2022 Power Strategic Long-Term Resource Plan (SLTRP)

Roadmap to 100% Carbon Free by 2035

SLTRP Advisory Group Meeting #8
Phase 4 (Preliminary Results)
April 28, 2022

Meeting Agenda

Joan Isaacson, Kearns & West

- Welcome & Introductions
- Meeting Purpose and Agenda Overview
- 2022 SLTRP Overview and Refinements
- 2022 SLTRP Preliminary Results
- Discussion, Q&A, and Polling
- 2022 SLTRP Public Outreach Meetings
- Wrap Up

Website: www.ladwp.com/SLTRP
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Guides for Productive Virtual Meetings

Advisory Group Role in 2022 SLTRP

The Advisory Group will provide input and feedback based on their expertise, knowledge, and resources of the organizations, institutions, and constituent groups represented by Advisory Group members.

Advisory Group Meeting Plan

Phase 1 | Q3 2021 Launch & Laying Foundation	Phase 2 | Q3 2021 Scenario Development	Phase 3 | Q4 2021 Modeling	Phase 4 | Q1-2 2022 Results	Phase 5 | Q2-3 2022 Outreach
#1 September 23 • Advisory Group Launch • LADWP Overview • LA100 (Achieving 100% Renewable Energy) • 2022 SLTRP Orientation • Advisory Group Protocols & Operating Principles	**#4 October 22** • Customer Focused Programs - Energy Efficiency & Building - Electrification - Transportation Electrification - Demand Response • Draft Scenario Matrix	**#7 December 17** • LA100 Equity Strategies Overview • Energy Storage Presentation • 2022 SLTRP What-If Sensitivities Discussion • Final Scenario Matrix	**February** ***(Email Update)*** • Modeling Progress Check-in, • Upcoming Board Meetings	**#9 June 9** • Preliminary Results on Sensitivities **August TBD** Community Outreach Meetings
#2 September 30 • *LA100 Study Review (NREL) at 9 am* • LA100 Rates Analysis (OPA) at 10 am • LA100 Next Steps (LADWP) • LA100 Assumptions (PSRP) • Consider Topics for October 22 • Consideration of Scenario Definition	**#5 November 10** • LA100 "No Combustion" Scenario • 2022 SLTRP Assumptions • Metrics & Evaluation Process • Scenario Considerations • Refine Scenario Matrix	**November – May** • Internal Modeling • Analysis of Scenarios	**#8 April 28** • Preliminary Results on Core Scenarios • (Capacity Expansion, LOLP and Production Cost Model)	**#10 August 11** Public Outreach Results **August** Review Draft 2022 SLTRP
#3 October 08 • SLTRP Deep Dive • SB100 Review (LADWP) • 100% Carbon-Free by 2035 Requirements (NREL) • Green Hydrogen in LA (LADWP) • 2022 SLTRP Key Considerations and Potential Scenarios	**#6 November 19** • Distribution Automation • 2022 SLTRP Advisory Group Feedback and Refined Draft Scenario Matrix • 2022 SLTRP What-If Sensitivities Discussion	Modeling Underway	**TBD** Potential field trip	**September** Submit Final 2022 SLTRP for approval

2022 SLTRP Overview and Updates

Jay Lim, LADWP Manager of Resource Planning





Recent Clean Energy Accomplishments

- Beat State target to reduce GHG emissions 40% below 1990 levels by 2030, 14 years early.
- Provided ~36.4% renewables and 55% clean energy in 2021.
- Placed major wind project (Red Cloud, 331 MW) in-service in December 2021.
- Expanded local solar with 300 MW Feed-in Tariff and 10 MW FiT+ pilot for optional energy storage.
- Replaced over 20,000 poles, 70,000 crossarms, 330 miles of cables, and 8,400 transformers since 2013.
- Surpassed goal of 10,000 commercial EV chargers 20 months ahead of 2022 target. Designated as #1 EV friendly City by Plug Share.

Red Cloud Wind Project

LADWP's largest & lowest cost wind farm

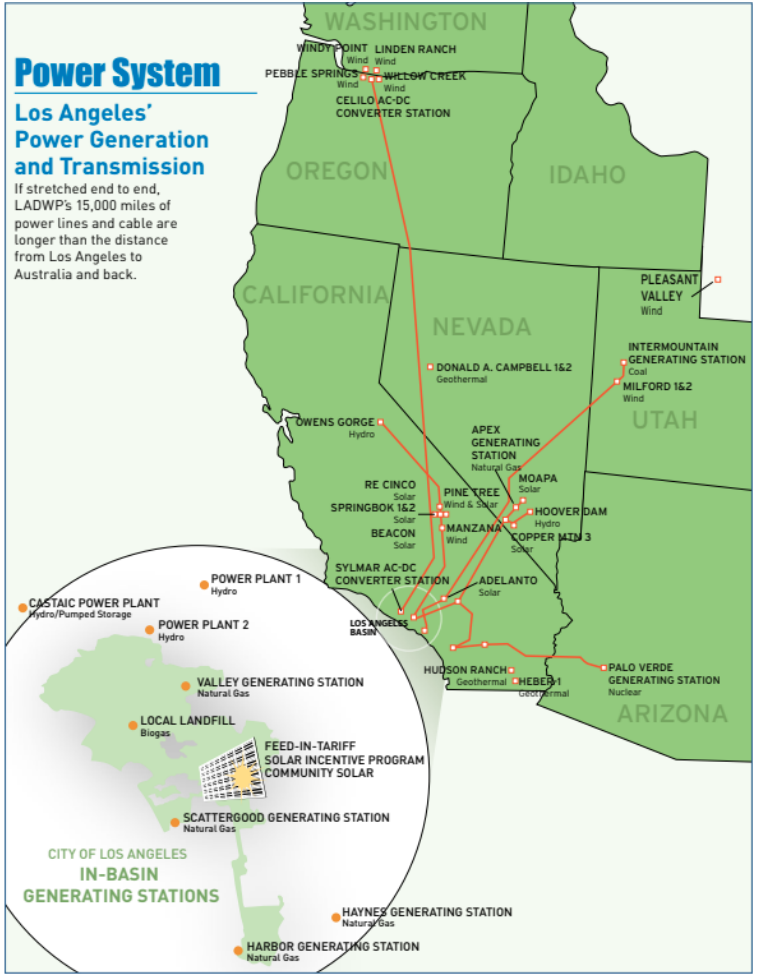
Power supply for 222,300 homes.

Offsets GHG emissions equivalent to ~100,000 gas cars.

Boosts renewable portfolio by 6%.

LADWP Power System Overview

- Largest municipal utility in the US with 1.5 million power customers
- FY2021 key figures:
  - Energy Sales: 22.5 million MWh
  - Operating Revenue: $4.3 billion
  - Total Liquidity as of February 28, 2022:
    - $2.8 billion on hand including approximately $488 million on deposit in a Debt Reduction Trust Fund*
    - Combined Revolving Line of Credit for both Water & Power Systems of $300 million with an accordion feature to provide up to an additional $200 million within 30 days notice.
- Owns more than 25% of state's transmission system
- Reached its 20% renewable target beginning in 2010, 37% in 2020, and targeting 80% renewable by 2030 and 100% carbon free energy by 2035
- Greater Los Angeles service territory is economically strong and diverse:
  - Stable, broad customer base with steady growth



Recent Accomplishments

80% Renewable by 2030	**Red Cloud Wind:** 331 MW in-service Dec 2021 **Eland Solar + Storage:** 2023 commercial operation **Local Solar:** 550 MW in-service to date
Transmission	**Toluca to Hollywood Line 1** permitting in process **Tarzana to Olympic Line 1** permitting in process Biweekly Implementation Meetings on-going
Local Generation	**Green hydrogen Request for Information** (RFI) issued **Scattergood hydrogen capacity** and **Haynes recycled water** Seeking external funding opportunities for green hydrogen
Energy Storage	Installed or contracted **333 MW of energy storage for 2023** Maximize use of solar + storage **Investment Tax Credits** **Scattergood energy storage** conceptual plans
Equitable DERs	**LA100 Equity Strategies Study** on-going through 2023 Expanded **Feed-in Tariff** from 150 MW to 450 MW, advertised **DER RFP**, launched thermostat **demand response** program

2022 SLTRP Overview

The Strategic Long-Term Resource Plan (SLTRP) is a roadmap to meet L.A.'s future energy needs and regulatory mandates while maintaining reliable service and reduce emissions in a cost-effective manner.

Outcome: Develop a recommended case that guides our near-term actions and future energy planning to achieve **100% carbon free by 2035** and **through 2045.**

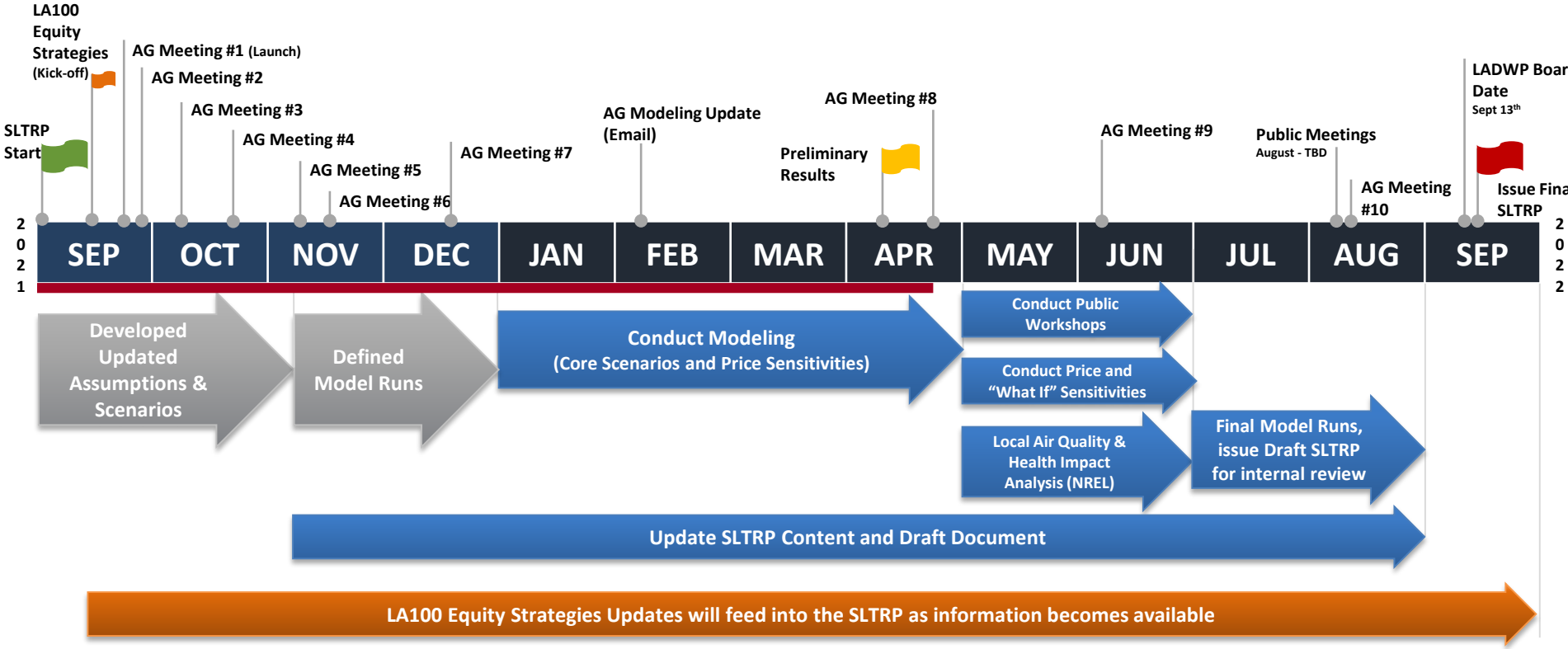
2022 SLTRP will also be supported by:

- Integrated Human Resources Plan
- Implementation & Constructability Assessment
- Procurement Risk Assessment
- Operations & Maintenance Assessment
- Supply Chain Risk Assessment

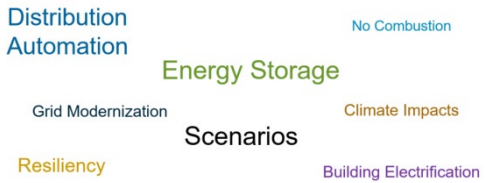
2022 SLTRP Overview – Comparison to 2017 SLTRP

Targets	2017 SLTRP	2022 SLTRP
Planning Horizon	through 2037	through 2045
2030 RPS Goal	55% based on sales	80% based on sales or generation
Ultimate Clean Energy Goal	65% RPS by 2035	100% carbon-free by 2035
Local Solar Goal (2035)	1,500 MW by 2035	2,240 MW or 2,900 MW by 2035
Electric Vehicles Goal (2030)	580,000 EV equivalents	757,000 EV equivalents *(includes medium/heavy duty)*
Energy Storage Goal (2030)	404 MW	over 1,300 MW

2022 SLTRP Overview - Timeline



Advisory Group Feedback



AG Feedback from first 7 Meetings

1) Model only 100% Carbon Free by 2035 scenarios
2) Include a "No Combustion" scenario and long-duration energy storage
3) Understand capital expenditures and cost, customer cost to electrify
4) Model emerging technologies and develop a process to evaluate
5) Explore "low load" sensitivities and impact to rates
6) Ensure environmental justice and study local air quality impacts

LADWP's Efforts to incorporate:

1) All scenarios comply with City Council Motion for 100% carbon free by 2035
2) "What-If" Sensitivities added. Presentation given on energy storage
3) SLTRP will evaluate cost & rates
4) Developing a process for "Technology Scouting and Innovation Assessment"
5) Will model a "low load" sensitivity
6) Partnering with NREL to conduct Local Air Quality and Health Impacts for SLTRP

~20 various presentation topics given at SLTRP meetings to date

2022 SLTRP Overview – Core Scenarios

Los Angeles Department of Water & Power

SCENARIOS (100% Carbon Free by 2035)

**Note: SB100 achieves 100% clean energy by 2045 based on retail sales; however, figures are shown in terms of generation for benchmarking purposes*

CLEAN ENERGY TARGETS

	SB 100 Reference Case	Case #1	Case #2	Case #3
Total Renewable Portfolio Standard 2030	60%	80%	90%	90%
Total Clean Energy (Renewable, Hydro and Nuclear) Penetration Achieved 2035 vs. 2045	2035: 80% 2045: 90%*	2035: 100% 2045: 100%	2035: 100% 2045: 100%	2035: 100% 2045: 100%
Distributed Energy Resource Deployments	Reference Levels	High Levels	High Levels	Highest Levels

2022 SLTRP Overview - Sensitivities

Commodity Prices	Examples	Price Sensitivity Scenarios Applied to 100% carbon free by 2035 Scenarios
Fuel Prices*	Natural Gas, Green Hydrogen, etc.	High/low sensitivities
GHG Prices*	GHG Allowance Prices	High/low sensitivities
Renewables and Energy Storage Prices*	Solar, Wind, Geothermal, Li-Ion, flow, etc.	High/low sensitivities

**bookend scenarios to evaluate price sensitivities by matching low and high commodity prices:*

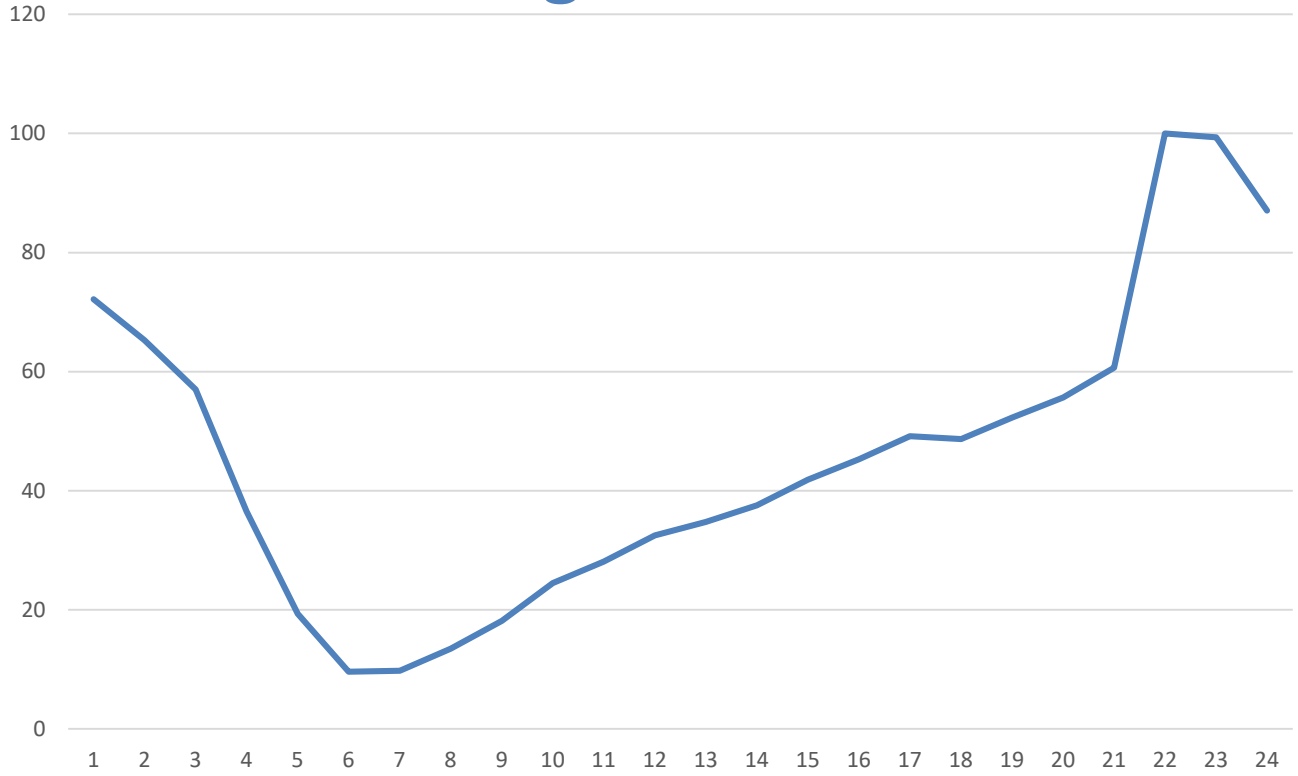
- ***Low Bookend:*** *Low natural gas prices, low hydrogen prices, low GHG prices, low renewable and energy storage prices*
- ***High Bookend:*** *High natural gas prices, high hydrogen prices, high GHG prices, high renewable and energy storage prices*

Implementation Risk	Description	"What-if" Sensitivities Applied to Tentative Recommended Case (based on preliminary results)
Emerging Technologies	No Combustion Alternatives	Long duration capacity (e.g. Hydrogen Fuel Cells)
Demand Side Resources	Demand Response	Reaching only half of the 576 MW of DR by 2035
Transmission	Transmission Upgrades (over 10 projects by 2030)	More difficult in-basin upgrades not completed by 2030
Load	Transportation/Building Electrification	Low Load and High Load

SLTRP Refinements Over the LA100 Study – PSRP Revamp Costs

- In the LA100 Study, only distribution system upgrade costs required to accommodate load growth and increased local solar and storage are considered. Distribution costs do not include the costs of upgrades to manage deferred maintenance, operations and maintenance, or potential costs to acquire land for some substation expansions.
- The 2022 SLTRP incorporates costs from the Power System Reliability Program (PSRP). The PSRP invests more than $1 billion per year to rebuild aging infrastructure and conduct proactive maintenance. Goals of the program include replacing distribution transformers, poles, underground cables, and substructures.

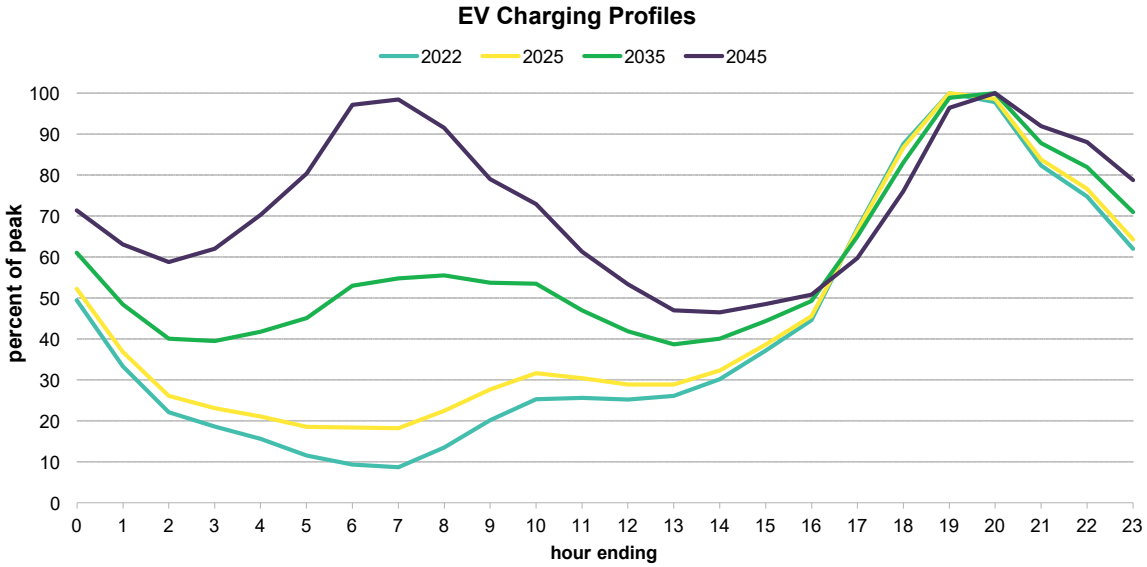
SLTRP Refinements Over the LA100 Study – Managed Electric Vehicle Charging



- This is what we've used in the past.
- Remains constant through 2045
- Peak is at HE22
- We'd like to capture the change in the load shape over time
- Why? Managed/delayed EV charging

SLTRP Refinements Over the LA100 Study – Managed Electric Vehicle Charging

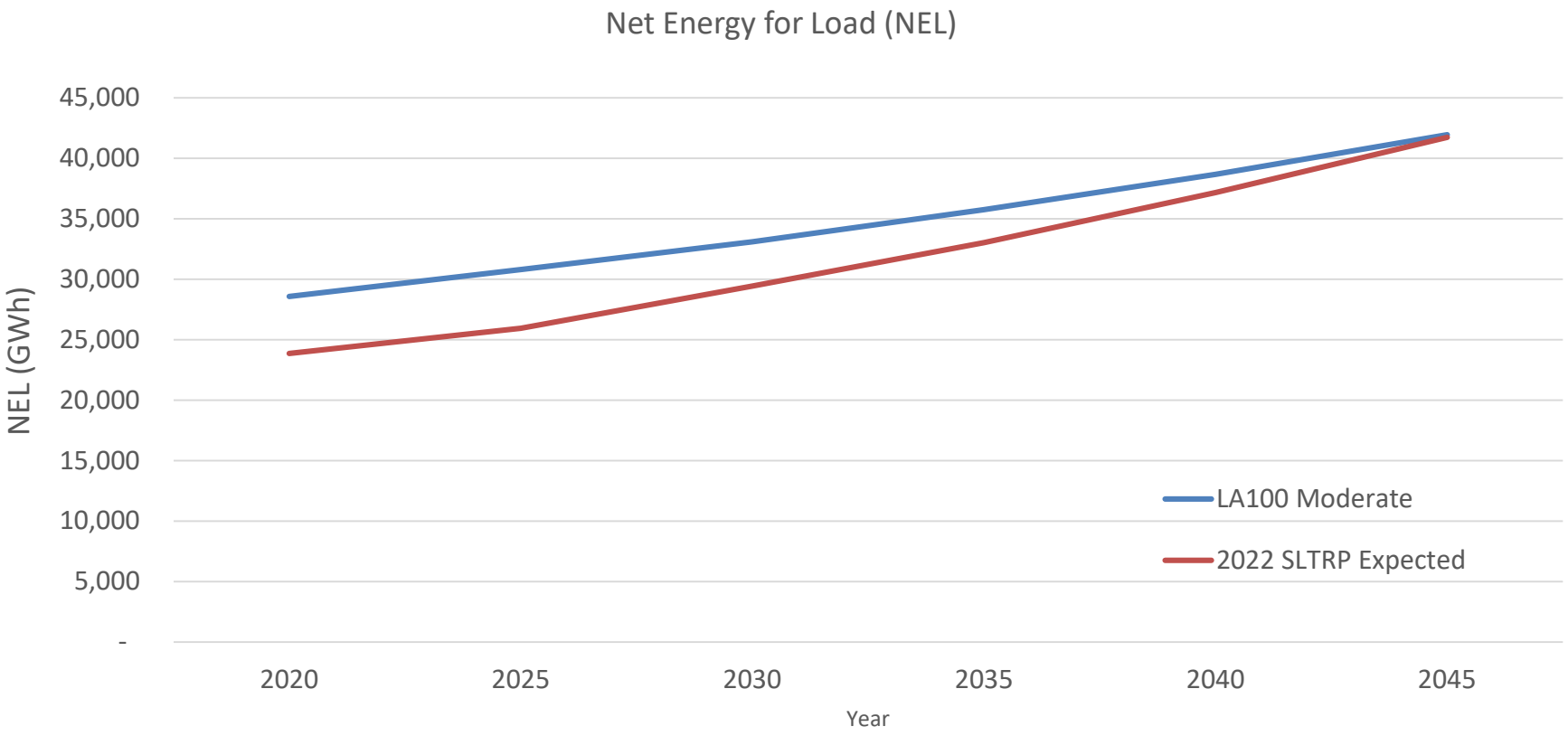
- **Home** Managed Charging Penetration: 0% in 2022 → 75% in 2050
- **Workplace** Managed Charging Penetration: 0% in 2022 → 50% in 2050



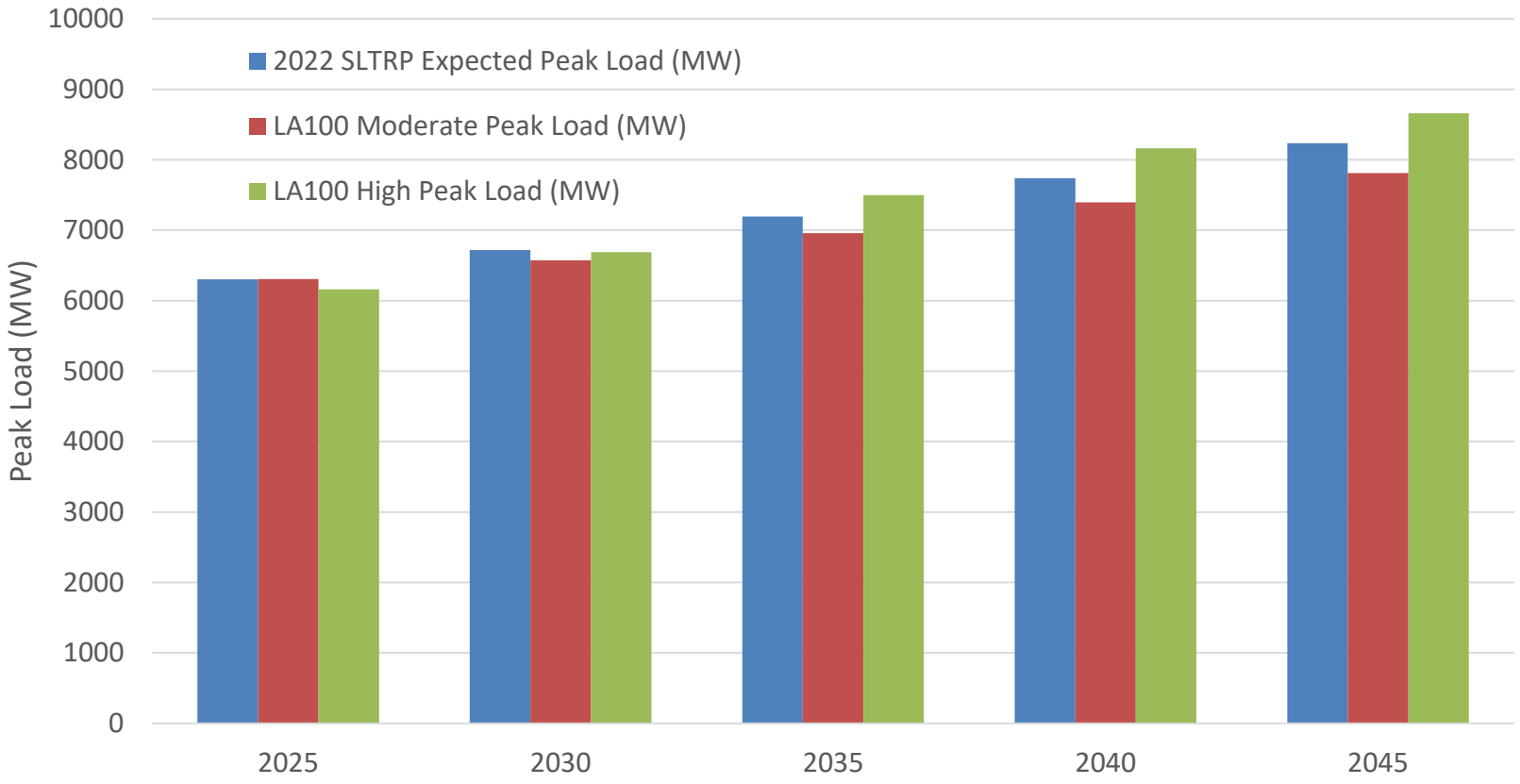
SLTRP Refinements Over the LA100 Study – Customer Demand

- The 2022 SLTRP is using the most recent load forecast from the LADWP Load Forecasting Group.
  - This latest forecast incorporates additional energy savings from several energy efficiency and distributed solar programs.
  - LADWP is accelerating these savings programs, and retail sales are expected to be reduced by an additional 1,883 GWh over the next five years.
  - The load forecast used in the 2022 SLTRP thus predicts lower overall customer demand, especially in the first several years of the modeling horizon, as compared to the LA100 Study.

SLTRP Refinements Over the LA100 Study – Net Energy for Load



SLTRP Refinements Over the LA100 Study – Peak Demand



Discussion and Q&A

2022 SLTRP: Preliminary Results

Zach Brode, Ascend Analytics
Jay Lim, LADWP Manager of Resource Planning



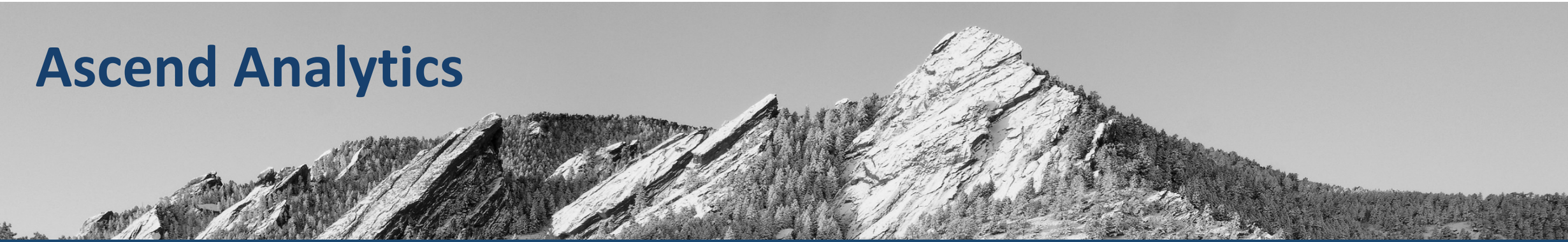


Ascend Analytics
Better models. Better decisions.

2022 SLTRP April Advisory Group Meeting

April 28th, 2022

Ascend Analytics



- Founded in 2002 with 50 employees in Boulder, Oakland and Bozeman
- Seven integrated software products for operations, portfolio analytics, and planning
- Consulting and custom analytical solutions

Proven and Broadly Adopted

New York Power Authority · nrg · Duke Energy · American Electric Power · Silicon Valley Clean Energy · Austin Energy · CPA · IPL an AES company · REU Redding Electric Utility · TID Water & Power · Ameren · BWL Lansing · NorthWestern Energy · LA DWP Los Angeles Department of Water & Power · Glendale Water & Power · 8minute Solar Energy · ISO new england · East Bay Community Energy · Nebraska Public Power District · Shell · Terra-Gen · NextEra Energy

Differentiated Value for Enhanced Decision Analysis

PowerSimm OPS
OPERATIONAL STRATEGY

- Optimal short-term dispatch
- Determine operating strategies from position and financial exposure
- Track realized customer revenue and costs to settled day ahead and real time price
- Optimize financial exposure between day ahead and real time prices

PowerSimm Portfolio Manager
PORTFOLIO MANAGEMENT

- Portfolio management
- Generation asset management
- Hydro and renewable asset modeling
- Retail management & pricing
- Energy purchases and sales
- CFaR, GMaR, EaR

PowerSimm Planner
VALUATION & PLANNING

- Asset valuation
- Resource Planning
- Capacity Expansion Planning
- Reliability Analysis
- Renewable Integration
- Long-term Price Forecasting

Smart Bidder
STORAGE OPTIMIZATION

- Optimal offers to ISO
- Continuous adjust ISO offers
- Forecast probabilities of price spikes
- Renewables plus storage

BatterySimm Valuation
STORAGE VALUATION

- Optimal siting and sizing
- Captures realistic revenues given imperfect foresight
- Battery cycle analysis

Ascend Market Intelligence

- Power, ancillary, and capacity price forecasts, including subhourly and geographic evolution
- Market reports and analysis
- Hourly and subhourly nodal and hub price simulations

Modeling Plan

Item	Status
Model inputs for existing and new resources	Complete
Scenario build out	Complete
Model Validation	Complete
Capacity Expansion Modeling	**Ongoing, preliminary results shown today**
Production Cost Modeling	**Ongoing, preliminary results shown today**
Resource Adequacy	Ongoing
Sensitivities (what ifs, high/low commodity prices, load)	Based on preferred case
Resiliency Study	Based on preferred case
Hydrogen Buildout	Based on preferred case

Modeling Approach

Ascend Analytics

Better models. Better decisions.

Modeling Scenarios

Ascend Analytics

SB100 Reference Case

- 60% RPS by 2030
- 100 Clean by 2045 (based on retail sales)
- Reference level of local solar (1500 MW by 2035)
- Moderate DR (576 MW by 2035)
- Moderate EE (3210 GWh by 2035)
- Moderate Transmission Upgrades

Case 1 Carbon Free by 2035 – Moderate

- 80% RPS by 2030 (based on sales)
- 100% carbon free by 2035 (based on generation)
- High level of local solar (2240 MW by 2035)
- Moderate DR (576 MW by 2035)
- High EE (4350 GWh by 2035)
- High Transmission Upgrades

Case 2 Carbon Free by 2035 – Aggressive

- 90% RPS by 2030 (based on sales)
- 100% carbon free by 2035 (based on generation)
- High level of local solar (2240 MW by 2035)
- Moderate DR (576 MW by 2035)
- High EE (4350 GWh by 2035)
- High Transmission Upgrades

Case 3 Carbon Free by 2035 – Aggressive with High DERs

- 90% RPS by 2030 (based on sales)
- 100% carbon free by 2035 (based on generation)
- Highest level of local solar (2400 MW by 2035)
- High DR (633 MW by 2035)
- Highest EE (4770 GWh by 2035)
- High Transmission Upgrades

SLTRP Modeling Overview

Ascend Analytics

ARS results roll into other modules within PowerSIMM framework

Automated Resource Selection (ARS)

- Selects least-cost combination of resources to meet future load while maintaining system needs and policy mandates

Production Cost Analysis

- Use ARS results to build LADWP system portfolios
- Shows how resources will dispatch over time to serve load
- Provides granular results for costs, emissions, renewable generation, etc.

Resource Adequacy

- Tests portfolios to ensure LADWP can meet load on an hourly basis throughout the year
- Provides updated values for capacity contribution of variable renewable resources and energy storage

Iteration is needed to ensure robust results

ARS Overview

Ascend Analytics

Configure Existing Resources

- Solar
- Wind
- Hydro
- Storage
- Natural Gas – Converting to H2
- Nuclear
- Geothermal

Candidate Resources (Resource Options for Expansion Portfolio)

- Solar
- Wind
- Hydro
- Storage
- Geothermal

Constraints

- Reserve Margin
- Emissions Targets
- RPS Mandates
- Energy Generation

ARS selects resources from the candidate list to determine the timing, location and quantity of new resources that will serve load at the least-cost subject to the constraints

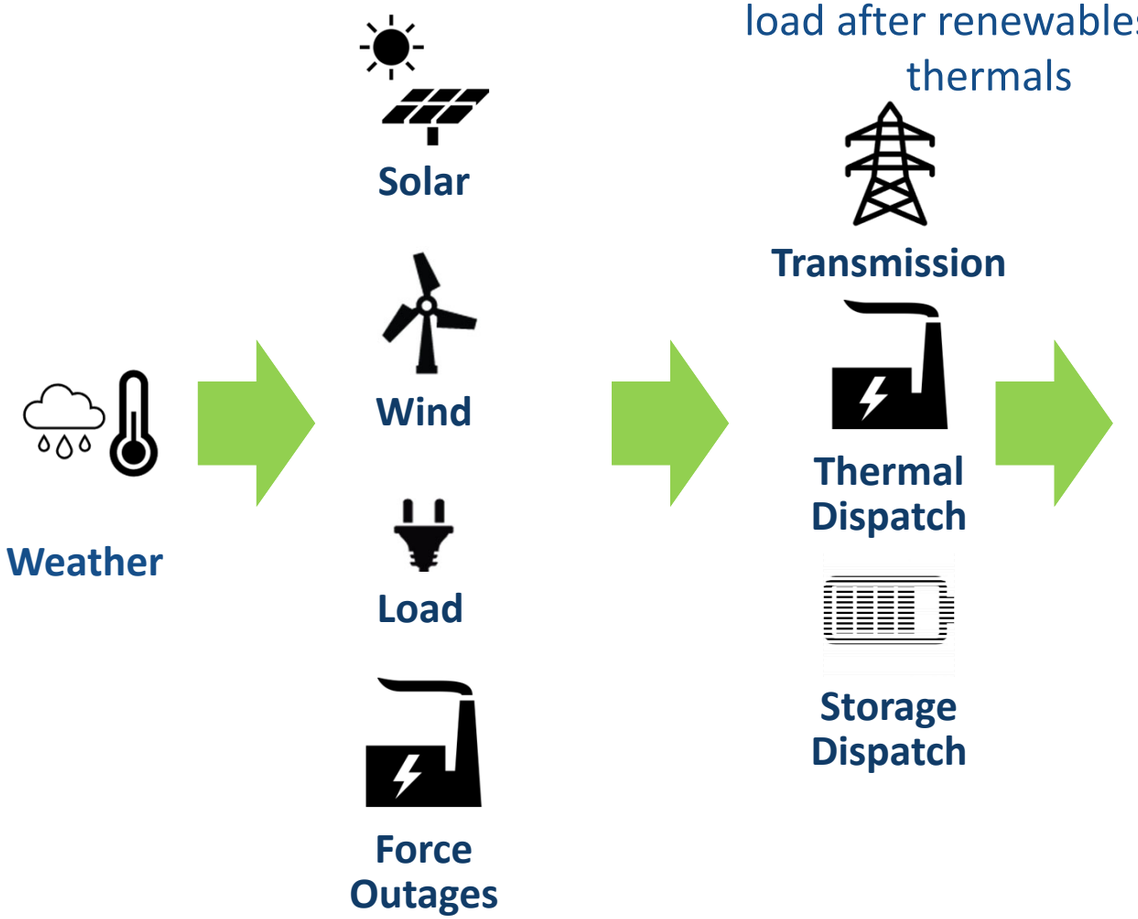
Production Cost Overview

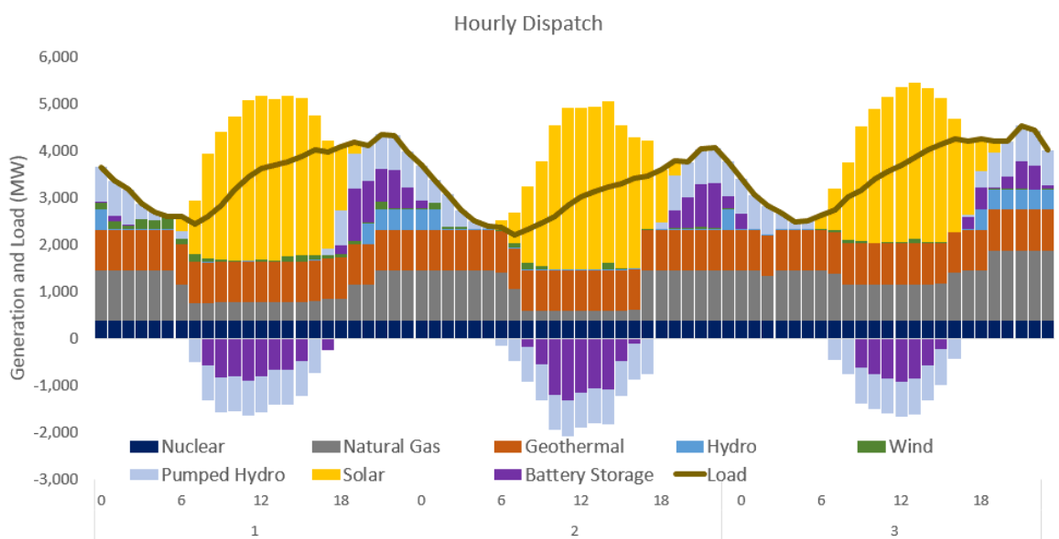
Simulate and Dispatch LADWP's system on an hourly basis to understand how the portfolio meets customer load

Simulated renewables, load and generator outages

Energy storage and transmission resources used optimally serve load after renewables and thermals

Hourly renewable generation, dispatch for thermal assets and batteries, emissions, curtailment, etc. are outputs from the production cost model





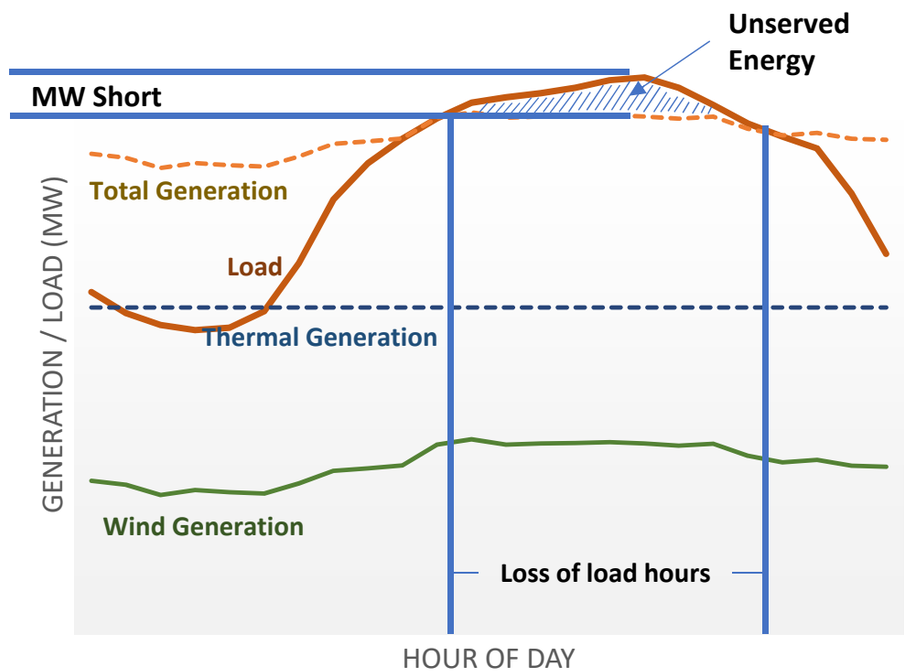
Ascend Analytics

Overview of Resource Adequacy

Given system uncertainty, how likely will resources supply customer load all hours of the year?

- Large sources of uncertainty include renewable generation, forced outages and load
- Probabilistic models provide metrics on loss of load events to fully understand potential harm/constraints

Metric	Description
LOLP	**Loss of load probability** – The probability of an event where load exceeds available generation resources
LOLH/LOLE	**Loss of load hours / expectation** – The expected number of hours (LOLH) or days (LOLE) where load cannot be met with available generation resources
EUE	**Expected energy unserved** – The expected amount of load, in MWh, that cannot be met with available generation
MW Short	The largest shortfall from inadequate generation resources
ELCC	**Effective load carrying capability** – The expected capacity contribution from variable renewable resources, usually as a function of the penetration of a renewable technology in a power system



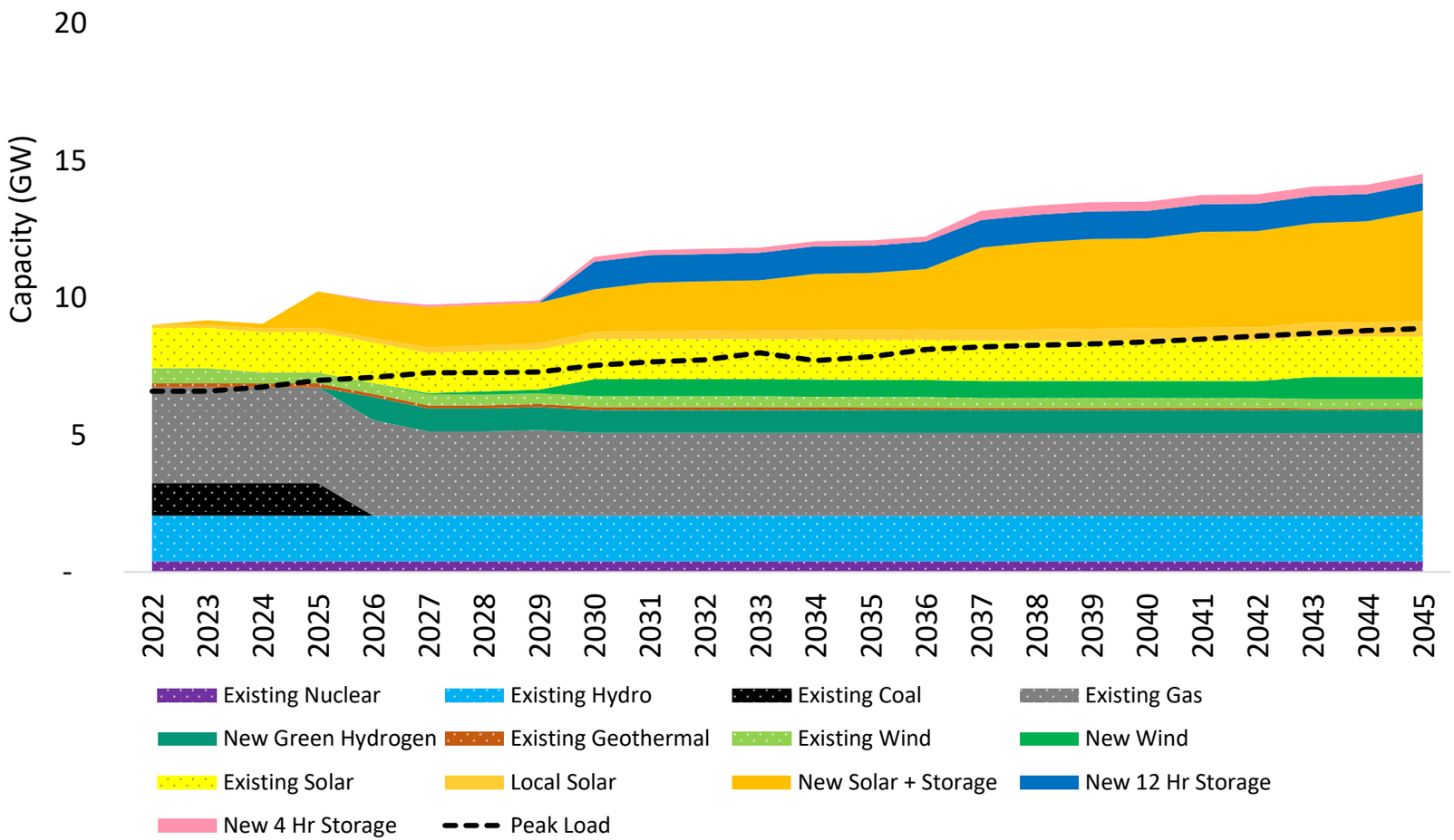
Results

Ascend Analytics

Better models. Better decisions.

Portfolio Capacity – SB100

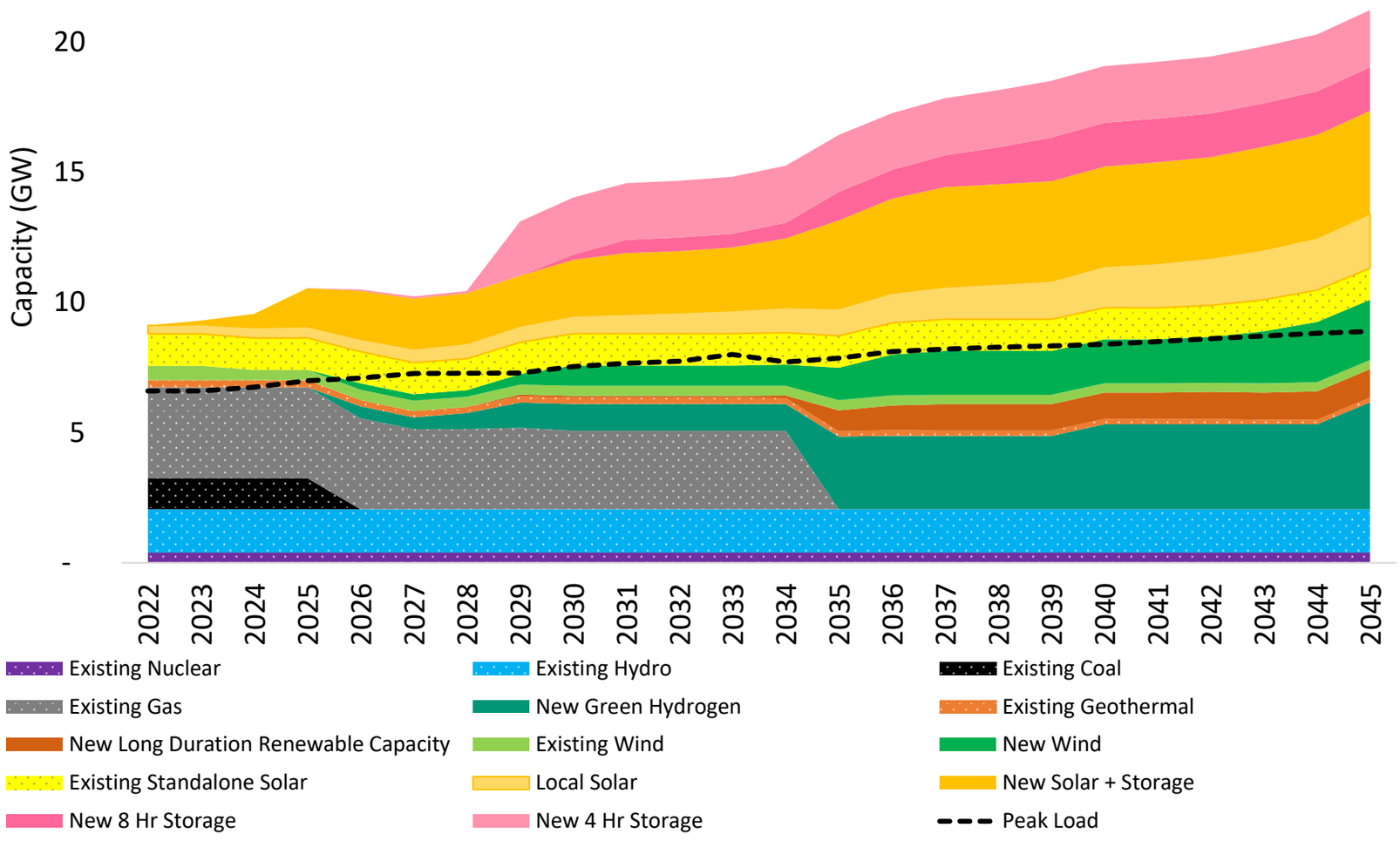
Reference Case to Benchmark Clean Energy Scenarios



- Additional capacity includes
  - Wind
  - Solar
  - Standalone storage
  - Solar plus storage
  - 12 Hr Storage
- Natural gas capacity continues to operate to 2045
- IPP Renewed is the only Green Hydrogen resource
- Natural gas units must reduce usage after 2045 to comply with clean energy target

Portfolio Capacity – Case 1

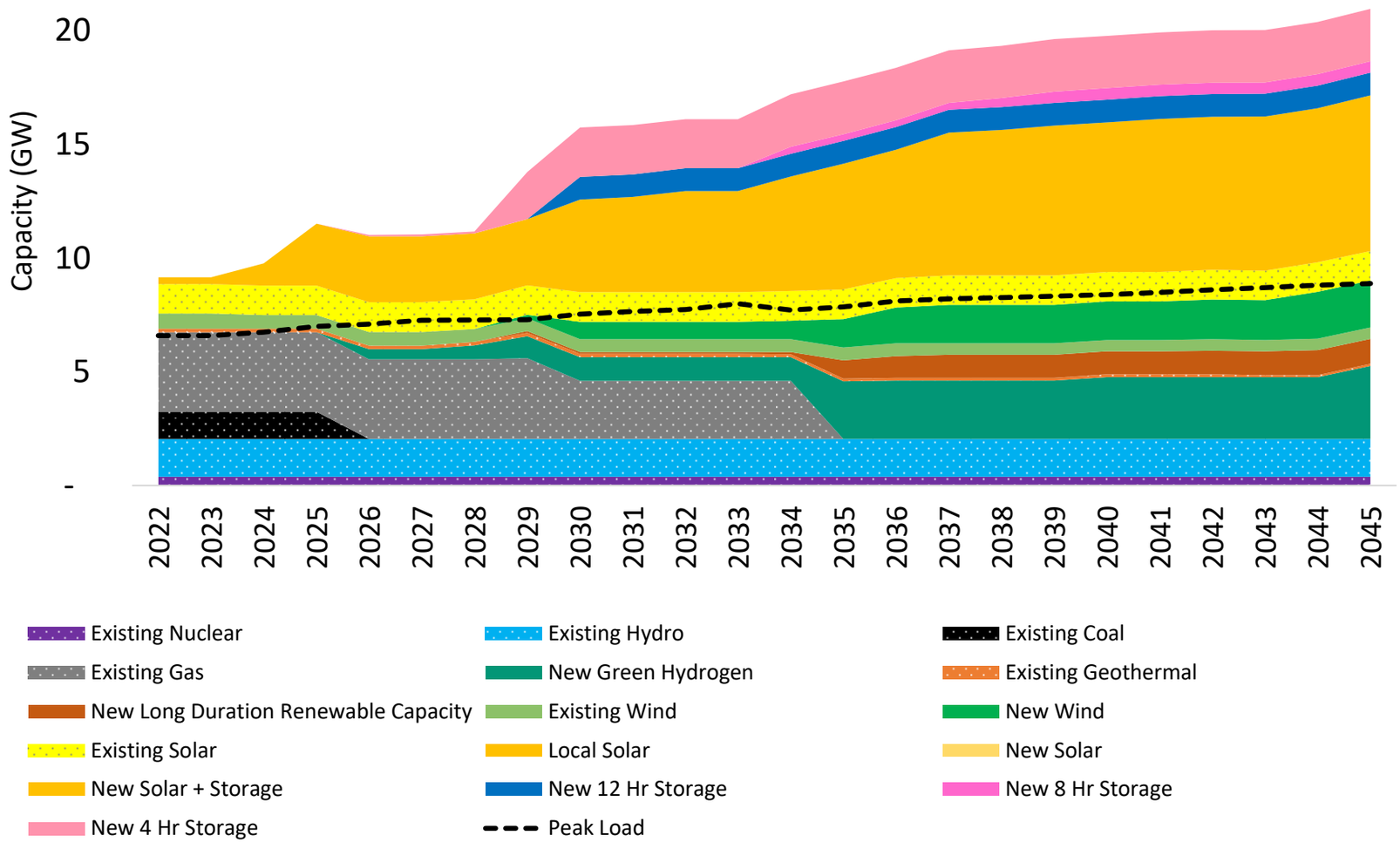
Technological Advancement Reduces Costs to Decarbonize in the 2030s



- Additional capacity includes
  - Wind
  - Solar plus storage
  - Long duration renewables
  - Standalone storage
- Green hydrogen capacity built at Harbor, Haynes, Scattergood, and Valley

Total Portfolio Capacity – Case 2

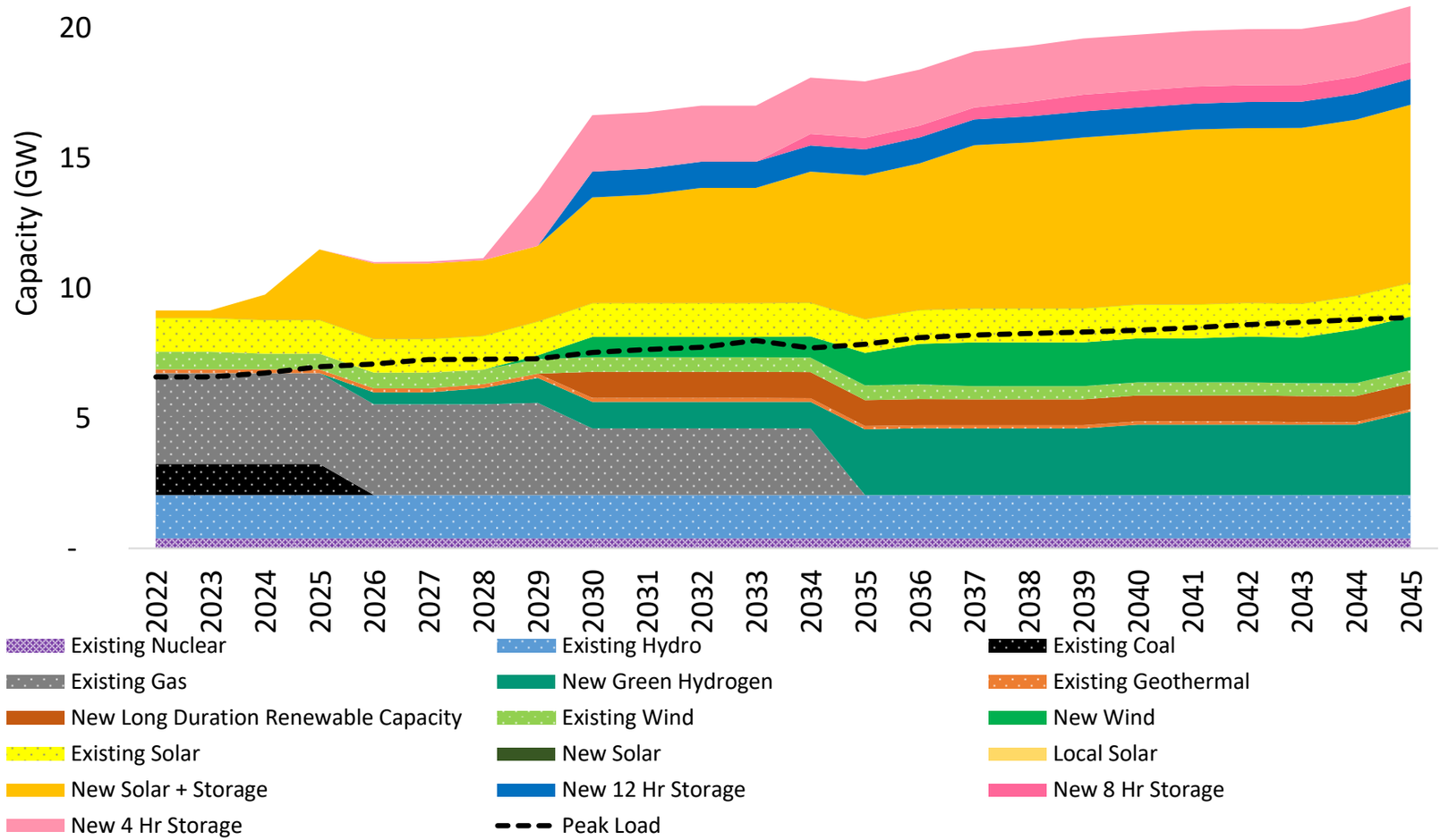
Rapid Decarbonization Initially with 10% Decarbonization in 2030s



- Additional capacity includes
  - Wind
  - Solar plus storage
  - 12 Hr Storage
  - Long duration renewables
  - Standalone storage
- Green hydrogen capacity built at Harbor, Haynes, Scattergood, and Valley

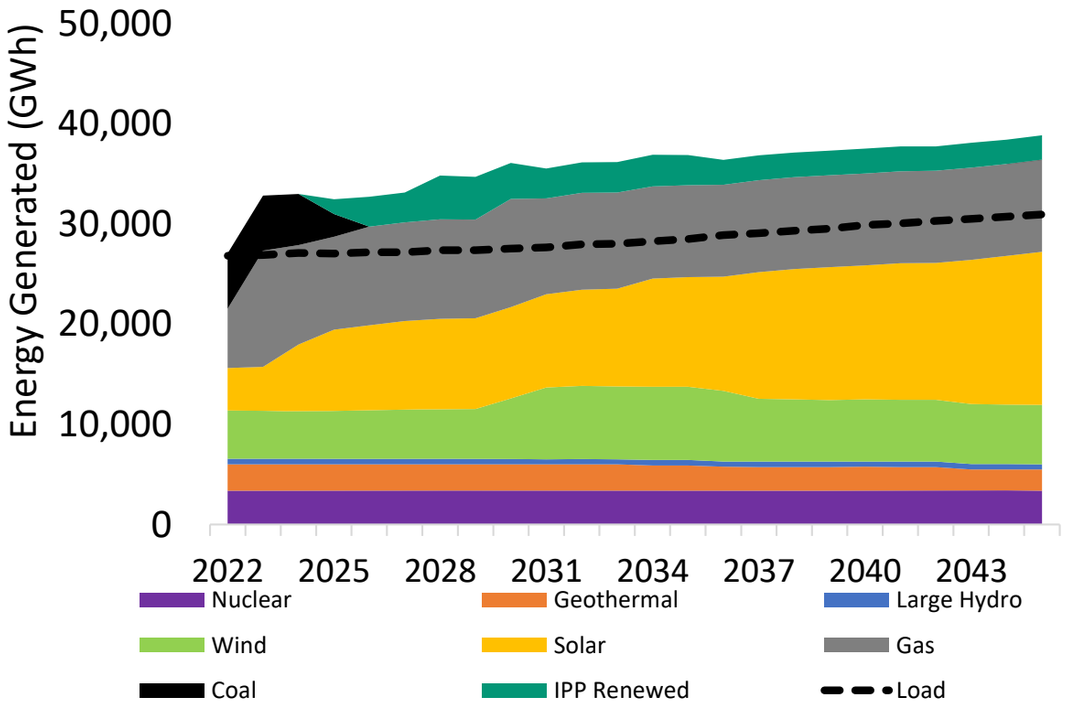
Total Portfolio Capacity – Case 3

Increased DER and DSM Lead Most Aggressive Decarbonization

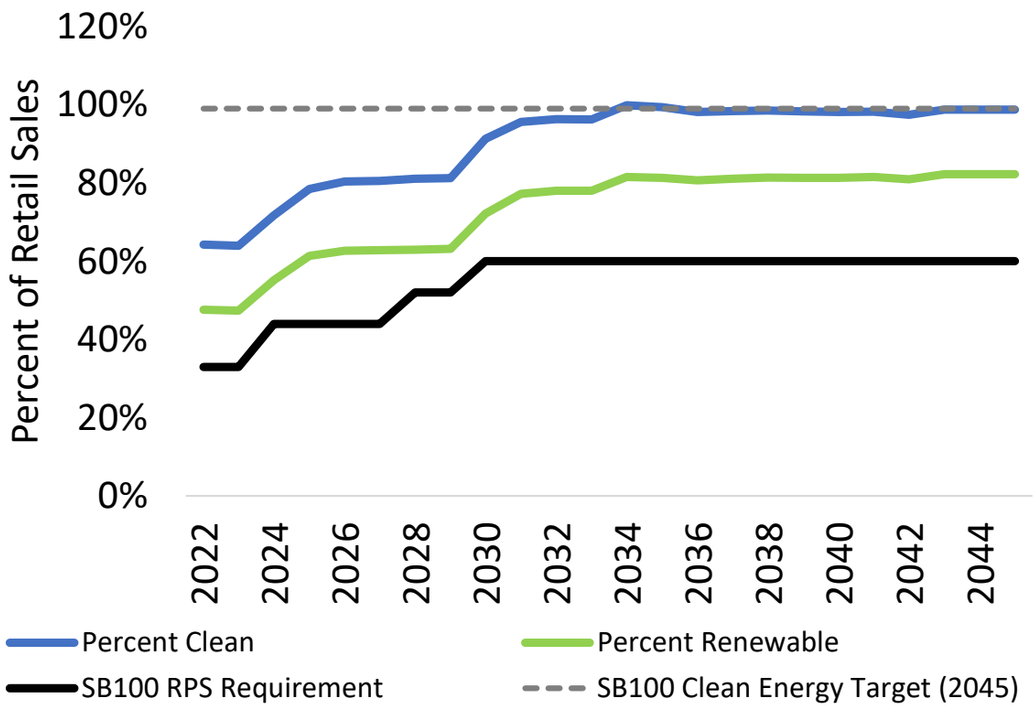


- Additional capacity includes
  - Wind
  - Solar plus storage
  - 12 Hr Storage
  - Long duration renewables
  - Standalone storage
- Green hydrogen capacity built at Harbor, Haynes, Scattergood, and Valley

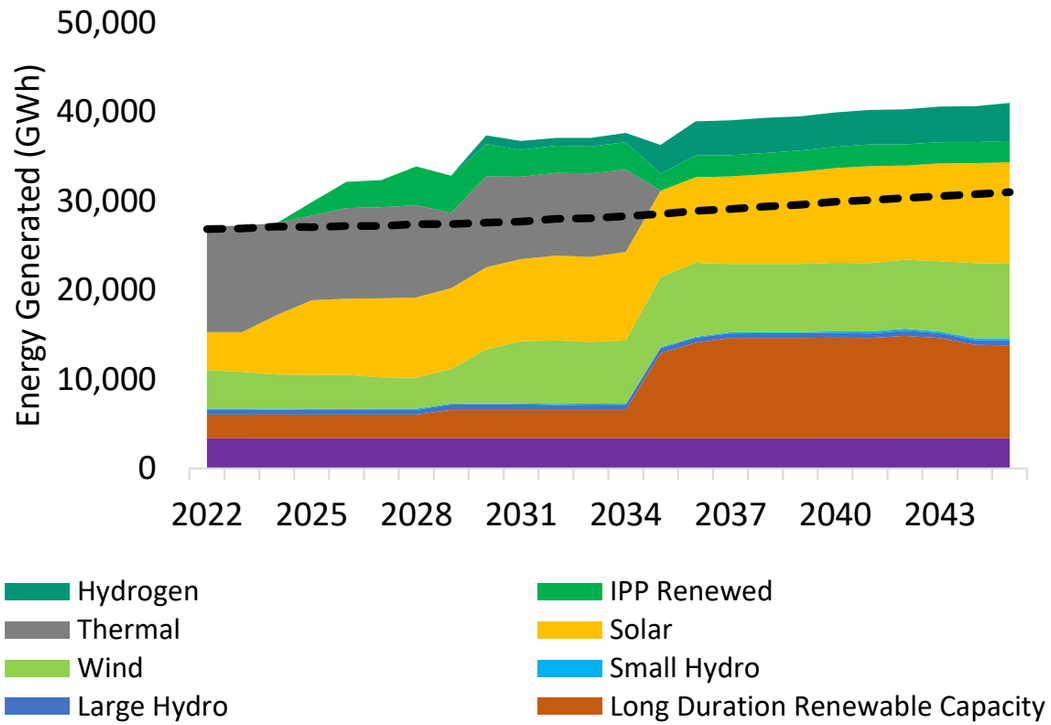
Energy Generation by Fuel Type – SB100



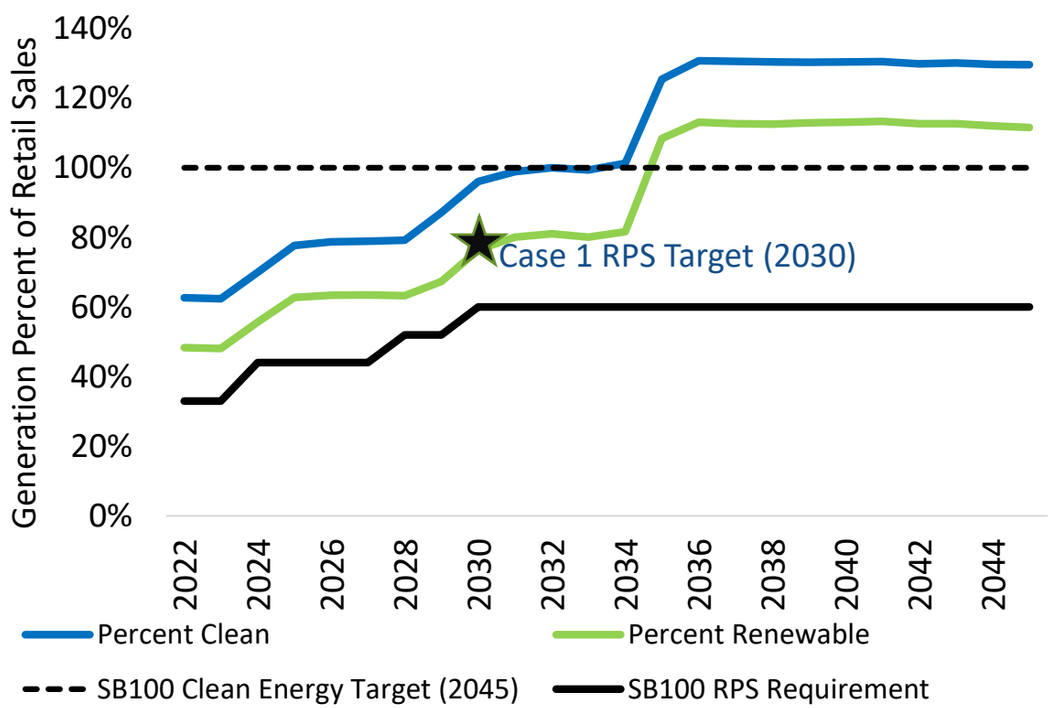
- Gas generation is dispatched to support renewable generation



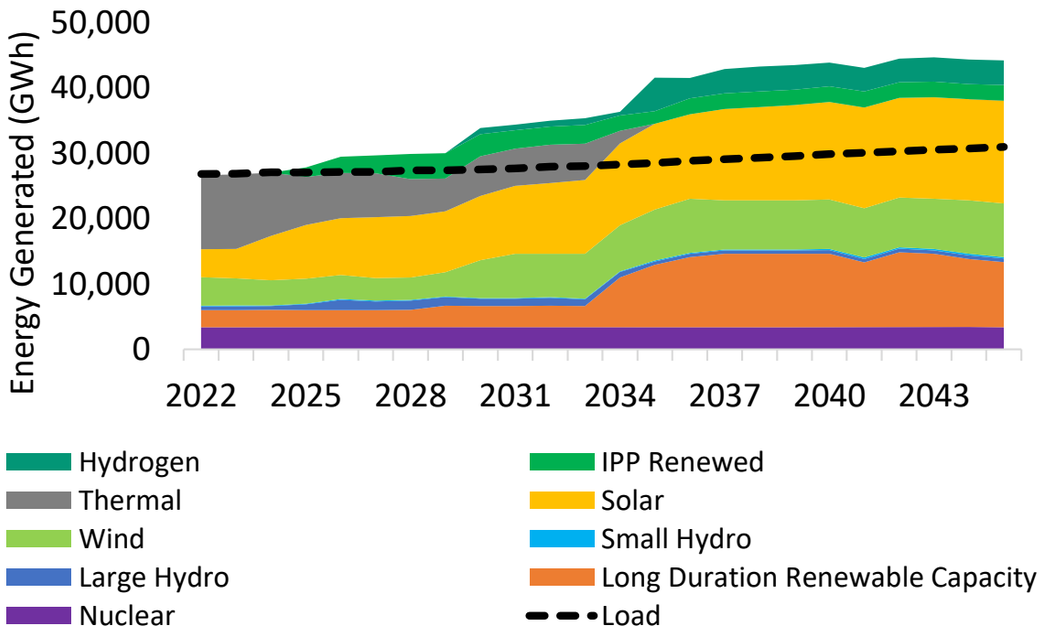
Energy Generation by Fuel Type – Case 1



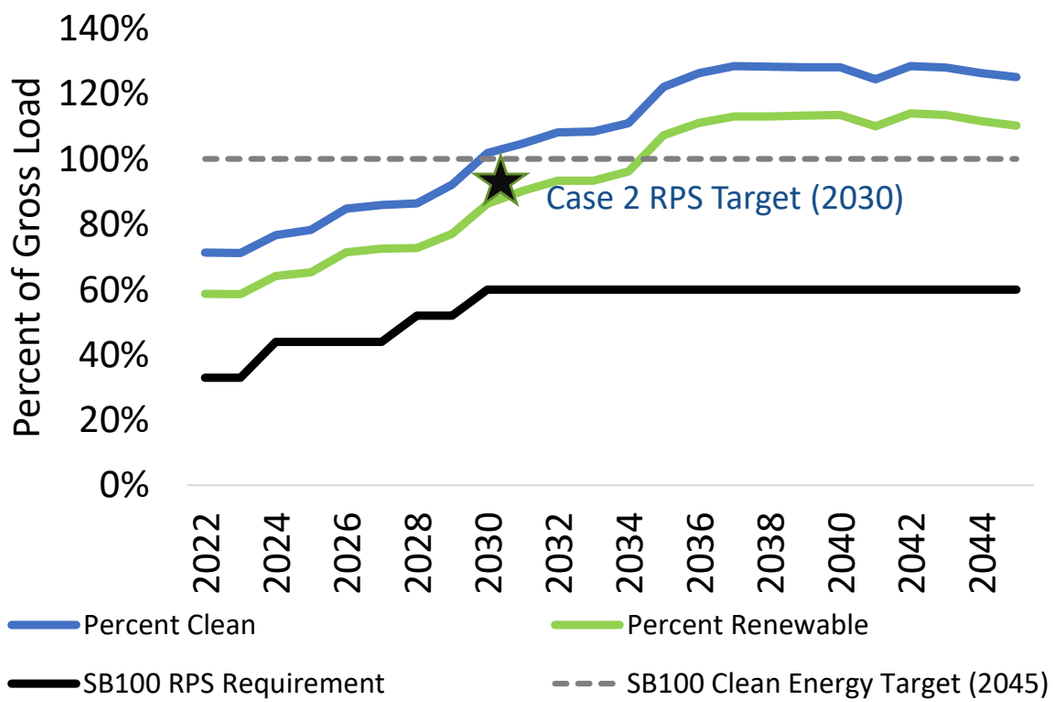
- Firm generation plays a key role in serving DWP customer load
- In-basin hydrogen generation runs at approximately a 5% capacity factor
- Generation in excess of load is due to storage losses and renewable curtailment



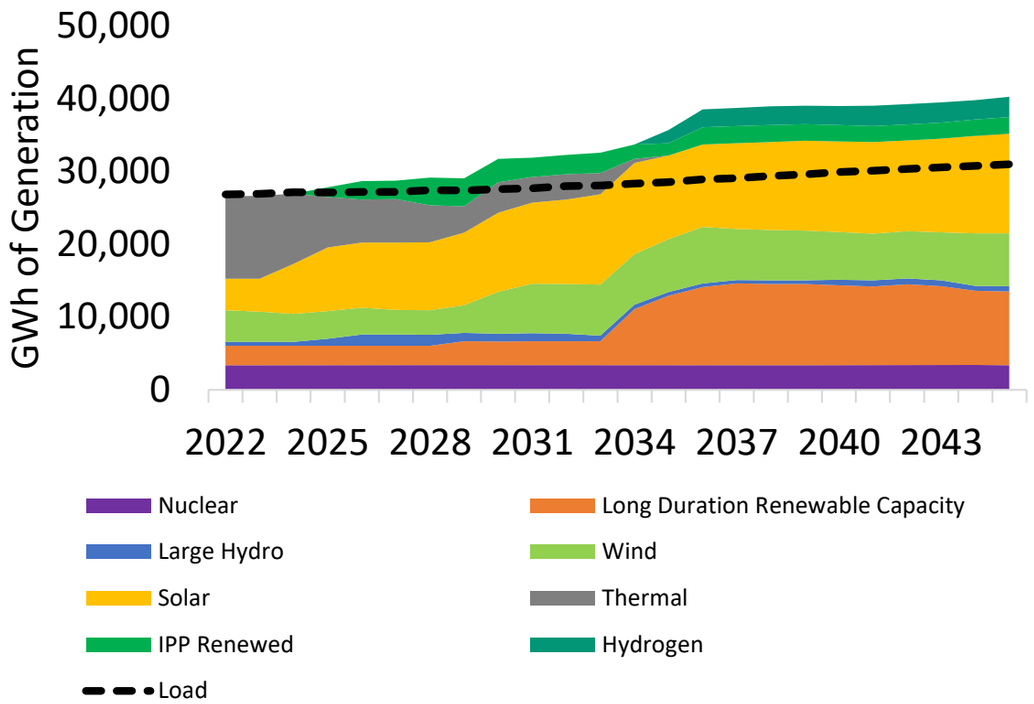
Energy Generation by Fuel Type – Case 2



- Firm generation plays a key role in serving DWP customer load
- Hydrogen provides critical capacity during periods of system stress
- Generation in excess of load is due to storage losses and renewable curtailment



Energy Generation by Fuel Type – Case 3



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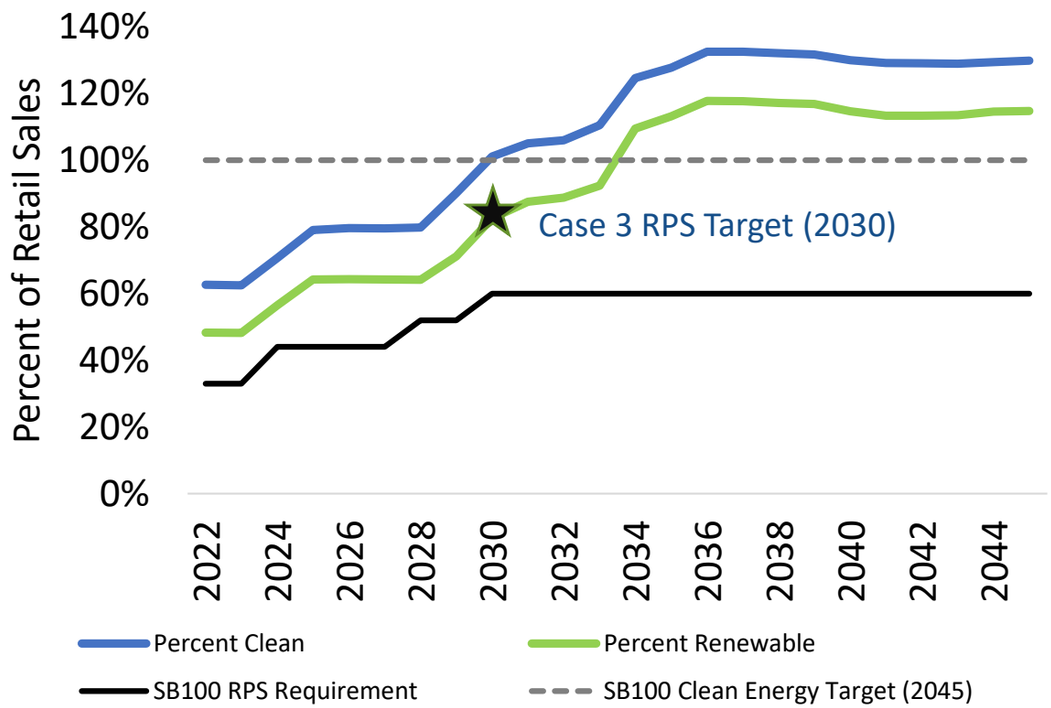
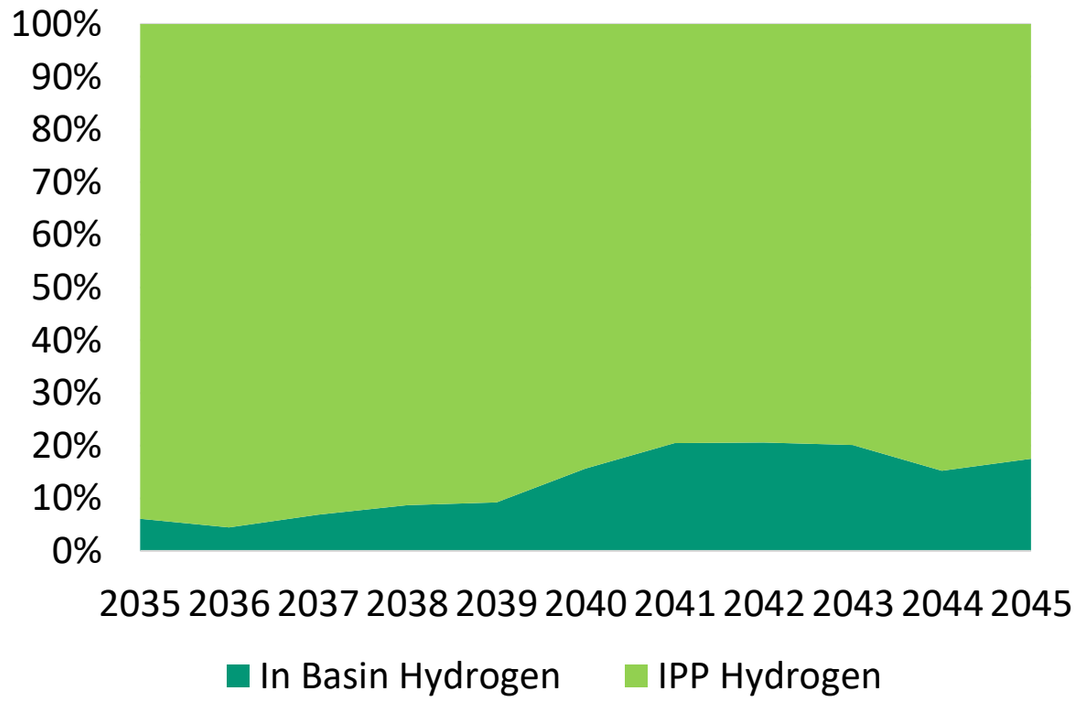
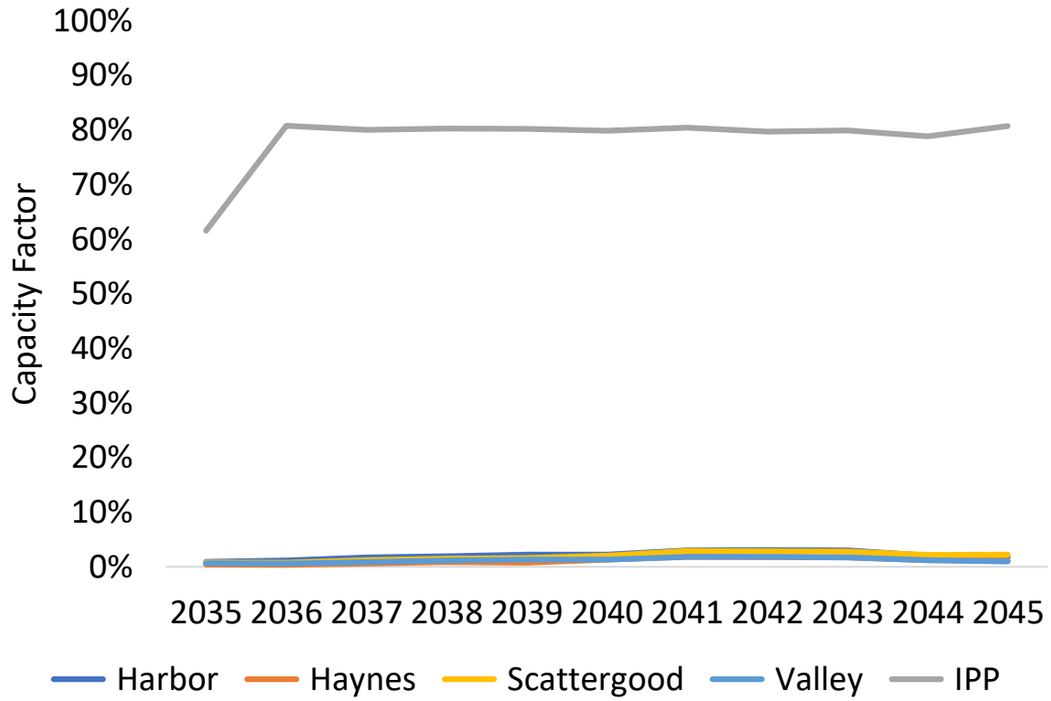
- Hydrogen provides critical capacity during periods of system stress
- Generation in excess of load is due to storage losses and renewable curtailment



Case 3 Hydrogen Generation Locations

IPP accounts for 80% - 90% of hydrogen generation in the LADWP system





Scenario Outcomes

Ascend Analytics

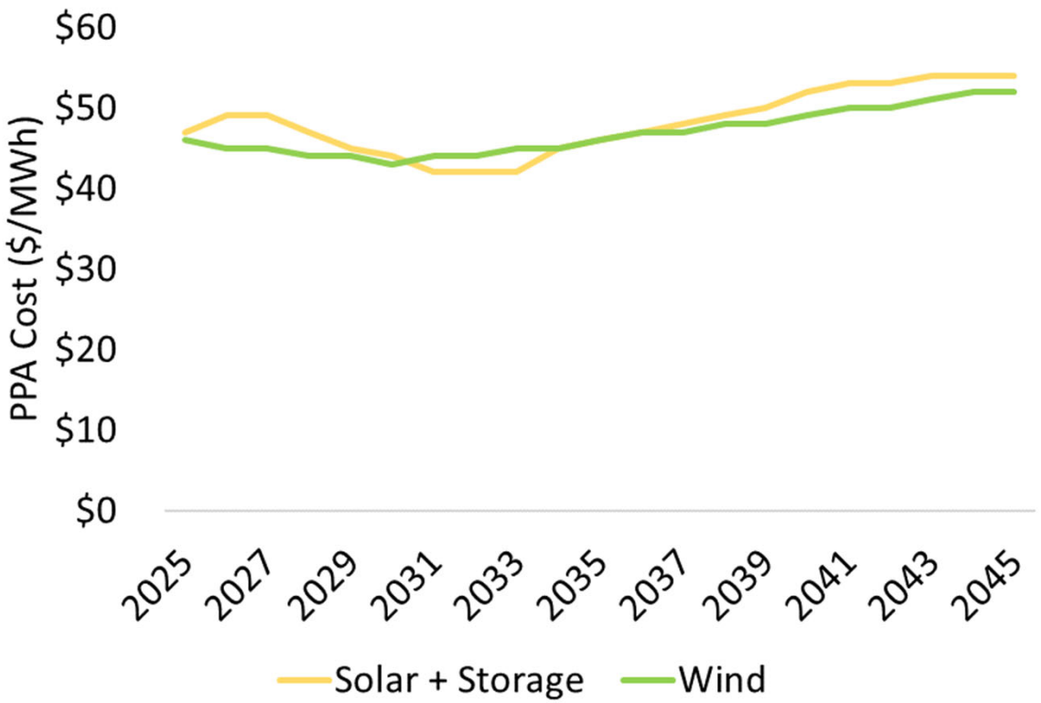
Better models. Better decisions.

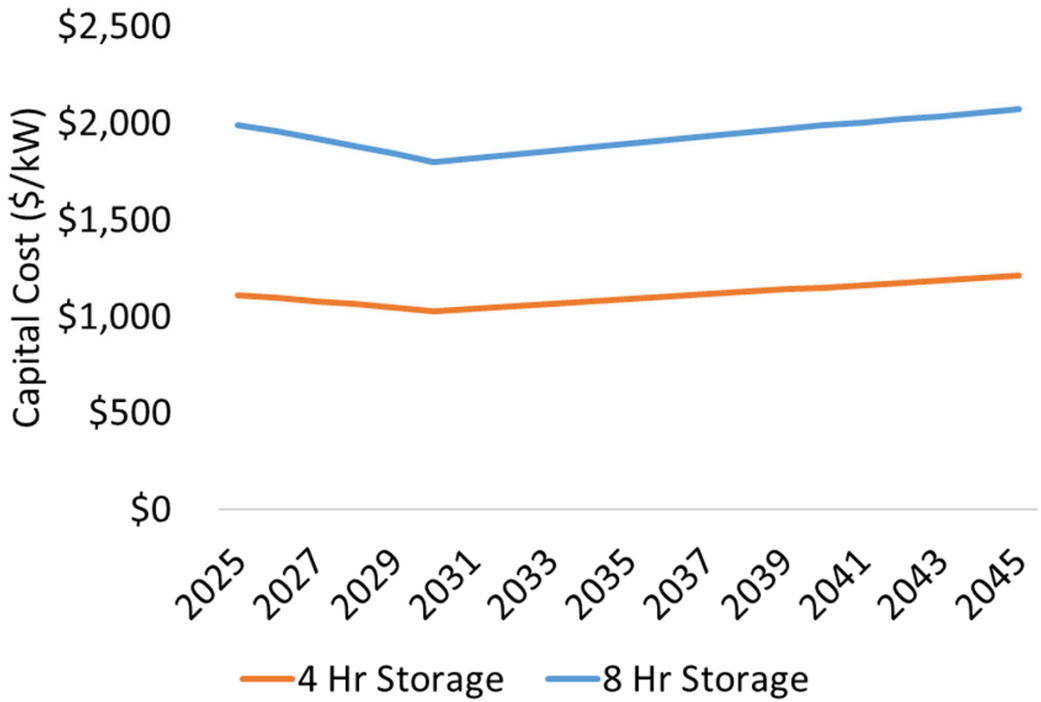
Tradeoffs between scenarios

- All three clean energy scenarios will lead LADWP to zero carbon emissions by 2035
- Case 1 will be more advantageous for DWP if the rate of technological improvement is less than expected
- Cases 2 and 3 will be advantageous for DWP if technological improvement is faster than expected
- Comparing Case 3 with Case 2 will show the value and cost of a more aggressive DER buildout

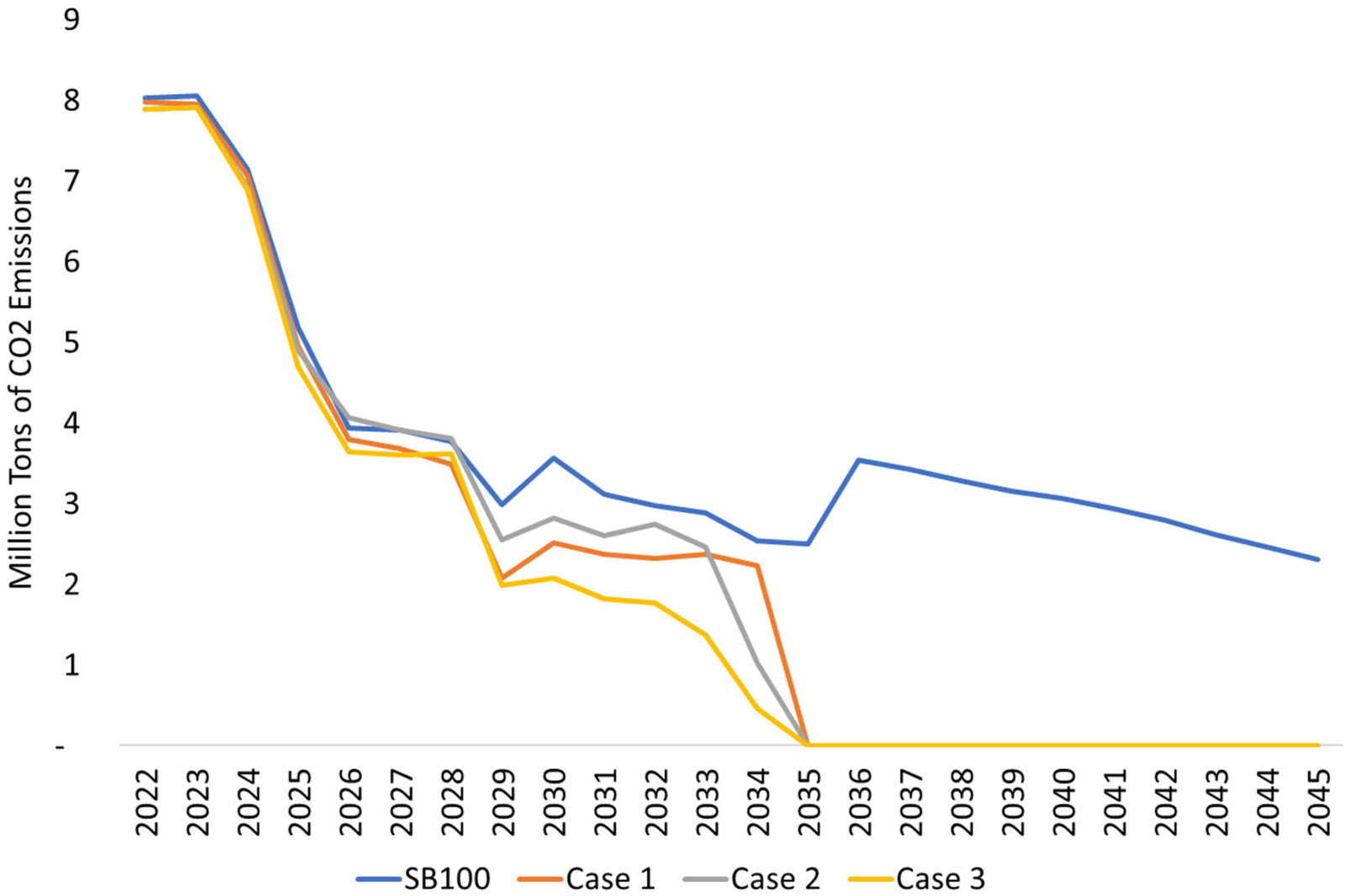
NREL ATB Costs

Nominal costs decline in the next decade and then increase with inflation in the long run





Carbon Emissions

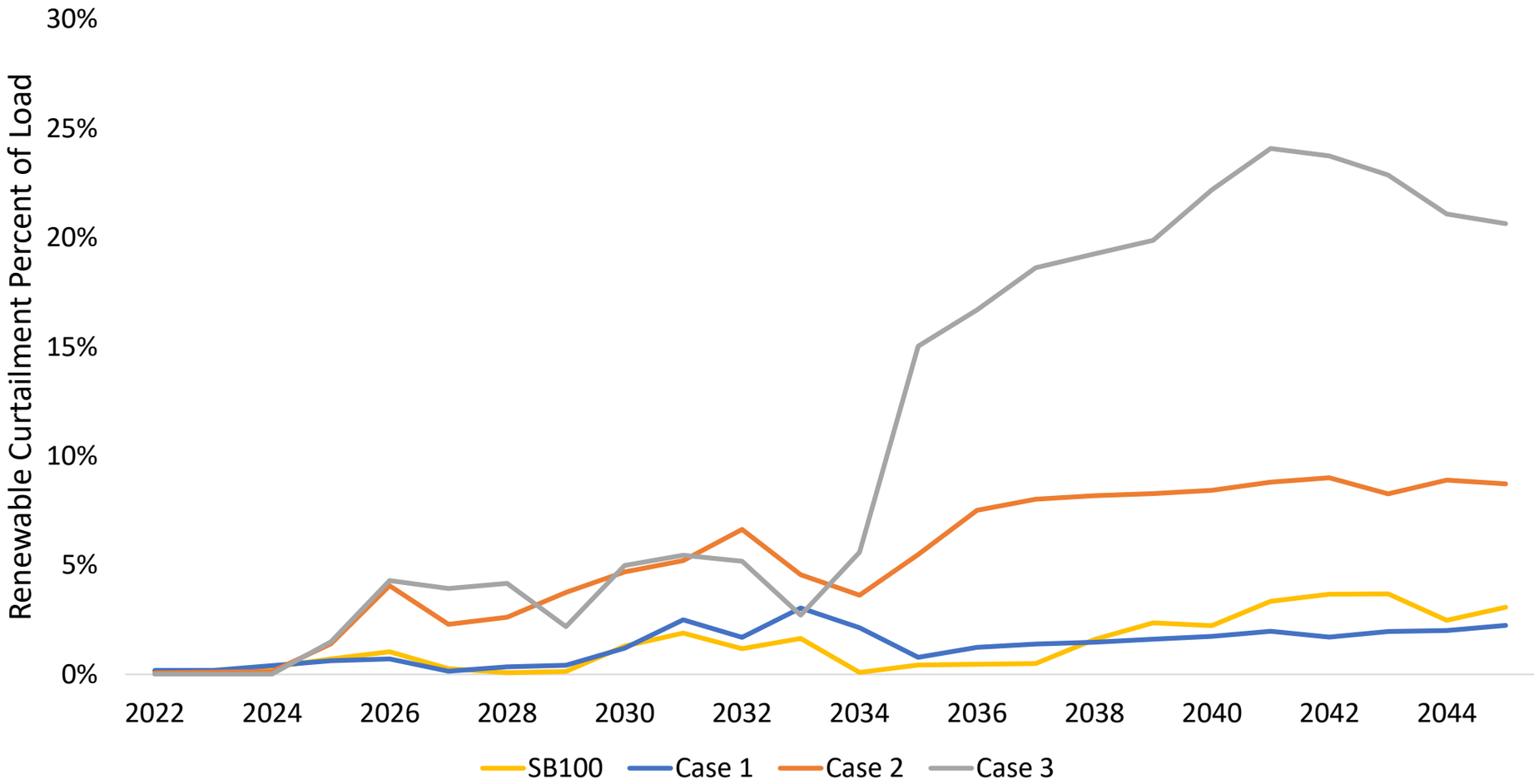


Cases 2 and 3 consistently have lower carbon emissions than case 1

SB100 carbon emissions remain fairly constant throughout the study for two reasons

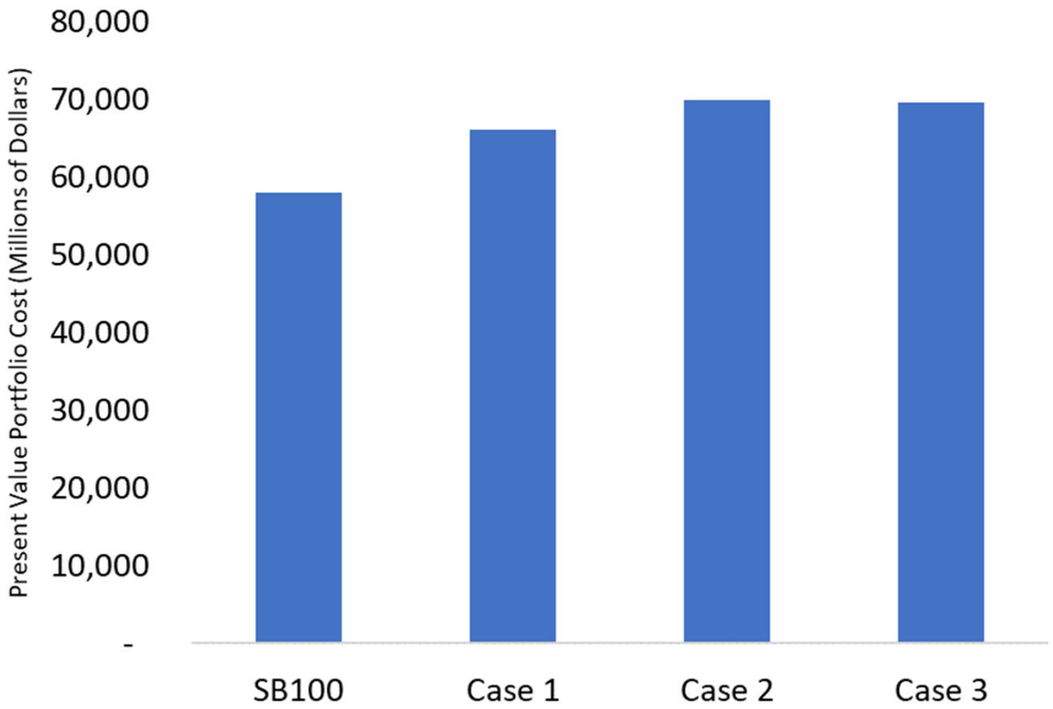
- In-basin gas capacity generates when there is not sufficient clean energy to serve load
- IPP does not convert to 100% hydrogen

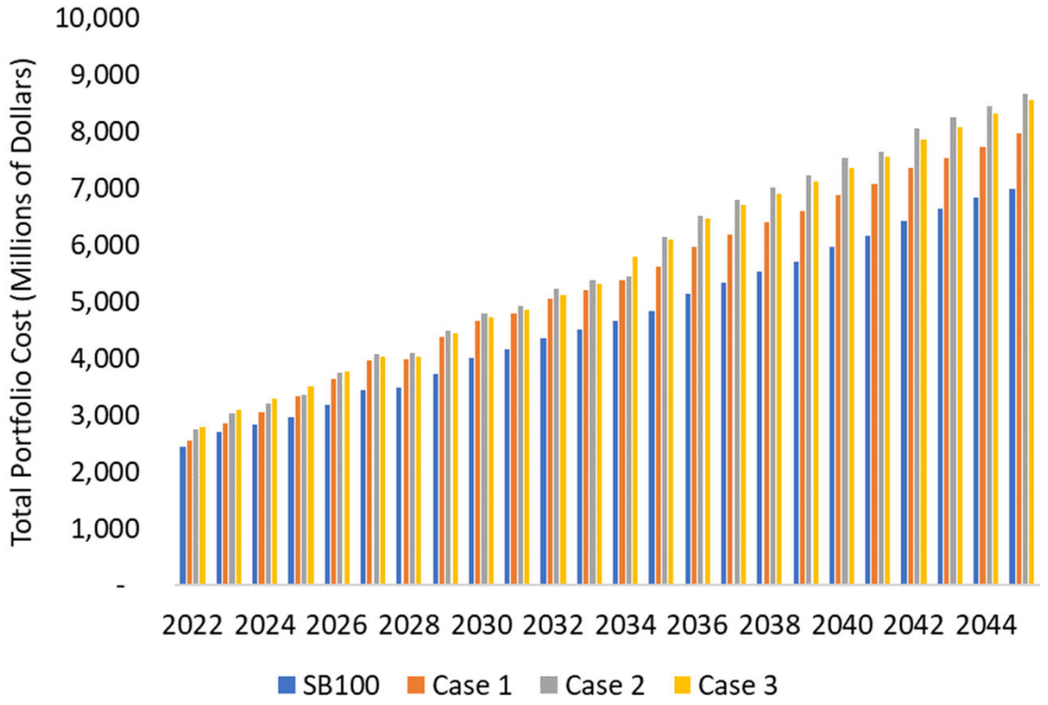
Renewable Curtailments



Accelerating Renewable Deployment vs Waiting for Cost Declines

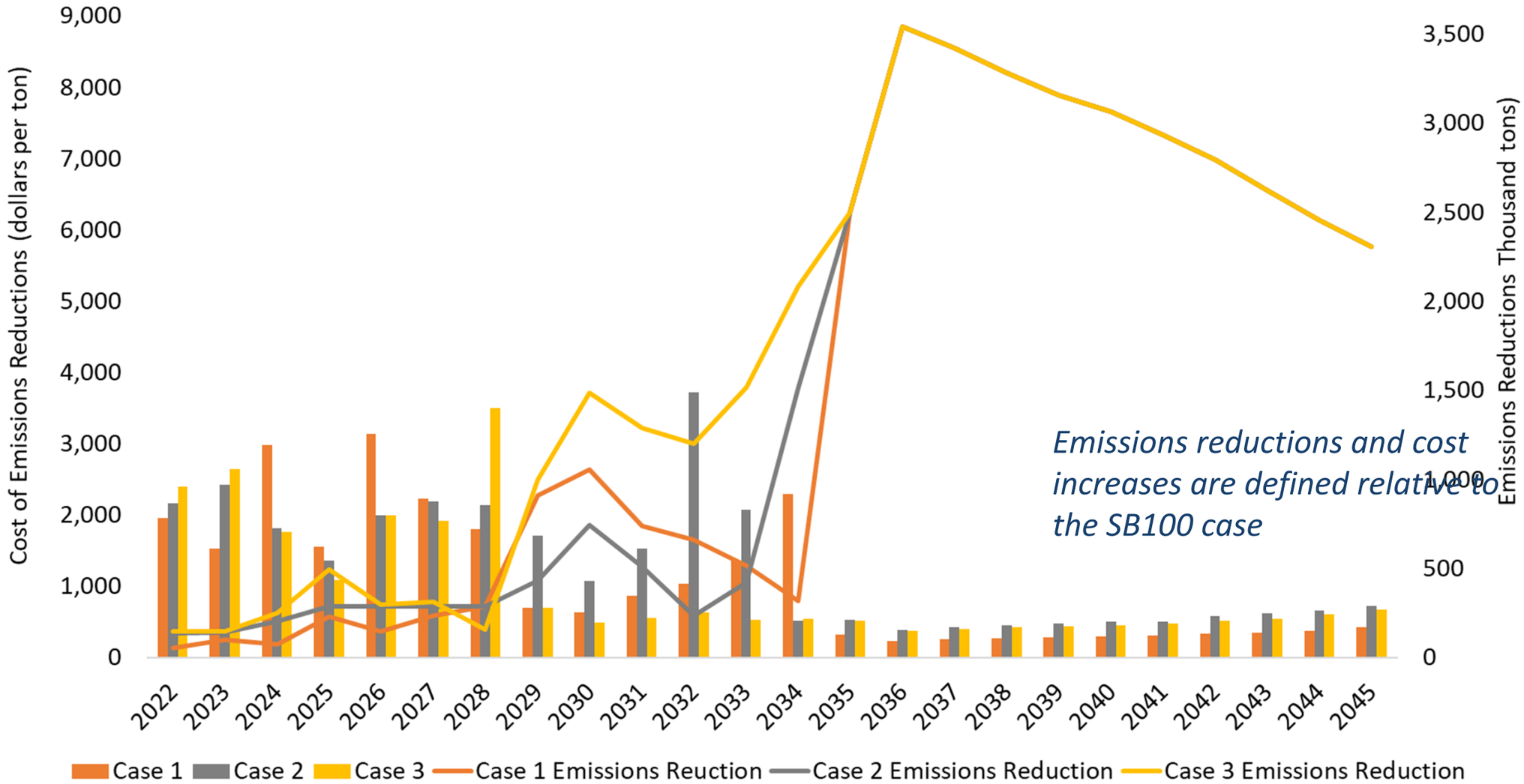
The zero carbon cases have larger portfolio costs than the SB100 compliance case





Cost of Carbon Reductions

Carbon reductions come at an additional cost to the LADWP system.

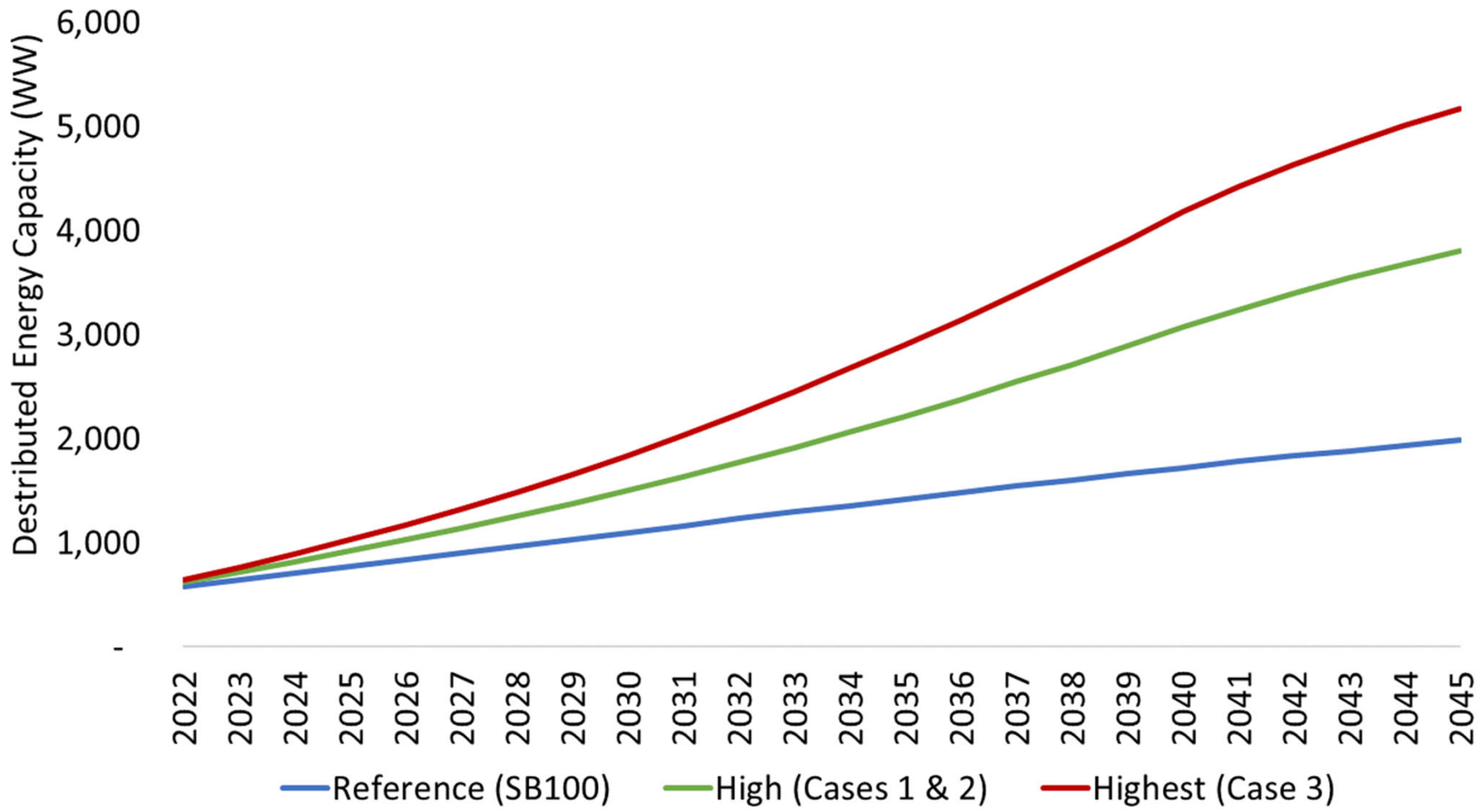


Emissions reductions and cost increases are defined relative to the SB100 case

DER Buildout

Ascend Analytics

Zero carbon scenarios assume higher levels of DER buildout



Source: LADWP DER Planning

What is the big takeaway

- All three zero carbon cases have very similar capacity buildouts in the early years
  - All cases rely on solar + storage for energy and standalone storage for capacity
- The planning and procurement cycle will give DWP an opportunity to reassess the least cost and most reliable path to zero carbon as new technologies become commercially viable
- Serving customer load with zero carbon emissions requires dispatchable and firm generation

Discussion and Q&A

2022 Public Outreach Meetings

Jay Lim, LADWP Manager of Resource Planning
Stephanie Spicer, LADWP Manager of Community Affairs





2022 SLTRP Public Outreach Meetings

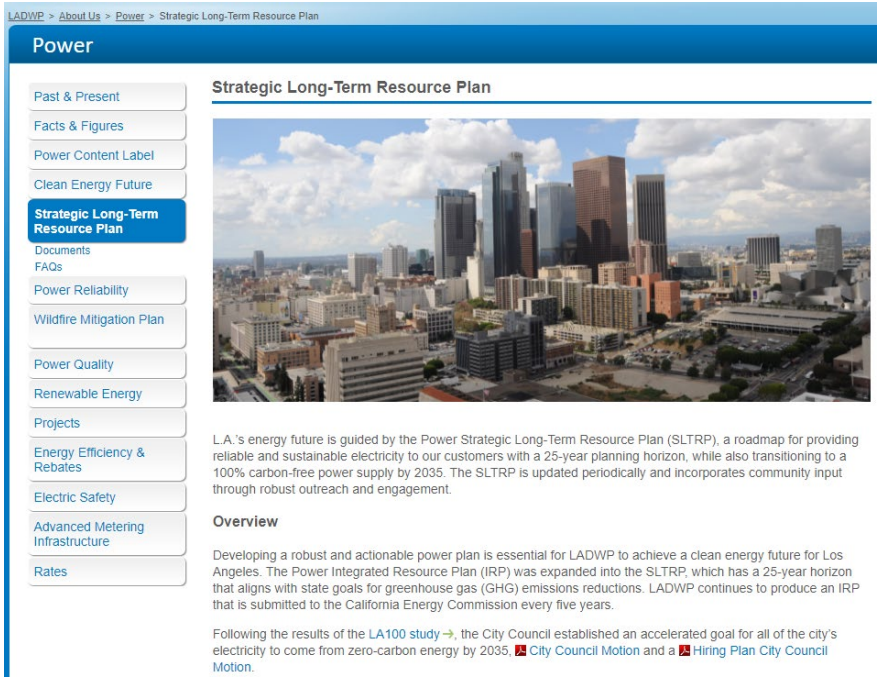
Virtual Meetings (August)	Meeting Description and Content (Topics to be covered)
3 Public Outreach Meetings*	• **Power System Overview:** LADWP Overview and Recent Accomplishments, LA100 Key Findings and Next Steps, 2022 SLTRP Orientation, Key Considerations • **2022 SLTRP Preliminary and Sensitivity Results:** SLTRP Case Scenarios and Sensitivities, Modeling Framework, Preliminary Results and Tradeoffs, Implementation and Considerations for Risk Factors • **Q&A, Discussion, and Polling**

**Note: Meeting dates to be finalized*

Discussion and Q&A

Communications & Public Affairs

- Website: ***ladwp.com/sltrp***
- Email address: ***powerSLTRP@ladwp.com***



Wrap Up & Next Meeting

Next Meeting:
June 9 (TBC), 2022(10 am to 12 pm)

Future Meeting:
August TBD, 2022

Website: www.ladwp.com/SLTRP
Email: powerSLTRP@ladwp.com