2022 Power Strategic Long-Term Resource Plan (SLTRP)

Roadmap to 100% Carbon Free by 2035

SLTRP Advisory Group Meeting #7
Phase II (Scenario Development)
December 17, 2021

Meeting Agenda

Joan Isaacson, Kearns & West

- Welcome & Introductions
- Meeting Purpose and Agenda Overview
- LA100 Equity Strategies
- 2022 SLTRP Advisory Group #6 Discussion Review
- Energy Storage Update Presentation
- 2022 SLTRP What-If Sensitivities Discussion
- Wrap Up

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

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 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	**#8 February TBD** Preliminary Results on Core Scenarios	**May – June TBD** Community Outreach Meetings **#10 July TBD** Public Outreach Results
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LA100 Equity Strategies Overview

Simon Zewdu

LADWP Director of Power Transmission Planning, Regulatory, and Innovation





Discussion and Q&A

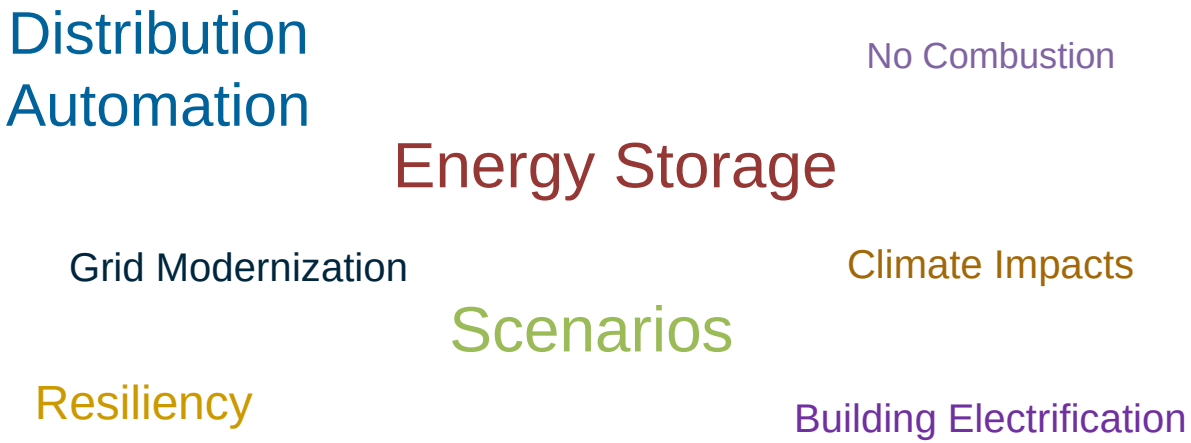
2022 SLTRP: AG#6 Discussion

Jay Lim, LADWP Manager of Resource Planning
Joan Isaacson, Kearns & West





Advisory Group Meeting #6 Discussion



Advisory Group Meeting #6 Discussion

How secure is our grid from **cyberattacks** and what are we doing to **protect our digital systems**?

What is the **cost** of **grid modernization**? Is the cost included in the LA100 analysis?

How will distribution automation help to **automate GHG emissions reporting** for buildings and facilities, and do you see it improving how we make policy and investments?

Interested to hear when the first **4.8 kV upgrade** to standard voltage will occur.

LADWP should consider and model **long duration energy storage** beyond just lithium-ion, flow, pumped hydro, and hydrogen. LADWP should **represent emerging storage technologies** with assumed cost and performance parameters, or issue an **RFI** to gather the relevant information.

How does the Department's **fiber network** fit into this system? What is the status of this roll-out and is LADWP coordinating with other City departments?

Is there anything customers can do to help fast track the **adoption** of smart meters?

How do we **prioritize** to whom the smart meters go to?

What energy **storage technologies** are **modeled** in addition to lithium-ion and flow batteries?

I think it's important at this point to analyze **actual** rather than abstract storage options.

Advisory Group Meeting #6 Discussion

When everything goes south, we may have to use fossil power while repairs are being made, but this will not happen in many if any years.

Do the ***What-If* sensitivities** still maintain 100% carbon-free by 2035?

One thing the SLTRP should consider and maybe show is the case where green hydrogen is not available or cost reasonable, what will be the GHG and cost impact of using natural gas for the ~5% it runs? We might even be able to cover that with RECs.

Can you explain more about **Case 3** and its natural gas, hydrogen, EE, and DER **relationship**?

The summary slides on the scenarios are so **dense** that having them to read offline will be very important.

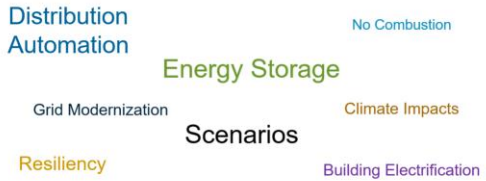
SLTRP should have a **metric** that indicates the impact of a **major failure** at a generating station, distribution station, etc.

Since we need to read and digest those very dense slides on scenarios, I hope there will be time for **Q&A** on those in December.

Advisory Group Meeting #6 Discussion

What does impact of "**climate realism**" have on risks/security of grid? Washington State/British Columbia's atmospheric river massive floods are only a change in the jetstream away from happening here. Allowing 15 more years of global GHG emissions is going to make much worse extreme weather impacts on the entire grid and our fragile global supply chain as well. See also drought.

Will there be any sensitivities on the **cost of electrification** for customers?



I think the “no combustion” effort is not a reasonable way to proceed.

When will marketplace.ladwp.com offer the same kind of **fuel switching incentives** and financing on par with those provided by marketplace.socalgas.com?

The problem is, there isn't just a certain amount of climate change and stop. It will keep getting hotter and worse the longer we emit GHGs. And methane is **highly potent** and **highly dangerous** and makes things worse faster.

Long-Duration Energy Storage Efforts (LDES)

Past and Ongoing Planning Efforts

- **2019-2020:** Boulder Canyon Pumped Storage Technical and Economic Feasibility
- **March 2021:** LA100 Study complete and scenarios all include over 2,600 MW of energy storage by 2045
- **May 2021:** Clean Grid LA Update presented to Board, includes over 1,000 MW of energy storage by 2030 with ~300 MW of in-basin LDES
- **Ongoing**: 2022 SLTRP will include a mix of firm capacity and LDES deployments in-basin

Past and Ongoing Procurement Efforts

- **2018:** Stand-alone Compressed Air Energy Storage Request for Proposal (RFP) issued
- **2019:** Distributed Energy Resources and Renewable Request for Information was released, which included LDES
- **2020:** LADWP issued an Energy Storage Rolling RFP that resulted in active negotiations of LDES projects, over 50 MW projects each
    - Compressed Air Energy Storage
    - Liquid Air Energy Storage
- **Ongoing:** Energy Storage Rolling RFP through Southern California Public Power Authority

LADWP has staff dedicated to energy storage studies, planning, and procurement in both long duration energy storage and energy storage and new technologies

LA100 Study
Common Investments

Energy Storage
+ >2,600 MW

Energy Storage Update

Ashkan Nassiri

LADWP Manager of Distributed Energy Resource Planning





Discussion and Q&A

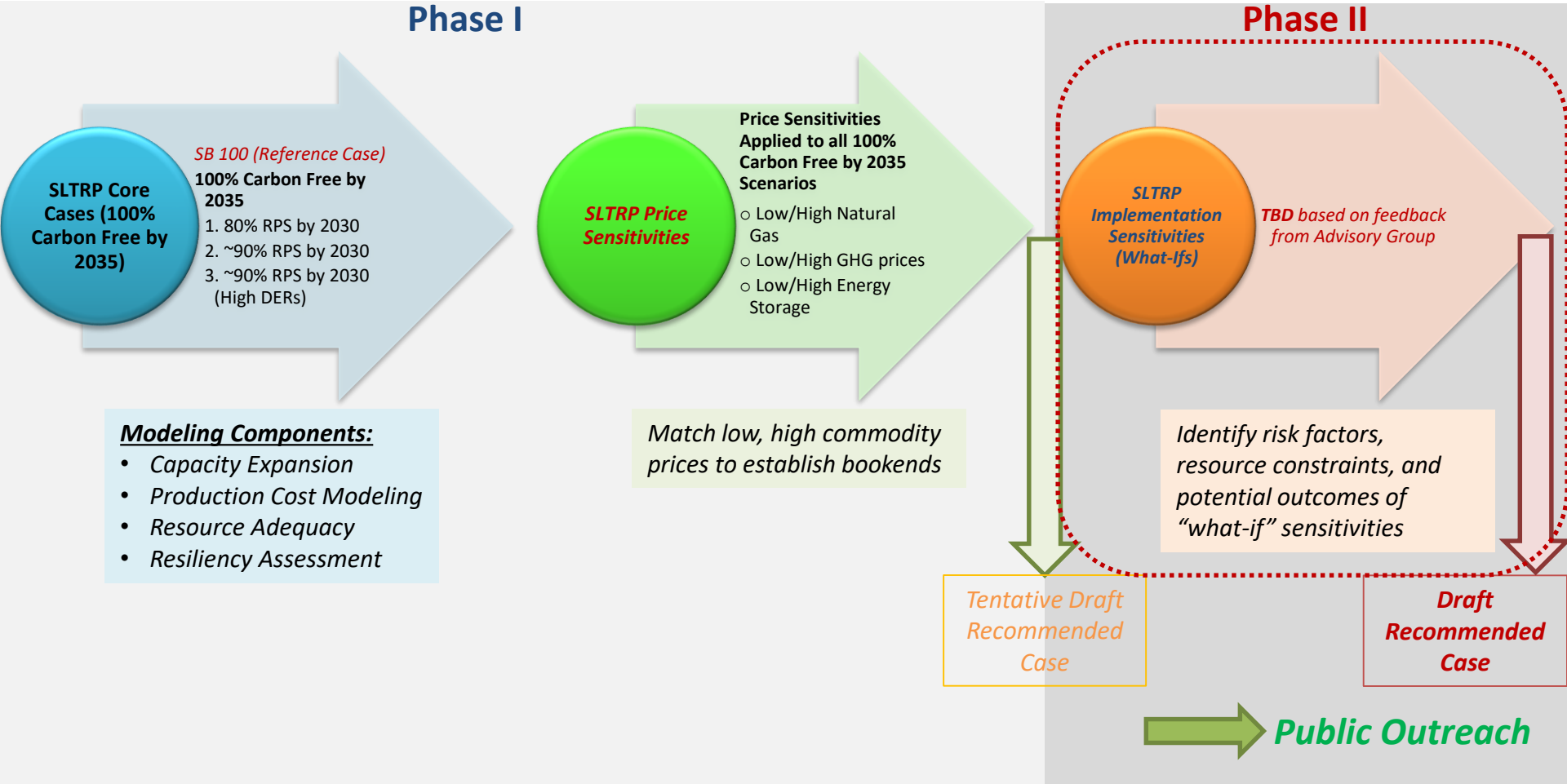
2022 SLTRP: Draft Final Scenario Matrix

Jay Lim, LADWP Manager of Resource Planning
Joan Isaacson, Kearns & West, Facilitator





2022 SLTRP Modeling Process



2022 SLTRP Core Scenarios *(Draft Final)*

		100% Clean Energy by 2045	100% Carbon Free by 2035		
		SB 100 (Reference Case)	**Case #1**	**Case #2**	**Case #3**
	2030 RPS Target	60% RPS by 2030	80% RPS by 2030	90% RPS by 2030 (80% RPS by generation)	90% RPS by 2030 (80% RPS by generation)
Eligible Technologies	Renewables (Wind, Solar, Geo, Small Hydro) *(primary)*	Yes*	Yes*	Yes*	Yes*
	Energy Storage *(primary)*	Yes*	Yes*	Yes*	Yes*
	Solid Biomass	No	No	No	No
	Biogas/Biofuels	Yes*	No	No	No
	Fuel Cells	Yes*	Yes*, hydrogen only	Yes*, hydrogen only	Yes*, hydrogen only
	Hydro - Existing	Yes*	Yes*	Yes*	Yes*
	Hydro - New	No	No	No	No
	Hydro - Upgrades	Yes*	Yes*	Yes*	Yes*
	Natural Gas	Yes*	Yes*, until 2035	Yes*, until 2035	Yes*, until 2035, Limited (More DERs)
	Zero Carbon H2 Turbines *(secondary)*	Yes*	Yes*	Yes*	Limited (More DERs)
	Nuclear - Existing	Yes*	Yes*	Yes*	Yes*
	Nuclear - New	No	No	No	No
Transform existing gas capacity (non-OTC units)	Haynes, Scattergood, Harbor, Valley	No	Yes	Yes	Yes
Distributed Energy Resources (DERs)	Local Solar	1500 MW by 2035 (Reference)	2240 MW by 2035 (High)	2240 MW by 2035 (High)	2400 MW by 2035 (Highest)
	Local Energy Storage	Reference	High	High	Highest (Max DERs)
	Energy Efficiency	3210 GWh by 2035 (Reference)	4350 GWh by 2035 (High)	4350 GWh by 2035 (High)	4770GWh by 2035 (Highest)
	Demand Response	576 MW by 2035 (Moderate)	576 MW by 2035 (Moderate)	576 MW by 2035 (Moderate)	633 MW by 2035 (High)
	Building Electrification	Reference	High	High	Highest (Max DERs)
Renewable Energy Credits (RECs)	Financial Mechanisms (RECs/Allowances)	Yes	No	No	No
Transmission	New or Upgraded Transmission	Moderate	High	High (possible new corridors)	High

**Note: Optimal portfolio will be determined through the capacity expansion model*

Note: Zero carbon includes RPS + nuclear + large hydro + green hydrogen

2022 SLTRP Price Sensitivities *(Draft Final)*

		Sensitivity Scenarios Applied to 100% carbon free by 2035 Scenarios
Fuel Prices**	Natural Gas, H2, etc.	High/low sensitivities
GHG Prices**	GHG Allowance Prices	High/low sensitivities
Storage Prices**	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 energy storage prices*
- ***High Bookend:*** *High natural gas prices, high hydrogen prices, high GHG prices, high energy storage prices*

2022 SLTRP What-If Sensitivities *(Initial Draft)*

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)
	Zero Caron Hydrogen Turbines	Not available until 2040 (slower deployment)
Demand Side Resources	Demand Response	Reaching only half of the 576 MW of DR by 2035
	Energy Efficiency	Substantially higher EE costs
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

2022 SLTRP What-If Sensitivities *(Updated Draft)*

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

2022 SLTRP *What-If* Sensitivities

1. Emerging Technologies and “No Combustion” Alternatives
2. The Role of the Customers
   - Demand Response
3. Transmission Upgrades
4. Load Uncertainties

Emerging Technologies and “No Combustion” Alternatives

Zero-Carbon Hydrogen Turbines: Overview

- Hydrogen gas turbines can be used for long-duration, firm capacity within the LA Basin
- LA100 found that ~**2000 MW** of in-basin firm capacity is needed by 2035
- General Electric, Mitsubishi, and Siemens are developing gas turbines that can run on 100% hydrogen

- Pragmatic approach: consider the challenges and risks with hydrogen

Zero-Carbon Hydrogen Turbines: Challenges and Risks

- **Resources**: Workforce will be stretched—project managers, engineers, construction forces, and suppliers
- **Fuel**: Where will the green hydrogen come from? What will it cost?
- **Footprint**: In-basin generating stations are land-constrained. Can we build the capacity on LADWP land?
- **Technology Availability**: No 100%-hydrogen gas turbine exists today*. While the manufacturers say they'll get there, when will they really be available?
- **Technology Maturity**: Technology and cost will improve over time with research and development

*There are niche cases of smaller-sized turbines fueled with pure hydrogen, but without Dry Low NOx combustors.

Zero-Carbon Hydrogen Turbines: Challenges and Risks

- **NOx Emissions**: Hydrogen as a fuel results in higher NOx emissions which requires larger selective catalytic reduction (SCR) systems to control NOx within existing permit limits
- **Safety**: Ensure safe operation of hydrogen turbines at generating stations
- **Siting**: Consider environmental justice
- **Financing**: Large capital requirements for high-risk projects
- **Reliability**: Outage coordination will be necessary to maintain reliability & resiliency, particularly when generation and local transmission lines are being upgraded

“No Combustion” Alternatives: Overview

What if we restricted the deployment of zero-carbon combustion technologies such as hydrogen gas turbines?

- Alternative generation technologies need to meet the following criteria:
  - Zero carbon
  - Combustion free
  - Dispatchable/firm
  - Footprint favorable
  - Long duration (>100 hours)
- LADWP is agnostic to the type of technology and will continue to seek alternative technologies

“No Combustion” GHG-Free Alternatives: Hydrogen Turbines v. Fuel Cells

	Hydrogen Turbines	Hydrogen Fuel Cells
Capital Cost	↓	↑
Operations & Maintenance Cost	↓	↑
Levelized Cost of Energy	↓	↑
Emissions	↑	↓
Operational Flexibility	↔	↔
Efficiency	↔	↔

Potential Zero-Carbon Firm Capacity Alternatives:

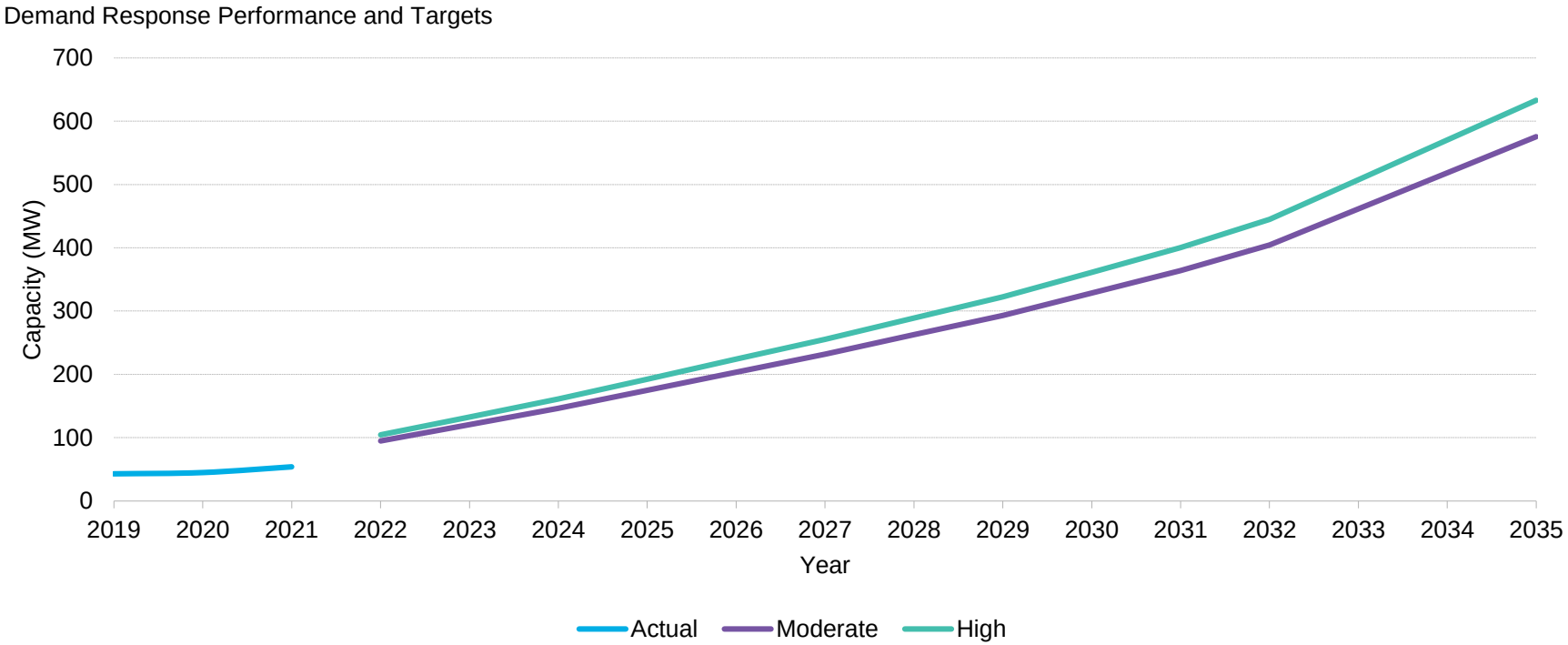
Hydrogen Fuel Cells

Long Duration Energy Storage

Firm, Zero-Carbon Capacity Purchase with New Transmission Corridors

Demand Response

What if demand response only achieved 50% of the targets due to lower-than-expected customer participation?



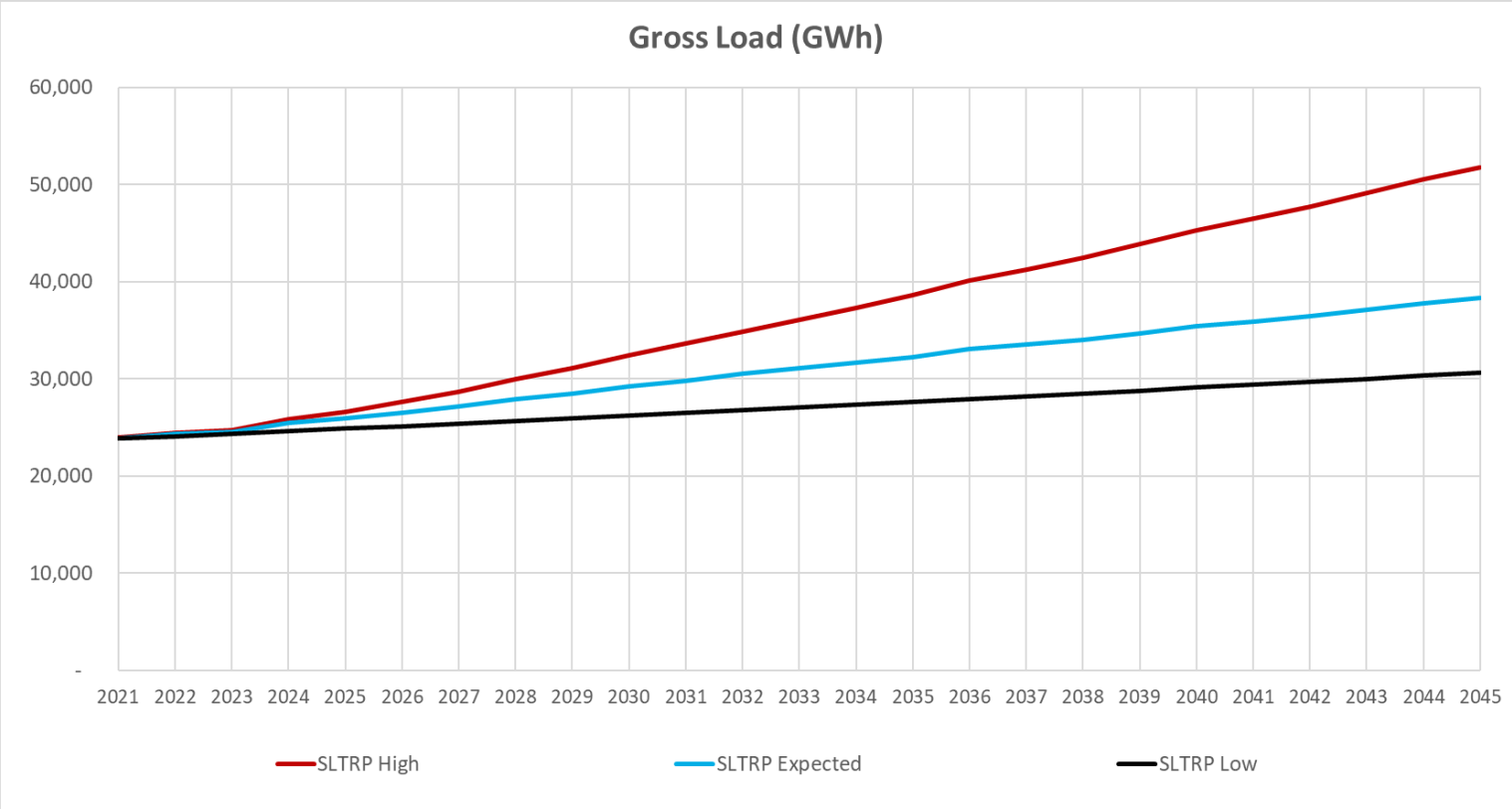
Transmission Upgrades

10 Necessary In-Basin Transmission Upgrades

Recommended Upgrade	Expected In-Service Date
Valley – Rinaldi Lines 1 and 2 Upgrade	June 1, 2022
Tarzana – Olympic Line 1 Conversion to 2-230kV Lines	April 15, 2025
Toluca – Hollywood Line 1 Underground Cable Upgrade	June 30, 2025
Rinaldi – Airway Lines 1 and 2 Upgrade	December 30, 2029
Toluca – Atwater Line 1 Upgrade	December 30, 2029
Fairfax – Olympic A and B Series Reactors Upgrade	2029
Hollywood – Fairfax A and B Series Reactors Upgrade	2029
Northridge – Olympic Cables A and B and Shunt Reactors	2029
Scattergood Phase Shifter Spare and Upgrade	TBD
Valley – Toluca Lines 1 and 2 Upgrade	TBD

Load Uncertainties

What if transportation and building electrification levels are lower than expected?



Q&A and Discussion

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Communications & Public Affairs

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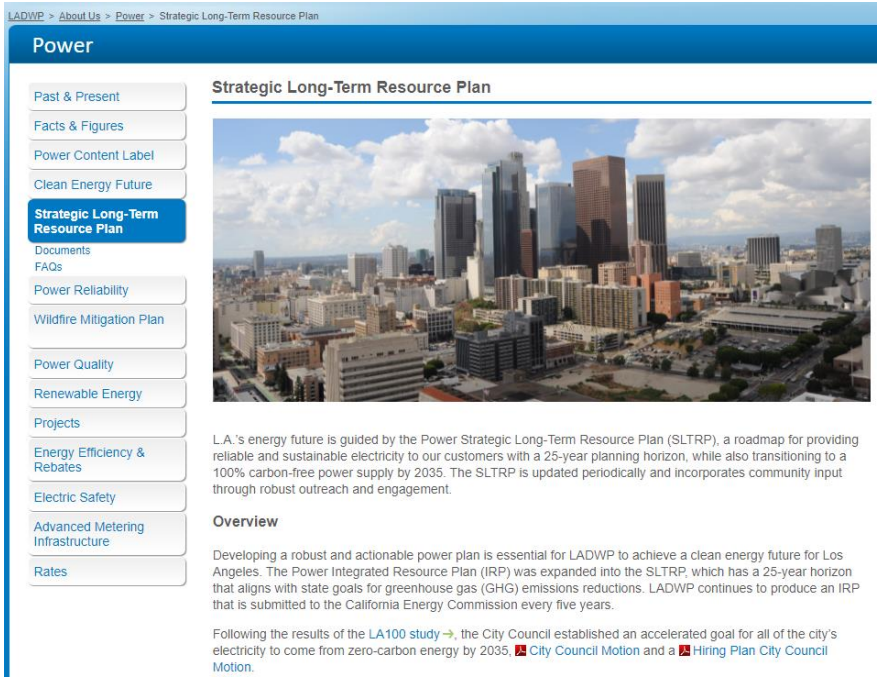

Wrap Up & Next Meeting

Next Meeting:
February 2022 (10 am to 12 pm)

Future Meeting:
July 2022

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