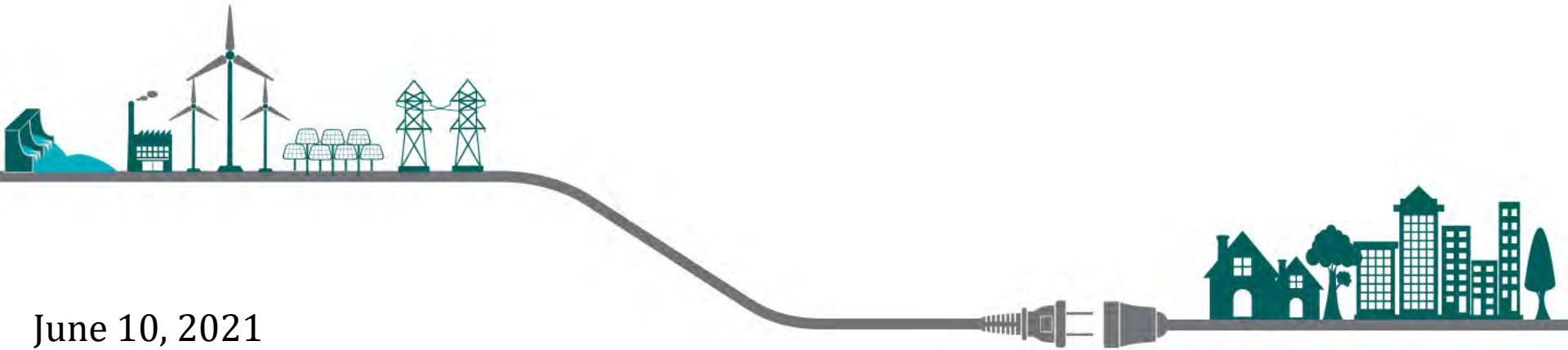
Modeling Reserve Requirements

Variable Energy Resource Integration Study



June 10, 2021

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Variable Energy Resource Integration Studies

- Purpose of Variable Energy Resource (VER) Integration Studies
  - Determine increased regulation reserve requirements and costs for integrating VERs

- Regulation reserve requirements from VER Integration Studies are used for IRP modeling within Aurora

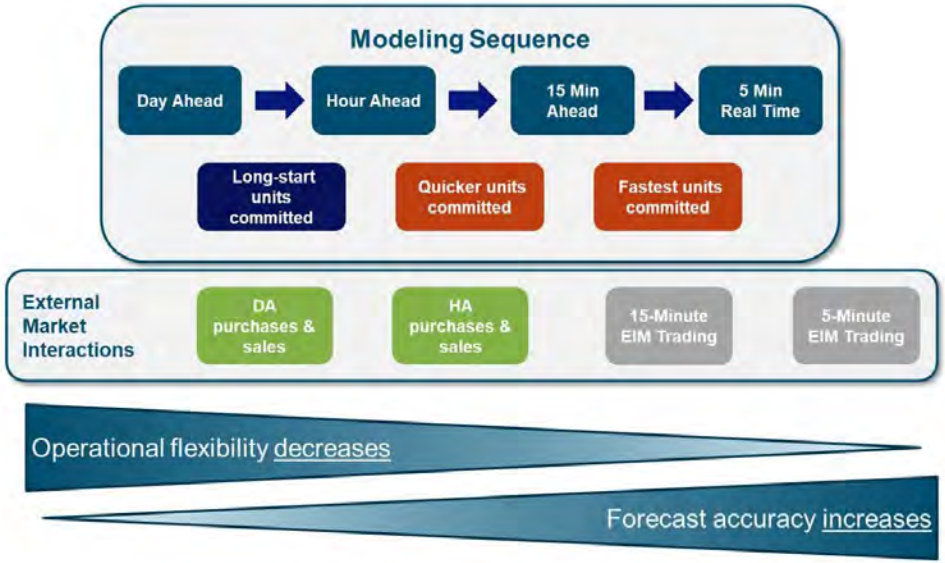
VER Integration Cost Definition

1. Costs incurred due to increased cycling of dispatchable units
   - Increased unit stops and starts
   - Increased ramping costs
2. Costs incurred due to less optimal unit commitment and dispatch due to resource variability
   - Increased fuel and market transaction costs for reserves

For IRP analysis, integration costs are modeled as increased level regulation reserve requirement.

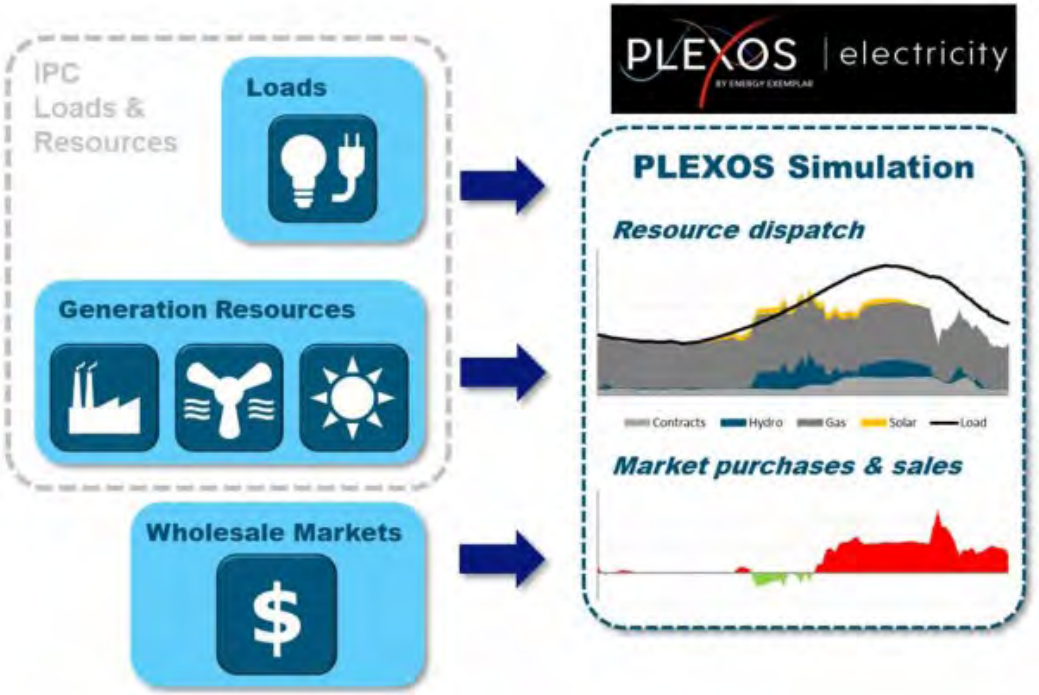
2020 VER Integration Study

- Included in 2019 IRP action plan
- Study performed by E3 (Energy and Environmental Economics, Inc.)
  - Multistage Model (PLEXOS)

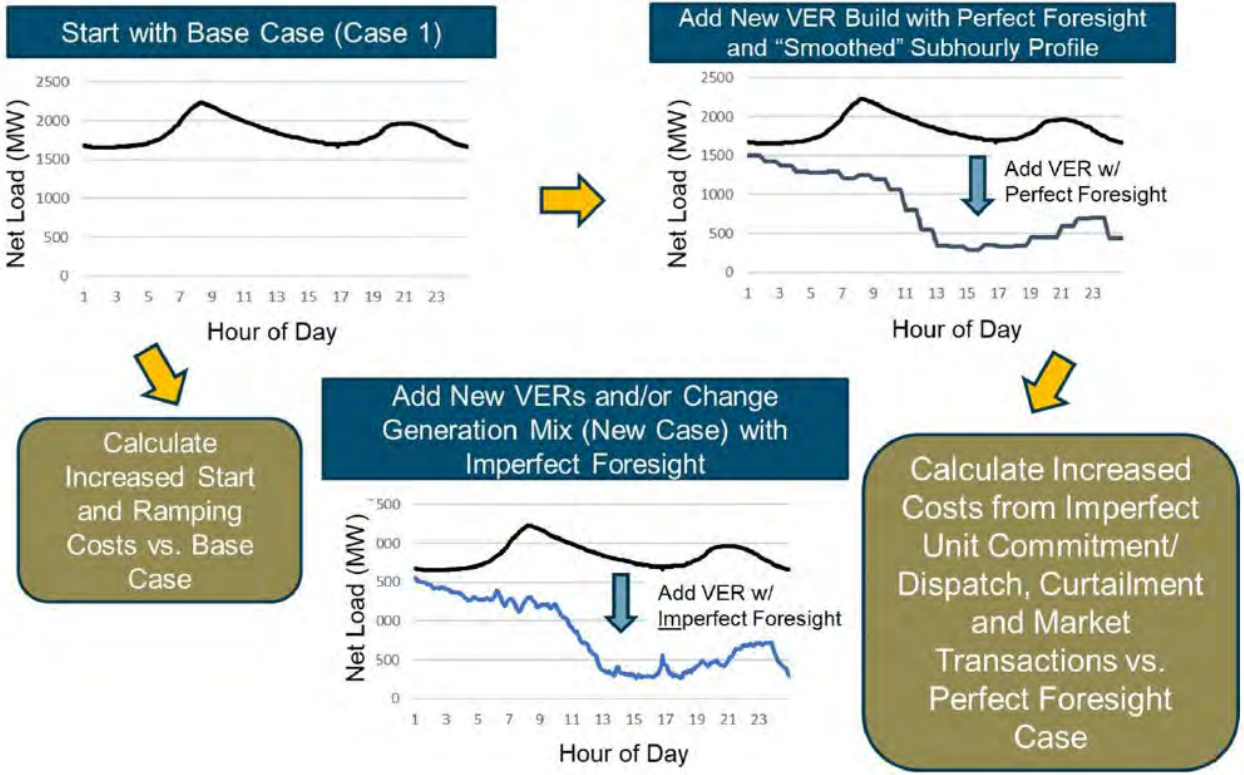


PLEXOS Model Benchmarking

- Benchmarked against 2019 historical data
- Hells Canyon Complex capability verified
  - Hydro budgets
  - Daily generation limits
  - Ramp rates



Study Methodology



Study Scenarios – Base Cases

Case	Description	First Bridger Unit	Solar Base Capacity	Wind Base Capacity	Hydro Conditions	New 2023 Solar Build	New 2023 Wind Build
1	Base Case	Exited	561 MW	728 MW	Normal	0 MW	0 MW
2	Base Case + First Bridger Unit Online	Online	561 MW	728 MW	Normal	0 MW	0 MW
7	Existing Solar Base Case	Exited	310 MW	728 MW	Normal	0 MW	0 MW

- 2023 is the study year for all scenarios.
- Case 1 and Case 2 base scenarios include Jackpot Solar (120 MW) and additional PURPA solar (131 MW).
- Existing solar base case includes 310 MW of solar from 2019 benchmarking year.

High Solar and Wind Scenarios

Case	Description	First Bridger Unit	Solar Base Capacity	Wind Base Capacity	Hydro Conditions	New 2023 Solar Build*	New 2023 Wind Build*
3	High Solar	Exited	561 MW	728 MW	Normal	794 MW	0 MW
4	High Solar, Low Hydro	Exited	561 MW	728 MW	Low	794 MW	0 MW
5	High Wind	Exited	561 MW	728 MW	Normal	0 MW	669 MW
6	High Solar + High wind	Exited	561 MW	728 MW	Normal	794 MW	669 MW

*2023 incremental solar and/or wind builds modeled at 10% average Idaho Power demand

Additional Scenario Cases

Case	Description	First Bridger Unit	Solar Base Capacity	Wind Base Capacity	Hydro Conditions	New 2023 Solar Build	New 2023 Wind Build
8	High Solar, High Hydro	Exited	561 MW	728 MW	High	794 MW	0 MW
9	High Solar + 200 MW Storage	Exited	561 MW	728 MW	Normal	794 MW	0 MW
10	High Solar + 400 MW Storage	Exited	561 MW	728 MW	Normal	794 MW	0 MW
11	Curtailable Solar	Exited	561 MW	728 MW	Normal	794 MW	0 MW

Regulation Values from 2020 E3 Study

Case #	Total MW Online Wind (MW)	Total MW Online Solar (MW)	Avg. CAISO RT15 FRP Up (MW)	Avg. CAISO RT15 FRP Down (MW)	Avg. Reg. Up (MW)	Avg. Reg. Down (MW)	Avg. Conting. Reserves (MW)	Avg. Total Reserves Up (percent of Avg. Load)	Avg. Total Reserves Down (percent of Avg. Load)
1. 2023 Base Case	728	561	100	97	40	41	104	10 %	7 %
2. 2023 Base Case w/out Bridger Unit Exit	728	561	100	97	40	41	104	10 %	7 %
3. High Solar	728	1,354	147	142	71	72	104	17 %	11 %
4. High Solar + Low Hydro	728	1,354	147	142	71	72	104	17 %	11 %
5. High Wind	1,396	561	152	147	50	52	104	16 %	10 %
6. High Solar + High Wind	1,396	1,354	193	186	79	81	104	19 %	13 %

2020 VER Integration Study Status

- E3 study work complete
  - Lower regulation reserve requirements
  - Reserve requirements will be put into the 2021 IRP model
- Idaho Power reviewing new integration costs
  - Taking feedback on results from the Technical Review Committee

Questions? Comments?