WECC

Data Development and Validation Manual (DDVM)

Version 3.0

Production Cost Data Subcommittee (PCDS)

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1. Introduction

The Anchor Data Set (ADS) case represents the expected loads, resources and transmission topology 10 years in the future for a given reference year. It is a compilation of load, resource and transmission topology information used by Western Planning Regions (WPR) and International Planning Regions (IPR) in their regional transmission plans.

The ADS includes two parts: a power flow (PF) case and a Production Cost Model (PCM) case. This Data Development and Validation Manual documents the processes used to develop and validate data used in the PCM case that is not used in the PF case, or that is used in the PF case but in a different way than in the PCM case.

WECC uses ABB GridView (GridView or GV) as its ADS PCM tool. The case's dataset is stored and maintained in GridView, which is an energy market simulation and analysis software tool distributed by ABB. GridView uses a Microsoft Access database file (GV Case Template.mdb) and numerous text-based shape files (*.DAT) to store the case information.

The purpose of this document is to describe the processes used to create the ADS PCM in GridView. It does not include details of specific data used in specific PCM cases. Those details are included in other documents such as case-specific Case Notes. WECC staff and stakeholders are expected to be able to use the processes in this document to create a functioning, fully-vetted PCM case, starting with a seed (selected initial input case) PF case.

Data and assumptions addressed in this document include the following types of data used in the ADS PCM:

- Area/Region/Balancing Authority (BA) descriptions;
- Transmission network model and parameters;
- Generation resource parameters;
- Load data;
- Variable operating costs and economics data; and
- WECC market model configuration parameters.

This manual is intended to be updated only occasionally. While the processes described in this manual may be used to create many specific PCM cases, and the processes may need to be revised occasionally. WECC and its stakeholders developed these processes over many years. They have proven to be effective in engaging a variety of knowledgeable stakeholders in the data review and vetting process to produce a reliable and useful PCM dataset. The Production Cost Data Subcommittee (PCDS) will consider modifications to this manual for subsequent approval.

1.1. Principles of Development

The PCM dataset is not created from scratch. Every two years, certain generation data (e.g., electrical location of generators, Pmax and Pmin of generators) and transmission topology data (e.g., lines, transformers, impedances, thermal ratings), are imported into the PCM from a seed PF case. The seed PF case is intended to reflect the transmission plans of the regional planning groups (e.g., CAISO, WestConnect, ColumbiaGrid, Northern Tier Transmission Group (NTTG), Alberta Electric System Operator (AESO), British Columbia Coordinated Planning Group, CENACE). Other data needed for the PCM (e.g., heat rates, fuel prices) will be updated periodically, with biennial changes to the target year. A copy of the "release" dataset and all related information will be archived.

All data is to be documented as to source and validation. The default documentation for every item is included in the latest release of the ADS, which documents all differences from the previous release.

- All changes for data elements are integrated or "collapsed" with a release.
- All changes to data and modeling conventions from a prior release of the PCM, other than error correction, are discussed and approved by the PCDS.
- All changes will be documented with cause and details.

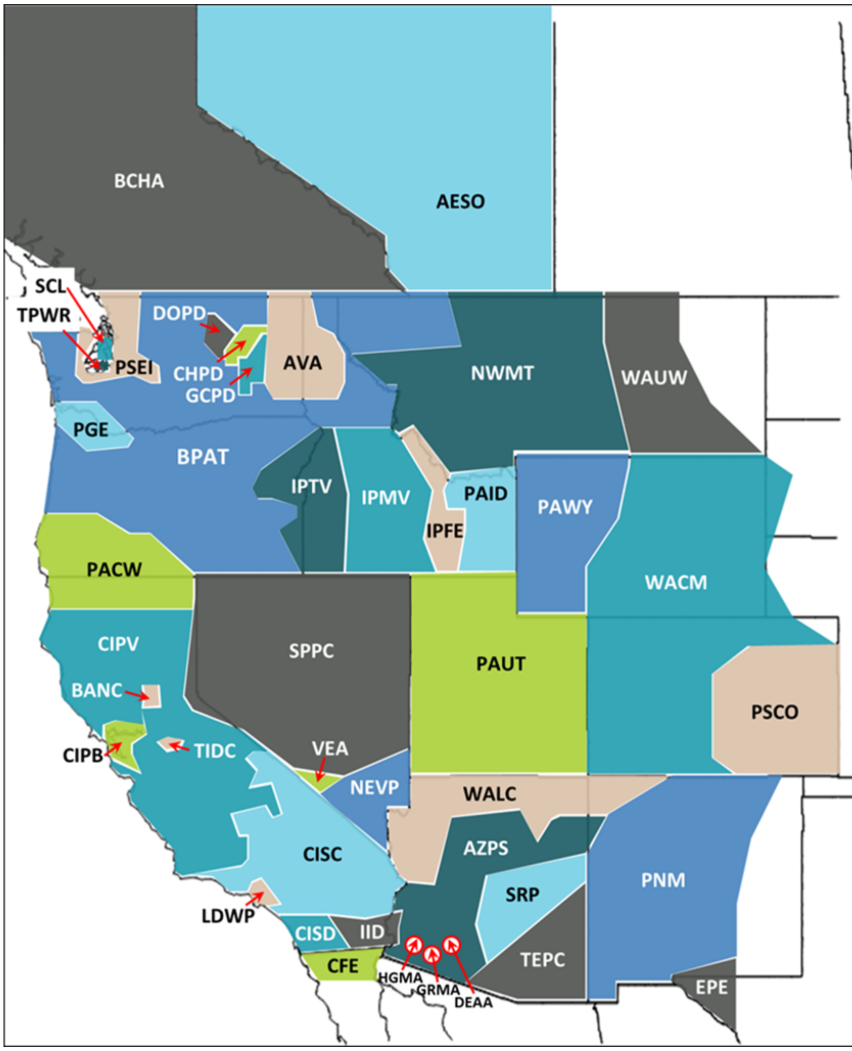
The dataset should assume all years start on January 1, and last 365 days, except a leap year, which adds another day. Time-sensitive elements should be adjusted to Mountain Standard Time. Holidays should be adjusted if deemed appropriate.

2. Area, Region, and BA Descriptions

Network components (i.e. generators) are assigned to an "area" and a "region," which serve as informational characteristics in the PCM.

Area or "load area" topologies are based on the large load centers with consistent load characteristics. In most cases, they are analogous to the boundaries of BA Areas (BAA) or Load-Serving Entities (LSE) (where more detail is needed). Figure 1 shows the load areas that are included in the topology.

Figure 1: Load Areas



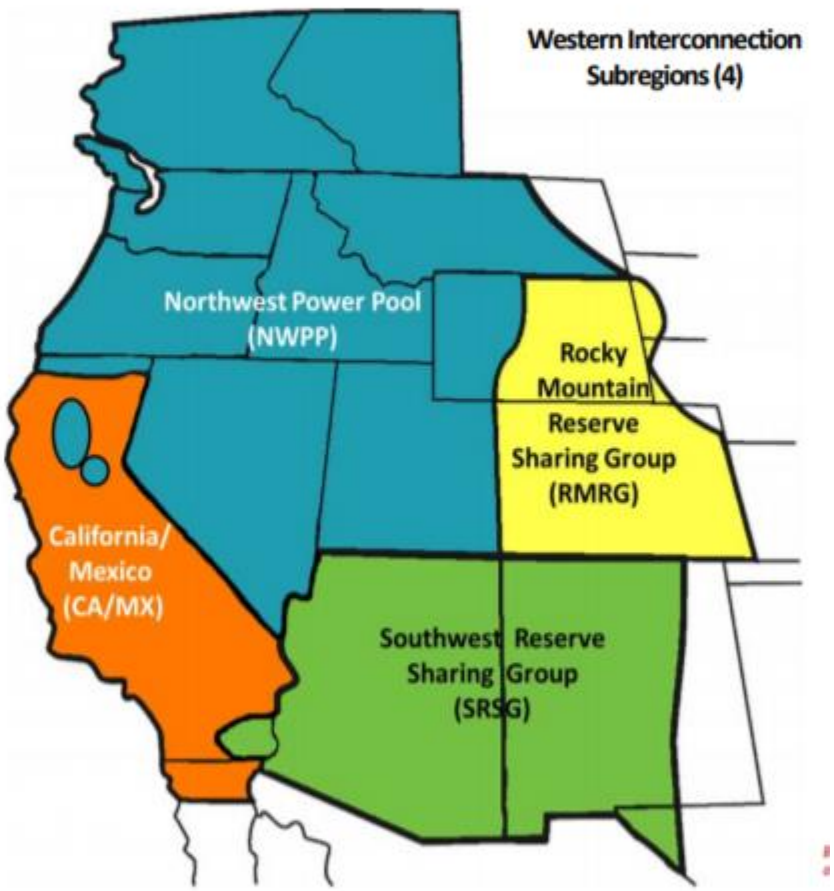
TEPPC Area	Area Description
AESO	Alberta Electric System Operator
AVA	Avista
AZPS	Arizona Public Service
BANC	Sacramento Municipal District
BCHA	British Columbia Hydro
BPAT	Bonneville Power Administration
CFE	Comision Federal de Electricidad
CHPD	Chelan Co PUD
CIPB	Pacific Gas & Electric Bay Area
CIPV	Pacific Gas & Electric Valley Area
CISC	Southern California Edison
CISD	San Diego Gas & Electric
DOPD	Douglas Co PUD
EPE	El Paso Electric
GCPD	Grant Co PUD
IID	Imperial Irrigation District
IPFE	Far East (Idaho Power)
IPMV	Magic Valley (Idaho Power)
IPTV	Treasure Valley (Idaho Power)
LDWP	Los Angeles Dept of Water & Power
NEVP	Nevada Power
NWMT	Northwestern Montana
PACW	PacifiCorp West
PAID	PacifiCorp East – Idaho
PAUT	PacifiCorp East – Utah
PAWY	PacifiCorp East - Wyoming
PGE	Portland Gen Electric
PNM	Public Service New Mexico
PSCO	Public Service Colorado (Xcel)
PSEI	Puget Sound Energy
SCL	Seattle City Light
SPPC	Sierra Pacific Power
SRP	Salt River Project
TEPC	Tucson Electric Power
TIDC	Turlock Irrigation District
TPWR	Tacoma Power
VEA	Valley Electric Association
WACM	Western Area Power Admin Colorado/Missouri
WALC	Western Area Power Admin Lower Colorado
WAUW	Western Area Power Admin Upper Missouri
N/A	DECA, LLC - Arlington Valley (DEAA)
N/A	Gila River Maricopa Arizona (GRMA)
N/A	Harquahala L.L.C. (HGMA)

Generator-only Balancing Authorities (BA) are not modeled as load areas, as they serve no load, and their generation is assigned to the closest defined load area.

Regions are modeled to consolidate operational aspects associated with a BA, like hurdle rates[1] and reserve requirements (including reserve sharing groups), which are explained later in this document. In most cases, regions correspond to the load area added to the front of the name. The Western Interconnection is broken into five subregions: Northwest (NW), Basin (BS), Rocky Mountain (RM), Desert Southwest (SW), California (CA), and combined British Columbia and Alberta. (e.g., the Los Angeles Department of Water and Power (LDWP) area is the CA_LDWP region). For some reporting, British Columbia and Alberta are broken out of the Northwest subregion. The figure below represents the four WECC Subregions.

[1] Hurdle rates represent the cost to deliver surplus energy among different regions.

Figure 2: WECC Regions



2.1. Areas and Trading Hubs

Areas are referred to as "topology based" on large load centers. These are Analogous to BA or LSE boundaries. The following load areas and trading hubs are defined in the Western Interconnection:

Table 1: Western Interconnection Areas

Area	Definition
AESO	Alberta Electric System Operator
AVA	Avista Corporation
AZPS	Arizona Public Service Company
BANC	Balancing Authority of Northern California
BCHA	British Columbia Hydro
BPAT	Bonneville Power Administration-Transmission
CFE	Comision Federal de Electricidad
CHPD	PUD No. 1 of Chelan County

Area	Definition
CIPB	California Independent System Operator—Pacific Gas & Electric Bay
CIPV	California Independent System Operator—Pacific Gas & Electric Valley
CISC	California Independent System Operator—Southern California Edison
CISD	California Independent System Operator—San Diego Gas & Electric
DOPD	PUD No. 1 of Douglas County
EPE	El Paso Electric Company
GCPD	PUD No. 2 of Grant County
IID	Imperial Irrigation District
IPFE	Idaho Power Far East
IPMV	Idaho Power Magic Valley
IPTV	Idaho Power Treasure Valley
LDWP	Los Angeles Department of Water and Power
NEVP	Nevada Power Company
NWMT	NorthWestern Energy
PACW	PacifiCorp West
PAID	PacifiCorp Idaho
PAUT	PacifiCorp Utah
PAWY	PacifiCorp Wyoming
PGE	Portland General Electric Company
PNM	Public Service Company of New Mexico
PSCO	Public Service Company of Colorado
PSEI	Puget Sound Energy
SCL	Seattle City Light
SPPC	Sierra Pacific Power Company
SRP	Salt River Project
TEPC	Tucson Electric Power Company
TH_Malin	Trading Hub—Malin
TH_Mead	Trading Hub—Mead
TH_PV	Trading Hub—Palo Verde
TIDC	Turlock Irrigation District
TPWR	City of Tacoma, Department of Public Utilities
VEA	Valley Electric Association
WACM	Western Area Power Administration, Colorado-Missouri Region
WALC	Western Area Power Administration, Lower Colorado Region
WAUW	Western Area Power Administration, Upper Great Plains West

2.2. Regions

Load areas defined at the operational level are referred to as "regions."

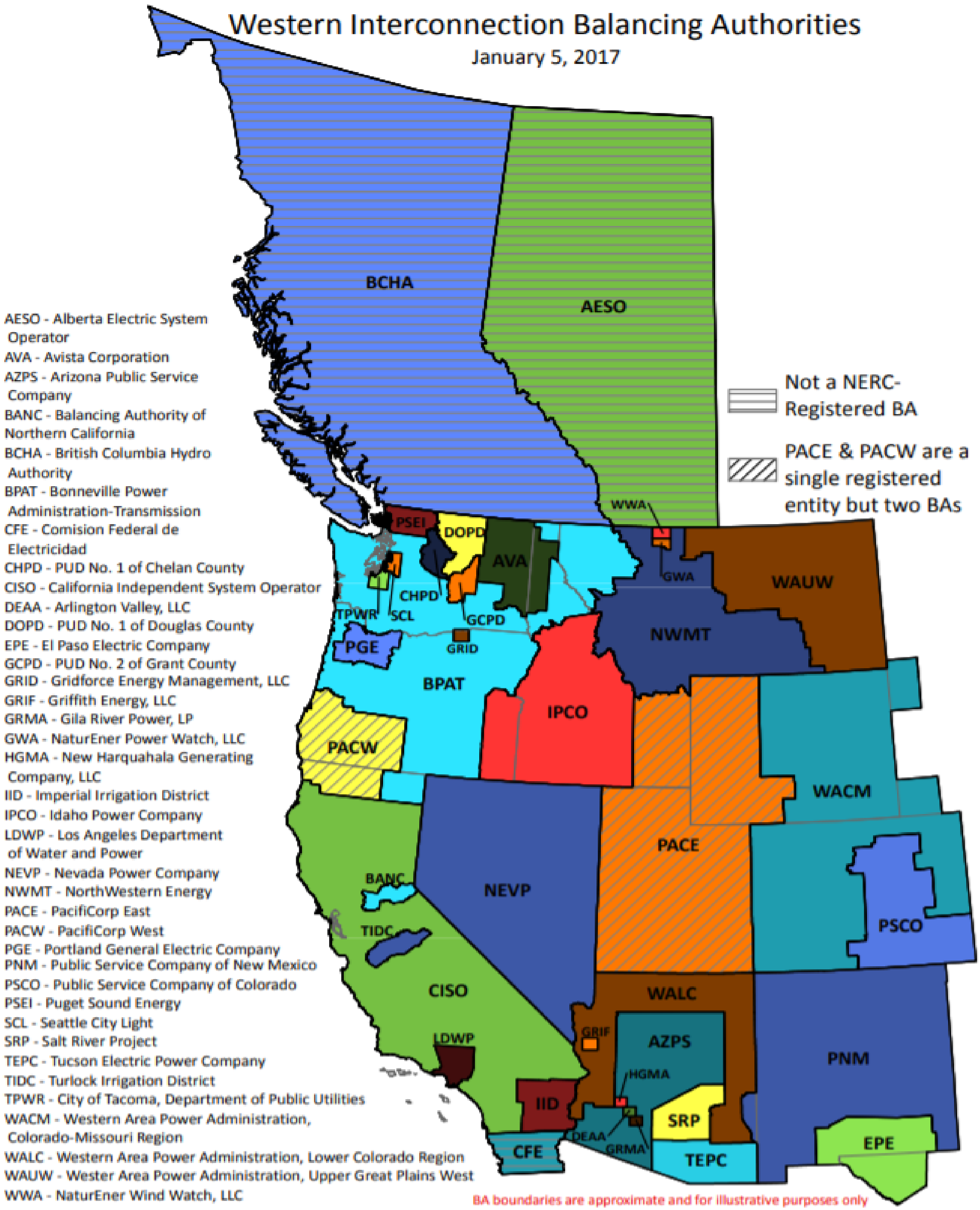
Table 2: Western Interconnection Regions

Region	Definition
AB_AESO	Alberta—Alberta Electric System Operator
BC_BCHA	British Columbia—British Columbia Hydro
BS_IPCO	Basin—Idaho Power Company
BS_PACE	Basin—PacifiCorp East
CA_BANC	California—Balancing Authority of Northern California
CA_CFE	California—Comision Federal de Electricidad
CA_CISO	California—California Independent System Operator
CA_IID	California—Imperial Irrigation District
CA_LDWP	California—Los Angeles Department of Water and Power
CA_TIDC	California—Turlock Irrigation District
NW_AVA	NorthWest—Avista Corporation
NW_BPAT	NorthWest—Bonneville Power Administration-Transmission
NW_CHPD	NorthWest—PUD No. 1 of Chelan County
NW_DOPD	NorthWest—PUD No. 1 of Douglas County
NW_GCPD	NorthWest—PUD No. 2 of Grant County
NW_NWMT	NorthWest—NorthWestern Energy
NW_PACW	NorthWest—PacifiCorp West
NW_PGE	NorthWest—Portland General Electric Company
NW_PSEI	NorthWest—Puget Sound Energy
NW_SCL	NorthWest—Seattle City Light
NW_TH_Malin	NorthWest—Trading Hub—Malin
NW_TPWR	NorthWest—City of Tacoma, Department of Public Utilities
NW_WAUW	NorthWest—Western Area Power Administration, Upper Great Plains West
RM_PSCO	Rocky Mountain—Public Service Company of Colorado
RM_WACM	Southwest—Western Area Power Administration, Colorado-Missouri Region
SW_AZPS	Southwest—Arizona Public Service Company
SW_EPE	Southwest—El Paso Electric Company
SW_NVE	Southwest—Nevada Energy
SW_PNM	Southwest—Public Service Company of New Mexico
SW_SRP	Southwest—Salt River Project
SW_TEPC	Southwest—Tucson Electric Power Company
SW_TH_Mead	Southwest—Trading Hub—Mead
SW_TH_PV	Southwest—Trading Hub—Palo Verde
SW_WALC	Southwest—Western Area Power Administration, Lower Colorado Region

2.3. Balancing Authorities

The responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a BAA, and regulates Interconnection frequency in real time.

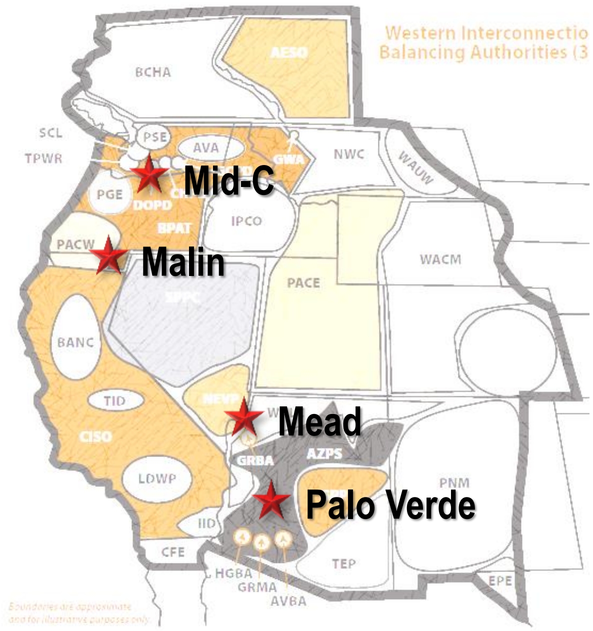
Figure 3: Western Interconnection Balancing Authorities



2.4. Trading hubs

A trading hub is an operational region with generation free-trading zones and no hurdle rate barriers. Trading hubs are aggregations of representative busses in an area used for price signals. Since each trading hub represents a group of localized busses, trading hubs are also modeled at the area and region levels to avoid unrealistic buildup of hurdle rates charges. There are three trading hubs in the Western Interconnection: Mead (SW_TH_Mead), Palo Verde (SW_TH_PV), and Malin (NW_TH_Malin).

Figure 4: Western Interconnection Trading Hubs



3. Transmission Network Model

WECC subcommittees are responsible for creating a central database of technical information about the Western Interconnection transmission system, including a PF model data. This PF model is used as the foundation for resources and transmission in the ADS PCM.

The PCM is based on a PF case created in GE's Positive Sequence Load Flow (PSLF) software through the use of EPC (*.epc) and EPCL (*.P) files. Several components of the PF model must be evaluated carefully to ensure compatibility with the PCM model, including but not limited to WECC transfer paths, generator topology, DC line modeling, and orphaned buses.

The transmission network topology includes: buses, loads, generators, transformers, and branches. These elements are imported from PF to PCM. An ADS PCM cases require additional parameters described in this section, which are developed to complete the transmission topology in the PCM case.

3.1. Network Topology

Transmission network topology comes from the PF and is imported into the PCM. Network topology includes—

- Buses;
- Loads;
- Generators;
- Transformers; and
- Branches.

Network topology does **not** include:

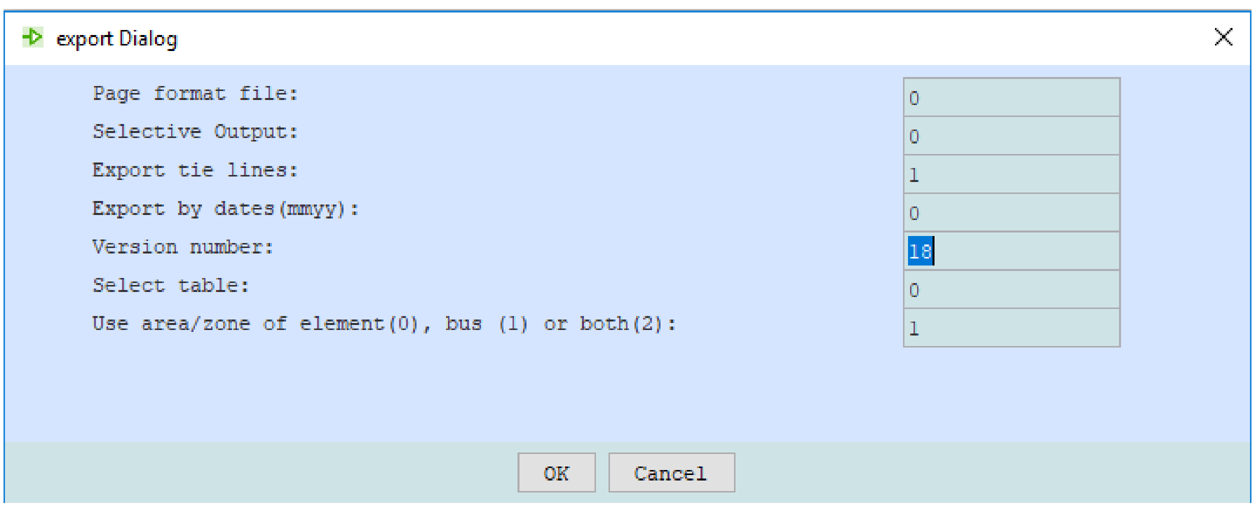
- Generation dispatch;
- Load profiles; and
- Component settings.

Exporting an EPC file from PSLF

To export an EPC file:

1. Open PSLF.
2. Load desired PF case.
3. Click the "Exim" tab.
4. Click the "Export EPC" tab.
5. Make sure the version number is "18" (no other fields must be modified).
6. Then click "Ok."

Figure 5: PSLF Export Dialog



Importing the case into GridView

To import a case—

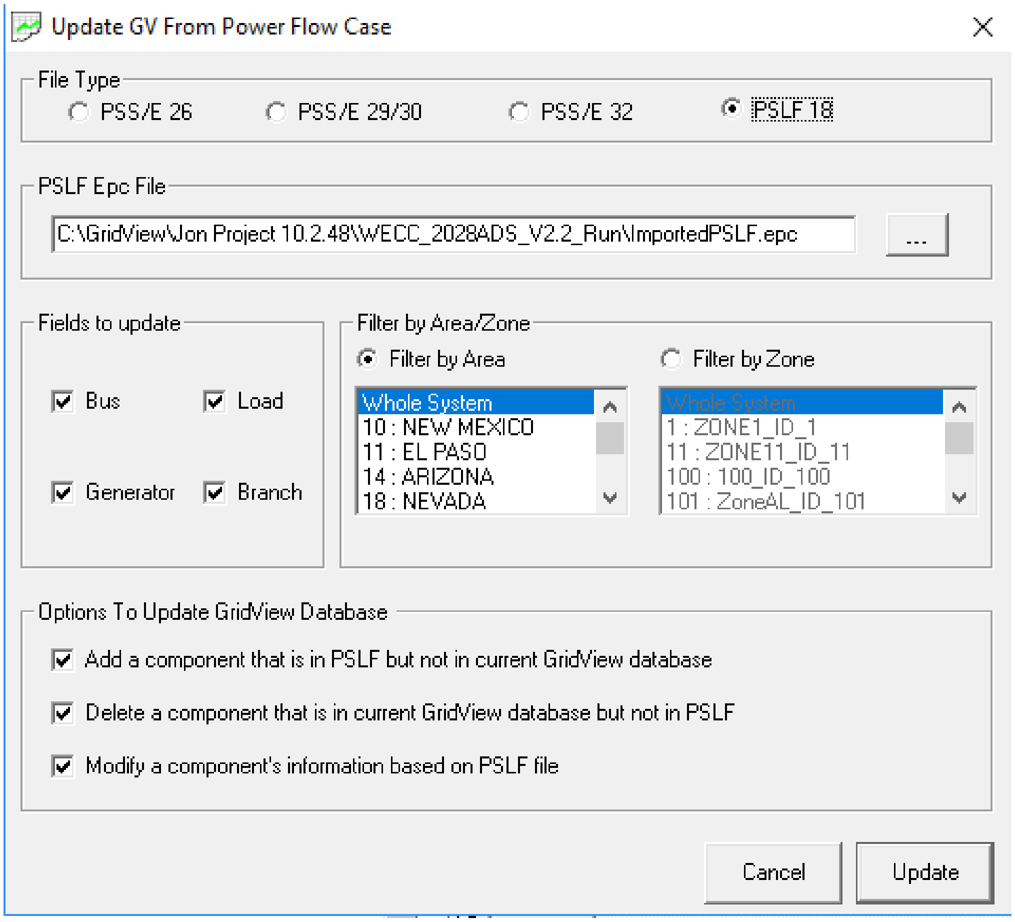
1. Open GridView.
2. Load PCM case that you would like to be the starting point.
3. Open "Im/Ex" tab in GridView.

4. Select "Update Data with Network Data."
   - The dialog box shown below will be displayed, allowing you to define how the imported data will be handled.

Figure 6: Importing PF Case into GridView

WECC uses PSLF to import topology. However, it may also be updated with PSS/E

Importing file must be an Epc file in version 18 of PSLF



WECC uses PSLF to import topology. However, it may also be updated with PSS/E. The importing file must be an EPC file in version 18 of PSLF.

WECC import selects fields: bus, load, and branch fields to be updated for the whole system with the following options selected:

- Add a component that is in PSLF but not in current GridView database;
- Delete a component that is in current GridView database but not in PSLF; and
- Modify a component's information based on PSLF file.

WECC imports generators first by reconciling generators between the PF and the starting PCM case, then by importing the reconciled generator list into the PCM.

3.2. Branch Description

3.2.1. Identification

Each branch in the ADS PCM will include the following identifying data:

- Name;
- From bus and to bus;
- Owner.

3.2.2. DC Ties

For each DC tie, each branch in the ADS PCM will include—

- Loss factor;
- DC cost; and
- DC MW limit.

There is an additional data requirement from Branch.csv to populate the DC tie information.

3.2.3. Operating Characteristics

Each branch in the ADS PCM will include the following operating characteristics:

- Impedance; and
- Status.

3.2.4. Constraints

Each branch in the ADS PCM will include the following constraints:

- Branch seasonal ratings (winter and summer ratings, normal and emergency);
- Branch penalty price ($/MWh) in normal and emergency conditions; and
- Monitored (enforced) flag.
  Note: If the "monitored" flag is not set for a particular branch, GridView will still dispatch resources to honor the seasonal ratings, but will not calculate a shadow price and congestion rents (line congestion rent from line users to line rights owners) in the event flows are at the level of the seasonal rating.

3.2.5. Phase Shifters

Each phase shifter modeled as a branch in the ADS PCM will include—

- Initial angle;
- Max angle;
- Min angle;
- Reactance at maximum angle;

- Max MW;
- Min MW;
- Normal condition angle cost;
- Normal condition angle step size (up and down);
- Emergence condition angle cost;
- Emergence condition angle step size (up and down); and
- Simulation setup for angle lock between normal and contingency condition.

Table 3: Data Requirements for Branch, DC Ties, and Phase Shifters

Branch.csv		
Field	**Description**	**Data Source(s)**
BranchID	Branch ID from G.V.	G.V. Generated
FrBusID	From Bus number	Data Owner
FrBusName	From Bus Name	Data Owner
FrBuskV	From Bus kV	Data Owner
ToBusID	To Bus number	Data Owner
ToBusName	To Bus Name	Data Owner
ToBuskV	To Bus kV	Data Owner
CKT	Branch Circuit number	Data Owner
RateA	Normal branch rating	Data Owner
RateB	Long-term branch emergency rating	Data Owner
Rate C	Short-term branch emergency rating	Data Owner
Status	True (in service) or False (out of service)	Data Owner
DCLineNum	DC Line number if this branch is a DC line, otherwise this field is 0	Data Owner
DCMWLevel	DC flow limits. Overwrites RateA/B/C, otherwise this field is 0	Data Owner
Cost($/MWh)	Cost in ($/MWh) for DC lines	Data Owner
R	Resistance in per unit	Data Owner
X	Reactance in per unit	Data Owner
DerateA	Summer rating multiplier for Rate A	User Defined
DerateB	Summer rating multiplier for Rate B	User Defined
DerateC	Summer rating multiplier for Rate C	User Defined
Penalty ($/MWh)	Penalty for violating the branch thermal limits	
FlowMonitored	True or False Indicates whether the branch is being monitored	User Defined
Angle	Angle if this branch is a PAR transformer	
PAR_Angle_Max	Maximum angle limit in degrees if this branch is a PAR, otherwise, this field is 0	
PAR_Angle_Min	Minimum angle limit in degrees if this branch is a PAR. Otherwise, this field is 0.	

Branch.csv		
Field	**Description**	**Data Source(s)**
PAR_MW_Max	Maximum flow limit in MW if this branch is a PAR. Otherwise, this field is 0	
PAR_MW_Min	Minimum flow limit in MW if this branch is a PAR. Otherwise, this field is 0	

Table 4: Branch Rating

Branch_Rating.csv		
Field	**Description**	**Data Source(s)**
FrBusID	From Bus number	Data Owner
FrBusName	From Bus Name	Data Owner
FrBuskV	From Bus kV	Data Owner
ToBusID	To Bus ID	Data Owner
ToBusName	To Bus Name	Data Owner
ToBuskV	To Bus kV	Data Owner
CKT	Branch Circuit number	Data Owner
Winter A	Winter A rating	Data Owner
Winter B	Winter B rating	Data Owner
Winter C	Winter C rating	Data Owner
Summer A	Summer A rating	Data Owner
Summer B	Summer B rating	Data Owner
Summer C	Summer C rating	Data Owner

3.2.6. Scheduled Maintenance

Scheduled maintenance for each branch modeled in the ADS PCM will include:

- Starting date and hour
  End date and hour

Table 5: Data Requirements for Scheduled Maintenance on a Branch

TransmissionScheduling.csv		
Field	**Description**	**Data Source(s)**
BranchID	Branch ID from G.V.	G.V. Generated
FrBusName	From Bus Name	Data Owner
FrBuskV	From Bus kV	Data Owner
ToBusID	To Bus ID	Data Owner
ToBusName	To Bus Name	Data Owner
ToBuskV	To Bus kV	Data Owner
CKT	Branch Circuit number	Data Owner
Mode (=0,1,2,3)	0 = Do nothing; 1 = Maintenance; 2 = Expansion; 3 = Retirement	
Date1 (mm/dd/yyyy)	Starting Date	

TransmissionScheduling.csv		
Field	**Description**	**Data Source(s)**
Hour1	Start Hour	
Date2 (mm/dd/yyyy)	Ending Date	
Hour2	Ending Hour	

3.3. Interfaces

The interfaces in the PCM represent three items:

- The WECC paths (as listed in the WECC Path Rating Catalog);
- Other paths within WECC as defined by areas or regions; and
- Wheeling rates (discussed in a later section).

Interface information for WECC paths is included in the PF but is not updated on import into GridView. The branches for WECC paths must be updated manually.

Table 6: Data Requirements for Paths (InterfaceGeneral.csv)

InterfaceGeneral.csv		
Field	**Description**	**Data Source(s)**
Interface Name	This is the descriptive name. For WECC Paths, the convention is *PXX Path Name.*	WECC Path rating Catalog
Type	Needs to be set as “Interface by Branches”—Interface that monitors each branch in the Interface for the paths	
Monitored	Yes or No—If yes, the set limits will be enforced, and the interface will be recorded	
Commitment	Yes or No—If yes, enforce interface constraint during unit commitment	
Dispatch	Yes or No—If yes, enforce interface constraint during economic dispatch	
Forward Penalty	Penalty for going over forward limit, generally $6,000 unless otherwise specified	
Backward Penalty	Penalty for going over backward limit, generally $6,000 unless otherwise specified	

Table 7: Data Requirements for Paths (InterfaceAssignment.csv)

InterfaceAssignment.csv		
Field	**Description**	**Data Source(s)**
Interface Name	Must match the Interface Name from the InterfaceGeneral.csv file	InterfaceGeneral.csv
Type	Type must match Type in InterfaceGenral.csv file	InterfaceGeneral.csv
Element ID	This is the Branch ID from the Branch.csv file	Branch.csv table
Element Type	This is “Branch” for path interface	WECC Path Rating Catalog

InterfaceAssignment.csv		
Field	**Description**	**Data Source(s)**
		Yr(x) HS1 PF
Element Name	Branch name in format FromBusNum_ToBusNum_BranchID	Branch.csv table
Br-Normal_Direction	If checked, default flow direction, else opposite direction	WECC Path Rating Catalog Yr(x) HS1 PF
Br-Coefficient	This is the branch coefficient and can be negative or positive. This is a multiplier on the branch that counts toward the interface. Generally set as positive 1	

3.3.1. Identification

Each interface modeled in the ADS PCM will include—

- Name and naming convention;
- Interface definition—branches; and
- Owner.

3.3.2. Constraints

Interfaces modeled in the ADS PCM will include the following constraint information:

- Monthly limits (min and max);
- Penalty price; and
- Flags for being enforced at the unit commitment (UC) stage, energy dispatch (ED) stage, or both.

3.4. Nomograms

Nomograms provide constraints based on expected system operations that enforce generator and transmission rules or improve the commitment and dispatch of the PCM. They can also restrict the ratio of local generation and energy imports to appropriate levels. On bi-pole DC lines, nomograms can ensure that the two poles are balanced.

3.4.1. Identification

Each nomogram modeled in the ADS PCM will include—

- Name and naming convention;
- Nomogram definition; and
- Owner.

3.4.2. Data Sources/Requirements

Nomogram definitions are provided by stakeholders familiar with current and future operating practices for a given area or combination of areas in the Western Interconnection.

3.4.3. Modeling

Nomograms modeled in the ADS PCM will include the following constraint information:

- Limit for UC;
- Penalty price for UC;
- Limit for ED;
- Penalty price for ED; and
- Flags for being enforced in UC, ED, or both.

Table 8: Nomogram—General

NomogramGeneral.csv		
Field	**Description**	**Data Source(s)**
Name	User defined	PCDS, User
Monitored	Indicates whether the Nomogram is monitored with Yes or No	PCDS, User
Limit_UC	Limit in MW for unit commitment	PCDS, User
Limit_ED	Limit in MW for economic dispatch	PCDS, User
Penalty_UC($/MWh)	Penalty in ($/MWh) for violating Limit_UC	PCDS, User
Penalty_ED($/MWh)	Penalty in ($/MWh) for violating Limit_ED	PCDS, User

Table 9: Nomogram—Definition

NomogramDefinition.csv		
Field	**Description**	**Data Source(s)**
NomogramName	User defined	PCDS, User
ItemTypeID	ID=0: Generator; ID=1: Interface	PCDS, User
ItemName	Unit Name or interface name.	PCDS, User
ItemCoefficient	Coefficient for each Nomogram item.	PCDS, User

3.4.4. Review/Modification Schedule

Nomograms should be reviewed and approved during each planning cycle by the appropriate WECC subcommittee.

3.4.5. Constraints

Nomograms modeled in the ADS PCM will include the following constraint information:

- Limit for UC
- Penalty price for UC
- Limit for ED

- Penalty price for ED
- Flags for being enforced in UC and/or ED

3.5. Contingency and Special Protection Schemes (SPS)

Contingencies are currently not modeled in the ADS PCM.

3.5.1. Identification

SPS modeled in the ADS PCM will include—

- Name and naming convention;
- Outage branch;
- Outage generator or generator tripping for SPS;
- Load shedding for SPS; and
- Monitored branches.
  Note, if a branch is not monitored, any associated SPS will not be activated in the event a contingency is taken for the branch.

3.5.2. Enforcement Flag

SPS modeled in the ADS PCM will include—

- Flag for being enforced in UC; and
- Flag for being enforced in ED.

3.6. Transmission Derates

The ADS PCM does not model transmission derates.

3.7. Identification

Derates modeled in the ADS PCM will include—

- Name and naming convention;
- Derate condition (e.g., line or generator derate due to scheduled outage or UC);
- Derated transmission components (branches, interfaces, and nomograms).

4. Generation Resources

This section describes the generating resources included in the ADS PCM and the ways in which they are modeled in the ADS PCM. WECC receives generator data from many sources and validates the data through the PCDS and the PCM Modeling Subcommittee (PCMS). WECC's goals are to obtain data that will allow each generating resource to be represented in the ADS PCM with a reasonable level of PCM modeling accuracy.

The major classes of electrical generators are often tied to their prime movers and fuel. The most common prime movers are hydro turbines, steam turbines, combustion turbines, wind turbines, specialty turbines (compressed air, tidal, etc.), and reciprocating engines. The prime movers drive electrical generators to produce electricity. Solar photovoltaic (PV) and electrochemical generators use other processes to make electricity. Table 10 lists the prime movers with their most common fuels.

Table 10: List of Prime Movers

Prime Mover	Common Fuels	Other
Hydro turbine	Water	Storage, run-of-river, or pumped storage
Steam turbine	Coal, Oil, Uranium, Natural Gas, Geothermal, Biomass, Solar thermal	Heat energy from fuel makes steam to drive turbine(s)
Combustion Turbine	Natural Gas	
Wind Turbine	Wind	
Reciprocating Engines	Oil derivatives, natural gas	
Specialty Turbines	Air, Water	

Generating units that use a heat source are called thermal resources. Other categories of units are hydroelectric, energy storage, variable renewable, and distributed generation. The dispatch order of a generation fleet is based on several factors, including cost, operating constraints, and reliability contribution.

4.1. Thermal Resources—Data Development

Thermal resources use heat energy to produce high pressure gas or steam, which turns a turbine connected to a generator. There are many different configurations, sizes, and efficiencies, depending on the fuel and design. A combined-cycle configuration produces high-pressure gas for one turbine and extracts heat from the exhaust gas to make steam for a second turbine. Although solar thermal resources use focused solar radiation to produce power, no fuel is consumed. See more under Variable Renewable Resources.

4.1.1. Plant/Unit Identification

Each thermal unit included in the ADS PCM will include—

- Name(s) of the project and unit numbering (including the U.S. Energy Information Administration (EIA) number if available);
- Unit shares assigned to identified Balancing Authorities for purposes of operating reserves;
- Geographical location (city or county, latitude and longitude); and
- Network location (interconnection bus name and PF transmission bus number).

4.1.2. Operating Characteristics

Each thermal unit included in the ADS PCM will include the operating characteristics:

In GridView, this is located in the Generator.csv table.

Unit Parameters

- In-service and retirement dates, initial connected/disconnected status in the case.
- Criteria for activating generators with status initially set to disconnected.
- Criteria for deactivating generators with status initially set to connected.
- Type of unit (e.g., reciprocating engine, combustion turbine, combined cycle, coal, nuclear, geothermal).
- Fuel type (e.g., diesel, oil, natural gas, synthetic natural gas, coal—lignite, coal—low sulfur, nuclear, geothermal steam, biomass, biogas).
- Planned maintenance (model-determined schedule using user-specified planned maintenance requirements (duration of "major" and "minor" planned outages), OR user-determined schedule).

  Note that the default method for planned maintenance scheduling is the process built into the simulation program, which attempts to minimize loss-of-load probability.

  The model-generated maintenance schedule can be overwritten in whole or part with externally-generated schedules, whether from an alternative maintenance scheduling tool or other source. Nuclear generating units have an established maintenance schedule linked to their refueling cycle.

- Forced outages (frequency and duration).

Variable Costs

- Startup cost ($/start).
- Startup fuel (type and quantity (BTU/start)).
- Fuel conversion efficiency (BTUs in/net kW out) for (i) net kW output levels at maximum output capability, (ii) Minimum output capability, and (iii) points in between.
  Note that "net kW out" is the electric injection into the grid less any station power loads withdrawn from the grid through a separate electric meter. Fuel conversion efficiency typically does not include startup fuel.
- Variable Operations and Maintenance (O&M)
  Note: variable O&M can include opportunity costs, if applicable.

Operating Constraints

- Maximum output capability.

Note that maximum output capability is typically Pmax from the PF program minus station power load withdrawn from the grid through a separate electric meter when the unit is running full-out.

- Minimum output capability.
  Note that minimum output capability is typically Pmin from the PF program minus station power loads withdrawn from the grid through a separate electric meter when the unit is running at its lowest stable level.
- Minimum up and down times, startup time, up-ramp rate (MW/hr), down-ramp rate (MW/hr)
- Must Run status. If the "Must Run" flag is checked, GridView will always run the unit at its minimum output level, unless, based on its fuel conversion efficiency curve and variable O&M, it is economical to dispatch the unit at a higher level. The exception is hours in which the unit is on planned maintenance or subject to a forced outage; in which case the unit is dispatched at zero. If the unit should be "Must Run" at a level higher than its physical minimum output level, the minimum output level in GridView needs to be set to the higher level. Note: If a unit is designated as "Must Run," GridView ignores start-up costs for dispatch purposes.
- Fuel limits—GridView does not directly model fuel limits. However, GridView does model fuel rates.
- Emission limits—GridView does not directly model emission limits. However, GridView does model emission rates.

Fuel Data

- Fuel type (e.g., diesel, oil, natural gas, synthetic natural gas, coal—lignite, coal—low sulfur, nuclear, geothermal steam, biomass, biogas)
- Fuel Price ($/BTU delivered at a particular location on the natural gas pipeline system, e.g., power plant burner-tip). Prices can be specified daily, monthly, or annual.
- Emissions —pounds of CO_2, NOx, SOx, particulate emitted per BTU of fuel consumed.

4.1.3. Data Sources

With so many data points for thermal generators, there are several data sources involved:

Table 11: Data Sources

Data Element	Primary Source(s)	Secondary Sources
Unit name, bus, and location	Loads and Resources (L&R), PF, EIA	Integrated Resource Plans (IRP)
Dates: in-service/retirement	L&R, EIA	
Unit type/configuration	L&R, PF, EIA	
Fuel information	California Energy Commission (CEC), Northwest Power and	

	Conservation Council (NWPCC), EIA	
Efficiency/heat rate	CEC, Columbia Grid(CG)	

4.1.4. Review/Modification Schedule

The review and modification schedule is currently on a biennial cycle, (once every two years) as cases are built for a Year 10 study program. For example, the main development work for the 2028 ADS case was during 2018, and the main development work for the 2030 ADS case was during 2020.

4.2. Storage

Storage includes batteries, pumped hydro, and compressed air energy storage (CAES).

4.2.1. Data Sources

The following are the data sources involved.

Table 12: Data Sources

Data Element	Primary Source(s)	Secondary Sources
Unit name, bus and location	L&R, PF, EIA	IRPs
Dates: in-service/retirement	L&R, EIA	
Unit type/configuration	L&R, PF, EIA	
Fuel information	CEC, NWPCC, EIA	

4.2.2. Review/Modification Schedule

The review and modification schedule is on a biennial cycle, (once every two years) as cases are built for a Year 10 study program. For example, the main development work for the 2028 ADS case was during 2018, and the main development work for the 2030 ADS case was curing 2020.

4.2.3. Validation Process

All the information pertaining to an energy storage unit is validated by the PCDS.

4.2.4. Plant/Unit Identification

Each storage unit included in the ADS PCM will include—

- Name(s) of the project and unit numbering (including EIA number if available);
- Unit shares assigned to identified balancing authorities for purposes of operating reserves;
- Geographical location (city, county, state); and
- Network location (PF transmission bus number).

Table 13: Data Requirements for Energy Storage Units (PumpedStorage_General.csv)

PumpedStorage.csv	
Field	**Description**
Generator Name	The descriptive name of each energy storage unit.
Pcap	The pumping capacity of each unit in MW.
Gcap	The generating capacity of each unit in MW.
Pumping Price	This field sets the locational marginal price (LMP) price at generator bus at which the unit starts pumps. This is set to "0" in the ADS case.
Generating Price	This field sets the LMP price at generator bus at which the unit starts generation. This is set to "200" in the ADS case.
Reserve contribution	This field sets the percentage contribution of generation to reserve requirements. This is usually set to "1," i.e., 100% in the ADS case.
Ramp Up	This field sets the Ramp-up rate of each energy storage unit. This field is usually set to "PCap" in the ADS case.
Ramp Down	This field sets the ramp-down rate of each Energy Storage unit. This field is usually set to "Gcap" in the ADS case.

4.2.5. Operating Characteristics

Table 14: Operating parameters for Energy Storage Units (PS_Plant.csv)

PS_Plant.csv	
Field	**Description**
Plant ID	This is a unique identifier assigned by GridView to each generator.
Max Pond Size	Max storage capacity of a storage unit in MW.
Min Pond Size	Minimum storage capacity of a storage unit in MW.
Plant Efficiency	Cycle efficiency of each storage unit.
Plant Capacity factor	Estimates or historical cap factor of each unit.
Schedule Mode	This field is used to select if a unit follows a load curve or a price curve.
Cost-Benefit Ratio	The estimated ratio of pumping cost to generation revenue for each storage unit.
Skip Monthly Schedule	This is a "true or false" flag. This flag is set to "False" in ADS case.

4.3. Hydroelectric Resources

Hydroelectric resources use the potential energy of water stored in a reservoir to turn the turbine that is connected to a generator. There are different types of hydroelectric resources, they include reservoirs and run-of-the river generating plants.

4.3.1. Plant/Unit Identification

Each hydro unit included in the ADS PCM will include—

- Name(s) of the project and unit numbering (including EIA number if available);
- Unit shares assigned to identified Balancing Authorities for purposes of operating reserves;

- Geographical location (city or county, latitude and longitude); and
- Network location (interconnection bus name and PF transmission bus number).

Table 15: Data Requirements for Hydro Units (HydroGeneral.csv)

HydroGeneral.csv	
Field	**Description**
Generator Name	This is the descriptive name of each hydro generator.
Schedule mode	This field is used to select the mode in which each hydro generator is dispatched 1-UseGivenSchedule; 2-PeakShaving; 3-LoadFollowing;
Curve name	This field specifies the hydro shape (curve), a hydro generator would follow if "1-UseGiven Schedule" schedule mode is selected
Capacity	This field specifies the max generating capacity of a hydro unit.
Spillage	This is a "true or false" field. If this is set to true, then the hydro unit is allowed to spill, not otherwise.
Ramp Rate	This field is used to set the ramp up and ramp down rate of a hydro generator.
Reserve Contribution	This field sets the percentage contribution of generation to reserve requirements.
Automatic Calculate K and P factors	This is a "true or false" flag, which specifies if GridView calculates the monthly load proportionality constants (*K* values), and monthly hydrothermal co-optimization fractions (p factors).

4.3.2. Operating Characteristics.

For each hydro generator, the following are the monthly variable operating parameters.

Table 16: Operating parameters for Hydro Units (HydroMonthlyVarSchedule.csv)

HydroMonthlyVarSchedule.csv	
Field	**Description**
VOMCost	The variable O&M cost of the hydro unit in $/MWh.
FixedCost	The fixed cost of the hydro unit in $/MWh.
MinGen	Minimum generating capacity of a hydro unit.
MaxCap	Maximum generating capacity of a hydro unit.
MonthlyEnergy	Monthly Energy each hydro unit can generate in MW.
KLoadFollowing	Monthly load proportionality constants (*K* value) of a hydro unit.
DispatchCost	Cost at which a hydro unit is dispatched in $/MWh. This value is set to "0" in the ADS case.
Pvalue	Monthly hydrothermal co-optimization fractions (p factor) of a hydro unit
DailyOpRange	The daily operating range of a hydro unit in MW.

Each hydro generator can be dispatched against either one region load curve or multiple region load curves with weighting factors specified in "Hydro_Region_Scheduling.csv" table.

Table 17: Weighting Factors

Hydro_Region_Scheduling.csv	
Field	**Description**
Generator Key	This is the unique identifier GridView assigns to each generator.
Bus Number	Bus Number at which the hydro unit is connected, usually from the power flow base case.
Region ID	ID of the region against which each hydro unit is dispatched.
Region Name	Name of the region against which each hydro unit is dispatched.
Weight	Weight assignment of a hydro unit to a particular region.

4.3.3. Data Sources

The following are the data sources involved.

Table 18: Data Sources

Data Element	Primary Source(s)	Secondary Sources
Unit name, bus, and location	L&R, PF, EIA	IRPs
Dates: in-service/retirement	L&R, EIA	
Unit type/configuration	L&R, PF, EIA	

4.3.4. Review/Modification Schedule

The review and modification schedule is currently on a biennial cycle, (once every two years) as cases are built for a Year 10 study program. For example, the main development work for the 2028 ADS case was during 2018, and the main development work for the 2030 ADS case was during 2020.

4.3.5. Validation Process

All the information pertaining to a hydro unit is validated by the PCDS.

4.4. Variable Renewable Resources

Variable renewable resources include solar and wind, which are non-dispatchable due to their fluctuating nature. The output of these resources can be predictable or unpredictable, depending on the day and season, but is more predictable in a short timeframe preceding the current hour or day. The unavailability of solar between sunset and sunrise is very predictable; however, cloud cover during the day is often unpredictable. For this reason, hourly resource profiles/shapes are created and assigned to each variable renewable resource. Each hourly shape is aligned to a common time zone, currently Mountain Standard Time(MST).

Solar and wind resources that are owned by a load-serving entity or have a power purchase agreement with a load-serving entity are often called "utility-scale resources" to differentiate them from behind-the-meter installations.

The different types of solar and wind are listed in below:

Table 19: Different Types of Solar and Wind

Type	Description
Solar—photovoltaic with tracking	Single to multi-axis tracking solar PV
Solar—photovoltaic without tracking	Fixed axis solar PV
Solar—concentrated	Parabolic Trough—Concentrated Solar Power, Concentrated Solar Thermal
Solar—tower	Solar Power Tower—Concentrated Solar Power, Concentrated Solar Thermal
Wind—on shore	On-shore or on-land wind
Wind—off shore	Wind offshore or in water

4.4.1. Data Sources

There is no way to accurately predict the behavior of solar and wind in a dispatch model for a future year. The most common modeling practices use historical data from monitoring sites or historical averages of actual installations. One of the best sources for solar and wind data for the United States is The National Renewable Energy Lab (NREL) in Colorado. NREL receives funding to compile many terabytes of historic data, which is eventually made available to the public. The NREL data is complex and requires further manipulation before it can be used.

NREL states that it, and its contractors, use weather simulation models to "integrate regional observational datasets into a comprehensive representation of the region's wind [and solar] resource. The result of these simulation models is a synthetic weather dataset, based largely on observations."[2] NREL's process uses actual monitoring stations and a mesoscale model to fill in areas between stations. The wind speeds and solar radiance can be applied to old and new technologies to calculate the zonal profiles.

4.4.2. Review/Modification Schedule

NREL is consistently improving its models for deriving historic wind and solar shapes. Sometimes its modeling improvements are retroactive to shapes that were released earlier.

[2] Hodge, Bri-Mathias. Final Report on the Creation of the Wind Integration National Dataset (WIND) Toolkit and API: October 1, 2013 - September 30, 2015. United States. doi:10.2172/1247462.

4.4.3. Validation Process

All the information pertaining to variable renewable resources is validated by the PCDS and PCMS.

4.4.4. Modeling Requirements

An hourly profile is required for each wind farm or solar array. These profiles are extracted from the synthetic weather data described above based on a carefully selected coincident year. The profile and maximum capacity determine the hourly output for the model.

This is modeled through the following tables in GridView:

Table 20: Hourly Resource—General

HourlyResource_General.csv		
Field	**Description**	**Potential Data Source(s)**
GeneratorKey	Internal Use Only. Do Not Change.	GridView
GeneratorName	Unit Name	NREL, PCDS
Type	User Input: Solar, Wind, or Others	NREL, PCDS
CommitmentShapeID	The commitment shape ID for the Hourly Resource.	NREL, PCDS
CommitmentShapeName	The commitment shape name for the Hourly Resource.	NREL, PCDS
CommitmentMultiplier	The commitment multiplier for Hourly Resource, applied to the hourly shape profile	NREL, PCDS
DispatchShapeID	The dispatch shape ID for the Hourly Resource.	NREL, PCDS
DispatchShapeName	The dispatch shape name for the Hourly Resource	NREL, PCDS
DispatchMultiplier	The dispatch multiplier for Hourly Resource, applied to the hourly shape profile	NREL, PCDS
CommitmentVariation	Variation used for unit commitment cycle	NREL, PCDS
CommitmentPdf	Probability density function used for unit commitment cycle	NREL, PCDS
DispatchVariation	Variation used for economic dispatch cycle	NREL, PCDS
DispatchPdf	Probability density function used for economic dispatch cycle	NREL, PCDS
Capacity	Hourly Resouce Unit Capacity	NREL, PCDS

HourlyResource_General.csv		
Field	**Description**	**Potential Data Source(s)**
Spillage	Determine whether program allows the hourly resource unit to spill generation	NREL, PCDS

Table 21: Hourly Resource—Monthly Schedule

Hourly_Resource_Monthly_Schedule.csv		
Field	**Description**	**Potential Data Source(s)**
Generator	Generator name	NREL, PCDS
Type	VOMCost (Variable O&M in $/MWH), FixedCost (Fixed O&M in $/MW–Month), DispatchCost (Dispatch O&M in $/MWH)	NREL, PCDS
M1	Value of first month	NREL, PCDS
M2	Value of second month	NREL, PCDS
…		NREL, PCDS
M12	Value of twelve month	NREL, PCDS

4.4.5. Plant/Unit Identification

Each renewable resource included in the ADS PCM will include —

- Name(s) of the project and unit numbering where applicable (including EIA number if available). Typically, wind and solar plants are comprised of numerous individual units, but, for PCM modeling purposes, the individual units are often modeled as a single generator connected at a specific transmission bus[3];
- Plant shares are assigned to identified Balancing Authorities for the purposes of operating reserves;
- Geographical location (city or county, latitude and longitude); and
- Network location (interconnection bus name and PF transmission bus number).

4.4.6. Operating Characteristics

Each renewable resource included in the ADS PCM will include these operating characteristics:

Unit Parameters

- In-service and retirement dates, initial connected/disconnected status in the case.
- Criteria for activating generators with status initially set to disconnected.
- Criteria for deactivating generators with status initially set to connected.

[3] This is also common practice for PF modeling purposes.

- Type of unit (e.g., wind, solar).

Variable Costs

- Variable O&M ($/MWh)—specified monthly.
  Note: variable O&M can include opportunity costs, if applicable.
  IMPORTANT: In GridView, all entries for a renewable resource's variable O&M are ignored when it comes to economically dispatch the resource; i.e., variable O&M is used only for bookkeeping purposes. If a renewable resource's variable O&M is to be used to economically dispatch the renewable resource, it must also be entered in the "Dispatch Price" field and the "Spillage" box must be checked.
- Dispatch Price ($/MWh)—specified monthly.
  IMPORTANT: In GridView, the Dispatch Price is used to economically dispatch the renewable resource **only if** "Spillage" is checked. The Dispatch Price should reflect the summation of variable O&M and opportunity costs if applicable. For example, if an existing wind plant has a variable O&M of $3/MWh, and an opportunity cost of -$25/MWh (because the wind plant would lose Production Tax Credits equal to $25/MWh for every MWh of curtailment below the plant's Maximum hourly energy output capability), then the Dispatch Price should be entered as -$22/MWh [$3/MWh + (-$25/MWh)].

Operating Constraints

- Maximum hourly energy output capability (MWh) for each hour of a year ("Hourly Profile"). Note that the maximum hourly energy output capability reflects the impact of expected forced and planned outages throughout the year. Forced and planned outages are not separately modeled in the PCM.
- Must Run status. If the "Spillage" box is not checked, GridView will dispatch the maximum hourly energy output capability of the plant regardless of the hourly Locational Marginal Price (LMP) at the transmission bus to which the plant is connected.
  If the "Spillage" box is checked, GridView will economically dispatch the maximum hourly energy output capability according to the specified Dispatch Price. In this case, GridView will curtail the output of the plant below the plant's maximum hourly energy output capability (to 0 MWh) whenever the Dispatch Price of the plant is greater than the hourly LMP at the transmission bus to which the plant is connected.

4.5. Distributed Generation Facilities and Demand Response

In creating the ADS PCM dataset, WECC assumes the definition of distributed generation (DG) here refers to photovoltaic (PV) generation and includes two parts:

- Wholesale DG—PV systems that are connected directly to the electric distribution network and sell the electricity on the wholesale market, typically 1–20 MW and often procured to meet state DG targets.
    - In creating the ADS PCM dataset, WECC assumes that the distributed generation is not included in the L&R load forecasts and DG is modeled as a resource in the dataset. In the dataset, it is treated as "fixed rooftop" solar PV profiles (.dat) and modeled as fixed-shape resource provided by NREL and the resource capacities are provided by L&R.
- Behind-the-meter (BTM) DG—small-scale solar PV installations that individual customers would install to avoid purchasing electricity from an electric utility.
    - BTM DG is provided by estimates developed by Energy + Environmental Economics (E3) and Lawrence Berkeley National Laboratory (LBNL). This forecast is validated against EIA 861 and modified to reflect current policies and utility IRP plans. For California, assumptions developed by the CEC in its load forecast is used. Wholesale DG is provided by the Loads and Resources Subcommittee (LRS) submissions, the EIA, and IRPs and validated through the generator reconciliation effort.
    - BTM PV and DG Adjustments. The forecast BTM PV and DG are added to the loads for each BA. LBNL has been identifying net-metered PV embedded in the L&R load forecasts. The net-metered PV is added back into the loads for the PCM case dataset.
    - DG Generators are also added to the PCM case by area to offset the added load.
- Demand Response (DR)
    - LBNL forecasts DR. The forecast DR is modeled like the BTM PV and DG, where it is added to the loads for each BA. The net-metered PV is added back into the loads for the PCM case dataset.
    - DR generators are also added to the PCM case by area to offset the load.

Each hourly shape is aligned to a common time zone, currently MST.

In GridView, the DG/DR generator distribution must be updated for export to PF. This will distribute the DG/DR generating units that were added in GridView to the proper areas so the exported PF will match the original imported case. Table 14 shows this.

Path in GridView—Tab: Im/Ex, Category: Generator, Item: Generator Distribution: Generation_Distribution.csv

Table 22: Generation—Distribution

Generation_Distribution.csv		
Field	**Description**	**Potential Data Source(s)**
Unit Name	Generator name	User
Unit ID	User defined or from PSS/E PF case.	User
Type	The type of element where the generation is dispatched. Either "BUS" or "AREA"	User

Element Name	Name of Area or Bus ID	User
Ratio	The percentage of total generation on the specified element. Total ratio that belongs to a unit should be 1	E3, LBNL, EIA, CEC, PCDS, PCMS

4.5.1. Validation/Approval

All the information pertaining to distributed generation facilities and demand response is validated by the PCDS, PCMS, and RAC.

4.6. Resource Adequacy

It may be appropriate to prepare an assessment of the resource adequacy before the release of a PCM dataset. There are several different methods for measuring resource adequacy; from a strictly deterministic test to a robust stochastic analysis. The goal is to build an adequate reserve margin into the PCM case as determined by a target planning margin or a loss-of-load probability metric. The evaluation should include—

- Load growth and changes in load patterns;
- Resource changes from expected retirements and additions;
- Expected load carrying capacity by resource type, season, and location;
- Need for flexible resources for areas with a high penetration of variable resources;
- Expected area transfers of remote projects and various other agreements; and
- Avoidance of generation overbuild that would diminish the accuracy of the dataset.

4.6.1. Regional Transfers for Resource Adequacy

It is pointless to try to quantify resource adequacy without including a process for predicting energy imports and exports. Many power plants are sited based on fuel supply and access to multiple customers. This includes many renewable plants such as wind, geothermal, and small hydro. The Western Interconnection has a robust transmission network that supports an active bilateral market and multiple energy imbalance markets.

An area's ability to meet its load and reserve requirements is based on local generation, imports, and exports. Unfortunately, there is no way to predict that ability. One workaround is to determine the surplus and deficit of every BA and then play with transfer scenarios.

4.6.2. Options for Checking Resource Adequacy

WECC has a few options for checking resource adequacy; though, all of them require making assumptions about hourly resource availability and interchange between regions. The more detailed the methodology, the more data is required. For example, the RECAP model that calculates the loss-of-load probability is very data intensive.

A final check is provided by the PCM in the form of a tally of unserved load and hourly operating reserve. A PCM provides generation results and interchange results for every hour of the study (generally every hour of a study year).

5. Load Data

Forecast hourly load shapes are created in a separate spreadsheet independent of GridView. The following procedure outlines the steps used to create and validate load shapes.

5.1. Update Inputs

1. Align base hourly load shapes to common time zone, currently MST.
2. Update with latest WECC monthly load forecast (primary load forecast WECC L&R).
    - For peak demand, use load codes 1–6 and 19.
    - For load, use load codes 23 and 24.
3. Update with latest FERC 714 annual load forecast (secondary load forecast).
4. If a balance area requests an exception to WECC L&R forecast, incorporate changes into forecast spreadsheet.
5. Update historic balance area monthly load based on FERC 714 hourly load.

5.2. Review Forecast Input

1. Set annual forecast and monthly shapes to default WECC L&R data
2. Review forecast load shape with historic shapes for potential error with annual peak demand, and monthly demand shape and monthly load factor.
    - If potential issues are found, review with data submitting balance area with concern
    - Change used values to best available data: annual forecast, monthly peak demand shape, and load shape
    - Review potential issues to the PCDS.
    - After reviewing potential issues with data submitter, use best available data.
3. Review findings with PCDS for approval.

5.3. Create Hourly Load Shapes

1. Once review of forecast data is complete, export the hourly load shapes into EEI files. EEI load shape will still contain the hourly sequence as base input load shape. We currently have 2009 hourly load shapes.
2. Import 2009 load shapes into GridView.
3. Use GridView to adjust hourly load shape to appropriate forecast year without any change to monthly peak demand and load.

Modeling

This is done in GridView through the Dat-LoadArea_Load.csv table

Table 23: Dat-LoadArea_Load

Dat-LoadArea_Load.csv		
Field	**Description**	**Potential Data Source(s)**
LoadAreaName	Name of area	GridView
Year	Year of loads	PCDS
LoadFile	Load shape/profile file	PCDS
PatternName	Load shape/profile name	PCDS

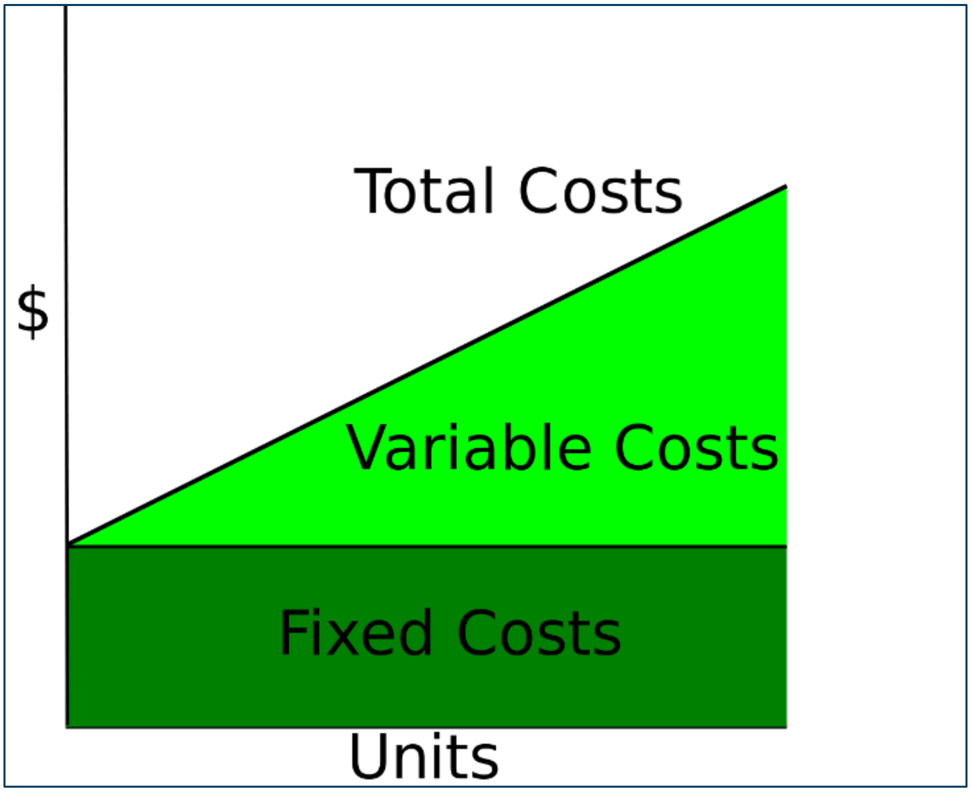
6. Costs and Economics

PCM only covers variable operating costs (VOM). Operating costs include fuel labor and maintenance, unlike capital costs which are "fixed" and do not vary with the level of output. In general, central station generators face a tradeoff between capital and operating costs. Those types of plants that have higher capital costs tend to have lower operating costs. Further, generators which run on fossil fuels tend to have operating costs that are extremely sensitive to changes in the underlying fuel price.

For example: Capital Cost ($/kW) \Operating cost ($/kWh)—NG ($400—$800)\0.04 -0.10; PV ($4,500 and up\less than 0.01.

In scenario analysis, both VOM and fixed costs should be accounted for when considering the most economic project.

Figure 7: Generating Unit Costs



6.1. Reference Year for Cost Data

Inflation Rate

Cost data such as fuel prices, variable O&M rates, and startup costs are often provided in different year's dollars and require conversion to a selected base year dollars. The base year is determined by the PCDS and is usually the build year for the case. For example, the 2030 ADS PCM case is being built in year 2020, thus the base year is 2020, so the case will be built using year 2020 dollars. These conversions are based on the Moody's GDP Inflator/Deflator series, licensed to the CEC.

6.2. Thermal Fuel Prices

Each thermal unit is associated with a fuel price. Fuels modeled in ADS PCM will included—

- Fuel Name;
- Cost schedule of fuel either monthly or daily; and
- Fuel group and correlation among fuel prices in the group.

Table 24: Data Requirement for Fuel Prices

Field	Description	Potential Data Source(s)	G.V. Table Name

FuelID	ID assigned to fuel type (GridView generated)	GridView	FuelList.csv
Fuel Name	User defined fuel name	User	FuelList.csv
DefaultFuel	Fuel Name	User	FuelCost_Monthly.csv
Year	Either base year or user-defined year	User	FuelCost_Monthly.csv
Jan (…Dec)	Monthly fuel rate	Possible sources EIA, CEC, NPCC, WECC subcommittee	FuelCost_Monthly.csv
Fuel Group ID	ID assigned to fuel group (GridView generated)		FuelGroup.csv
Fuel Group Name	User defined fuel group name	User	FuelGroup.csv
Percentile	User defined	User	FuelGroup.csv
Distribution	Fuel price volatility by probability distribution function	User	FuelGroup.csv

6.3. Modeling

In GridView, this is done through the following tables: FuelCost_Monthly.csv, FuelList.csv, FuelGroup.csv

6.4. Non-Fuel Startup Costs

1. **Plant Maintenance Cost**

The plant maintenance cost for each thermal unit in the ADS PCM will include—

- Start Date;
- Start Hour;
- End Date;
- End Hour; and
- Derate capacity under partial maintenance.

Table 25: Data Requirements for Plant Maintenance Cost

GeneratorMaintenance.csv		
Field	**Description**	**Potential Data Source(s)**
GeneratorKey	Unique ID for generator	G.V. generated
Gen Name	Thermal unit name	Data Owner/ PF
M Start Date	Maintenance start date	WECC subcommittee
M Start Hour	Maintenance start hour	WECC subcommittee
M End Date	Maintenance end date	WECC subcommittee
M End Hour	Maintenance end hour	WECC subcommittee

GeneratorMaintenance.csv		
Field	**Description**	**Potential Data Source(s)**
Derate Cap (MW)	The new capacity under partial maintenance	WECC subcommittee

2. **Plant Start-up cost**

   The plant start-up cost for each thermal unit in the ADS PCM will include—

   - Fixed startup cost;
   - Cold start cost; and
   - Fuel type.

Table 26: Data Requirements for Plant Start-up Cost

Generator_Startup_Cost.csv		
Field	**Description**	**Potential Data Source(s)**
Unit Name	Thermal Unit Name	Data Owner/PF
Fixed Startup Cost	Cost for thermal unit to startup	Possible sources EIA, CEC, NPCC, WECC subcommittee
Cold Start Cost	Cost for thermal unit to initially startup	Possible sources EIA, CEC, NPCC, WECC subcommittee
Startup Fuel	Primary fuel name for thermal unit	User defined

3. **Fixed O&M (FOM) and Variable O&M (VOM) costs:**

The fixed O&M and variable O&M costs for thermal units in ADS PCM will include—

Table 27: Data Requirements for Plant FOM and VOM Costs

MonthlyVarSchedule.csv		
Field	**Description**	**Potential Data Source(s)**
Generator Name	Thermal Unit Name	Data Owner/PF
DataTypeName	FOM and VOM cost or Economy Max (EcoMax) or Min (EcoMin)	User Defined
DataTypeID	FOM and VOM cost or Economy Max (EcoMax) or Min (EcoMin)	User Defined
Year	Study year. Default year = 0	User defined
Jan (…Dec)	Monthly variables (VOM = $/MWH; FOM = $/MW–Month).	Possible sources EIA, CEC, NPCC, WECC subcommittee

7. Market Model

The market model (or system model) includes only non-physical constraints, limitations, operation requirements, in operation and settlement, etc. This includes transmission charges, emission charges, remote generator representation, remote generation assumptions and system regulation, etc.

7.1. BAA Model

A BAA is a collection of generation, transmission, and loads in the metered boundaries of the BA. The BA maintains load and resource balance within this area.

The BAA model is made up primarily by the area and region models.

7.1.1. Area

Each area modeled in the ADS PCM will include—

Path in GridView—Tab: Im/Ex, Category: Area, Item: General Information: Area_General.csv

Table 28: Area—General

Area_General.csv		
Field	**Description**	**Potential Data Source(s)**
LoadAreaID	ID number for each load area	User
LoadAreaName	User-defined	User
RegionName	Which GridView Region Name the bus has been assigned to	User
EnforcedReserve	Indicates whether the Reserve is enforced with Yes or No	User, PCDS
Commitment	Indicates whether the Commitment is monitored/enforced with Yes or No	User, PCDS
Dispatch	Indicates whether the Dispatch is monitored/enforced with Yes or No	User, PCDS
Reserve (%)	Reserve Requirement by percent of the load (0~100)	User, PCDS
BaseLoad (%)	Reserve based on the Load percentage (0~100)	User, PCDS
Generation (%)	Reserve based on the Generation percentage (0~100)	User, PCDS
MWReserve	Reserve Requirement by MW Spin Portion (%)	User, PCDS
Spin Portion (%)	Spin Percentage of total reserve (0~100)	User, PCDS
MC Variation	Random Variable Variation = (Standard deviation)/Mean	User, PCDS
MC Percentile	Percentile for Random Variable (0~100)	User, PCDS

Area_General.csv		
Field	**Description**	**Potential Data Source(s)**
MC Distribution	Distribution function: 0-Uniform, 1-Normal, 2-LogNormal	User, PCDS
Cost_UB	The upper bound of the cost of unserved load	User, PCDS
Cost_LB	The lower bound of the cost of unserved load	User, PCDS
Cost_Blocks	The number of blocks for unserved load cost curves	User, PCDS
BaseLoad (MW)	Reserve based on the Load MW	User, PCDS
loadProfileScalar (%)	The loss percentage for the area percentage (0~100)	User, PCDS
LossPercentage (%)	The loss percentage for the area percentage (0~100)	User, PCDS
IfUseShapeAdder	Indicates if whether the Shape added is enforced with Yes or No	User, PCDS
ShapeAdderMultiplier	The multiplier for shape, applied to the hourly shape profile	User, PCDS
ShapeAdderFile	The shape name for the adder	User, PCDS
GHGVisibleForCommitment	Indicates whether the Commitment is monitored/enforced with Yes or No	User, PCDS
GHGVisibleForDispatch	Indicates whether the Dispatch are monitored is enforced with Yes or No	User, PCDS
InsideGHGFootPrints	Indicates whether the greenhouse gas (GHG) footprint is monitored is enforced with Yes or No	User, PCDS
LossInterfaceMonitored	Indicates whether the interface losses are monitored is enforced with Yes or No	User, PCDS

7.1.2. Region

Each Region modeled in the ADS PCM will include—

Path in GridView—Tab: Im/Ex, Category: Region, Item: General Information: Region_General.csv

Table 29: Region—General

Region_General.csv		
Field	**Description**	**Potential Data Source(s)**
Region Name	User-defined	User
EnforcedReserve	Indicates if whether the Reserve is enforced with Yes or No	User, PCDS
CommitmentReserve (%)	Commitment Reserve Requirement by percent of the load (0~100)	User, PCDS
CIfExternalSystem	If the region is part of the study system	User, PCDS
BaseLoad (%)	Reserve based on the Load percentage (0~100)	PF case
Generation (%)	Reserve based on the Generation percentage (0~100)	User, PCDS
MWReserve	Reserve Requirement by MW	User, PCDS
ReserveSelect		User, PCDS
Spin Portion (%)	Spin Percentage of total reserve (0~100)	User, PCDS
ExtLossModeled	Indicates if the external losses are monitored is enforced with Yes or No	User, PCDS
LargestOnLineUnit	Indicates whether the largest unit online is selected with Yes or No	User, PCDS
CapMultiplier	Capacity multiplier for the largest online unit	User, PCDS
IfUseShapeAdder	Indicates whether the Shape added is enforced with Yes or No	User, PCDS
ShapeAdderMultiplier	The multiplier for shape, applied to the hourly shape profile	User, PCDS
ShapeAdderFile	The shape name for the adder	User, PCDS
Commitment	Indicates whether the Commitment is monitored/enforced with Yes or No	User, PCDS
Dispatch	Indicates whether the Dispatch are monitored is enforced with Yes or No	User, PCDS

Region_General.csv		
Field	**Description**	**Potential Data Source(s)**
LossInterfaceMonitored	Indicates whether the interface losses are monitored is enforced with Yes or No	User, PCDS

7.1.3. Validation/Approval

All the information pertaining to region and area is validated by the PCDS, PCMS, and RAC.

7.2. Hurdle Rates Model

Hurdle rates represent the cost to deliver surplus energy among different regions or BAAs. A hurdle is a cost adder for generators in PCM, normally modeled on interfaces between BAAs (regions). The purpose of modeling hurdles in PCM is to have a realistic dispatch and flow pattern across the system.

Hurdle rates may include:

- Wheeling charge rates (Transmission Access Charge)—charges paid to the owner of a transmission line for the right to transport power across the line;
- Grid management charges; and
- Market friction—PCM (of Western Interconnection) assumes a single market, which is not true in reality. Market and operation hurdles always exist in reality.

The hurdle model in ADS PCM is based on export wheeling. Trading hubs have zero export hurdle.

7.2.1. Validation/Approval

All the information pertaining to hurdle rates is validated by the PCDS, PCMS, and RAC.

7.3. Wheeling Charge Model

Wheeling charges are defined at the region level for BAAs or utilities Transmission Access Charges (TAC) or tariff.

The source for the tariff rates are derived from is the Open Access Same-time Information System (OASIS) rates posted by the applicable transmission owners as compiled by the California Independent System Operator (CAISO).

The wheeling charge rates for the PCM are modeled as tariffs in the interfaces. For the PCM, we assign wheeling charges to this interface table:

Path in GridView—Tab: Im/Ex, Category: Interface, Item: General Information: InterfaceGeneral.csv

Table 30: Interface—General

InterfaceGeneral.csv

Field	Description	Potential Data Source(s)
…	…	…
Forward Tariff 1	First forward tariff price of the wheeling interface	CAISO OASIS
UC Forward Friction 1	First UC Export Friction price of the zonal wheeling	CAISO OASIS
ED Forward Friction 1	First ED Export Friction price of the zonal wheeling	CAISO OASIS
Forward MW 2	Second forward MW of the wheeling interface	CAISO OASIS
Forward Tariff 2	Second forward tariff price of the wheeling interface	CAISO OASIS
UC Forward Friction 2	Second UC Export Friction price of the zonal wheeling	CAISO OASIS
ED Forward Friction 2	Second ED Export Friction price of the zonal wheeling	CAISO OASIS
…	…	…

7.3.1. Validation/Approval

All the information pertaining to wheeling charges is validated by the PCDS, PCMS, and RAC.

7.4. Greenhouse Gas (GHG) Model

The GHG model is defined on regional boundary interfaces.

Greenhouse Gas model is modeled as a percentage tax in the LMP for California, Alberta, and BC.

There are a few tables to consider when creating the GHG model:

Path in GridView—Tab: Im/Ex, Category: Emission, Item: Emission Type: EmissionType.csv

Table 31: Emission Type

EmissionType.csv		
Field	**Description**	**Potential Data Source(s)**
EmissionID	ID assigned to emission type (GridView generated)	GridView
Emission Name	User-defined emission name	User
Monitor	Indicates whether the emission type is being monitored with Yes or No	User
EmissionType	Either “Fuel Based” or “Unit Based”	User

Path in GridView—Tab: Im/Ex, Category: Emission, Item: Fuel Emission Rate: FuelEmissionRate.csv

Table 32: Fuel Emission Rate

FuelEmissionRate.csv		
Field	**Description**	**Potential Data Source(s)**
FuelName	Specific name of fuel	User
EmissionType	User-defined emission name (i.e., SO2, CO2, NOx…)	User
Year	Study Year. Default year = 0.	User
EmissionRate(lb/MMBtu)	Emission rate (lb/MMBtu)	EIA, PCDS

Path in GridView—Tab: Im/Ex, Category: Emission, Item: Emission Group: EmissionGroup.csv

Table 33: Emission Group

EmissionGroup.csv		
Field	**Description**	**Potential Data Source(s)**
EmGroupID	GridView generated	GridView
EmGroupName	User-defined	User
EmissionName	User-defined emission name	User
GeneratorName	Unit name	User
Percentage	The percentage for emission group ownership	EIA, PCDS

Path in GridView—Tab: Im/Ex, Category: Emission, Item: Emission Allowance: EmissionAllowance.csv

Table 34: Emission Allowance

EmissionAllowance.csv		
Field	**Description**	**Potential Data Source(s)**
EmGroupOption	0-Area, 1-Region, 2-System, 3-Customized	User
EmGroupName	User defined	User
EmTypeID	Emission pollutant type: 0-SO2, 1-NOx, 2-CO2	User
Enforced	YES if the allowance must be respected in simulation; otherwise NO	User
Allowance(Short Ton)	Allowed pollutant amount in Ton	EIA, PCDS
StartDate	StartDate Start date of emission allowance	EIA, PCDS
EndDate	End date of emission allowance	EIA, PCDS
Tolerance(%)	Tolerance level to determine the convergence of the iterative algorithm	EIA, PCDS
CreditCost($/lb)	Credit cost for emission in ($/lb)	EIA, PCDS

7.4.1. Validation/Approval

All the information pertaining to greenhouse gases is validated by the PCDS, PCMS, and RAC.

7.5. Transmission Rights Model

Transmission rights models are not currently modeled in the ADS PCM, but can be modeled through the Congestion Revenue Rights (CRR) model in the PCM if desired.

7.6. Remotely Owned/Contracted Generator Model

With the topology for area loads and regions, it is necessary to associate remotely owned (or contracted) resources with the participating areas or regions. "Remote Resources" are defined as resources that have an attached transmission service agreement in place to supply a certain amount of power per that agreement. This provides the information that GridView needs to count the generation shares for reserves and to deliver the associated energy with no hurdle rate charge (assumes that delivery cost is a fixed cost). The list of remote generators that are modeled in the dataset is dynamic and dependent on stakeholder input.

Remote generator models are defined on interfaces for market friction or access charges.

Remote generators are exempt from the export wheeling charges of the regions they physically locate.

Remote generation can be assigned through the emission group table. Assign each generator to the proper emission group.

Path in GridView—Tab: Im/Ex, Category: Emission, Item: Emission Group: Emissiongroup.csv

Table 35: Emission Group

EmissionGroup.csv		
Field	**Description**	**Potential Data Source(s)**
EmGroupID	GridView generated	GridView
EmGroupName	User defined	User
EmissionName	User defined emission name	User
GeneratorName	Unit name	User
Percentage	The percentage for emission group ownership	EIA, PCDS

Path in GridView—Tab: Im/Ex, Category: Generator, Item: Reserve Capacity Distribution: ReserveCapacity_Distribution.csv

Table 36: Reserve Capacity Distribution

ReserveCapacity_Distribution.csv		
Field	**Description**	**Potential Data Source(s)**
Unit Name	Generator Name	User

ReserveCapacity_Distribution.csv		
Field	**Description**	**Potential Data Source(s)**
Type	The type of element where the generation is dispatched. Either "BUS" or "AREA"	User
Element Name	Name of Area or Bus ID	User
Ratio	The percentage of total generation on the specified element. Total ratio that belongs to an unit should be 1	L&R
IfExempt	Enforce unit to exempt or not	User
WaiveExportWheeling	Enforce unit to waive export wheeling or not	User
Dynamic Proportion	The portion of the unit to contribute to the dymanics	L&R, User

7.6.1. Validation/Approval

All the information pertaining to remotely owned generation is validated by the PCDS, PCMS, and RAC.

7.7. Ancillary Service (AS) Model

Ancillary services (AS) are defined at the BAA or region level.

Ancillary services are modeled through the following table:

Path in GridView—Tab: Im/Ex, Category: Ancillary Services, Item: AS Req by Area/Region/Combined: AS_Requirement_Area_Region.csv

Table 37: AS Requirement by Area or Region

AS_Requirement_Area_Region.csv		
Field	**Description**	**Potential Data Source(s)**
Name	Area or region name	User
Area/Region	Area or region	User
Enforced	Yes or No	User
Ratio of Load	Ratio	CAISO, PNNL, WestConnect
Ratio of Generation	Ratio	CAISO, PNNL, WestConnect
AS Adder (MW)	ASType: 1-Regulation Down 2-Load Following Down 3-Regulation Up 4-Spinning Reserve 5-nonSpinng Reserve 6-Load Following Up 7-Frequency Response	CAISO, PNNL, WestConnect

AS_Requirement_Area_Region.csv		
Field	**Description**	**Potential Data Source(s)**
IfUseLargestOnlineUnit	Yes or No	CAISO, PNNL, WestConnect, User
UnitCapMultiplier	Multiplier	CAISO, PNNL, WestConnect, User
IfUseShapeAdder	Yes or No	CAISO, PNNL, WestConnect, User
ShapeAdderMultiplier	Multiplier	CAISO, PNNL, WestConnect, User
ShapeName	Name of shape to apply	CAISO, PNNL, WestConnect, User

7.7.1. Validation/Approval

All the information pertaining to ancillary services is validated by the PCDS, PCMS, and RAC.

7.7.2. A/S Requirements

- Regulation up/down.
- Spin/non-spin.
- Load following up/down.
- Frequency response.

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