WECC

LDES Advisory Group Information Gathering

June 9, 2022

Stan Holland

Overview

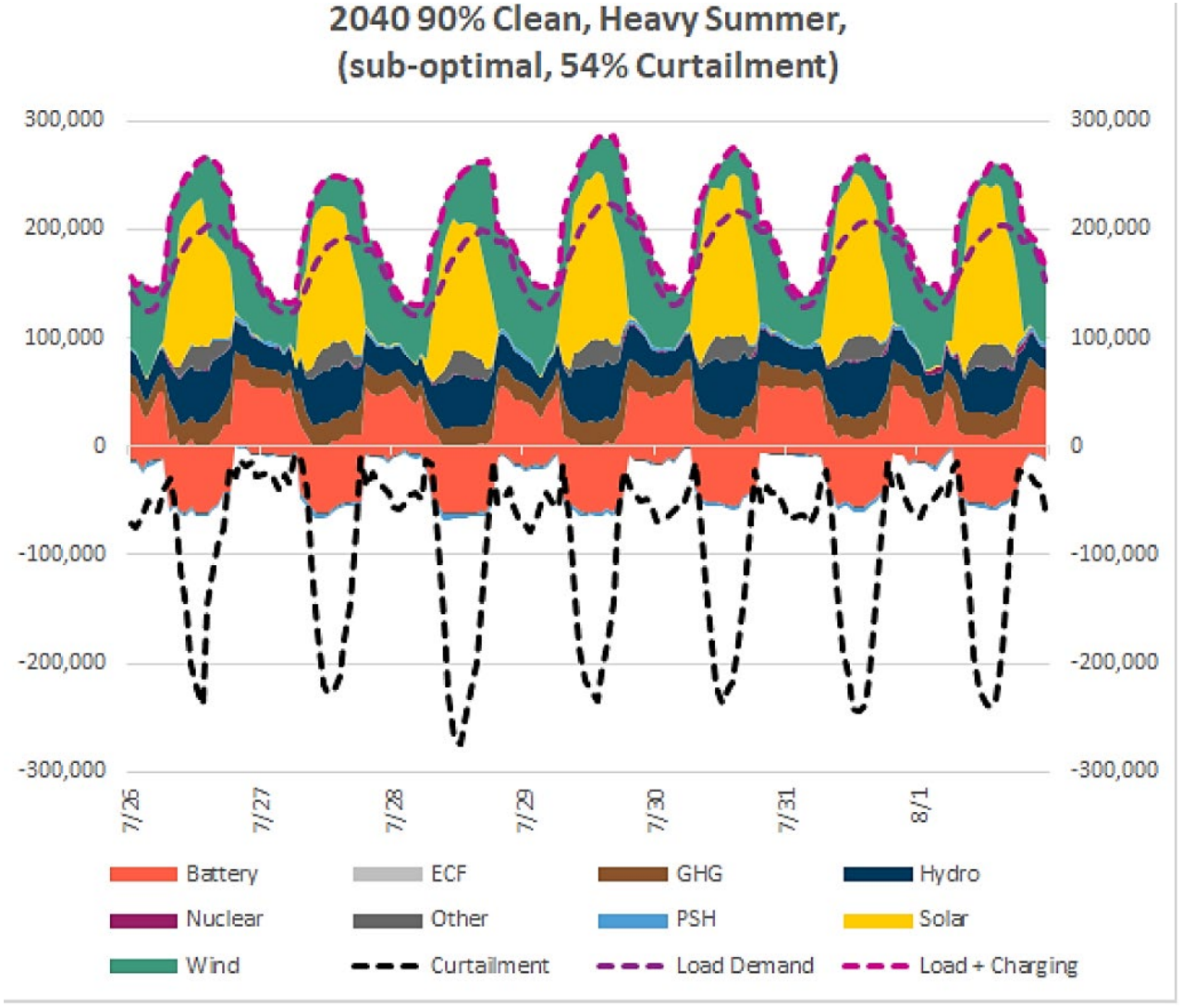
- 2040 Clean Scenarios Study - questions from last meeting
- LDES Technology attributes
- LDES Cost projections
- GridView PCM Energy Storage models
- Energy Storage Collaboration
- Next steps

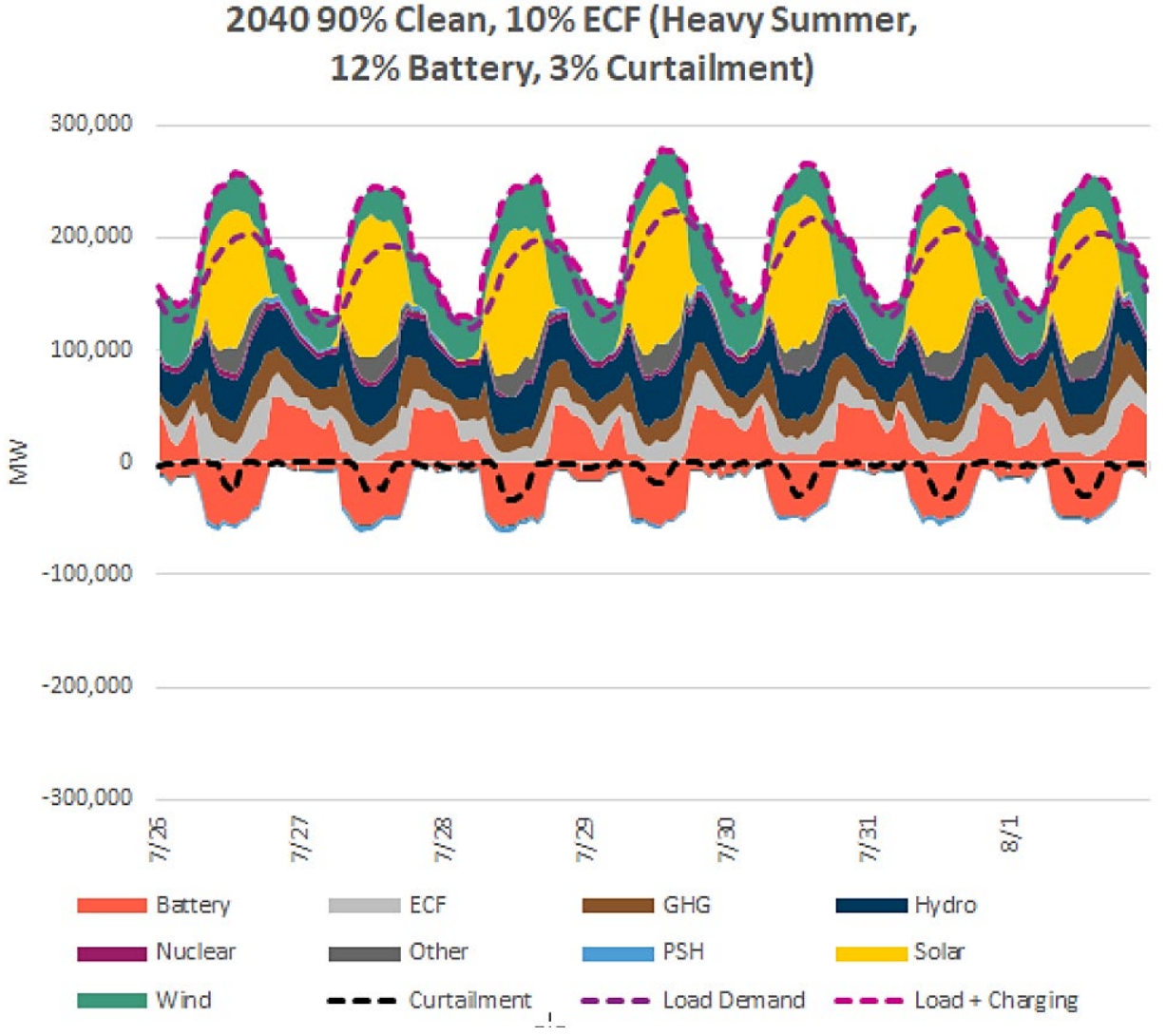
2040 Clean Scenarios Study Questions from last meeting

2040 Clean Energy Scenarios Study Report Questions

- Are the dispatch and curtailment problems just problems with the GridView solution that would be avoidable in "real" system operations?
  - A PCM finds the optimal, least-cost solution, which may not be how each individual system is ultimately operated.
  - In the 2040 scenarios that Mike Bailey ran
    - Adding more VRE resources increased curtailments of VRE and hydro
    - Adding more BESS decreased curtailments, but reached saturation level
  - The LDES study will test the hypotheses that long duration storage can mitigate some or all of the challenges.
- How much 12-hour battery storage was added?
  - Nearly 51,000 MW for the 90% Clean case

Sub-optimal Summer (No ECF) versus Optimal (10% ECF)





ECF = emerging clean and flexible resources. Note that other seasons would have different results

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90% Clean Scenario – Max Candidate Capacity Used (MW)

	Battery	ECF	Solar	Wind	Thermal	Hydro
Alberta	0	3840	164	0	756	0
British Columbia	0	3840	8	113	207	444
Basin	4375	11290	15157	12621	1807	344
California/MX	22975	7625	69043	14658	8738	156
Northwest	6940	11520	14912	12800	5556	4288
Rocky Mountain	3330	3840	8230	6842	1649	0
Desert Southwest	13295	12606	23550	23603	8520	5
== Total ==	50915	54561	131064	70637	27234	5237
	12 hour				10%	

Several candidate resources were added and the maximum dispatch for each was tracked and summed by category. Those not dispatched at all are not needed and could be removed.

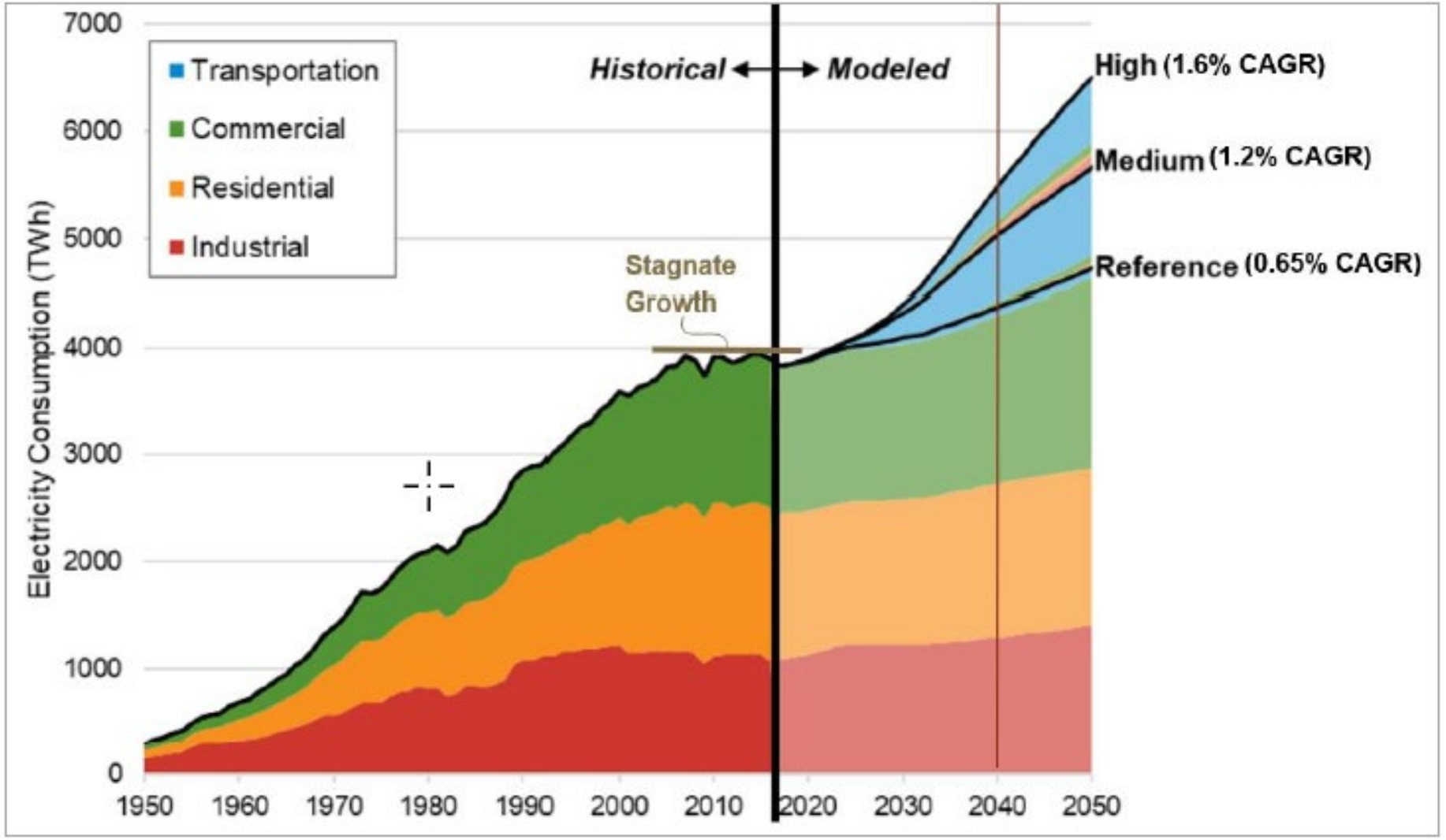
What are Emerging Clean and Flexible (ECF) Resources

- Placeholders for new technologies yet to be developed that are carbon free and flexible
- In the 2040 Clean Scenarios studies the ECF resources had the following characteristics:

Ramp rate: 6000 MW/min
Minimum Up/Dn: 1 hour
FO rate: 6.29%
Summer Derate: 0.94
Startup Cost: $0
Var. O&M: $2.083/MWh
Fixed cost: $712.36/MW/Month

Fuel: Unspecified-Clean
Fuel cost: $5/MMBtu
Heat Rate: ~5.5 MMBtu/MWh
Emission rate: 0 lb/MMBtu

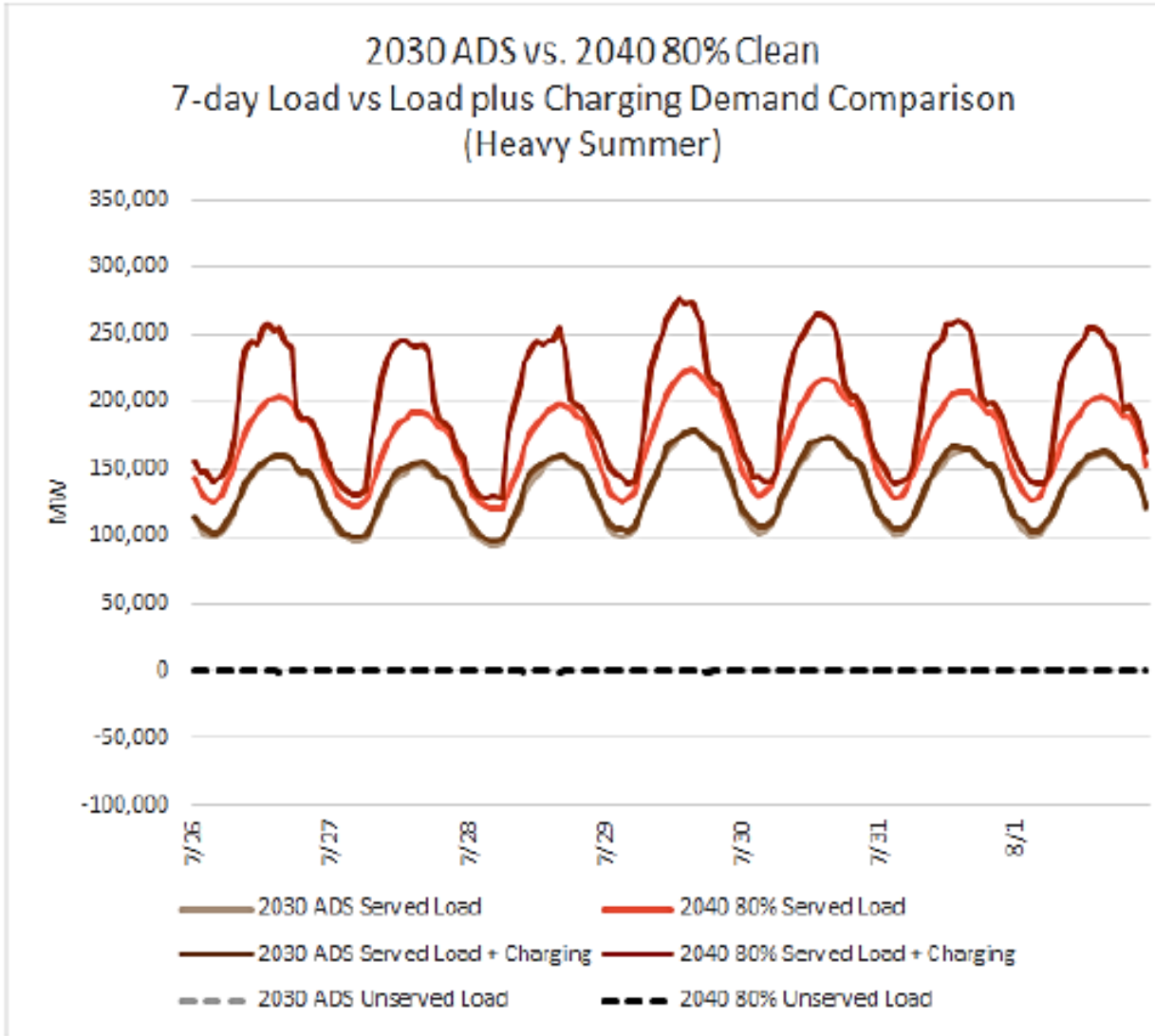
NREL EFS – U.S. Electricity consumption growth potential

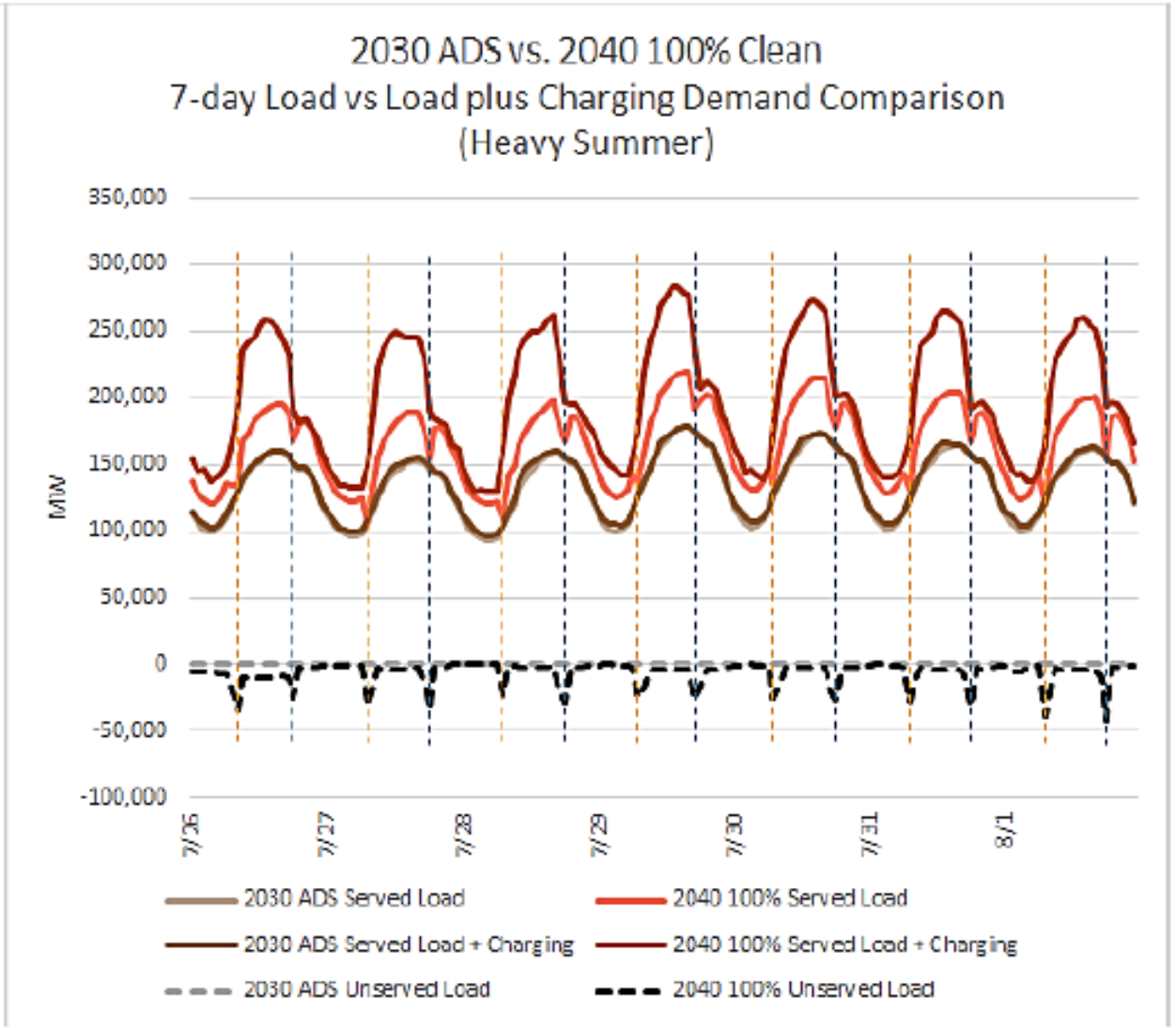


Considered

- Electric vehicle charging
- Building electrification
- Other electrification

All impacting the compound annual growth rate.


2030 ADS vs. 2040 80% Clean
7-day Load vs Load plus Charging Demand Comparison
(Heavy Summer)
MW
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
-50,000
-100,000
7/26
7/27
7/28
7/29
7/30
7/31
8/1
2030 ADS Served Load
2040 80% Served Load
2030 ADS Served Load + Charging
2040 80% Served Load + Charging
2030 ADS Unserved Load
2040 80% Unserved Load


2030 ADS vs. 2040 100% Clean
7-day Load vs Load plus Charging Demand Comparison
(Heavy Summer)
MW
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
-50,000
-100,000
7/26
7/27
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2030 ADS Served Load
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2030 ADS Served Load + Charging
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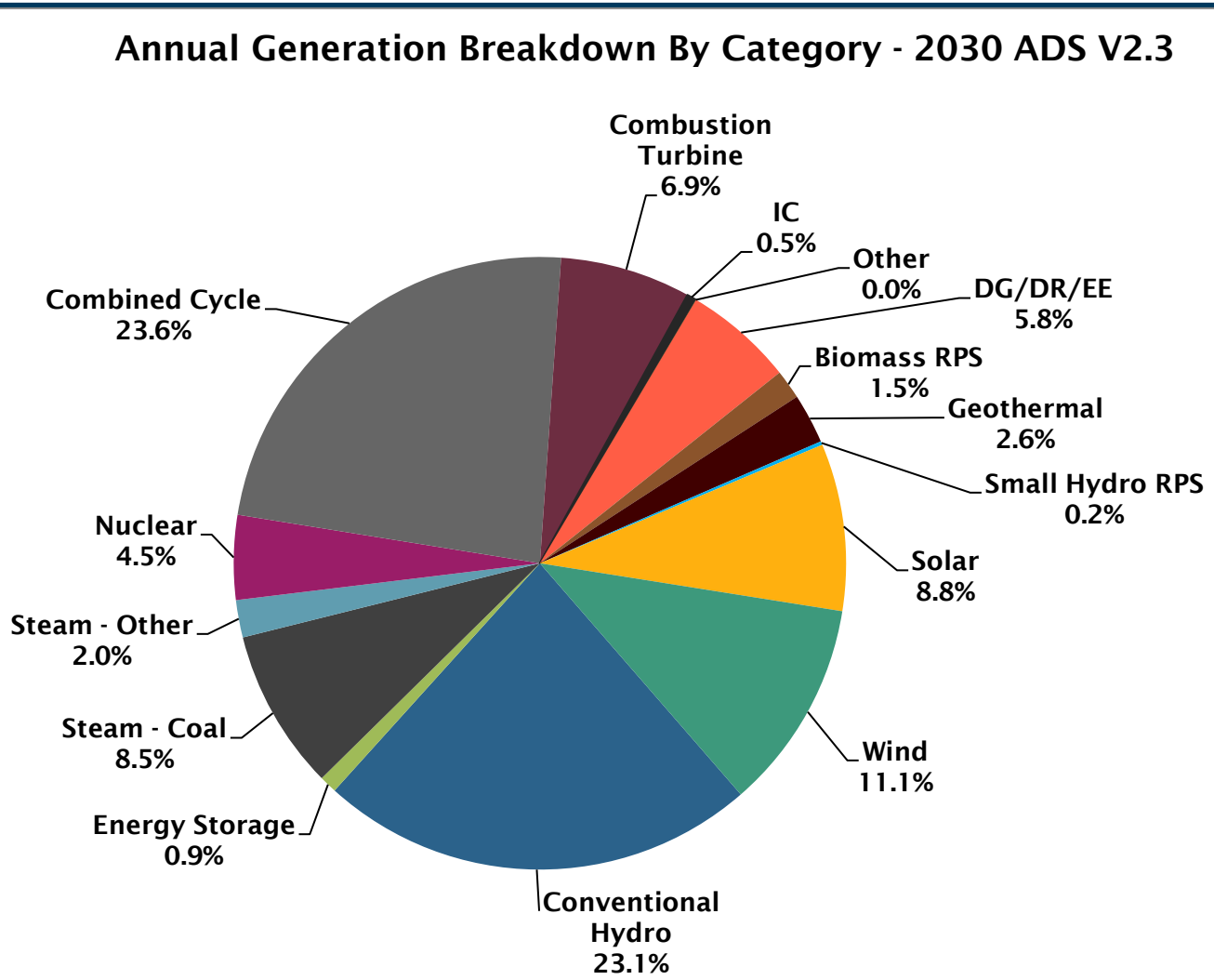
2030 ADS Unserved Load
2040 100% Unserved Load

Generation Breakdown



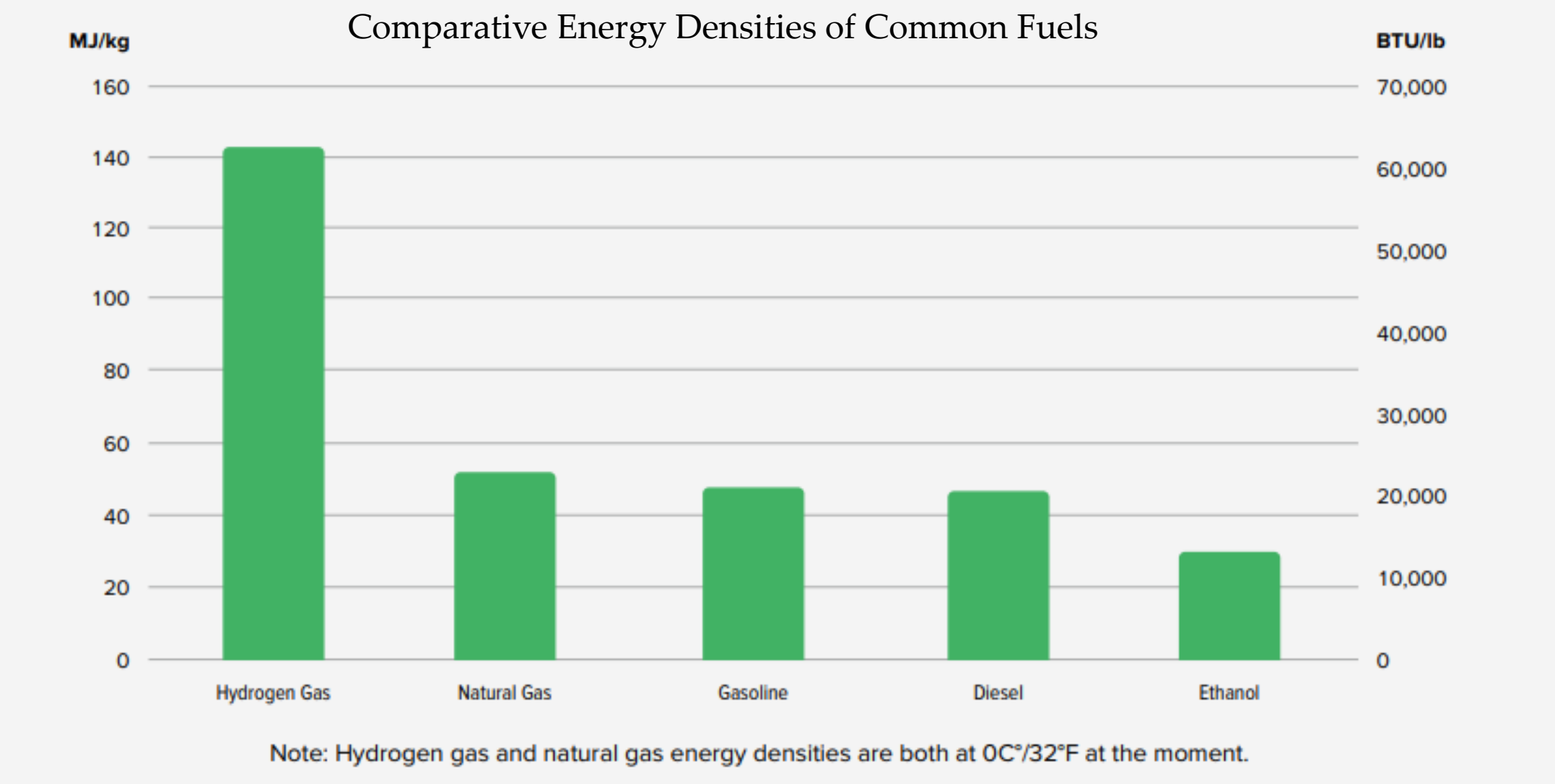
Category	2030	2040
ST - Coal	8.5%	0%
CC/CT	30.5%	10%
Hydro	23.1%	?
Energy Storage	0.9%	?
Solar	14.6%	?
Wind	11.1%	?

LDES Technology Attributes

LDES Technology List

- LDESAG members and interested parties can help with populating the working document posted with the May 26 meeting material
  - LDES types and attributes
  - LDES types with advantages and disadvantages
- The information will be used to help with the technology selections for the study

From Green Hydrogen Guidebook (GHC)



LDES Study Approach Questions

- How will long duration storage be added to the PCM study?
  - LDES resources will replace other generation types
- Which long duration storage technologies will be represented?
  - LDESAG needs to choose their top 4 or 5
- How will they be modeled in PCM?
  - Likely multiple runs (recommend limiting to a reasonable number for reporting purposes)
  - GridView has models for pumped hydro and compressed air storage

90% Clean Scenario – Max Candidate Capacity Used (MW)

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Replace with LDES	?	yes			yes	

LDES Cost Projections

LDES Cost Projections

- Outside of scope but may help with technology selection. PCM only, no capital expansion study planned
- A few LDESAG members have submitted some cost information, and these are posted with the meeting material
- Costs could change
  - DOE Hydrogen Shot seeks to reduce the cost of clean hydrogen by 80% to $1/kg in one decade ($5/kg in 2021 to $1/kg in 2031)
  - Lithium-ion batteries experienced a steady cost reduction, but recently prices are up

GridView Production Cost Model Energy Storage Models

PCM Inputs for Pumped Hydro Storage

- Maximum and Minimum storage "pond" (MWh)
- Initial storage at first hour of study (MWh)
- Efficiency
- Capacity Factor
- Schedule Mode 1 (load curve, price curve)
- Schedule Mode 2 (hourly, daily, weekly)
- Multi-day schedule pattern (storage targets)
- Cost Benefit Ratio
- Charge capacity max/min (MW); Discharge capacity max/min (MW)
- Weekly Energy (MWh) [optional]
- LMP Price to charge ($); LMP Price to discharge ($)
- Ramp up / down rates (MW/hour)
- Reserve contribution (%); Ancillary Services contribution (%)

PCM Inputs for Compressed Air ES

- Maximum and Minimum storage (MWh)
- Initial storage at first hour of study (MWh)
- Schedule Mode
- Cost Benefit Ratio
- Charge capacity max/min (MW); Discharge capacity max/min (MW)
- LMP Price to charge ($); LMP Price to discharge ($)
- Ramp rate (MW/hour)
- Reserve contribution (%)
- Pump Required
- HeatRate
- FuelID
- Startup Cost
- Schedule Area/Region

Energy Storage Collaboration

Energy Storage Collaboration Efforts

- Of course, the LDESAG is a collaboration between its members and WECC, Strategen, WIRAB, and others
- Erin Childs (Strategen) has set up "collaboration" meetings with:
  - Prof. Sarah Kurtz (UC-Merced) who co-authored an article "Evaluating emerging long-duration energy storage technologies", and is finishing work on a second report "Storage Technology Summary"
  - Mitsubishi Power Americas
    - Delta H2 project Link Mitsubishi
- Sandia National Lab sponsored an event (RFI) this week called "Long Duration Energy Storage for Everyone, Everywhere". Synopsis?
- DOE, National labs, WGHI Workshops

Energy Storage Information

- How can we take advantage of the extensive research effort around the world to make long duration energy storage a viable solution to our clean energy goals?
- This information needs to get to the load-serving entities to help them choose the best resources for the future.

Next Steps

Next Steps

- Continue collection of long duration energy storage technology information
- Choose which LDES technologies to include in study
  - Criteria, amounts, etc.
- Choose where to place LDES resources and which resources from the previous study to replace
- Run studies and review results
- Make any recommended changes and re-run
- Write report and review

WECC

Electric Reliability and Security for the West

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