



The Value of CSP with Dispatchable Thermal Energy Storage

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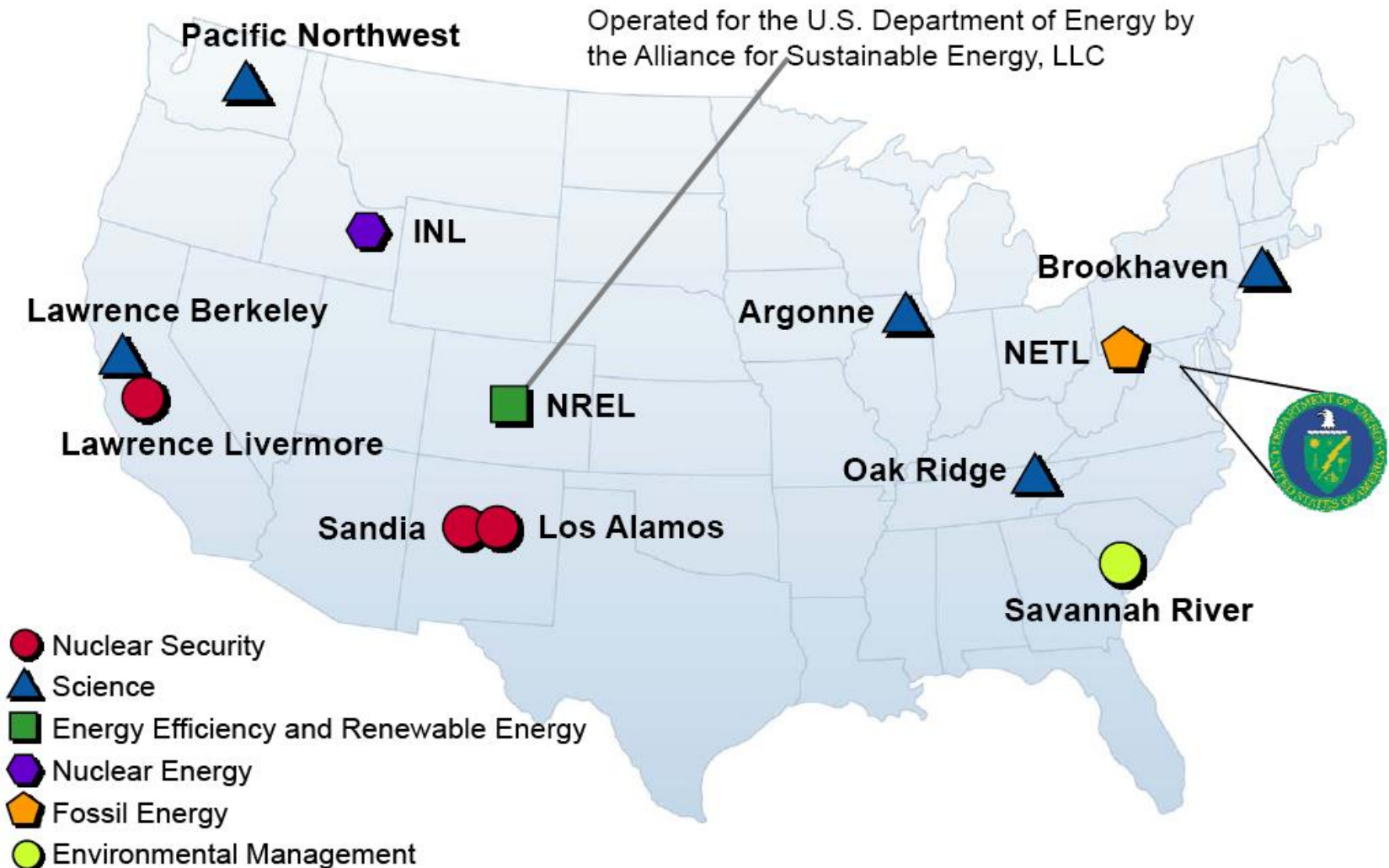
Program Manager, CSP NREL

ATA Webinar: The Solar Dispatchability Challenge

September 5, 2017

U.S. National Laboratories

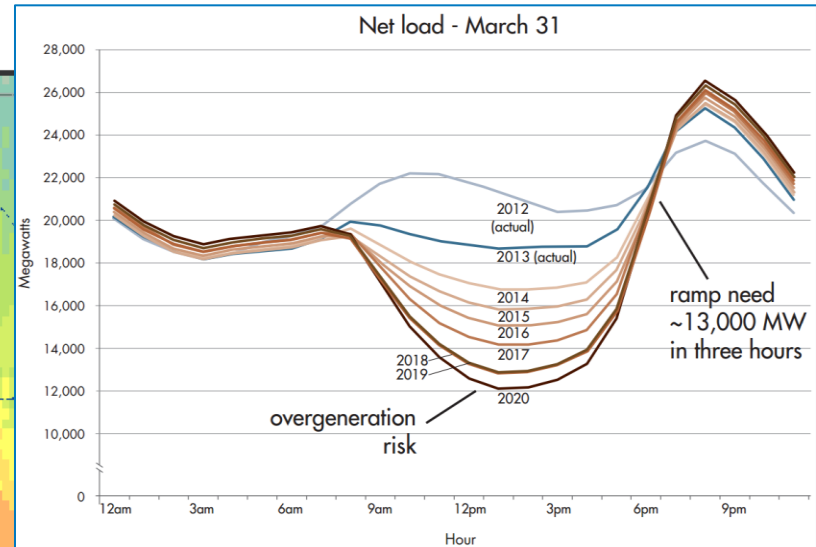
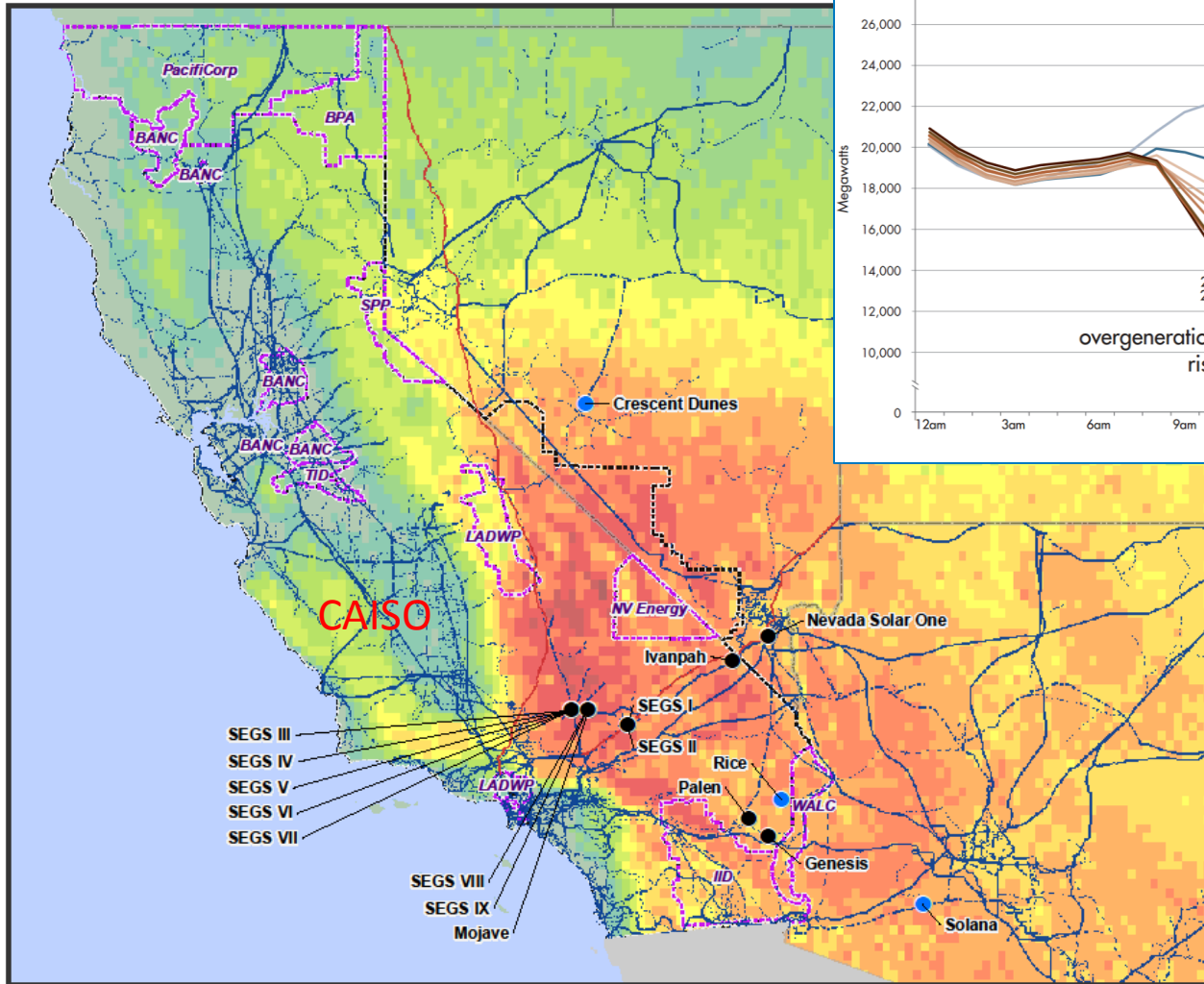
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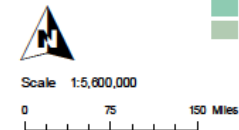
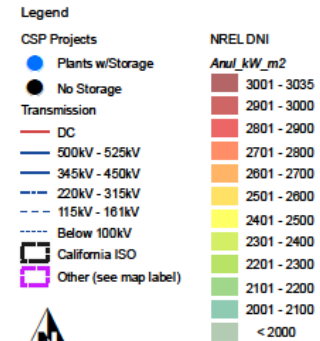
Summary of Discussion

- 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.

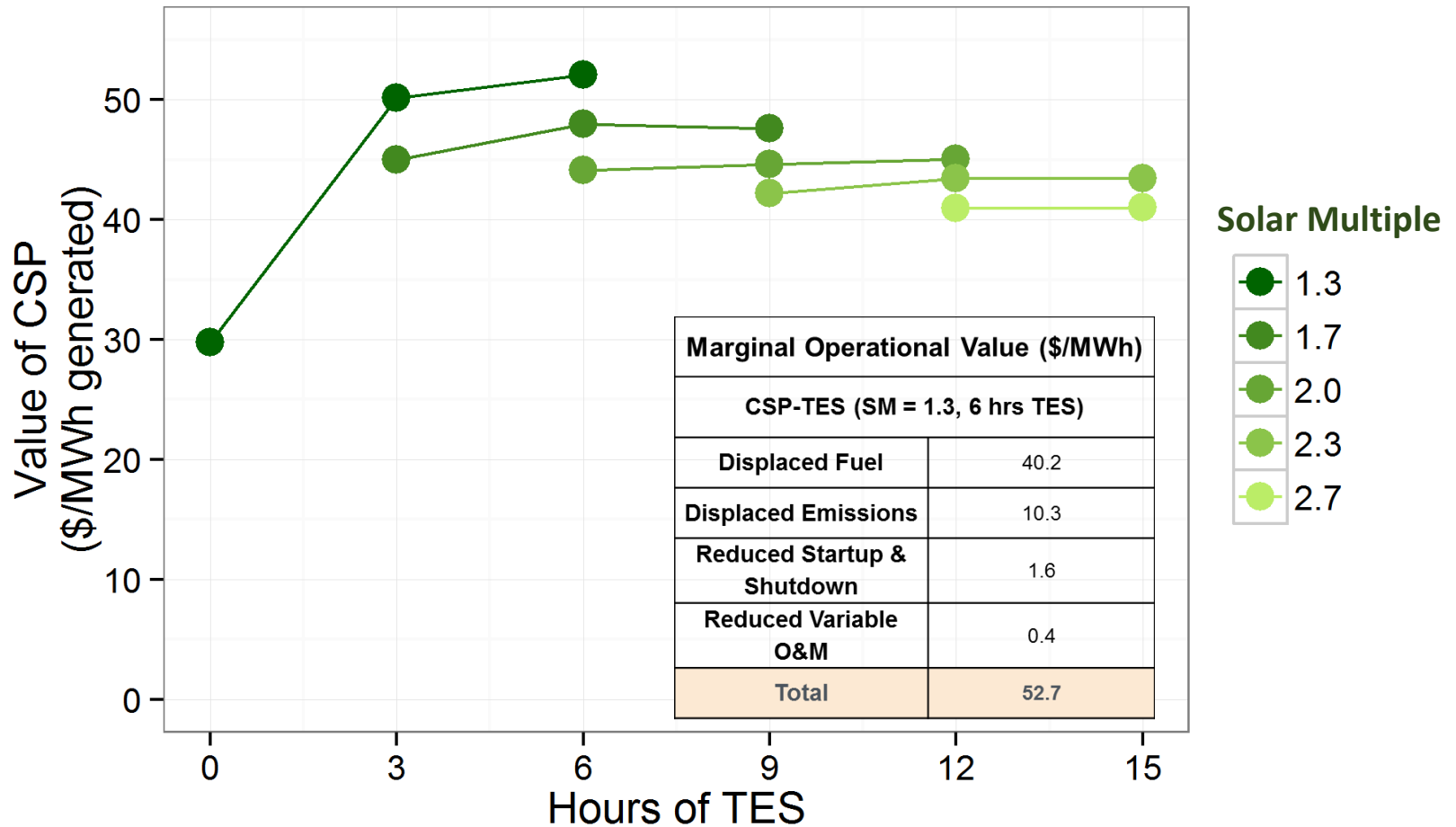
PLEXOS Analysis of Operational and Capacity Benefits of CSP in Southwest Balancing Area



Solar Thermal Plants in Southwestern USA



CAISO Analysis – Operational Value



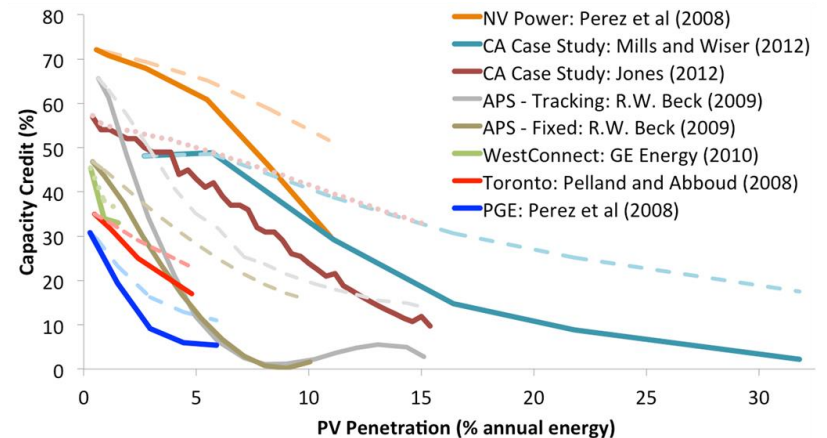
Lowest solar multiples (lower annual capacity factors) yield the highest operational system value

CAISO Analysis – Capacity Value

CSP integrated with thermal energy storage maintains high capacity value

	Capacity Credit (%)	
	CSP-TES (with > 3 Hrs Storage)	PV
33% RPS Scenario	92.2%	22%
40% RPS Scenario	96.6%	3.4%

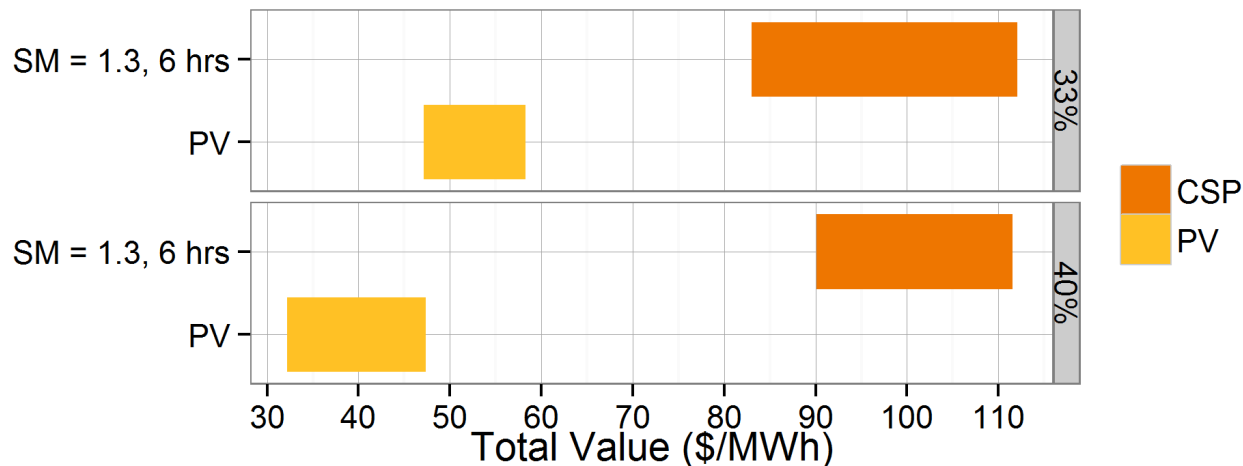
NREL 2014



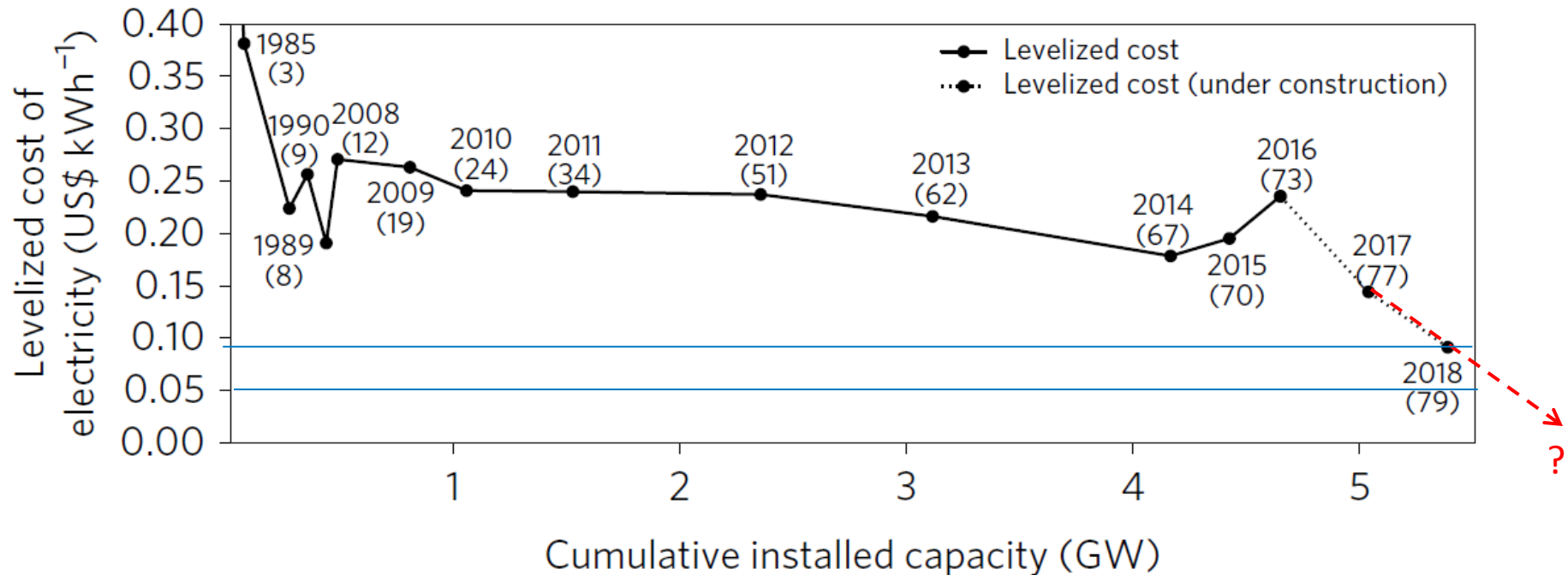
Mills and Wisner 2012

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



Cost Reduction Impact of Policy and Learning



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

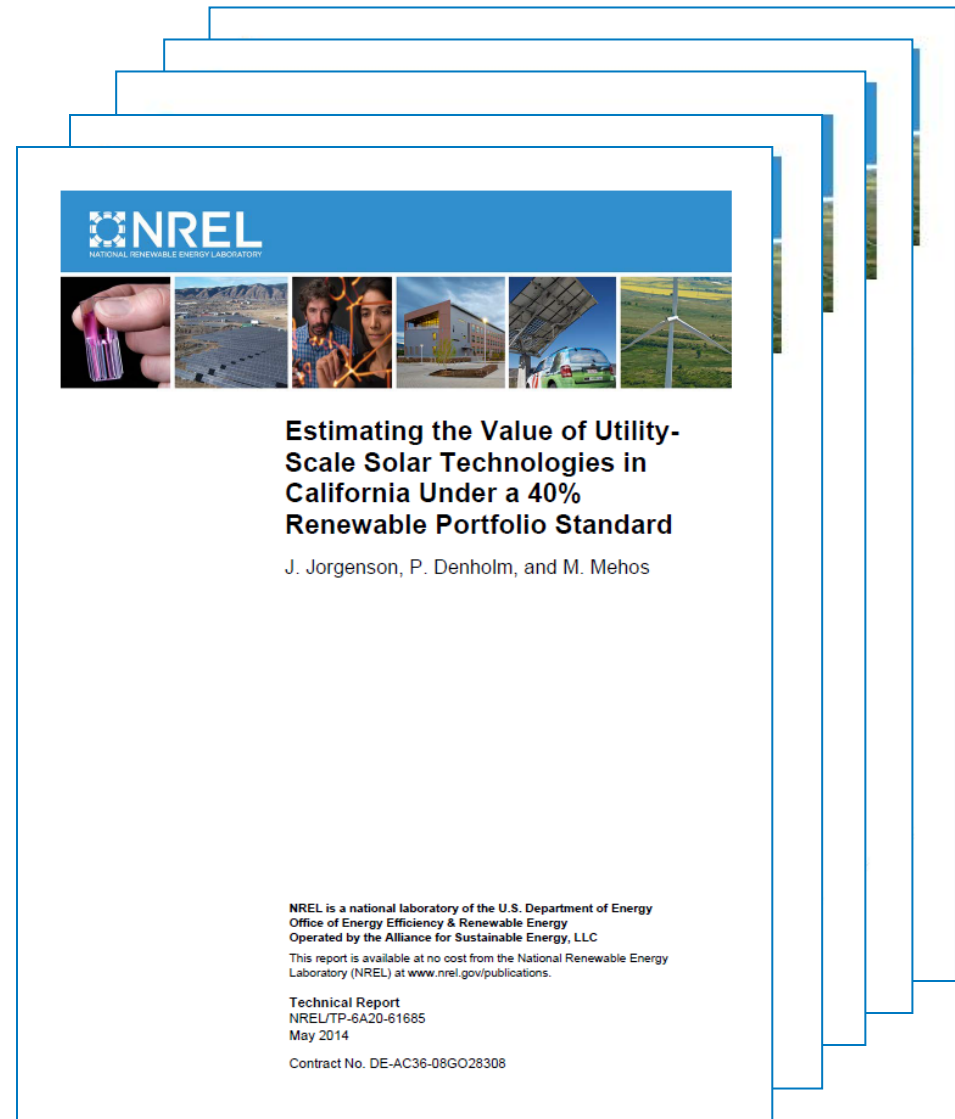
Reports available at
<https://www.nrel.gov/research/publications.html>

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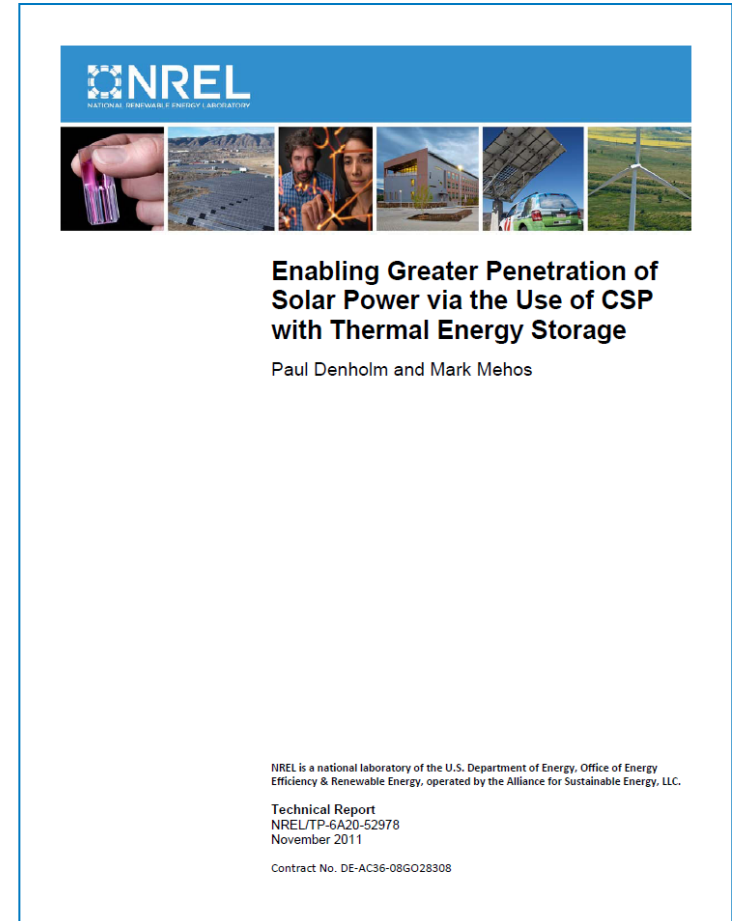
Key Words

- Concentrating Solar Power

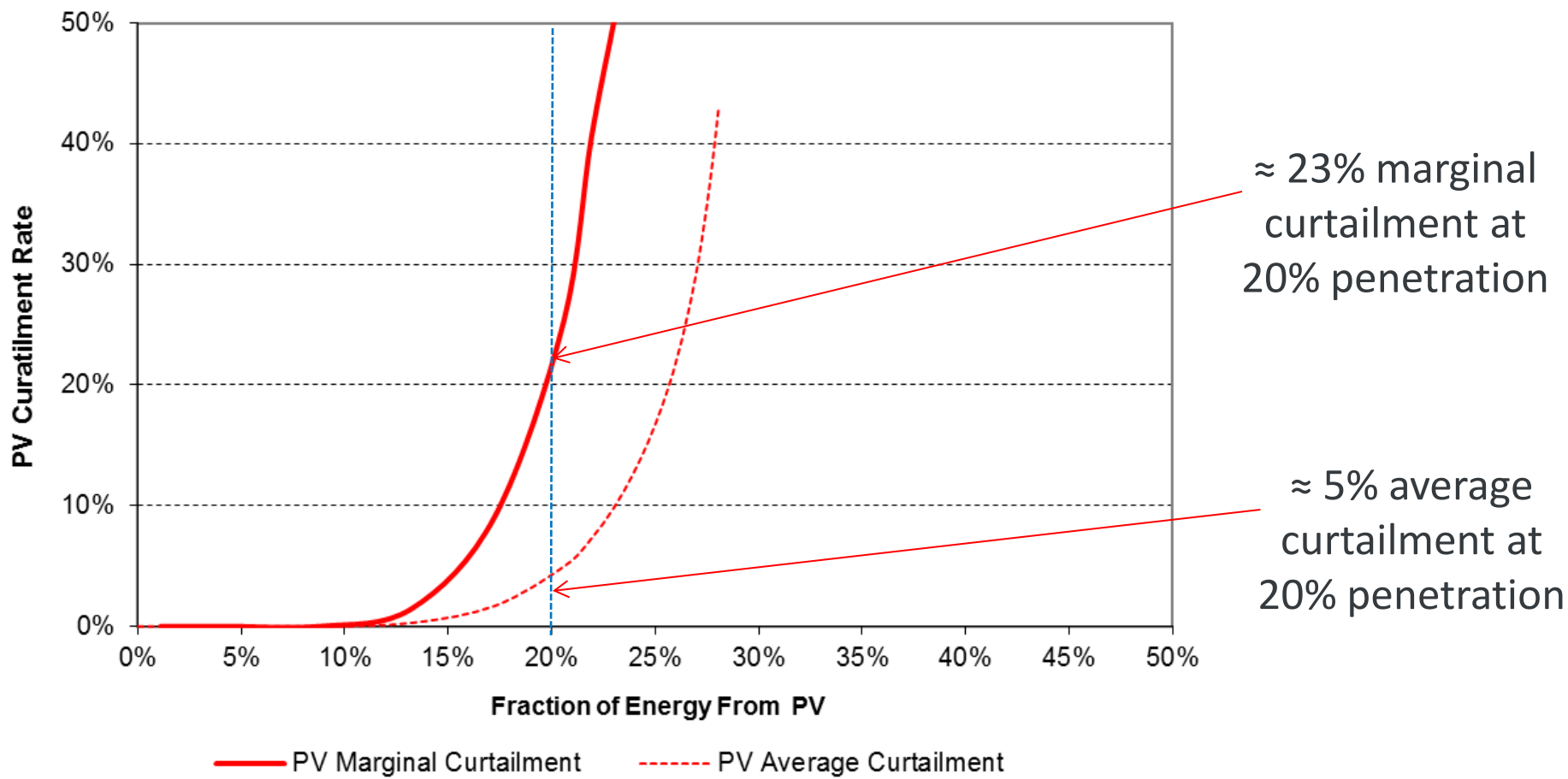


Synergistic Benefits of PV and CSP with Thermal Energy Storage

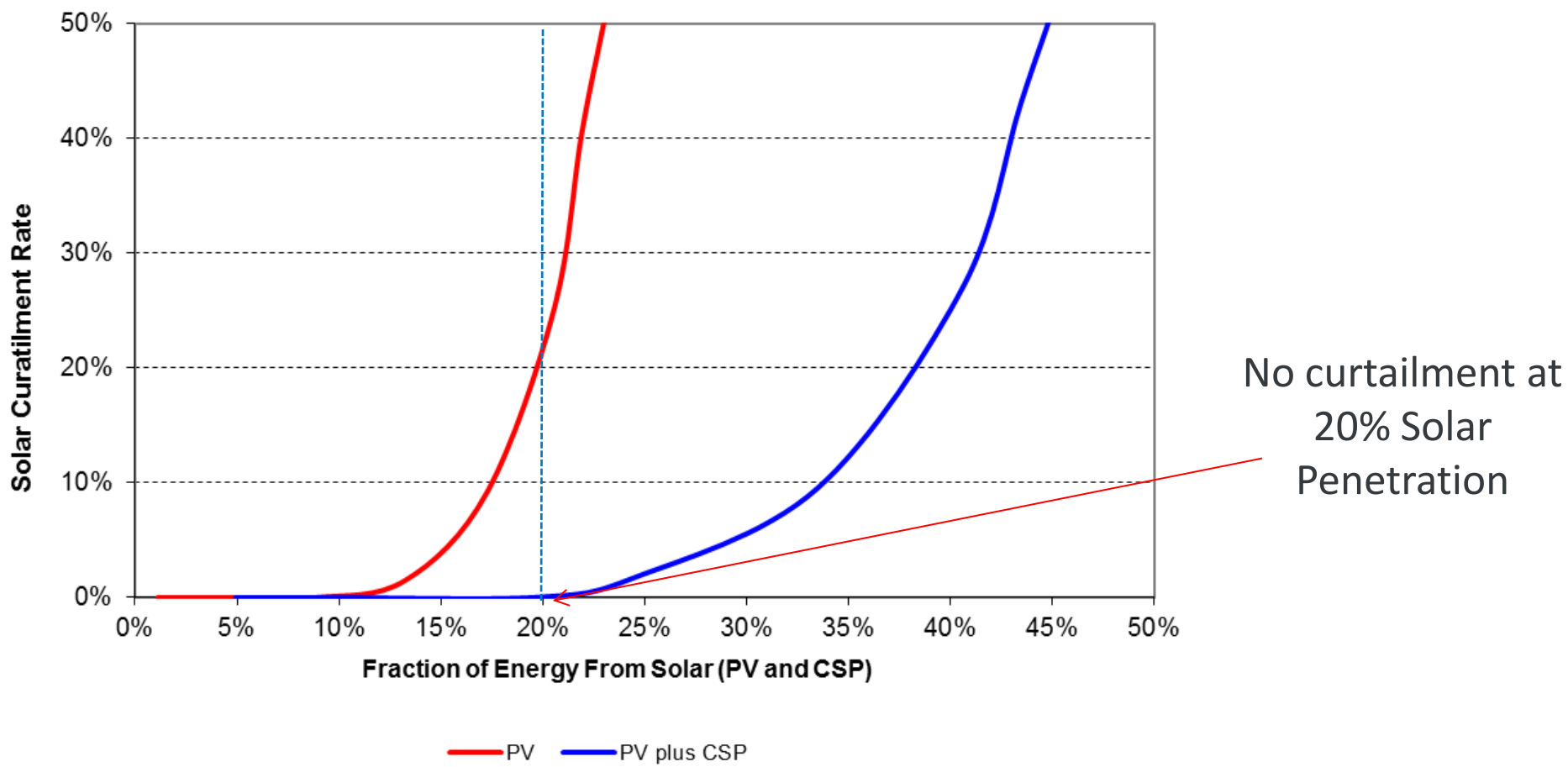
Investigated the impact of CSP w/ thermal energy storage as an enabling technology for high penetrations of solar (PV and CSP).



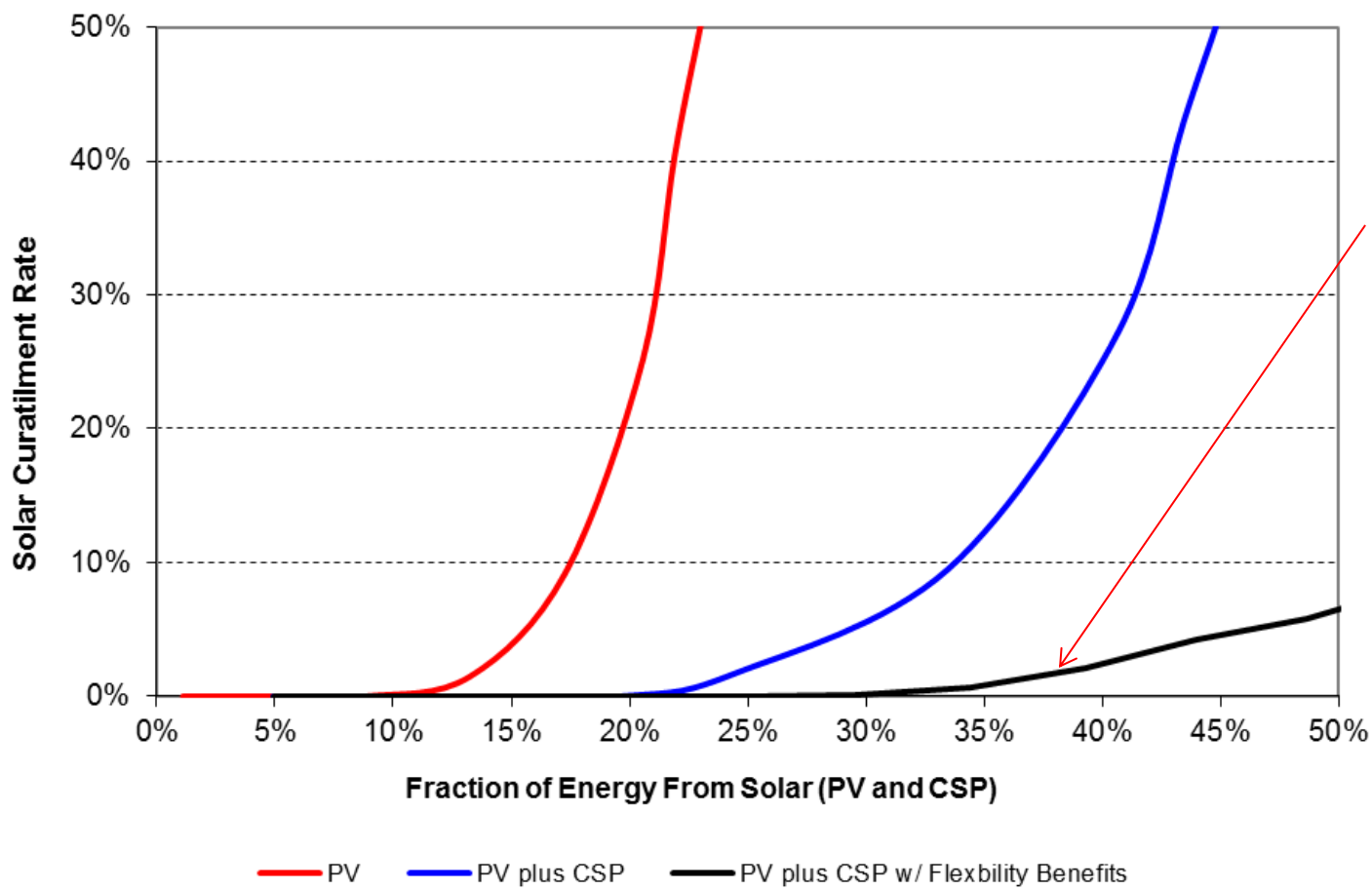
Average and marginal curtailment rates of PV in base scenario



Marginal curtailment of solar assuming equal energy mix of PV and 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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