LADWP Power Strategic Long-Term Resource Plan (SLTRP)

Advisory Group (AG): Meeting #3

Friday, October 08, 2021
10:00 am – 12:00 pm
WebEx Platform (Virtual)

Meeting Summary (Draft)[1]

Attendees:

Advisory Group Members/Observers

1. California State University, Northridge (CSUN), Loraine Lundquist
2. Center for Energy Efficiency and Renewable Technologies (CEERT), John V. White
3. City of Los Angeles - Council District 02, Councilmember Paul Krekorian, Matt Hale
4. City of Los Angeles - Council District 03, Councilmember Bob Blumenfield, Jeff Jacobberger
5. City of Los Angeles - Council District 05, Councilmember Paul Koretz, Andy Shrader
6. City of Los Angeles - Council District 08, Councilmember Marqueese Dawson, Belem Llamas
7. City of Los Angeles - Council District 10, Councilmember Mark Ridley-Thomas, Maurice Johnson
8. City of Los Angeles - Legislative Aide, Luis Huerta
9. City of Los Angeles - Office of the City Attorney, Jean-Claude Bertet
10. City of Los Angeles - Office of the Mayor, Paul Lee
11. City of Los Angeles - Office of the Mayor, Rebecca Rasmussen
12. City of Los Angeles - Office of the City Administrative Officer (CAO), Sarai Bhaga
13. City of Los Angeles - Office of Public Accountability (OPA), Frederick Pickel
14. Food and Water Watch, Jasmin Vargas
15. Green Hydrogen Coalition, Nick Connell
16. Los Angeles Business Council (LABC), Adam Lane
17. Los Angeles Business Council (LABC), Arielle Lopez
18. Los Angeles Business Council (LABC), Mary Leslie
19. Los Angeles Unified School District (LAUSD), Christos Chrysiliou
20. LADWP Advocacy Committee, Jack Humphreville
21. LADWP Board of Commissioners, Mia Lehrer
22. LADWP Board of Commissioners, Susana Reyes
23. LADWP Memorandum of Understanding Oversight Committee, Tony Wilkinson
24. National Resources Defense Council (NRDC), Amanda Levin
25. Neighborhood Council Sustainability Alliance (NCSA), Dan Kegel
26. Port of Los Angeles (POLA), Carlos Baldenegro
27. Sierra Club, Carlo De La Cruz
28. Sierra Club, Francis Yang
29. Southern California Public Power Authority (SCPPA), Randy Krager
30. University of California, Los Angeles (UCLA), Bonny Bentzin
31. University of Southern California (USC), Zelinda Welch
32. Valero Wilmington Refinery, Brissa Sotelo-Vargas
33. Valley Industry Commerce Association (VICA), Giancarlo Rubio

[1] This summary, prepared to the best ability of the notetakers, is provided as synopsis of the meeting for review of topics covered, and is not intended to represent an official record or transcript of all matters presented or discussed. Not all attendees may be reflected due to early log-offs, no self-identification, and other factors.

34. Water and Power Associates, William Barlak
35. Water and Power Associates, Bill Engels
36. 2132****39
37. 3033****34
38. 4159****56

LADWP Staff

1. Stephanie Spicer
2. Dawn Cotterell
3. James Barner
4. Glenn Barry
5. Michael Buck
6. Kai Choi
7. Michael D'Andrea
8. Roberto Gonzalez
9. Aaron Guthrey
10. Paul Habib
11. Scott Hirashima
12. Robert Hodel
13. Matt Hone
14. Greg Huynh
15. Alan Hwang
16. Carlos Jimenez
17. Jimmy Lin
18. Jay L. Lim
19. Monique Earl
20. Haik Movsesian
21. Ashkan Nassiri
22. Daniel Novoa
23. Linda Novoa
24. Cindy Parsons
25. Kevin Peng
26. Bernardo Perez
27. David Rahimian
28. Katherine Rubin
29. Nermina Rucic-O'Neill
30. Arash Saidi
31. Armen Saiyan
32. Ann Santilli
33. Steve Ruiz
34. Nancy Sutley
35. Jeremiah Valera
36. Julie Van Wagner
37. Lisa Yin
38. Lister Yu
39. John Levy
40. Louis Ting
41. Mark Fernandes
42. Eric Montag

43. Luis Martinez

Project Team
1. Joan Isaacson, Kearns & West (Facilitator)
2. Alyson Scurlock, Kearns & West (Polling)
3. Christian Mendez, Kearns & West
4. Brady Cowiestoll, National Renewable Energy Laboratory (NREL)
5. Jaquelin Cochran, National Renewable Energy Laboratory (NREL)
6. Paul Denholm, National Renewable Energy Laboratory (NREL)
7. Brandon Mauch, Ascend Analytics
8. Zach Brode, Ascend Analytics

Note: The meeting presentation slides are posted at ladwp.com/sltrp.

1. Welcome and Introductions
    - Joan Isaacson, meeting facilitator from Kearns & West, welcomed the Advisory Group (AG) for Meeting #3.

2. Meeting Purpose and Agenda Overview
    - Isaacson explained that in this meeting the team would continue to share updates on the many considerations for the SLTRP, including state efforts related to California's SB 100: The 100% Clean Energy Act of 2018 (presented by LADWP), 100% Carbon-free by 2035 Requirements (presented by NREL), and Green Hydrogen in L.A. (presented by LADWP).

    - Furthermore, Isaacson explained that an important first step of the SLTRP process is identifying scenarios, and that today, the project team would present a preliminary first-cut of potential scenarios based on input from the AG. As part of an iterative process, the project team will be revisiting the scenarios in subsequent AG meetings through November, to receive more input and feedback.

3. California SB 100 Joint Agency Report
    - Jay Lim, LADWP Manager of Resource Planning, presented an overview on California's Senate Bill 100 (SB 100): The 100% Clean Energy Act of 2018. Lim explained that SB 100 requires electric utilities in the state to power 100% of their retail electricity sales through renewable and zero-carbon energy by 2045.

    - Furthermore, Lim explained that the Joint Agencies, comprised of the California Energy Commission, the California Public Utilities Commission, and the California Air Resources Board, hired consultant E3 (Energy and Environmental Economics, Inc.) to conduct capacity expansion modeling for the state to reach its SB 100 goals. Key findings, found in the 2021 SB 100 Joint Agency Report (energy.ca.gov/sb100), a joint policy report that is to be issued every four years, include:

        - SB 100 is technically feasible through multiple pathways
        - Construction of clean electricity generation and storage resources must be implemented and sustained at record-setting rates
        - Diversity in energy resources and technologies lowers overall costs
        - Retaining some natural gas power capacity may minimize costs while helping ensure

an uninterrupted power supply during the transition to 100% clean energy
- Increased energy storage and advancements in zero-carbon technologies can reduce natural gas capacity needs
- Further analysis, including power flow and reliability studies, still needs to be performed

- Lim also shared an overview of priority SB 100 actions to accelerate the transition to carbon-free energy, as summarized in a September 2021 report by the Joint Agencies to Governor Newsom. This Joint Agency report was in response to Newsom's proclamation of a State of Emergency, issued on July 30, 2021, to free up electricity to meet demand during extreme heat events and wildfires, and to expedite deployment of clean energy resources. During the August 2020 Heat Wave in California, LADWP actually helped support the California Independent System Operator to meet state power deficiencies.

- The 2021 SB 100 Joint Agency Report outlined challenges to meet SB 100 goals, actions currently being undertaken, and recommendations for priority actions such as the following:

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 SB 100 and reliability
   a) Analytical enhancements to reflect climate change impacts
   b) Adapting state planning to support SB 100 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

- Lim concluded the presentation by relating the statewide SB 100 efforts to those of the SLTRP in that both efforts are aiming for ambitious clean energy goals, however the City of LA's goals are much more aggressive. Furthermore, Lim highlighted that many of the challenges found in the LA100 Study were also found in modeling by the Joint Agencies, and that LADWP is currently facing many of the same implementation challenges the state is facing with respect to unprecedented build rates, resource procurement, planning, permitting, and interconnection, among others. LADWP plans to model SB 100 as a scenario in the SLTRP, and seeks input from the AG on additional scenarios and modeling considerations. The Power Regulatory Standards and Compliance group was also in attendance to answer any questions the AG had regarding the Senate Bill itself.

- Major Themes from Advisory Group Member Discussion and Questions
    - None

4. LA100 - 100% Carbon-free by 2035 Requirements

- Dr. Brady Cowiestoll, National Renewable Energy Laboratory (NREL), gave an overview of the requirements and considerations to get to 100% Carbon-free by 2035, as found by the LA100 Study. She emphasized that the LA100 Study had to make assumptions, and that the goal was to see if getting to 100% was possible, as opposed to how to do it.

- Dr. Cowiestoll reviewed the four scenarios from the LA100 Study (SB 100, Early & No Biofuels, Transmission Focus, and Limited New Transmission), and highlighted the three different customer demand projections (Moderate, High, Stress), explaining that the various demand projections assumed different levels of energy efficiency, electrification, and demand response.

- Going over results, Dr. Cowiestoll explained that common across all scenarios was a need for multiple different technologies such as load flexibility via energy efficiency and electrification, tremendous growth in customer solar as well as utility-scale renewables such as solar and wind, energy storage, transmission and distribution upgrades, and renewably-fueled combustion turbines. These resources represented about ~90% of the capacity requirements, across all scenarios.

- The last 10% in getting to the 100% renewable energy goal, was emphasized to be the most challenging and costly part. The LA100 Study found that by 2045, common across all scenarios, renewably-fueled combustion turbines, very similar to a jet engines, were required in the LA Basin to maintain reliability. The main difference in the type of renewably-fueled combustion turbines used was the type of renewable fuel chosen for the combustion turbines, either biofuels (including biogas), or hydrogen, as in the case of the Early & No Biofuels scenario, biofuels were not allowed.

    - In the case of combustion turbines operated off of biofuels and biogas (denoted as RE-CTs), the assumption was that these fuels would be market-derived and purchased directly from the market. These include commercially available fuels today such as biogas that may be procured from landfills, municipal solid waste plants, and dairy farms, as well as biofuels like ethanol and biodiesel.
    - In the case of combustion turbines operated off of hydrogen (denoted as H2-CTs), the assumption was that hydrogen would be self-produced by LADWP, using renewable energy for the electrolysis process, which uses electricity to turn water into hydrogen and oxygen, and storing the hydrogen fuel on site. Alternatively, converting the hydrogen into a fuel that is easier to store and transport such as ammonia, was also considered.

- With respect to costs, the LA100 Study found that self-producing hydrogen, such as assumed in the Early & No Biofuels scenario, as opposed to purchasing commercially available fuels from the market like biofuel and biogas, added ~20% to the cumulative costs. It is important to note that cumulative costs shown (up to $86 billion for Early & No Biofuels, High Load) do not include existing LADWP debt including existing expenditures for demand response, energy efficiency, existing power purchase agreements for renewable energy projects, investments in the Power System Reliability Program, and costs to address existing distribution system overloads, among others.

- On the required build-rates to achieve 100% carbon-free by 2035, it was noted the amount of resource capacity (capability of delivering instantaneous power) doubled by 2030, relative to 2020, for each of the scenarios. This was primarily led by buildouts in wind and solar, including utility-scale solar coupled with batteries, as well as customer solar. The level of year-over-year growth required is approximately equivalent to the maximum amount contracted by LADWP for deployment in a single year (~600 MW), a rate that has not been sustained, and would have to remain constant well into the next decade. Furthermore, changes to firm capacity in the LA Basin will also be widespread, primarily through the deployment of renewably-fueled combustion turbines (biofuels and/or hydrogen), as firm in-basin capacity was found to be key for reliability.

- With respect to maintaining reliability for a power system supplied 100% through carbon-free resources, it was explained that the last 10% needed to be comprised of technologies with characteristics that allows such technologies to be sited with the LA Basin at specific locations where power capability is needed, and that can operate for extended periods of times such as days or longer, as opposed to merely hours. Dr. Cowiestoll emphasized that access to transmission is key, and that due to unknown climate change impacts moving forward, such as the potential for long-duration outages as a result of wildfires, it was critical that the firm capacity had the capability to operate for days to weeks, something that present energy storage solutions could not achieve with duration characteristics of only hours.

- Options for flexibility in achieving the last 10% reliably were discussed, including fuel flexibility, and voluntary and equitable multi-day demand response. An example of fuel flexibility is that observed in the SB 100 scenario, which allows for renewable energy credits and biofuels to be used to offset the minimal use of natural gas and delay committing to hydrogen infrastructure until technologies further matured. In the case of a low biofuel supply and a not fully-mature hydrogen market, the use of renewable energy credits, capped at a small percent of generation, would be the fastest way to reach 100% while still gaining most or all of the greenhouse gas emission reduction, air quality, and health benefits. With regards to demand response, it was emphasized that options included voluntary customer participation in programs, and were not related to unexpected outages. Such voluntary options included interruptible load, in which customers are compensated to reduce load up to 4 hours/day on up to 12 peak days a year, scheduled pumping of water systems, shifting half of pumping loads by up to 12 hours, and shifting commercial and residential electricity end-use. It was further noted that although these demand response options were promising, the LA100 Study did not look into how to measure, implement, and automate such programs.

- Furthermore, assumptions were discussed regarding the combination of option alternatives that if realized, could potentially delay the fast-tracked building of new renewably-fueled combustion turbines. Such assumptions and combinations include:

- Energy efficiency and demand flexibility measures that help offset climate and electrification-driven load growth, supporting reliability and potentially helping offset higher electricity rates
- Greater electrification to provide higher public health and greenhouse gas emissions reduction benefits, as well as help reduce per-unit electricity costs
- Building greater amounts of local solar and storage
  - The LA100 Study showed between 2.8 GW – 3.9 GW of customer solar adopted by 2045, out of a 13 GW technical potential
- Deploying new technologies and techniques to increase capacity of existing transmission and plan new transmission that can be built
  - Includes some of the most uncertain inputs into the LA100 Study modeling. The study did not analyze construction schedules for transmission builds, and also made simplifications to represent transmission, assuming the system could be operated closer to its thermal limits.

- Dr. Cowiestoll explained that if all of these and other assumptions made in the LA100 Study were not realized, then additional in-basin capacity would be needed, compared to what was identified in the study. Furthermore, a list of open-ended questions and factors not analyzed in the LA100 Study include:
  - Consideration for how climate change may impact wind and solar supply patterns, as well as electricity use patters due to increased temperatures and extreme weather events
  - When hydrogen fuels will be commercially available, whether or not they will be a part of a larger economy-wide transition, and where and how hydrogen will be stored – including if ammonia will be an acceptable storage medium?
  - The costs for implementing energy efficiency, electrification, and demand flexibility, and how the costs and benefits would be shared?
  - Additional pollution reduction benefits that could be gained through medium and heavy-duty vehicle electrification
  - The feasibility of accelerated deployment, including siting and permitting, supply chain and labor availability, and construction schedules
    - Detailed construction schedules will need to be developed and significant coordination challenges overcome to ensure reliability is maintained as transitions are made. Flexibility in the timing of bringing online new resources and retirement of existing resources will be key.

- In closing, Dr. Cowiestoll reiterated that solutions can be found that provide reliable operation under normal operations and many contingencies, and that such solutions will depend on a mix of renewable energy and carbon-free resources, in-basin dispatchable capacity, and transmission upgrades. However, standard reliability approaches and definitions have yet to be sufficiently tested under a 100% carbon-free scenario.

- <u>Major Themes from Advisory Group Member Discussion and Questions</u>
  - Can you help us understand why the LA100 Limited New Transmission scenario is cheaper than the Transmission Focus scenario?
    - *A (NREL): The Limited New Transmission scenario relies more on customer PV offsetting some electricity, however there are additional distribution infrastructure costs that are not covered in the LA100 Study cost estimates.*

- Lessons learned should be taken from Europe and their ongoing power crunch as a result of reducing nuclear, and also due to import constraints on natural gas pipelines. Power reliability is very important for community progress and health. Since power in L.A. is reliable at the moment, it is easier to push for aggressive ideals, however this is engineering and solutions to achieve greenhouse gas emission reductions should only be considered feasible after reliability has been taken into account.
- What is the total cost to consumers when installing residential rooftop solar?
    - *A (NREL): Projections in the LA100 Study were made via the dGen model. Basically, each individual customer was modeled and the model's objective was to model each individual customer adoption by themselves, not the utility imposing this. We do not have the costs readily available, but they are in the public reports. In the model, customers choose to adopt solar because it was beneficial to them, not necessarily because the utility was paying for the systems.*
- The scenarios assume many power purchase agreements. What are the capital expenditures for the entities supplying power via such power purchase agreements?
    - *A (NREL): We do not have these costs readily available, but they may be available in the public reports. In the LA100 Study, we did look at how much certain deployments would cost on a $/kW, $/kWh basis, but the focus was LADWP.*
- You mentioned 2.8 GW - 3.9 GW for the local solar goal, but only mentioned net-energy metering. Was the Feed-in Tariff (FiT) program included in that goal, given commercial and industrial rooftops represent a large portion of in-basin solar capacity? It would be helpful to know what the commercial and industrial goals are.
    - *A (NREL): The LA100 Study did not model local solar goals or programs like FiT, explicitly. Instead, the results are all modeling outcomes from a combination of our customer solar model from the customer perspective, as well as our capacity expansion model from the LADWP perspective. The following link allows the public to explore results from the LA100 Study and toggle between scenarios, deployment versus technical potential, and sectors such as residential vs commercial and industrial: https://maps.nrel.gov/la100/data-viewer?Theme=distribution-grid&SubTheme=rooftop&Resolution=tract&LoadScenario=high&RpmScenario=dist&LayerId=distribution.local-solar-rooftop-deployment-potential&Year=2045&Variable=pv_kw*
- Concerns regarding the transmission feasibility of importing into the LA Basin all of the geothermal resources prescribed in the LA100 Early and No Biofuels scenario. In particular, the "Green Path North" transmission line to CA's Imperial Valley geothermal resources was defeated long ago.
- Are there contingency scenarios on the very significant potential load growth that may result from electrification of the port, airports, as well as medium and heavy-duty vehicle sectors?
    - *A (NREL): The moderate, high, and stress load scenarios in the LA100 Study do capture some of these considerations.*
- Appreciation for NREL presenter's thoroughness on result caveats and modeling assumptions, as modeling is generally for insights and not numbers.
- Concerns regarding potential hinderances to electrification in LADWP territory, as a result from obstacles for electric vehicle (EV) fast charger deployment by major EV

infrastructure developers, when compared to areas outside of LADWP service territory. Also concerns regarding impact to customer rates.

- Will this SLTRP process cover the steps LADWP and L.A. in general can take to dive into the electrification potential noted by others?
    - *A: The SLTRP process will provide insights and set various goals and funding, such as for electrification programs, which would then drive our program development teams to develop programs to meet those targets. For example, the 2017 SLTRP analyzed a "base" and a "high" electrification scenario, and the "high" scenario was ultimately adopted as the recommended scenario. We then use the SLTRP to plan our programs towards meeting those goals. Since 2017 EV projections have increased dramatically, so we will re-assess various levels this year as part of the 2022 SLTRP.*
- Commercial, industrial, and retail solar in L.A. is the fastest to achieve and is about 7 GW out of a 9 GW potential.

5. Green Hydrogen in LA

- Greg Huynh, LADWP Intermountain Power Project Operating Agent Manager, and Aaron Guthrey, LADWP Engineer of Generation Station and Facilities Engineering, led a presentation on green hydrogen efforts by LADWP, focused on achieving the last 10% of carbon-free generation. Huynh also presented Kevin Peng, LADWP Manager of External Generation – Generation and Hydrogen, and Roberto Gonzalez, LADWP Supervisor of Long Duration Energy Storage. Guthrey's presentation focused on providing an overview of green hydrogen, the need for large-scale energy storage, challenges with the technology, and LADWP's in-basin efforts. Huynh's presentation presented an overview of green hydrogen efforts with the Intermountain Power Project Renewed.

- Guthrey described the properties of hydrogen, including being the most abundant element in the universe, as well as a colorless, odorless, and tasteless gas. With regards to potential hydrogen fuel sources, the colors brown, gray, and blue were introduced to describe hydrogen derived from fossil fuel sources through processes such as gasification and reformation of coal or lignite (brown hydrogen), steam methane reformation of natural gas (gray hydrogen), and carbon capture and sequestration during gasification of natural gas (blue hydrogen). For hydrogen derived from renewable sources, electrolytic green hydrogen refers to hydrogen produced from splitting the water molecule via the electrolysis process powered through renewable energy. The option for gasification and reformation of biogas or biomass also exists under the category of non-electrolytic green hydrogen.

- An overview was given of green hydrogen as a potential renewable fuel substitute for natural gas in gas turbines, which essentially operate similar to a jet engine. The benefits are that green hydrogen would present an option for renewably-fueled dispatchable capacity without any carbon emissions, however several technical challenges would have to be addressed as the technology matures for power generation applications.

- In addition to presenting an option for renewably-fueled dispatchable capacity, green hydrogen can also be used as an energy storage medium, and unlike present-day battery storage solutions, can potentially address multi-day and seasonal energy storage needs. The main principle would be to take excess renewable energy such as solar and wind during times of the day when it is surplus to the load, use that renewable energy to drive the electrolysis process that splits the water molecule into hydrogen and oxygen, and then store the renewable hydrogen fuel for days, weeks, or months, until the power system has needs for dispatchable capacity such as during heatwaves, wildfires, or other extreme weather events, that traditional renewable energy resources may not be able to fulfill, during which the renewable hydrogen fuel would be used to operate a combustion turbine. When compared to other energy storage system technologies such as batteries, compressed air, and pumped hydro storage, green hydrogen is expected to have a lower efficiency, however compensates with providing a longer duration that can extend beyond hours into possibly days, weeks, and months.

- Some current challenges with using green hydrogen as a fuel include technical challenges such as the requirement for massive storage volumes due to the low volumetric energy density of hydrogen (in addition to lack of appropriate pipelines and available space), embrittlement, challenging combustion characteristics, and potentially higher levels of nitrogen oxides (NOx). In terms of logistics and economics, challenges also exist such as sourcing green hydrogen at the necessary quantities, enabling multi-sector coordination to develop a green hydrogen market at scale, and the high costs that currently price green hydrogen at approximately ten times higher than natural gas.

- With regards to needs for in-basin generation, the LA100 Study determined that upwards of approximately 2,000 MW of in-basin dispatchable capacity, spread across all in-basin generating stations, would be required to maintain a reliable power system. That capacity can be potentially fueled with green hydrogen or biofuels. As a result, LADWP has advertised a Request for Information (RFI), inviting current industry leaders to respond on potential solutions and strategies for in-basin green hydrogen, for LADWP to take into consideration. The Request for Information covers LADWP in-basin generating stations including Scattergood Generating Station hydrogen power capacity, the potential for retrofits of existing natural gas combustion turbines to run off green hydrogen, options for new green-hydrogen combustion turbines, technology considerations in relation to different segments of the green hydrogen spectrum (production, transportation, storage, and end use), as well as considerations for safety and environmental stewardship. LADWP expects to receive and begin to evaluate responses towards the end of 2021. LADWP also continues to partner with national and international organizations such as the Low-Carbon Resources Initiative, the Green Hydrogen Coalition, HyDeal Los Angeles, and others, in hopes of advancing the state of the science with regards to the potential benefits of green hydrogen as an option towards a decarbonized future.

- With regards to the Intermountain Power Project (IPP) Renewed, Huynh presented a background of IPP, including its current location in Delta, Utah, and commissioning in 1986 with an 1,800 MW coal-fired generating station at the heart of the project. Moving forward as part of IPP Renewed, the existing coal units will be retired by 2025, and replaced with a downsized 840 MW generating station that will be capable of using increased levels of green hydrogen as the technology permits, and play a significant role in long-term energy storage. IPP Renewed will be one of the first projects nationwide, to attempt to operate a power plant of such size, incorporating utilization of green hydrogen. Additionally, IPP Renewed will provide dispatchable energy to maintain reliability and support the critical high-voltage direct current transmission system that allows for the increased import of renewable energy from the Utah geographical area to Los Angeles.

- Expanding on the unique characteristics of IPP Renewed, Huynh emphasized the geographical opportunity for the project as it sits in a confluence of renewable energy resources, with over

2,300 MW of current solar interconnections in queue, and a potential of up to 1,500 MW of Wyoming wind. For this reason, IPP is often considered the "Western Renewable Energy Hub". A key additional characteristic unique to IPP Renewed are the underground salt domes at the location, suitable for storing green hydrogen. It has been estimated that one cavern may store up to 5,500 tons of green hydrogen and holds enough volume to fit the Empire State Building. Furthermore, it is estimated that the development of over 100 such caverns may be possible in the area, presenting an opportunity for energy storage with seasonal shifting characteristics.

- With regards to the combustion turbines at IPP Renewed, the project will consist of two M501 JAC gas turbines (to be supplied by Mitsubishi Hitachi Power Systems) in a combined cycle configuration. In 2025, it is expected that these turbines will be capable of incorporating green hydrogen as 30% of the volumetric fuel blend, with hopes of reaching technological advances that permit for a fuel blend comprised 100% via green hydrogen in the future. In order to get to combustion turbines that allow for fuel blend that consists 100% of green hydrogen, several milestones that need to be reached include development of combustor technology, as well as modifications to balance of plant equipment and infrastructure to support 100% green hydrogen. Presently, the IPP Renewed team is designing a plant layout that will take into account considerations for future hydrogen equipment, as well as installing flexible green hydrogen and natural gas fuel mixing systems, in order to future proof the project in preparation for a full transition to green hydrogen.

- Current combustor technology can support stable operations with incorporation of up to 30% green hydrogen by volume, at such a large scale. High concentrations of hydrogen currently present technological challenges of NOx emissions, flashback, and flame stability, however improvements to the heat recovery steam generator will help reduce NOx emissions below regulatory limits. As such, major research and development investments are being made to improve performance and prevent component damage.

- Huynh also went over a predicted operating profile for IPP Renewed under a fuel blend with a 30% volumetric composition of green hydrogen, and it showed that the energy storage cavern (underground salt dome) would essentially store green hydrogen electrolytically-produced from excess renewables during the spring months, and in the late summer through winter months, the stored green hydrogen would be used to power the combustion turbines and maintain system reliability.

- In terms of a timeline, Huynh explained that although the manufacturer currently estimates to have 100% hydrogen-ready turbines by 2040, they are working to accelerate the implementation of this to 2035 to align with the accelerated timeline for a 100% carbon-free power system. With technology maturity in the industry, there is also an expectation that the cost of electricity produced from green hydrogen will drop over time, resulting in a greater cost-effectiveness to compete with resources such as natural gas. Next steps for IPP Renewed include completing 3rd party negotiations for 30% hydrogen by volume, with anticipation of awarding a Hydrogen Supply Project agreement by December 2023.

- In summary, several takeaways from Guthrey and Huynh include:

    - Green hydrogen provides a potential pathway for renewably-fueled dispatchable generation

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

- <u>Major Themes from Advisory Group Member Discussion and Questions</u>
  - How adjustable will the IPP fuel blend be? Will the hydrogen/methane mix be adjustable on a daily basis (e.g. if the hydrogen supply has an outage)?
    - *A: Great question. The turbines can take dual fuels very well and the percentage of hydrogen can be dialed up to and from 30%. It cannot happen instantaneously of course, but we are working with the manufacturers on the capabilities and steam guide sheets will be provided to the operators on how to operate the units.*
    - *A (NREL): Not speaking for LADWP, but NREL modeled hydrogen combustion turbines with similar characteristics as natural gas-fueled combustion turbines. They can be started and stopped pretty fast, and have relatively low turn-down rates. A little more care may be desired during starts and stops to make sure the emissions controls are working properly. If you want to see how hydrogen combustion turbines are used (and not used) in one of the NREL scenarios, below is a link that shows a Fall day with low wind. The plants run overnight, but when the sun comes up they are turned off completely* *https://maps.nrel.gov/la100/data-viewer?Theme=xmission&Resolution=rs&LoadScenario=moderate&RpmScenario=la_leads&LayerId=xmission.generation-dispatch&Year=2045&Variable=mw&TemporalResolution=hourly&TimePeriod=fall*
  - The politically-determined goal of 100% carbon-free by 2035 should be a matter of public policy debate.
  - If solar is plentiful, and the caverns are full, how far can we turn down the turbines and operate directly on solar?

6. 2022 SLTRP - Key Considerations and Potential Scenarios

- Lim opened up the discussion on key considerations and potential scenarios for the SLTRP. As previously mentioned, actual scenario implementation was not fully vetted through the LA100 Study, thus the 2022 SLTRP process was charged with developing a practical roadmap for LADWP's power system, knowing where generation needs to be maintained for 24/7 reliability.

- A summary of Advisory Group feedback received to date was presented, with high-level categorization of stated SLTRP priorities as follows:

  - Path/trajectory towards stated goals (29%)
  - Risk assessment (18%)

- Rates (15%)
- Customer Programs (11%)
- Reliability (9%)
- Other (5%)
- SLTRP Process (4%)
- GHG Emissions (3%)
- Green Hydrogen (3%)
- Resiliency (3%)

- The top priorities three priorities appeared to be path/trajectory towards stated goals, risk assessments, and rates, thus the AG was encouraged to start thinking about potential scenarios that could align with addressing these.

- Furthermore, Lim reiterated the guiding SLTRP principles of environment and equity, reliability and resiliency, and affordability and rate impacts, highlighting the criticality of implementation risks for potential scenarios in this year's SLTRP, pertaining to the following topics:

  - Build rates and deployment
  - Local capacity requirements
  - Reliance on emerging technologies
  - Permitting timeline
  - Workforce developments
  - Once-through cooling retirement deadlines

- In specific, Lim highlighted the monumental annual build rates required of approximately 629 MW of renewable energy resources coupled with energy storage (out-of-basin), 342 MW of solar coupled with storage (in-basin), and 175 MW of dispatchable hydrogen turbines (in-basin), as prescribed by the LA100 Study, to achieve 100% carbon-free by 2035.

- Additionally, Lim explained that the 2022 SLTRP will update the set of resources for consideration after updated capacity expansion modeling with updated loads. Capacity is critical for reliability, resiliency, power flows, and allows LADWP flexibility to take the necessary outages to build the transmission required to decarbonize. Depending on the load scenario, by 2035, approximately up to 3,400 MW of in-basin dispatchable capacity would be required, but this grows up to 5,500 MW by 2045 to sustain 100% carbon-free. This would really require a ramp of build rates, requiring a transformation of over 2,000 MW in just five short years, between 2030-2035. To mitigate risk, LADWP may be able to build earlier, such as through projects like a green hydrogen-capable unit at Scattergood Generating Station. Over the next several meetings, scenarios will continue to be refined with input, feedback, and recommendations from the Advisory Group.

- With respect to potential 2022 SLTRP scenarios, Lim presented the following three for AG input and feedback:

  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

- Lim also proposed the following sensitivities to be studied by the project team:
  1) High transportation and building electrification loads
  2) Low/high fuel prices
  3) Low/high energy storage prices

- In reviewing the scenarios, Lim described Scenario 2 as giving LADWP latitude and flexibility to focus on renewable energy projects and mitigating risks by incrementally and prudently phasing in the last ~10% of power system decarbonization. LADWP would maintain non-ocean-cooled units such as existing peakers, which studies indicate would only be used ~5% of the time, in order to decarbonize properly.

- With respect to upcoming meetings, poll results from AG Meeting #2 were shared, indicating AG interest in learning more about the following program/project topics:

  1) Transportation and building electrification (~35%)
  2) Energy efficiency (~23%)
  3) Demand Response (~21%)
  4) Customer-sided energy storage (~14%)
  5) Local solar (~7%)

- The top program topics were transportation and building electrification, energy efficiency, and demand response. The project team proposed to bring some of those program groups to present to the AG in future meetings and continue the dialogue. Lim also referenced the powerSLTRP@ladwp.com email address available for further input.

- Major Themes from Advisory Group Member Discussion and Questions
  - Concern and surprise at seeing reliability topics only comprise ~9% of the AG poll responses.
  - Underwater transmission between the in-basin generation stations may help reliability. This requires direct-current transmission though and the converter stations required at each end have high fixed costs and are expensive.
  - Positive feedback on scenarios, but suggestion to rename them.
  - Clarifying question about Scenario 2 vs 3: What is the difference between 100% based on sales vs generation?
    - *A: The current law defines the Renewable Portfolio Standard (RPS) to be based off of retail electric sales, however utilities normally overgenerate by about 10-12% in order to bring energy to the load centers while accounting for system losses. By "Generation" means that every single kWh is renewable or carbon-free, whereas the RPS means 100% of retail sales are based on renewable and carbon-free resources, but there is more of a buffer on how to compensate for the system losses.*

- Interest in seeing a potential "equity priority" scenario and a "no in-basin hydrogen" scenario.
- Interest in seeing demand response to incentivize consumers to be more efficient, as well as more community solar that can also provide grid flexibility and resilience.
- In the future, we need more opportunity for group input, even if input by text. These sessions are entirely watch and listen.
- If City Council is mandating Scenario 3, which is more aggressive than Scenario 2, why are we considering Scenario 2?
    - *A: We do recognize the City Council motion instructs LADWP to achieve carbon-free by 2035, but as we look at AG interest as well as implementation challenges, Scenario 2 gives us flexibility to address "what-if" situations should hydrogen technology not be fully mature in time, as well as other options. Modeling Scenario 2 will also provide insight as to how much we are paying for the last 10% of power system decarbonization. This was studied indirectly via the LA100 Study, but it was not an "apples-to-apples" comparison. Prudently, it is our fiduciary duty to go through such a process and analysis in regards to what how ratepayer money is spent.*

7. Discussion and Polling

- Continuing the scenario discussion dialogue, the AG was polled for their thoughts on the potential scenarios presented today by the project team, as well as additional scenarios or elements they would recommend to bolster the draft scenarios presented.

POLLING RESULTS[2]

Question #1: Do the draft scenarios presented by LADWP today capture the full spectrum of the Advisory Group's interests and priorities for the SLTRP process?

- Total Responses: 10
    - Yes - 4 responses
    - No - 6 responses

Question #2: If you selected no, what additional scenarios or elements would bolster the draft scenarios presented by LADWP today?

1. If City Council is mandating option 3, which is more aggressive than option 2, why are we considering option 2?
2. Scenario without last 10% which seems to be most costly.
3. Look at various demand scenarios re pace of electrification in transportation and building sectors; seems like that has huge impact on pace and magnitude of increased power needs.
4. Shouldn't we be analyzing multiple different scenarios that all meet the requirements from LA City Council, rather than looking at options that don't meet it?
5. Option 2 and 3 should be the same for all contracts up to a certain decision date, and that date should be made clear.
6. While I like the three options provided, they do not include DIVERGENCE from the political direction to the Department. As an independent engineering business, if there are impracticalities in the

[2]Comments and poll results shown are informal and should not be considered a representative nor complete illustration of the Advisory Group's opinion at large.

politically-directed goals, or if achieving those goals will cost ratepayers too much for them to reasonably bear, those political directive should be questioned.

7. LA100 pointed out there is a risk that climate change will affect renewable production. I would like to see this risk modeled. The risk is to concentrate solar or wind installations in a location that may have decreased radiance or wind in the future.
8. Look at sales scenario with a continued decline in load.
9. Ok.
10. Also, what is the risk in rates if widespread electrification does not materialize.
11. Analyze one pathway so easier to understand.
12. Yes.
13. Impact of growing opposition to large-scale solar and wind on undisturbed lands, and mining for materials needed for electrification.
14. A possible equity priority scenario and a no in-basin hydrogen scenario.
15. Analyze more pathways to better understand contingencies.
16. The scenarios should all be within the scope of the city council motion. The scenarios can have separate electrification demand, no in basin gas or hydrogen. Multiday demand response scenario.
17. More scenarios are always good but better to focus on revisiting and testing underlying assumptions in various scenarios.
18. Can we use scenarios to look at the effect of rate design on cost?
19. The recent AG interest is the importance of electrification of transportation and building to maximum GHG reduction and health benefits, the goal of 100% versus a lower level, or the use of RECs, should be considered in terms of spending more on EVs etc. to maximize GHG reduction.
20. Community based solution scenario!
21. Sorry I missed the other questions.
22. Can you post them again?
23. When will this presentation be posted? Also for meeting #2.
24. Contingencies in load level, technology and its cost, renewable performance...

8. Wrap Up and Next Steps

- Next meeting will be on Friday, October 22, 2021 (10am-12pm) and will go deeper into various LADWP programs of interest such as transportation electrification and energy efficiency. The meeting material and summaries will be available on the website after review.

Next Meeting: Friday, October 22, 2021; 10:00 am-12:00pm, WebEx Platform (Virtual)