Developing Avoidable Cost Rates for Existing Generation

PRESENTED BY

BRATTLE AND S&L
PROJECT TEAM

PRESENTED TO

PJM MARKET IMPLEMENTATION
COMMITTEE

OCTOBER 6, 2022

Brattle

Goals and Contents of Today's Presentation

Goals of Today's Presentation

- **Solicit stakeholder feedback** on proposed approach for choosing resource types and determining their gross avoidable costs

Contents

- **Motivation** of study and how ACRs will be used
- **Approach**
- Initial list of **types**
- 2020 analysis of **gross costs** for these types

Background on the ACR and its Application

- For MOPR purposes, PJM's tariff requires PJM to update its Default ACRs in 2022, then every four years

- Default ACRs are also needed now for Market Seller Offer Caps (MSOC)
  - In March 2021, FERC found the existing MSOC to be **unjust and unreasonable**
  - FERC explained that the **assumption of 30 hours of expected Performance Assessment Intervals each year is too high** given the actual number of PAIs in recent years
  - Further, FERC found that an offer cap based on **Net CONE times the Balancing Ratio has not been lower than the competitive offer** estimate for a resource with a high avoidable cost rate
  - As a result, FERC **found that the current MSOC is too high and inappropriate**, and that PJM should revert back to Net ACRs reflecting actual costs for default offer cap purposes

- Application of new Default ACRs as MSOCs is likely to be more consequential since MOPR has been modified to have more focused application

Sources: 174 FERC ¶61,212, March, 18, 2021.

Purpose of Our Analysis

- PJM requested **Brattle and S&L analyze the gross costs for existing generation types**, provide information on **drivers of cost** variation, and solicit input from **stakeholders**
- Based on this analysis, **PJM will determine the resource types and Gross ACRs to file**
- **Default offer caps will then be determined by Gross ACRs minus unit-specific PJM Market Revenues** (to be determined by IMM)
  - Subject to unit-specific review for resources wishing to offer higher (or lower, with MOPR)

Conceptual Approach

Key Ideas

- **Asymmetries of information**: plant owners have more information on their costs
- **Variability** among plants with different characteristics; natural groupings of "types"; but still variation among individuals within a type.
- Single value for resource type cost should **balance the risk of over-mitigating and under-mitigating**
  - For default offer caps, too high a single value could under-mitigate; too low could over-mitigate with many reviews and information asymmetries
  - Exposures for MOPR are the opposite

Approach

- **Group plants into types** so there is not too much variation within the types
- For types with **highly idiosyncratic costs** among individuals (e.g., older, non-standard technology), rely on unit-specific reviews for offers > 0 rather than defining a "type"
- For each type, **develop representative characteristics and cost estimates** as well as the low end and high end, to inform PJM's choice of a single value per type
- Consider **analyzing only merchant generation** for all types (coal likely most affected)
- **Gross costs include fixed O&M** but exclude major CapEx and all variable costs (defined consistent with the PJM tariff); provide info on variable costs just for completeness
- No estimates for units that might mothball if not cleared

Conceptual Approach

Identify Resource Types

- Pre-CP resource types
- Analysis of drivers of cost variation
- Stakeholder feedback

Analyze Costs

- Bottom-up cost analysis
- Identify low, representative, and high end cost characteristics per type

Iterate where we determine there are important sub-types with substantially different costs

Cost Components of Gross ACRs

Fixed Operation and Maintenance Costs* — ***Included*** *in Gross ACRs*

Labor, Fixed Expenses, Property Taxes, Insurance

Variable Operation and Maintenance Costs — ***Not included*** *in Gross ACRs* but we will provide for context

Variable Operating Costs, Major Maintenance Costs*

Discretionary CapEx — ***Not included*** *in Gross ACRs*

Non-routine costs for upgrading performance

*For nuclear plants, our report will also present an alternative with major maintenance costs included in Gross ACRs, in case a currently-active stakeholder proposal for that treatment is adopted.

Existing Generation Resource Types

PJM requested that we develop Gross ACRs for the following existing generation resource types as an **initial list to be iterated upon** via internal discussions with PJM and the stakeholder process.

Some other resource types are too idiosyncratic to develop generalized representative costs, so rely on unit-specific reviews for non-price-taker offers.

PJM Proposed Resource Types
(red indicates types that are new since pre-CP)

Technology Type
Single-unit nuclear
Multi-unit nuclear
Coal
Natural gas combined-cycle
Natural gas simple-cycle combustion turbine
Onshore wind
Large-scale (>1 MW) solar photovoltaic

Pre-CP ACR Resource Types

Technology Type	2017/2018 Retirement ACR ($/MW-Day)
Combustion Turbine - Industrial Frame	$40.08
Coal Fired	$191.45
Combined Cycle	$49.36
Combustion Turbine - Aero Derivative	$45.10
Diesel	$39.22
Hydro	$109.12
Oil and Gas Steam	$93.28
Pumped Storage	$34.28

Source: PJM RPM Default Avoidable Cost Rates for the 2017/2018 Delivery Year

2020 Single Unit Nuclear Plants Gross Avoidable Costs

Population characteristics

- Only 2 in PJM
- 1,000 – 1,300 MW
- 33 – 43 years of operations

Drivers of cost variation

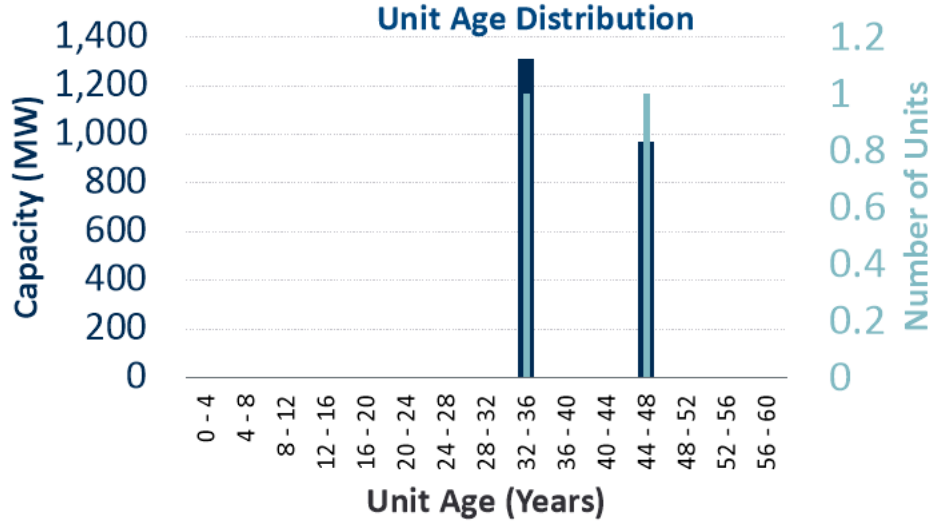
- Due to the limited number of plants and similar designs, we do not plant on analyzing high end or low end single unit nuclear plants

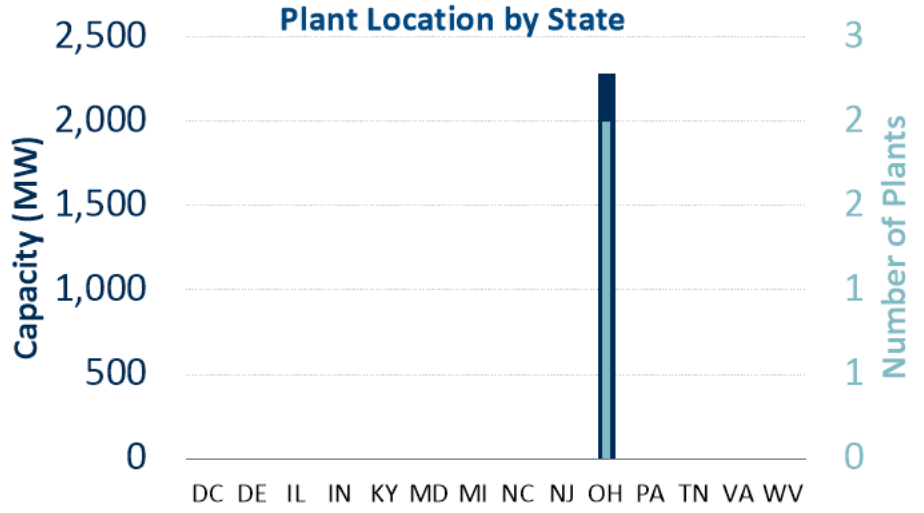
Gross Avoidable Costs for **Single-Unit Nuclear** from 2020 Study

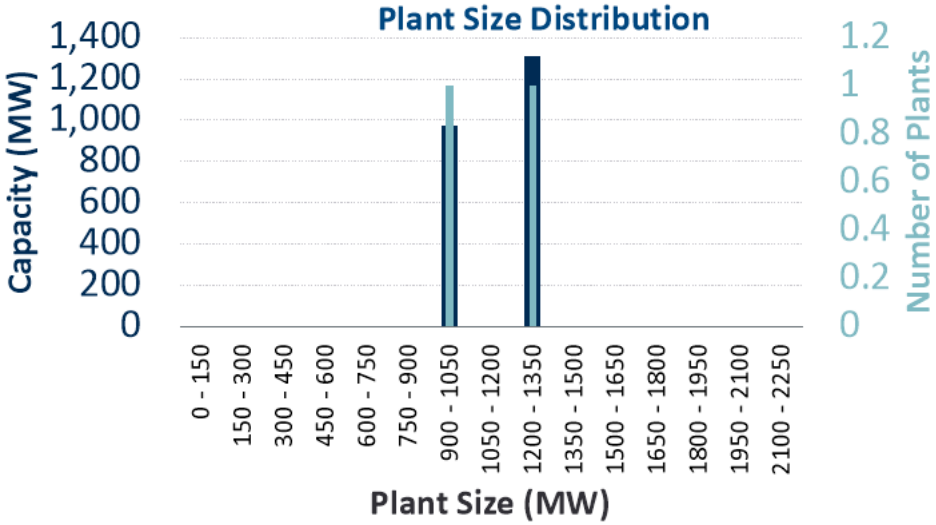
Low: ---	Representative: $697/MW-day	High: ---
• Only 3 plants in PJM • Too few units to estimate a range	• 1,200 MW • Boiling Water Reactor • Ohio • 35 years old	• Only 3 plants in PJM • Too few units to estimate a range

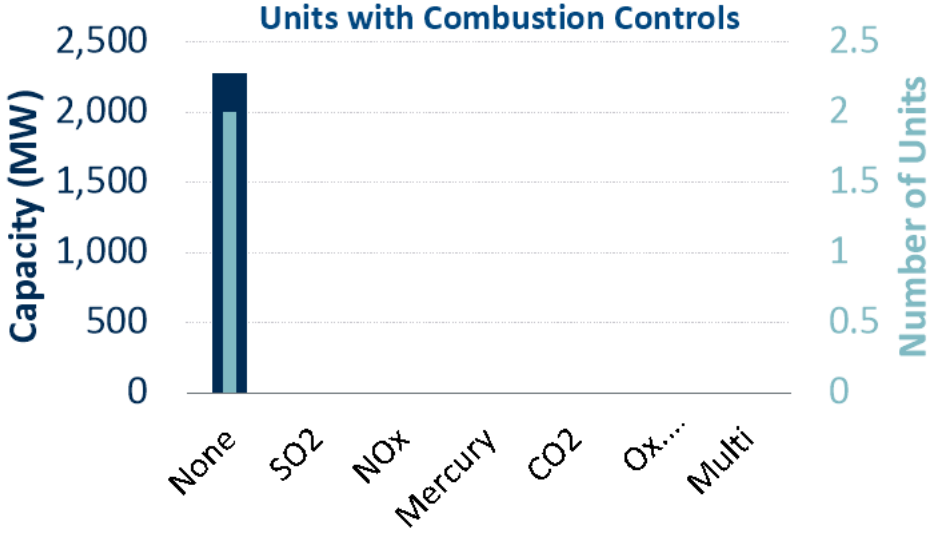
Brattle and S&L will investigate whether the FERC Form 1 and other data availability permits following the same approach as for the other types, rather than relying on NEI estimates again.

2022 Single Unit Nuclear Fleet









2020 Multi Unit Nuclear Plants Gross Avoidable Costs

Population characteristics

- 1,900 – 2,800 MW
- Most capacity in PA and IL
- 30 – 50 years of operations

Drivers of cost variation

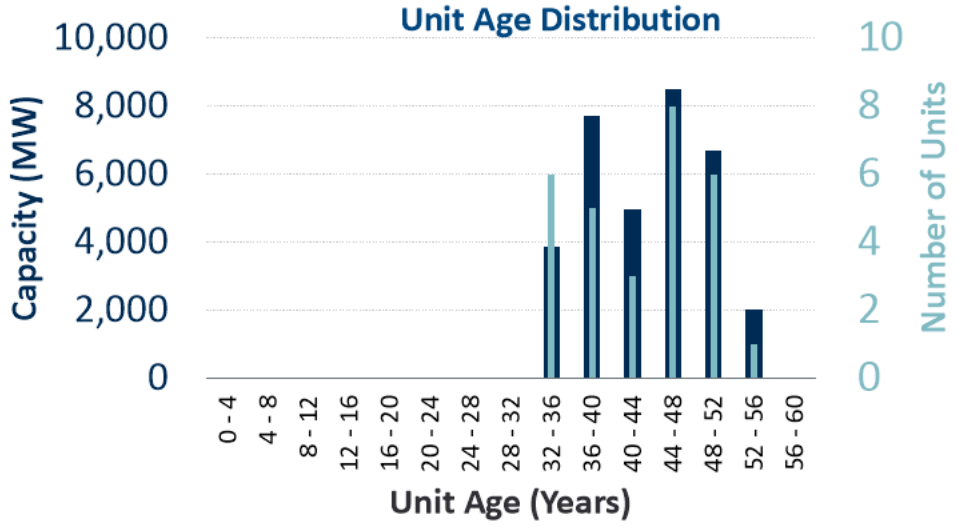
- Plant design: PWR vs BWR
- Going-forward regulatory commitments
- Location

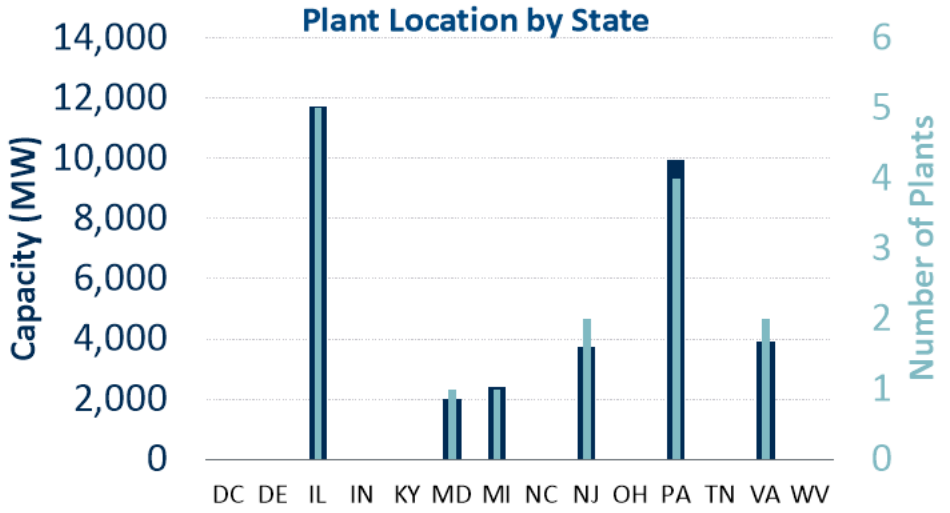
Gross Avoidable Costs for **Multi-Unit Nuclear** from 2020 Study

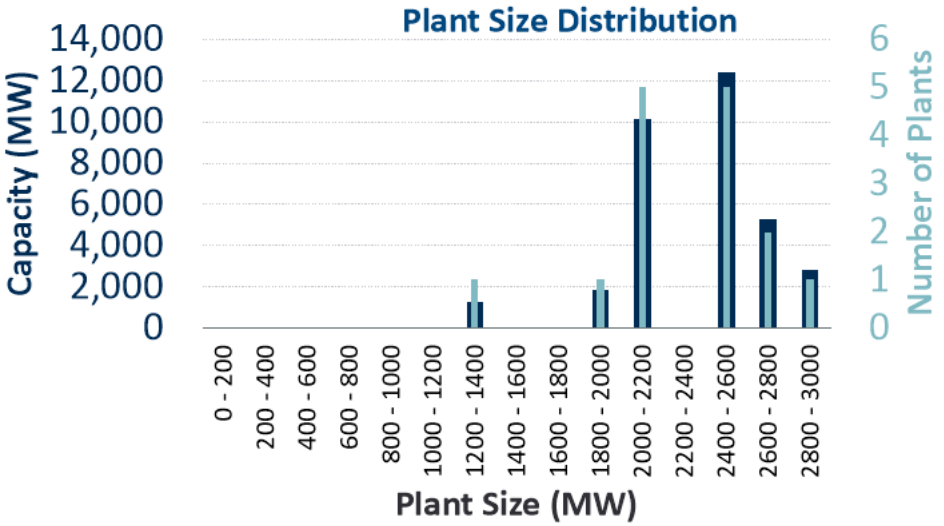
Low: $405/MW-day	Representative: $445/MW-day	High: $457/MW-day
•2,400 MW (2 x 1,200 MW) •Pressurized Water Reactor •Illinois •35 years old •Minimal regulatory costs	•2,400 MW (2 x 1,200 MW) •Boiling Water Reactor •Pennsylvania •35 years old •Minimal regulatory costs	•2,400 MW (2 x 1,200 MW) •Boiling Water Reactor •Pennsylvania •35 years old •Potential regulatory costs

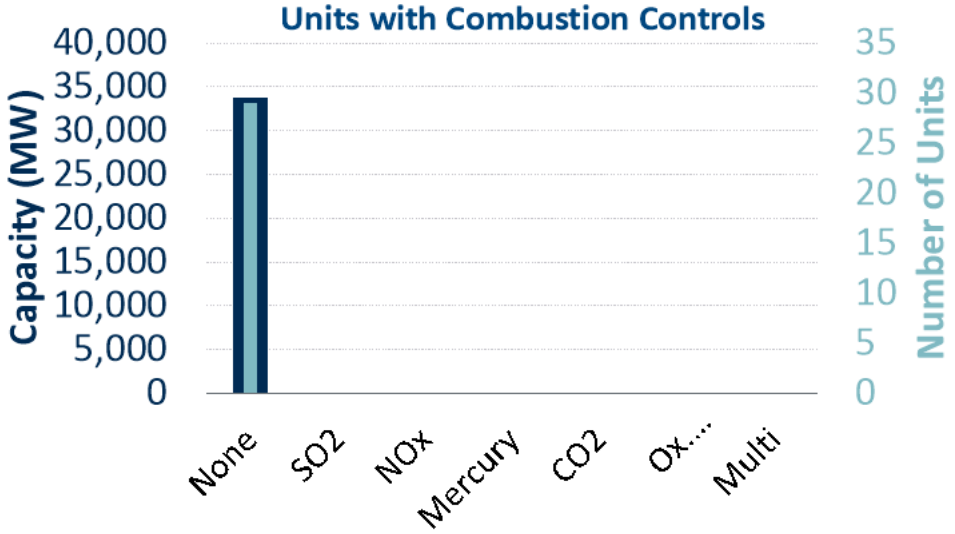
Brattle and S&L will investigate whether the FERC Form 1 and other data availability permits following the same approach as for the other types, rather than relying on NEI estimates again.

2022 Multi Unit Nuclear Fleet









2020 Coal Plants Gross Avoidable Costs

Population characteristics

- Wide range of capacities (mostly 500 – 3,000 MW); average is 1,100 MW
- Nearly all plants have an FGD
- Most capacity in WV, PA, OH
- Over half are 35 – 55 years old

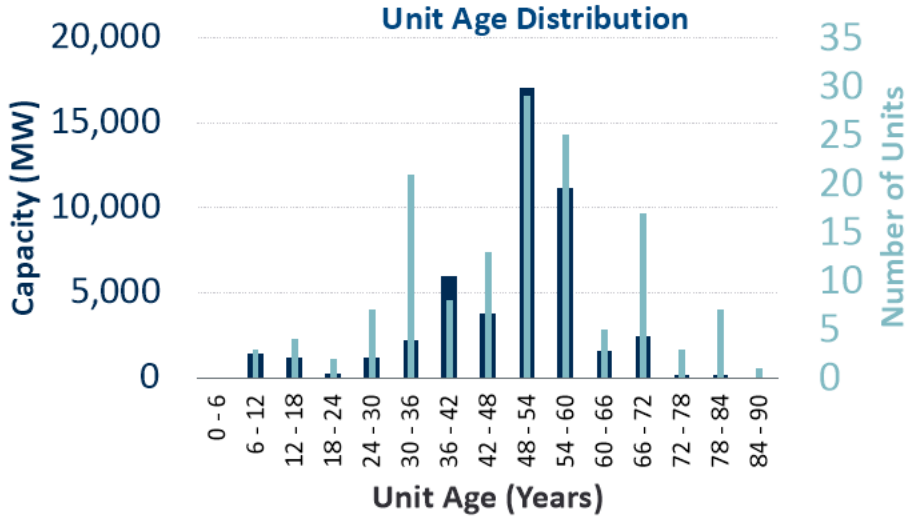
Drivers of cost variation

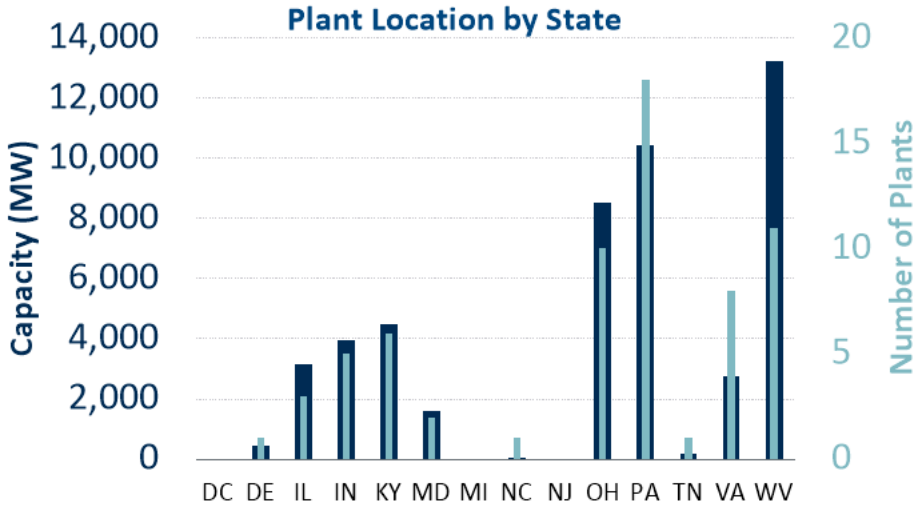
- Range of capacity (primary driver included below)
- Post-combustion control technologies (FGD is largest cost driver)
- Location

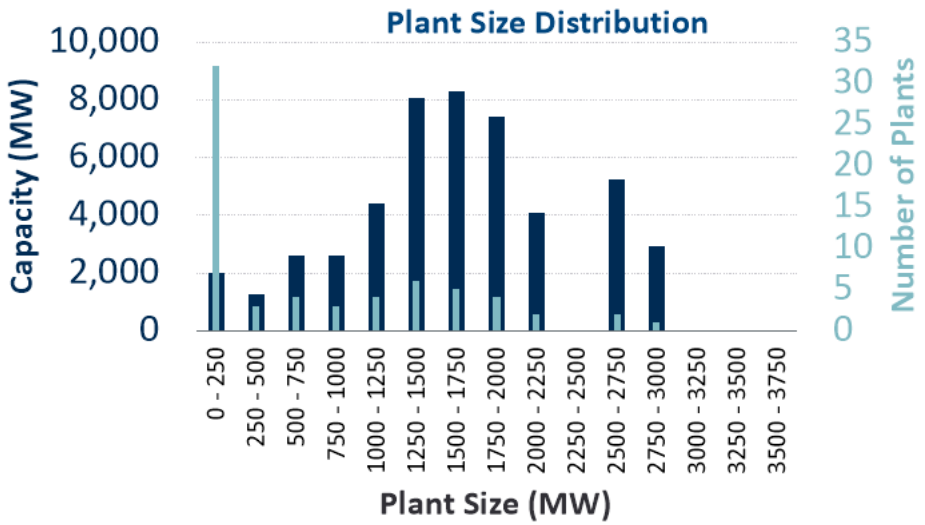
Gross Avoidable Costs for **Coal** from 2020 Study

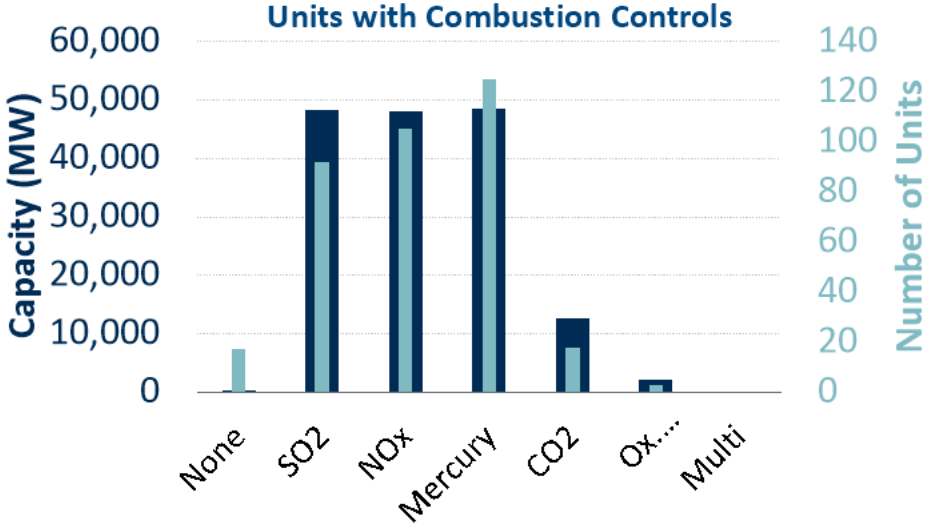
Low: $74/MW-day	Representative: $80/MW-day	High: $166/MW-day
•1,800 MW (2 x 900 MW) •Appalachian coal (high sulfur) •Wet limestone FGD •West Virginia •45 years old	•1,200 MW (2 x 600 MW) •Appalachian coal (high sulfur) •Wet limestone FGD •West Virginia •45 years old	•300 MW (2 x 150 MW) •Appalachian coal (high sulfur) •Wet limestone FGD •West Virginia •45 years old

2022 Coal Fleet









2020 Natural Gas CC Plants Gross Avoidable Costs

Population characteristics

- Mostly built 15-20 years ago or in the past 5 years
- 600–1,000 MW common in early 2000s, mostly F-class
- SCRs are common on CCs
- Most capacity in PA, VA, NJ, OH

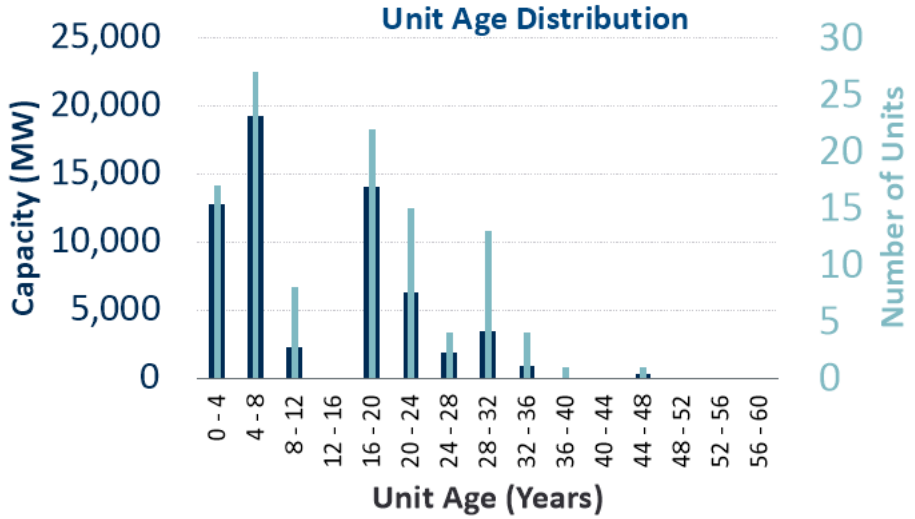
Drivers of cost variation

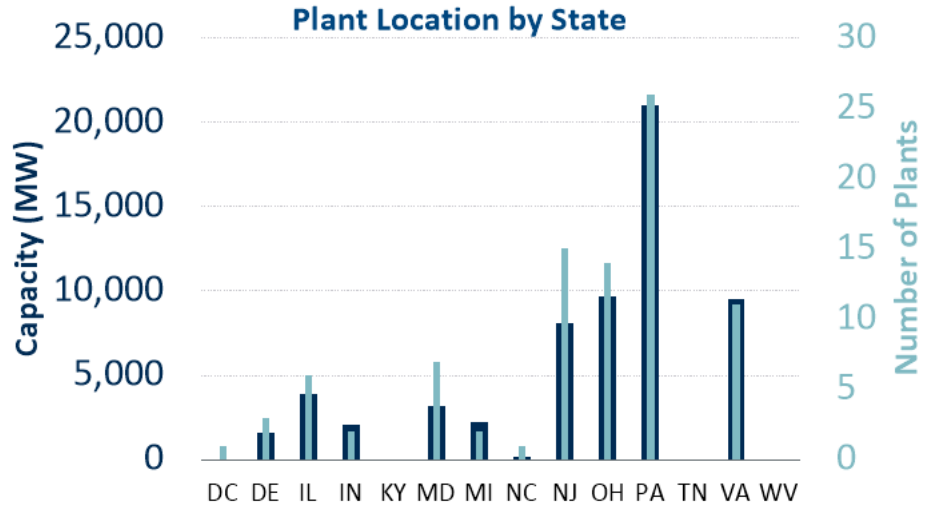
- Range of capacity, configuration, and turbine type
- Operating years
- Location

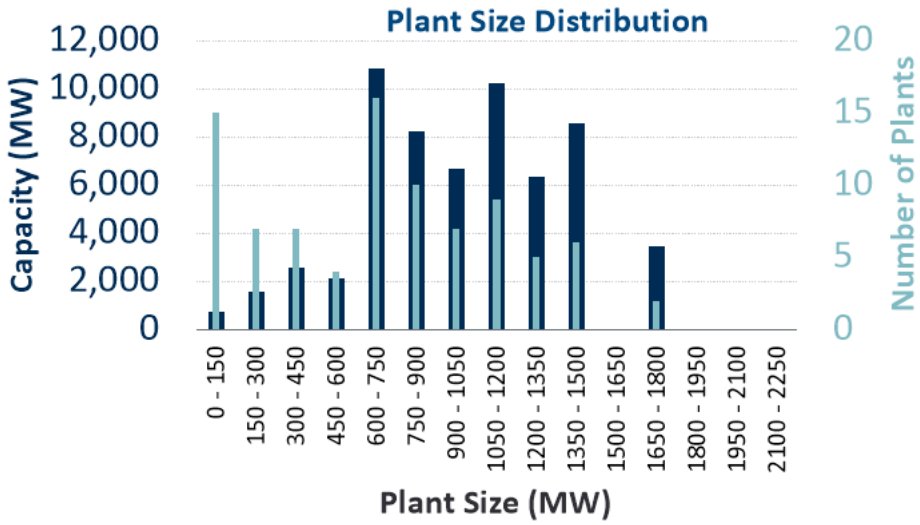
Gross Avoidable Costs for **Natural Gas CC** Plants from 2020 Study

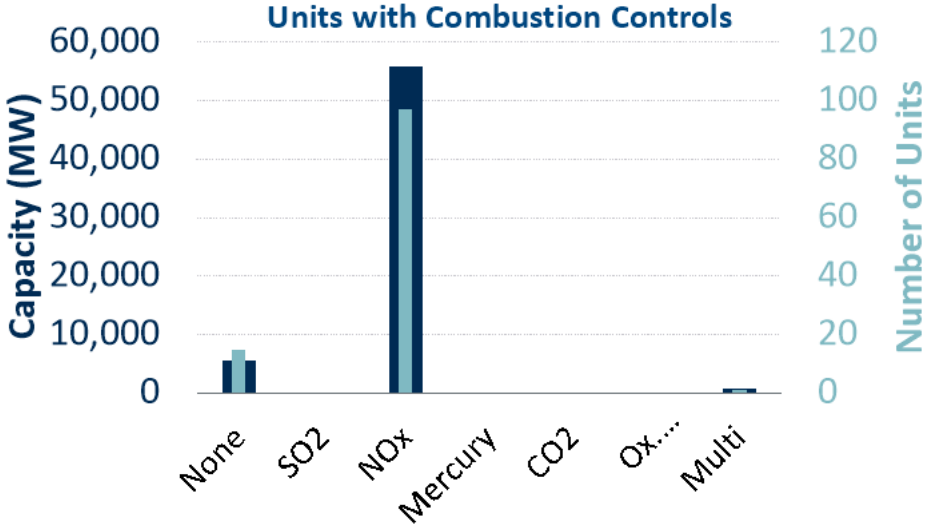
Low: $55/MW-day	Representative: $56/MW-day	High: $79/MW-day
•1,100 MW •H-class turbines (2x1) •SCR •Pennsylvania •5 years old	•750 MW •F-class turbines (2x1) •SCR •Pennsylvania •15 years old	•360 MW •F-class turbines (1x1) •SCR •Pennsylvania •15 years old

2022 Natural Gas CC Fleet









2020 Natural Gas CT Plants Gross Avoidable Costs

Population characteristics

- Wide range of size, number and type of turbines
- SCR not common on CTs
- Primarily built 15-20 years ago
- Most capacity in IL, OH, VA

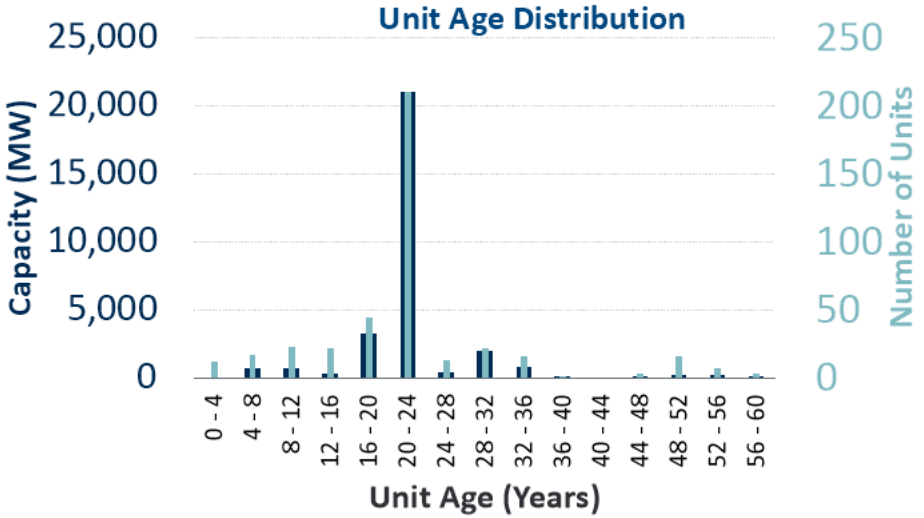
Drivers of cost variation

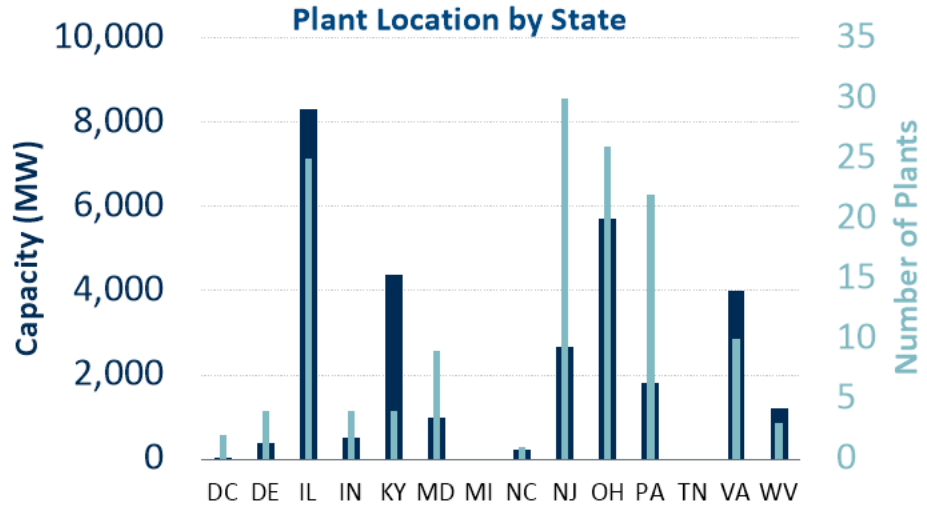
- Range of capacity, configuration, and turbine type
- Location

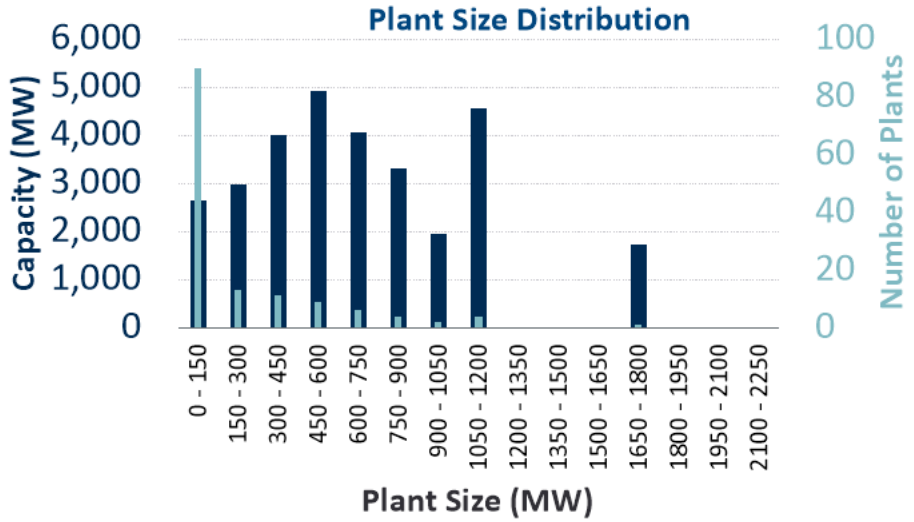
Gross Avoidable Costs for **Natural Gas CT** Plants from 2020 Study

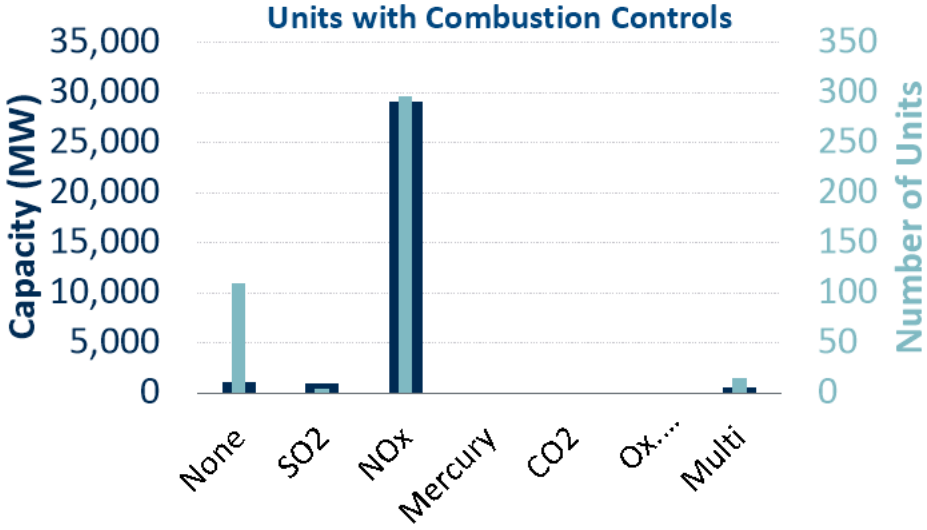
Low: $42/MW-day	Representative: $50/MW-day	High:$65/MW-day
•320 MW (2 x 160 MW) •F-class turbines •No SCR •Illinois •15 years old	•640 MW (8 x 80 MW) •E-class turbines •No SCR •Illinois •15 years old	•100 MW (2 x 50 MW) •LM6000 •No SCR •Pennsylvania •15 years old

2022 Natural Gas CT Fleet









2020 Solar PV Plants Gross Avoidable Costs

Population characteristics

- Most capacity is <10 MW
- Most capacity in NJ and NC
- Built in past 10 years old

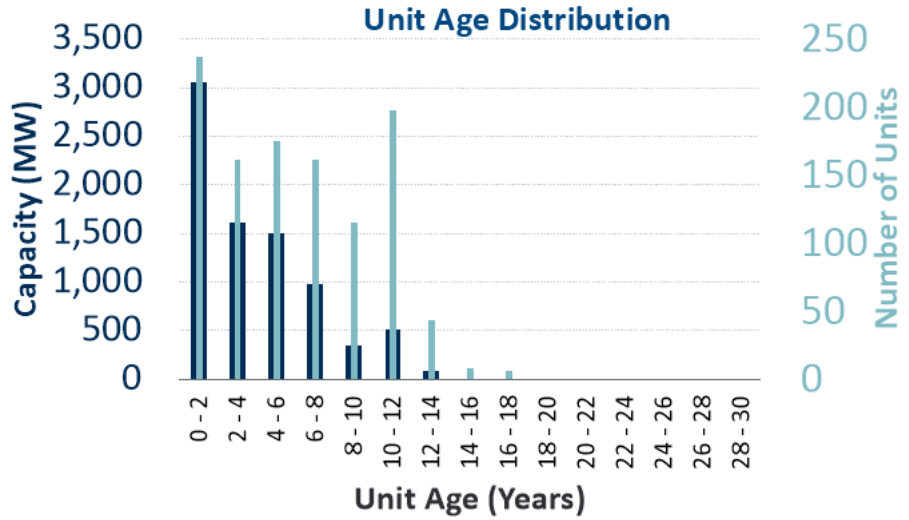
Drivers of cost variation

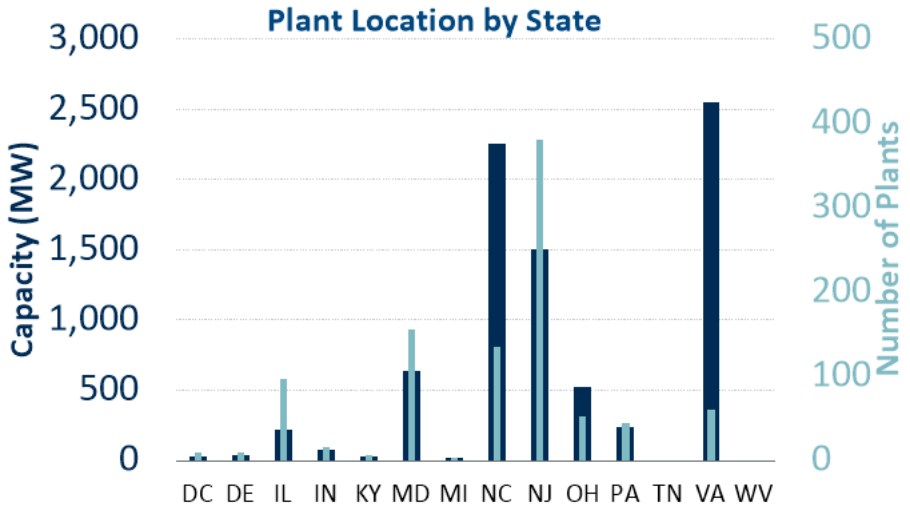
- Capacity
- Location

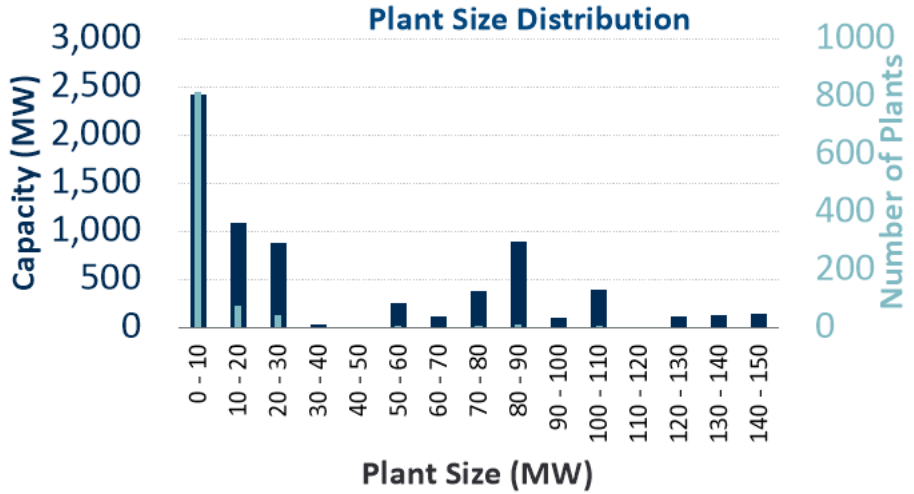
Gross Avoidable Costs for **Solar PV Plants** from 2020 Study

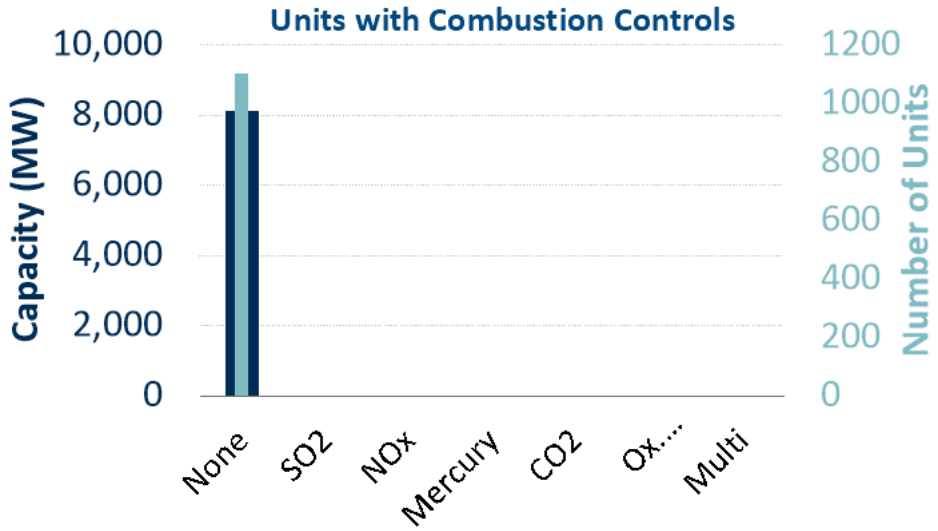
Low: $29/MW-day	Representative: $40/MW-day	High: $60/MW-day
•80 MW •Polysilicon •Single axis tracking •North Carolina •5 years old	•10 MW •Crystalline silicon •Single axis tracking •New Jersey •5 years old	•2 MW •Crystalline silicon •Single axis tracking •New Jersey •5 years old

2022 Solar PV Fleet









2020 Onshore Wind Plants Gross Avoidable Costs

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
- 5 – 15 years of operations

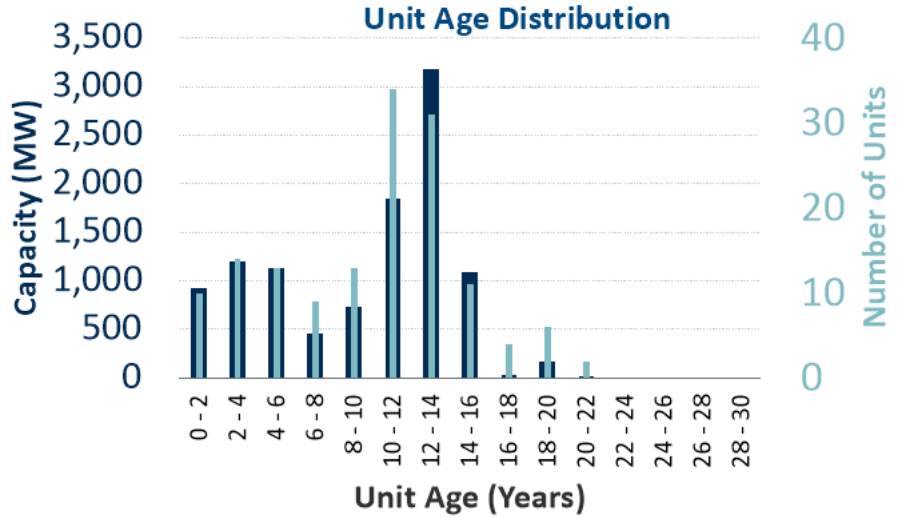
Drivers of cost variation

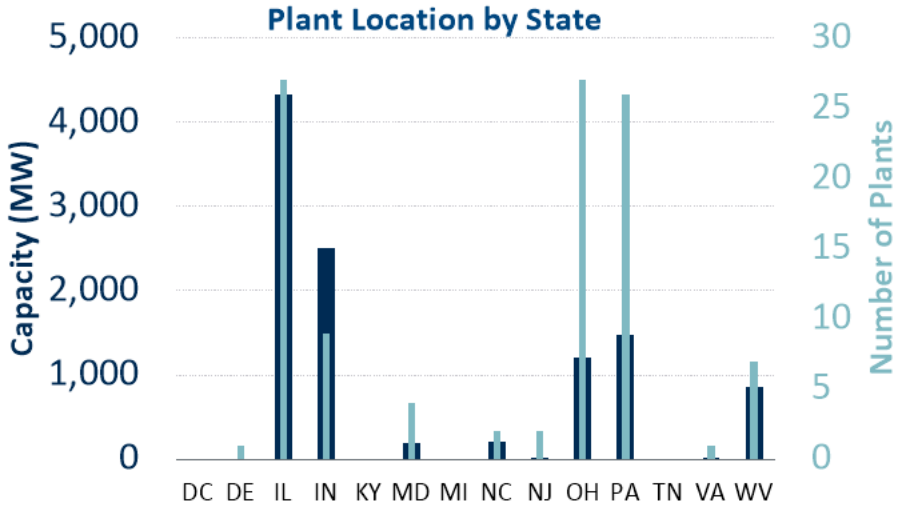
- Capacity
- Location

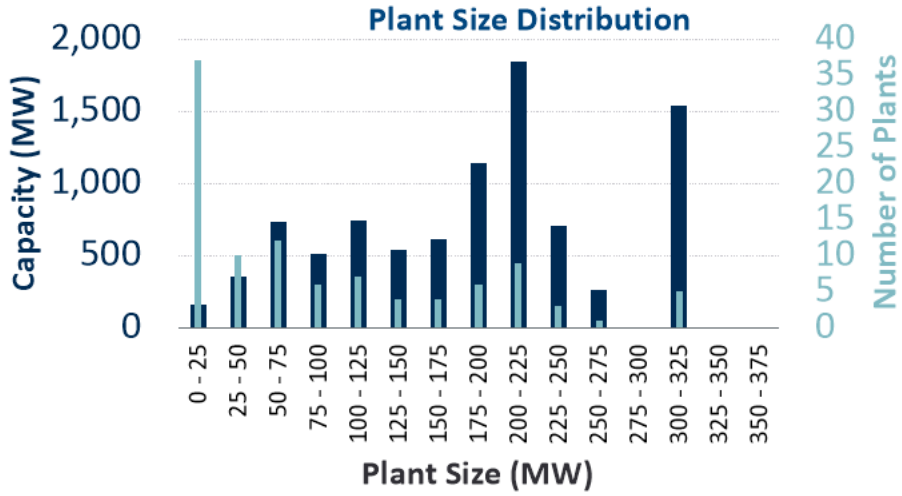
Gross Avoidable Costs for **Onshore Wind** Plants from 2020 Study

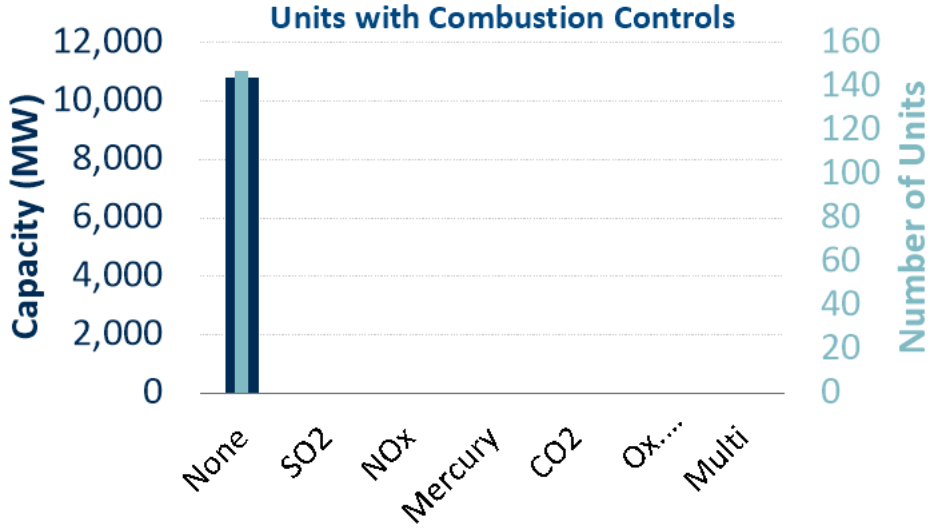
Low: $76/MW-day	Representative: $83/MW-day	High: $128/MW-day
•300 MW (150 x 2 MW) •Illinois •10 years old	•60 MW (40 x 1.5 MW) •Pennsylvania •10 years old	•30 MW (30 x 1.5 MW) •Pennsylvania •10 year old

2022 Onshore Wind Fleet





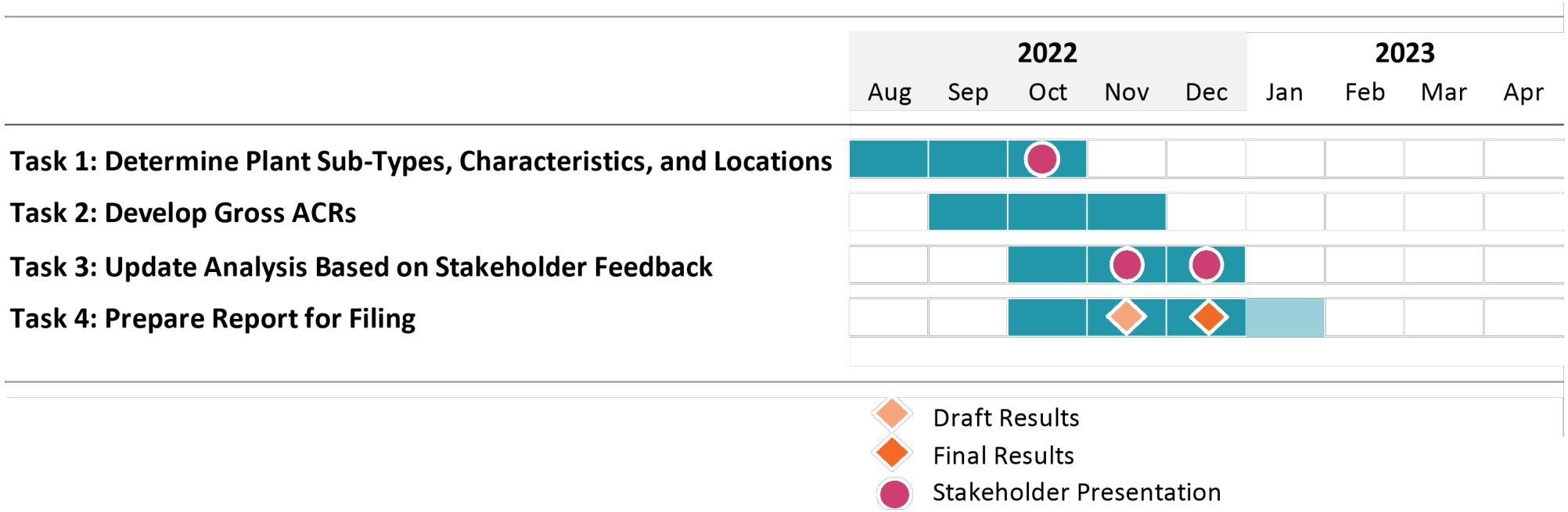




Next Steps

- Identify any additional resource types or changes to Gross ACR estimation approach
- Review publicly available costs as additional reference points

Project Timeline



THE POWER OF ECONOMICS

BRATTLE.COM

Brattle