Los Angeles Department of Water & Power

2022 Power Strategic Long-Term Resource Plan (SLTRP)

Roadmap to 100% Carbon Free by 2035

SLTRP Advisory Group Meeting #3

October 8, 2021

Meeting Agenda

Joan Isaacson, Kearns & West

- Welcome & Introductions
- Meeting Purpose and Agenda Overview
- California SB100 Joint Agency Report
- LA100 – 100% carbon free by 2035
- Green Hydrogen in LA
- 2022 SLTRP Key Considerations and Potential Scenarios
- Wrap Up

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

Guides for Productive Virtual Meetings

- Use Chat for input OR Raise Hand to join the conversation
- Help to make sure everyone gets equal time to give input
- Keep input concise so others have time to participate
- Actively listen to others, seek to understand perspectives
- Offer ideas to address questions and concerns raised by others

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** • LA100 Equity Strategies • Electrification • Energy Efficiency • Draft Scenario Matrix	November-January • Internal Modeling • Analysis of Scenarios	**#7 February TBD** Preliminary Results	**#8 July TBD** Public Outreach Results
#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 October 28** • Metrics & Evaluation Process • Scenario Considerations -Implementation & Feasibility -Supply Chain Impacts -Human Resources Plan -Energy Burden • Refine Scenario Matrix	Modeling Underway	March – April TBD Potential field	August Review Draft 2022 SLTRP
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Protocols and Operating Principles for Advisory Group

What

A document that establishes: 1) the role of Advisory Group in the SLTRP, 2) general parameters for Advisory Group communication, meetings, etc.

Why

To provide a “road map” for members in order to anticipate involvement and contributions, and to ensure that meetings and overall process are productive for all members.

California Senate Bill 100 Joint Agency Report

Jay Lim, LADWP Manager of Resource Planning





The 2021 SB100 Joint Agency Report and Summary Document can be found at:

https://www.energy.ca.gov/SB100

Key Takeaways from SB100 Modeling

- This initial analysis suggests SB 100 is technically achievable through multiple pathways.
- Construction of clean electricity generation and storage facilities must be sustained at record-setting rates.
- Diversity in energy resources and technologies lowers overall costs.
- Retaining some natural gas power capacity may minimize costs while ensuring uninterrupted power supply during the transition to 100 percent clean energy.
- Increased energy storage and advancements in zero-carbon technologies can reduce natural gas capacity needs.
- Further analysis is needed.

LA DWP

https://www.energy.ca.gov/SB100

SB100 Next Steps

Proclamation of a State of Emergency issued by Governor Gavin Newsom on July 30, 2021

September 2021: Report to the Governor on Priority SB100 Actions to Accelerate the Transition to Carbon-Free Energy (Summary of Recommendations):

1) **Challenges to Realization of Procurement**
   a) Potential Supply Chain and Project Development Impacts
   b) Clean Electricity Generation and Storage Project Permitting Considerations
   c) Transmission Planning, Permitting, and Interconnection
2) **Improving Long Term Planning to Support SB100 and Reliability**
   a) Analytical Enhancements to Reflect Climate Change Impacts
   b) Adapting State Planning to Support SB100 and Reliability
3) **Rate Impacts**
   a) New Financing Mechanisms and Rate Designs to Address Affordability Impacts
4) **Considerations for Long Lead Time Resources**
   a) Emerging Resources to Meet Long-Term Reliability Needs
   b) Procurement of Long Lead-Time Resources
   c) Advancing Responsible Offshore Wind Energy Development
5) **Funding Technology Development and Demonstration**
6) **Maximizing Demand Response and Demand Flexibility**
7) **Regional Markets**
8) **Alignment with Federal Efforts**

https://www.energy.ca.gov/sites/default/files/2021-09/CEC-200-2021-008.pdf

Discussion and Q&A

LA100 – 100% Carbon Free by 2035 Requirements

Dr. Brady Cowiestoll, National Renewable Energy Laboratory

Discussion and Q&A

Green Hydrogen in LA

Greg Huynh, LADWP IPP Operating Agent Manager
Aaron Guthrey, LADWP Engineer of Generating Station and Facilities Engineering





Green Hydrogen: Achieving the Last 10% of Carbon-Free Generation

SLTRP Advisory Group Meeting

October 8, 2021

Today's Agenda

1. Hydrogen Overview
2. Need for Large-Scale Energy Storage
3. Challenges
4. LADWP's In-Basin Efforts
5. Intermountain Power Project Renewed
6. Wrap-Up

Hydrogen and its colors

- Most abundant element in the universe, and forms a colorless, odorless, and tasteless gas
- On Earth, primarily bound in molecules of water or hydrocarbons
  - H_2: Hydrogen gas
  - H_2O: Hydrogen atoms paired with oxygen atom

	Color	Energy Source	Process	
Fossil Fuel Feedstocks	Brown	Coal or lignite	Gasification & reformation	Fuel to Hydrogen
	Gray	Natural gas	Gasification (SMR)	
	Blue	Natural gas	Carbon Capture Sequestration during gasification	
Renewable Feedstocks	Green	Biogas or biomass	Gasification & reformation	
		Water	Electrolysis	Clean Electricity to Hydrogen

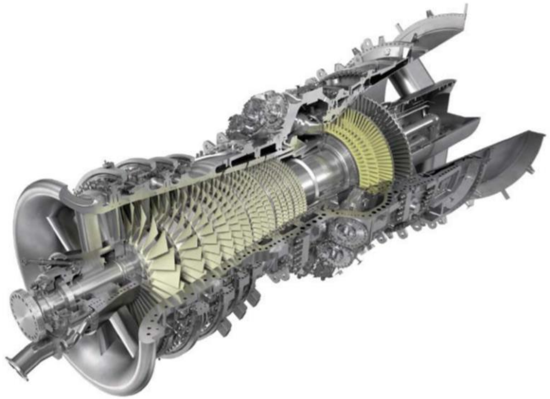
Carbon impact (kg CO_2/kg H_2)

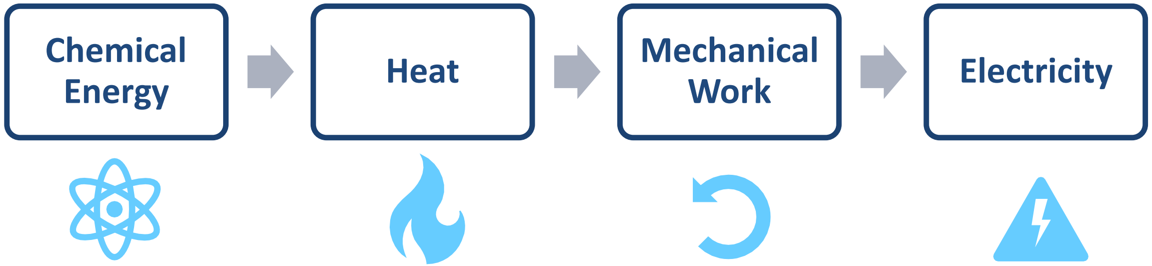
- 18 to 20
- 10 to 12
- 0.6 to 3.5
- 0

Source: Green Hydrogen Coalition

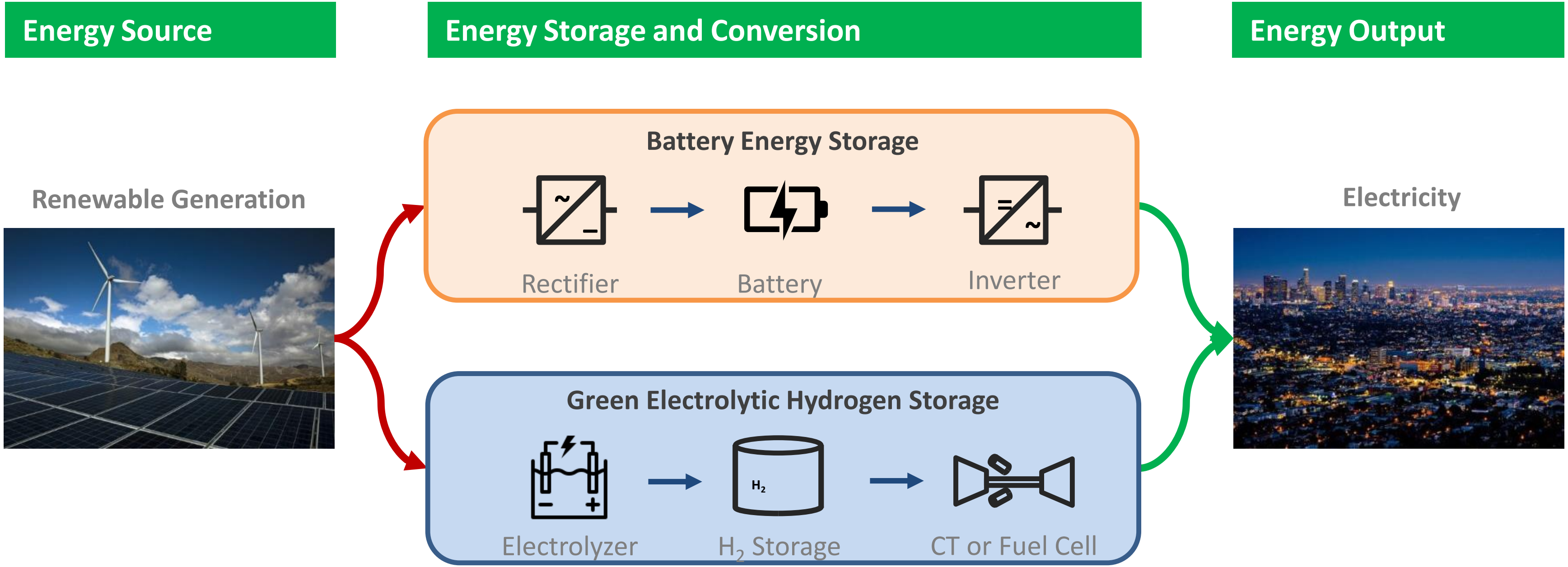
Green Hydrogen: A renewable fuel for gas turbines

- Core technology: jet engine
- Replace fuel: natural gas → green hydrogen
- Renewably fueled dispatchable capacity
- Zero carbon emissions
- Technical challenges to be discussed



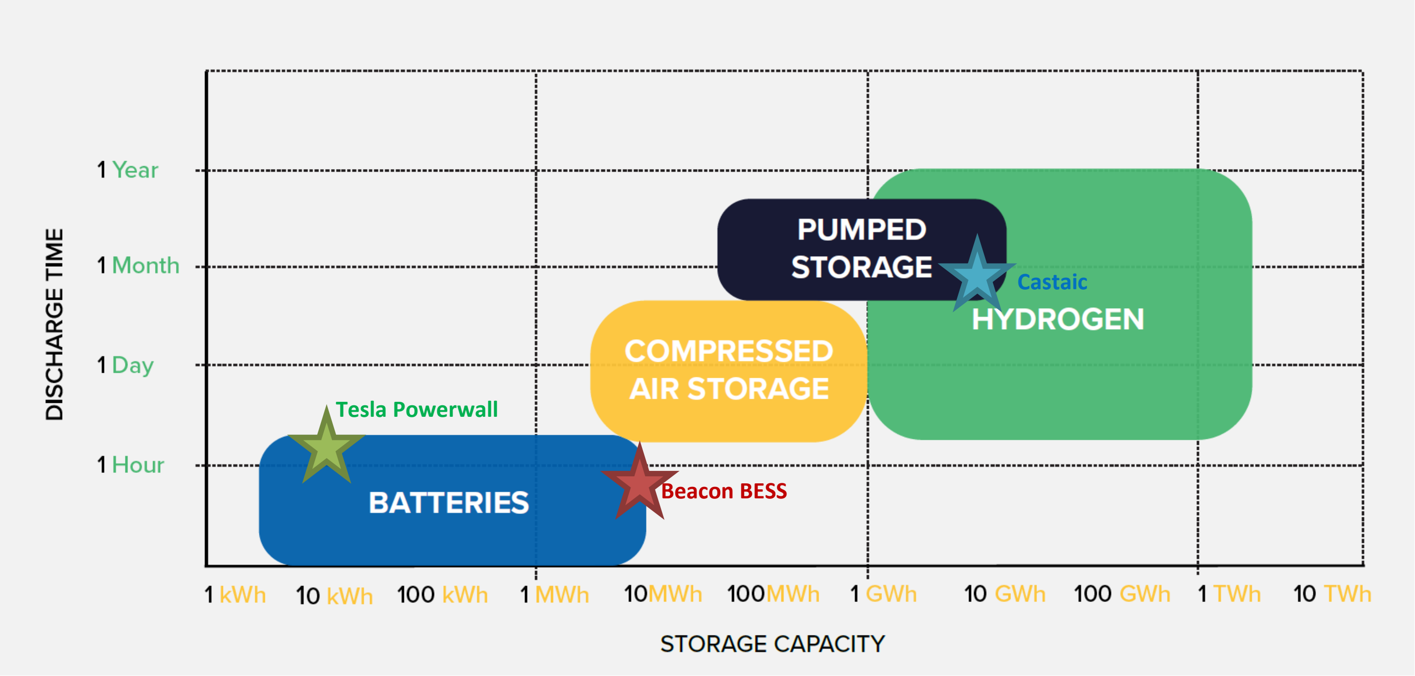


Green electrolytic hydrogen can be used as an energy storage medium… and unlike batteries can address multi-day and seasonal needs



Bulk Energy Storage

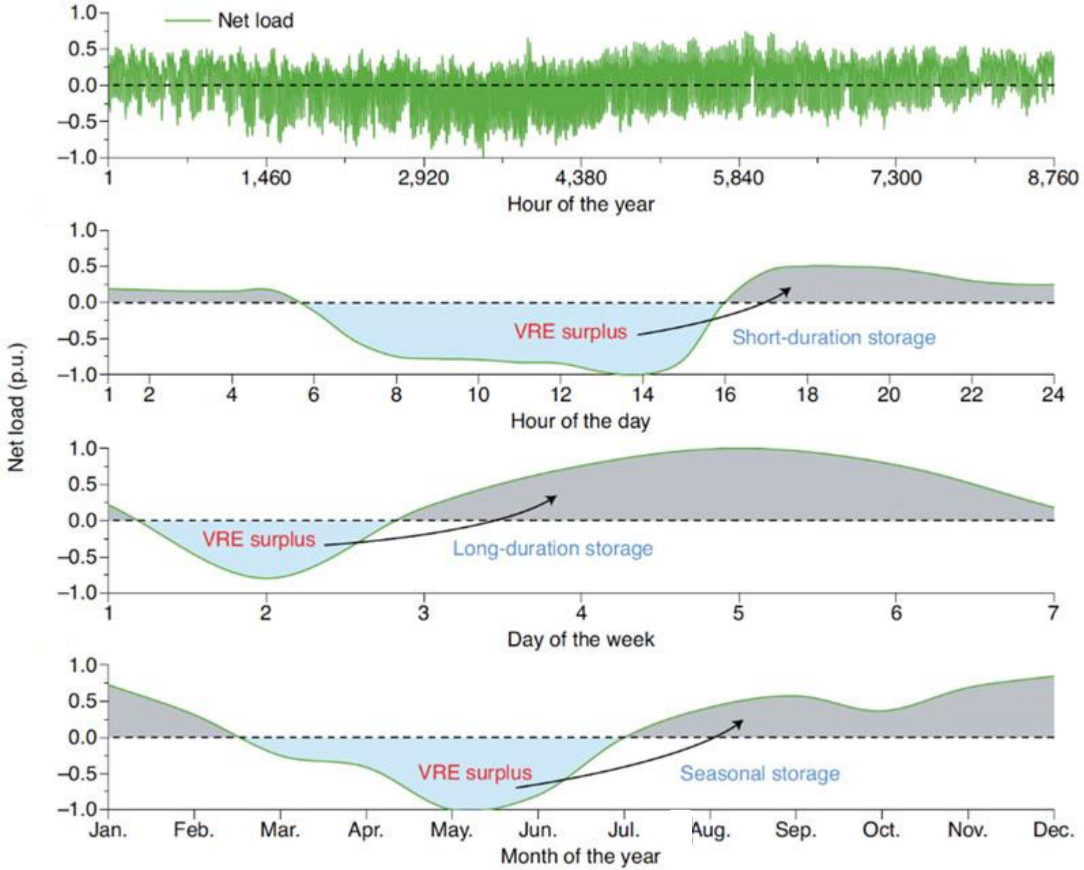
Note: Both axes are logarithmic, meaning multiples along the axes are **exponential**



Source: Green Hydrogen Coalition

Hydrogen is a promising solution for multi-day and seasonal energy storage at the grid scale.

Energy Storage Needed at Multiple Scales



Net Load throughout year

Short-duration storage (**hours**)

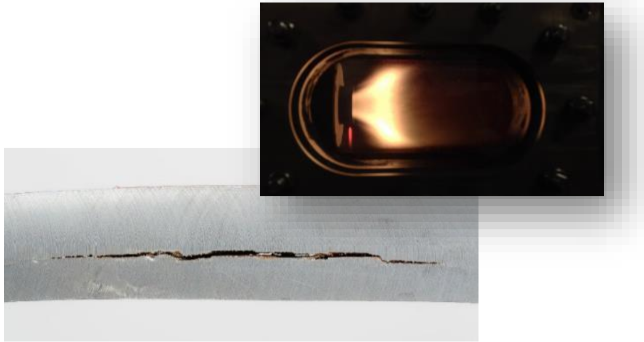
Long-duration storage (**days**)

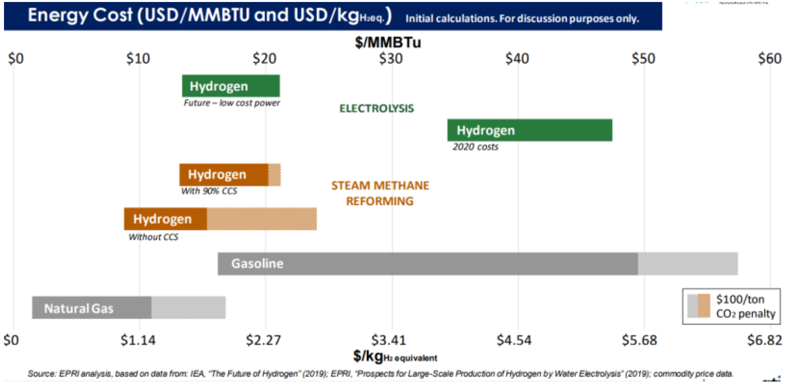
Seasonal storage (**months**)

Source: National Renewable Energy Laboratory

Challenges with Hydrogen as a Fuel

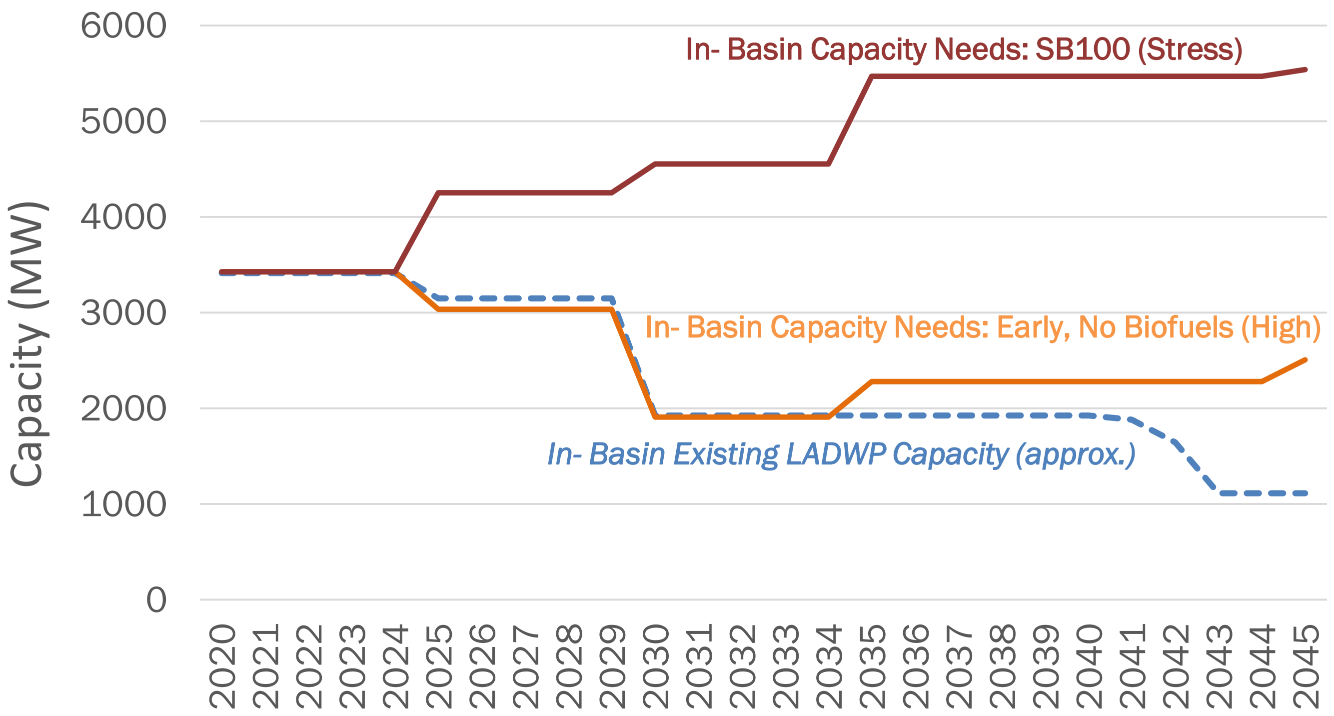
- Technical
  - Low volumetric energy density requires massive storage volumes
  - Embrittlement
  - Challenging combustion characteristics (flame speed, flashback, stability, flame temperature)
  - Higher combustion NOx may require further abatement
- Logistics and Economics
  - Sourcing green hydrogen at necessary quantities
  - Multi-sector coordination to develop green hydrogen market and achieve scale
  - Cost of green hydrogen is higher than fossil fuel derived hydrogen and 10x higher than natural gas



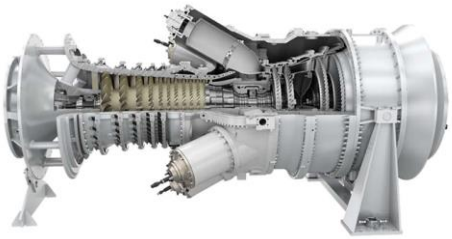


Changing Needs of In-Basin Generation

LA100: Capacity (MW) of Total In-Basin generation (H2, gas, biofuels), year by year



LA100
The Los Angeles 100% Renewable Energy Study



Transforming In-Basin Generation

- *LA100 study* identified the need for **dispatchable capacity** at all in-basin generating stations
- **Request for Information** (RFI) will help form the basis of LADWP's in-basin green hydrogen strategy for all in-basin generating stations
  - Scattergood Hydrogen Power Capacity
  - Retrofits to existing natural gas combustion turbines
  - New hydrogen-fired combustion turbines
  - Technologies of Interest as they relate to, hydrogen production, transportation, storage, and end use
  - Safety and environmental stewardship

LA100
The Los Angeles 100% Renewable Energy Study

LADWP Hydrogen Request for Information Timeline

July
2021
Feedback Incorporated: Final RFI revisions completed

August 5
2021
RFI Advertised

September 2
2021
RFI Q&A Posted

September 28
2021
LADWP Announces 30-Day Extension

We are here

November 8
2021
Updated RFI Submission Deadline

November & December
2021
Evaluation of RFI Submittals

Future
Hydrogen Demonstration

In-Basin Plant Challenges

- **Sourcing Renewable Fuel**
  - Hydrogen
  - Ammonia
  - Biogas
- **Infrastructure Challenges**
  - Pipelines
  - Maritime
  - Ocean cooling elimination
- **Storage and Backup Fuel**
  - Limited available space
  - No local geologic salt dome formations
  - Liquified green fuel challenges
- **Retrofits for Existing LADWP Resources**
  - F-Class turbine retrofits
  - Aeroderivative turbine retrofits
  - Maintaining generation 24/7 during transition
  - Currently no 100% hydrogen fueled F-Class turbines available

LADWP's Current In-Basin Gas Turbine Fleet

LADWP's Green Hydrogen Request for Information is positioned to receive information on current and future available hydrogen retrofits for the existing fleet

Model	Net Maximum Unit Capacity	Valley GS	Scattergood GS	Haynes GS	Harbor GS
GE - 7FA	162–206 MW	2	1	2	
GE - LMS100	99.2–102 MW		2	6	
GE - 7EA	73 MW				2
GE - LM6000	43–47.4 MW	1			5

*Anticipated changing capacity factors from 30% to 5%

Scattergood Hydrogen Power Capacity

- Capacity at Scattergood is our most immediate need for **system reliability**
- **Ocean-cooled** units will need to be retired by 2029
- Loss of capacity must be replaced
- Opportunity to **demonstrate** green hydrogen electricity generation in-basin
- RFI will help guide strategy at Scattergood

Global Shared Expertise

Low Carbon Research Initiative

- Multi-sector collaboration that is coordinated by:
  - Electric Power Research Institute
  - Gas Technology Institute

HyDeal LA

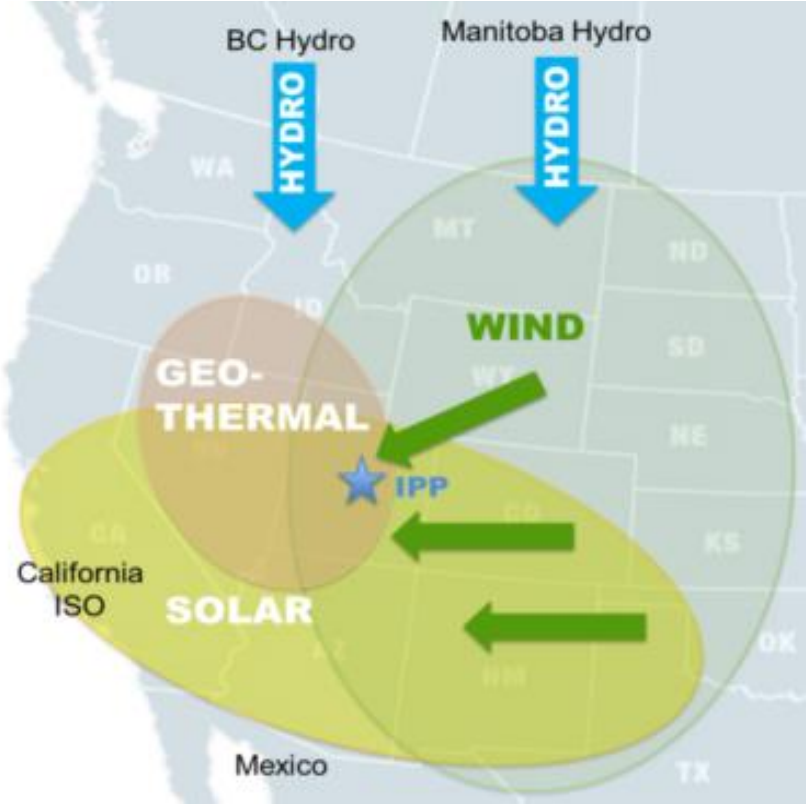
- Founded by the Green Hydrogen Coalition
  - Intended to architect a green-hydrogen cluster at scale in the LA area
  - Leveraging lessons being learned in Europe

Intermountain Power Project (IPP): Renewed

- Background
  - Located in Delta, Utah
  - Coal-fired with 1,800 MW net capacity
  - Commissioned in 1986
- IPP Renewed
  - Retire existing coal units by 2025
  - Construct 840 MW units by 2025
  - Provides dispatchable energy to maintain reliability and support HVDC transmission
  - Increase renewables
  - Green hydrogen production and long-term storage

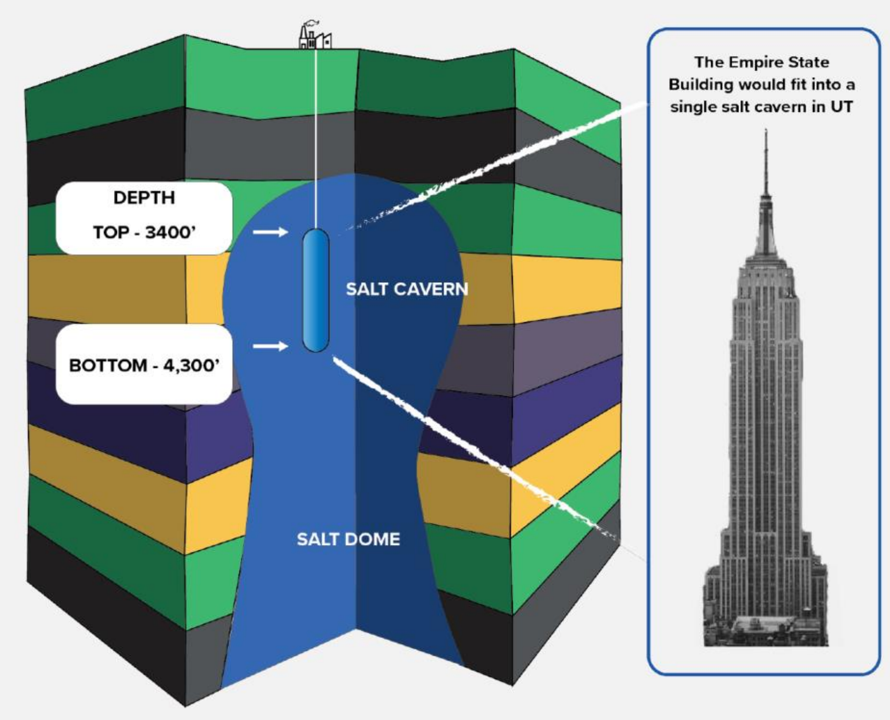
Utah’s Renewable Hub

- Intermountain sits in a confluence of renewable resources
- Currently interconnected about 400 MW of wind generation and geothermal
- 2,300 MW of current solar interconnection requests in queue
- Seeking 1,500 MW of Wyoming wind interconnects
- Considered the “Western Renewable Energy Hub”



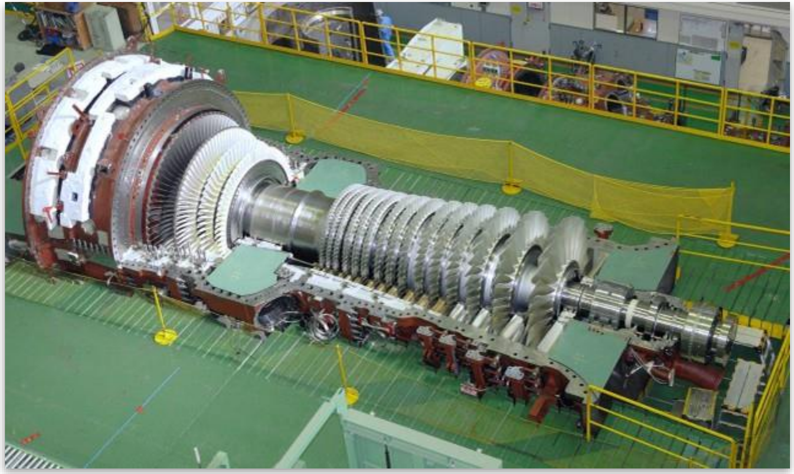
Salt Domes at Intermountain: A Unique Opportunity

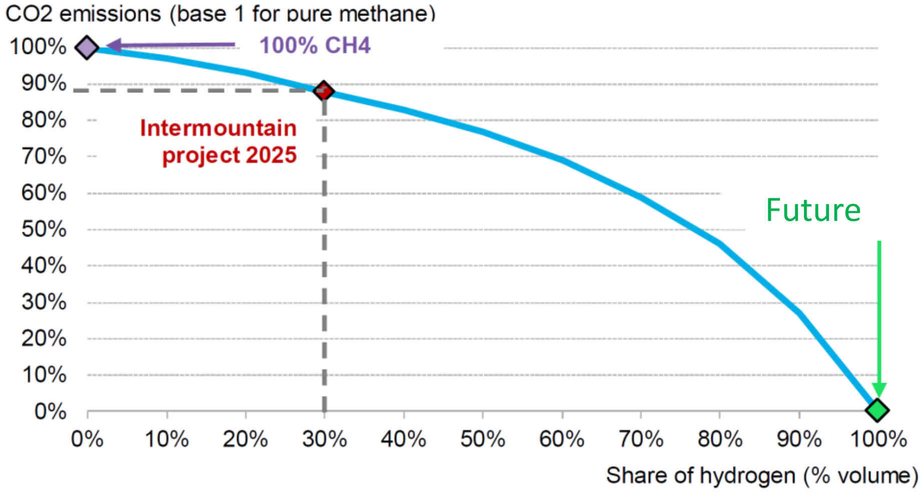
- Underground salt domes beneath Intermountain
- Suitable for storing green hydrogen
- Created by solution mining
- 1 cavern = 5,500 tons H_2 storage
  - Equivalent to 1 million fuel cell cars
- Over 100 caverns possible near Intermountain
- Allows for seasonal shifting of energy storage



Green Hydrogen at Intermountain: Capabilities

- Two MHPS M501 JAC gas turbines
  - Combined cycle configuration
  - Two ‘1 x 1’ power trains
- Hydrogen-fueled capabilities:
  - 30% H_2 in 2025
  - 100% H_2 in future





Source: Bloomberg New Energy Finance

Future Proofing for H2

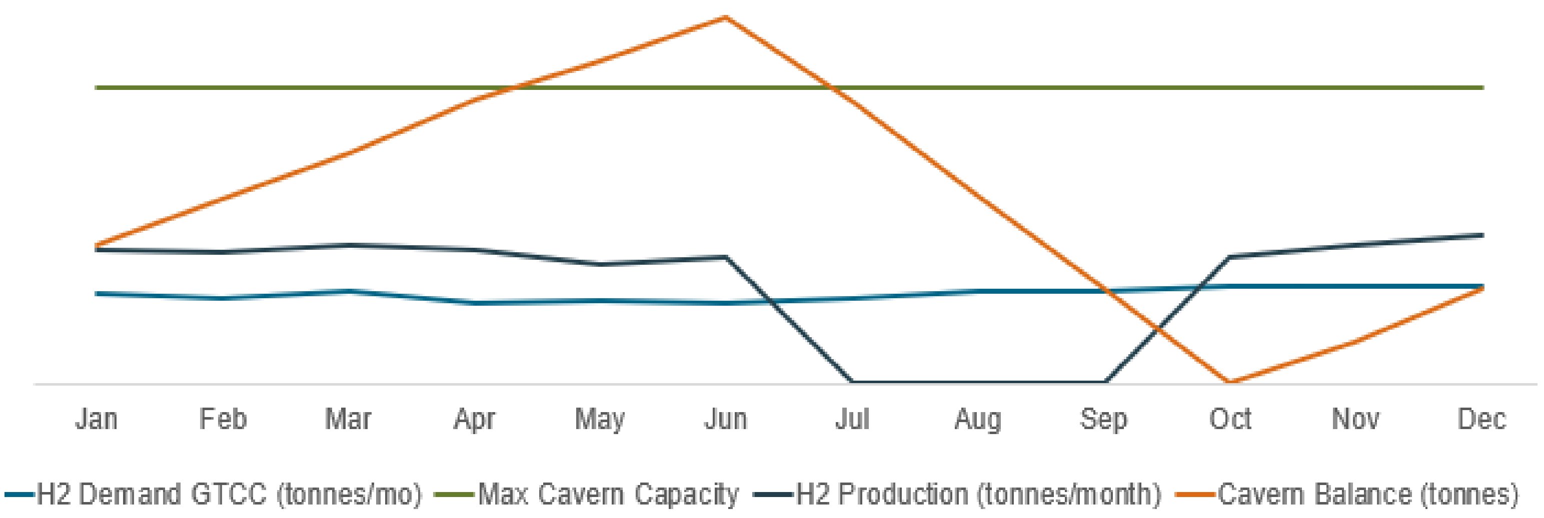
- What's needed to get to 100%
  - Combustor technology development
  - Modifications to Balance of Plant equipment
  - Infrastructure to support 100% Hydrogen
- What we're doing today
  - Plant layout designed for installation of future H2 equipment
  - Installation of flexible green H2 and natural gas fuel mixing systems
  - Designing the systems to lower the life cycle costs of transition to 100% H2

Current State of Technology

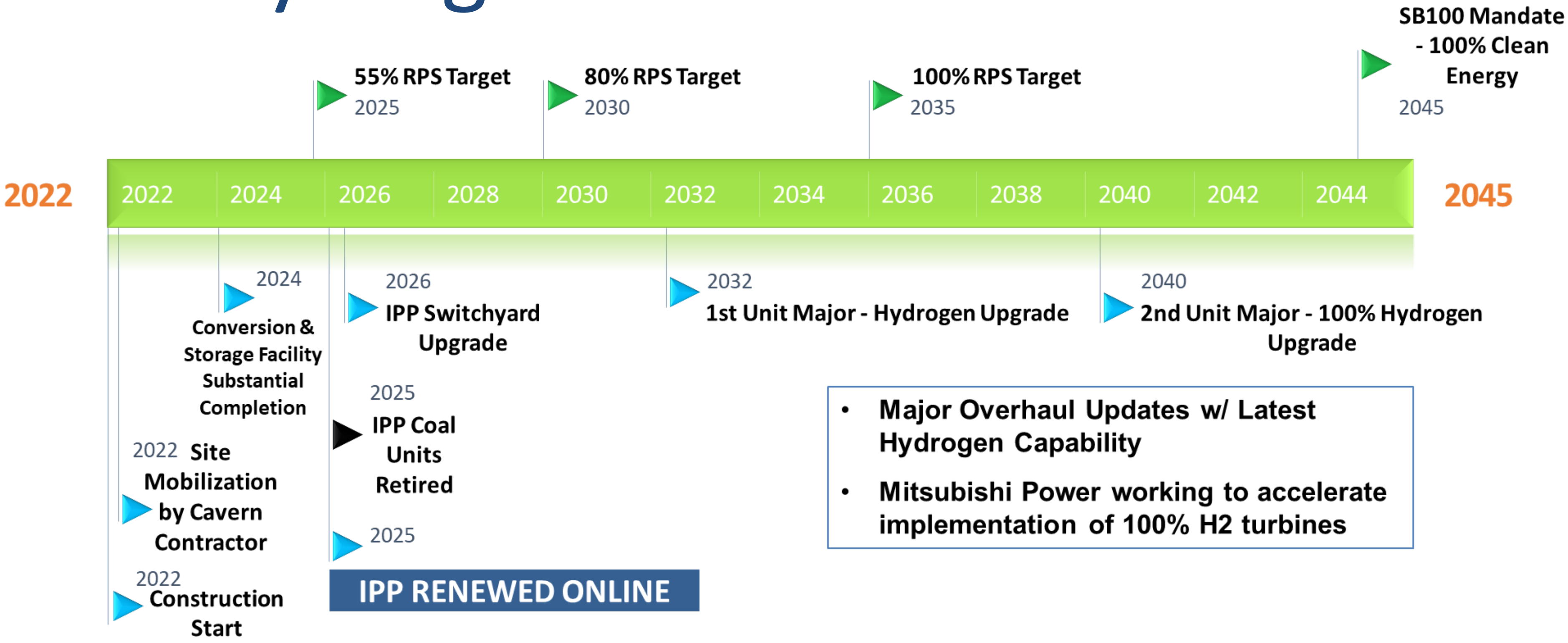
- Current combustor technology can support stable operation up to 30% at this scale
- High concentrations of hydrogen presents challenges with:
  - NOx Emissions
  - Flashback
  - Flame Stability
- Improvements in the Heat Recovery Steam Generator can help reduce NOx emissions below regulatory limits
- Major R&D investments are being made to improve performance and prevent component damage

Multi Cluster Combustor (ETN Global)

Projected IPP 30% Hydrogen Operating Profile

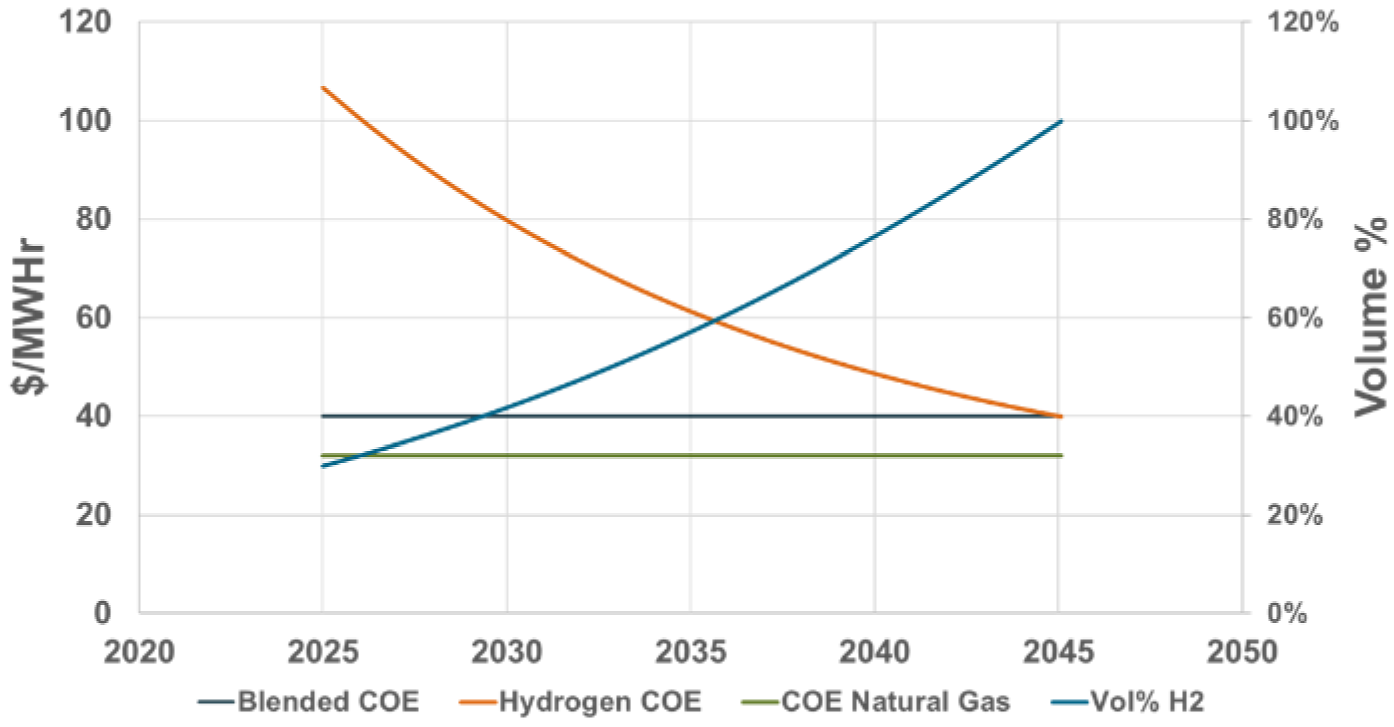


IPP Hydrogen Timeline



- Major Overhaul Updates w/ Latest Hydrogen Capability
- Mitsubishi Power working to accelerate implementation of 100% H2 turbines

Cost of Electricity (COE) Over Time for an Increasing Blend of Green Hydrogen



Next Steps for IPP Renewed

- Green Hydrogen Fuel Supply
  - Complete 30% hydrogen volume negotiations with 3rd-Party November 2021
  - A Multi-Stage RFP was submitted by the Intermountain Power Agency in June 2020
    - Stage 1 responses received and evaluated
    - Stage 2 scheduled to be advertised in July 2022
  - Anticipated award of Hydrogen Supply Project agreement by December 2023

Summarizing Thoughts

- Green hydrogen provides a potential pathway for renewably fueled dispatchable generation
- Challenges: cost, sourcing for needed hydrogen quantities, infrastructure development, technical challenges (NOx control, embrittlement, combustion characteristics, etc.)
- Industry is focusing on safety of hydrogen to ensure reliable operation while also protecting personnel
- Green hydrogen Request for Information will inform the market potential for green hydrogen in the LA Basin and provide input into the Strategic Long Term Resource Plan
- Unique resources at Intermountain provides an opportunity to demonstrate green hydrogen as an energy storage system

Discussion and Q&A

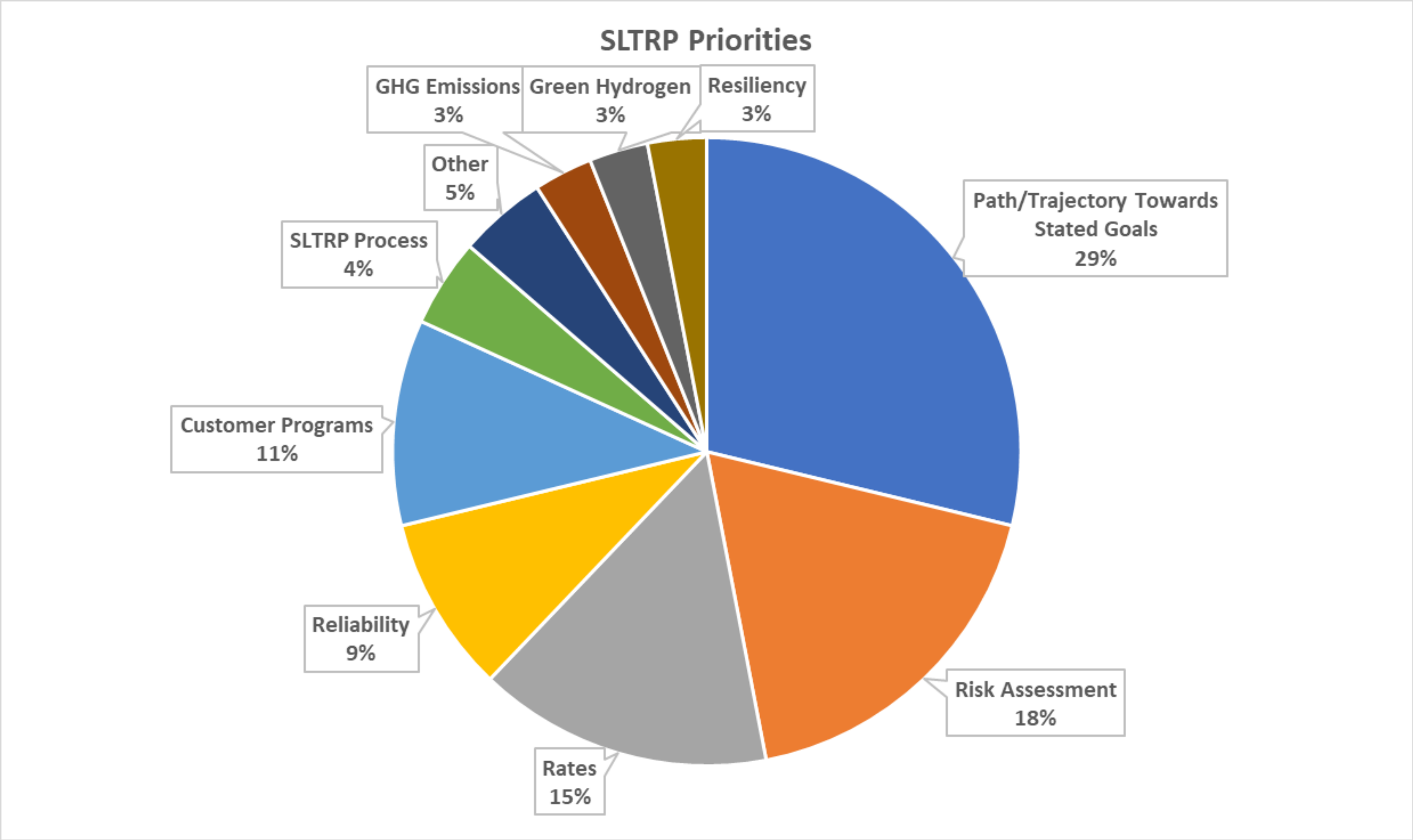
2022 SLTRP: Key Considerations and Potential Scenarios

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





Summary of Feedback From Advisory Group



Response Topics

Path/Trajectory Towards Stated Goals	Risk Assessment	Rates	Reliability	Customer Programs	SLTRP Process	Climate Change/GHG Emissions	Green Hydrogen	Resiliency	Other
Pilot programs should be considered.	Is the timeline set forth to achieve goals realistic?	Rates should remain affordable.	Contingency planning for emergencies should be considered.	LADWP should aggressively pursue customer programs such as EE, DERs, and electrification.	Preliminary results should be sent out prior to AG meetings to allow enough time to review.	The entire lifecycle (including methane production and transportation) of GHG emissions should be considered.	Perhaps green hydrogen should be implemented later in order to minimize rate impacts.	Ability to withstand natural disasters should be considered.	Impacts on transmission capacity should be provided.
Annual targets for renewables and fuel switching should be established.	Are the goals technologically feasible?	Consideration should be given to maintaining affordability to middle and lower-income households.	Scenarios should strike a balance between affordable rates and reliability.	LADWP should recruit customers for multi-day DR programs.	Would the recommended scenario be one the AG creates, or would it be NREL's (or some other entity)?	GHG emissions reductions should be made as soon as possible.	All impacts related to green hydrogen should be considered (e.g., cost, availability, etc.)		
Realistic goals should be established based on past experience with large construction projects.	Will long-term weather patterns be considered?	More information on how rates will impact LADWP's balance sheet and cash flow should be provided.	Distribution overloads and how to mitigate them should be considered.	Customers should have multiple DR options.		Focus more on EV adoptions since the transportation sector accounts for the most GHG emissions.			
How will PPAs be structured to minimize environmental impacts?	An analysis of risks that may hinder achievement of goals should be performed.	How can we improve customer trust, particularly as it relates to rates and the notion that this may be politically motivated?		Given LA's building density, DERs should leverage existing infrastructure when feasible.					

LADWP

Response Topics (continued)

Path/Trajectory Towards Stated Goals	Risk Assessment	Rates	Reliability	Customer Programs	SLTRP Process	Climate Change/GHG Emissions	Green Hydrogen	Resiliency	Other
A concise set of scenarios should be presented.	Environmental permitting and resource availability should be considered.								
A rationale regarding the recommended technology resource mix should be provided	LADWP should ensure they have adequate internal resources (e.g., staffing).								
Early EV adoption and later renewables build-out should be considered.	A review of internal proceedures should be conducted in order to streamline procurement processes.								
Allowable fuel and renewable technologies should be clearly stated.	Uncertainty in renewable energy production should be addressed.								
Bold steps implementing some new technology may help in achieving goals.	Investments should enhance optionality.								
Diversity in technology and strategies should be considered.									

2022 Power Strategic Long-Term Resource Plan (SLTRP)

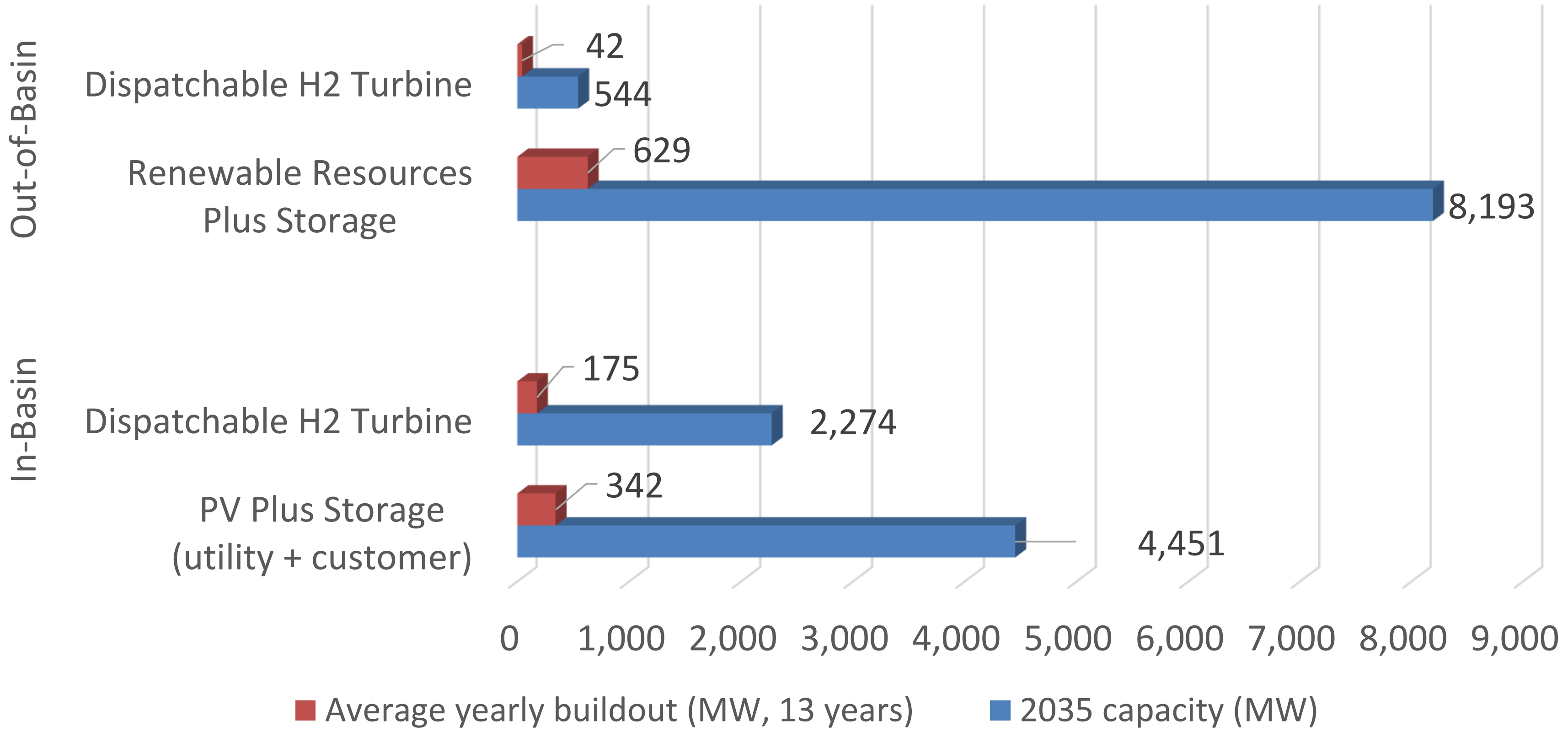
Key Considerations to 100% Carbon Free

1) **Environment and Equity**
2) **Reliability and Resiliency**
3) **Affordability and Rate Impacts**

Implementation Risks

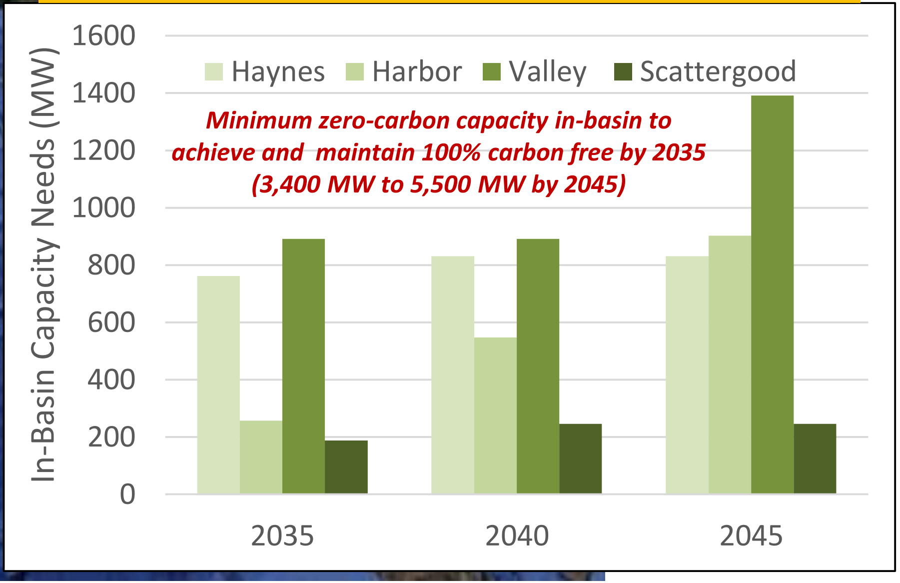
- Build Rates and Deployment
- Local Capacity Requirements
- Reliance on Emerging Technologies
- Permitting Timeline
- Workforce Development
- Once-through Cooling Retirement Deadline

LA100's 100% Carbon Free 2035 Scenario Required Yearly Buildouts (MW)



Role of In-Basin Capacity for the Last 10% Carbon Free

Based on LA100 Study Results (subject to further evaluation)



Potential 2022 SLTRP Scenarios

1) **Reference:** SB100 (60% RPS by 2030, 100% zero-carbon by 2045 based on sales)
2) **Balanced Decarbonization:** 80% RPS by 2030, 100% RPS by 2035 based on sales, 100% carbon free by 2040/2045 (last 10%) based on technology maturity and implementation roadmap
3) **City Council Motion:** 80% RPS by 2030, 100% carbon-free by 2035 based on generation

While evaluating Local capacity requirements

Sensitivities:

a) *High Transportation and Building Electrification Loads*
b) *Low/High Fuel Prices*
c) *Low/High Energy Storage Prices*

LA DWP

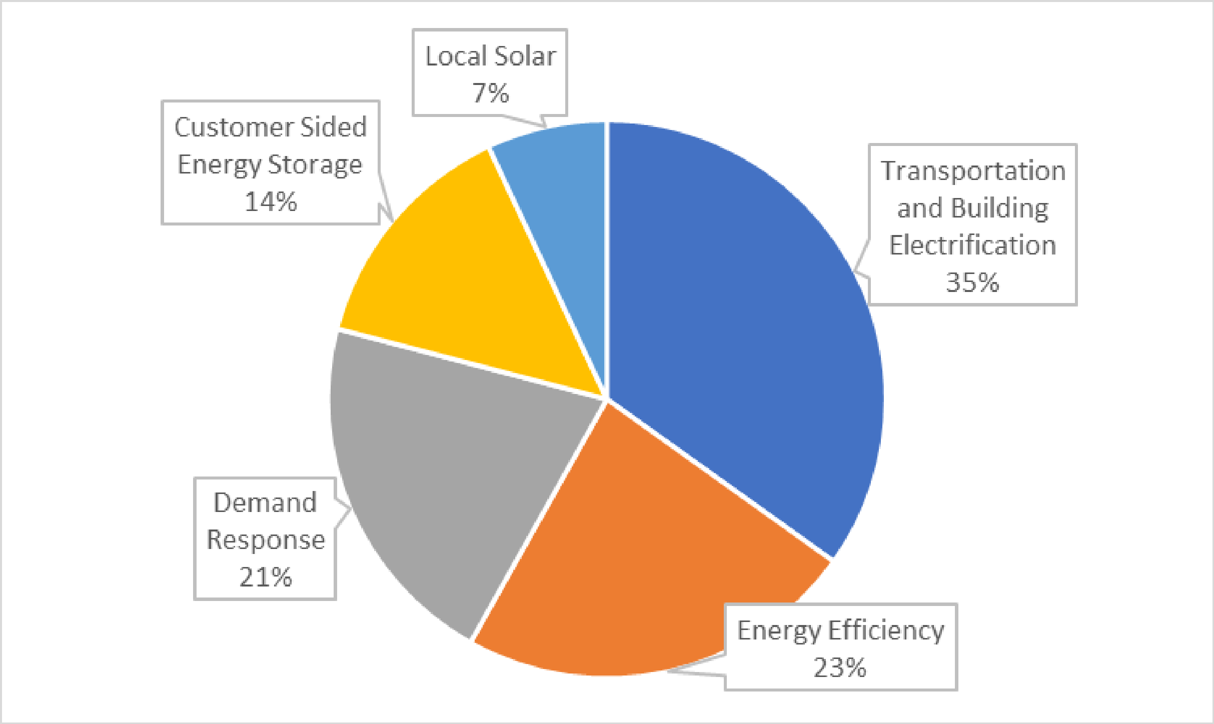
SLTRP Polling & Discussion
(Kearns & West)

10-minute questionnaire for all Advisory Group members

Thank you for your input!

Poll Results

The SLTRP process typically analyzes various programs and projects as part of its resource mix. What types of programs are you interested in and would like to learn more about at the upcoming 10/22 meeting?



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Wrap Up & Next Meeting

Next Meeting:
October 22, 2021 (10 am to 12 pm)

Future Meeting:
October 28, 2021 (10 am to 12 pm)

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

LA100 Study

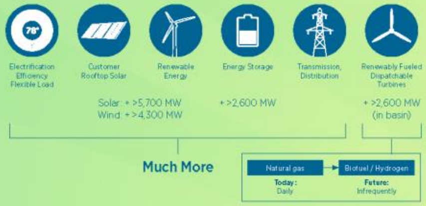
Completed

Unprecedented analysis ID'd multiple paths to achieve 100% target

Considers reliability, equity, sustainability and affordability

- Confirmed 100% by 2035 achievable
- Community & stakeholder input

Common Investments Across All Scenarios



LA100 Equity Strategies

Fall 2021-23

Community-driven, objective to achieve equity

Robust community engagement

Areas of Focus

- Improve air quality
- Solar access
- Energy Efficiency
- Affordable rates
- Demand management
- Debt relief
- EV charging access

2022 SLTRP

Fall 2021-2022 | 2035 & 2045 Targets

Our comprehensive integrated power plan

Recommends path forward to achieve our goals

- Integrates findings of LA100
- Community & stakeholder input
- Prioritizes reliability, resiliency, equity, affordability, sustainability

Considerations

- Workforce
- Building, Operating & Maintaining
- Cost to customers
- Supply Chain Risk
- Implementation and Feasibility

LA100 Equity Strategies

Dr. Patricia Romero Lankao, National Renewable Energy Laboratory

Discussion and Q&A