Attachment H

Transition Costs for Multi-Stage Generator Resources

H   Transition Costs for Multi-Stage Generator Resources

Transition Ceosts are a type of Sstart-Uup Ceost specific to multi-stage generators. Transitions Ceosts can be thought of as the costs to "start" a configuration (or conversely the cost savings to "shut down" a configuration). The CAISO uses different terminology to differentiate between changes in configuration when the resource is already "On" versus a plant-level Sstart-Uup, which turns the resource "On" from the "Off" state per the CAISO tariff definitions.

Multi-Stage Generating Resources that are subject to CAISO Tariff Appendix II must register a tTransition Ceost of $0/MWh for all transitions in their transition matrix.

Transition and Sstart-Uup Ceosts will be calculated and treated as follows:

- A Sstart-Uup Ceost is incurred when a resource is turned "On." If a resource is already On but incrementing between configurations, it may incur a Ttransition Ceost in the upward direction. For the purposes of this discussion, the "lower" configuration is a configuration with a smaller minimum operating level than the "higher" configuration.
- Transition costs will be calculated as the difference between the "To" and "From" configurations when the resource is increasing from a lower configuration to a higher configuration. Transition Ceosts will only be calculated for possible transition paths.   The CAISO does not recognize a downward Ttransition Ceost. Transition Ceosts must be either a zero or positive number and will default to zero if negative.

Scheduling coordinators may bid start-up costs and transition costs according to whether the resource is subject to the Pproxy or Rregistered Ccost option. Under the proxy cost option, scheduling coordinators may bid up to 125 percent of the start-up,, and bid up to 125% of the or transition cost ,,on a daily basis for each configuration and for each transition. Under the Rregistered Ccost option, scheduling coordinators may register bids up to 150 percent of the start-up and transition cost, subject to a minimum, 30-day period. Transition costs, which are the costs to transition from one configuration to a higher configuration, reflect the fuel input and major maintenance costs, sas appropriate, to transition from one configuration to a higher configuration. The fuel input is based on the resource's actual unit-specific performance parameters, as required in tariff section 30.4.1.1.1.

The process diagram below shows how the transition cost caps are developed under the pProxy and Rregistered Ceost methods.

| Step 1: SC data submission | Step 2: CAISO uses submitted data to calculate Proxy tTransition Ceosts | Step 3: SC bids under Pproxy Cost option or registers Ttransition Ccosts under Rregistered Ceost |

Step 1: Scheduling Coordinator data submission

FEASIBLE TRANSITIONS

A resource that has been registered as an MSG unit will ~~also~~ fill out a transition matrix, which contains operating constraints associated with the feasible transitions between configurations. Scheduling Coordinators must provide all feasible transition paths to the CAISO.

COST COMPONENTS AND RESOURCE CHARACTERISTICS

Scheduling Coordinators must provide enough information about each cost component and physical resource characteristic of both ~~S~~start-~~U~~up and indirect ~~S~~start-~~U~~up c~~C~~osts for each configuration based on quantifiable and verifiable costs as required in tariff section 30.4.1.1.1. A ~~S~~start-~~U~~up C~~c~~ost is the cost incurred for a configuration that the resource can directly start into (also referred to as a "startable" configuration).[1] A ~~S~~start-~~U~~up C~~c~~ost also refers to the cost an MSG incurs when the resource is turned On for the first time. Since an MSG resource can start directly into any of its startable configurations, each has the potential to be the first ~~S~~start-~~U~~up C~~c~~ost.

An *indirect* ~~S~~start-~~U~~up reflects the start of a configuration that cannot be directly started. An indirect ~~S~~start-~~U~~up C~~c~~ost is only calculated for the purpose of calculating T~~t~~ransition C~~c~~osts and will not be used when a resource is turned On (and is not a biddable parameter). An example of a configuration that an MSG resource cannot directly start into is the duct firing capability of a combined cycle resource if the combustion turbine is modeled as the lower configuration and the duct firing is modeled as the higher configuration. The resource would physically need to be near the maximum capability of the combustion turbine in order to access duct firing. Therefore, this resource cannot directly start into the duct firing configuration. For this type of example, a non-negative transition cost can be incurred when the resource transitions from the lower (combustion turbine) to the higher (duct firing) configuration. Even configurations that cannot be directly started can have verifiable physical parameters and/or costs as required in tariff section 30.4.1.1.1. These parameters and/or costs are used to calculate the indirect ~~S~~start-~~U~~up C~~c~~ost.

Indirect ~~S~~start-~~U~~up C~~c~~osts have the same components as s~~S~~tart-~~U~~up C~~c~~osts and follow the calculation methodology for the ~~p~~Proxy Cost and ~~r~~Registered C~~c~~ost options. Please see Attachment G for P~~p~~roxy Cost and the R~~r~~egistered ~~c~~Cost option calculations. Transition costs must be calculated using the same cost option as the ~~S~~start-~~U~~up C~~c~~ost methodology selected for the resource as required by tariff section 30.4.

INSUFFICIENT DATA

According to tariff section 30.4.1.1.1, if there is insufficient data for the CAISO to determine the resource's ~~S~~start-~~U~~up C~~c~~ost in the lowest startable configuration or one or more components of

---

[1] Note that the CAISO tariff does not differentiate between ~~S~~start-~~U~~up and indirect ~~S~~start-~~u~~Up but refers to both generically as "Start-Up." This is because the two concepts are treated in essentially the same manner. However, this BPM makes the differentiation to help market participants to provide the correct information.

the resource's sStart-Uup Ceosts (either Sstart-Uup or indirect Sstart-Uup) then the CAISO will set the sStart-Uup Ceost or cost component(s) is as zero. As part of the validation process, the CAISO may request additional information from the SC before setting a cost to zero.

For configurations higher than the lowest startable configuration, tariff section 30.4.1.1.3 allows the CAISO to use a component associated with the next-lowest MSG configuration, if feasible, to backfill insufficient data.

Costs for higher configurations (*i.e.,* a configuration with a higher Pmin) are ***cumulative*** with respect to lower configurations. The CAISO broadly considers two types of MSG resources. The first is represented by distinct peakers, steam turbines or machines (such as pumps) while the second is duct firing capacity paired with distinct peakers or turbines. For a peaker, steam turbine or similar machine, the configurations reflect separate, modular machines. For example, configuration 1 reflects running one turbine while configuration 2 reflects running two turbines. Therefore, configuration 2 is approximately double the cost of configuration 1. As described in greater detail below, the transition cost is calculated as the cost difference between the Sstart-Uup Ceosts of the two (from and to) configurations for feasible transitions plus a transition Opportunity Cost adder if applicable.

For MSG resources with duct firing capability, the costs do not uniformly increase from configuration 1 to 2 or from 3 to 4. Unlike starting a separate plant, there is an increase in fuel input to transition to duct firing when the combustion turbine is operating at 85 percent of capacity and small incremental increases in the costs due to the change in the configuration Pmin. Costs in the higher configuration reflecting duct firing should be cumulative of the costs of the lower configuration reflecting the combustion turbine. As described in greater detail below, the transition cost is the cost difference between the two configuration Sstart-Up eCosts for feasible transitions plus a transition Opportunity Cost adder if applicable and would reflect the small cost increase for reaching duct firing configuration.

Step 2: CAISO uses submitted data to calculate transition cost bid caps

The CAISO calculates Ttransition Ceosts as the difference between two Sstart-Uup Ceosts for each feasible upward transition plus a transition Opportunity Cost if applicable. Start-Uup Cost and indirect Sstart-Uup Ceost bid caps will be calculated based on the Pproxy Cost or Rregistered Ceost methodology.

Transition Ceost bid cap calculation will be under the same methodology as that selected for Sstart-Uup Ceosts in accordance with tariff section 30.4. Since the configuration costs are cumulative, tTransition Ceosts can only be zero or positive. Any negative Ttransition Ceosts will be replaced with zero pursuant to tariff section 30.4.1.1.5.

Scheduling Coordinators under the Proxy Cost option can bid daily up to 125 percent of the proxy transition cost excluding the transition cost opportunity cost plus 100 percent of the transition cost opportunity cost in the proxy cost if applicable. A Scheduling Coordinator may not change its Registered Cost or change to Proxy Cost for a minimum 30-day period. The Registered Cost

option has slightly different inputs to the Proxy Cost option as explained in Attachment G of the Market Instruments BPM. For Multi-Stage Generators under the Proxy Cost Option that have registered start use limitations in the ULPDT and depending on the outcome of the CAISO procedures to establish opportunity costs pursuant to Section 30.4.1.1.6.1.2, the Multi-Stage Generator may also have transition opportunity costs in its bid cap. In cases where a transition between configurations is considered a start to which the start limitation applies, a start opportunity cost will be calculated for each to-configuration. For feasible transitions, the CAISO will set the transition bid cap for the transition as 125% of the difference between the 'To Configuration' and 'From Configuration' start proxy costs plus the start-up opportunity cost of the 'To Configuration'.

The transition cost bid cap under proxy cost option is calculated as follows:

$$TC_{From \to To} = [1.25 * (SUC_{To} - SUC_{From})] + SU\_OC_{To}$$

Where,

$TC_{From\text{-}>To}$ Transition proxy cost bid bap for transition from from-config to to-config

SUC_{To} Proxy start-up cost of to-configuration

SUC_{From} Proxy start-up cost of from-configuration

SU_OC_{To} Start-up opportunity cost of to-configuration

For MSG configuration starts and transitions, the start-up opportunity cost is calculated per implied start for each configuration. This value is multiplied by the number of implied starts registered in the Generator Resource Data Template to derive the opportunity costs that will included in the start-up cost bid cap or transition cost bid cap, as applicable.

Scheduling Coordinators eligible for the Registered Cost option can register transition costs of up to a 150 percent cap of projected transition costs, which do not include a transition opportunity cost.

Step 3: Scheduling Coordinator subject to daily bids under Proxy Cost option or registers Transition Costs under Registered Cost option, if available

Transition Costs are calculated under the same methodology as the MSG resource's selected Start-Up Cost option. Scheduling Coordinators eligible for the Proxy Cost and Registered Cost options can bid or register Transition Costs subject to the Proxy Cost Bid Cap and Registered Cost Bid Cap respectively. The Proxy Cost and Registered Cost Bid Caps are described in Step 2. A Scheduling Coordinator may not change its Registered Cost or change to Proxy Cost election for a minimum 30-day period. The Registered Cost option has slightly different inputs from the Proxy Cost option as explained in Attachment G.

H.1 Examples: Transition Costs for natural gas-fired resources

EXAMPLE 1: NATURAL GAS-FIRED RESOURCES WITH DISTINCT PEAKERS OR STEAM TURBINES

```
Step 1: SC data
submission
```

Table H1 below shows an illustrative example of the cost items included for a resource, Unit A, with distinct peakers or steam turbines. Unit A has four configurations. Only configurations 1 and 3 are directly startable and all transition paths are possible except from 2 to 4. In this example, a new configuration entails starting a new peaker or steam turbine. Therefore, most of the costs and physical parameters approximately double from the first to the second configuration. The CAISO expects that all the columns in yellow are verifiable costs and/or verifiable physical parameters of the resource. For example, the CAISO should be able to verify the heat input, start-up energy, configuration Pmin, and start-up time for each configuration. The CAISO clarifies that the heat input is the amount to reach the Pmin of the peaker or steam turbine. This is different from the transition heat input which is the difference in heat input between the configurations. Each higher configuration should be presented as *cumulative* costs or amounts from the lower configurations.

The non-highlighted columns are costs that remain the same for all configurations and are provided by the CAISO, such as the daily gas price index under the Proxy Cost methodology or the projected gas price based on monthly natural gas price futures.

Table H1
Proxy Start-Up and indirect Proxy Start-Up Cost calculation: peaker or steam turbine

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-Up energy (MWh)	Elec. price index ($/MWh)
UnitA_1	1 – Startable	80	$4.00	$12.00	0.053963	$250	50	20	$0.38	20	$1.00
UnitA_2	2 – NOT startable	160	$4.00	$12.00	0.053963	$550	100	20	$0.38	20	$1.00
UnitA_3	3 – Startable	240	$4.00	$12.00	0.053963	$1,000	150	20	$0.38	20	$1.00
UnitA_4	4 – NOT startable	320	$4.00	$12.00	0.053963	$1,500	200	20	$0.38	20	$1.00

Table H1 assumes that the CAISO has enough information from the Scheduling Coordinator to calculate each Start-Up and indirect Start-Up Cost. As noted above, if information is insufficient to calculate configuration level data (aside from the lowest configuration) the CAISO may use information from the next lowest configuration to backfill. Table H2 below provides an illustrative example where the data in yellow (for the startable configurations) has been provided but the data in orange (for the indirect start-ups) has not be provided but is instead copied from the next lowest configuration. As discussed in greater detail later, not providing Resource Data

Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for certain start-up or indirect start-up costs may result in a lower or zero transition cost.

Table H2
Proxy Start-uUp and indirect Proxy Sstart-Uup Ceost calculation for missing data: peaker or steam turbine

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-uUp energy (MWh)	Elec. price index ($/MWh)
UnitA_1	1 – Startable	80	$4.00	$12.00	0.053963	$250	50	20	$0.38	20	$1.00
UnitA_2	2 – NOT startable	80	$4.00	$12.00	0.053963	$250	50	20	$0.38	20	$1.00
UnitA_3	3 – Startable	240	$4.00	$12.00	0.053963	$1,000	150	20	$0.38	20	$1.00
UnitA_4	4 – NOT startable	240	$4.00	$12.00	0.053963	$1,000	150	20	$0.38	20	$1.00

Step 2: CAISO uses submitted data to calculate Proxy Ttransition Ceosts bid caps

Table H3 reproduces the same inputs as Table H1. The last column in blue has been added to calculate the total Proxy Sstart-Uup or indirect Proxy Sstart-Uup cost:

Proxy Start-up Cost = (Heat Input or Start-uUp Fuel x Gas Price) + (Start-Up Energy x Energy Price Index) + (Pmin x Start-Up Time Period in min / 60 min/hour x GMC adder / 2) + (Heat Input or Start-Up Fuel x GHG Emission Rate x GHG Allowance Price) + Major maintenance adder

Table H3
Proxy Start-Uup and indirect Proxy Sstart-uUp eCost calculation: peaker or steam turbine

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-uUp energy (MWh)	Elec. price index ($/MWh)	Cost
UnitA_1	1 – Startable	80	$4.00	$12.00	0.053963	$250	50	20	$0.38	20	$1.00	$645
UnitA_2	2 – NOT startable	160	$4.00	$12.00	0.053963	$550	100	20	$0.38	20	$1.00	$1,320
UnitA_3	3 – Startable	240	$4.00	$12.00	0.053963	$1,000	150	20	$0.38	20	$1.00	$2,145
UnitA_4	4 – NOT startable	320	$4.00	$12.00	0.053963	$1,500	200	20	$0.38	20	$1.00	$3,020

Table H4 shows the Proxy Transition costs based on the Start-Up and indirect Start-Up Costs shown in Table H3. The Proxy Transition costs are equal to 100 percent of the Proxy Start-Up Costs. All of the Proxy Transition Costs are calculated as the difference between the "To" configuration and "From" configuration Proxy Start-Up Cost and indirect Proxy Start-Up Costs. For example, the Start-Up cost for configuration 1 is $645 and for configuration 2 is $1,320 as shown in the last column of Table H3. If the resource transitions from configuration 1 to 2, it would incur an additional $675 in Transition Costs shown in the first row, second column of Table H4, which is the difference between the two configuration Start-Up Costs. This unit cannot transition from configuration 2 to 4 so this transition path is not calculated. When the resource stays in configuration 1 it incurs only the Start-Up for configuration 1. After it transitions, it would only incrementally incur the Transition Cost to configuration 2. There are no Transition Costs from a higher to a lower configuration or if the resource stays in the same configuration. As a simplifying assumption, if each configuration has more than one segment, the highest priced segment will be used in the calculation.

Table H4

Calculated Proxy Transition Cost: peaker or steam turbine

		"To" configuration			
		UnitA_1	UnitA_2	UnitA-3	UnitA_4
"From" configuration	UnitA_1		$675	$1,500	$2,375
	UnitA_2			$825	n/a
	UnitA_3				$875
	UnitA_4				

Assuming the resource has a $0 start-up opportunity cost, the transition cost bid cap under the Proxy Cost option for the transition from configuration 1 to configuration 2 is calculated as follows:

= [1.25*$675] +$0

= $843.75

If information is not provided for each configuration (even if the configuration is not startable), then the ISO will use data from the next lowest available configuration. Refer back to Table H2 where data is missing for configurations 2 and 4. For data missing for configuration 2, the CAISO will use data from configuration 1 and for data missing for configuration 4 the CAISO will use data from configuration 3.

The consequence of not providing Resource Data Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for configurations 2 and 4 (and the CAISO using information from configurations 1 and 3, respectively), is a zero Proxy Transition Cost calculated for transition paths C1 to C2 and C3 to C4, reduced Transition Cost from C1 to C4, and an increase in Transition Cost from C2 to C3 because the C2 cost is now lower. Transitioning from C2 to C4 is not possible for this resource. This is shown in Table H5.

Table H5

Proxy Transition Cost calculation for missing data: peaker or steam turbine

		"To" configuration		
		UnitA_1	UnitA_2	UnitA-3	UnitA_4
"From" configuration	UnitA_1		$0	$1,500	$1,500
	UnitA_2			$1,500	n/a
	UnitA_3				$0
	UnitA_4				

Step 3: SC bids under Proxy Cost option or registers Transition Costs under Registered Cost option

Transition Costs are calculated under the same methodology as the MSG resource's selected Start-Up Cost option. Scheduling Coordinators eligible for the Proxy Cost and Registered Cost options can bid or register Transition Costs subject to the Proxy Cost Bid Cap and Registered Cost Bid Cap respectively. The Proxy Cost and Registered Cost Bid Caps are described in Step 2. A Scheduling Coordinator may not change its Registered Cost or Proxy Cost election for a minimum 30-day period. The Registered Cost option has slightly different inputs from the Proxy Cost option as explained in Attachment G.

Transition costs are calculated under the same methodology as the MSG resource's selected start-up cost option. Scheduling coordinators eligible for the Registered Cost registered cost option can register transition costs of up to 150 percent of projected transition costs. Scheduling Coordinators under the Proxy Cost option can bid daily up to 125 percent of the calculated transition cost. A Scheduling Coordinator may not change its Registered Cost registered cost or change to proxy cost for a minimum 30-day period. The Registered Cost registered cost option has slightly different inputs to the Proxy Cost option as explained in Attachment G.

EXAMPLE 2: NATURAL GAS-FIRED RESOURCES WITH DUCT FIRING

Step 1: SC data submission

Table H6 below shows an illustrative example of the cost items included for a resource, Unit B, with duct firing. Unit B has four configurations. Only configurations 1 and 3 can be directly started and configurations 2 and 4 reflect duct firing and cannot be directly started. All transition paths are possible except from 2 to 4. In order to access the duct firing in configuration 2, the resource will be operating at 85 percent of the capacity of the combustion turbine in configuration 1. Unlike

starting a separate unit, the resource needs to increase its energy output from the Pmin of configuration 1 (200 MW) through to the Pmin of configuration 2 (250 MW) and would be paid for the energy produced in the dispatchable portion of configuration 1 (between 200 and 249 MW). Unlike starting an additional peaker or steam turbine, the main costs incurred for transitioning to duct firing is a small amount of additional fuel input (as opposed to incurring significant major maintenance costs, for example).

The CAISO expects that all the columns in yellow are verifiable costs and/or verifiable physical parameters of the resource. For example, the CAISO should be able to verify the heat input, Start-Up energy, configuration Pmin, and Start-Up Time for each configuration. The heat input is the amount to reach the Pmin of the combustion turbine or duct firing (assuming the combustion turbine supporting the duct firing is near maximum capacity).   This is different from the transition heat input which is the difference in heat input between the configurations. Each higher configuration should be presented as *cumulative* costs or amounts from the lower configurations.

Scheduling Coordinators can establish major maintenance adders by submitting cost information to the CAISO, as described in detail in Attachment L. In this example, there is no additional major maintenance adder for the duct firing configurations. Therefore, the major maintenance costs between configurations 1 and 2 are the same (*i.e.*, the cost for configuration 1 is $11,590 but the incremental cost for configuration 2 is $0 so the cumulative cost, as reflected in the configuration 2 major maintenance adder, is $11,590 + $0 = $11,590). The non-highlighted columns are costs that remain the same for all configurations and are provided by the CAISO, such as the daily gas price index under the proxy cost methodology.

Table H6

Proxy Start-Up and indirect Proxy Start-Up Cost calculation: duct firing

Start-up and indirect start-up cost calculation: duct firing

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. Adder	Config Pmin	Config startup time	GMC	Start-Up energy (MWh)	Elec. price index ($/MWh)
UnitB_1X1	1 – Startable	1,500	$4.00	$12.00	0.053963	$11,590	200	60	$0.38	20	$1.00
UnitB_1X1DF	2 – NOT startable	1,550	$4.00	$12.00	0.053963	$11,590	250	60	$0.38	20	$1.00
UnitB_2X1	3 – Startable	2,500	$4.00	$12.00	0.053963	$23,180	400	60	$0.38	20	$1.00
UnitB_2X1DF	4 – NOT startable	2,550	$4.00	$12.00	0.053963	$23,180	450	60	$0.38	20	$1.00

Table H6 assumes that the CAISO has enough information from the Scheduling Coordinator to calculate each Proxy Start-Up and indirect Proxy Start-Up Cost. As noted above, if

information is missing to calculate configuration level data (aside from the lowest configuration) the CAISO may use information from the next lowest configuration to backfill. Table H7 below provides an example where the data in yellow (for the startable configurations) has been provided but the data in orange (for the indirect start-ups) has not been provided but is instead copied from the next lowest configuration. As discussed in greater detail later, not providing Resource Data Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for certain sStart-uUp or indirect Sstart-uUp cCosts parameters in the Master File may result in a lower or zero transition cost.

Table H7
Proxy Start-Uup and indirect Proxy Sstart-uUp Ccost calculation for missing data: duct firing

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. Adder	Config Pmin	Config startup time	GMC	Start-Uup energy (MWh)	Elec. price index ($/MWh)
UnitB_1X1	1 – Startable	1,500	$4.00	$12.00	0.053963	$11,590	200	60	$0.38	20	$1.00
UnitB_1X1DF	2 – NOT startable	1,550	$4.00	$12.00	0.053963	$11,590	200	60	$0.38	20	$1.00
UnitB_2X1	3 – Startable	2,500	$4.00	$12.00	0.053963	$23,180	400	60	$0.38	20	$1.00
UnitB_2X1DF	4 – NOT startable	2,550	$4.00	$12.00	0.053963	$23,180	400	60	$0.38	20	$1.00

Step 2: CAISO uses submitted data to calculate Proxy Ttransition Ceosts bid caps

Table H8 reproduces the same inputs as Table H6. The last column in blue calculates the total Proxy sStart-uUp or indirect Proxy Sstart-uUp Ceost:

Proxy Start-uUp Cost = (Heat Input or Start-uUp Fuel x Gas Price) + (Start-Up Energy x Energy Price Index) + (Pmin x Start-Up Time Period in min / 60 min/hour x GMC adder / 2) + (Heat Input or Start-Up Fuel x GHG Emission Rate x GHG Allowance Price) + Major maintenance adder

Table H8
Proxy Start-uUp and indirect Proxy sStart-uUp Ceost calculation: duct firing

Config ID	Configuration	Heat input (MMBtu)	Gas price ($/MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-uUp energy (MWh)	Elec. price index ($/MWh)	Cost
UnitB_1X1	1 – Startable	1,500	$4.00	$12.00	0.053963	$11,590	200	60	$0.38	20	$1.00	$18,604
UnitB_1X1DF	2 – NOT startable	1,550	$4.00	$12.00	0.053963	$11,590	250	60	$0.38	20	$1.00	$18,845
UnitB_2X1	3 – Startable	2,500	$4.00	$12.00	0.053963	$23,180	400	60	$0.38	20	$1.00	$34,869
UnitB_2X1DF	4 – NOT startable	2,550	$4.00	$12.00	0.053963	$23,180	450	60	$0.38	20	$1.00	$35,110

Table H9 shows the calculated Proxy Transition Costs based on the Start-Up and indirect Proxy Start-Up Costs shown in Table H8. The calculated Proxy Transition Costs do not include headroom (*i.e.*, are 100 percent of the costs). All of the Transition Costs are calculated as the difference between the "To" configuration and "From" configuration Proxy Start-up Up and indirect Proxy Start-up Up Costs. For example, the Start-Up Cost for configuration 1 is $18,604 and for configuration 2 is $18,845 as shown in the last column of Table H8. If the resource transitions from configuration 1 to 2, it would incur an additional $241 in Transition Costs shown in the first row, second column of Table H9, which is the difference between the two configuration Proxy Start-Up Costs. This unit cannot transition from configuration 2 to 4 so this transition path is not calculated. When the resource stays in configuration 1 it incurs only the Start-Up Cost for configuration 1. After it transitions, it would only incrementally incur the Transition Cost to configuration 2. There are no Transition Costs from a higher to a lower configuration or if the resource stays in the same configuration. As a simplifying assumption, if each configuration has more than one segment, the highest priced segment will be used in the calculation.

Table H9

Proxy Transition Cost calculation: duct firing

		"To" configuration			
		UnitA_1	UnitA_2	UnitA-3	UnitA_4
	UnitA_1		$241	$16,265	$16,507
"From"	UnitA_2			$16,024	n/a
configuration	UnitA_3				$241
	UnitA_4				

If information is not provided for each configuration (even if the configuration is not startable), then the ISO will use data from the last available configuration. Refer back to Table H4 where data is missing for configurations 2 and 4. For data missing for configuration 2, the CAISO will use data from configuration 1 and for data missing for configuration 4 the CAISO will use data from configuration 3.

The consequence of not providing Resource Data Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for configurations 2 and 4 (and the CAISO using information from configurations 1 and 3, respectively), is a zero Transition Cost calculated for transition paths C1 to C2 and C3 to C4, reduced Transition Cost from C1 to C4, and an increase in transition cost from C2 to C3 because the C2 cost is now lower. Transitioning from C2 to C4 is not possible for this resource.

Table H10

Proxy Transition cCost calculation for missing data: duct firing

		"To" configuration		
		UnitA_1	UnitA_2	UnitA-3	UnitA_4
"From" configuration	UnitA_1		$0	$16,265	$16,265
	UnitA_2			$16,265	n/a
	UnitA_3				$0
	UnitA_4				

Step 3: SC bids under pProxy Cost option or registers tTransition Ceosts under Rregistered Ceost option

Transition costs are calculated under the same methodology as the MSG resource's selected start-up cost option. Scheduling Ceoordinators eligible the Proxy Cost and Registered Cost options can bid or register Transition Costs subject to the Proxy Cost Bid Cap and Registered Cost Bid Cap respectively. The Proxy Cost and Registered Cost Bid Caps are described in Step 2.for the registered cost option can register transition costs of up to 150 percent of projected transition costs. Scheduling coordinators under the proxy cost option can bid daily up to 125 percent of the calculated transition cost. A scheduling coordinator may not change its Registered Cost or Proxy Cost electionits registered cost or change to proxy cost for a minimum 30-day period. The Rregistered cCost option has slightly different inputs to the Pproxy Ccost option as explained in Attachment G.

H.2   Examples: Ttransition Ceosts for non-natural-gas fired resources

The CAISO uses the same three step process to calculate costs for tTransition cCosts for non-natural gas resources (thermal and non-thermal). The major differences are the cost components. Modeling of non-natural gas-fired resources can follow the generic set-up of modular turbines or machines (*e.g.*, pumps) or the relationship between combustion turbines and duct firing capacity.

For non-natural gas-fired resources (thermal and non-thermal), the CAISO system uses a single cost amount (in dollars) or a single cost amount per configuration (in dollars) in Sstart-uUp Ceosts instead of a heat input multiplied by the gas price. Other cost items remain largely the same except for different inputs used between the pProxy Cost and rRegistered Ceost options as described in Attachment G.

EXAMPLE 3: NON-NATURAL GAS-FIRED RESOURCES WITH DISTINCT TURBINES

Step 1: SC data submission

Table H11 below shows an example of the cost items included for a resource, Unit C, with distinct engines. Unit C has four configurations. Only configurations 1 and 3 are directly startable and all transition paths are possible except from 2 to 4. In this example, a new configuration entails starting a new turbine (or generically a discrete machine). Therefore, most of the costs and physical parameters approximately double from the first to the second configuration. The CAISO expects that all the columns in yellow are verifiable costs and/or verifiable physical parameters of the resource. For example, the CAISO should be able to verify the heat input, sStart-Uup energy, configuration Pmin, and sStart-uUp Ttime for each configuration. This resource has a greenhouse gas compliance obligation (or volunteered to be compliant). Each higher configuration should be presented as *cumulative* costs or amounts from the lower configurations.

The non-highlighted columns are costs that remain the same for all configurations and are provided by the CAISO, such as the greenhouse gas compliance cost.

Table H11

Proxy Start-uUp Ceost calculation: non-natural gas-fired, turbine-based and thermal

Config ID	Configuration	Non-nat gas start cost ($)	Heat input (MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-uUp energy (MWh)	Elec. price index ($/MWh)
UnitC_1	1 – Startable	$1,000	1,500	$12.00	0.0530752	$10,000	200	60	$0.38	20	$1.00
UnitC_2	2 – NOT startable	$2,000	2,300	$12.00	0.0530752	$20,000	250	60	$0.38	20	$1.00
UnitC_3	3 – Startable	$3,000	3,400	$12.00	0.0530752	$35,000	400	60	$0.38	20	$1.00
UnitC_4	4 – NOT startable	$4,000	4,400	$12.00	0.0530752	$42,000	450	60	$0.38	20	$1.00

Table H11 assumes that the CAISO has enough information from the Scheduling Coordinator to calculate each Proxy sStart-uUp and indirect Proxy Sstart-uUp Ceost. As noted above, if information is missing to calculate configuration level data (aside from the lowest configuration) the CAISO may use information from the next lowest configuration to backfill. Table H12 below provides an illustrative example where the data in yellow (for the startable configurations) has been provided but the data in orange (for the indirect start-ups) has not be provided but is instead copied from the next lowest configuration. As discussed in greater detail later, not providing Resource Data Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for certain sStart-uUp or indirect sStart-Uup Ceosts may result in a lower or zero tTransition Ceost.

Table H12

Proxy Start-Uup and indirect Proxy Sstart-Uup Ceost calculation for missing data: non-natural gas-fired turbine-based and thermal

Config ID	Configuration	Non-nat gas start cost ($)	Heat input (MMBtu)	GHG price	GHG emission rate	Major maint. adder	Config Pmin	Config startup time	GMC	Start-Up energy (MWh)	Elec. price index ($/MWh)
UnitC_1	1 – Startable	$1,000	1,500	$12.00	0.0530752	$10,000	200	60	$0.38	20	$1.00
UnitC_2	2 – NOT startable	$1,000	1,500	$12.00	0.0530752	$10,000	200	60	$0.38	20	$1.00
UnitC_3	3 – Startable	$3,000	3,400	$12.00	0.0530752	$35,000	400	60	$0.38	20	$1.00
UnitC_4	4 – NOT startable	$3,000	3,400	$12.00	0.0530752	$35,000	400	60	$0.38	20	$1.00

Step 2: CAISO uses submitted data to calculate tTransition Ceosts bid caps

Table H13 reproduces the same inputs as Table H11. The last column in blue calculates the total Proxy sStart-Uup or indirect Proxy Sstart-Uup eCost:

Proxy Start-Uup Cost = (Non-natural gas sStart-Up Ceost) + (Start-Up Energy x Energy Price Index) + (Pmin x Start-Up Time Period in min / 60 min/hour x GMC adder / 2) + (Heat Input x GHG Emission Rate x GHG Allowance Price) + Major maintenance adder

Table H13

Proxy Start-Uup Ceost calculation: non-natural gas-fired, turbine-based and thermal

Config ID	Configuration	Non-nat gas start cost ($)	Heat input (MMBtu)	GHG price	GHG emission rate	Major maint. Adder	Config Pmin	Config startup time	GMC	Start-Up energy (MWh)	Elec. price index ($/MWh)	Cost
UnitC_1	1 – Startable	$1,000	1,500	$12.00	0.0530752	$10,000	200	60	$0.38	20	$1.00	$12,104
UnitC_2	2 – NOT startable	$2,000	2,300	$12.00	0.0530752	$20,000	250	60	$0.38	20	$1.00	$23,533
UnitC_3	3 – Startable	$3,000	3,400	$12.00	0.0530752	$35,000	400	60	$0.38	20	$1.00	$40,262
UnitC_4	4 – NOT startable	$4,000	4,400	$12.00	0.0530752	$42,000	450	60	$0.38	20	$1.00	$48,908

If the resource is non-thermal, the only difference is the elimination of the greenhouse gas cost calculation. The formula would be the same for a non-natural gas thermal resource without a greenhouse gas obligation.

Proxy Start-uUp Cost = (Non-natural gas Sstart-Up Ceost) + (Start-Up Energy x Energy Price Index) + (Pmin x Start-Up Time Period in min / 60 min/hour x GMC adder / 2) + Major maintenance adder

At this time the ISO cannot directly reflect multiple fuels for the same resource.

Table H14 shows the calculated Proxy Ttransition Ceosts based on the Sstart-Uup and indirect Proxy Sstart-Uup Ceosts shown in Table H13. The calculated Proxy tTransition Ceosts are equal to 100 percent of Ttransition Ceosts (i.e. no headroom scalar applied). All of the tTransition Ceosts are calculated as the difference between the "To" configuration and "From" configuration Proxy Sstart-Uup and indirect Proxy Sstart-uUp Ceosts. For example, the sStart-Uup Ceost for

configuration 1 is $12,104 and for configuration 2 is $23,533 as shown in the last column of Table H13. If the resource transitions from configuration 1 to 2, it would incur an additional $11,429 in Transition Costs shown in the first row, second column of Table H9, which is the difference between the two configuration Start-Up Costs. This unit cannot transition from configuration 2 to 4 so this transition path is not calculated. When the resource stays in configuration 1 it incurs only the Proxy Start-Up Cost for configuration 1. After it transitions, it would only incrementally incur the Proxy Transition Cost to configuration 2. There are no Transition Costs from a higher to a lower configuration or if the resource stays in the same configuration. As a simplifying assumption, if each configuration has more than one segment, the highest priced segment will be used in the calculation.

Table H14

Proxy Transition Cost calculation: non-natural gas-fired, turbine-based and thermal

		"To" configuration			
		UnitC_1	UnitC_2	UnitC_3	UnitC_4
"From" configuration	UnitC_1		$11,429	$28,158	$36,804
	UnitC_2			$28,158	n/a
	UnitC_3				$8,646
	UnitC_4				

Scheduling cCoordinators eligible for the rRegistered Ccost option can register Transition Ccosts of up to 150 percent of calculated Proxy Transition Ccosts. A scheduling coordinator may not change its election of Rregistered Ccost or change to pProxy Ccost for a minimum 30-day period.

If information is not provided for each configuration (even if the configuration is not directly startable), then the ISO will use data from the last available configuration.   Refer back to Table H12 where data is missing for configurations 2 and 4. For data missing for configuration 2, the CAISO will use data from configuration 1 and for data missing for configuration 4 the CAISO will use data from configuration 3.

The consequence of not providing Resource Data Template values for the parameters used in Proxy Start-Up Costs or Proxy Transition Costs data for configurations 2 and 4 (and the CAISO using information from configurations 1 and 3, respectively), is a zero Transition Cost calculated for transition paths C1 to C2 and C3 to C4, reduced Transition Cost from C1 to C4, and an increase in Transition Cost from C2 to C3 because the C2 cost is now lower. Transitioning from C2 to C4 is not possible for this resource.

Table H15

Proxy Transition Cost calculation for missing data: non-natural gas-fired, turbine-based and thermal

	"To" configuration			
	UnitA_1	UnitA_2	UnitA-3	UnitA_4
"From" UnitA_1		$0	$28,158	$28,158
configuration UnitA_2			$28,158	n/a
UnitA_3				$0
UnitA_4				

> Step 3: SC bids under proxy or registers transition costs under registered cost option

Transition Costs are calculated under the same methodology as the MSG resource's selected Start-Up Cost option. Scheduling Coordinators eligible for the Registered Cost option ~~can~~ must register Transition Costs of up to 150 percent of ~~projected~~ Proxy Transition Costs. Scheduling Coordinators under the Proxy Cost option can bid daily up to 125 percent of the calculated transition cost plus a transition cost opportunity cost ~~adder~~ if applicable. A scheduling coordinator may not change its election of Registered Cost or ~~change to p~~Proxy Cost for a minimum 30-day period. The Registered Cost option has slightly different inputs to the Proxy Cost Option as explained in Attachment G.