Energy+Environmental Economics

Achieving New York's "Green New Deal" And Deep Decarbonization Of The Electric Sector

Independent Power Producers of New York

33rd Annual Spring Conference

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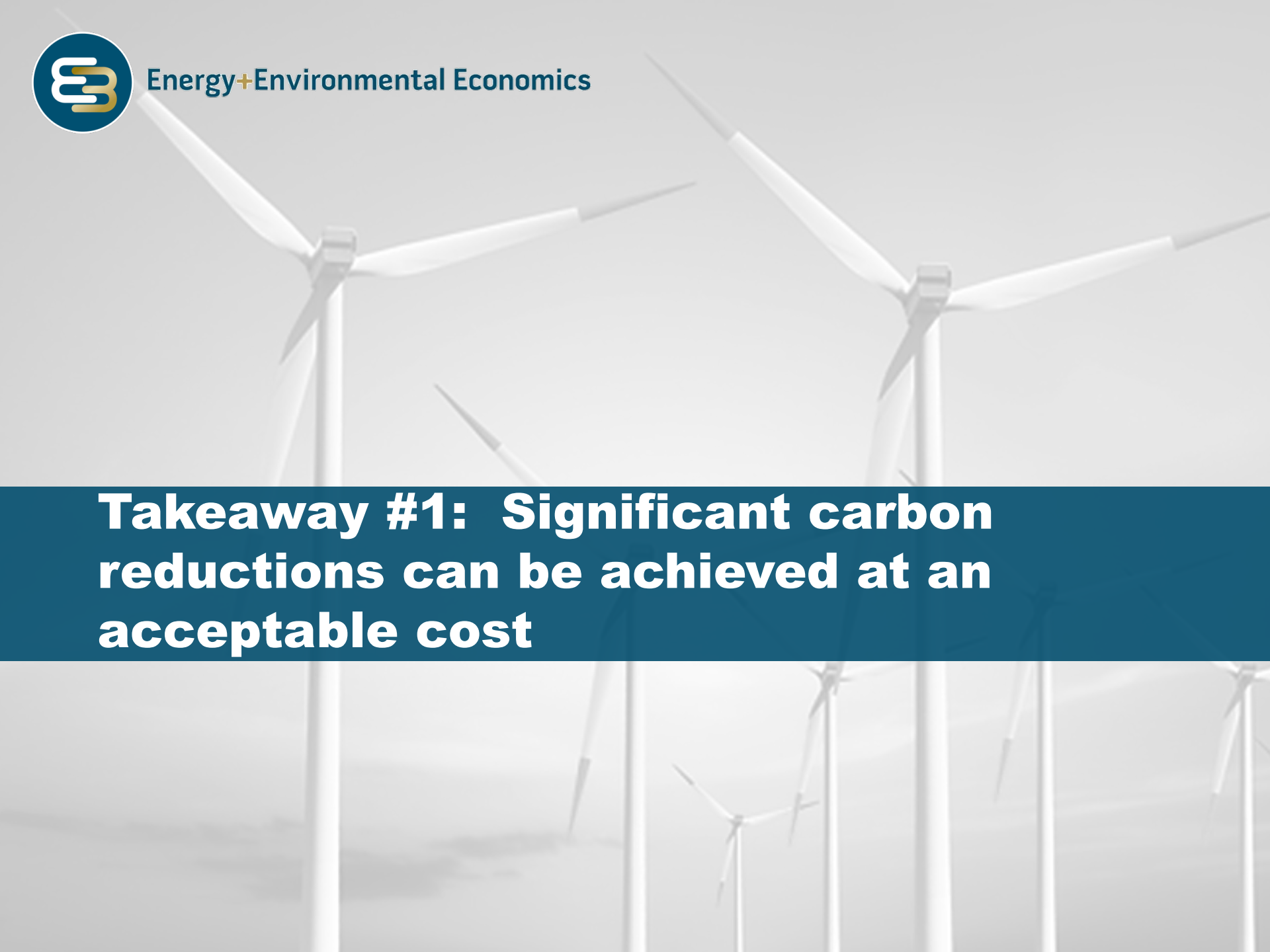
E3 is a San Francisco-based consultancy with significant experience in renewable integration & decarbonization modeling

- **This presentation is based on lessons learned from studies in many other jurisdictions**
  - **California:**
    - Ongoing support in CPUC's Integrated Resource Planning (IRP) proceeding
    - Landmark 2014 study of 50% RPS goal conducted for five largest utilities
    - Resource planning support for LADWP and SMUD's 100% RPS plans
    - Reliability implications of 100% RPS for Calpine
    - Renewable integration modeling for CAISO
  - **Hawaii:**
    - Supported development of HECO's plan to achieve 100% renewables by 2045
  - **Pacific Northwest:**
    - Cost and reliability implications of 100% renewables for NW utilities
  - **Upper Midwest:**
    - Resource planning support for Xcel Energy's 100% zero carbon goal
  - **Western Electricity Coordinating Council:**
    - Assessment of flexibility challenges under 50%+ high renewables

Five key takeaways from studies in other jurisdictions

- Takeaway #1: Significant carbon reductions can be achieved at a reasonable cost
- Takeaway #2: Dispatchable renewables & storage can help solve operational reliability challenges
- Takeaway #3: Firm capacity is needed for resource adequacy
- Takeaway #4: The last 10% is a killer!



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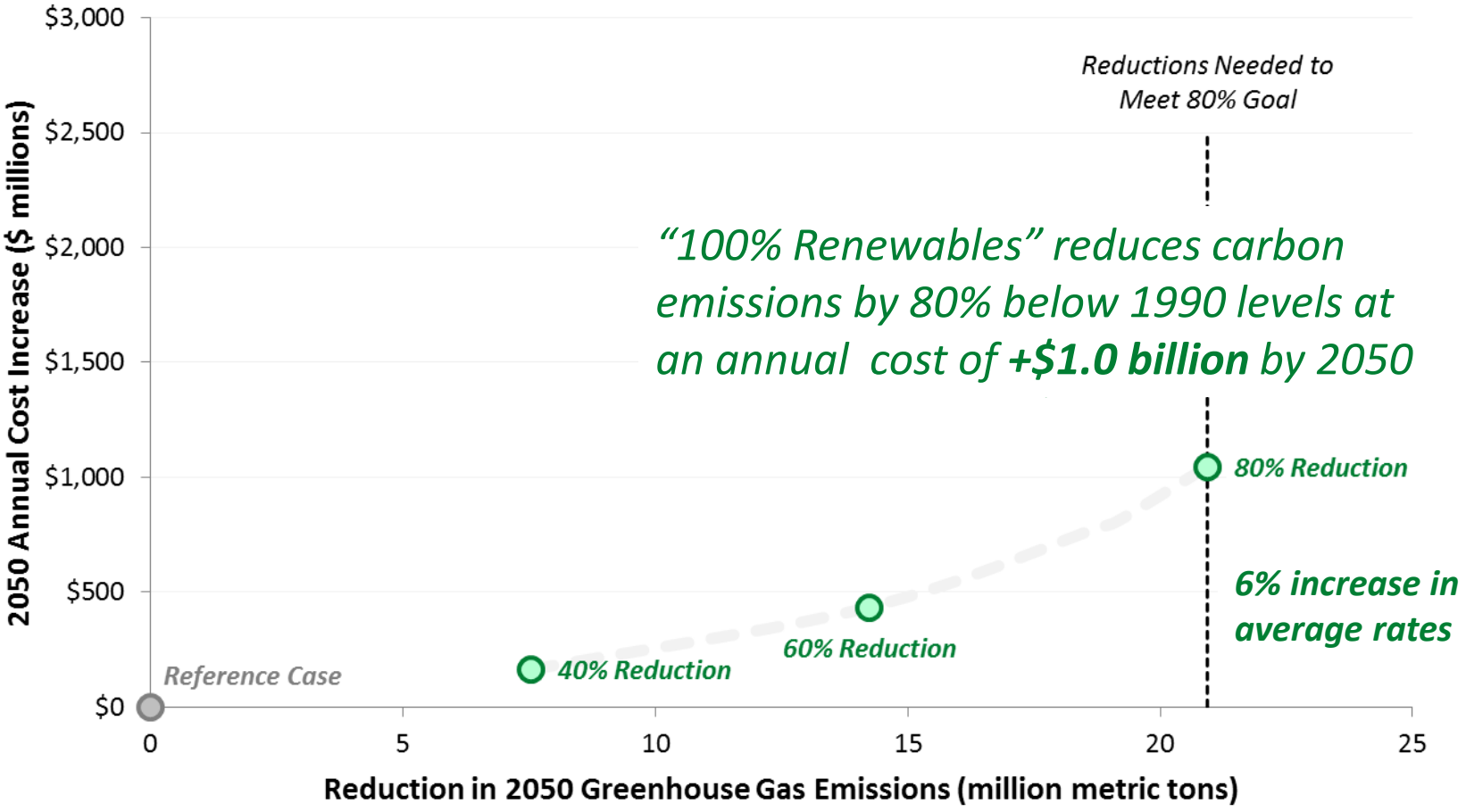
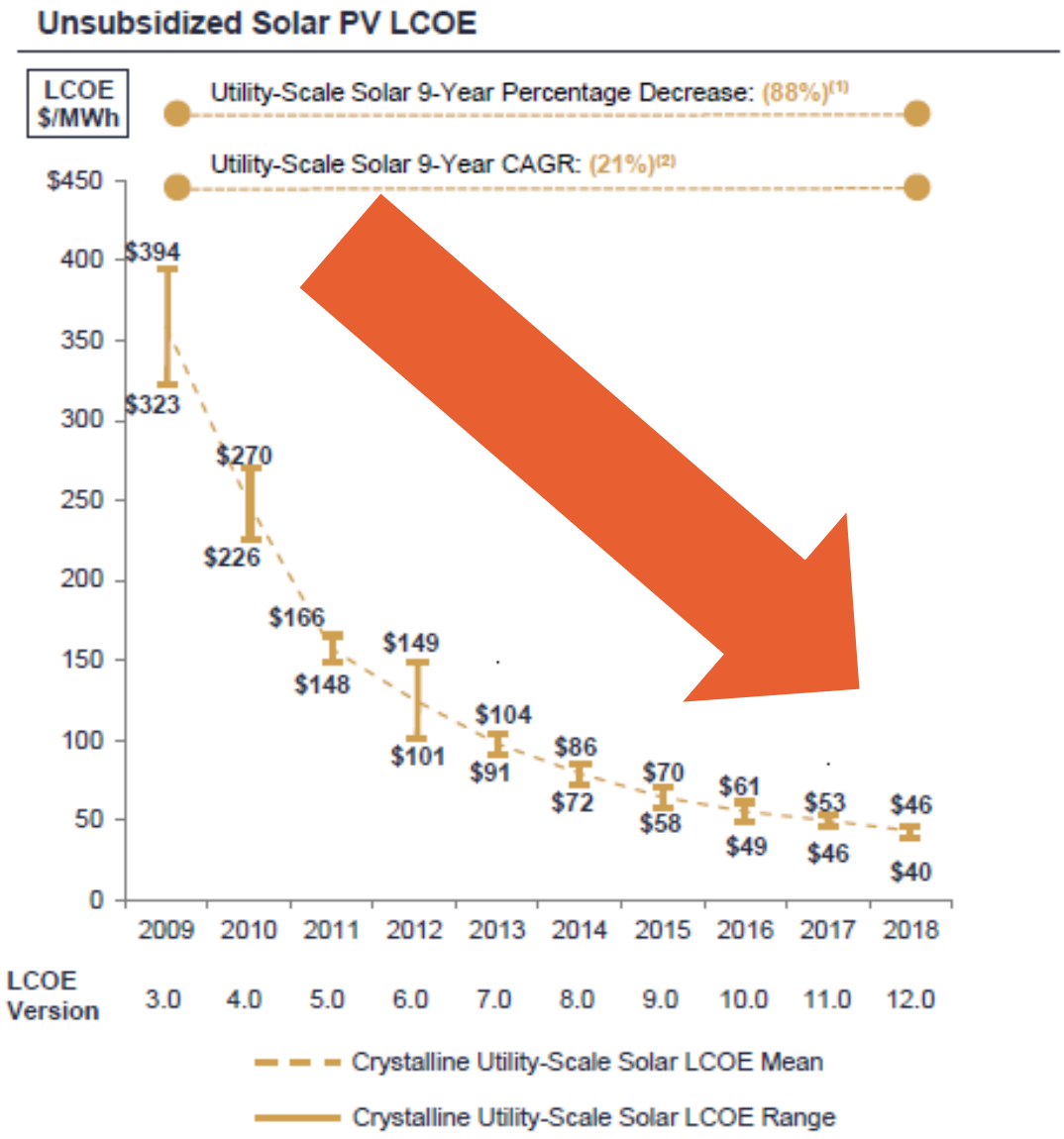
Takeaway #1: Significant carbon reductions can be achieved at an acceptable cost

Pacific Northwest: 80% CO2 reductions achieved with high wind/solar penetration



Technology advancement is reducing the cost of achieving higher renewables



- Solar, wind and battery storage costs continue to fall
- New solar and wind are now competitive with gas and coal on an energy basis

Idaho Power 2019: solar PV PPA at $21.75/MWh!

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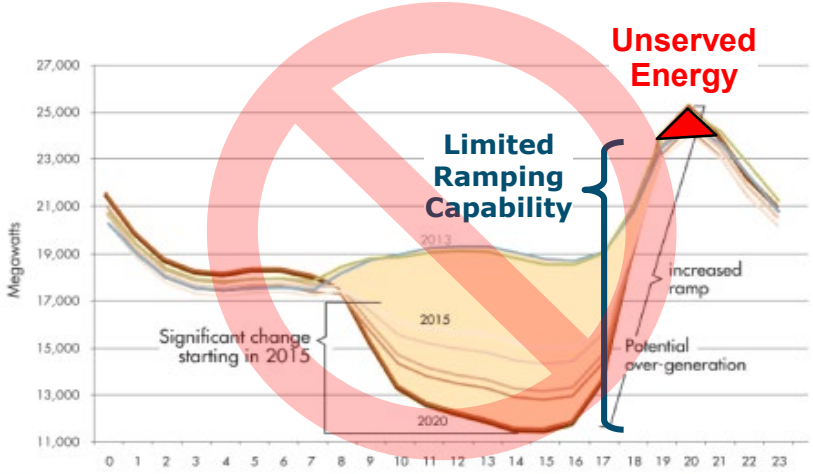
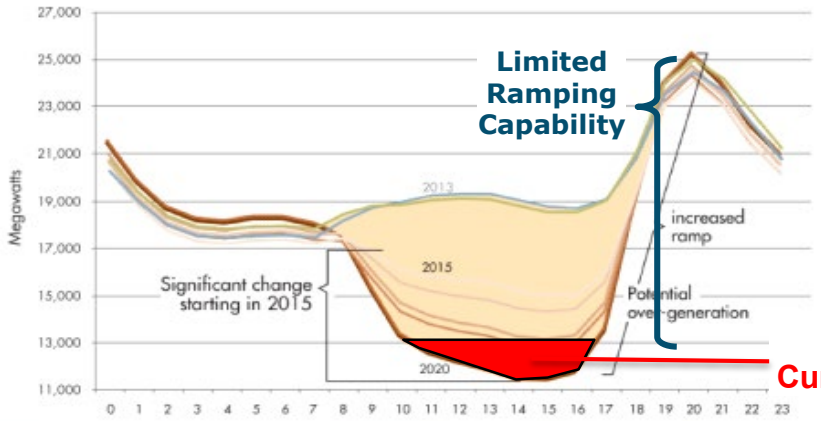
Takeaway #2: Dispatchable renewables & storage can help solve operational reliability challenges

California: dispatchable solar takes care of the "duck curve"

Early worry: insufficient ramping capability causes loss of load after sunset



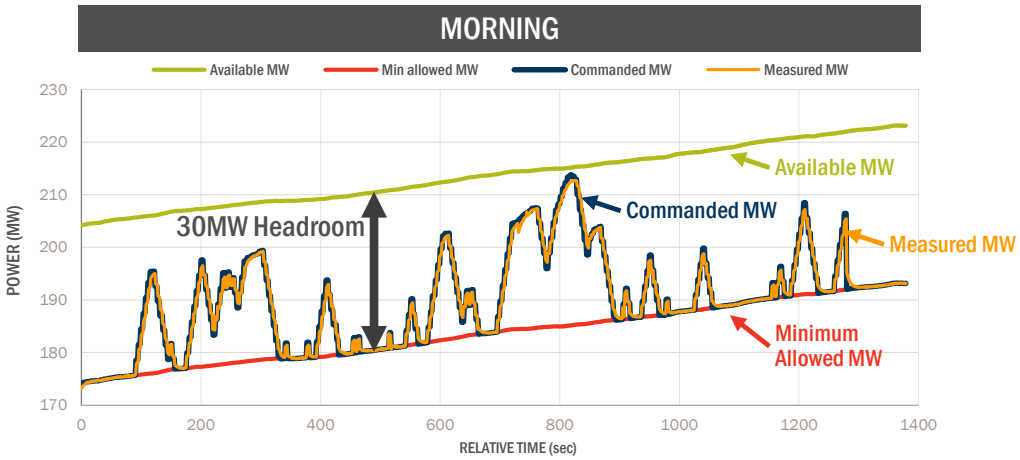
Solution: Dispatch solar to ensure reliability

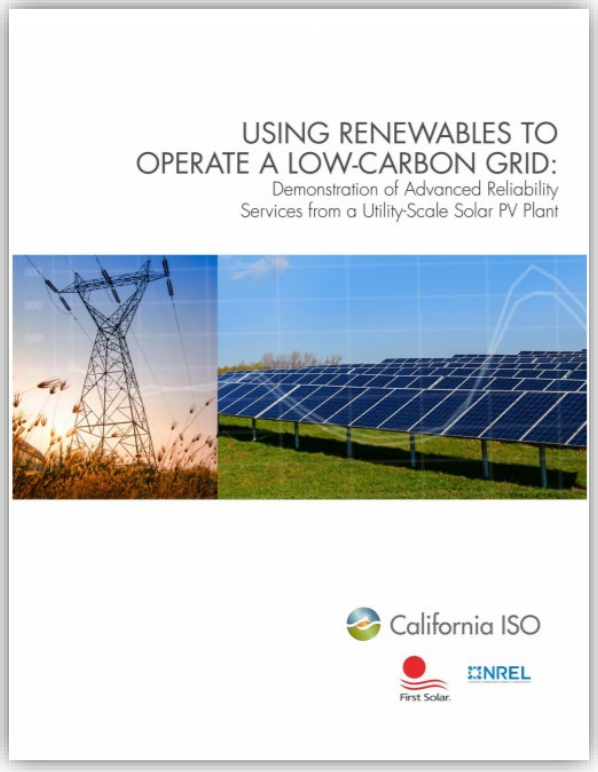


First Solar/NREL/CAISO demonstration of using solar for essential grid services

Inverter-based resources such as utility-scale solar can provide NERC essential reliability services with greater precision than comparable conventional alternatives

- Example: regulation service / following AGC signal





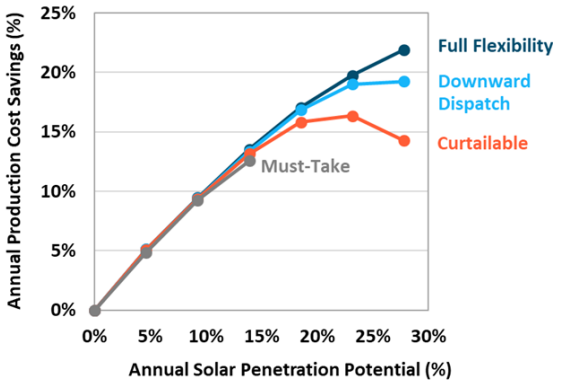
2017 NARUC Award Winner
Utility Industry Innovative Pilots or Demonstration Projects

http://www.caiso.com/Documents/TestsShowRenewablePlantsCanBalanceLow-CarbonGrid.pdf

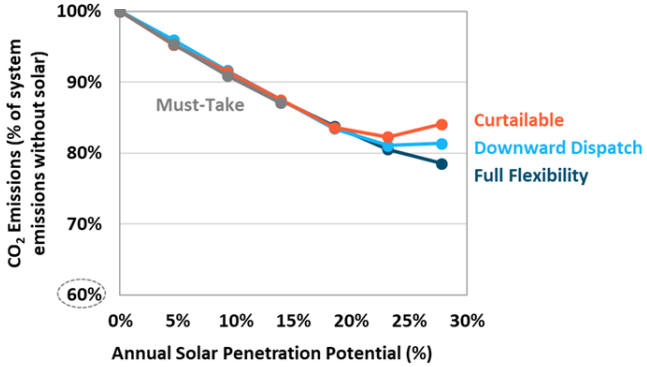
E3/First Solar/TECO study demonstrates the value of flexible solar power plants

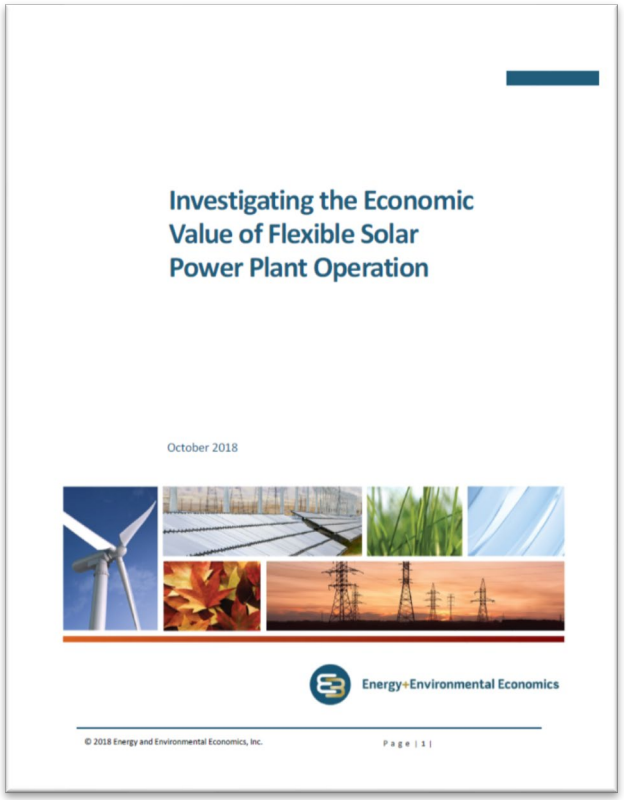
- Detailed study of operations under high solar penetration (up to 28% of annual energy supply)
- Dispatchable solar is key to retaining value of solar at penetrations in excess of 20%

Production Cost Savings



Emissions





2018 Top Innovators
Public Utilities Fortnightly

Nelson, J. et al. October 2018. *Investigating the Economic Value of Flexible Solar Power Plant Operation*. Energy & Environmental Economics. https://www.ethree.com/wp-content/uploads/2018/10/Investigating-the-Economic-Value-of-Flexible-Solar-Power-Plant-Operation.pdf

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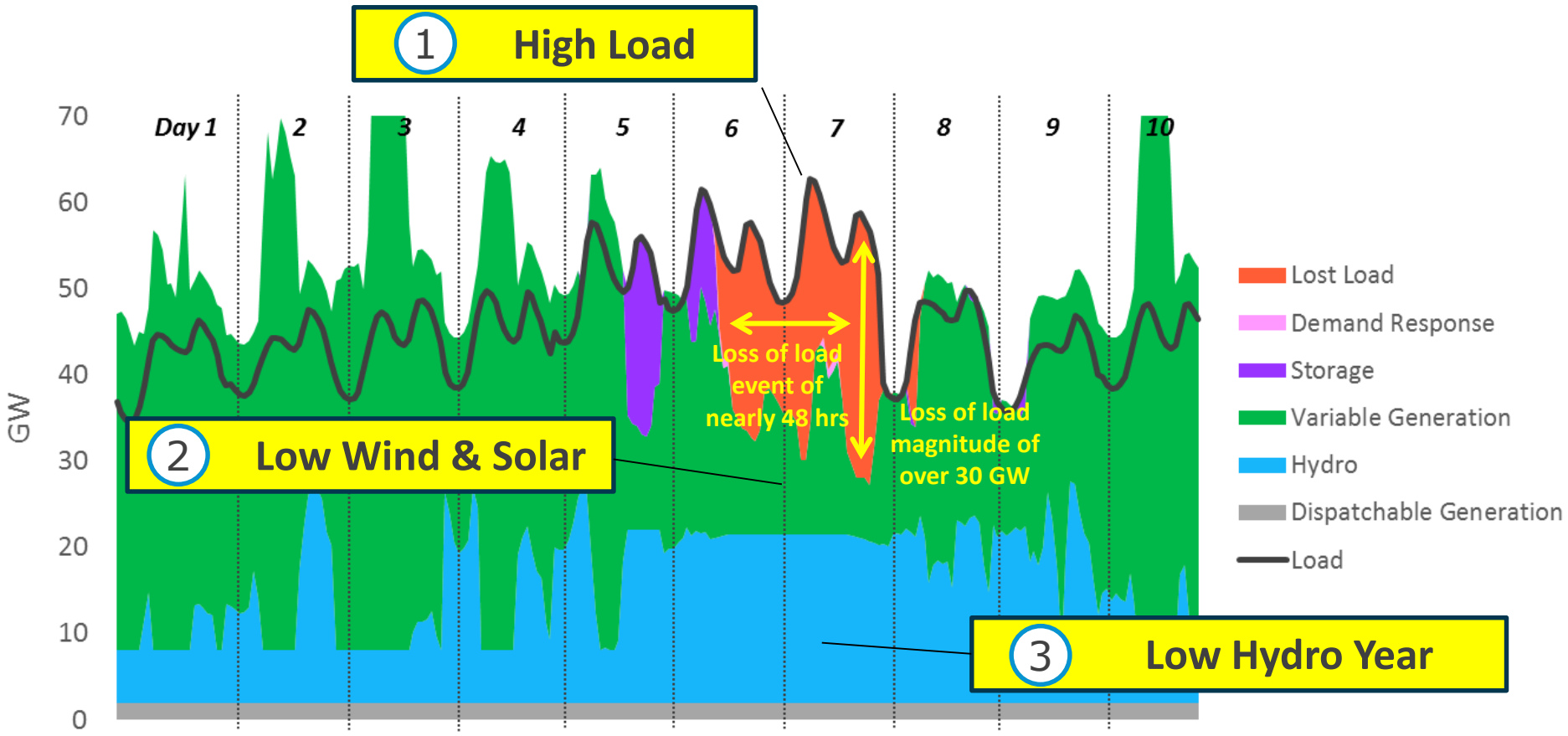
Takeaway #3: Firm capacity is needed for resource adequacy

Most challenging condition is a multi-day stretch of high loads and low production



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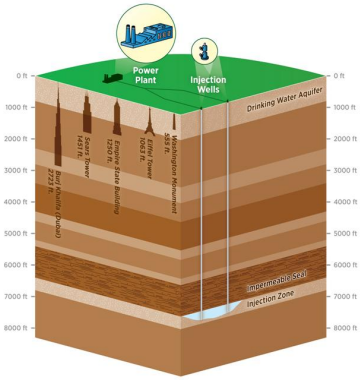
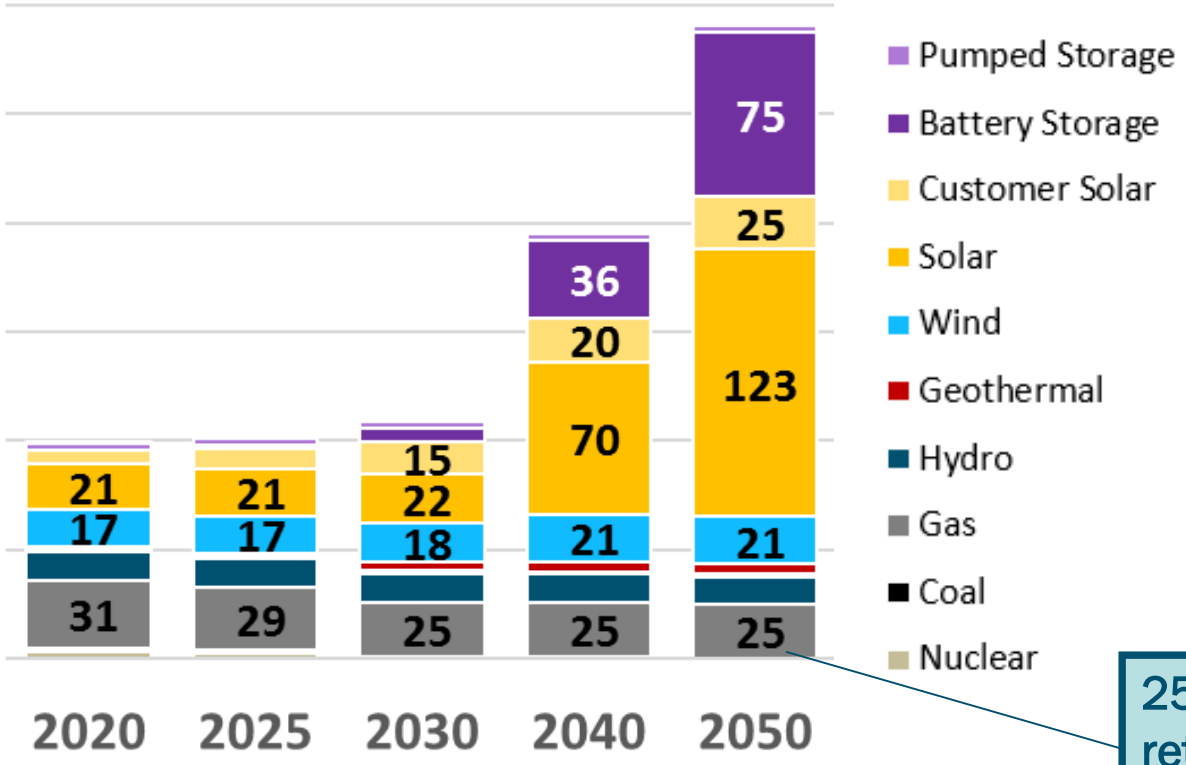
Candidate technologies to provide firm capacity in a low-carbon grid

+ **Nuclear**
  - Conventional: *baseload low-carbon resource*
  - Small modular reactors: *potentially flexible low-carbon resource (not considered)*
+ **Fossil generation with carbon capture and sequestration**
+ **Renewables with ultra-long duration energy storage**
+ **Carbon-neutral gas**
  - Gasified biomass
  - Synthetic gas (hydrogen or synthetic methane)
+ **Conventional gas generation (and live with a small amount of emissions)**



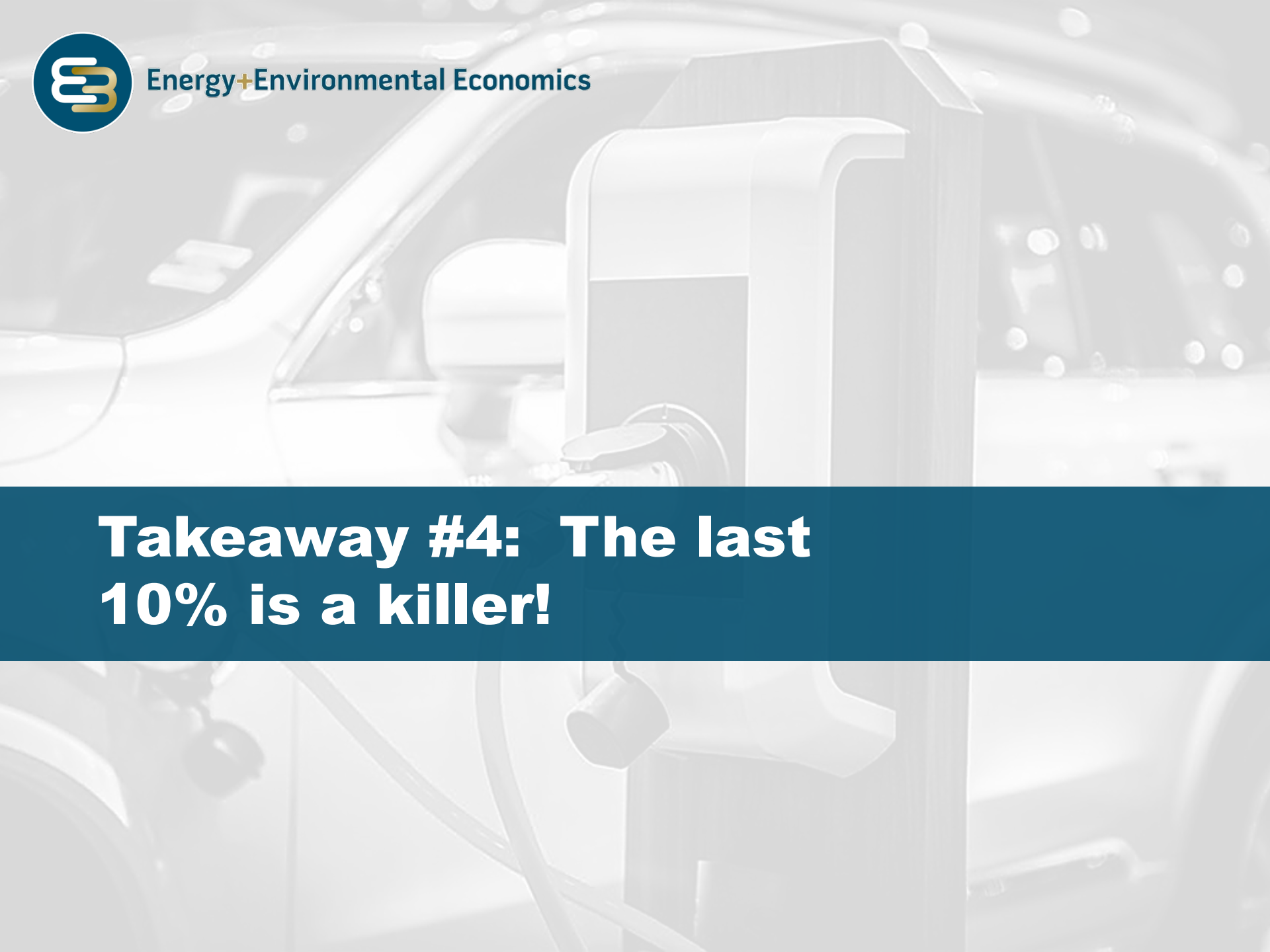
California case achieves deep CO2 reductions while maintaining gas for resource adequacy

2050 Portfolio Achieving 92% CO2 reductions in California



Achieves "100% Renewables" on a net basis (complies with SB 100)

25 GW of gas generation retained through 2050 (<10% capacity factor)



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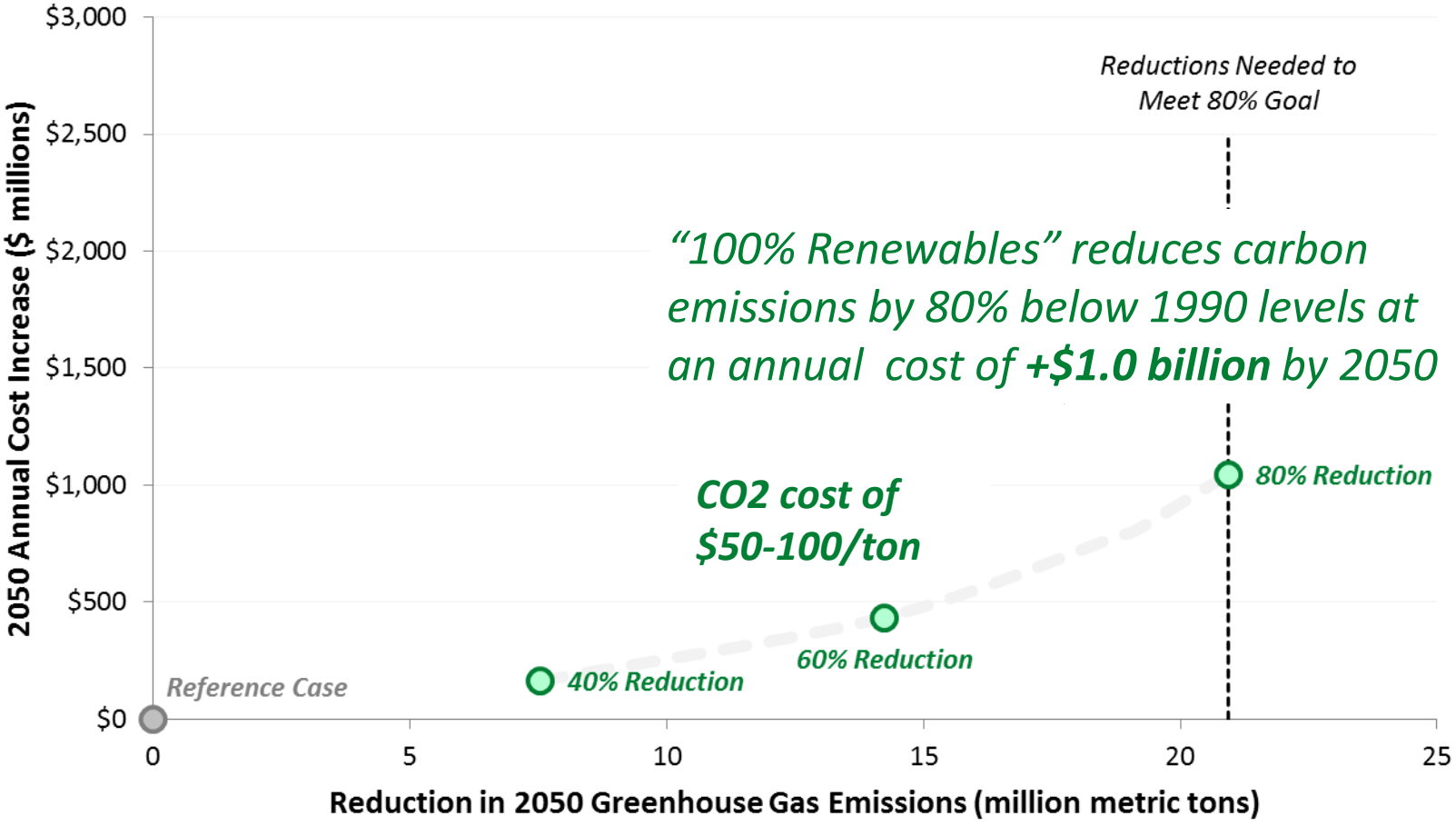
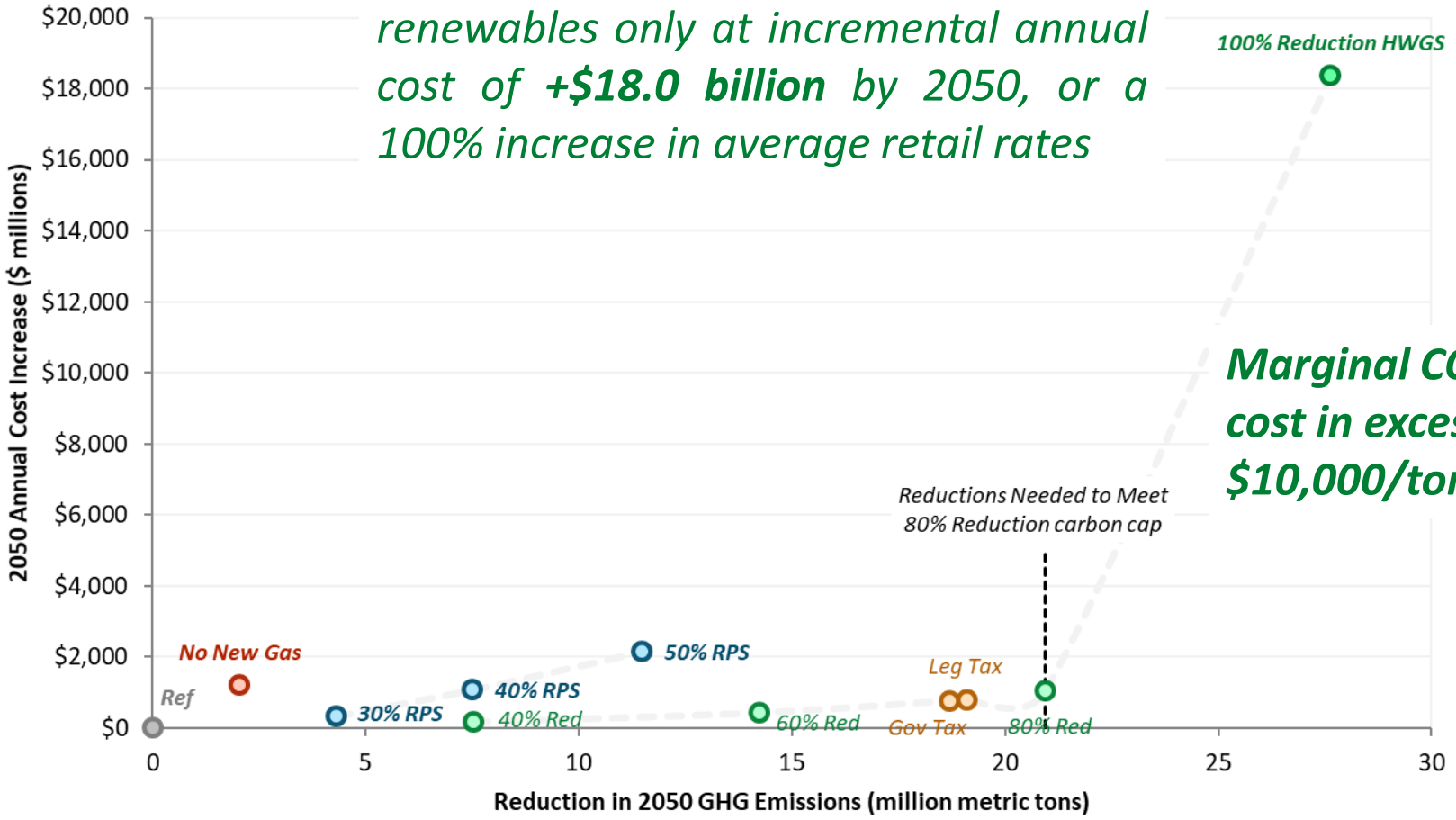
Takeaway #4: The last 10% is a killer!

Pacific Northwest: 80% CO2 reductions achieved with high wind/solar penetration



Pacific Northwest: 100% CO2 reductions would result in a doubling of retail rates

*100% CO2 reductions achieved with renewables only at incremental annual cost of **+$18.0 billion** by 2050, or a 100% increase in average retail rates*



Marginal CO2 cost in excess of $10,000/ton

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Thank You!

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