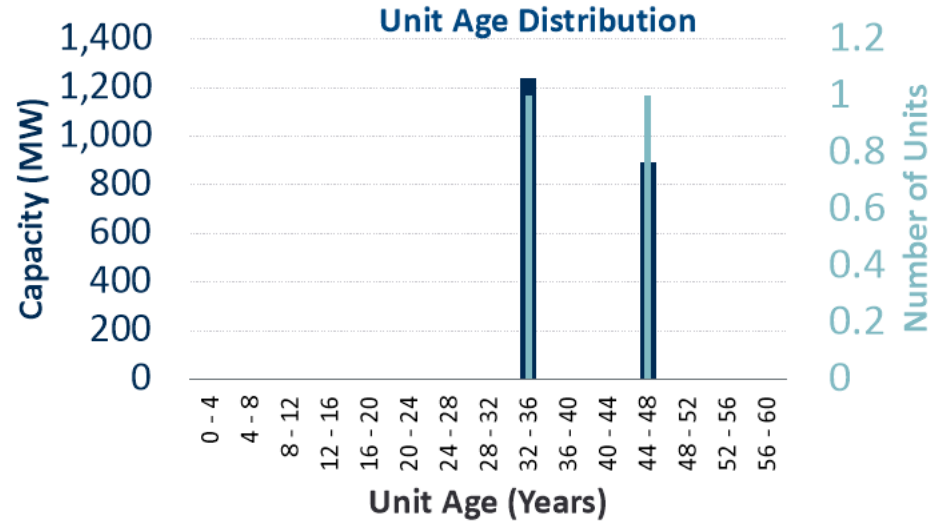
Single-Unit Nuclear Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$491-\$614/MW-day (\$22-\$27.50/MWh)* <i>compare to \$697/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • Only 2 plants in PJM • Too few units to estimate a range 	<ul style="list-style-type: none"> • 1,200 MW • Boiling Water Reactor • Ohio • 38 years old 	<ul style="list-style-type: none"> • Only 2 plants in PJM • Too few units to estimate a range

*This is before adding property taxes of approx. \$17/MW-day (\$0.77/MWh)

We will also provide alternative Gross ACRs *including Major Maintenance costs*, which will add about \$46/MW-day (\$2.06/MWh) of “Sustaining CapEx” and \$1.6/MW-day (\$0.07/MWh) of “Capital Spares”

Single-Unit Nuclear Fleet



Existing Coal Plants

Population characteristics

- 🌀 Wide range of capacities (mostly 250 – 3,000 MW); average is 750 MW
- 🌀 Nearly all plants have an FGD
- 🌀 Most capacity in WV, PA, OH
- 🌀 Over half of coal units are 35 – 60 years old

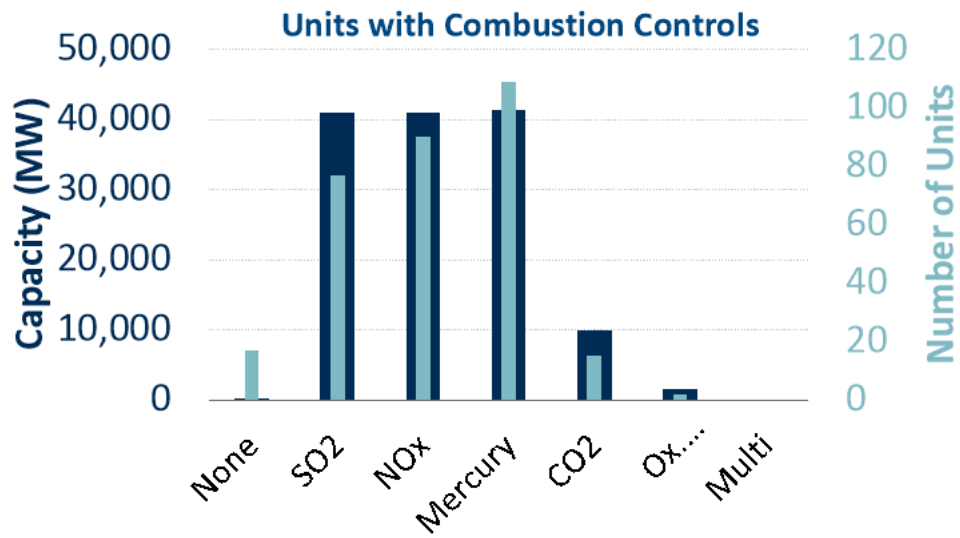
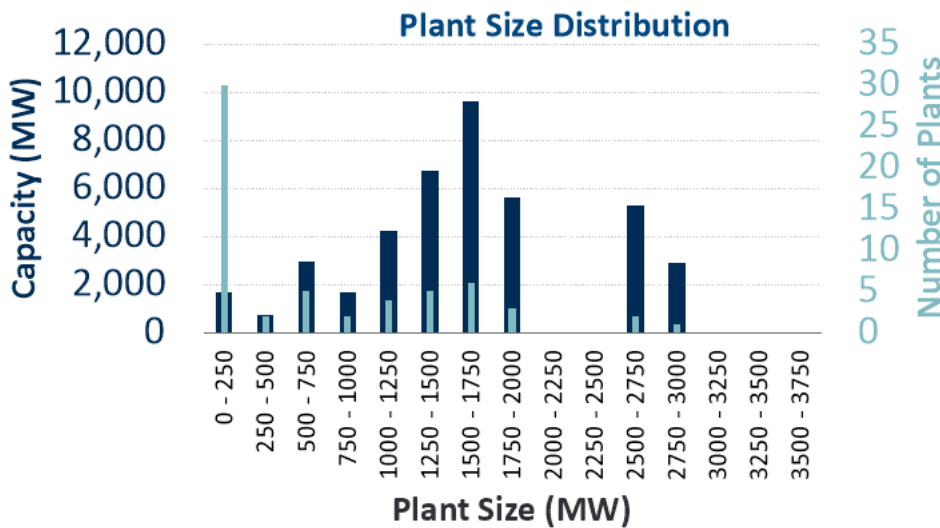
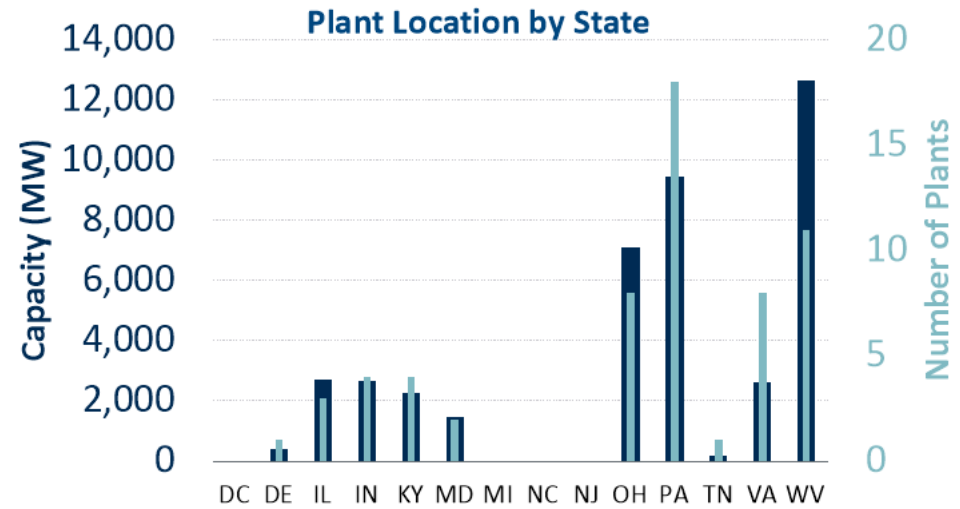
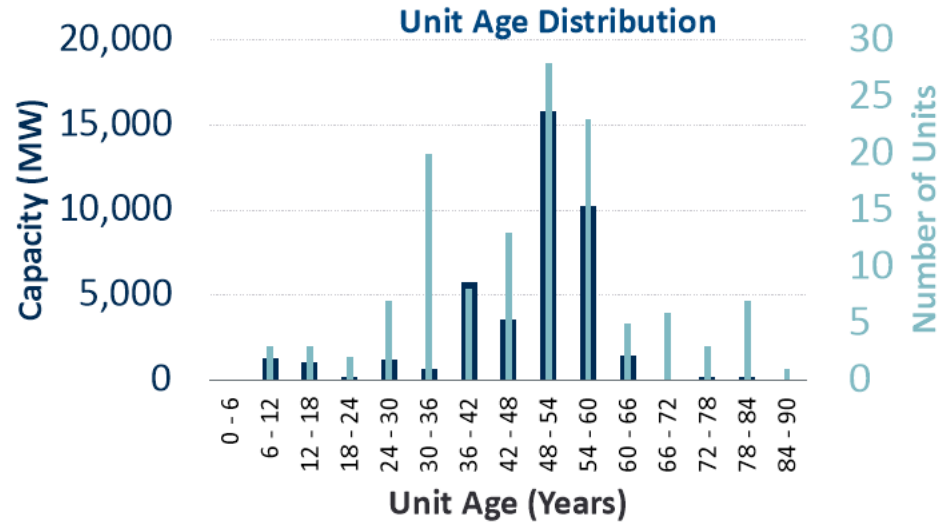
Primary drivers of cost variability

- 🌀 Range of capacity, configuration, and boiler type
- 🌀 Operating years
- 🌀 Capacity factor
- 🌀 Location

Coal Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$84 - \$94.50/MW-day <i>compare to \$80/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • 1,800 MW (2 x 900 MW) • Appalachian coal (high sulfur) • Wet limestone FGD • Pennsylvania • 52 years old 	<ul style="list-style-type: none"> • 1,500 MW (2 x 750 MW) • Appalachian coal (high sulfur) • Wet limestone FGD • Pennsylvania • 52 years old 	<ul style="list-style-type: none"> • 100 MW (1 x 100 MW) • Appalachian coal (high sulfur) • Wet limestone FGD • West Virginia • 30 years old

Existing Coal Fleet



Existing Natural Gas CC Plants

Population characteristics

- ⌘ Mostly built 16-20 years ago or in the past 8 years
- ⌘ 600–1,000 MW common in early 2000s, mostly F-class
- ⌘ SCRs are common on CCs
- ⌘ Most capacity in PA, VA, NJ, OH

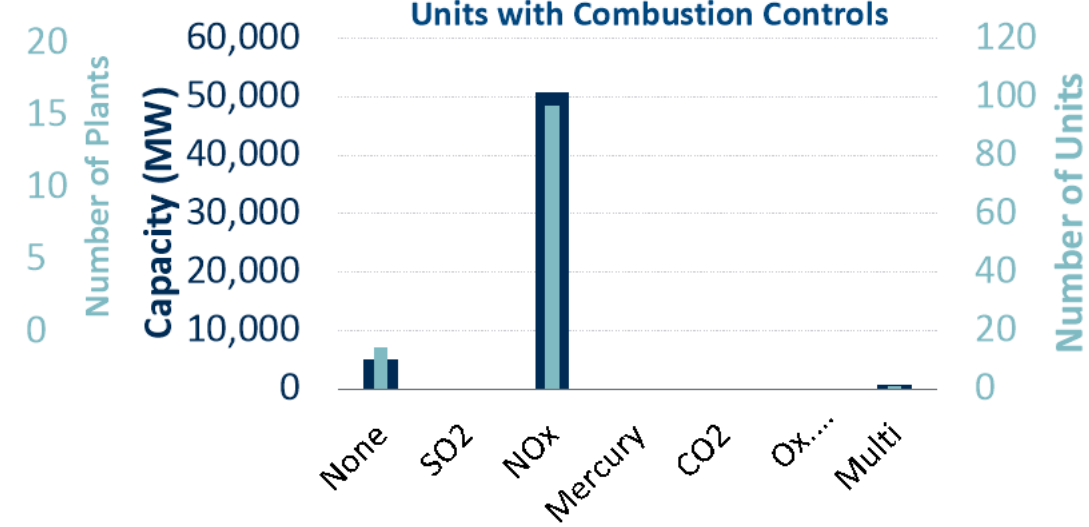
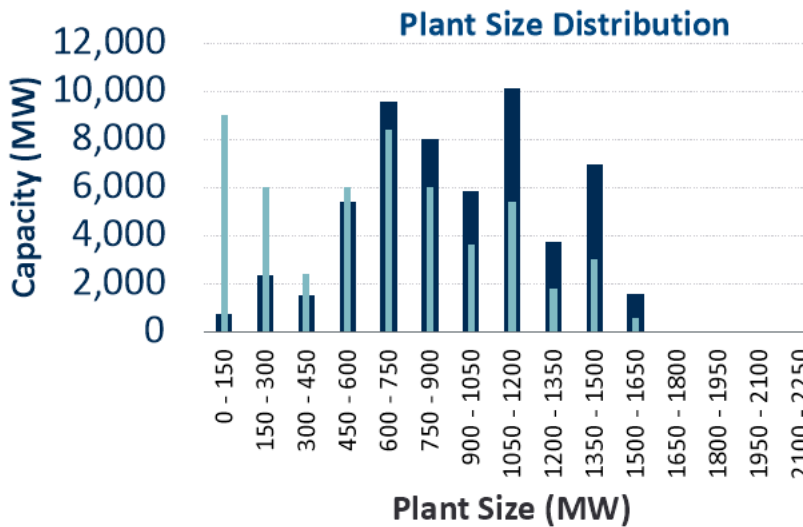
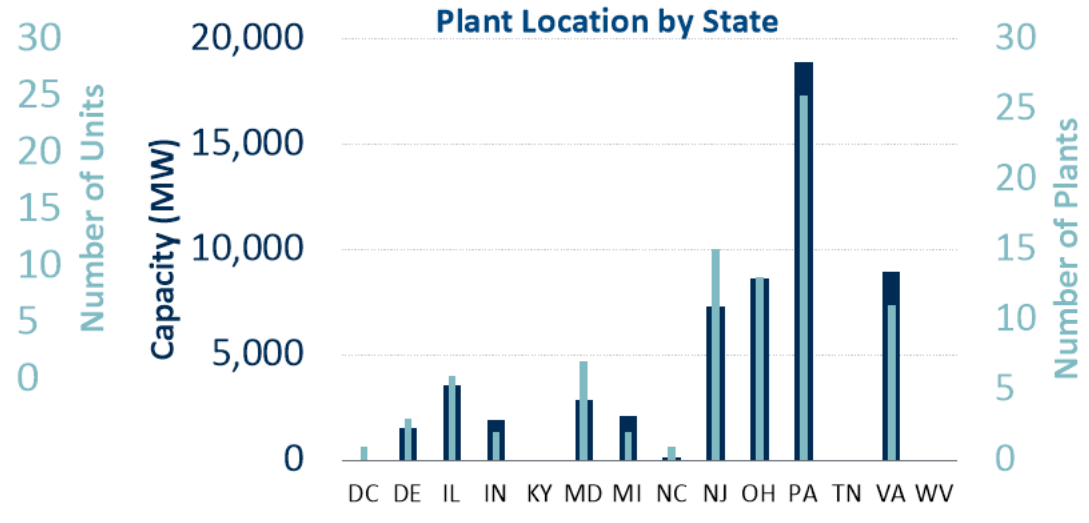
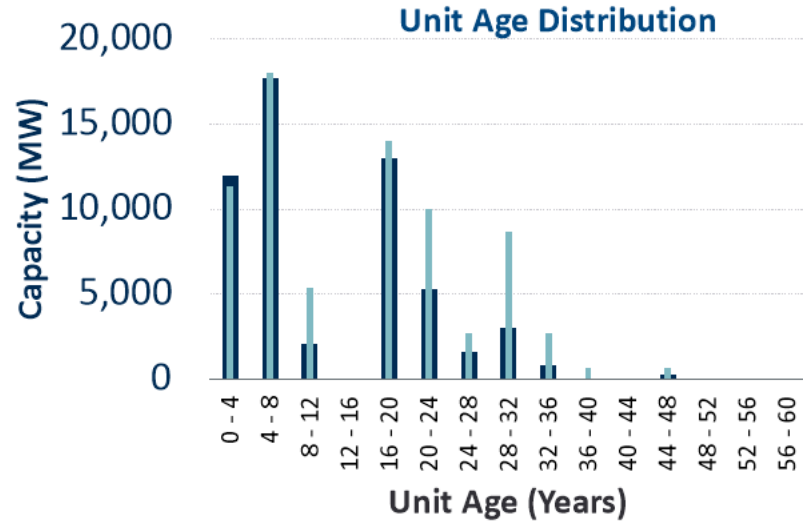
Primary drivers of cost variability

- ⌘ Range of capacity, configuration, and turbine type
- ⌘ Operating years
- ⌘ Capacity factor
- ⌘ Location

Natural Gas CC Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$58.50 - \$66/MW-day <i>compare to \$56/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • 1,100 MW (2 x 550 MW) • H-class turbines (2x1x1) • SCR • Pennsylvania • 5 years old 	<ul style="list-style-type: none"> • 750 MW • F-class turbines (2x1) • SCR • Pennsylvania • 18 years old 	<ul style="list-style-type: none"> • 400 MW • F-class turbines (1x1) • SCR • Virginia • 30 years old

Existing Natural Gas CC Fleet



Existing Simple-Cycle CT Plants

Population characteristics

- 🌀 Wide range of size, number and type of turbines
- 🌀 SCR not common on CTs
- 🌀 Primarily built 20 to 24 years ago
- 🌀 Most capacity in IL, KY, OH, VA

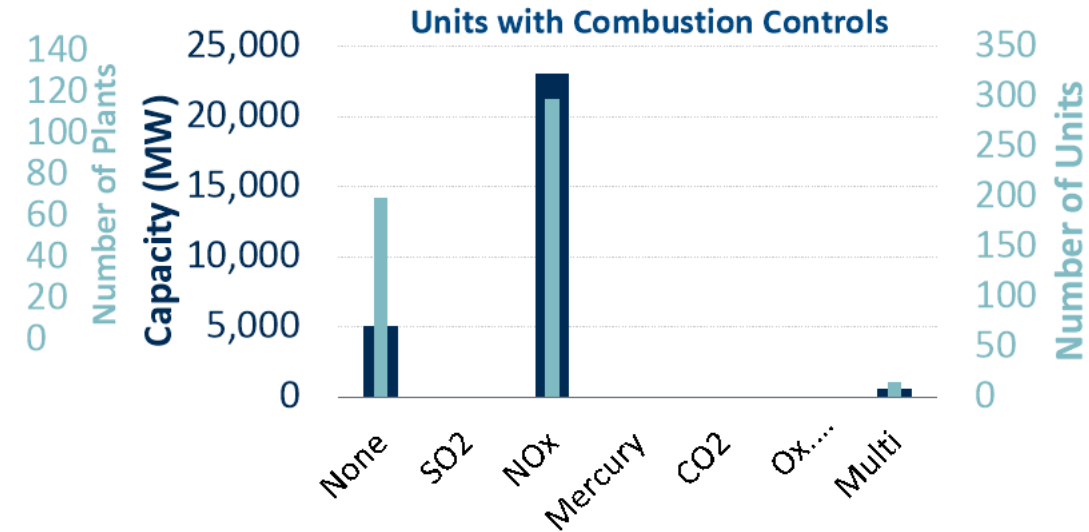
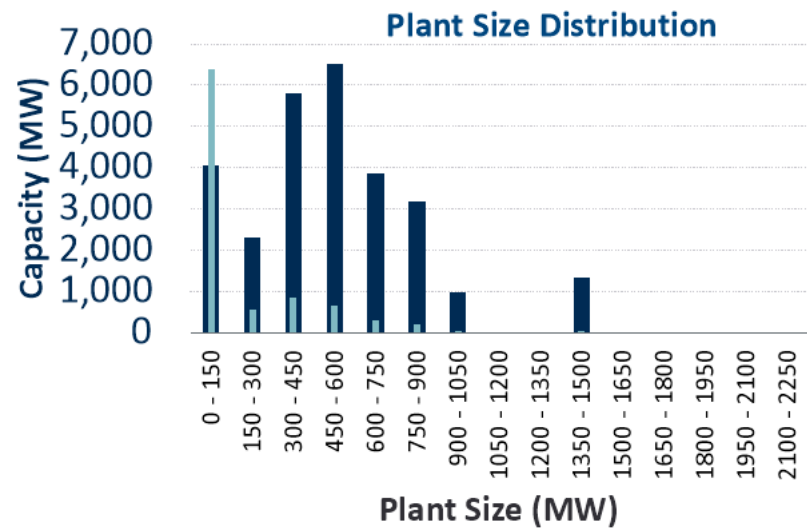
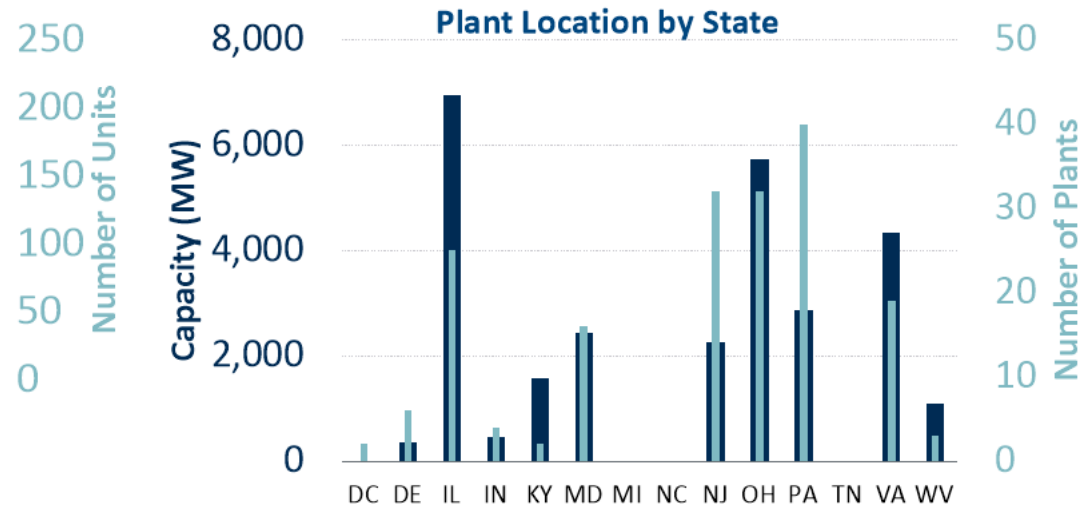
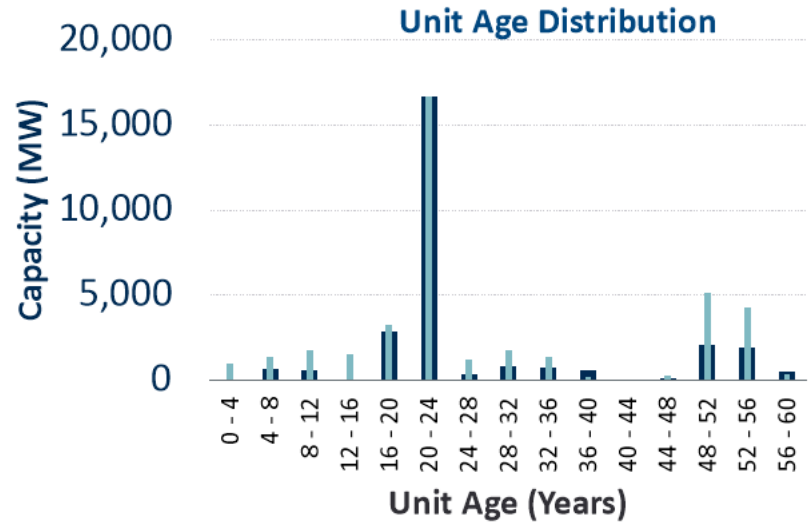
Primary drivers of cost variability

- 🌀 Range of capacity, co-located quantity, and turbine type
- 🌀 Operating years
- 🌀 Capacity factor
- 🌀 Location

Simple-Cycle CT Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$53 - \$58/MW-day <i>compare to \$50/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • 320 MW (2 x 160 MW) • F-class turbines • No SCR • Illinois • 20 years old 	<ul style="list-style-type: none"> • 640 MW (8 x 80 MW) • E-class turbines • No SCR • Illinois • 20 years old 	<ul style="list-style-type: none"> • 100 MW (2 x 50 MW) • LM6000 • No SCR • Pennsylvania • 20 years old

Existing Simple-Cycle CT Fleet



Existing Solar PV Plants

Population characteristics

- ☞ Most capacity is <10 MW
- ☞ Most capacity in VA, NJ and NC
- ☞ Built in past 12 years

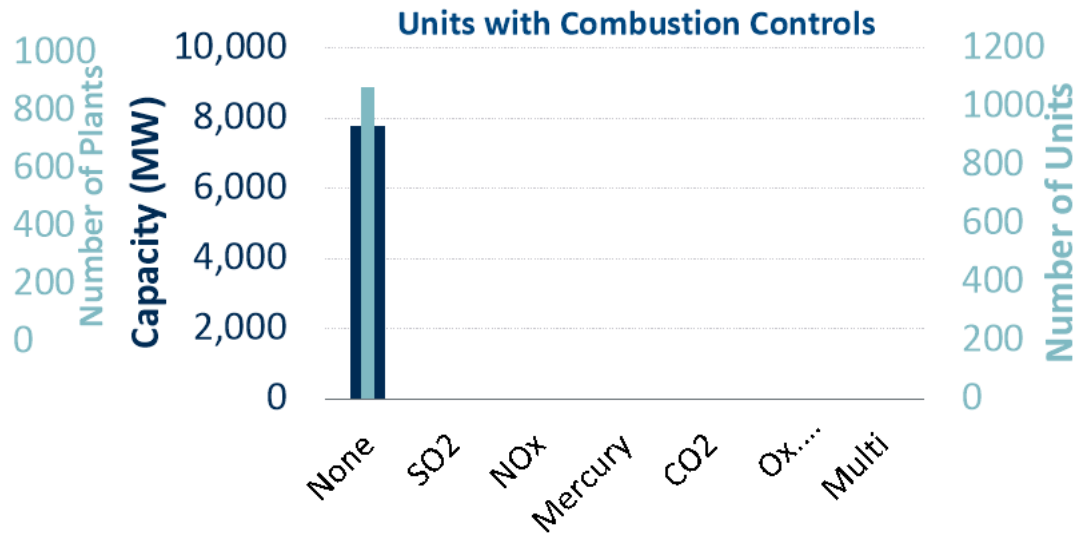
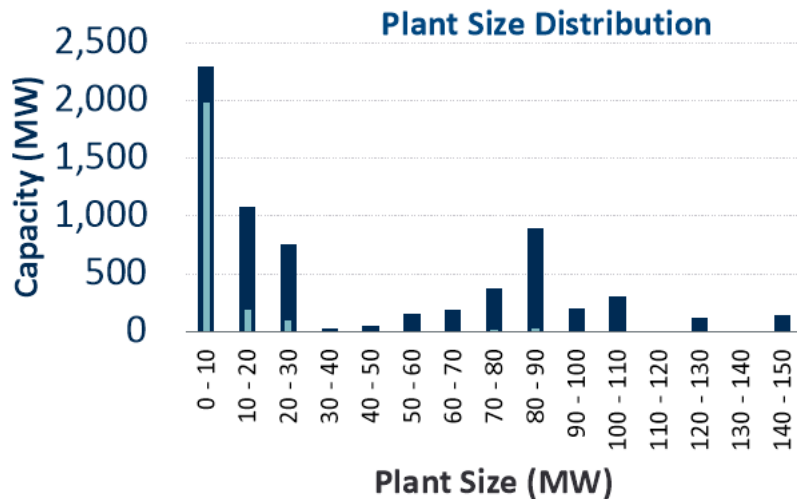
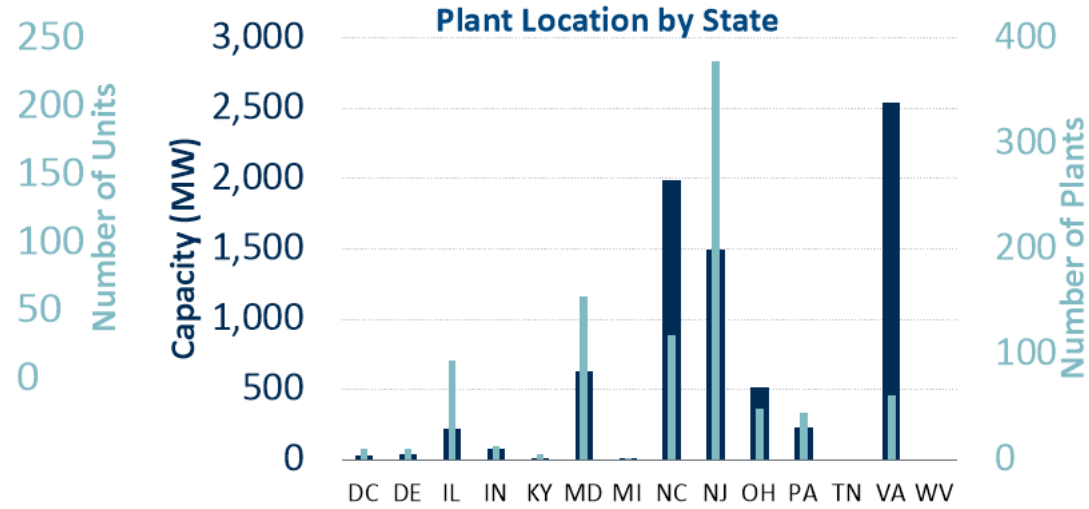
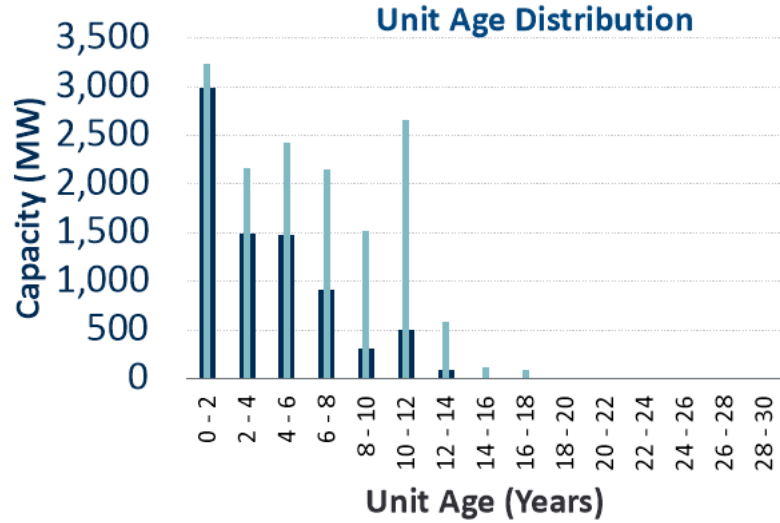
Primary drivers of cost variability

- ☞ Range of capacity, co-located quantity
- ☞ Location

Solar PV Plant Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$47-\$66/MW-day <i>compare to \$40/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> •80 MW •Polysilicon •Single-axis tracking •North Carolina •2 years old 	<ul style="list-style-type: none"> •10 MW •Crystalline silicon •Single-axis tracking •New Jersey •5 years old 	<ul style="list-style-type: none"> •2 MW •Crystalline silicon •Single-axis tracking •New Jersey •7 years old

Existing Solar PV Fleet



Existing Onshore Wind Plants

Population characteristics

- ∞ Wide range of sizes, average (100 MW) skewed by a few large plants (>750 MW)
- ∞ Most capacity in IL and IN, but mainly larger plants; smaller plants mostly in PA and OH
- ∞ 5 – 15 years of operations

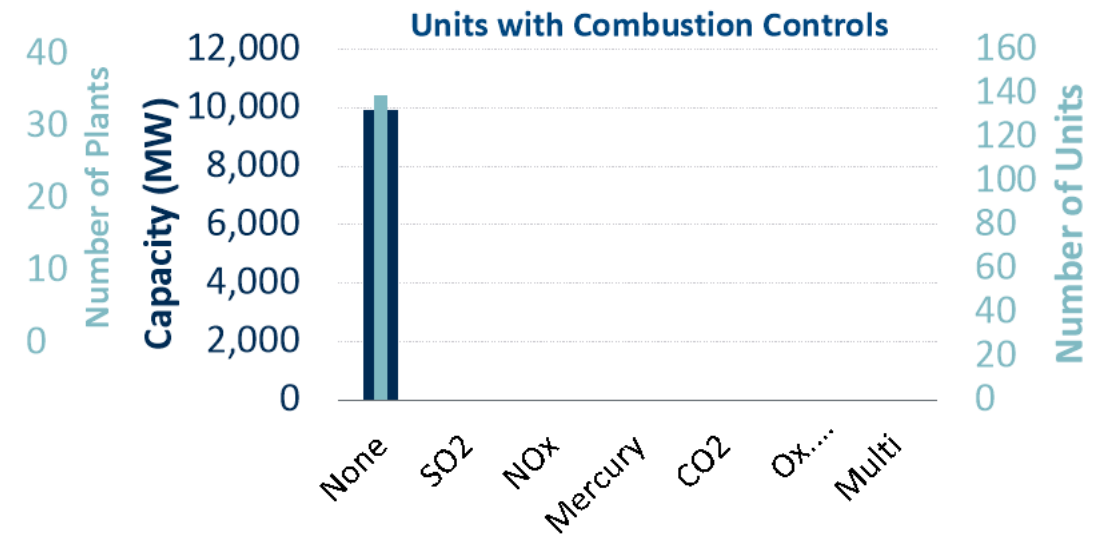
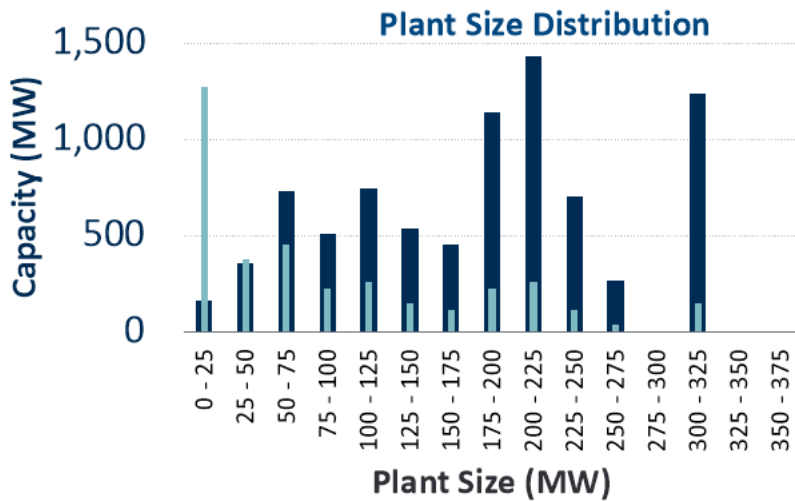
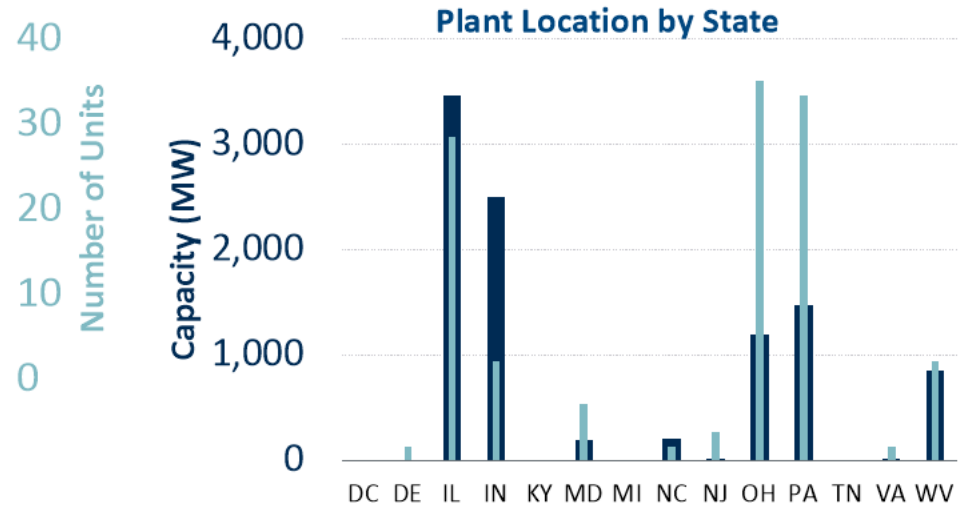
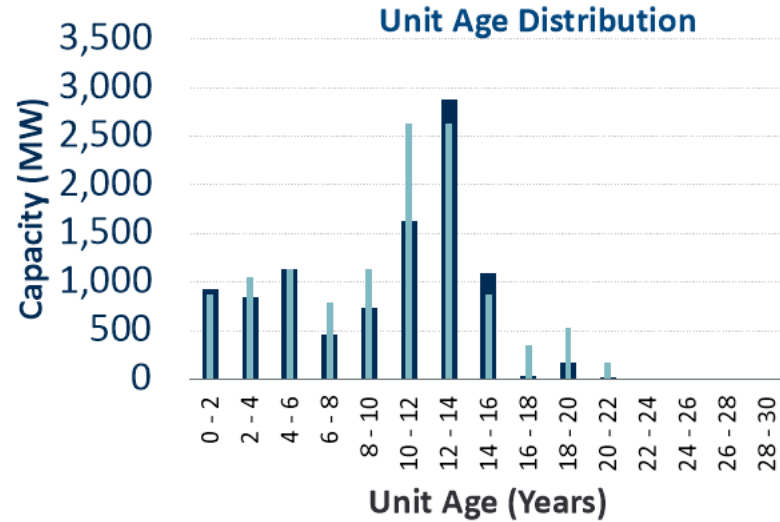
Primary drivers of cost variability

- ∞ Range of capacity, co-located quantity
- ∞ Location

Onshore Wind Characteristics and Costs in 2022

Low Cost Representative Plant	Representative Plant \$115 - \$151/MW-day <i>compare to \$83/MW-day in 2020</i>	High Cost Representative Plant
<ul style="list-style-type: none"> • 300 MW • Illinois • 10 years old 	<ul style="list-style-type: none"> • 200 MW • Illinois • 12 years old 	<ul style="list-style-type: none"> • 30 MW • Pennsylvania • 12 years old

Existing Onshore Wind Fleet



Existing ST/O&G Plants

Population characteristics

- Wide range of sizes, average (277 MW) skewed by a few large plants (>200 MW)
- Most capacity in PA, but mainly larger plants; smaller plants mostly in OH and NJ
- 2 – 85 years of operations

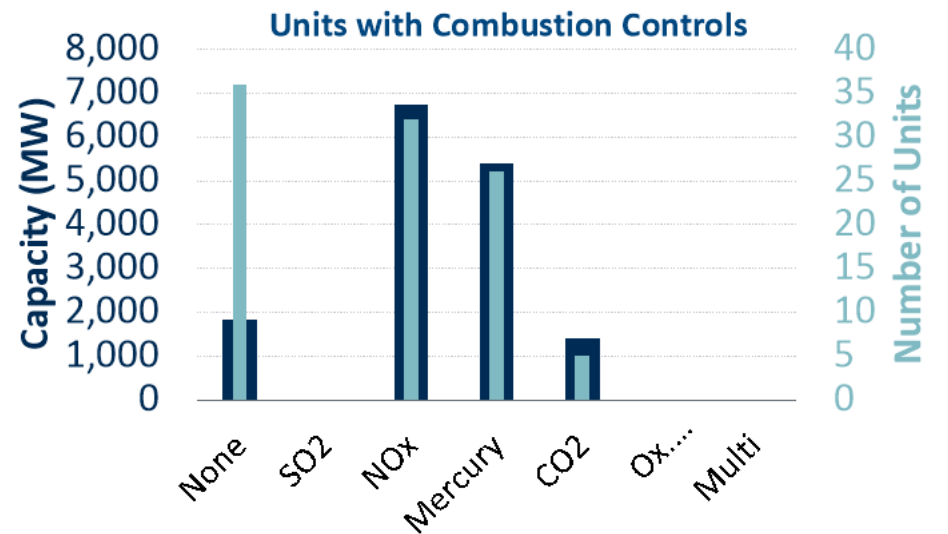
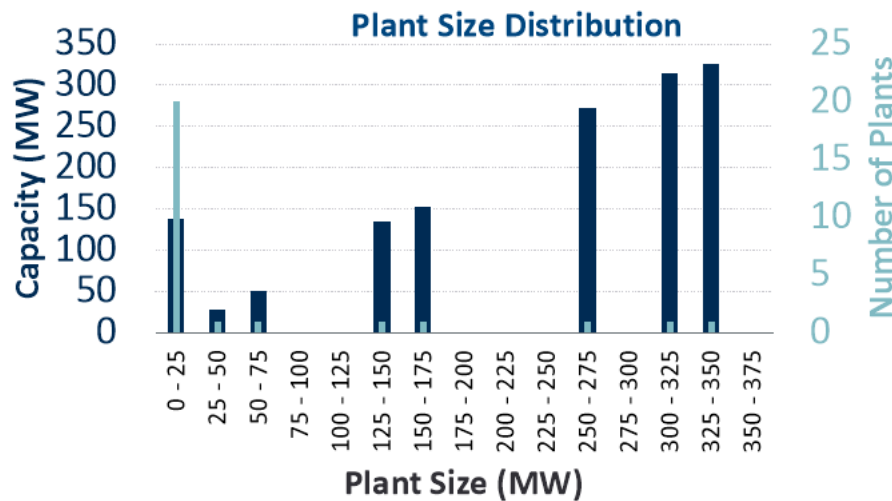
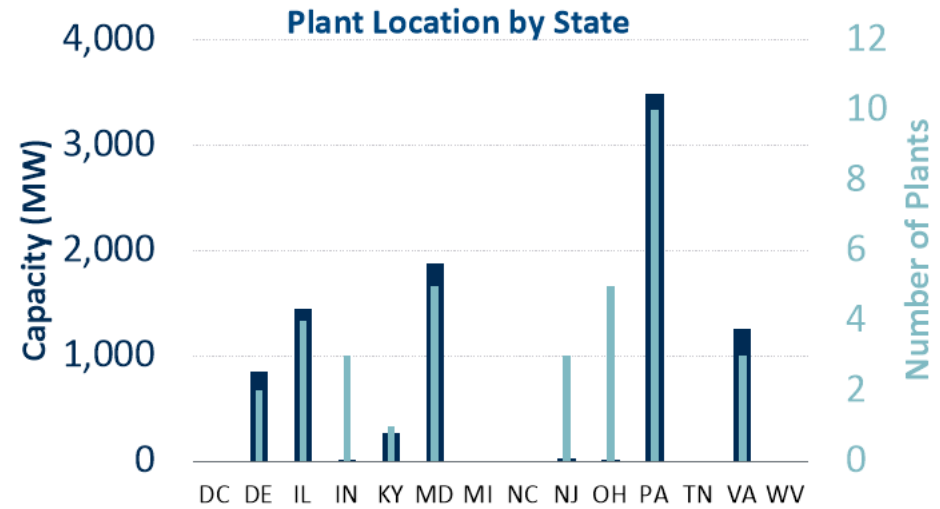
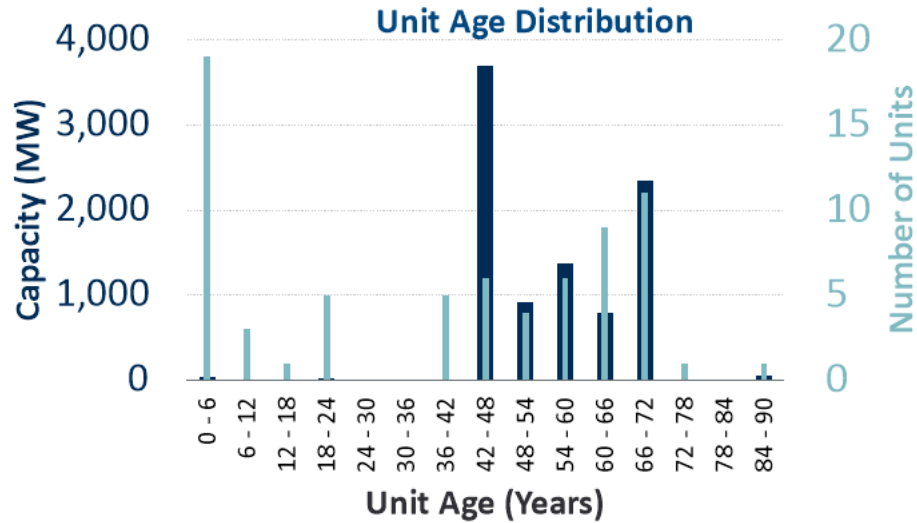
Primary drivers of cost variability

- TBD

ST/O&G Characteristics

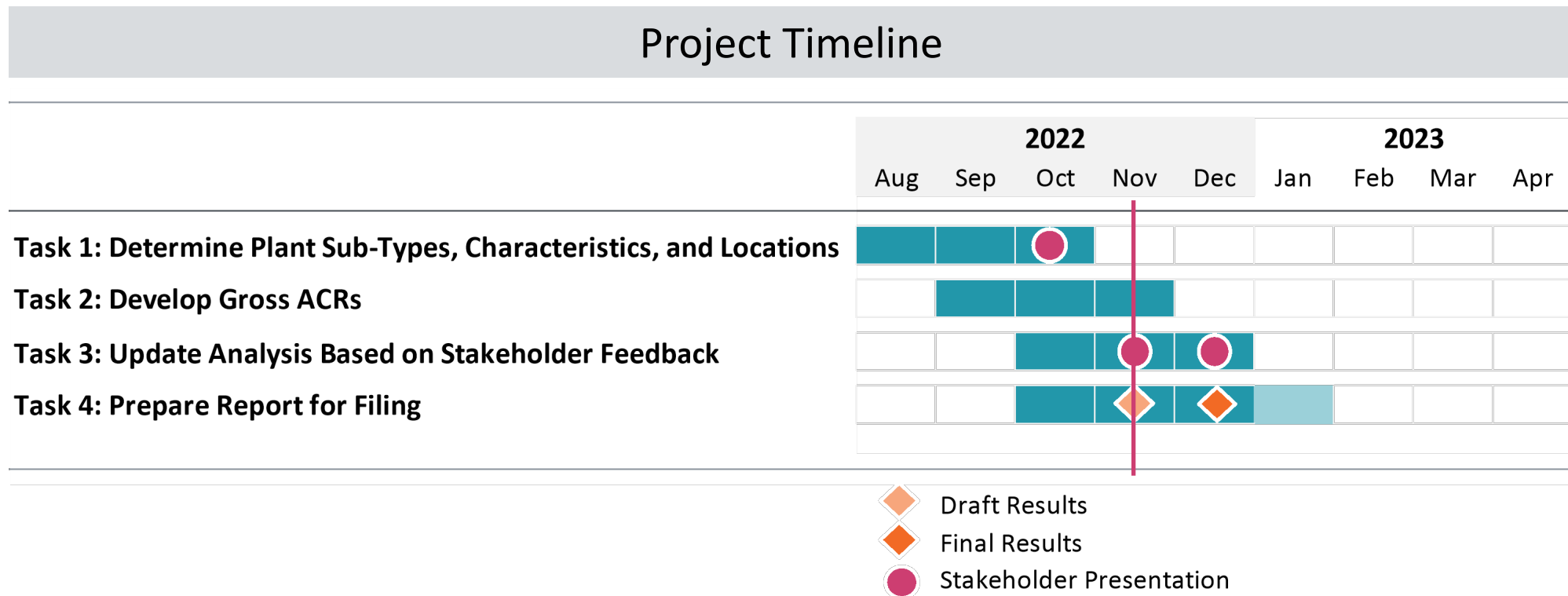
Low Cost Representative Plant	Representative Plant (In Progress)	High Cost Representative Plant
<ul style="list-style-type: none"> • 1,300 MW • Pennsylvania • 47 years old 	<ul style="list-style-type: none"> • 900 MW • Pennsylvania • 47 years old 	<ul style="list-style-type: none"> • 350 MW • Pennsylvania • 65 years old

Existing ST O&G Fleet



Next Steps

- Identify any additional resource types or changes to Gross ACR estimation approach
- Finalize Gross ACR costs



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