The Los Angeles 100% Renewable Energy Study

Los Angeles 100% Renewable Energy Study

Advisory Group Meeting #12

July 9, 16, 23, 30, and August 6, 2020

Meeting Summary[1]

Meeting Notes Compiled by Kearns & West

Location

Virtual Meeting

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Virtual Session #1

Thursday, July 9, 2020, 10:00 a.m. to 12:00 p.m.

[1] This summary is provided as an overview of the meeting and is not meant as an official record or transcript of everything presented or discussed. The summary was prepared to the best of the ability of the note takers.

Los Angeles Department of Water & Power | NREL Transforming ENERGY

Virtual Session #1 Attendees

Advisory Group Members

Adam Lane, Los Angeles Business Council
Allison Smith, Southern California Gas
Amanda Pantoja, Food & Water Action
Andy Shrader, Council District 5

Bonny Bentzin, University of California, Los Angeles (UCLA)
Bruce Tsuchida, The Brattle Group
Camden Collins, Office of Public Accountability (Ratepayer Advocate)
Carter Atkins, Los Angeles World Airports
Christos Chrysiliou, Los Angeles Unified School District
Dan Kegel, Neighborhood Council Sustainability Alliance
Duane Muller, UCLA
Frank Lopez, Southern California Gas
Fred Pickel, Office of Accountability (Ratepayer Advocate)
Jack Humphreville, DWP Advocacy Committee
Jasmin Vargas, Food & Water Action
Jean-Claude Bertet, City of Los Angeles Attorney
Jim Caldwell, Center for Energy Efficiency and Renewable Technologies
Kendal Asuncion, LA Chamber
Lauren Harper, Los Angeles Cleantech Incubator
Liz Anthony Gill, Center for Energy Efficiency and Renewable Technologies
Luis Amezcua, Sierra Club
Matt Hale, Council District 2
Michael Webster, Southern California Public Power Authority
Mike Swords, Los Angeles Cleantech Incubator
Priscila Kasha, City of Los Angeles Attorney
Ralph Krager, Southern California Power Authority
Sergio Duenas, California Energy Storage Alliance
Tony Wilkinson, Neighborhood Council

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Jimmy Lin
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Paul Schultz
Scott Moon
Stephanie Spicer

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Doug Arent, NREL
Garvin Heath, NREL
Jaquelin Cochran, NREL
Meghan Mooney, NREL
Paul Denholm, NREL
Ramin Faramarzi, NREL
Scott Haase, NREL
Vikram Ravi, NREL
Joan Isaacson, Kearns & West
Taylor York, Kearns & West
George Ban-Weiss, University of Southern California (USC)
Jiachen Zhang, USC

Observers

Bill Engels, Water and Power Associates
Elaine Ulrich, U.S. Department of Energy Solar Office
Ethan Senser, Food and Water Action
Li Yun, USC
Priya Sreedharan, GridLab
Steve Ruiz
Zelinda Welch, USC

Call to Order and Agenda Overview

Joan Isaacson, LA100 Advisory Group meeting facilitator from Kearns & West, welcomed all the virtual meeting attendees. She noted that this was the first of five virtual sessions that compose Meeting #12 of the Advisory Group. She noted that this session would address pathways to achieving 100% renewable energy, including emerging insights and opportunities. NREL is also seeking input on a set of focused questions on priorities.

Greg Huynh, LADWP Manager of the 100% Clean Energy Innovation Group, welcomed Advisory Group members to the virtual session and thanked them for their time and participation. He noted that LADWP is

excited to see the product of NREL's work, which will explore different pathways, economic implications, and tradeoffs of a 100% renewable energy grid. He highlighted subsequent session topics, which will include environmental, job, and distribution impacts, among others.

Jaquelin Cochran, NREL LA100 Principal Investigator, welcomed Advisory Group members, thanked them for their participation, and highlighted the importance of hearing Advisory Group member perspectives. She provided an overview of topics for each session of the Advisory Group Meeting #12 series, noting that the current (July 9) session would provide a bulk system perspective, focusing on large scale investments needed to achieve 100% renewable energy, and provide a broad overview of methods and considerations across the different scenarios. Subsequent sessions will cover jobs and economic analysis (July 16), environmental analysis (July 23), and distribution analysis (July 30). A question and answer session is also planned (August 6).

Isaacson noted that Advisory Group meetings are open to the public but asked that discussion during the sessions be reserved for Advisory Group members. However, public feedback on the study is welcome and encouraged. Comments can be emailed to the project team at ashkan.nassiri@ladwp.com.

Slides from all presentations are available on the LA100 website.

Evaluating Bulk-System Pathways to 100% Renewable Energy

Cochran introduced Dan Steinberg, NREL Senior Researcher and Group Manager, who is leading the work on bulk-system analysis. She noted that outputs from bulk system modeling are core to the study and are used to inform other modeling.

Cochran highlighted the importance of feedback from the Advisory Group. NREL has modeled pathways to reliable 100% renewable energy but still needs feedback from Advisory Group members on priorities to shape the final analysis. Specific questions to guide Advisory Group member feedback include:

- What is your vision for this transition to 100% renewable energy?
- How can NREL enable your vision and values to be considered in decision-making that emerges from this study?
- What additional analysis can we do to inform decisions?

Cochran then provided an overview of where Advisory Group #11 meetings left off, which can be found in the presentation slides for this session and in the Advisory Group Meeting #11 summaries available on the LA100 website.

Steinberg then started his presentation, first reviewing four different topics during the session, including options for providing peaking capacity, bulk system modeling results common to all scenarios, results by scenario, and system costs. He provided a quick recap of different scenarios and noted that, although the LA Leads scenario does not allow combustion of biofuels, it does allow combustion of hydrogen starting in 2030. He also addressed an additional option for the Transmission Renaissance case, related to development of a direct current (DC) backbone option.

Transmission Renaissance: DC Backbone Option

The Transmission Renaissance scenario assumes a future with increased feasibility and lower costs of development of transmission. In addition, NREL assumes the development of a DC transmission backbone, reported Steinberg. This system would provide DC connections to resources located outside of the basin and make interconnections for major in-basin generation sites that already have robust transmission systems.

Options for Peaking Capacity and Associated Infrastructure Requirements

Steinberg next explained that peaking capacity can be built both in- and out-of-basin. In-basin peaking capacity, however, is highly valuable for system reliability in achieving the 100% renewable target. Steinberg summarized a set of generation technology options, highlighting fuel source, storage options, feasibility for in-basin siting, and net emissions. Technologies include combustion turbines, fuel cells, geothermal energy, and concentrating solar power with thermal energy storage. He noted that fuel storage is crucial to ensure the availability of peaking plants on-demand.

Combustion turbine technologies operating on liquid biofuel, biogas, and renewably derived methane provide the most mature, ready-to-deploy options for addressing peaking capacity in the near-term. Storage for these types of fuel is simple, requiring very few changes to existing infrastructure. Options include inexpensive on-site tanks, pipeline networks, and cavern storage. Combustion of hydrogen presents challenges in the near-term, as combustion turbine technology is not readily available, and hydrogen is difficult to store. One option is to convert hydrogen to ammonia, which can be more easily stored.

Fuel cell technologies provide benefits over combustion in emissions but face the same storage and transport challenges as hydrogen combusted in turbines, said Steinberg. Geothermal energy can be sited out-of-basin only, which requires more significant transmission capacity. Steinberg reviewed examples of siting for the various options, noting variances and considerations for site space, energy density, and storage or production of fuels on site. He also highlighted how the generation options are captured in the modeling. Renewable Combustion Turbine (RE-CT) options assume market-supplied fuel, and analysis of these options does not include electricity required to produce fuel on site. Hydrogen Combustion Turbine Options (H2-CT) and fuel cell options assume self-produced fuel using an electrolyzer.

Major Themes from Advisory Group Member Questions and Discussion

- Although existing natural gas storage fields could be considered an option to store hydrogen, LADWP should use caution and choose operators wisely, as these facilities have been known to leak. Two examples of studies were provided by an Advisory Group member: https://www.osti.gov/biblio/975258 and https://core.ac.uk/download/pdf/43717954.pdf.
- Further information was requested on timing and space considerations for the different generation options presented, including tradeoffs related to the cost of developing new transmission.
- Renewable natural gas and combustion turbines utilizing any fuels are not a good solution. If siting these in-basin, consideration should be given to environmental justice communities.
- Is NREL capturing cost efficiency when converting hydrogen to ammonia and back?
- There may be options to expand existing transmission lines on a shorter timescale than 2035.

Common Results Across Scenarios

Next, Steinberg discussed the role of wind and solar as crucial generation sources across all scenarios, with large-scale development occurring irrespective of the pathway. Distributed photovoltaic solar is also a large component in the near-, mid-, and long-term. Short duration storage stores excess energy produced during the day, shifting supply to times of deficiency, though this storage is not enough to meet demand at all times and peaking generation is still required in all scenarios. All scenarios have both in- and out-of-basin generation, with most utility-scale wind and solar developed out-of-basin. A greater portion of peaking generation is developed in-basin.

Results by Scenario

Steinberg provided an overview of assumptions for each scenario, then highlighted results for both capacity mix (amount and type of energy that can be produced) and annual generation (what energy is actually produced to meet load).

SB100

The SB100 scenario assumes compliance with California SB 100, capturing policy constraints and allowing for the use of Renewable Electricity Certificates. The scenario assumes Once-Through-Cooling (OTC) units are retired by 2030 and non-OTC natural gas units are retired by 2045, explained Steinberg. Transmission in and around the basin is assumed to be expensive through 2045, to reflect barriers to upgrading existing lines. For capacity mix, a decrease in existing natural gas use occurs between 2020 and 2030 due to retirement of OTC units. This shift prompts use of combustion turbines, which are assumed to be fueled by market-purchased biofuel. Some geothermal capacity is built out-of-basin. Though different types of peaking assets show up in the generation mix, their contribution to annual generation is low, as is typical for peaking plants.

LA Leads

Steinberg explained that the LA Leads scenario assumes early compliance with the 100% target and cannot use in-basin biofuel combustion. Because in-basin combustion is not allowed, replacement of OTC units involves increasing wind, solar, and geothermal capacity, as well as short- and long-duration storage in the form of batteries and hydrogen-CTs. Generation mix changes significantly during the 2030–2035 timeframe with retirement of OTC units and replacement by variable generation and geothermal. The scenario also builds offshore wind, which would connect to Scattergood via marine DC cable and effectively serve as in-basin generation.

Additionally, NREL modeled two types of sensitivities for the LA Leads case — one assuming increased feasibility of new transmission, and the other assuming that high costs for hydrogen continue to 2035. Increasing the feasibility of transmission shifts capacity to out-of-basin, and high hydrogen costs drive further deployment of in-basin connected offshore wind and photovoltaic capacity.

Transmission Renaissance

This scenario looks very similar to SB100, with the exception of the 2045 timeframe when no natural gas generation is allowed, said Steinberg. This scenario leads to greater deployment of out-of-basin wind and utility-scale solar, although significant capacity is still deployed in-basin.

High Distributed Energy Future

Steinberg then talked about the High Distributed Energy Future scenario's greater deployment of wind generation. Because the value of out-of-basin solar is decreased, alleviating stress on transmission lines and allowing higher generation from other types of resources (e.g., wind) out-of-basin. Combustion turbines are still used to meet peaking capacity. For this case NREL also modeled a sensitivity allowing for development of the DC backbone.

Major Themes from Advisory Group Member Questions and Discussion

- Hydrogen storage is successfully conducted in the Gulf of Mexico region, and could be researched for LA100.
- Are all natural gas units intended to be shut down by 2035, or could they continue to operate on renewable fuel?
- In what geographic location would offshore wind be sited? There may be challenges in siting these turbines given restrictions placed by the Navy.
- Was tidal generation considered, and is implementation more feasible given its minimal impact to the coastline?
- Slides showing capacity mix and annual generation are confusing.
- Is there a way for Advisory Group members to adjust generation sources or mix and match scenarios to further refine scenarios?
- The options presented are more complicated than needed; there are simpler options.
- Lack of in-basin baseload generation in all options is a concern. If Victorville to Los Angeles transmission lines get damaged the City will lose electricity.
- Does modeling show generally where new transmission investment is needed and the amount of transmission that would be needed?
- What are the reliability implications of greater reliance on transmission?

System Costs

Steinberg reviewed results for costs, which are displayed in slides 54 to 58 of the meeting presentation. System costs are broken into four categories: capital, fixed operations and maintenance, fuel, and variable operations and maintenance. Estimates include generation, storage, and transmission costs for the bulk system, and capital and fixed operations and maintenance costs for customer-owned distributed generation. Estimates exclude existing debt on capital expenses, distribution system costs, and costs of energy efficiency and demand response programs.

There are significantly higher costs associated with reaching 100% renewable energy sooner. The study to date utilizes supply-side oriented engineering approaches, which do not have the capability to identify potentially cost-effective means to reduce costs through options other than new generation, storage, and transmission. Exploring further options for compliance may allow substantially reduced costs and provide community, environmental, and social benefits. Examples of this include more innovative, multiday demand response programs, cost-optimal 100% decarbonization that extends beyond the electric sector, and creative, advanced transmission.

Major Themes from Advisory Group Member Questions and Discussion

- Is LADWP incurring customer photovoltaic costs? What are they?
- Information on renewable penetration for each scenario in 2030 would be useful.
- Does the study assume any additional "hardening" of the system due to wildfire or additional undergrounding of lines?
- In the long run, LA Leads will be the cheaper option. LADWP should spend the money to address climate change and to accelerate the transition.
- There was interest in discussing impacts of creative options for compliance.
- Scenario cost presented as annualized cost is very helpful, but it would also be helpful to examine costs in terms of cashflow over time. This would make estimating costs for future changes much easier.
- What long-term storage options are included in the scenarios?
- Does the Advisory Group provide input on how scenarios are blended? Is there a public engagement component?
- Will LADWP discuss rate impacts of the various scenarios?
- There was concern that the transition to renewable energy would create high-cost electricity, discouraging electrification and preventing emission reductions in other sectors such as transportation.

Wrap-up and Next Steps

NREL has prepared a public-facing website to display study results. This site will be published and password-protected ahead of public release, allowing Advisory Group members to review before it is made public.

Isaacson thanked Advisory Group members, noting that the next session for Meeting #12 would be held in one week.

Virtual Session #2

Thursday, July 16, 2020, 10:00 a.m. to 11:30 a.m.

Virtual Session #2 Attendees

Advisory Group Members

Adam Rose, University of Southern California
Agustin Cabrera, RePowerLA
Allison Smith, Southern California Gas
Amanda Pantoja, Food & Water Action
Andrea Rojas, Sierra Club
Armando Flores, Valley Industry Commerce Association
Austin Eriksson, California State University, Northridge
Ben Airth, Center for Sustainable Energy
Bonny Bentzin, University of California, Los Angeles
Bruce Tsuchida, The Brattle Group
Camden Collins, Office of Public Accountability (Ratepayer Advocate)
Christos Chrysiliou, Los Angeles Unified School District
Dan Kegel, Neighborhood Council Sustainability Alliance
Danielle Mills, American Wind Energy Association California
Dominique Hargreaves, Office of the Mayor
Duane Muller, University of California, Los Angeles
Elaine Ulrich, U.S. Department of Energy Solar Office
Fred Pickel, Office of Accountability (Ratepayer Advocate)
Jasmin Vargas, Food & Water Action
Jean-Claude Bertet, City of Los Angeles Attorney
Jim Caldwell, Center for Energy Efficiency and Renewable Technologies
Jin Noh, California Energy Storage Alliance
Kendal Asuncion, Los Angeles Chamber of Commerce
Loraine Lundquist, California State University, Northridge
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Lauren Harper, Los Angeles Cleantech Incubator
Lisa Yin
Salem Afeworki, City of Costa Mesa
Steve Ruiz

Call to Order and Agenda Overview

Joan Isaacson, LA100 Advisory Group meeting facilitator from Kearns & West, welcomed the virtual meeting attendees. She noted that this was the second of five virtual sessions that compose Meeting #12 of the Advisory Group. She thanked members for their commitment to the LA100 process, attendance at the Advisory Group meetings, and continued feedback on the process. She noted that this session would address jobs and economic analysis, and that the first part of the session would continue the July 9 discussion on methods for reducing costs and involving communities.

Welcome Remarks

Greg Huynh, LADWP Manager of the 100% Clean Energy Innovation Group, welcomed Advisory Group members to the virtual session and thanked them for their time and participation. He highlighted the valuable discussion from the July 9 session and encouraged continued engagement as the project team approaches final results. He noted that the July 16 topics are key to the study, adding that LADWP considers the clean energy sector to be a major economic driver.

Jaquelin Cochran, NREL LA100 Principal Investigator, provided an overview of topics for each session of the Advisory Group Meeting #12 series, noting that the current (July 16) session would include continued discussion of cost reduction strategies and address jobs and economic analysis. Subsequent sessions will cover environmental analyses (July 23), and distribution grid analysis (July 30). A question and answer session is also planned (August 6).

Continued Discussion on Cost Reduction Strategies

During the first session of the Advisory Group Meeting #12, the NREL team led a discussion on strategies that could be employed to reduce the high expected costs of moving to a 100% renewable energy system. These strategies could include revolutionary demand response, cost-optimal decarbonization beyond the electric sector, and creative transmission. Cochran noted that this input will not necessarily change the course of the modeling, but it can help to shape the reporting for the study. She asked Advisory Group members to comment on the strategies and to provide further suggestions for reducing costs.

Major Themes from Advisory Group Member Questions and Discussion

- Strategies that involve demand response should be completely automatic and standardized. Asking ratepayers to perform complex actions to reduce demand will not be effective. Incentivizing large customers to adopt battery storage on local solar may be more effective than demand response.
- Could a post-Covid-19 economy change LADWPs outlook on demand response, considering more people may be working from home? Has LADWP seen significant shifts in demand recently?
- Demand response interruptible load programs are normally used for peak heat days to address load, but consideration of these methods for cloudy days to address supply could be worthwhile.
- If set up correctly, demand response can be advantageous to electric vehicle owners.
- Could shutting down large loads during extended outages or low wind periods help address extended outages? Past efforts to address outages linked to dry years have included shutdown of direct connect industries, removing thousands of megawatts from demand for a period of 6 months or more.

- Taking credit for reduction in other segments of the economy should not be considered an effective method for reaching 100% renewable energy.
- The California Air Resources Board (CARB) is considering methods for direct air capture or carbon capture to address decarbonization in other sectors – something that LADWP could consider.
- What is the thinking behind overbuilding generation in all scenarios, and how did it occur given the modeling protocols? What are the plans for further investigation?
- It is essential that decarbonization in other sectors is cost-optimal, as decarbonization solutions can be expensive.
- Transmission technologies, such as direct current with voltage support, flexible alternating current, and other transmission power flow technologies, can help provide efficiency in the power system. Costs for these technologies have also decreased considerably.

LA100: Jobs and Economic Impact Modeling

David Keyser, NREL Senior Economist, provided an update on the jobs and economic impact modeling, including workforce implications of the LA100 scenarios. Keyser requested feedback from Advisory Group members on the relevance of this analysis, how it is communicated, and additional information that would be helpful. Modeling objectives include assessment of net impacts within the City of Los Angeles for the different scenarios, estimation of both positive and negative impacts, and estimation of workforce needs within the LADWP basin.

Keyser explained that NREL is using two different types of models for this analysis: the Computable General Equilibrium (CGE) and the NREL Jobs and Economic Development Impact (JEDI) suite. CGE is used to estimate net impacts, including negative economic impacts, addressing overall implications of each scenario. JEDI is used to estimate gross impacts, only accounting for positive changes and job creation, addressing detailed impacts associated specifically with the energy sector. Both models are needed and share an underlying set of data. Both models assume complex connections among sectors in the economy, with CGE addressing many components of the broader economy and JEDI addressing impacts specific to the LA100 scenarios. Both models consider three types of impacts, with CGE producing aggregate results and JEDI producing separate results for:

- Onsite Impacts – occur solely within impacted industries and tend to be physically at a location, e.g. solar installers and electricians.
- Supply Chain Impacts – occur throughout the supply chain, e.g. construction companies and hardware suppliers.
- Induced Impacts – accrue because of expenditures made by workers, e.g. if ratepayers pay more for electricity they may spend less elsewhere in the economy.

Both models present results aggregated across sectors (businesses/industries, households, investors, government, etc.), so this analysis does not address impacts in specific sectors. CGE results are aggregated in terms of overall impact, meaning the model does not present positive and negative impacts separately. For this analysis, results only show what is monetized in the capacity expansion modeling and do not include effects on non-monetized factors such as environmental or health. However, these factors will be addressed in a separate analysis.

Keyser noted that the data presented at this Advisory Group meeting session is not based on the most recent capacity expansion modeling results, due to the time required to set up and run these models. These interim results are meant to serve as an example of the types of results that will be presented in the final report. Keyser also noted that results are based solely on electricity supply and demand, and do not include impacts from energy efficiency. Because these results are meant to be illustrative, Keyser only presented results for the SB100 scenario, noting that updated results for all scenarios will be presented in the fall.

CGE Model Results

Keyser noted that the CGE model assumes changes in prices for electricity, assuming that these changes are needed to fund the investments in the capacity expansion modeling. The model assumes uniform increases in retail rates because rate changes that differentiate by customer class would be guided by policy decisions, which is beyond the scope of the analysis. The model considers existing LADWP debt, assumes ratepayers pay for implementation of the scenarios, and presents results by household income cohort.

For the SB100 scenario, the CGE results show minimal net negative changes in jobs, which are most significant initially but decline approaching 2045. Results show a net loss of 300 jobs, which Keyser noted is functionally zero when compared to such a large employment base as in Los Angeles.

Household income changes estimated by CGE indicate a net loss of $10 million up to 2045. Average percent changes in income are close to zero, but still more significant for lower income households than higher income households.

Next steps for the CGE model include input of final capacity expansion modeling results, said Keyser, and incorporation of construction and operations and maintenance job estimates produced by the JEDI model. This refinement helps results better represent renewable technologies and may cause results to change in either a positive or negative direction.

JEDI Model Results

Keyser explained that results for the JEDI model are in-basin and specific to LADWP, clarifying that out-of-basin impacts are not included. Results presented at this session are based on previous model runs, with changes expected in the final run reflecting significant levels of generation moved in-basin. These results are important because they address a large sector of the economy, including companies that hire workers and workers who may be considering working in this industry, which influences programs for training workers to fill these needs. A significant number of qualified students studying renewable and wind energy do not enter the field, resulting in a difficulty for wind energy employers to find employees. Recruiting challenges are greatest for scientists and trade workers, due to the length of education time needed and better opportunities in other sectors.

Keyser noted that jobs are driven by capacity results, illustrated by the highest number of jobs created by the LA Leads scenario and the lowest number of jobs under the SB100 High Load scenario. Importantly, these results are expected to change once updated capacity expansion model results are incorporated. Results are based on technologies used, as well as the location of construction. Keyser provided examples of other scenarios, noting that the model will also show construction and installation jobs and operations and maintenance jobs for solar and storage. In addition, the model will indicate jobs by type, including onsite, supply chain, and induced. He noted that earnings for workers in the solar and storage industry are above average.

Economic Estimates and Covid-19

Keyser reviewed a set of considerations for results in light of Covid-19, supported by a paper recently published by the University of Southern California entitled "Impacts on the U.S. Macroeconomy of Mandatory Business Closures in Response to the COVID-19 Pandemic". The JEDI model does not assume changes in the structure of the economy, so results are assumed to have occurred in the year of the economic data (2017). The CGE model does have the capability to change over time, but impacts of Covid-19 are not explicitly incorporated. These estimates are long term (2045) and impacts from Covid-19 are currently expected to be short or medium term.

Major Themes from Advisory Group Member Questions and Discussion

- LADWP could consider working with partners such as WattTime to offer incentives to EV drivers who charge their vehicles when carbon emissions are low.
- Presentation of jobs related to in-basin energy storage would be helpful.
- What is the expectation of increase in electricity cost for the SB100 scenario? Given that SB100 has a cost of $40 billion, it is hard to believe that energy expenditure would be moderate.
- Will results be identifying high-road jobs versus low-road jobs?
- What is the cost of the SB100 scenario relative to the 2017 Power Strategic Long-Term Resource Plan baseline? Including this information in all cost graphs would be helpful.
- Would job gains in the LA100 scenario decline once construction of the system concluded?
- Consideration of job quality and terms, as well as location with priority on EJ communities, is important.
- It would be useful to see actual jobs created per year to more clearly illustrate how jobs increase over time.
- Assuming nearly all wind development will be in other states, why is NREL's research on wind employees relevant?
- Why do jobs level out in the SB100 Moderate Load case and decline in the SB100 High Load case, while jobs in other scenarios continue to increase post-2040? Should demand growth increase in all scenarios?
- Is there a link between jobs for renewable energy and jobs for other infrastructure projects planned for the near future? Would that affect the project timeline?
- Does the economic modeling account for potential repowering of existing land-based wind sites or new offshore wind jobs?
- What are assumptions about jobs related to transmission build-out?
- A layperson explanation of economic models would be useful.
- How will LADWP ensure that jobs created are high-quality union jobs for workers who live in the communities that are receiving energy efficiency upgrades, electric vehicles, and solar with battery storage? If LADWP invests in communities and clean energy faster, the economy is stimulated.
- Higher costs of power could discourage electrification in the transportation sector because the "fuel" will cost more. There needs to be a balance between carbon savings from generation and from transportation electrification.

- Does the economic model include wages? Is there an implicit assumption between union and non-union jobs? These assumptions would be useful. Full-time equivalent salary input assumptions can be changed in IMPLAN as long as the modeler has the necessary data.

Wrap-up and Next Steps

Isaacson noted that the team could provide a deeper dive into this material if requested by Advisory Group members. She also noted that the next Meeting #12 session will take place on Thursday, July 23, and will focus on the LA100 environmental analyses.

Virtual Session #3

Thursday, July 23, 2020, 10:00 a.m. to 12:00 p.m.

Virtual Session #3 Attendees

Advisory Group Members

Allison Smith, Southern California Gas
Amanda Pantoja, Food & Water Action
Andrea Rojas, Sierra Club
Andy Shrader, Council District 5

Bonny Bentzin, University of California, Los Angeles
Bruce Tsuchida, The Brattle Group
Camden Collins, Office of Public Accountability (Ratepayer Advocate)
Dan Kegel, Neighborhood Council Sustainability Alliance
Duane Muller, University of California, Los Angeles
Elaine Ulrich, U.S. Department of Energy Solar Office
Ernesto Hidalgo, Neighborhood Council Sustainability Alliance
Fred Pickel, Office of Accountability (Ratepayer Advocate)
Jack Humphreville, DWP Advocacy Committee
Jim Caldwell, Center for Energy Efficiency and Renewable Technologies
Jin Noh, California Energy Storage Alliance
Kendal Asuncion, Los Angeles Chamber of Commerce
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Salem Afeworki, City of Costa Mesa
Steve Ruiz
Terra Weeks, California Energy Commission

Call to Order and Agenda Overview

Joan Isaacson, LA100 Advisory Group meeting facilitator from Kearns & West, welcomed the virtual meeting attendees. She noted that this was the third of five virtual sessions that compose Meeting #12 of the Advisory Group. She explained that this session would focus on the environmental analyses for the study, including presentations on environmental justice, air pollutant emissions inventories, and mortality and monetization methods.

Welcome Remarks

Greg Huynh, LADWP Manager of the 100% Clean Energy Innovation Group, welcomed Advisory Group members. He assured members that LADWP and the City of Los Angeles are continuing their work despite the current COVID-19 crisis, including negotiating new power purchase agreements. He noted that LADWP and the City have not scaled back commitment to renewables aligned with the LA 100% Renewable Energy Study.

Jaquelin Cochran, NREL LA100 Project Manager, welcomed Advisory Group members and thanked them for their continued dedication to weekly sessions. She provided an overview of the remaining topics for the Advisory Group Meeting #12 series, including a session focusing on distribution grid analysis (July 30) and a question and answer session (August 6).

Environmental Justice Updates

Cochran presented an overview of environmental justice themes that have emerged from Advisory Group member feedback during the LA100 study process, which include:

- Community outreach needs (e.g., meetings, partnerships with community organizations, accessibility of information in materials and presentations, public comment opportunities)
- Better incorporation of the range of environmental justice and community priorities as a framework for decisions emerging from the LA100 study
- Greater focus on specific outcomes from the LA100 study (e.g., access to high quality clean energy jobs, affordable rates, local renewable energy infrastructure, low-income resident programs).

NREL plans to address these themes in the following ways:

1. Better incorporate Advisory Group priorities and input into the framing of the analysis.
2. Organize and conduct community meetings that will broaden outreach, encourage discussion, and lead to a vision for Los Angeles' power system that is tangible and neighborhood specific. Outreach materials will be developed in late summer 2020 and will be discussed during the first session of the Advisory Group meeting #13 series.
3. Include specific information in the study about how the transition can be more inclusive of disadvantaged communities. It will be important to gather this information from community members.
4. Facilitate a framework for decision-making on investments and programs that connects analysis from the LA100 study with community priorities. For example, are there blends of scenarios that have broad support? Could information from outside the study be included to better support decision-making processes? What priorities emerge from community engagement?

Major Themes from Advisory Group Member Questions and Discussion

- Facilitation of community decision-making is appreciated. Of specific interest are themes related to energy needs and priorities.
- Although formal modeling is for the electric sector only, how does NREL plan to provide information related to environmental impacts of electrification in transportation/buildings where the load is embedded in the electric sector scenarios?
- NREL must play an objective role in this process.
- Though it may not be within the scope of the study, highlighting the top two health impacts of $PM_{2.5}$ and NO_x would be helpful.
- Climate impacts of LA100 need to be carefully considered in the study, e.g., the costs of addressing methane leaks.

Impact of LA100 Scenarios on Air Pollutant Emissions (First Step of Air Quality Modeling)

George Ban-Weiss, professor at the University of Southern California, provided an overview of possible impacts of LA100 scenarios on air pollutant emissions. This analysis is the first step in modeling overall air quality impacts for the study. The goal is to identify the affected sectors and air pollution source types that contribute most to overall air pollutant reduction, focusing on ozone and particulate matter. Ban-Weiss explained that ozone is a secondary pollutant formed in the atmosphere via chemical reactions and is not directly emitted by sources. Particulate matter is both directly emitted by sources and formed in the atmosphere. Air quality analysis for the LA100 study is guided by two overarching questions:

1. How could future scenarios of renewable energy adoption by LADWP change air pollutant emissions and concentrations in Los Angeles, focusing on ozone and particulate matter?
2. How could changes in ozone and particulate matter concentrations alter deleterious health consequences from air pollution exposure within the LADWP service territory?

Ban-Weiss noted that a set of five steps have been identified for addressing these questions. His presentation at this Advisory Group session focused on the first two steps:

- Constructing a model-ready emissions inventory from source-oriented raw emissions for "current" time (2012)
- Creating emissions inventories that project air pollutant emissions under selected LA100 scenarios for 2045

These two steps are the most time-consuming and critical components of the air quality analysis. An emissions inventory specifies where, when, and how much of each pollutant is emitted and can account for many pollutants. Total emissions can be estimated by multiplying the quantity of the activity (e.g., miles traveled, engine output, and fuel consumption rate) by an emissions factor (e.g., amount of emissions per mile, power output, or thermal units). The emissions inventory is based on the official 2012 South Coast Air Quality Management District (SCAQMD) dataset, which is the most recent, publicly available, source-oriented set. This dataset includes more than 5,000 specific source types and allows for modification of source types that change in the LA100 scenarios.

Ban-Weiss described the four scenarios that will be simulated to estimate the impacts of future renewable energy adoption. These include LA Leads Moderate Load Electrification, LA Leads High Load Electrification, and SB100 High Load Electrification. These scenarios will be compared to 2012 baseline data. Comparison among scenarios will provide further information on effects of electrification and removal of natural gas powerplants. Emissions from four sectors are investigated, including power, residential and commercial buildings, transportation (light-duty vehicles and buses), and the Port of Los Angeles (ocean-going vessels, cargo handling equipment, and heavy-duty vehicles at the port).

Projections for emissions from these different sectors through 2045 are guided by a set of overarching assumptions and a specific methodology. Emissions from sources investigated for LA100 scenarios (e.g., LADWP-owned power plants in the South Coast Air Basin) up to 2045 are projected using NREL model output or input assumptions. Emissions in 2045 for the power sector are estimated by multiplying emission source activity in 2045 by emissions factors for 2045. For other sectors, emissions in 2045 are estimated by multiplying

the raw emissions in 2020 or 2031 (depending on sector) by a growth factor for activity and a control factor for emission factor (emissions per unit of activity). Emissions out of the scope of LA100 follow SCAQMD's 2031 projections, assuming 2031 and 2045 are the same.

Developing 2045 Emissions Inventory for Specific Sectors

Ban-Weiss provided detail on how emissions inventories were projected for 2045 for each of the four sectors that are affected by LA100 (power, residential and commercial buildings, transportation, and Port of Los Angeles).

Power sector emissions inventories assume both natural gas and hydrogen are allowed in SB100 for both LADWP and non-LADWP utilities. In the LA Leads scenario, only hydrogen is allowed for LADWP utility, while non-LADWP utilities do not have restrictions on the source of power. Results for LADWP utilities are based on NREL-projected hourly fuel consumption in 2045 and emissions factors for natural gas and hydrogen, while emissions from non-LADWP facilities follow SCAQMD 2031 projections.

Residential and commercial building emission inventories assume different levels of electrification for moderate and high scenarios and consider water and space heating, clothes drying, and cooking. Results are based on raw emissions from SCAQMD, growth factors for natural gas consumption derived from NREL building energy demand models and SCAQMD-sourced control factors for emission factors from 2020 to 2045.

For transportation sector emissions, the moderate electrification scenario assumes 30% of vehicle stock is plug-in electric vehicles (50% plug-in hybrid and 50% battery electric), while the high electrification scenario assumes 80%. Both assume 100% electrification of school and urban buses. Analysis considers various emissions sources from transportation (e.g., brake and tire wear), not just tailpipe emissions.

Port of Los Angeles emission inventories assume 100% electrification of cargo handling equipment and heavy-duty vehicles by 2045 based on 2017 Clean Air Action Plan (CAAP), with 80% electrification of shore power used by ocean-going vessels (i.e., containership and tanker) at berth in the moderate scenario and 90% in the high scenario.

Results

Ban-Weiss reviewed preliminary results, noting that reductions in LA100 related emissions in 2045 (NO_x and particulate matter) are predominantly from mobile sources. This is due in part to vehicle electrification but also to strengthening of emissions standards for petroleum fueled vehicles, which lowers emission factors. Port of Los Angeles and LADWP-owned power plant emission reductions have less of a spatial impact at city-scale but play important roles for near source emission reductions. Ban-Weiss presented preliminary results for total NO_x emissions for LADWP-owned power plants located in the South Coast Air Basin, noting large decreases in NO_x emissions for all three 2045 scenarios compared to baseline 2012 emissions.

Future steps for air quality analysis include predicting future ozone and fine particulate matter concentrations, assessing changes in health impacts from exposure to these emissions, and presenting results for air quality, public health, and effects on environmental justice communities.

Major Themes from Advisory Group Member Questions and Discussion

- Does electrification of ocean-going vessels assume activities only while in dock or moving through the port?
- Does analysis include cargo trains? Particulate matter from diesel truck and train engines (mobile and stationary) is an important consideration. This demonstrates why transportation electrification is a critical goal.
- If NREL is not modeling heavy-duty trucks, will the air quality assumptions misalign with the NREL results? Consideration of these vehicles could be helpful to the study and could include listing the continued levels of contribution from these vehicles. This could help for inferring benefits from electrification of these vehicles.
- Does the analysis consider all particulate matter or just $PM_{2.5}$? Larger particulate matter also presents a challenge.
- There is concern that the success of the building/port/transportation electrification is relied upon too heavily, and that assumptions do not appear to vary much across scenarios. Can a "partial compliance" scenario be developed to help frame the impact?
- Does analysis consider emissions from just LADWP customers or from the full SCAQMD air basin?
- How much reduction in NO_x and other emissions is needed to comply with ozone regulations? Showing this as part of the presentation would be helpful. This data is available in the 2016 SCAQMD Air Quality Management Plan, which can be found here: http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/final-2016-aqmp.
- Further explanation, including data on industrial load, of the 2012 emissions data would be helpful for clarifying results.
- Is electrification assumed to be uniform across the region?
- Public presentation materials should show whole-basin emission contributions, including the most significant "other" contributions and emissions from other utilities in the air basin.

Methodology and Assumptions for Mortality Analysis and Monetization of Environmental Benefits

Garvin Heath, Senior Scientist, and David Keyser, Economist for NREL, presented on methods for modeling mortality and monetization of health and GHG benefits. Heath noted that mortality outcomes were added to the analysis in response to Advisory Group feedback, and that mortality and monetization of health impacts (now both mortality and selected morbidity) are now part of the overarching questions guiding the air quality analysis. Building on Ban-Weiss' presentation, Heath focused on two more of the five steps guiding the air quality analysis:

- Assessing changes in mortality and selected morbidity health impacts from exposure to ozone and particulate matter
- Monetizing the health benefits due to changes in air pollutant concentrations and comparing with project costs

Heath provided a background on air pollutants and health effects of concern. He noted that the health effects with the greatest monetary damages are premature mortality from long-term exposure to ozone and particulate matter. Due to the value placed on life, premature mortality effects comprise 90% of the monetary impact of air pollution.

Heath explained that premature mortality analysis for the study will quantify avoided premature death from changes in pollutant concentrations. Morbidity analysis will quantify avoided health effects as emergency department visits for asthma and cardiovascular causes related to air pollutants. He reviewed the US EPA's Benefit Mapping and Analysis Program – Community Edition (BenMAP-CE) tool that will be used to estimate health impacts and economic variation (https://www.epa.gov/benmap). This tool is peer-reviewed and used in many regulatory and research applications by the US Environmental Protection Agency, the California Air Resources Board, SCAQMD, and others. Health impact functions in BenMAP-CE result from many epidemiological studies and related literature. These functions are calculated using concentration change, exposed population, and baseline incidences. These three factors are multiplied by health effect estimates to assess overall health impacts across neighborhoods.

Monetization of health impacts for morbidity are based on the cost of illness (e.g., hospitalization and prescription costs). For example, if a policy reduces emergency room visits for asthma the cost of each of those visits is avoided. Monetization of mortality is based on the value of statistical life (VSL), which is the monetary value that a group of people is willing to pay to reduce the risk of premature deaths. For example, if a reduction in pollution helps avoid one premature death in 10,000, the VSL can be calculated by multiplying the number of people by the value that each of those people is willing to pay to reduce the risk.

Keyser provided an overview of monetization of GHG reduction. The methodology NREL will use was developed in 2016 by the federal Interagency Working Group on the Social Cost of Carbon, a diverse group of stakeholders composed of various federal government agencies. Computable General Equilibrium (CGE) modeling, discussed in the previous Advisory Group session, provides a secondary methodology for assessing these costs and benefits. Results provided by these two models can be combined to calculate the implicit cost of GHG reduction for City of Los Angeles residents.

Heath provided examples of how health impact analysis results would be presented. The LA Leads High, LA Leads Moderate, and SB100 High scenarios — the scenarios selected for air quality modeling — will be evaluated for the year 2045. Avoided premature deaths and emergency department visits will be reported with a 95% confidence interval. He reminded Advisory Group members that the health benefits from improved air quality for various scenarios will be based on the SCAQMD baseline air quality data from 2012 as a foundation from which changes in each scenarios for LA100-affected sectors are considered. Health benefits will then be monetized using the US EPA's BenMAP-CE tool. Values for premature mortality and morbidity will also be evaluated. Monetized benefits from GHG reduction will be reported using a 95% confidence interval.

Major Themes from Advisory Group Member Questions and Discussion

- A map depicting spatial distribution of emissions could be useful to the analysis and could include CalEnviroScreen health impact and/or cancer hotspot data. This map could also include locations of highest morbidity and mortality rates.

- Advisory Group members reacted positively to this first subset of analysis, though it was noted that other important health related costs could also be considered.
- Could health multiplier problems like COVID-19 be included in the analysis?
- Does analysis only quantify the health benefits of air quality improvements, or does it also account for cost of illnesses?
- How many emergency room visits are assumed per year?
- Because these values are calculated across the entire population, analysis may not consider different costs for different age groups (e.g., young people vs. retired people).
- The California Air Resources Board has commissioned two studies (one by University of California, Los Angeles and the other by University of California, San Francisco) on implications of air quality on susceptibility to COVID-19. The study is expected to take one year to complete.
- Are NREL or LADWP planning to review these results with SCAQMD prior to publication of the LA100 study?
- Are there direct health benefits of GHG reductions, or are the health benefits related to co-benefits in the reduction of NOx and particulate matter?
- Urban heat island-caused mortality may be a significant impact, and GHG-caused warming can worsen this effect.

Wrap-up and Next Steps

Isaacson noted that the next session will take place on Thursday, July 30. The final session for the Advisory Group Meeting #12 series will be a question and answer session on August 6.

Virtual Session #4

Thursday, July 30, 2020, 10:00 a.m. to 12:00 p.m.

Virtual Session #4 Attendees

Advisory Group Members

Allison Smith, Southern California Gas
Andrea Rojas, Sierra Club
Ben Airth, Center for Sustainable Energy
Bonny Bentzin, University of California, Los Angeles
Bruce Tsuchida, The Brattle Group
Camden Collins, Office of Public Accountability (Ratepayer Advocate)
Carlos Baldenegro, Port of Los Angeles
Christos Chrysiliou, Los Angeles Unified School District
Dan Kegel, Neighborhood Council Sustainability Alliance
Duane Muller, University of California, Los Angeles
Fred Pickel, Office of Accountability (Ratepayer Advocate)
Jack Humphreville, DWP Advocacy Committee
Jasmin Vargas, Food & Water Action
Jean-Claude Bertet, City Attorney
Jim Caldwell, Center for Energy Efficiency and Renewable Technologies
Jin Noh, California Energy Storage Alliance
Kendal Asuncion, Los Angeles Chamber of Commerce
Luis Amezcua, Sierra Club
Michael Webster, Southern California Public Power Authority
Priscila Kasha, City of Los Angeles Attorney
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Salem Afeworki, City of Costa Mesa
Steve Ruiz

Call to Order and Agenda Overview

Joan Isaacson, LA100 Advisory Group meeting facilitator from Kearns & West, welcomed the virtual meeting attendees. She noted that this was the fourth of five virtual sessions for Meeting #12 of the Advisory Group. She explained that this session would focus on the distribution grid analysis.

Slides from all presentations are available on the LA100 website.

Welcome Remarks

Greg Huynh, LADWP Manager of the 100% Clean Energy Innovation Group, welcomed Advisory Group members. He noted that the distribution system is complex and critical, and highlighted the development of the LADWP Distributed Resource Plan, which will help guide future program decisions. He reinforced LADWP's commitment to renewable resources and the LA100 study.

Jaquelin Cochran, NREL LA100 Project Manager, welcomed Advisory Group members and thanked them for their continued dedication to the weekly sessions. She noted that this Advisory Group session would address distribution grid analysis. She encouraged Advisory Group members to attend the discussion/Q&A session scheduled for August 6. Its focus will be on questions and comments covering the Meeting #12 sessions.

Cochran noted that the distribution grid analysis considers many aspects of the study that have been previously presented, including electricity demand, customer adopted solar, and capacity expansion modeling. It also examines how these factors affect the distribution system, including needed system upgrades. Results from this analysis will inform the bulk power modeling and further distribution systems modeling.

Distribution Grid Analysis

Kelsey Horowitz, Senior Engineer for NREL, delivered the distribution grid analysis, and started by explaining that she would cover costs and impacts to the distribution system due to changes in load and local solar and storage (customer- and utility-scale). She noted that the presented results are draft and will be updated for the final analysis. Horowitz then reviewed the set of questions that guide the distribution grid analysis:

- How do changes in load and deployment of distributed solar and storage associated with 100% renewable energy scenarios affect LADWP's electrical distribution system?
- What are the costs associated with distribution system upgrades to accommodate these changes?
- In a 100% renewable energy future, do increased distributed solar and storage deployment provide an opportunity for deferring distribution system upgrades?
- In 2045, where could utility-scale distributed solar (i.e., local solar) be deployed within Los Angeles with the lowest distribution system costs?
- Where will distributed solar and storage, as well as distribution infrastructure upgrades, be built with respect to disadvantaged communities? What are the potential impacts to those communities and how could they benefit?

Horowitz noted that the first three questions would be addressed at this meeting, and the analysis for the remaining questions regarding distribution grid upgrades and impacts to disadvantaged communities will be presented during the next Advisory Group meeting series in fall 2020.

The distribution grid analysis concerns LADWP's sub-transmission (34.5 kilovolt [kV]) and distribution (4.8 kV) systems, and Horowitz referred to these different systems by their voltage during her presentation. Collectively, Horowitz referred to the combination of both the 4.8kV and 34.5kV systems as "the distribution system." The 34.5 kV system serves larger industrial customers and utility-scale distributed solar. NREL assumes that all direct current (DC) fast charging for electric vehicles is connected to this system. The 4.8 kV system serves commercial and residential customers and community solar, including small rooftop, and levels I

and II electric vehicle charging. Both systems deliver power to the customer and host generation that is geographically closer to loads than traditional generation sources.

Within the distribution analysis are two categories of in-basin energy resources: (1) utility-scale and (2) customer adopted storage and rooftop solar. Utility-scale is built to meet overall system needs and includes resources located at existing Once-Through Cooling (OTC) and local utility-scale solar. Local utility-scale solar and customer adopted storage and rooftop solar are connected to the distribution system; these are included in this analysis. Resources located at OTC sites are connected to the transmission system and are not included.

Horowitz provided an overview of the flow of core distribution grid analysis, which begins with understanding overloading and voltage challenges associated with a present-day electrical model of LADWP's distribution system. This process used in the results presented during the meeting uses snapshots in time, rather than time-series analysis, and is based on 11 time points throughout the year. NREL's analysis assumes that before moving forward, present-day challenges have been addressed to isolate existing issues from those caused by 100% renewable scenarios. Analysis then considers how load growth between now and 2030 impact needed upgrades. Solar and storage, including customer-adopted rooftop solar and utility-scale local solar and storage, for 2030 are then added to understand additional impacts of generation on distribution upgrade needs. Once analysis is complete for 2030, a similar process is completed for 2045 beginning with 2030 as the "current" year.

Horowitz provided an overview of how the distribution grid analysis relates to LADWP's Power System Reliability Program (PSRP), showing where they address similar and different issues. She also provided further detail on the process for conducting the distribution cost analysis, which includes:

1. Generating electrical models of LADWP's entire distribution system
2. Allocating loads from LA100 scenarios to the distribution equipment
3. Identifying any voltage or thermal overloading problems
4. Determining upgrades that can solve problems
5. Calculating the cost of these upgrades

Major Themes from Advisory Group Member Questions and Discussion

- There was a question whether the analysis assumes 100% of existing generation at OTC sites is available and therefore whether changes to the sites would impact distribution system needs and require transmission between OTC sites to ensure distribution grid access.
- Timing of upgrades to the distribution systems needs to be addressed in the very short term to ensure completion of larger changes.
- Converting natural gas turbines at the OTC sites to hydrogen combustion could help maintain baseload generation.
- Moving large loads from the 4.8 kV system to the 34.5 kV system or upgrading the 4.8 kV system to 12 or 25 kV has not been discussed and could help address certain problems — could these be qualitatively assessed? Although there are no plans to upgrade the entire 4.8 kV system, targeted upgrades are being considered. Large loads are placed on the 34.5kV system in NREL's analysis.

Core Findings

Horowitz overviewed and then provided further details on four core findings from the distribution systems analysis. These are outlined below.

Upgrading the distribution system today can resolve existing issues and decrease the cost of integrating new loads, distributed solar, and distributed storage associated with 100% renewable electricity pathways.

Horowitz explained that addressing the existing upgrade backlog in the distribution system decreases the cost of integrating future loads, as transformers and lines then have headroom to accept additional load or distributed energy resources without exceeding their capacity. Prioritizing the location of these upgrades involves determining where existing equipment is overloaded and where the most benefit exists for utilizing distributed energy resources (including overall costs and community benefits). Horowitz reviewed utility-scale local solar capacity by scenario built out in NREL's capacity expansion model by 2045, noting that the total estimated technical potential overall in Los Angeles is much larger than what is currently being built in their models, but that some areas of the city are building out 100% of their technical potential due to transmission constraints and site availability. The utility-scale local solar systems are all connected to the 34.5 kV system and include parking lot canopy, ground mounted solar, and ground mounted hybrid solar and battery systems. More in-basin solar is expected in subsequent model runs.

Guided by geographic information systems (GIS) analysis, potential sites are rank ordered according to levelized cost of energy. Sites are then deployed until capacity expansion needs are met in each region. This results in a clustered distribution pattern driven by transmission constraints, especially in the high distributed future scenario, which does not allow new transmission. Horowitz noted that the total land area required by these resources is small even in the High Distributed Future scenario. The levelized cost of energy used in this analysis does not reflect distribution system upgrade costs. These costs are calculated separately and fed back into the capacity expansion model along with results from distribution system modeling.

Local solar and storage are needed to achieve 100% renewable energy in all scenarios, and these can cost money to integrate on the distribution system depending on where they are located. However, this cost is lower if you first upgrade the distribution system to accommodate load growth and customer-adopted solar and storage.

Horowitz noted that the additional cost to integrate these distributed resources onto the distribution system can be lower if the distribution system is first upgraded to accommodate load growth and customer adopted solar and storage. Additionally, integration of utility-scale solar ahead of customer adopted solar could provide cost benefits, but these would not be as extensive since these sites are more concentrated and limited to the 34.5kV network, and NREL has not conducted quantitative analysis for this benefit. Horowitz provided an example of how solar and properly-dispatched storage can help align energy profiles, increasing hosting capacity by balancing direction of load and voltage. She also noted that load differences are a larger driver of system-wide distribution system upgrade costs than the amount of customer adopted solar.

Additional costs to integrate utility-scale solar vary throughout the City, although these represent a small fraction of the average local solar installed system cost. The higher cost per kW in some areas is driven by a lower technical potential, while in others it is driven by higher absolute distribution upgrade costs.

The estimated capital cost of distribution system upgrades needed for changes associated with 100% renewable electricity pathways from 2020 to 2045 ranges from $190M to $460M depending on the scenario. But this could be an underestimate.

Horowitz noted that this analysis is in draft form and will be updated. Cost results are low compared to LADWP's current annual spending on distribution, and NREL is reviewing these results carefully.

Results of this analysis do not include the cost of resolving existing distribution issues or routine maintenance and capital costs unrelated to load growth or solar and storage deployment. Analysis also considers only autonomous advanced solar inverter functions and traditional infrastructure upgrades and control changes. Other system-wide upgrades and emerging solutions could affect cost. Horowitz noted that these results should be considered an estimation for evaluating LA100 scenarios. She provided an overview of estimated system costs by scenario. Costs for SB100 are higher in the high load scenario, driven by the need for distribution system upgrades. However, for LA Leads, the costs for the high load scenario are lower than for moderate load due to the synergistic effects of solar on hosting capacity discussed earlier.

Horowitz noted that despite the higher per unit cost of upgrades for the 34.5 kV system, fewer upgrades are needed. Because of this, the majority of costs are for the 4.8 kV system upgrades; however, these results could change in the final model run if much more utility-scale local solar is installed. Analysis shows that about 69% of distribution circuits in the LADWP system may need upgrades, with transformer replacements being the most common and contributing the most to total costs. She noted that first upgrading transformers resolves many voltage issues. Horowitz provided a cost overview of different types of distribution upgrades. These upgrades could be caused by load, solar, and storage in the system.

Cost for full circuit replacements is not currently accounted for in this analysis. NREL is working with LADWP to estimate new circuit costs and add them to the analysis.

Major Themes from Advisory Group Member Questions and Discussion

- Is local solar clustered around existing generating stations to take advantage of existing distribution systems?
- Do particular load types drive higher distribution costs?
- The use of different line styles in figures and graphs, rather than color differences, could improve readability of presentation material.
- Is the northwest cluster located at a load pocket on the west edge of the city with open land available for a largish solar plant?
- If LADWP plans for the case with the highest stress, will issues related to lower stresses be addressed?
- Are distribution costs in addition to bulk system costs presented during the first Advisory Group session of this meeting series?
- Advisory Group members are interested in exploring ways to create different combinations of scenarios. This could help policymakers better understand how different components contribute and possibly prompt them to request further analysis as policy is developed.
- There was concern that a tradeoff is being made between reliability of the system and achieving the 100% renewable goal.
- The high cost of the LA Leads scenario could lead to higher electricity rates, which could impact low-income communities. Meeting aggressive renewable energy goals should be weighed against other social needs.
- Because distribution issues are localized, can a distribution strategy adapt more quickly than a transmission strategy? Is there an established timeframe for conducting updates to the distribution system?

Advisory Group Meeting #13 Preview

Horowitz provided a preview of topics for the next Distribution Grid Analysis presentation, including:

- Where and when do solar and storage help versus hurt the distribution system?
- Where will distributed resources be built with respect to disadvantaged communities? What are the impacts on these communities and how can they benefit?
- Updated results informed by feedback cycles with the capacity expansion model

Wrap-up and Next Steps

Isaacson noted that the final session for the Advisory Group Meeting #12 series will be a discussion/Q&A session on August 6. She invited Advisory Group members to email the project team before the discussion/Q&A session to request specific topics for discussion.

Cochran noted that Advisory Group Meeting #13 will be hosted virtually, in a similar format as this series. Sessions are expected to take place in September and October 2020.

Follow-Up Q&A Session

Thursday, August 6, 2020, 10:00 a.m. to 12:00 p.m.

Follow-Up Q&A Attendees

Advisory Group Members

Allison Smith, Southern California Gas
Andrea Rojas, Sierra Club
Ben Airth, Center for Sustainable Energy
Bruce Tsuchida, The Brattle Group
Camden Collins, Office of Public Accountability (Ratepayer Advocate)
Carlos Baldenegro, Port of Los Angeles
Christos Chrysiliou, Los Angeles Unified School District
Dan Kegel, Neighborhood Council Sustainability Alliance
Duane Muller, University of California, Los Angeles
Fred Pickel, Office of Accountability (Ratepayer Advocate)
Jasmin Vargas, Food & Water Action
Jean-Claude Bertet, City Attorney
Jim Caldwell, Center for Energy Efficiency and Renewable Technologies
Loraine Lundquist, California State University, Northridge
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Randolph Krager, Southern California Public Power Authority
Steve Ruiz

Call to Order and Agenda Overview

Joan Isaacson, LA100 Advisory Group meeting facilitator from Kearns & West, welcomed the virtual meeting attendees to the fifth and final session for Meeting #12 of the Advisory Group. She noted that this session would provide an opportunity for Advisory Group members to ask questions and discuss material presented during the previous four sessions. Isaacson commented on the importance of Advisory Group member involvement and invited members to provide feedback on how to make the virtual meetings more engaging and interactive.

Welcome Remarks and Timeline for Remaining Meetings

Jaquelin Cochran, NREL LA100 Principal Investigator, welcomed Advisory Group members and thanked them for their continued participation. She provided an overview of agenda topics for upcoming Advisory Group Meetings #13 and #14 and meetings in early 2021. Sessions for Meeting #13 will address community outreach and engagement, including environmental justice outreach materials and process; the interactive LA100 website;

and final results for investment pathways (bulk power) and greenhouse gas (GHG) emissions. Meeting #13 sessions will take place in late September and early October 2020. Sessions for Meeting #14 will address final results for the distribution system and jobs and economic impacts (including a presentation from the LADWP Financial Services Office on potential rate impacts), and distribution of major sections of the draft LA100 report.

In early 2021, Advisory Group meetings will address final results for air quality, health, environmental justice, and monetization of benefits. The complete draft report will be distributed, and NREL will request feedback from Advisory Group members.

Major Themes from Advisory Group Member Questions and Discussion

Build-Out of In-Basin Solar

- There was concern that in-basin solar is not built out to its full technical potential in the modeling. There was interest in modifying transmission restrictions in the High Distributed scenarios to evaluate the impact of in-basin solar deployment. Further deployment of in-basin solar could reduce combustion generation.
- Transmission is the bottleneck, as solar and storage are rapidly getting cheaper.

Greater Report Customization

- There was concern that study results only present "bookend" scenarios, and presentation tools do not allow for customization to refine scenarios. Suggestions included using an interactive slider similar to what is provided for En-ROADS (https://www.climateinteractive.org/tools/en-roads/).
- Some Advisory Group members would like access to the detailed data incorporated into the modeling, to allow further analysis of scenarios. This data might include technical specifications, such as megawatt and megawatt-hour ratings of different technologies.

Policy Choices Beyond the Technology

- There was concern about a lack of transparency in the decision-making process for the study.
- Further conversation about how the technical analysis can inform future policy decisions, rather than focusing primarily on technology, was advocated for.

Cost and Rate Impacts

- Expanded discussion about the impact to rates for each scenario was suggested, including preparation of a "strawman" guide to provide an estimate of how rates may be impacted.
- The later that the potential rate impacts are discussed in the LA100 process the less opportunity there will be to adjust the study in response to feedback.
- Rate design is complex, but tools such as the "system average rate" could be important for estimating rate impacts. This can be used to calculate an average bill for different sectors (single-family residential, multi-family residential, and/or commercial).
- Future rates may be composed of more fixed charges and fewer variable charges as the system transitions to generation sources with larger capital costs and smaller marginal costs.

- There was concern that the ability of LADWP to bond capital expenses could have a significant impact on rates, notably in a case where projected costs exceed LADWP's 65% debt level.
- There was a request for more information on the types of financial information to be analyzed before the results are compiled and presented. This will allow for Advisory Member feedback on the types of financial information that will be helpful.
- There was a request for City Ratepayer Advocate to move forward soon with a rate analysis, to begin addressing next steps.
- Could the upcoming LADWP rate case analysis, planned for 2021, be used to create a rate range for each scenario? Estimating rates to 2030 may be the most useful, as it is difficult and likely inaccurate to project rates out further.
- It could help build trust by highlighting use of lower cost technology to achieve the initial percentage of renewable energy while costs decline over time for more advanced technology.

Community Engagement

- Tools are needed to help community and environmental organizations engage and educate the public on the LA100 study process and results. Tools could include well-crafted educational resources designed to help the broader public understand this complex study.
- The project website under development could provide engagement tools for the public. Tools such as polling could help to assess public priorities and inform policy conversations to ensure that results are community-driven.
- Website resources may be most useful for community and environmental organizations in supporting their engagement and education efforts.

Environmental Justice

- There was concern that more focus is needed on how the LA100 scenarios impact communities of color, low-income communities, and environmental justice communities, especially when considering solutions to achieve the full 100% renewable goal.
- Concerns were raised about cost, rates, and economic burden, especially for low-income and environmental justice communities.
- When conducting community engagement, it will be important to consider access to technology, especially in low-income communities.

Advisory Group Member Engagement

- How can Advisory Group members best be prepared to provide valuable feedback during the next series of meetings?
- Deeper discussion in facilitated breakout sessions during the next series of meetings could be useful for increasing Advisory Group member understanding of more technical aspects of the study.
- Facilitated breakout sessions may also be helpful in guiding through the project website.
- Scheduling meetings earlier in the morning or later in the afternoon may increase Advisory Group member participation. Shorter sessions and shorter, less technical presentations could also increase engagement.

- It may be useful to begin subsequent Advisory Group sessions with an overview of what was previously discussed – a "Cliff Notes" version. This would provide a refresher for Advisory Group members and could be used to convey study information to the public. Additionally, showing how each meeting fits into the original meeting process chart, as done in earlier meetings, would be helpful.
- Updates to the Advisory Group Meeting Plan document were requested.
- Providing more simplified presentations, rather than focusing in detail on technical aspects, may help increase Advisory Group member participation.

Other Questions and Discussion

- Will the status of Once-Through Cooling plants be included in the LA100 study report?
- Reviewing examples of renewable energy technology use from other organizations may be helpful. Examples include UC Irvine's Advanced Power and Energy Program and the National Fuel Cell Research Center.

Wrap-up and Next Steps

Isaacson and Cochran wrapped up the meeting and wished everyone a good and safe summer. They also expressed their appreciation for all of the input shared during this meeting, including suggestions for making the Advisory Group virtual sessions more productive and to increase member involvement in the discussions.