

## Modeling Generation Senior Task Force Stakeholder Requirements

General	
Design Component	Details
Implementation	<ul style="list-style-type: none"> <li>• Day-Ahead Solution time 2 hours or less.</li> <li>• Real Time/SCED Solution Time less than 3 minutes</li> <li>• IT SCED solution time less than 5 minutes</li> <li>• A configuration must be a subset of one unit ID only and a configuration will have all of the same characteristics as a unit today (One market unit ID per combined cycle unit)</li> <li>• Pseudo models will not be created</li> <li>• Ability to select amount of flexibility offered despite modeling details</li> </ul>
Sequencing	<ul style="list-style-type: none"> <li>• Any change in a unit's operating mode that requires a hold time/transition time would have to be modeled as a separate configuration</li> <li>• PJM can start up or shut down into/out of any valid configuration</li> </ul>

\*\*Items in Purple are possible customizations

\*\*Items in Red are confirmed customizations

Near Term	
Design Component	Details
<b>Day Ahead</b>	
<p>DA modeling of additional segments on the Energy Offer Curve</p>	<ul style="list-style-type: none"> <li>• Startup and No-load costs may be differentiated hourly</li> <li>• <b>Min run times may be differentiated hourly.</b></li> </ul>
<p>DA Modeling of Hourly Differentiated Ramp Rate Curve</p>	<ul style="list-style-type: none"> <li>• Allow Market Participants to submit hourly differentiated ramp rates for resources in both the Day Ahead and Real Time Markets.</li> <li>• Allow Market Participants the ability to change a resource's ramp rate Intraday to better manage resource configuration changes.</li> <li>• Provide Market Participants the ability to improve alignment with existing intraday offer logic rules that allow updates to be submitted up to 65 minutes prior to operating hour.</li> </ul>
<p>DA Modeling of Soak Time</p>	<ul style="list-style-type: none"> <li>• Hot/Warm/Cold Soak Times (hours) will be entered into Markets Gateway for each schedule. Market Gateway will also allow the entry of the unit's expected MWh for each hour.</li> <li>• The unit's DA award will reflect the market participant's submitted values for the soak time intervals.</li> </ul>
<b>Real Time</b>	
<p>RT modeling of additional segments on the Energy Offer Curve</p>	<ul style="list-style-type: none"> <li>• Startup and No-load costs may be updated hourly by the participant at least 65 minutes prior to start of operating hour reflecting the planned resource configuration</li> <li>• The ability to update startup and no-load costs is only available for units that elected cost-based startup and no-load.</li> <li>• Updates to resource min-run times will not be reflected in dispatch for already committed units. PJM Dispatch systems will maintain the original min-run time from the time of resource commitment. In addition, min-run times cannot be updated for committed hours, only non-committed hours.</li> </ul>
<p>RT Modeling of Hourly Differentiated Ramp Rate Curve</p>	<ul style="list-style-type: none"> <li>• Allow Market Participants to submit hourly differentiated ramp rates for resources in both the Day Ahead and Real Time Markets.</li> <li>• Allow Market Participants the ability to change a resource's ramp rate Intraday to better manage resource configuration changes.</li> <li>• Provide Market Participants the ability to improve alignment with existing intraday offer logic rules that allow updates to be submitted up to 65 minutes prior to operating hour.</li> </ul>

Long Term	
Design Component	Details
<b>Day Ahead</b>	
DA Modeling of Start-Up Time	<ul style="list-style-type: none"> <li>• <b>The Startup Time for each significant component/configuration of the plant, including megawatt quantity will be modeled.</b></li> <li>• The model should ensure that individual component/configuration schedules are simple to submit.</li> </ul>
DA Modeling of Start-Up Cost	<ul style="list-style-type: none"> <li>• Start costs for additional operational states and configurations – additional generators, duct burners, etc. will be allowed and reflected in resource offers.</li> <li>• Start cost for Combined Cycles may need further investigation/discussion</li> </ul>
DA Modeling of No-Load Cost	<ul style="list-style-type: none"> <li>• No-Load Costs should have the ability to be modeled for different states/configurations</li> </ul>
DA Modeling of Fuel Switching Cost	<ul style="list-style-type: none"> <li>• <b>Create the ability to model fuel type or source switching using transition matrices and schedule switching and availability</b></li> </ul>
DA Modeling of Soak Time	<ul style="list-style-type: none"> <li>• Hot/Warm/Cold Soak Times (hours) will be entered into Markets Gateway for each schedule. Market Gateway will also allow the entry of the unit's expected MWh for each hour.</li> <li>• The unit's DA award will reflect the market participant's submitted values for the soak time intervals.</li> </ul>
DA Transition Timing	<ul style="list-style-type: none"> <li>• The model has the capability to capture timing for transitions</li> <li>• The DA Market expects to use the transition timing</li> <li>• Transition timing is not state dependent.</li> </ul>
DA Transition Cost	<ul style="list-style-type: none"> <li>• <b>The model has the ability to handle both cost based and priced based transitions</b></li> </ul>
DA Modeling of Operating Modes/Configurations (Duct Burners, Sprays, Peak Firing, etc.)	<ul style="list-style-type: none"> <li>• Ability to model individual components including unique operating parameters</li> <li>• Identify decision points to commit duct firing or other configuration/operating mode options.</li> <li>• Ability to recognize operating modes/configurations (switching from 3x1 to 2x1).</li> <li>• Identify the process to incrementally commit or de-commit stages of a combined cycle unit.</li> </ul>
Day Ahead Scheduling Reserve Eligibility	<ul style="list-style-type: none"> <li>• <b>PJM's model will have the capability to model the Startup Time for multiple fueled units. Eligibility of DASR during transition times is reflective of available MWs and timing.</b></li> </ul>
DA modeling of additional segments on the Energy Offer Curve	<ul style="list-style-type: none"> <li>• Startup and No-load costs may be differentiated hourly.</li> <li>• <b>Min run times may be differentiated hourly.</b></li> </ul>
DA Modeling of Hourly Differentiated Ramp Rate Curve	<ul style="list-style-type: none"> <li>• Allow Market Participants to submit hourly differentiated ramp rates for resources in both the Day Ahead and Real Time Markets.</li> <li>• Allow Market Participants the ability to change a resource's ramp rate Intraday to better manage resource configuration changes.</li> <li>• Provide Market Participants the ability to improve alignment with existing intraday offer logic rules that allow updates to be submitted up to 65 minutes prior to operating hour.</li> </ul>

Long Term (cont.)	
Design Component	Details
<b>Real Time</b>	
RT Modeling of Start-Up Time	<ul style="list-style-type: none"> <li>• <b>PJM has the capability to model start up time for multiple fueled units.</b></li> <li>• <b>For PJM to model the Startup Times for different plant components, configurations, and states.</b></li> </ul>
RT Modeling of Start-Up Cost	<ul style="list-style-type: none"> <li>• Start costs for additional operational states and configurations – additional generators, duct burners, etc. – will be allowed and reflected in resource offers.</li> <li>• Startup costs will be associated with the current unit configuration/state.</li> <li>• Start cost for Combined Cycles may need further investigation/discussion</li> </ul>
RT Modeling of No-Load Cost/Incremental Offer Curve	<ul style="list-style-type: none"> <li>• No-Load Costs/Incremental Offer Curve should have the ability to be modeled for different states/configurations</li> </ul>
RT Modeling of minimum run time for each step (additional CTs, duct, hydro units, etc.)	<ul style="list-style-type: none"> <li>• PJM can start up or shut down into/out of any valid configuration.</li> <li>• Every operating mode/configuration has the same parameters that a market unit has.</li> <li>• <b>Respect min run time only for downward transitions</b></li> </ul>
RT Modeling of Operating Modes/Configurations (Duct Burners, Sprays, Peak Firing, etc.)	<ul style="list-style-type: none"> <li>• Create the ability to optimize overlapping configurations assuming configurations for CCs are not limited to just number of CTs online.</li> <li>• RT Modeling of minimum run time for each step (additional CTs, duct, hydro units, etc.).</li> <li>• Any change in a unit's operating mode that requires a hold time/transition time would have to be modeled as a separate configuration.</li> <li>• Any change in a unit's operating mode that requires a hold time/transition time would have to be modeled as X number of fixed segments of output or ramp rate [in the incremental offer curve].</li> </ul>
RT Transition Timing	<ul style="list-style-type: none"> <li>• Any change in a unit's operating mode that requires a hold time/transition time would have to be modeled as a fixed output or ramp rate [in the incremental offer curve].</li> <li>• PJM will reflect back SE MWs during transition periods</li> <li>• Transition timing is not state dependent.</li> </ul>
RT Transition Cost	<ul style="list-style-type: none"> <li>• <b>The model has the ability to handle both cost based and priced based transitions</b></li> </ul>
RT modeling of additional segments on the Energy Offer Curve	<ul style="list-style-type: none"> <li>• Increase the number of segments on the energy offer curve from 10 to 20 for all resources.</li> </ul>
RT Modeling of Hourly Differentiated Ramp Rate Curve	<ul style="list-style-type: none"> <li>• <b>Allow Market Participants to submit hourly differentiated ramp rates for resources in both the Day Ahead and Real Time Markets.</b></li> <li>• Allow Market Participants the ability to change a resource's ramp rate Intraday to better manage resource configuration changes.</li> <li>• Provide Market Participants the ability to improve alignment with existing intraday offer logic rules that allow updates to be submitted up to 65 minutes prior to operating hour.</li> </ul>
RT Modeling of Price/MW pairs	<ul style="list-style-type: none"> <li>• <b>Allow Market Participants to update hourly differentiated price/MW pairs in real-time.</b></li> </ul>

Long Term (cont.)	
Design Component	Details
<b>Modeling Enhancements</b>	
Transition Sequence Optimization	<ul style="list-style-type: none"> <li>• Hold periods and operation mode transitions which can be dynamic based on ambient temperature conditions - Check with GE</li> <li>• includes fuel switching (pipeline/dual fuel)</li> </ul>
Modeling of Multiple Fuel Optimization and Utilization	<ul style="list-style-type: none"> <li>• PJM optimizes available schedules for dispatch within the current construct</li> <li>• Each configuration will now have: 1 price schedule, 1 PLS schedule, *12 cost schedules</li> <li>• 1 price based schedule per fuel cost based schedule - requires additional discussion</li> </ul>
Modeling of Fuel Market and Supply Limitations	
Features to Model Resource Flexibility	<ul style="list-style-type: none"> <li>• Modeling pipeline switching</li> <li>• Modeling multiple fuel switching</li> <li>• Modeling firm/non-firm fuel transport and supply from each pipeline per generator (if possible)</li> <li>• Commercial implications of flexibility</li> </ul>
<b>Reserves</b>	
Synchronized Reserve Eligibility/Modeling	<ul style="list-style-type: none"> <li>• Capture the interactions between synchronized reserve and transitions in RT.</li> <li>• Capture time for transitions.</li> <li>• Capability to model units in transition to provide Synchronized Reserve</li> <li>• Capability to model opting out to provide synchronized reserves during transition</li> <li>• Capability to accurately represent expected output during transition in calculating synch reserves</li> </ul>
Non-Synchronized Reserve Eligibility	<ul style="list-style-type: none"> <li>• Resources must have the capability to provide a continuous 10 minute response</li> <li>• Add modeling capability in case 30 minute reserve product is developed</li> </ul>
<b>Telemetry</b>	
Telemetry Requirements	<ul style="list-style-type: none"> <li>• Telemetry should reflect the current configuration of unit.</li> <li>• Requires additional data (ICCP/Markets Gateway) points for unit configurations and when the unit is in a transitioning state</li> </ul>
<b>Other</b>	
Regulation Capability	<ul style="list-style-type: none"> <li>• Capability to model resource providing regulation during transition</li> <li>• Regulation Capability is configuration dependent</li> </ul>
Unit Commitment Rules and Practices	<ul style="list-style-type: none"> <li>• PJM optimizes unit commitment based on offers with multiple configurations.</li> <li>• Time to dispatch between operation mode transitions which can be dynamic based on ambient temperature conditions or notification time.</li> </ul>
Ability to model individual components including unique operating parameters	<ul style="list-style-type: none"> <li>• Definitions on new operating parameters and changes to existing operating parameters to reflect configuration modeling</li> </ul>
Configuration Availability Management and Outage Reporting	<ul style="list-style-type: none"> <li>• Ability to change availability of configurations and operating modes in RT or Day Ahead.</li> <li>• Gens to provide availability status of configurations</li> <li>• Ability for the market model reflect configuration outages for generation resources in eDart and Markets Gateway and link to EMS</li> </ul>