The Value of CSP with Dispatchable Thermal Energy Storage

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• CSP with dispatchable thermal energy storage provides and maintains both operational benefits (fuel and emissions) and capacity (reliability) benefits to regional grids

• This is especially true at high penetrations of variable renewable technologies such as PV and wind

• CSP can support additional generation of variable technologies due to its flexibility relative to inflexible baseload coal generation.
PLEXOS Analysis of Operational and Capacity Benefits of CSP in Southwest Balancing Area
Lowest solar multiples (lower annual capacity factors) yield the highest operational system value
CSP integrated with thermal energy storage maintains high capacity value

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<th>Capacity Credit (%)</th>
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<tr>
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<td>CSP-TES</td>
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<td>(with &gt; 3 Hrs Storage)</td>
<td>92.2%</td>
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<td>33% RPS Scenario</td>
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<tr>
<td>40% RPS Scenario</td>
<td>96.6%</td>
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NREL 2014
CAISO Analysis – Total Valuation

- Relative value of CSP is $48/MWh greater than PV in the 33% scenario and about $63/MWh greater in the 40% scenario.
Source: Lilliestam et. al., Empirically observed learning rates for concentrating solar power and their responses to regime change”, Nature Energy, 2017
Quantifying the Benefits of CSP with Thermal Energy Storage

Reports available at https://www.nrel.gov/research/publications.html

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Key Words
- Concentrating Solar Power
Investigated the impact of CSP w/ thermal energy storage as an enabling technology for high penetrations of solar (PV and CSP).
Average and marginal curtailment rates of PV in base scenario

- ≈ 23% marginal curtailment at 20% penetration
- ≈ 5% average curtailment at 20% penetration
Marginal curtailment of solar assuming equal energy mix of PV and CSP

No curtailment at 20% Solar Penetration

Fraction of Energy From Solar (PV and CSP)

Solar Curtailment Rate

PV

PV plus CSP
Marginal curtailment of solar assuming equal energy mix of PV and CSP and additional CSP grid flexibility

Low curtailment at 30% solar penetration
Thank you!

For more information:
http://www.nrel.gov/csp/

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