Challenges of Modelling CSP for Integrated Resource Plans in Low-Carbon Grids

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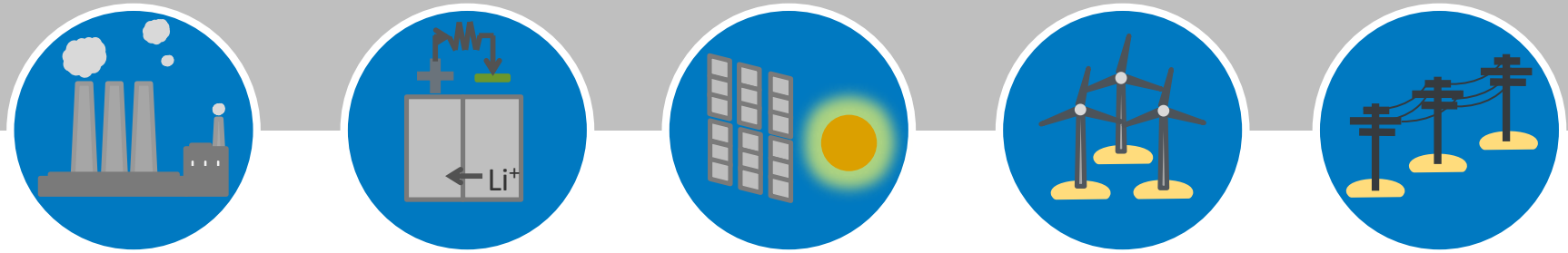
Integrated Resource Planning Processes

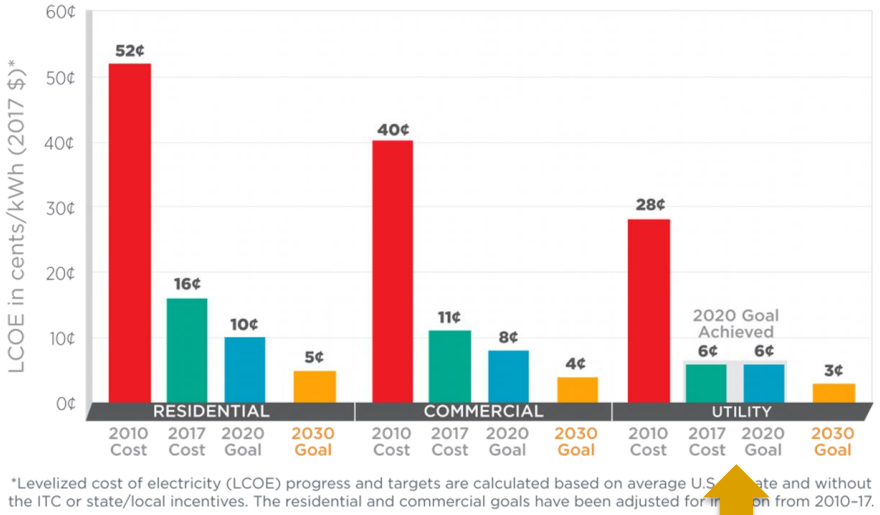


- Generation and transmission have long asset lives
- Electricity use can change over time
- States or other jurisdictions have evolving **policy objectives**
- To consider these factors, utilities undergo a process to look at different investment options for decades into the future
- **There is no one established practice for resource planning, but general principles include:**

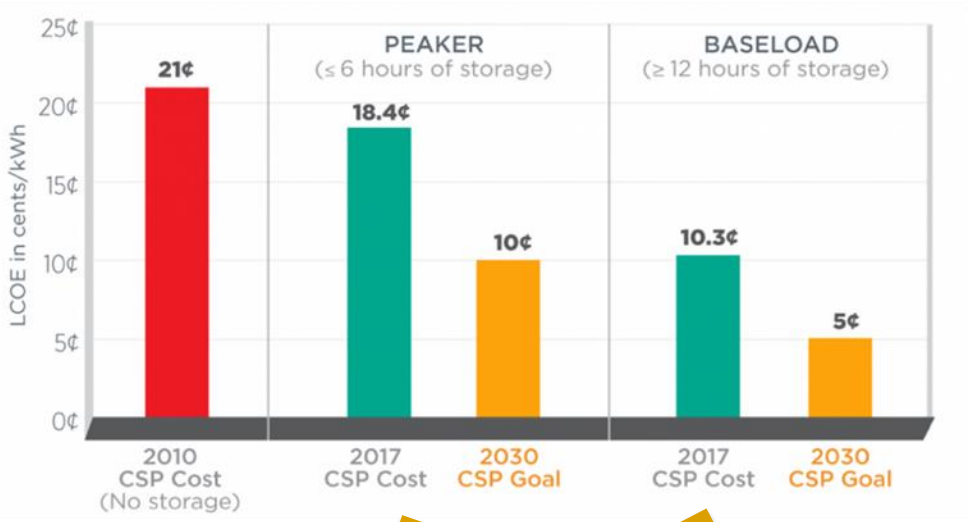
Reduce the cost of delivering electricity **Maintain reliability**

CSP is more expensive than PV on an LCOE basis

SunShot PV Progress and Goals



SunShot CSP Progress and Goals

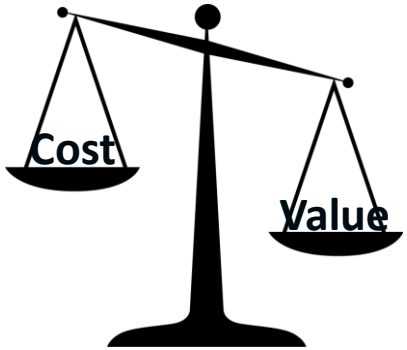


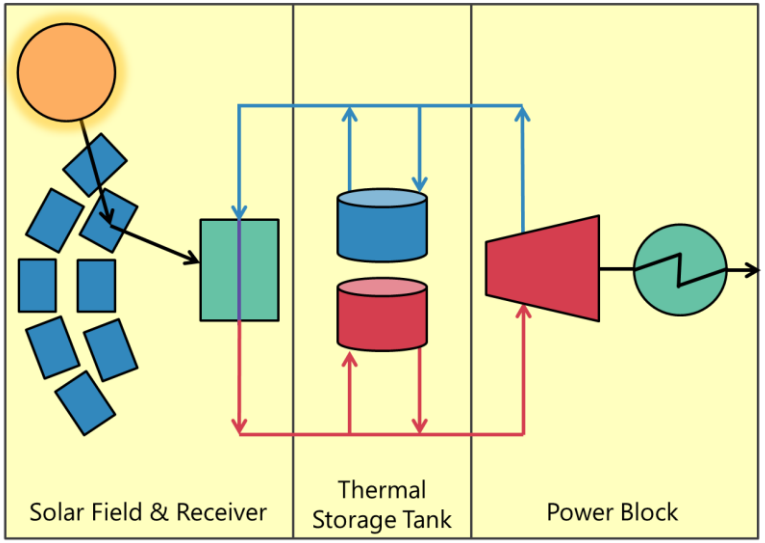
Utility PV: $0.06/kWh

CSP: $0.10 - $0.18/ kWh

Figure source: https://www.energy.gov/eere/solar/goals-solar-energy-technologies-office

LCOE is not the whole story





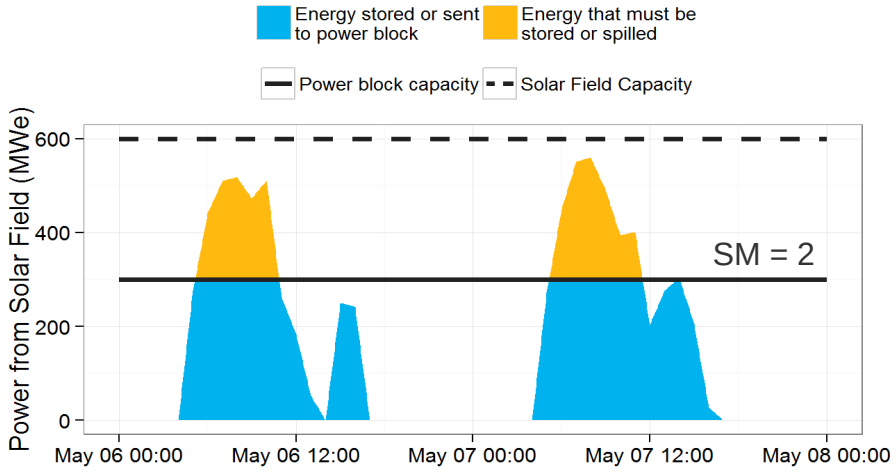
- ✗ More expensive than PV
- ✗ More moving parts than PV
- ✗ Without TES, it can be variable and uncertain like PV

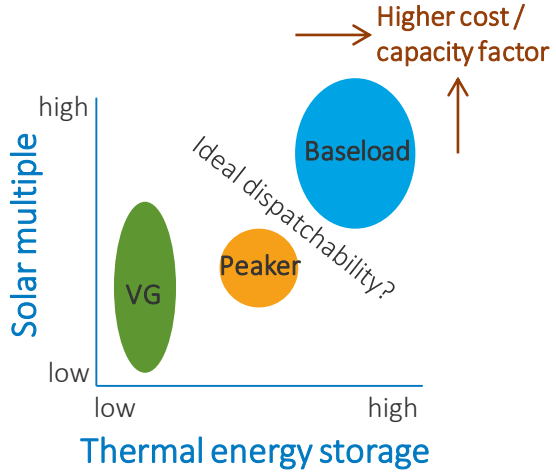
BUT pairs well with Thermal Energy Storage

- ✓ With TES, it's dispatchable, flexible
- ✓ Less dependent on solar resource
- ✓ Can provide ancillary services
- ✓ Can provide grid stability, inertia
- ✓ Can have higher capacity credit
- ✓ Can be configured to fit system needs

CSP can be challenging to model for utility planning processes

1. CSP-TES can be configured in multiple ways
   - Solar multiple (SM = ratio of solar field to power block), thermal energy storage (TES) duration





CSP can be challenging to model for utility planning processes

1. CSP-TES can be configured in multiple ways
2. Representation of the time-varying value of energy to capture benefit of dispatchability

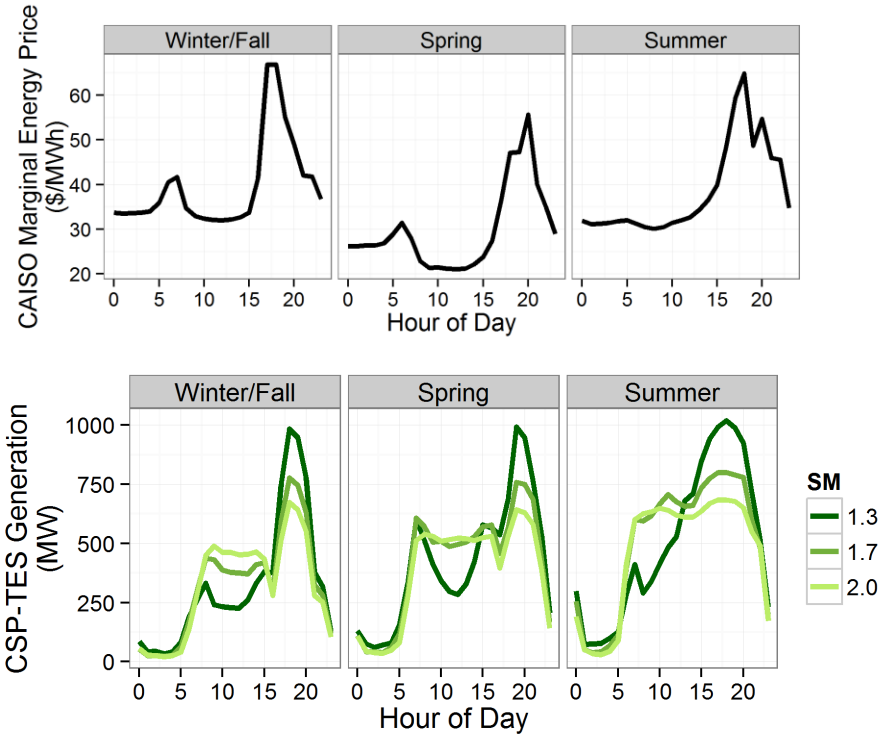
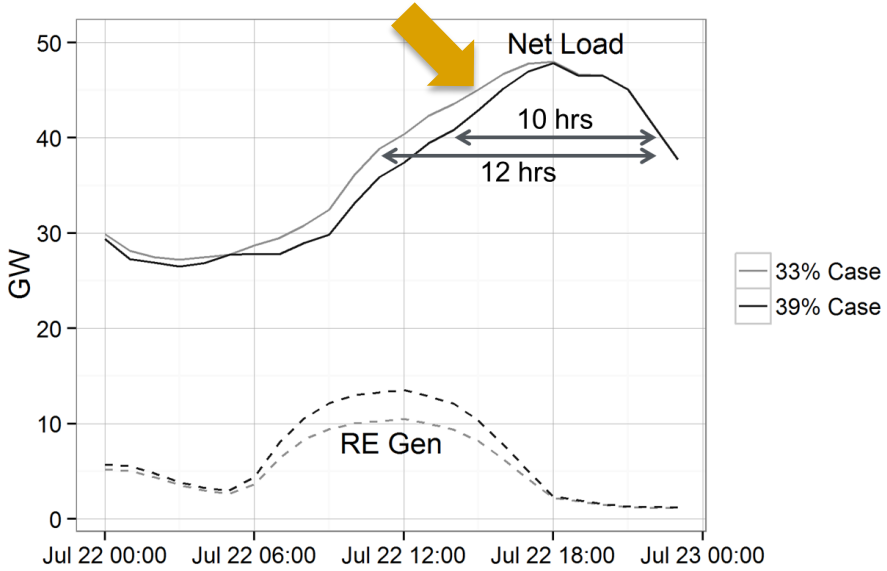


Figure from: https://www.nrel.gov/docs/fy14osti/61685.pdf

CSP can be challenging to model for utility planning processes

1. CSP-TES can be configured in multiple ways
2. Representation of the time-varying value of energy to capture benefit of dispatchability
3. Representation of capacity value

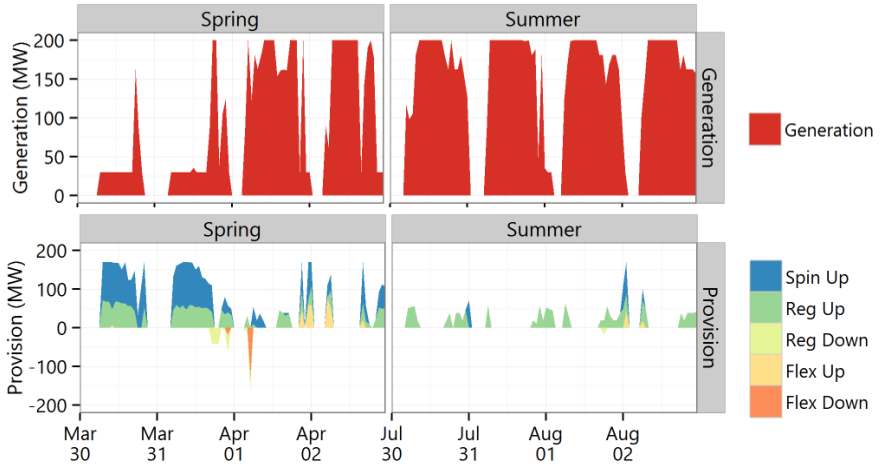
Peak net load hours



With increased PV penetration, the capacity credit of PV decreases while the capacity credit for CSP-TES may *increase*

CSP can be challenging to model for utility planning processes

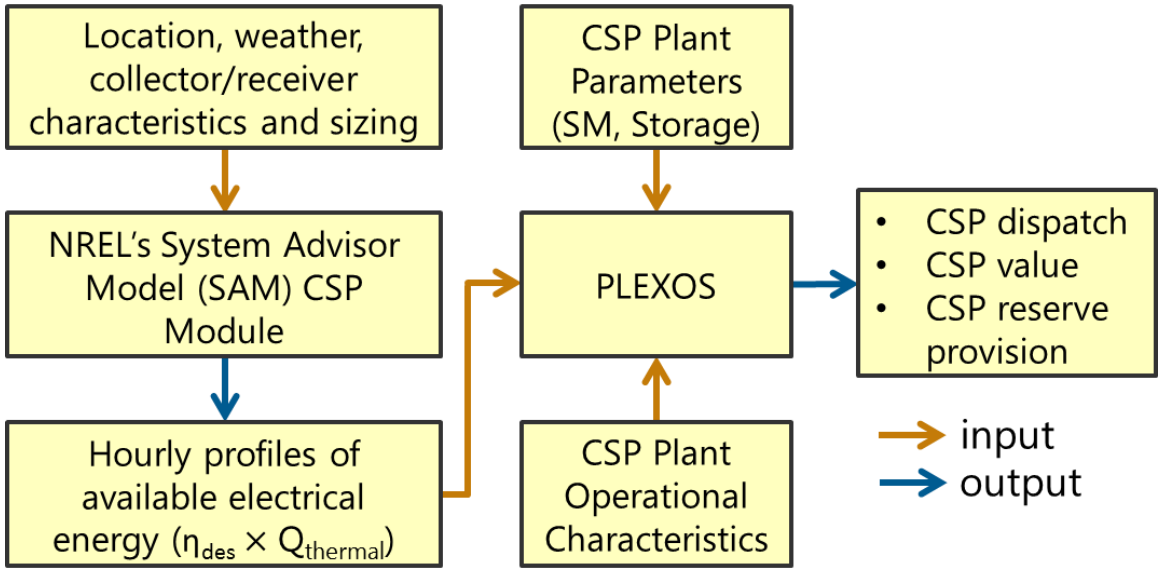
1. CSP-TES can be configured in multiple ways
2. Representation of the time-varying value of energy to capture benefit of dispatchability
3. Representation of capacity value
4. Consideration of other sources of value
   - Ancillary services
   - Grid stability, inertia



Probably less important sources of value:

- Less value than capacity and energy
- Shallow markets, more competition
- Not necessarily monetized (or no market exists)

Modeling CSP is complex and data intensive, but it can be done for Production Cost Simulations



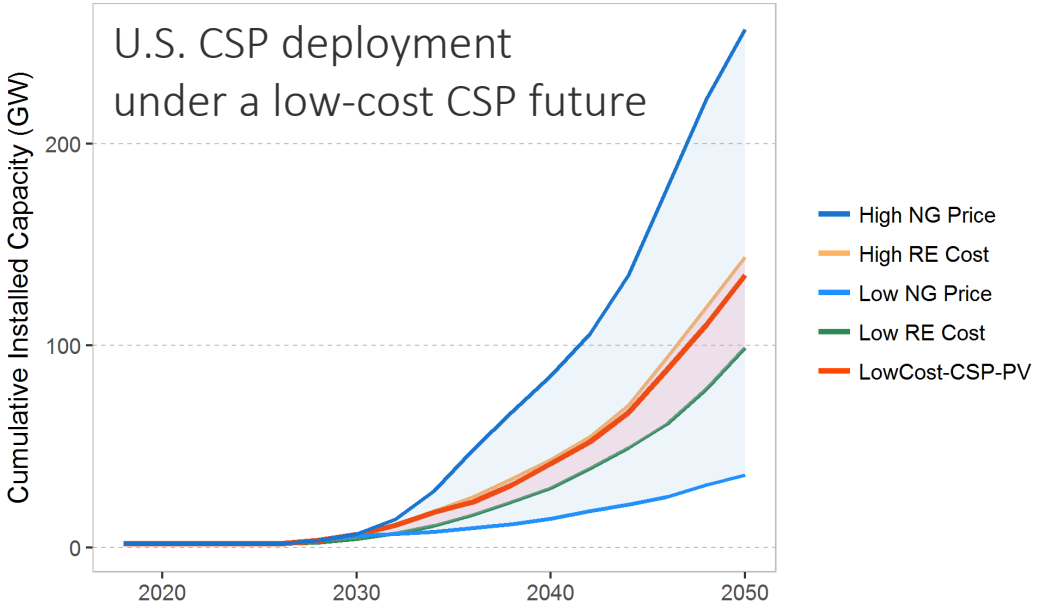
https://www.nrel.gov/docs/fy19osti/68527.pdf

A Guide to Implementing Concentrating Solar Power in Production Cost Models

Jennie Jorgenson, Matthew O'Connell, Paul Denholm, Janna Martinek, and Mark Mehos

National Renewable Energy Laboratory

Modeling CSP is complex and data intensive, but it can be done for Capacity Planning Models



https://www.nrel.gov/docs/fy19osti/71912.pdf

The Potential Role of Concentrating Solar Power within the Context of DOE's 2030 Solar Cost Targets

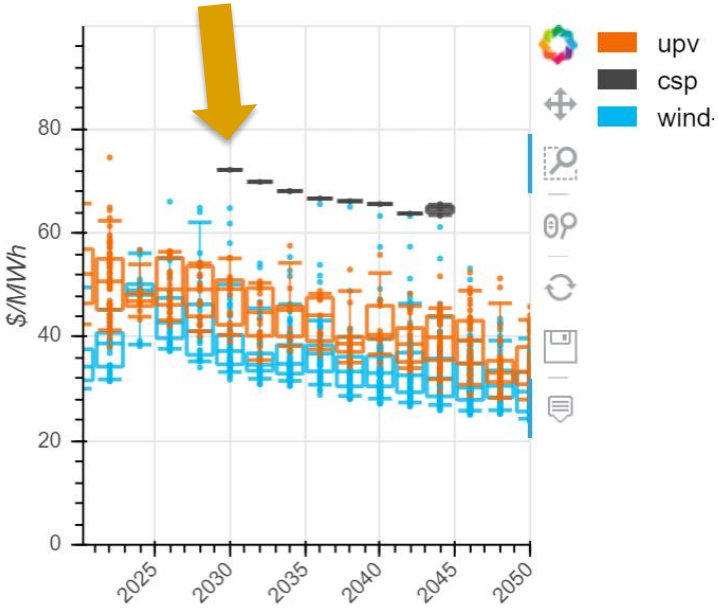
Caitlin Murphy, Yinong Sun, Wesley Cole, Galen Maclaurin, Craig Turchi, and Mark Mehos

National Renewable Energy Laboratory

Conclusions

- CSP is complex to model because of the needed geospatial detail and multiple technology configurations and grid services
- Despite these challenges, it can be and has been done—including for models used for IRPs
  - Detailed chronological modeling needed to inform capacity planning models
- Modeling can reveal if the higher value of CSP-TES can overcome its higher cost relative to other options and, ultimately, the extent of CSP's role in a low-carbon grid
  - Also applies to many other low-carbon technologies

$72/MWh in 2030



The "Mid-case" scenario of NREL's 2019 Standard Scenarios

https://www.nrel.gov/analysis/standard-scenarios.html

Thank you!

www.nrel.gov

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