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## **Changes to 2028 ADS PCM from Phase 1 V1.0 to V2.2 and Phase 2 V2.0**

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July 18, 2019

## Phase 1 ADS PCM

“Phase 1” of the 2028 Anchor Data Set (ADS) includes the transmission topology and resources from the 2028 Heavy Summer (28HS1) Power flow. The only topology changes from the 28HS1 to the Phase 1 ADS PCM are changes that were submitted to both the base case modification process and the PCM. Other data is added so that the PCM can run. The other data includes heat rates, hourly load and resource profiles, wheeling rates, etc.

As examples of other data applied to create a PCM from a PF, consider:

- **Heat Rates:** Heat rates apply to thermal units and give the program blocks of capacity for each unit. For example, suppose a combustion turbine’s capacity is 100 MW. It might have three operational blocks with a minimum of 50 MW and two additional blocks of 25 MW each. Each block could have a heat rate of, for example, 10, 9, and 8 MMBTU/ MW, respectively. The PCM model then knows how much gas will be used in each operating block and therefore the cost of operating the different blocks.
- **Hourly Profiles:** Hourly profiles include the hourly energy for each area load area and hourly units. The shapes are fixed for the entire 8,760 hours of the model. Hourly loads are created using the Loads and Resources submittal from each BA. Hourly units include wind, solar, and some hydro plants. The wind and solar profiles are developed with data from NREL from 2009. A Python script was developed by PNNL that created the hourly profiles. The hydro profiles are created from historic data collected by Kevin Harris.
- **Wheeling Rates:** Wheeling rates are derived from work done on past Common Cases. Wheeling rates are charges for transferring energy between entities.

## Changes applied to 2028 ADS PCM Phase 1 V1.0 to create V1.2

The main changes made between V1.0 and V1.2 were generation changes found when the round-trip generation verifications were performed. Demand Response was also implemented into the case using the profiles created by LBNL. WECC staff identified a couple of issues with the PDCI and IPP with loop flows and wheeling being applied to PDCI. See the details below in the table.

Change Case Name	Description of Change
2018-7-2_DR_PaloVerdeCap_TB.mdb	The 2028 demand response shapes that were created by LBNL were added. The demand response shapes represent non-firm load that is interrupted due to locational marginal price indicators. Palo Verde Capacity was also updated.
2018-7-2_FuelEmissionRate.csv	Emission rates (lb/MMBTU) were missing for coal units in the case. The emission rates were added.
2018-7-2_PancakeWheeling edits_Diff.mdb	Ownership of one pole of the pacific DC intertie (PDCI) was changed from LDWP to Southern California Edison (CISC).

Change Case Name	Description of Change
	This corrected wheeling charges being applied since CISC owns that portion of the power coming from PDCI.
2018-7-10 DeleteAddedGensToADS_JJ.mdb	Generators were removed from case that were not in the original 28HS1 PF.
2018-7-10_GenEditstoV1.0_Stan-BK.Diff.mdb	General generator edits made such as changing commission dates, generator IDs, and status set to true to make the unit available for dispatch. Intermountain CC, Coolwater CC, HurricaneCityPwr.
2018-7-10 HourlyResourceAddShapes.csv	GridView was deleting shapes if the unit wasn't being used. This was corrected through adding the "None" shape. This change was used only to correct errors while building the PCM case.
2018-7-16 RoundTripCorrections_TB.mdb	For generators to export out of GridView into PSLF format, the status needed to be "On." Generators that were retired had been changed to status "Off." Their status was set to "On."
2018-7-17_Gen Changes.Diff- BK & Stan.mdb	Sub types for Alberta cogens were updated for reporting. Heat rates for several units were updated.
2018-8-2_IPP-CC.mdb	Commission dates for Intermountain CC units were updated so that they would dispatch. Retirement dates for the Intermountain coal units were updated to retire in 2025.
2018-8-2 RT_Add65408unit_Diff_JJ.mdb	HurricaneCityPwr7 was modeled on an incorrect bus that wasn't connected to the system. This unit was placed on the correct bus and made available for dispatch.
20180626 DCbal InterFaces Diff.mdb	To avoid loop flows, a charge was applied to the DC lines IPP and PDCI.

### Changes applied to 2028 ADS PCM Phase 1 V1.2 to create V2.0

There were many iterative changes between V1.2 and V2.0. Most of these were error corrections such as removing duplicate generators but also included several changes to the way generators were modeled. Within the changes below were also changes to fuel costs which were decided in PDWG.

Change Case Name	Description of Change
2018-8-2 NavajoRetireDiff_JJ_Updated.mdb	Navajo 2 and 3 retired with a retirement date of 12/31/2019. Units are off in the power flow.
2018-8-14 BPA_Line_BrothersHamptonChristmas_Diff_JJ.mdb	This was a base case modification submitted by the owner and applied to the PCM case.



Change Case Name	Description of Change
2018-9-10 EFOR_ADSV1.2_JJ&BK.mdb	The forced outage rates were updated for many coal units. This parameter controls the how many forced outages occur for generators.
2018-9-10 Scattergood_Haynes_Diff_JJ2.mdb	Haynes retirement date was updated to be available for dispatch in 2028. Scattergood heat rates and capacities were updated. Heat rates control the amount of fuel per MW produced in blocks of capacity.
2018-9-12 Beacon_BonnybrookSolar_confure as_hourly_resource_correct_capacity _TB.mdb	Beacon and Bonnybrook solar plants were configured as thermal resources. Updated the plants to be the correct capacity and changed to solar plants following a fixed profile.
2018-9-12 Delete_HyattPumpedHydro duplicate units_TB.mdb	There were duplicate Hyatt pump hydro units in the case, so staff deleted the duplicates.
2018-9-20 Coal Prices updated to DS approved prices_TB.mdb	Coal prices were not applied to the correct units. This was updated in the case to give the correct coal prices to the correct machines.
2018-9-20 NWTopologyDiff_JJ.mdb	BPA made an error in the transmission topology on putting in lines in the Klamath Falls area. This change included modifying line impedances and capacitor setting, and removing two lines that should not have been in the case.
2018-9-24 Captjack- Tracy_500kV_BANC_Diff_JJ.mdb	Bus ownership was incorrectly assigned to PACW and PG&E. The ownership was changed to BANC/SMUD.
2018-9-27 126 Dispatch shapes updated to match commitment shapes_multipliers updated_TB.mdb	126 hourly units, wind and solar, had discrepancies between the dispatch and commitment shapes and multipliers. Corrected to be consistent.
2018-9-27 CoalPricesUpdated_75%_TB.mdb	It was determined that coal prices should be discounted to represent the net burner-tip price and not both fixed and variable prices.
2018-10-3_Antelope Nuclear_12 units & Load-Wind- Solar_Implemented_BK.mdb	The Antelope Nuclear plant was submitted as one aggregated unit. For this plant to operate as it is designed it needed to be split it up into the twelve 50 MW units.
2018-10-3_SDGE Carlsbad battery_ChangeCase by Yi Zhang.mdb	Carlsbad battery was not modeled as a battery. This change allowed the unit to operate as a battery.
2018-10-11_Avoid Hyrdo spillage outside CA-BK.mdb	The spillage flag was unchecked for many hydro units outside of California. The flag was changed so that energy could be used and would not go to waste.
2018-10-11_Antelope maintenance updated to 6 units per year (one unit in two months)-BK.mdb	After talking to UAMPS, we found that every two months one unit will be down for refueling and other planned maintenance. The case was modeled to represent this in the model.



Change Case Name	Description of Change
2018-10-12 Branch_RatingNTTGimport_JJ.csv	Branch ratings were updated to reflect the summer and winter ratings for several buses in the northwest.
2018-10-12 KH_updates_InterfaceBranchAssignment.csv	Branch assignments for WECC paths were updated to properly reflect the path rating catalog. Paths 3, 4, 5, and 73 were affected.
2018-10-16 Unpark_Grapeland_CTRPKGEN_PeakingUnits.mdb	Two units, Grapeland and CTRPKGEN, had been placed on an unused bus. Placed the units back into service to be able to be dispatched.
2018-10-17 HourlyResource_MultiplierShapeCorrections.mdb	Multipliers were incorrect on many hourly resources, wind and solar, and were corrected. The multipliers represent the capacities of hourly units.
2018-10-17 Hyatt_Thermalito_Emission_BranchMonitoring-Jon-BK-Stan.mdb	The Thermalito hydro units were changed from pump storage to traditional hydro units. A software error that adds additional emission groups to the database was corrected. Branches were set to be monitored for reporting.
2018-10-18 CorrectFuelCosts.mdb	Fuel costs for fuels not specific to an area, such as bio fuels, petroleum, uranium, etc., were updated for the 2028 case.
EEI_Format_Data_Load_withAAEE_CEC_2028[09].csv	Additional achievable energy efficiency (AAEE) in a portion of the California loads. AAEE decreases the load and was not initially included in the hourly load profiles. AAEE was applied to all load profiles in California.
x0801a_Misc_Fixes_HY_MoVarOnly.mdb	Hydro generation variables such as monthly energy and minimum/maximum capacity tables were incorrect, and units were underperforming. The variables were corrected.

### Changes applied to 2028 ADS PCM Phase 1 V2.0 to create V2.1.1

Several changes were made including deleting duplicates, some topology changes and wheeling rates in the northwest.

Change Case Name	Description of Change
2018-11-27_all nuclear must run.mdb	Nuclear units were made must run which means that the units run at least at minimum generation except for forced outage and maintenance.
2018-12-7_Alberta coal conversions and Stan Duplicate edits-BK & Stan.mdb	Several units in Alberta had been converted to combined cycle and should have been converted to natural gas steam units. There were also a few duplicates that were removed from the case.
2018-12-7_DuplicatesFixed_JJ.mdb	There were a few duplicated units found and deleted.
2018-12-10 AB_GenEdits_RemoveDuplicates_TB.mdb	There were a few duplicated units found and deleted.



Change Case Name	Description of Change
2018-12-11 EPE_TopoChanges_JJ.mdb	Line topology was modified in the El Paso Electric (EPE) area. This was also submitted to the base case modification.
2018-12-12_EPE_Changes_JJ.mdb	General EPE changes were made. Such things as capacities of units and names of units according to EPE.
ADS 2028 V2.0_fixed Wheeling Rates.mdb	Wheeling rates in the Northwest were modified to have a zero charge. The wheeling rates between areas in the Northwest were determined to be zero according to contracts.
CG_v2.00_1102a_Klondike III 2 Fix.mdb	Klondike wind units had the incorrect capacities and multipliers to follow the hourly profiles.

### Changes applied to 2028 ADS PCM Phase 1 V2.1.1 to create V2.2

Wheeling rates were found to not include the complete set of changes agreed upon, thus were updated. Thermal temporal data was deleted and hourly wind shapes for CISO were updated.

Change Case Name	Description of Change
2019-1-10 Phase1_CISOwindShapes.mdb	Several wind farms in California had 40-60% capacity factors. Historic capacity factors had been approximately 20-30%. CISO produced new profiles based off the same 2009 data that had more reasonable capacity factors.
2019-1-17 RemoveThermalTemporalData.mdb	Temporal data for thermal units had derates for summer, station service loads, etc. The derates were also applied through changing the heat rates previously. Temporal data was removed to avoid duplication.
2019-1-17 UpdateWheeling_TB.mdb	Wheeling changes in the NW to zero were not fully applied in V2.1.1, they were updated in this change.
CG_0717a_Rock_Island_Hydro.mdb	Monthly Maximum Capacities of the Rock Island hydro plant in NW were much lower than they were supposed to be. They were updated to actual data.

## Phase 2 PCM

Phase 2 PCM diverges from Phase 1 ADS PCM and therefore the original 28 HS1 power flow. All phase 2 changes were changes to the generation and included transmission topology only to integrate resources. Phase 2 started with Phase 1 V2.2 and the following generation changes were applied.

### Resource changes applied to 2028 ADS PCM Phase 2 V1.2

All changes were done with feedback the owner of the data. There was 3,276 MW of thermal generation retired and 4,906 MW of generation added. For details see the table below.



California 50% RPS resources are planned to be added once the data can be obtained from the CAISO.

Retirements		
State	Technology	Capacity (MW)
Arizona	Steam - Gas	150
	<b>Arizona Total</b>	<b>150</b>
California	Combined Cycle	161
	Steam - Gas	691
	<b>California Total</b>	<b>852</b>
Colorado	Steam - Coal	660
	<b>Colorado Total</b>	<b>660</b>
Nevada	Steam - Coal	522
	<b>Nevada Total</b>	<b>522</b>
Wyoming	Steam - Coal	762
	Steam - Gas	330
	<b>Wyoming Total</b>	<b>1,092</b>
<b>WECC Total</b>		<b>3,276</b>

Additions		
State	Technology	Capacity (MW)
Arizona	Internal Combustion	189
	<b>Arizona Total</b>	<b>189</b>
Colorado	SolarPV-Tracking	707
	WT-Onshore	969
	<b>Colorado Total</b>	<b>1,676</b>
New Mexico	WT-Onshore	215
	SolarPV-Tracking	50
	<b>New Mexico Total</b>	<b>265</b>
Nevada	Combined Cycle	121
	SolarPV-Tracking	1,001
	Battery Storage	100
	<b>Nevada Total</b>	<b>1,222</b>
Wyoming	WT-Onshore	570
	<b>Wyoming Total</b>	<b>570</b>
Montana	WT-Onshore	460
	SolarPV-Tracking	80
	<b>Montana Total</b>	<b>540</b>
Oregon	WT-Onshore	60
	SolarPV-Tracking	199
	<b>Oregon Total</b>	<b>259</b>
Utah	WT-Onshore	79
	SolarPV-Tracking	106
	<b>Utah Total</b>	<b>185</b>
<b>WECC Total</b>		<b>4,906</b>



## CAISO 50% Renewable Portfolio Standard (RPS) resource changes

Resources were removed, modified, or added to align with the CAISO 2018/2019 Transmission Planning Process 2028 Economic Planning Study. Only resources in California were modified.

Parked/ Turned Off		Modified - Unparked		Added	
Technology	Capacity (MW)	Technology	Capacity (MW)	Technology	Capacity (MW)
Combined Cycle	562	Battery Storage	96	Battery Storage	213
Combustion Turbine	290	Hydro	9	Bio-Combined Cycle	77
Concentrated Solar Power	594	Bio-Internal Combustion	54	Bio-Combustion Turbine	27
SolarPV-NonTracking	139	SolarPV-NonTracking	6	SolarPV-NonTracking	837
SolarPV-Tracking	1,363	SolarPV-Tracking	216	SolarPV-Tracking	4,156
WT-Onshore	106	<b>WECC Total</b>	<b>381</b>	WT-Onshore	751
<b>WECC Total</b>	<b>3,053</b>			<b>WECC Total</b>	<b>6,060</b>

## Changes applied to 2028 ADS PCM Phase 2 V1.2 to create Phase 2 V2.0

Change Case Name	Description of Change
<b>2019-2-22</b> <b>Fix_Demand_Response.mdb</b>	Demand Response units for EPE, LDWG, PACW, PAWY, PNM, TEPC, and WACM had not initially been added. The units were added with their associated shapes.
<b>2019-3-14</b> <b>Path14RatingSetToMatchPRC.mdb</b>	Path 14 rating was set as if the Boardman to Hemmingway line was in the case. This line wasn't in the case so the line rating was reverted back to match the current rating in the Path Rating Catalog.
<b>2019-4-26</b> <b>CAISO_50perc_RPS_Portfolio.mdb</b>	The 50% RPS CAISO portfolio was added to the Phase 2 case. 3,091 MW were parked and made unavailable and 6,807 MW were added. See details above.
<b>2019-5-2 Add Delaney to Col River to Paths 46 &amp; 49.mdb</b>	Delaney to Colorado River 500 kV line added to Path 46 WOR and Path 49 EOR. Increase Path 46 rating from 11200 to 12250 and Path 49 rating from 10100 to 10650
<b>2019-5-20 PhaseShifterEditsDiff.mdb</b>	Change settings for Phase Shifters: MW min and max range as well as price for angle shift was changed.
<b>2019-6-7 UpdateMaintenance.mdb</b>	Update maintenance to not occur during summer hours in summer peaking areas. Moved maintenance in the Northwest from fall to spring.





<b>2019-5-23 Disaggregate CCCTs.mdb</b>	Many to one CCCTs were made multiple one to one CCCTs. Heat rates were updates for several units in EPE area.
<b>2019-5-30 Add Broadview Grady Generators.mdb</b>	Add in Broadview and Grady Wind Units totaling ~500 MW in New Mexico. The units were not in the power flow yet. They are connected at Blackwater.
<b>2019-6-4 VEA_branch_rating.mdb</b>	Update rating of branch 19012 - 189040. The original rating of 286.8 MVA / 382.4 MVA is being upgraded to 926 MVA / 1195 MVA and will be in service in 2020. This was upgraded due to overloading found in the CAISO PCM model.
<b>2019-6-12 DCI Corrections.mdb</b>	All DC interties were not in the case. Added the missing units and added their associated shapes from 2012 historic data.
<b>2019-6-14 Aeolus South Path.mdb</b>	Aeolus South path direction is not correct. Reverse direction.
<b>2019-6-17 Add Anticline to Populus 500 kV to Path19.mdb</b>	Add Anticline to Populus 500 kV line to Path 19, Bridger West. The rating had been changed but the line not added.
	Spin Reserve was activated in simulation settings.

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