Energy+Environmental Economics

Reducing Emissions in California at High VRE Penetrations

ESIG Fall Session 9: System Planning Considerations for High VRE Penetration

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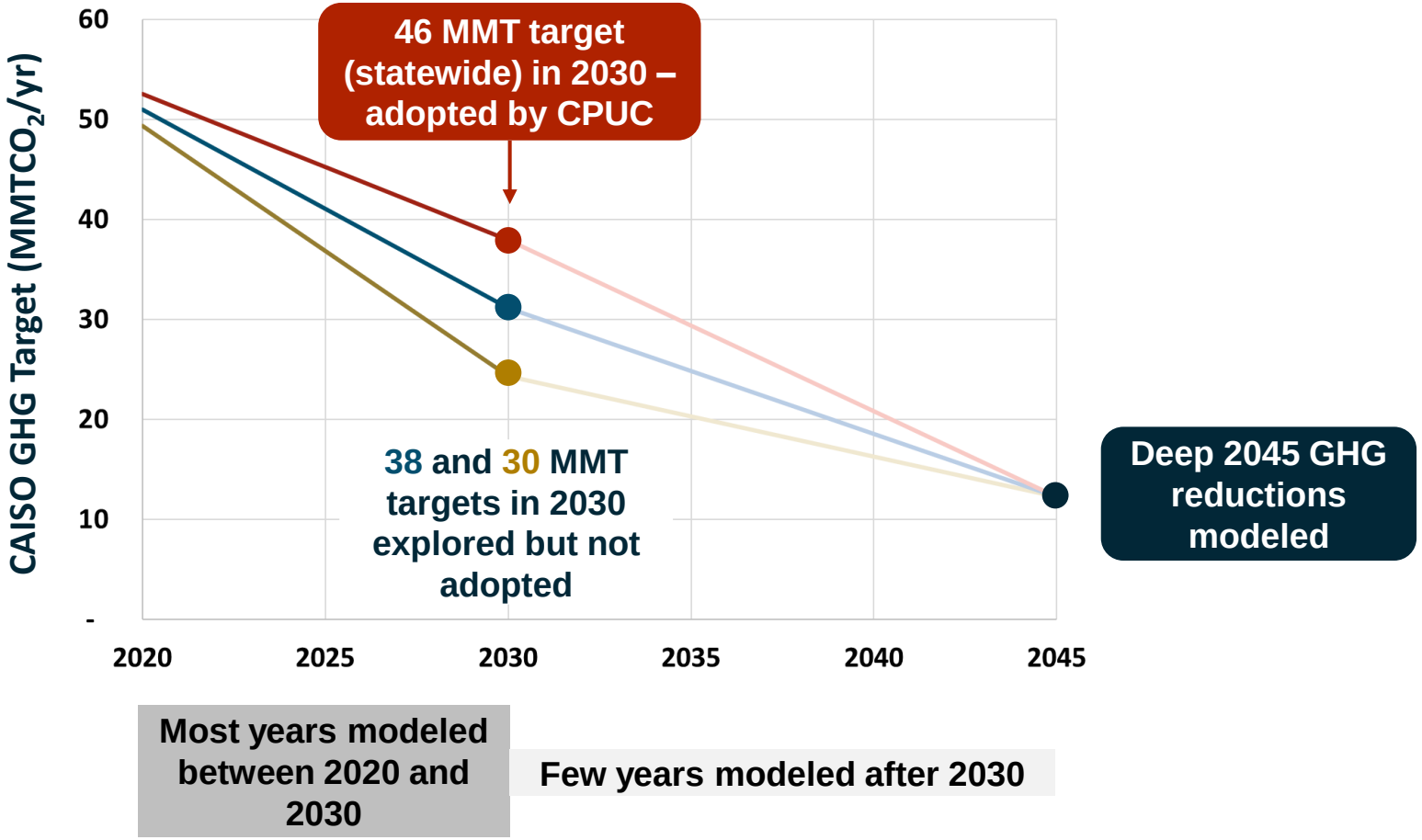
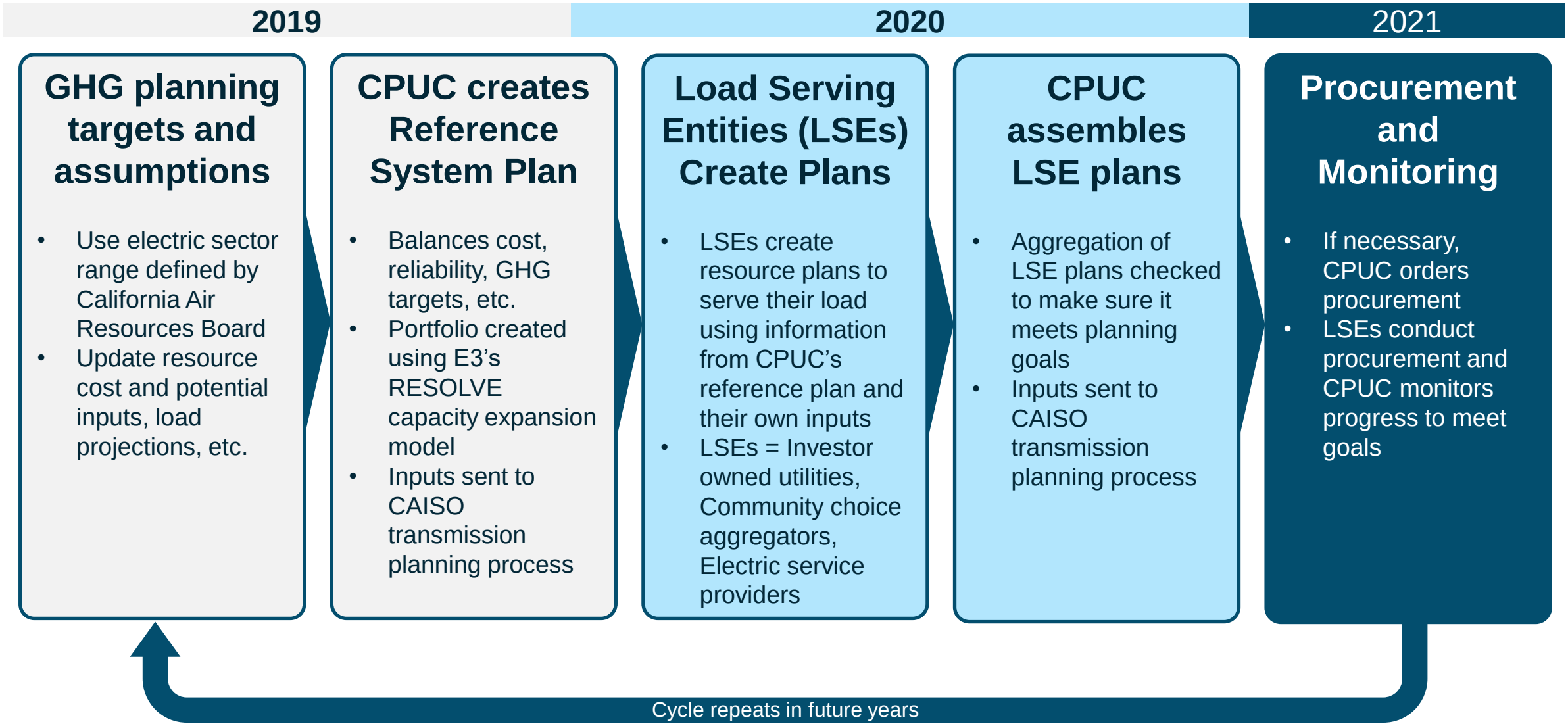
GHG planning targets

- **The California Public Utilities Commission (CPUC) Integrated Resource Plan (IRP) focuses on the electric sector resource portfolio between 2020 and 2030**
- **E3 is a consultant to the CPUC for the IRP**
  - *Disclaimer: Opinions expressed in the presentation are those of the presenter, not of the CPUC*
- **IRP covers load balanced by CAISO (California Independent System Operator), reflecting ~80% of California load**
  - GHG targets named according to statewide level



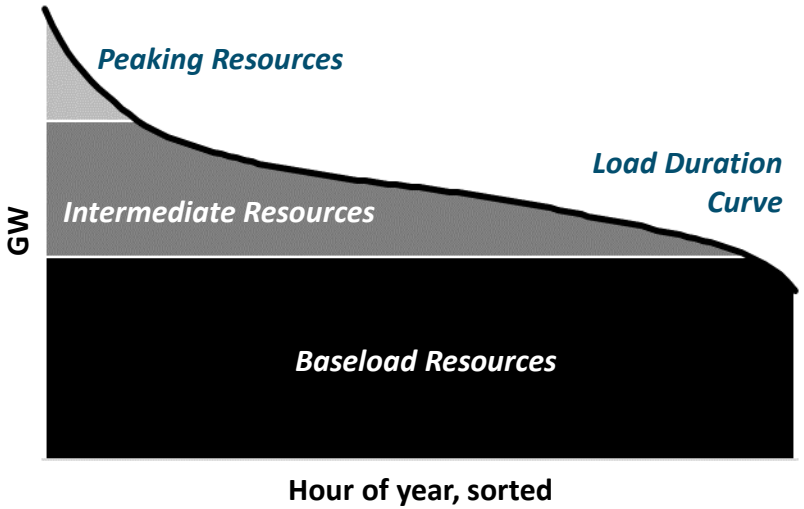
Overview of the CPUC IRP 2019-20 Process



Evolving considerations in planning: system operations

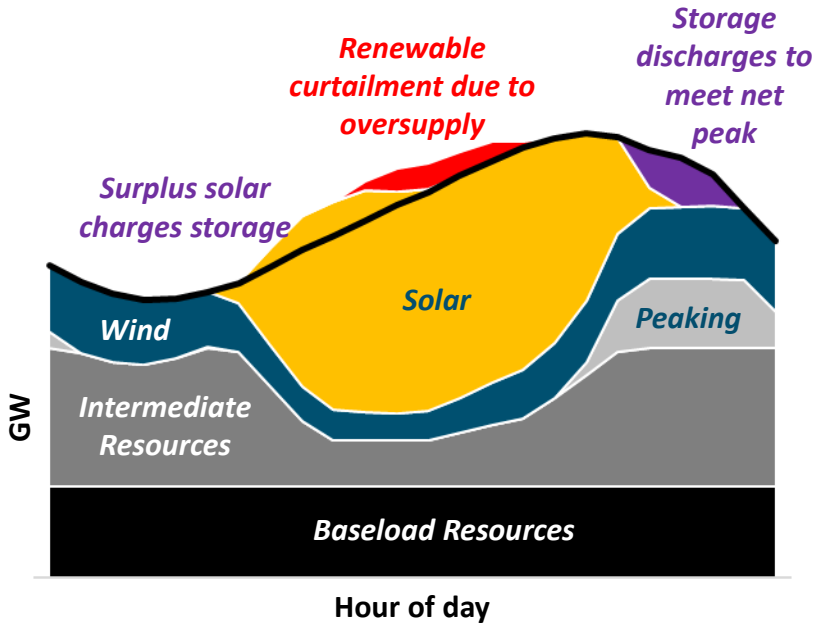
Traditional Planning Paradigm

+ **Heuristic approaches provide a reasonable means of evaluating resource needs and investment options**
  - Tradeoff between capital-intensive resources with low operating costs and low capital resources with high operating costs



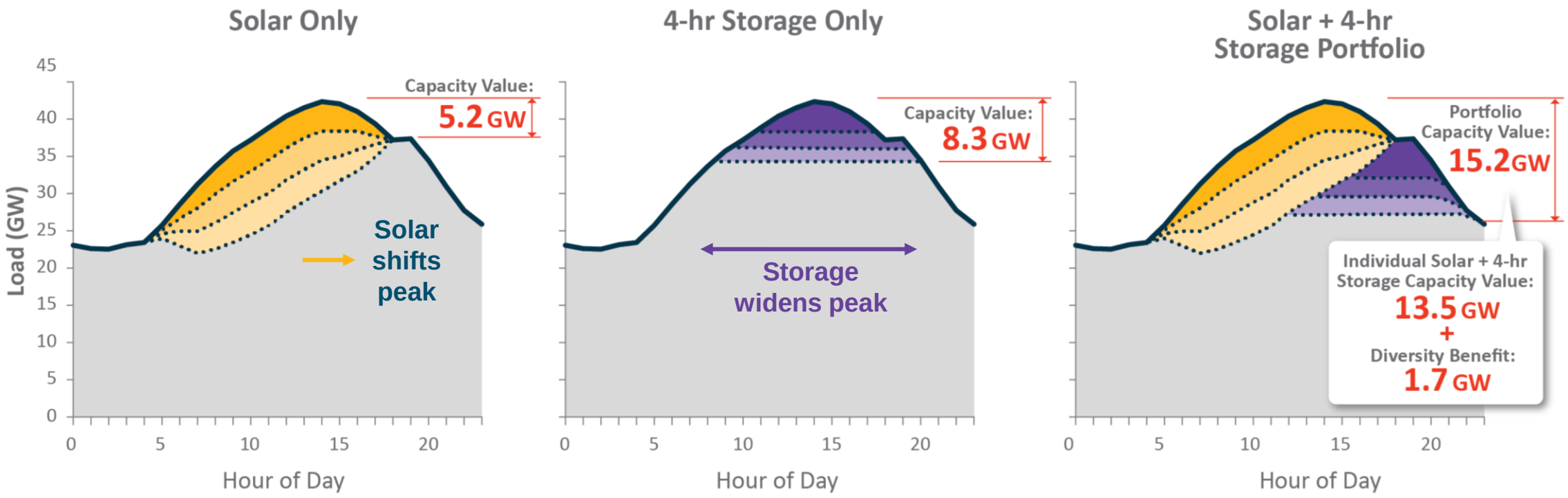
New Planning Paradigm

+ **Understanding system dispatch becomes necessary to evaluate investments**
  - Chronological simulation needed to capture operational impact of solar, wind, storage, and other energy-limited resources



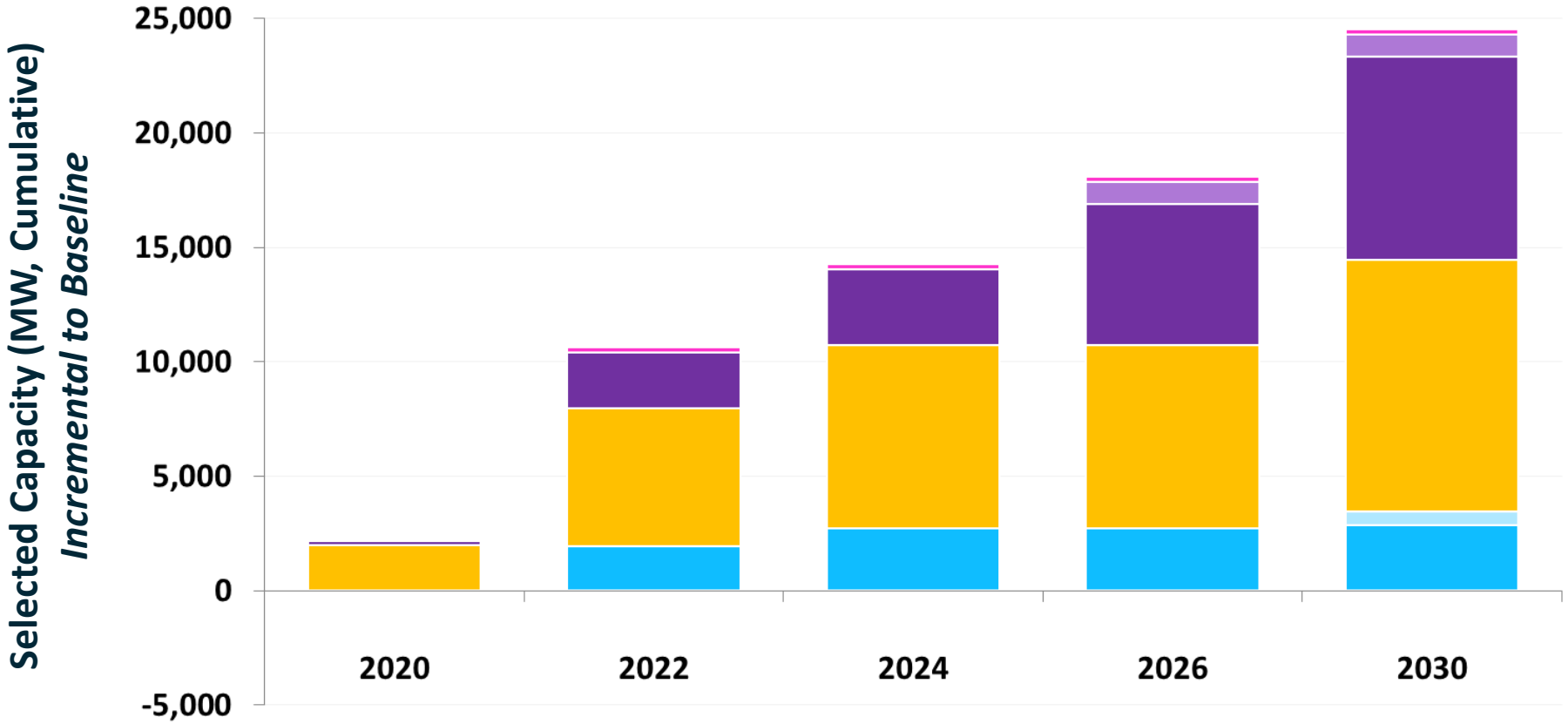
Planning for net peak

Values are illustrative



+ Goal is for marginal *and* total resource adequacy contribution of energy-limited resources to reflect resource capabilities
+ RESOLVE implementation adjusts capacity value for solar, wind, and battery resources, and at a high level, captures interactive effects

Battery and solar growth dominate portfolio



Some demand response selected

Moderate pumped storage growth

Transformative **battery growth**

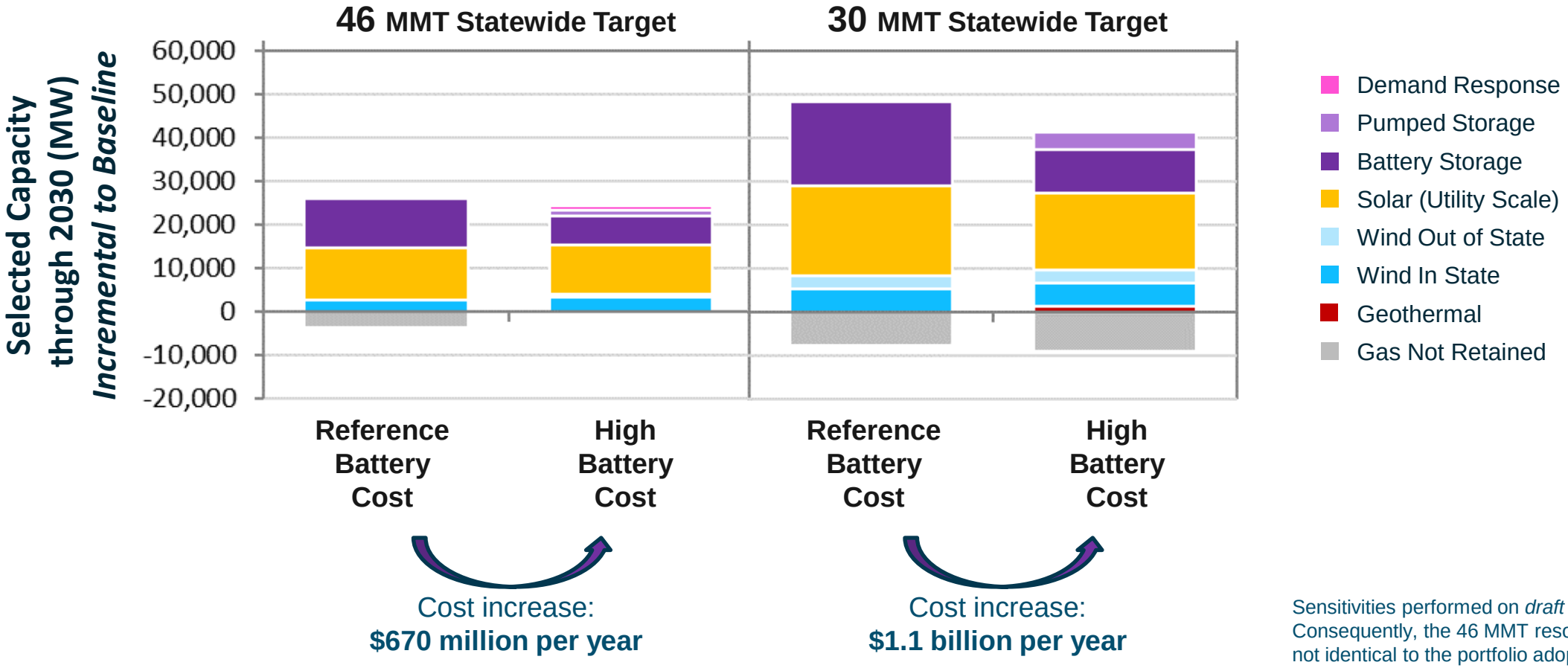
Large incremental solar buildout

Wind provides resource diversity

Virtually all **gas retained through 2030**

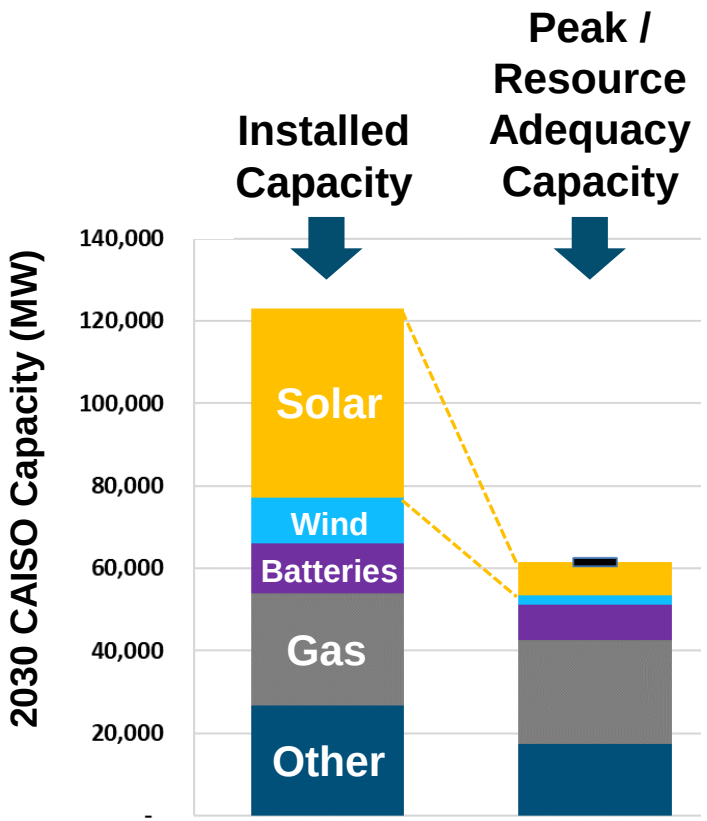
Higher battery costs increase resource diversity

Higher cost batteries result in partial replacement of batteries with pumped storage and a more diverse resource portfolio.
But even at higher cost, batteries are not eliminated from the 2030 portfolio.



Sensitivities performed on *draft* assumptions. Consequently, the 46 MMT resource build here is not identical to the portfolio adopted by the CPUC

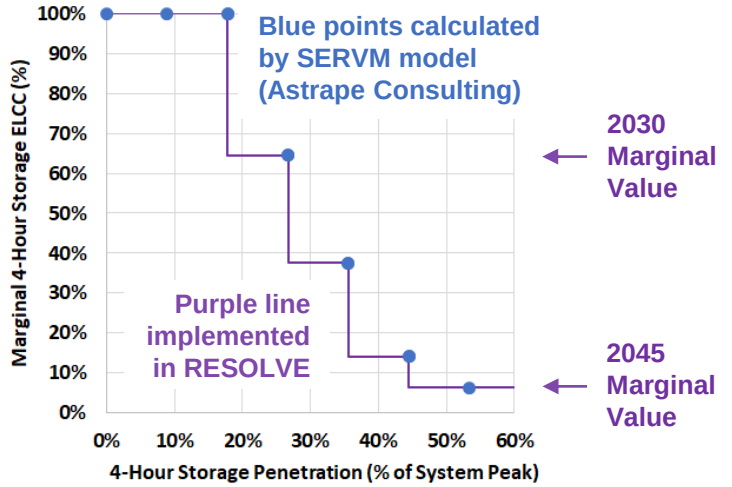
Resource adequacy in 2030



Despite a large buildout of solar capacity, the contribution to resource adequacy is much lower than installed capacity due to saturation at net peak.

Relatively low wind capacity value results in small contribution relative to resource adequacy need

12 GW of battery storage capacity, with an average of ~3 hours of duration, provides 8.5 GW of resource adequacy capacity in 2030.



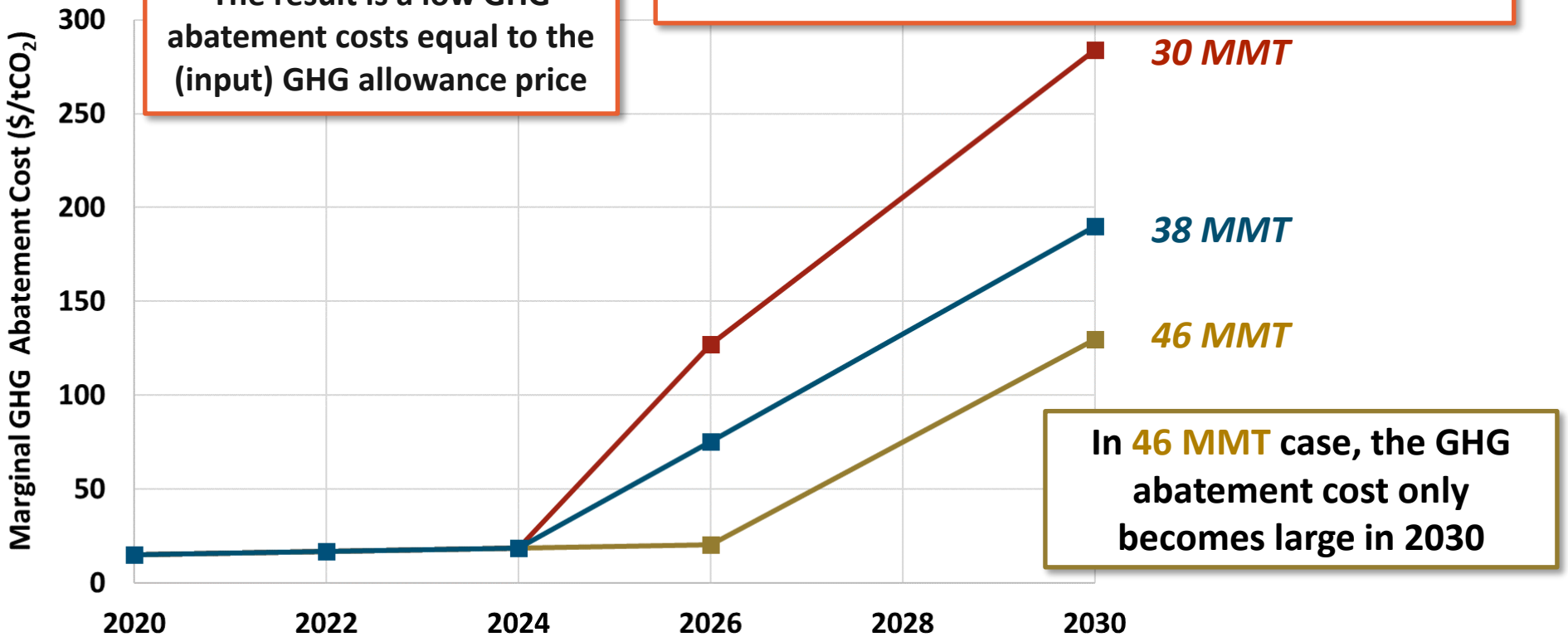
Gas retained for resource adequacy needs and dispatchability

Other includes hydro, geothermal, bio, existing nuclear, pumped storage, demand response, and imports – resources that generally have limits to scalability

GHG abatement costs rise in late 2020s

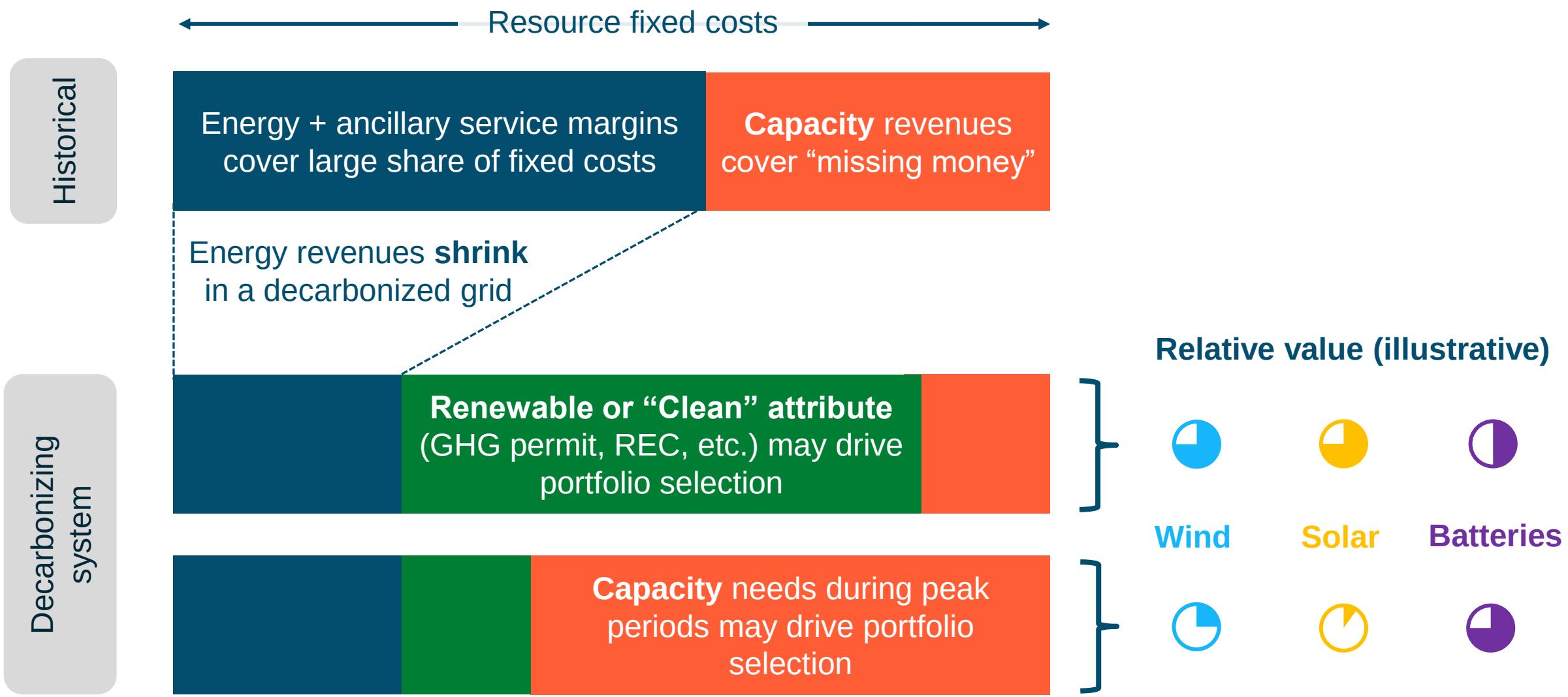
Through 2024, investments are driven by factors other than the GHG constraint - including tax credits and the planning reserve margin. The result is a low GHG abatement costs equal to the (input) GHG allowance price

In 38 MMT and 30 MMT cases, the GHG constraint first becomes a main driver of new investments in 2026. The marginal cost of emissions abatement increases quickly thereafter as marginal GHG reductions become more expensive



In 46 MMT case, the GHG abatement cost only becomes large in 2030

Does capacity or "clean" attribute drive portfolio?



References / links

- **E3 website:**
  - https://www.ethree.com/
- **CPUC links:**
  - IRP landing page:
    - https://www.cpuc.ca.gov/General.aspx?id=6442459770
  - Reference system plan portfolio, adopted by CPUC in March 2020:
    - https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M330/K357/330357384.PDF
  - Proposed reference system plan materials, including sensitivity studies:
    - https://www.cpuc.ca.gov/General.aspx?id=6442463190
  - RESOLVE model, inputs, and results, are publicly available:
    - https://www.cpuc.ca.gov/General.aspx?id=6442464143
- **E3 study for PJM (reference for energy-limited capacity contribution):**
  - https://www.pjm.com/-/media/committees-groups/task-forces/ccstf/2020/20200807/20200807-item-04-e3-allocating-elccmw-from-portfolio-to-classes.ashx

Thanks!