Variable Operations and Maintenance Cost Review

Revised Straw Proposal

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Market Analysis & Forecasting

Stakeholder Call
May 11, 2020

CAISO Policy Initiative Stakeholder Process

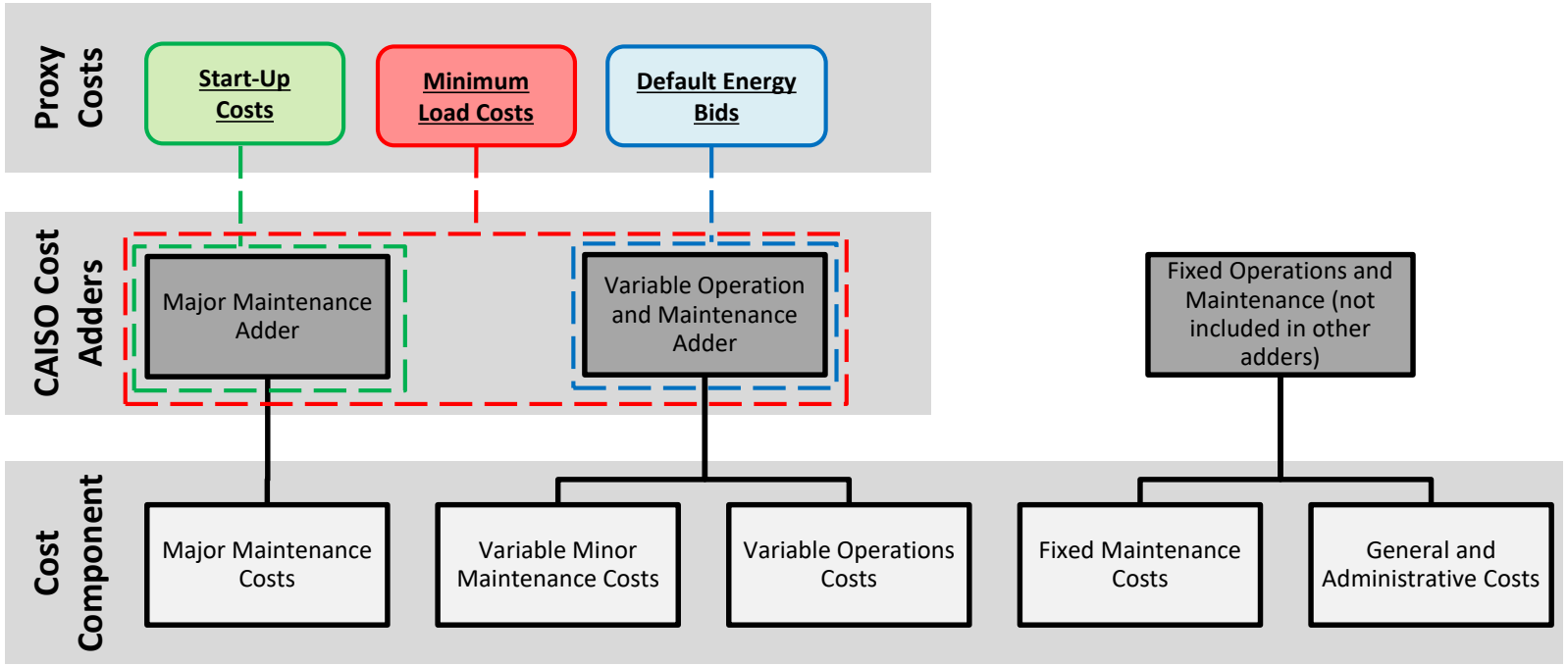
Agenda

Topic	Speaker
Welcome and stakeholder process	Isabella Nicosia
Introduction/Background	Kevin Head
Stakeholder Comments on Straw Proposal	Kevin Head
Proposal Component B: Refine Variable Operations Adders Component A: Definitions Component C: Calculate Default Maintenance Adders	 Nexant Kevin Head
Next Steps	Isabella Nicosia

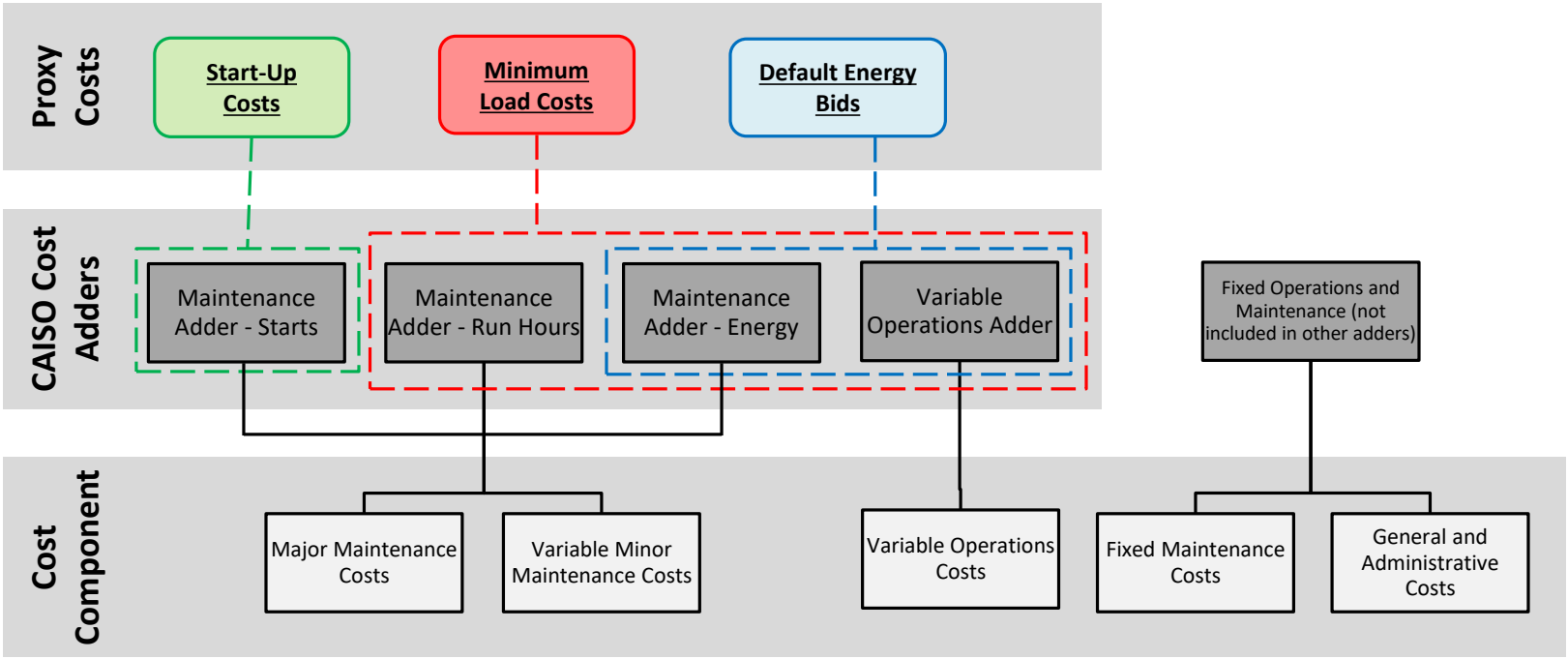
Introduction/Background

- CAISO has committed to revisit Variable O&M (VOM) adder values once every three years
- December 2018: CAISO published a report developed by Nexant proposing updates to VOM adder values that had been in place since 2012
- July 2019: Proposed updated definitions and held 5 tech specific stakeholder workshops to discuss definitions
- December 2019: Issued issue paper and straw proposal
- January 2020: Stakeholder call on straw proposal
- May 2020: Issued revised straw proposal and supporting calculations

Current Practice



Proposed Cost Recovery Framework in ISO Markets



Stakeholder Comments on Component A (Definitions)

- Comments were largely supportive of proposed definitions
- Stakeholders provided helpful feedback on improvements and replacements by pointing to FERC definitions

Stakeholder Comments on Component B (VO Adder)

- Many withheld comments on VO adders until updated values were presented
- Comments mixed on proposed technology grouping changes

Stakeholder Comments on Component C (Default Maintenance Adders)

- Most controversial component of proposal
- Comments focused on:
  - Scaling methodology based only on Pmax being overly simple or not representative of drivers of cost
  - 60% scaling factor being unnecessary or inappropriate
  - 50/50 split of adder between $/run-hour and $/start being arbitrary or inaccurate

Summary of Revised Straw Proposal

- Component A: Define O&M Cost Components
  - Tariff definitions vs. BPM guidance
- Component B: Refine Variable Operations Adders
  - Publishing updated VO adder values
  - Adjusting technology groups
- Component C: Calculate Default Maintenance Adders
  - Proposing two options for calculating default maintenance adders
  - Cross-validate estimates against existing MMAs

Component B: Refine Variable Operations Adder

- External consultant Nexant has updated VO Adder values based on stakeholder feedback on values proposed in December 2018
- CAISO is proposing to update technology groups from those originally proposed in Straw Proposal
  - Eliminate Advanced CT and CCGT groups, add an Aeroderivative CT group
  - Eliminate Solar Thermal and Integrated Coal Gasification CC group

CAISO
Variable Operations Cost Report - Version 2

Nexant
Reimagine tomorrow.

May 11, 2020

Topics

- Background
- Results
- Discussion

Background

Objectives:

- To revise the current technology types and default values for Variable Operations (VO) in its Tariff to reflect the current technology and technology-specific VO costs in the Western Interconnection

Requirements:

- VO values should adhere to the CAISO's definition of Variable Operations Costs

Background (2)

CAISO VO Definition:

- Variable Operations (VO) costs are the portion of the operations costs that are a function of the level energy production (MWh) of the generating unit over any period of interest (vary directly with MWh production)
- Includes consumables and waste disposal,
- Examples raw water, waste and wastewater disposal expenses, chemicals, catalysts and gases, ammonia for selective catalytic reduction, consumable materials and supplies
- Has not changed since the first Nexant report - VO values should adhere to the CAISO's definition of Variable Operations Costs

Since Last Report

Updated Number of Generators Based Upon Feedback

- First report included 23 different generator types
- Stakeholder feedback to CAISO and feedback to Nexant resulted in reduction to 10 generator default values

Update Costs Based Upon Feedback

- Used wet cooling tower water usage values for CCs and CTs
- Developed some CA based costs by scaling up NYISO costs for water and SCR catalyst and ammonia, by factor of 1.32 and 1.21 respectively

Default Adder Results

- Ten values developed in 2019 dollars
- Four have increased due to factors previously described
- One decreased (Nuclear) to remove maintenance cost inadvertently included

Note: These values are not comparable to current default values because of changes in definitions over time

Default Adder Results (From CAISO PPT)

Technology Type	Previously Proposed (December 2018) VO Adder ($/MWh)	Currently Proposed VO Adder ($/MWh)
Coal	2.69	2.69
Steam Turbines	0.32	0.33
Combined Cycle Gas Turbines (CCGTs)	0.26	0.59
Combustion Turbines (CTs)	0.82	0.97
Aeroderivative Combustion Turbines	0.82	2.15
Internal Combustion Engines	1.10	1.10
Nuclear	1.87	1.08
Biomass Power Plant	1.65	1.65
Geothermal Power Plant	1.16	1.16
Land Fill Gas	1.21	1.21

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Discussion

Component B: Refine Variable Operations Adder

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Component A: Definitions

- CAISO is proposing definitions for O&M cost components
  - Definitions are the foundation of the remainder of the proposal and are useful in both the development of default values and in negotiations after implementation
- We will differentiate the formal definitions (proposed to be included in the Tariff) and BPM guidance (more detailed and enumerative)
- Full definitions in the paper, today's discussion will focus on changes from Straw Proposal

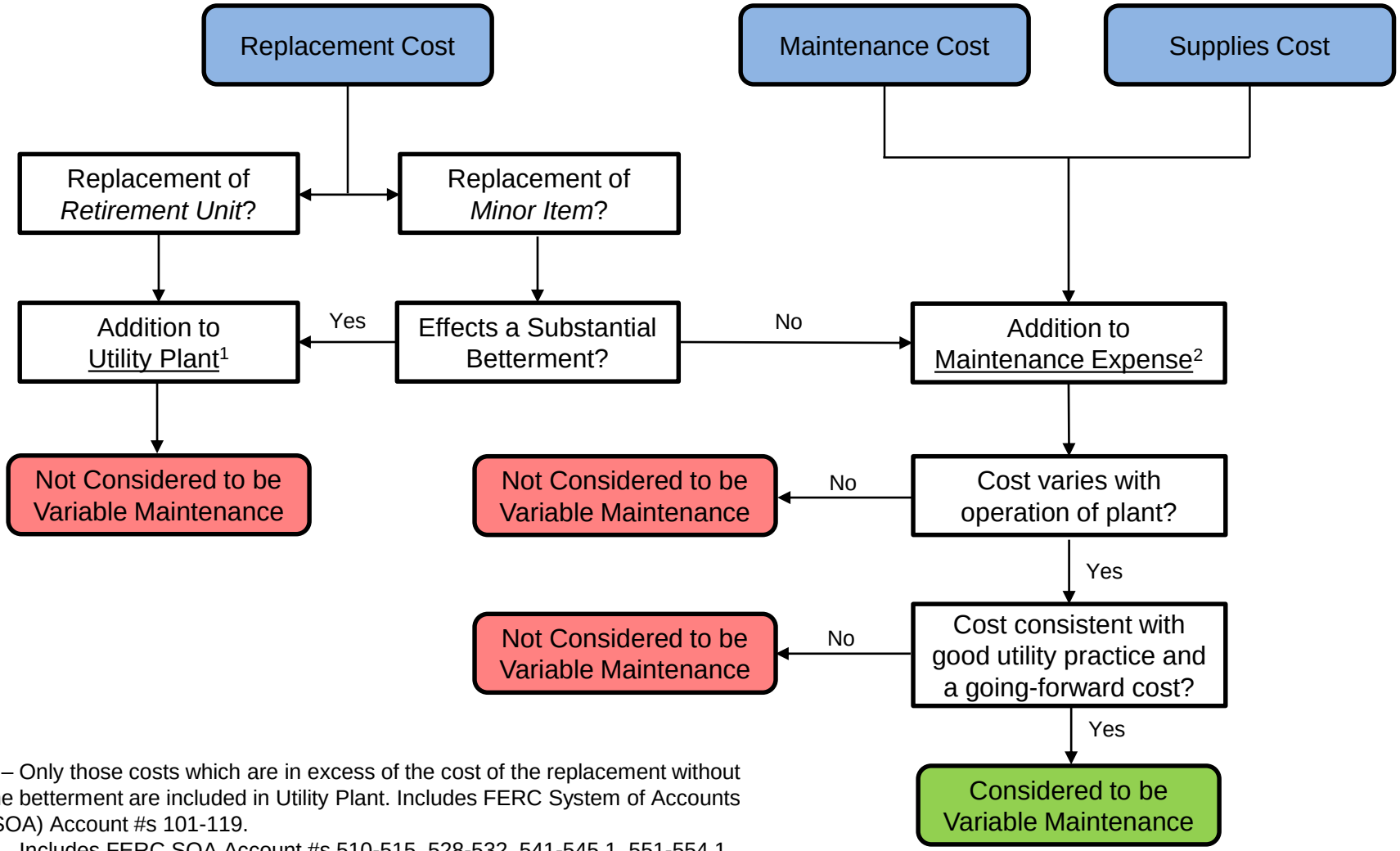
Component A: Definitions

Variable Maintenance Costs:

Variable Maintenance costs are the costs associated with the repair, overhaul, replacement, or inspection of a Generating Facility that adhere to the following conditions:

1) *Such costs must vary with the electrical production (i.e. the run-hours, electricity output, or the start-up) of the Generating Facility.*
2) *Such costs should reflect going-forward costs that are expected to be incurred within the lifespan of the unit.*
3) *Such costs should be consistent with good utility practice.*
4) *If the item is a replacement of existing plant or equipment, such costs should not effect a substantial betterment to the Generating Facility.*

Component A: Definitions – Proposed Decision Tree



1 – Only those costs which are in excess of the cost of the replacement without the betterment are included in Utility Plant. Includes FERC System of Accounts (SOA) Account #s 101-119.
2 – Includes FERC SOA Account #s 510-515, 528-532, 541-545.1, 551-554.1

Component C: Calculate Default Maintenance Adders

- CAISO is proposing two options to calculate the default maintenance adder (MA):
  - **Option 1** involves fewer assumptions and proposes default adders for 3 technology types
  - **Option 2** involves more assumptions and proposes default adders for 4 technology types
- Both options involve cross-validating external estimates against negotiated MMA values
- Presentation will walk through sample calculations and summarize advantages and disadvantages, but first…

Component C: Calculate Default Maintenance Adders

… let's discuss the guiding principles:

- **Conservativism**: default values should be a conservative estimate of costs because they are used as a proxy of marginal costs during local MPM
- **Usefulness**: default values should be set at a level that they can be used by most resources, most of the time

These two principles are often in competition with each other

Component C: Calculate Default Maintenance Adders

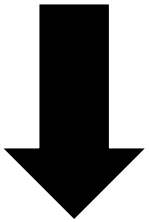
Both of the options utilize a similar methodology in their calculation:

1) Estimate variable maintenance costs using external sources
2) Determine which adder type ($/run-hour, $/start, or $/MWh adder) is most appropriate as a default for each technology type
3) Convert the variable maintenance costs to the appropriate default adder type
4) Cross-validate the estimate from external sources against interpolated major maintenance adder values to determine a default maintenance adder
5) Using the default maintenance adder, calculate a unit-specific adder

<u>Steps 1-4 are outlined in detail in Supporting Calculations</u>

Component C: Calculate Default Maintenance Adders

- Calculation steps are interdependent
- Requirements in later steps will drive a decision in an earlier step, e.g.:
  - CAISO can only cross-validate the external estimates for technology groups that have a sufficient number of negotiated MMAs (Step 4)



  - Therefore, we only gather external source estimates for these technology groups (Step 1)

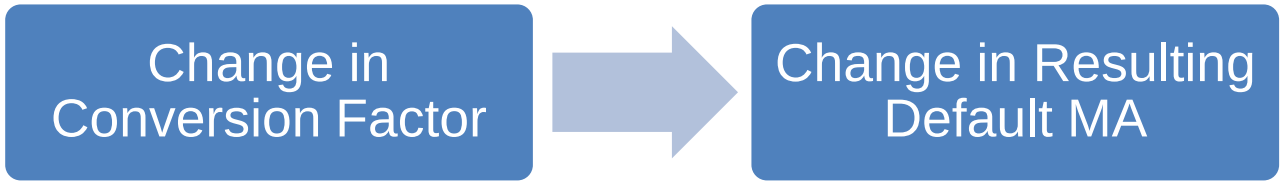
Component C: Calculate Default Maintenance Adders

	Option 1	Option 2
Inputs		
Number of external sources used per technology	Single source	Multiple sources
Conversions		
Conversions of VOM to variable maintenance allowed?	No	Yes
Conversions between adder types ($/MWh, $/run-hour, $/start) allowed?	No	Yes
Outputs		
# of technology types covered	3	4
Coverage of proposed DMAs*	37% of resources	74% of resources

* - For the purposes of this calculation, the CAISO ignores technology types which don't have maintenance activities which can be specifically linked to their variable production (e.g. solar photovoltaic resources).

Component C: Calculate Default Maintenance Adders

- Calculation is also sensitive to assumptions
- In both options, CAISO uses estimates of conversion factors such as *starts per year* and *run-hours per year*



- In Option 1, the conversion factors are taken directly from the source documentation
- In Option 2, the conversion factors are estimated based on CAISO/EIM operating data

Component C: Calculate Default Maintenance Adders

Step 1: Estimate variable maintenance costs using external sources

Option 1	Option 2
Single source - Cleanest, easiest-to-explain way to start the calculation - May present a limited picture by relying on single source	Multiple sources - Allows for a diversity of cost estimates - Makes an already complex calculation more complicated
External source: - NYISO cost of new entry reports (2010, 2016)	External source: - NYISO cost of new entry reports (2010, 2016) - APS (2017) - Pacificorp (2019) - PSE (2018) - EPA (2016) - EIA (2020)

Component C: Calculate Default Maintenance Adders

Step 1 (continued)

Example: CT variable maintenance costs, NYISO 2016 report

Option 1 Variable Maintenance Costs ($/cycle per MW)

Cost of labor	2,840,000	$/cycle (2015 dollars)
x Labor scaling factor	1.1	Derived from BLS wage data
Scaled cost of labor	3,133,888	$/cycle
+ Plus: cost of parts	22,100,000	$/cycle
Variable maintenance costs	25,233,888	$/cycle (2015 dollars)
x Inflation factor	1.0793	Derived from BLS CPI data
Variable maintenance costs	27,234,081	$/cycle (2019 dollars)
÷ Pmax	218	MW
Variable maintenance costs	**125,118**	**$/cycle per MW**

Component C: Calculate Default Maintenance Adders

Step 1 (continued)

Example: CT variable maintenance costs, APS 2017

***Option 2** Variable Maintenance Costs ($/year per MW)*

Variable O&M			2.28	$/MWh (2017 dollars)
		x		
Inflation factor			1.0436	
Variable O&M			2.38	$/MWh (2019 dollars) ÷
		-		
Less: Variable operations costs**			0.97	$/MWh
Variable maintenance costs	①		1.41	$/MWh
		x		
Capacity factor	②		10%	
		x		
Hours per year	③		8760	hours/year
Variable maintenance costs			**1,235**	**$/year per MW (①*②*③)**

** - Option 2 subtracts out estimate of VO costs to arrive at variable maintenance costs

Key difference between Option 1 and Option 2

Component C: Calculate Default Maintenance Adders

Step 1 (continued)

Option 1 Variable Maintenance Costs ($/cycle per MW)

Technology Type	NYISO
CCGT	123,203
[Frame] CT	125,118
Aeroderivative CT	266,407

Option 2 Variable Maintenance Costs ($/year per MW)

Technology Type	NYISO	EPA	APS	PAC	PSE	EIA
CCGT	11,053	-	6,626	-	3,804	5,824
[Frame] CT	3,324	-	1,235	6,178	2,102	4,168
Aeroderivative CT	3,657	-	201	3,750	-	1,284
Hydro	-	8,321	-	-	-	4,021

Component C: Calculate Default Maintenance Adders

Step 2: Determine which adder type ($/run-hour, $/start, or $/MWh adder) is most appropriate as a default for each technology type

- Same default adder type for both Option 1 and Option 2
- No longer proposing any 50/50 blended default values

Technology Type	Proposed Default Adder Type
CCGT	$/run-hour
[Frame] CT	$/start
Aeroderivative CT	$/run-hour
Hydro	$/run-hour

Component C: Calculate Default Maintenance Adders

Step 3: Convert the variable maintenance costs to the appropriate default adder type

Option 1 Variable Maintenance Costs ($/starts per MW)

Example: CT variable maintenance costs, NYISO 2016 report

Variable maintenance costs	÷	125,118	$/cycle per MW
Starts per cycle		2,400	Starts/cycle
Variable maintenance costs		52.13	$/start per MW

Option 2 Variable Maintenance Costs ($/cycle per MW)

Example: CT variable maintenance costs, APS 2017

Variable maintenance costs	÷	1,235	$/year per MW
Starts per year**		64	Starts/year
Variable maintenance costs		19.36	$/start per MW

** - Option 2 uses an estimate of starts per year based on CAISO/EIM operating data

Key difference between Option 1 and Option 2

Component C: Calculate Default Maintenance Adders

Step 3 (cont.)

Option 1 Variable Maintenance Costs

Technology Type	NYISO	
CCGT	2.57	$/run-hour per MW
[Frame] CT	52.13	$/start per MW
Aeroderivative CT	5.33	$/run-hour per MW

Option 2 Variable Maintenance Costs ($/year per MW)

Technology Type	NYISO	EPA	APS	PAC	PSE	EIA	Wtd. Avg.	Units
CCGT	2.57	-	1.54	-	0.88	1.35	**1.91**	$/run-hour per MW
[Frame] CT	52.13	-	19.36	96.88	32.96	65.36	**52.89**	$/start per MW
Aeroderivative CT	5.33	-	0.29	5.46	-	1.87	**3.94**	$/run-hour per MW
Hydro	-	1.51	-	-	-	0.73	**1.12**	$/run-hour per MW

Component C: Calculate Default Maintenance Adders

Step 4: Cross-validate the estimate from external sources against interpolated MMA values to determine a default maintenance adder

Option 1 Proposed default maintenance adder

Technology Type	Ext. Estimate VM Cost	Interpolated MMA Values	Default MA	Units
CCGT	2.57	1.69	1.69	$/run-hour per MW
[Frame] CT	52.13	> Ext. Estimate	52.13	$/start per MW
Aeroderivative CT	5.33	> Ext. Estimate	5.33	$/run-hour per MW

Option 2 Proposed default maintenance adder

Technology Type	Ext. Estimate VM Cost	Interpolated MMA Values	Default MA	Units
CCGT	1.91	1.69	1.69	$/run-hour per MW
[Frame] CT	52.89	> Ext. Estimate	52.89	$/start per MW
Aeroderivative CT	3.94	> Ext. Estimate	3.94	$/run-hour per MW
Hydro	1.21	0.36	0.36	$/run-hour per MW

Component C: Calculate Default Maintenance Adders

Step 5:Using the default maintenance adder, calculate a unit-specific adder

- Same calculation method for both Option 1 and Option 2
- Simply multiply the default maintenance adder by the resource or configuration's Pmax to arrive at a unit-specific adder
- This is what will be used to calculate the default start-up bids or default minimum load bids (commitment cost bid caps)

Component C: Calculate Default Maintenance Adders

Summary of Advantages and Disadvantages of Options 1 and 2

Inputs	
Option 1	**Option 2**
Advantages: - Clear connection between source documentation and proposed default MA	Advantages: - Multiple sources incorporate a variety of estimates - Uses estimates from CAISO and EIM area - Allows for future updates of inputs as new data become available
Disadvantages: - Single source may present a limited estimate of costs - May be difficult to update inputs in the future if external estimate source changes/is unavailable	Disadvantages: - In some cases, CAISO needs to subtract out VO costs from VOM values in source documentation, introducing uncertainty

Component C: Calculate Default Maintenance Adders

Summary of Advantages and Disadvantages of Options 1 and 2

Conversions/Calculations	
Option 1	**Option 2**
Advantages: - Few conversions necessary to convert the external source estimates to default MA values - Any conversions uses conversion factors from source documentation	Advantages: - Averaging of sources diminishes the importance of individual definitions used and estimates made in source documentation
Disadvantages: - None	Disadvantages: - Unit conversions using CAISO/EIM operating data introduces uncertainty into calculation

Component C: Calculate Default Maintenance Adders

Summary of Advantages and Disadvantages of Options 1 and 2

Outputs	
Option 1	**Option 2**
Advantages: - Allows for some flexibility for streamlined negotiations for CT and CCGT resources	Advantages: - Proposed default MAs covers more technologies and resources: four technologies, representing 74% of resources
Disadvantages: - Only three technologies, representing 37% of resources, are covered	Disadvantages: - No streamlined negotiations are possible

Stakeholder Engagement and Implementation Timeline

Date	Milestones
December 19, 2019	Post Straw Proposal
January 6, 2019	Hold stakeholder call on Straw Proposal
January 21, 2019	Stakeholder written comments due on Straw Proposal
May 4, 2020	Post Revised Straw Proposal
May 11, 2020	Hold stakeholder call on Revised Straw Proposal
May 26, 2020	Stakeholder written comments due on Revised Straw Proposal
August 10, 2020	Post Draft Final Proposal
August 17, 2020	Hold stakeholder call on Draft Final Proposal
August 31, 2020	Stakeholder comments due on Draft Final Proposal
Aug. - Sept. 2020	Tariff & BRS Development
November 4, 2020	EIM Governing Body
November 18-19, 2020	Board of Governors
Independent Release 2021 *or* Spring 2021 Release	Go-Live

Next Steps

Please submit written comments by May 26, 2020 to

initiativecomments@caiso.com