National Renewable Energy Laboratory
Innovation for Our Energy Future

Quantifying the Value of Dispatchable CSP: Technical Update

Paul Denholm
NREL

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Analytic Goals

- Quantify the benefits of CSP with thermal storage
  - Examine its ability to provide dispatchable energy and ancillary services
  - Examine how the value changes as a function of penetration of other renewables

Technical Update

- New SAM runs to better allow better representation of thermal storage
- Two types of CSP simulated – troughs with indirect storage, towers with direct storage

Implementation of CSP/TES in PLEXOS

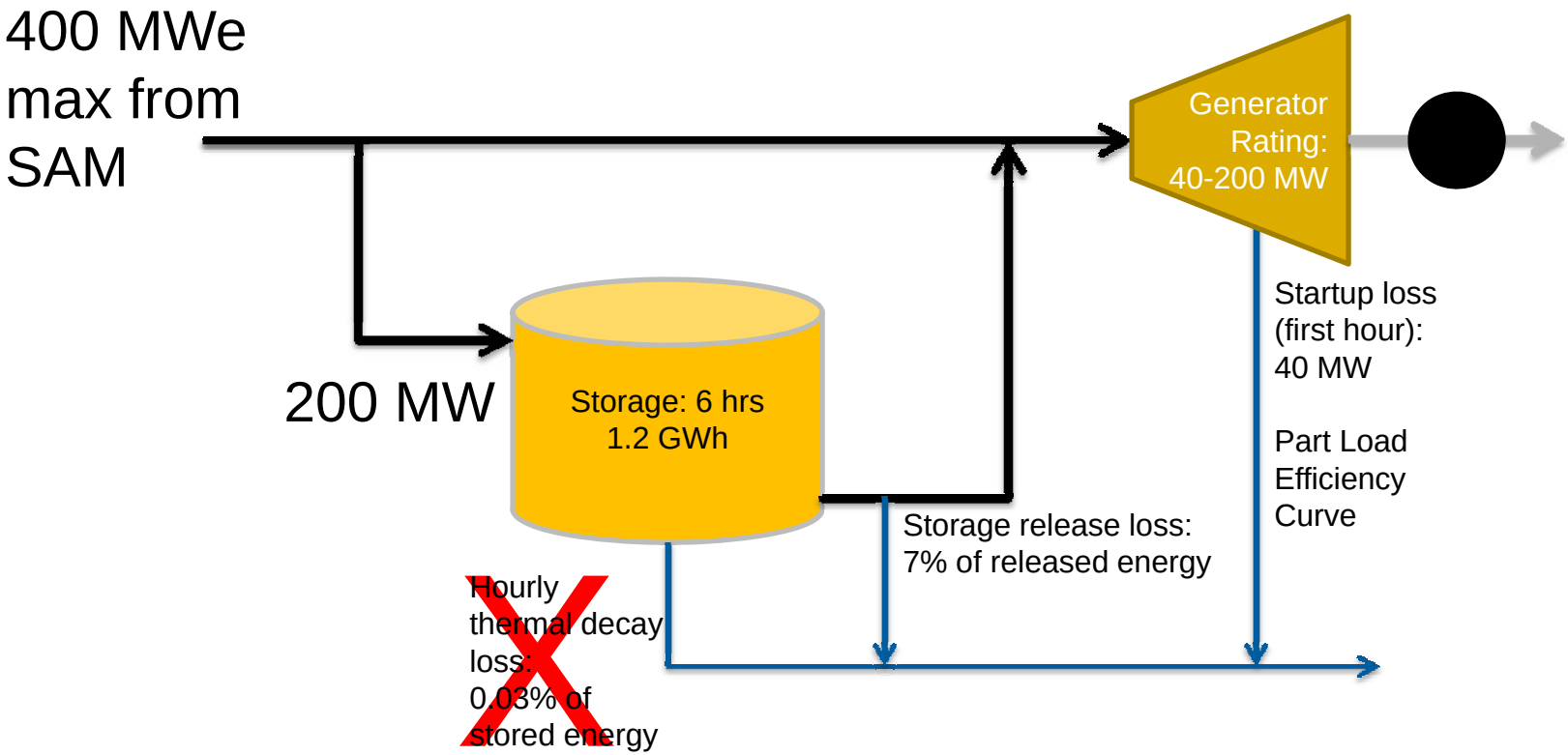
- Part 1 – SAM
- CSP w/o storage SM=1.3, normal values for heat rate start losses, min output etc.
  - Profiles put straight into PLEXOS
- CSP w/storage SAM generates electrical equivalent output from a CSP plant without storage, SM=1, flat heat rate, no start losses, and 0 minimum output level
- Variable parasitic losses are removed from the electric output.
- Constant parasitics are calculated separately
- This creates and electrical equivalent thermal output that can be dispatched by PLEXOS

Implementation of CSP/TES in PLEXOS

- Part 2 – PLEXOS
- Electrical equivalent output from is entered into a modified hydro algorithm. Ratio of electrical output from SAM to power block establishes solar multiple.
- PLEXOS power block accounts for start-up losses, variable heat rate, minimum output level and ramp rate
- Leaks are added to the hydro system to account for round-trip losses in indirect storage and (eventually) decay losses
- Constant parasitics are added as a constant load on the same bus as the CSP plant

Implementation of CSP/TES in PLEXOS

- Example SM = 2



Status

- Completed analysis of the value of CSP in a test system based on PSCO/WACM (Colorado/Wyoming)
- CSP (trough both with and without storage) added to the San Luis Valley, replacing an equivalent amount of PV
- Two scenarios –
  - TEPPC 2020 (BAU) 12% wind/2%PV
  - High RE 25.6% wind/9.5% PV
- Three A/S products (reg, spin, flex)
- PV and CSP w/o TES adds to A/S requirements based on EWIT methodology
- CSP w/TES does not add to A/S requirements, and can provide all services
- Full co-optimization of energy and A/S

Results – TEPPC 2020 Case (14.6% RE)

- What is the difference in value between PV and CSP?
- CSP w/o storage: $1.0/MWh (we didn't attempt to estimate difference in A/S requirements for the different technologies)
- CSP – 8 hours: $10.6/MWh
- CSP – 10 hours: $11.1/MWh

Results – High RE (35%) Case

- What is the difference in value between PV and CSP?
- CSP w/o storage: -$0.8/MWh
- CSP – 8 hours: $19.4/MWh
- CSP – 10 hours: $19.6/MWh

Results – Discussion

- About what we expected and have seen from WECC GridView, preliminary CAISO analysis and Mills & Wiser results
- Again, A/S isn't a savior
- Capacity value to be added, but reminder at low penetration CSP ~ PV,

Next steps

- Run a tower case
- Run a coal retirement case closer to CO clean air/clean jobs
- NG price sensitivity
- Distribute draft early September
- Finish ongoing CAISO analysis