2022 Power Strategic Long-Term Resource Plan (SLTRP)
Roadmap to 100% Carbon Free by 2035

SLTRP Advisory Group Meeting #11
NREL Air Quality and Health Impacts, LA100 Equity Strategies Update, Wrap Up
September 22, 2022

Meeting Agenda

Joan Isaacson, Kearns & West

- Welcome & Introductions
- Meeting Purpose and Agenda Overview
- SLTRP Process Update and Public Outreach Feedback
- NREL Air Quality and Health Impacts Study for SLTRP (Initial Results)
- LA100 Equity Strategies Update
- Closing Remarks
- Wrap Up

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

Guides for Productive Virtual Meetings

Advisory Group Role in 2022 SLTRP

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

Advisory Group Meeting Plan

Phase 1 | Q3 2021 Launch & Laying Foundation	Phase 2 | Q3 2021 Scenario Development	Phase 3 | Q4 2021 Modeling	Phase 4 | Q1-2 2022 Results	Phase 5 | Q2-3 2022 Outreach
#1 September 23 • Advisory Group Launch • LADWP Overview • LA100 (Achieving 100% Renewable Energy) • 2022 SLTRP Orientation • Advisory Group Protocols & Operating Principles	**#4 October 22** • Customer Focused Programs - Energy Efficiency & Building - Electrification - Transportation Electrification - Demand Response • Draft Scenario Matrix	**#7 December 17** • LA100 Equity Strategies Overview • Energy Storage Presentation • 2022 SLTRP What-If Sensitivities Discussion • Final Scenario Matrix	**February** ***(Email Update)*** • Modeling Progress Check-in, • Upcoming Board Meetings	**#9 June 30** • Preliminary Results on Reliability, resiliency, and Sensitivities
#2 September 30 • *LA100 Study Review (NREL) at 9 am* • LA100 Rates Analysis (OPA) at 10 am • LA100 Next Steps (LADWP) • LA100 Assumptions (PSRP) • Consider Topics for October 22 • Consideration of Scenario Definition	**#5 November 10** • LA100 "No Combustion" Scenario • 2022 SLTRP Assumptions • Metrics & Evaluation Process • Scenario Considerations • Refine Scenario Matrix	**November – May** • Internal Modeling • Analysis of Scenarios	**#8 April 28** • Preliminary Results on Core Scenarios • (Capacity Expansion, LOLP and Production Cost Model)	**#10 August 12** Final Sensitivities SLTRP Key Findings **August** • Community Outreach Meetings • Review Draft 2022 SLTRP
#3 October 08 • SLTRP Deep Dive • SB100 Review (LADWP) • 100% Carbon-Free by 2035 Requirements (NREL) • Green Hydrogen in LA (LADWP) • 2022 SLTRP Key Considerations and Potential Scenarios	**#6 November 19** • Distribution Automation • 2022 SLTRP Advisory Group Feedback and Refined Draft Scenario Matrix • 2022 SLTRP What-If Sensitivities Discussion	Modeling Underway	**TBD** Potential field trip	**#11 September 22** Public Outreach Results NREL Air Quality Modeling LA100 Equity Strategies **October 11 Board Date**

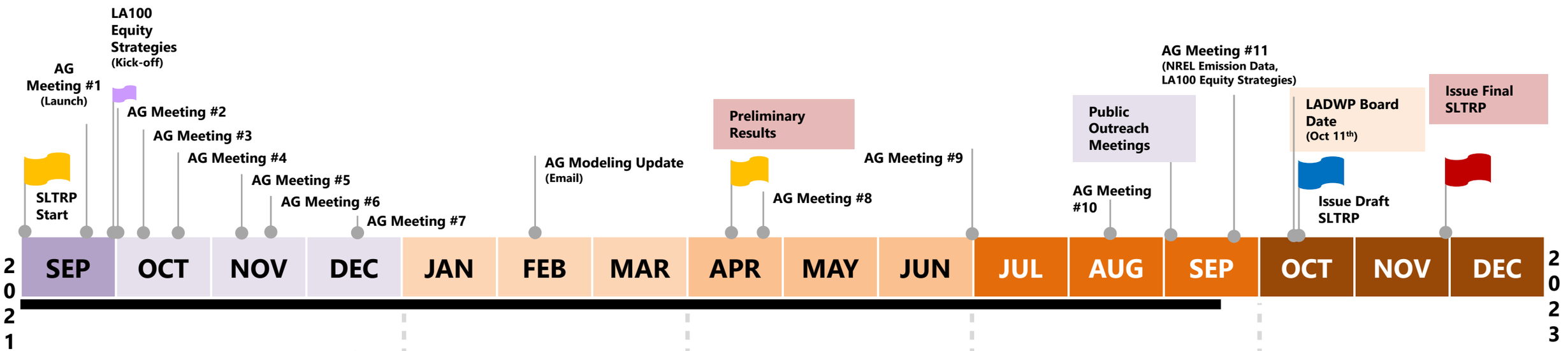
SLTRP Process Update and Public Outreach Feedback

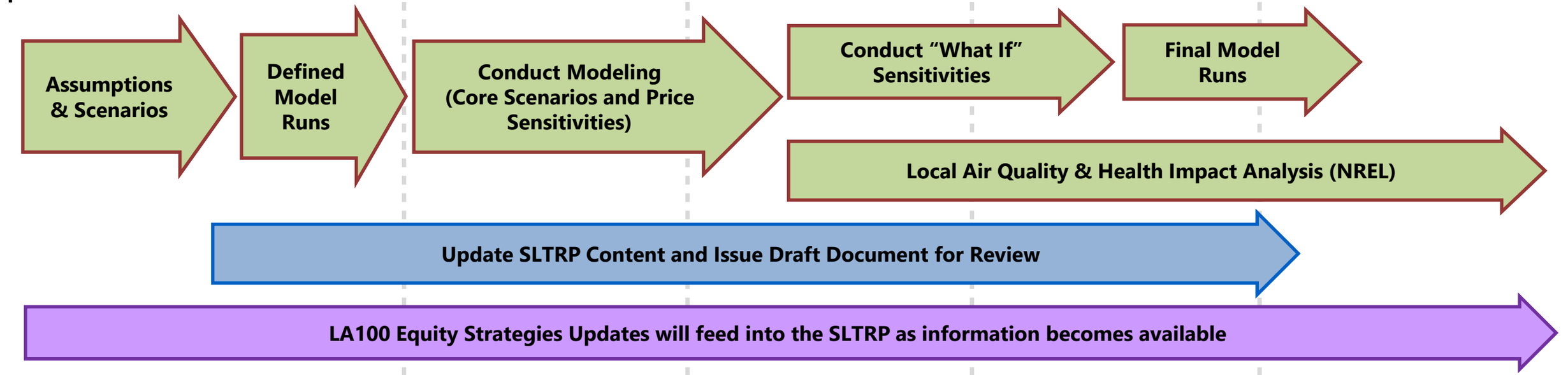
Jay Lim, LADWP Manager of Resource Planning





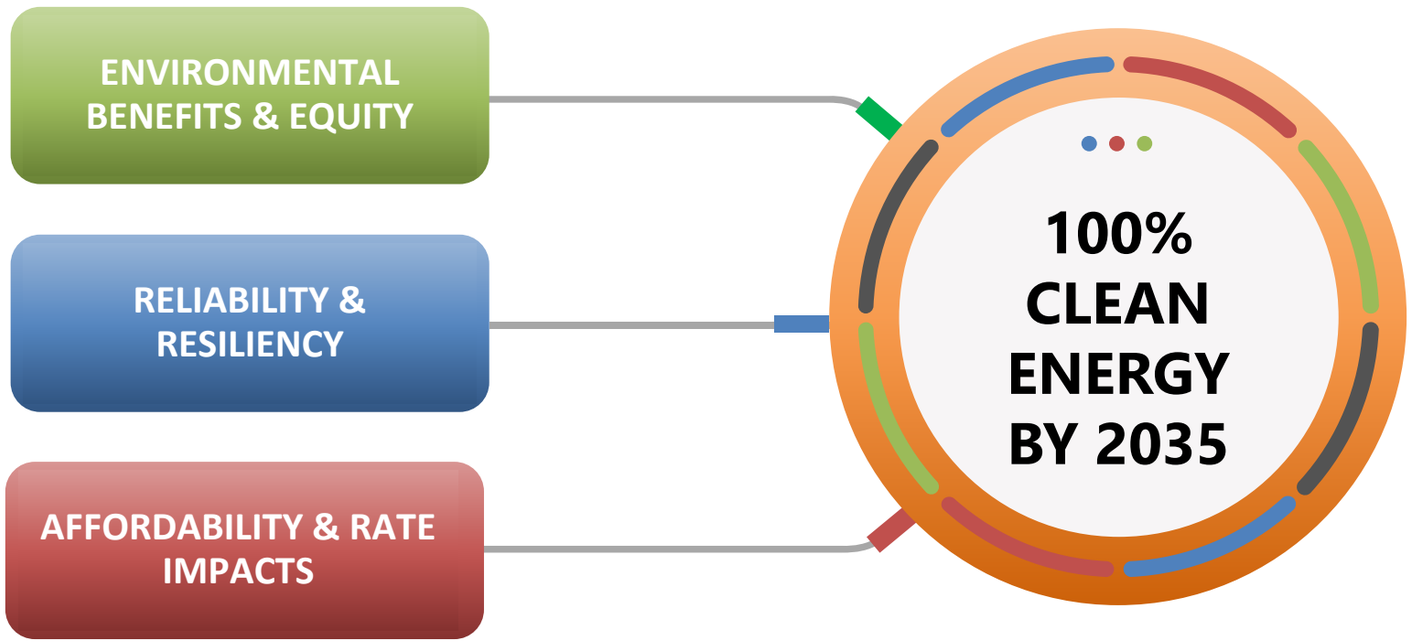
SLTRP TIMELINE





GUIDING PRINCIPLES

THE SLTRP IS A ROADMAP TO MEET OUR FUTURE ENERGY NEEDS



OUTCOME:

DEVELOP A RECOMMENDED SCENARIO THAT GUIDES OUR NEAR-TERM ACTIONS AND FUTURE ENERGY PLANNING

Community Meetings

Our Clean Energy Future Is Now

LA DWP

Join us for virtual community meetings to learn more about the paths under consideration for reaching 100% carbon-free energy for L.A. and provide input on the 2022 Power Strategic Long-Term Resource Plan.

August 30 Tuesday
6 p.m. – 7:30 p.m.

September 1 Thursday
6 p.m. – 7:30 p.m.

September 7 Wednesday
6 p.m. – 7:30 p.m.

English-Spanish simultaneous interpretation available for all meetings.

PUBLIC OUTREACH FEEDBACK

WE CONTINUED BUILDING COMMUNICATION PATHWAYS

RATES AND ENERGY BURDEN

The price of power is the **most common** feedback topic.

LADWP will need to continue being **transparent** of costs and rate drivers.

A **holistic** and **equitable** approach will be needed to fully communicate the impacts of transitioning to 100% carbon free when accounting for energy costs, energy burden, incentives/rebates, and potential savings from clean energy technologies.

LADWP has been tasked with determining the optimal clean energy pathway with **minimal adverse impacts** on ratepayers.

Our current rate estimates are derived from **today's** financial **capabilities**, technologies, and required resources.

HYDROGEN & EMISSIONS

Local air quality and community impacts are a **major concern** for Angelenos.

LADWP will need to continue analyzing how hydrogen resources will **impact local communities** during normal and critical operations.

It is important to **synergize** with other economic sectors to lower emissions and catalyze the clean energy transition – especially for transportation and industrial sectors.

PUBLIC OUTREACH FEEDBACK

WE CONTINUED BUILDING COMMUNICATION PATHWAYS

CLEAN ENERGY POLICY

Wildfires, droughts, and heat waves are **challenges** facing us today.

Varying opinions on balancing the **rate of change** for 100% carbon free goals and the financial impacts of either accelerating or delaying these timelines.

LADWP must continue to **seek guidance** and **provide input** on clean energy policies with elected officials, lawmakers, regulatory agencies, industry experts, academia, and the broader community.

CUSTOMER RESOURCES

Customers need and want **support** for developing their own local clean energy systems.

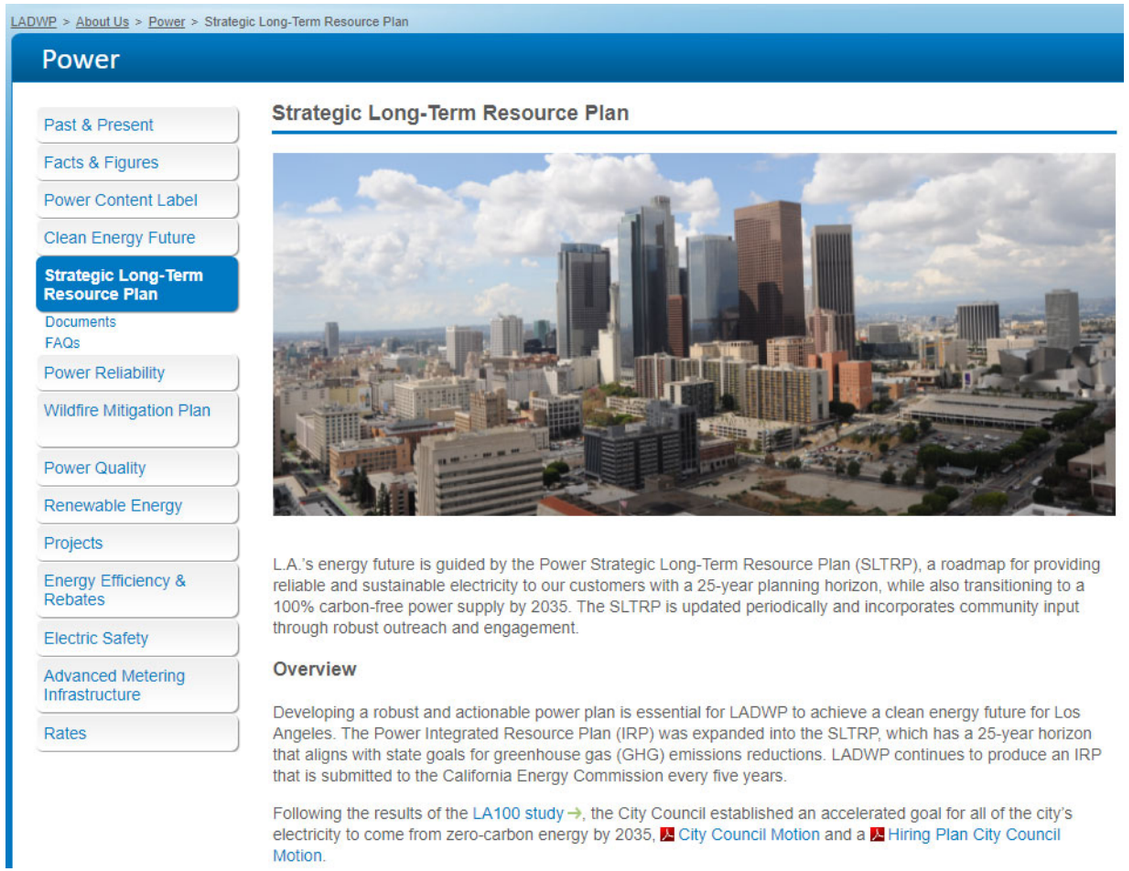
LADWP must continue developing new **clean energy programs and incentives** to support local development.

The City of Los Angeles is a **leader** in solar adoption, and it is critical for LADWP to maintain that leadership position.

The SLTRP will require a vast portfolio of clean energy resources. **Local resources,** including both behind and in-front of the meter, are necessary for all clean energy pathways.

Communications & Public Affairs

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



LA100 Equity Strategies Update

Denis Obiang and Iris Castillo, LADWP Manager of Transmission Planning





SLTRP Advisory Meeting
September 22, 2022

LA DWP

NREL
Transforming ENERGY

KEARNS & WEST

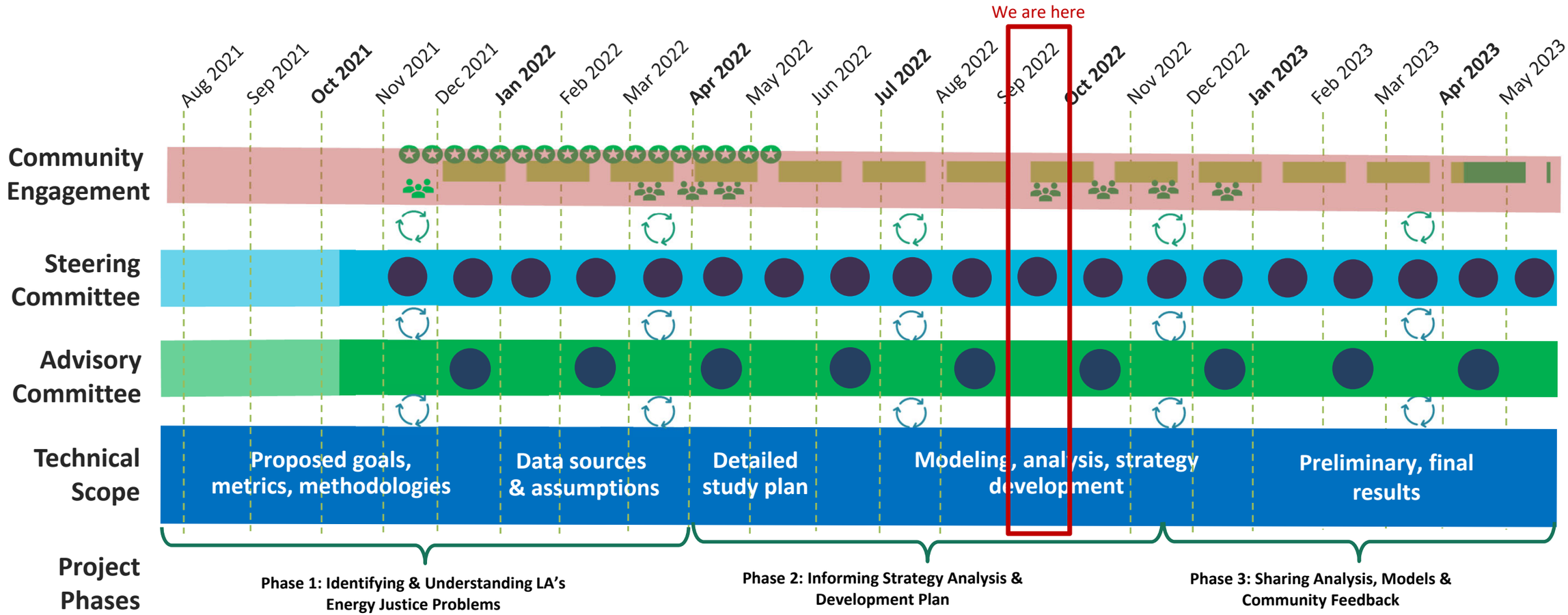
UCLA

LA100 Equity Strategies picks up where LA100 left off to answer the question:

How can Los Angeles ensure its transition to 100% clean energy with high levels of electrification **improves energy justice**?


All communities will share in the **benefits and burdens** of the clean energy transition.
Improving equity in participation and outcomes would require intentionally designed policies and programs.

LA100 EQUITY STRATEGIES: TIMELINE & FRAMEWORK



Legend

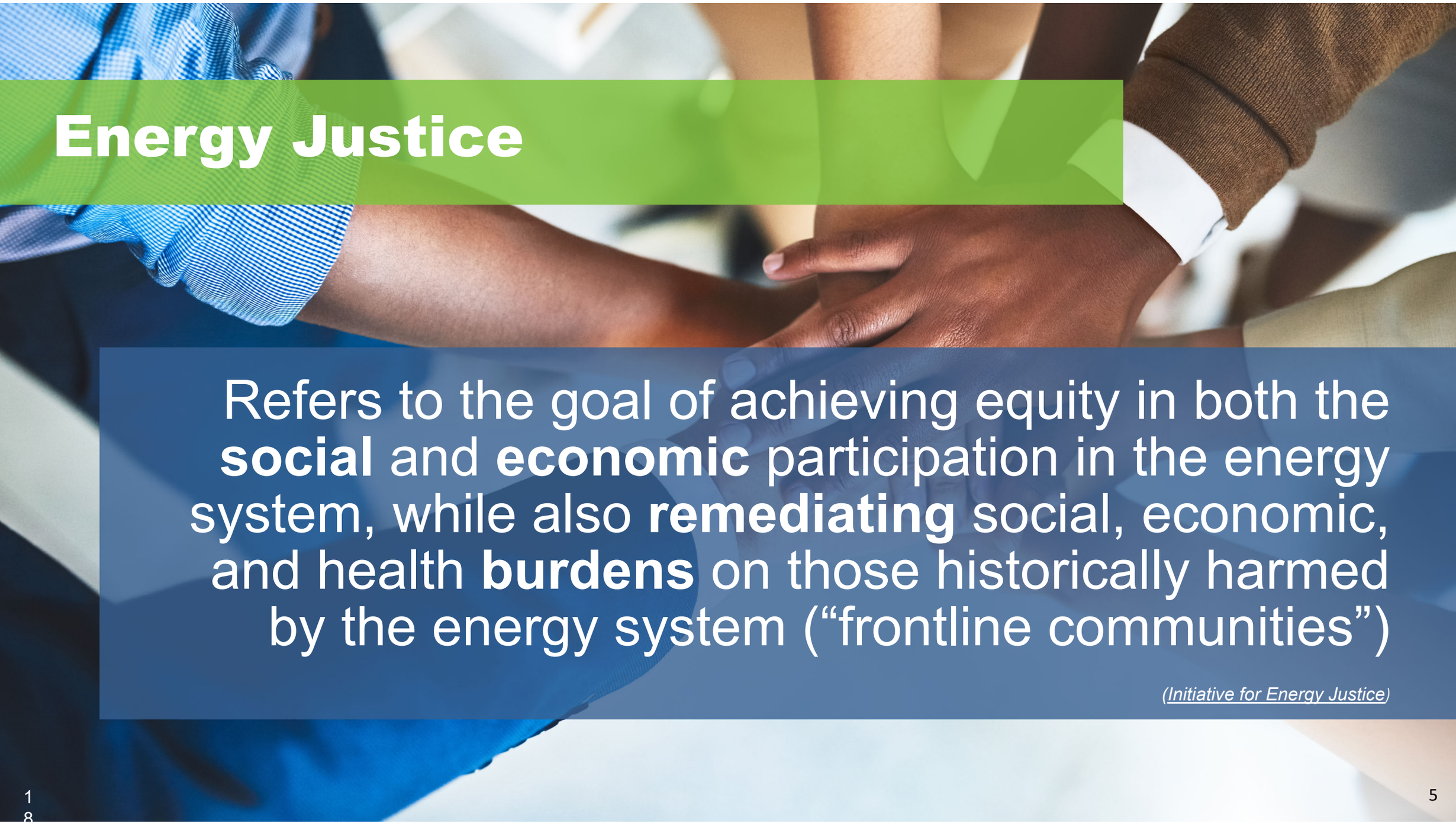
Key connections
- Feedback loops

Engagement
- Community Engagement
- Steering Committee
- Advisory Committee

Digital Engagement Phases
- LA100 ES Digital Engagement
- Post-LA100 ES Engagement

Meetings
- Steering Committee
- Advisory Committee

Interviews
- One on One
- Listening Sessions



Energy Justice

Refers to the goal of achieving equity in both the **social** and **economic** participation in the energy system, while also **remediating** social, economic, and health **burdens** on those historically harmed by the energy system ("frontline communities")

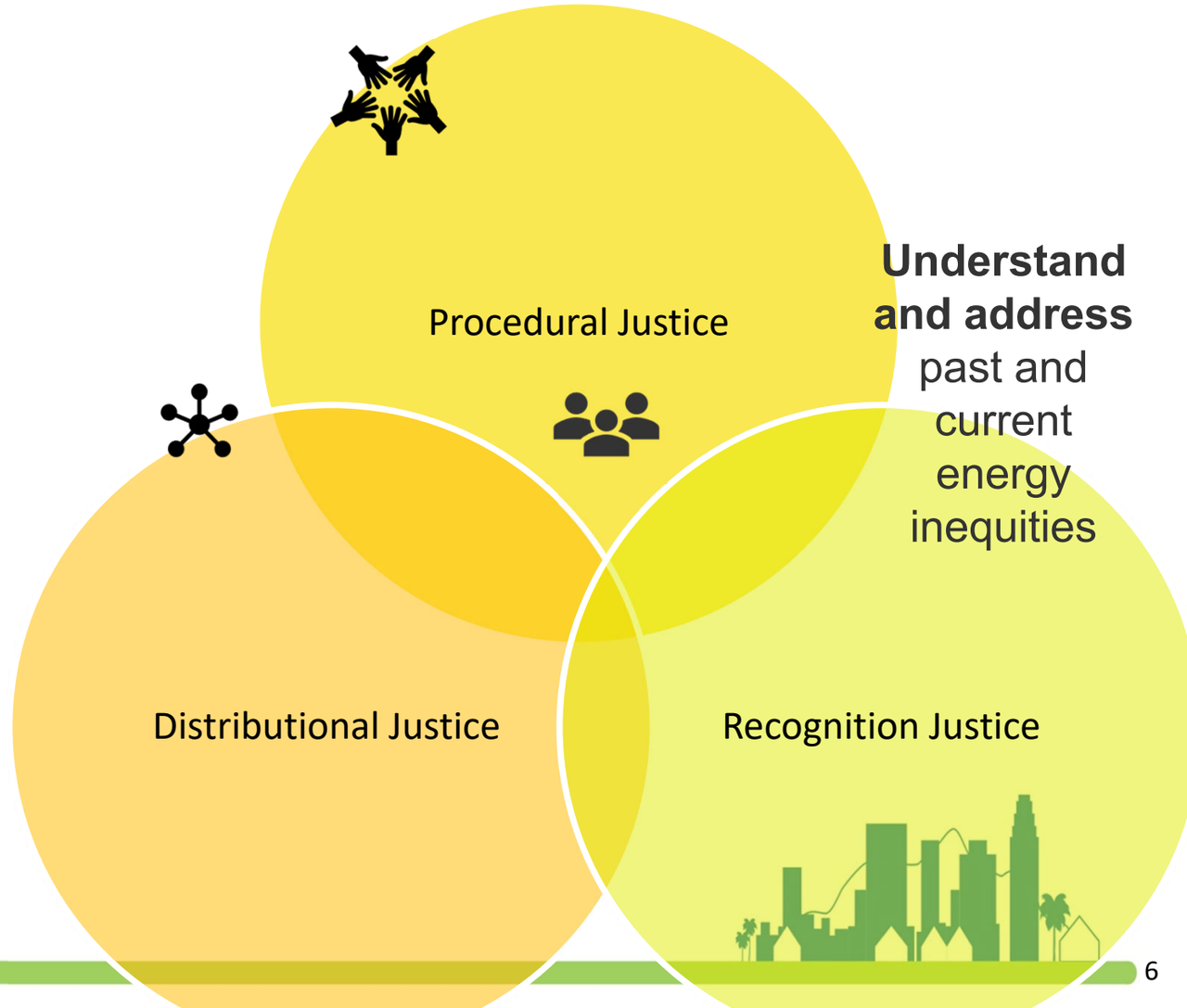
(Initiative for Energy Justice)

Tenets of Energy Justice

Enable **community leadership** in the process

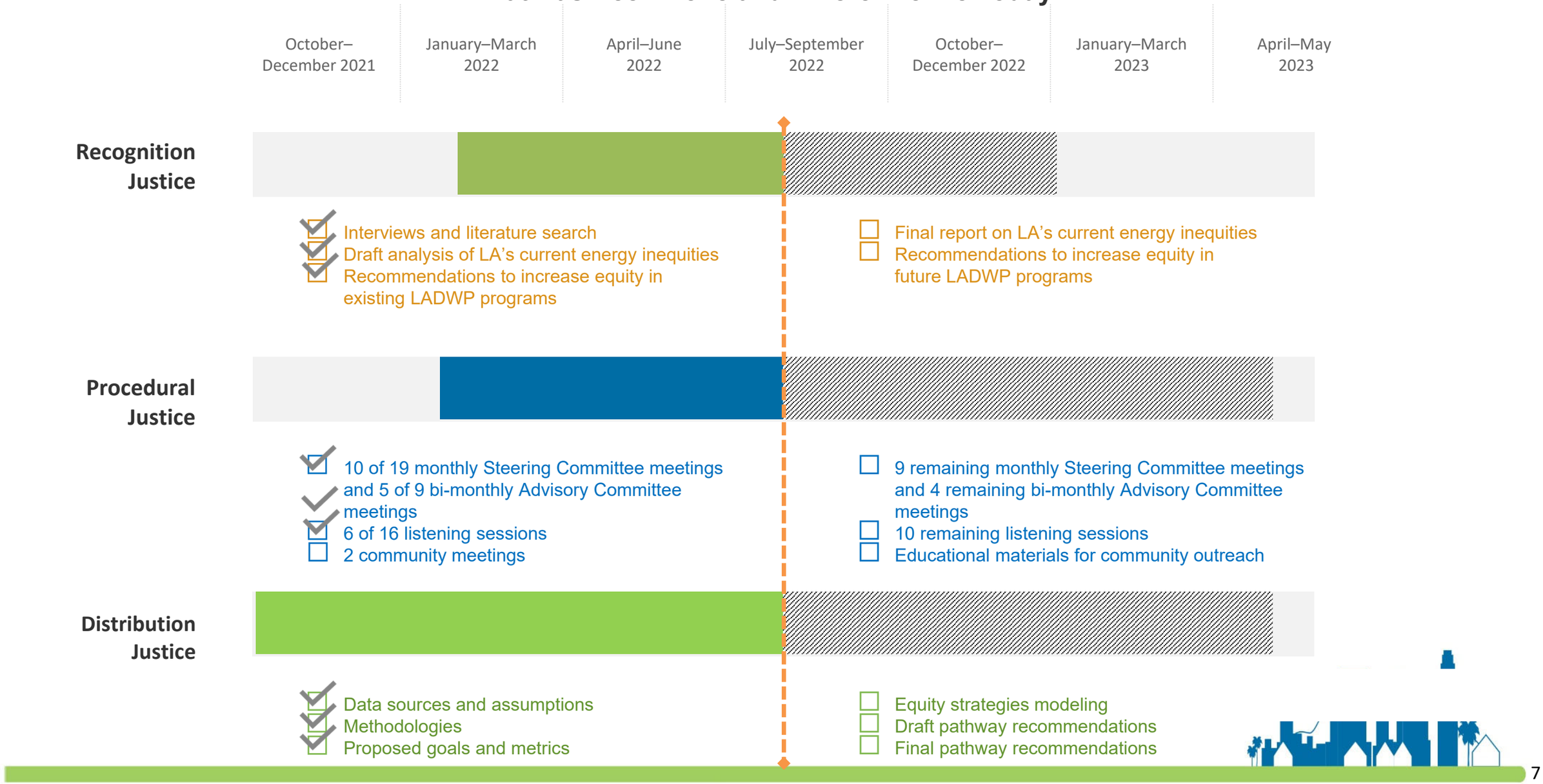
Ensure **just and equitable distribution** of benefits and negative impacts of clean energy transition

Understand and address past and current energy inequities



LA100 Equity Strategies Progress Dashboard

What Has Been Done and Where Are We Today?



LA100 Equity Strategies: Where Are We Going?

Developing Energy Justice Strategies

LA100 Equity Strategies *will co-develop* ***practical, implementation-ready strategies*** *intended to increase* ***energy equity outcomes*** *on* ***LA's road to 100% clean energy.***

Technical Scope

Proposed goals, metrics, methodologies	Data sources & assumptions	Detailed study plan	Modeling, analysis, strategy development	Preliminary, final results

Project Phases

- **Phase 1: Identifying & Understanding LA's Energy Justice Problems**
- **Phase 2: Informing Strategy Analysis & Development Plan**
- **Phase 3: Sharing Analysis, Models & Community Feedback**

Community Priorities

- **Affordability & Burdens**
- **Access & Use**
- **Health, Safety, & Resilience**
- **Jobs**

Strategy Development Pathways

- Energy bill stability
- Energy burdens
- Universal home cooling
- Solar, storage, energy efficiency (multifamily, renter-occupied buildings)
- Community solar
- Light-duty electric vehicles & charging
- Mitigation of heavier-duty vehicle health impacts
- Building weatherization and resilience
- Resilience through solar-plus-storage siting
- Support electric reliability through distribution grid upgrades
- Clean energy jobs and workforce development

Topics

- Rates and affordability
- Buildings
- Local solar & storage
- Transportation
- Reliability and resilience
- Air quality and health
- Jobs and workforce development

LA100

ACHIEVING 100% RENEWABLE ENERGY IN LOS ANGELES

LA100 Study

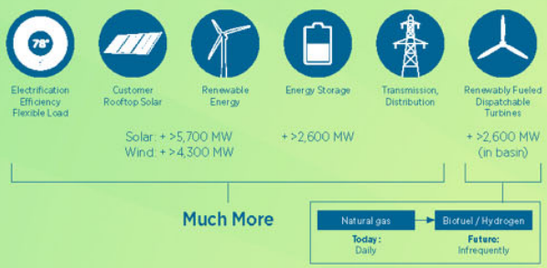
Completed

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

Considers reliability, equity, sustainability and affordability

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

Common Investments Across All Scenarios



LA100 Equity Strategies

Fall 2021-23

Community-driven, objective to achieve equity

Robust community engagement

Areas of Focus

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

2022 SLTRP

Fall 2021-2022 | 2035 & 2045 Targets

Our comprehensive integrated power plan

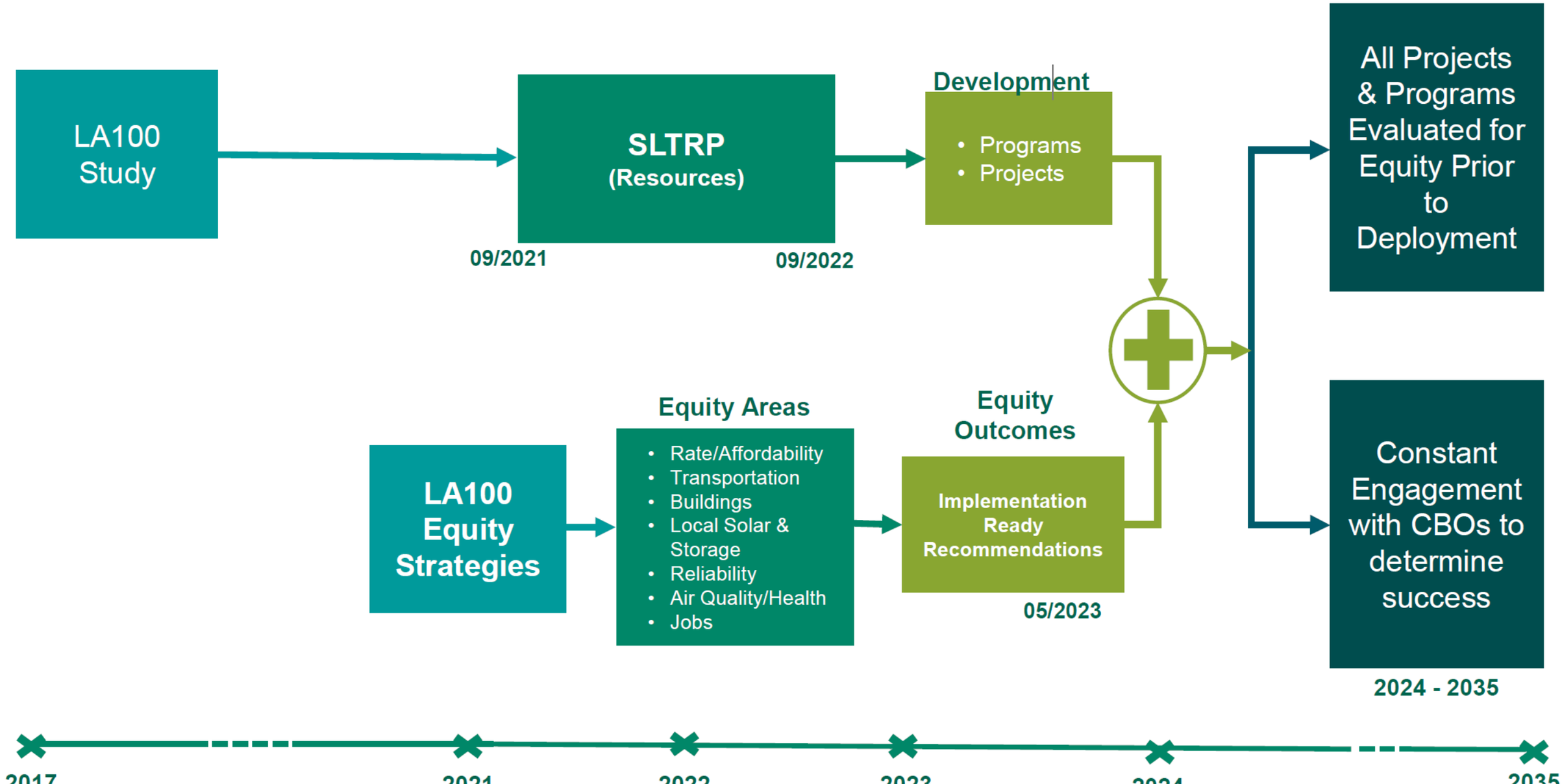
Recommends path forward to achieve our goals

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

Considerations

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

Next Steps

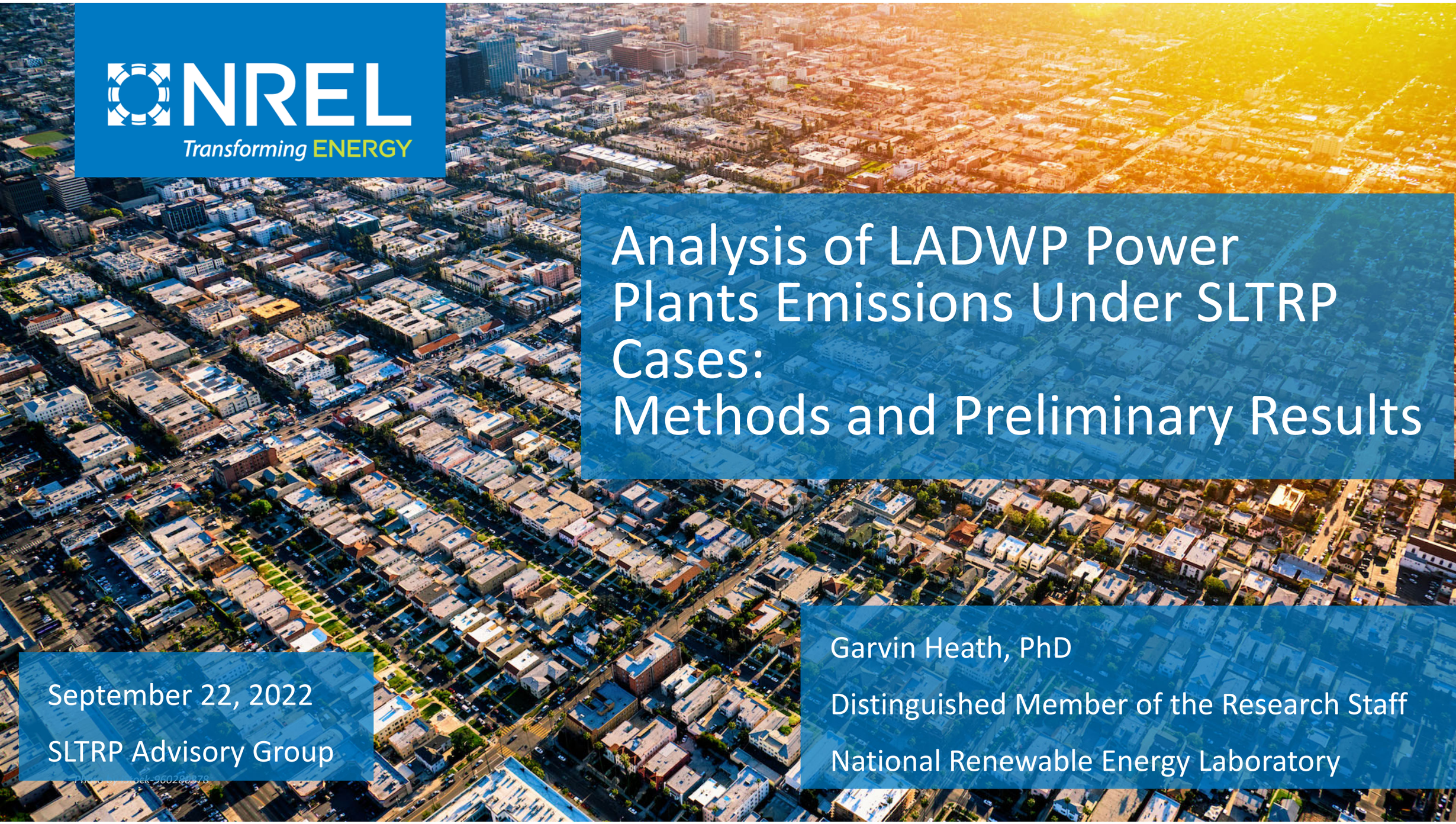

LA100 Study
SLTRP (Resources)
09/2021
09/2022
Development
• Programs
• Projects
All Projects & Programs Evaluated for Equity Prior to Deployment
LA100 Equity Strategies
Equity Areas
• Rate/Affordability
• Transportation
• Buildings
• Local Solar & Storage
• Reliability
• Air Quality/Health
• Jobs
Equity Outcomes
Implementation Ready Recommendations
05/2023
Constant Engagement with CBOs to determine success
2024 - 2035
2017
2021
2022
2023
2024
2035

Thank you!

Discussion and Q&A

SLTRP Air Quality and Health Impacts (Initial Results)

Garvin Heath, National Renewable Energy Laboratory



Analysis of LADWP Power Plants Emissions Under SLTRP Cases: Methods and Preliminary Results

September 22, 2022

SLTRP Advisory Group

Garvin Heath, PhD

Distinguished Member of the Research Staff

National Renewable Energy Laboratory

Goals

Evaluate SLTRP cases' effect on emissions, air quality (concentration), health, and equity.

Place LADWP facility's emissions in context to other sources in Los Angeles

Define a baseline for comparison to future cases

Evaluate emissions at hourly timescales, accounting for time-varying emissions.

How to estimate air quality and health effects

SLTRP scenarios

3 SLTRP cases in 2030, 2035 and 2045

Emissions inventory

Estimates of emissions from natural gas and hydrogen-fueled plants

Air quality modeling

Estimate $PM_{2.5}$, ozone and NO_2 concentrations, considering emissions and atmospheric chemistry and physics

Health impact estimation

Premature mortality from exposure to $PM_{2.5}$, ozone and NO_2

Equity analysis

Analyze distribution of concentrations and health impacts

NREL's Scope and Timing

Phase 1 – Air emissions and air quality (concentrations)		
Topic	**Tentative Due Date**	**Description**
Air emissions	October	1. Power sector compared to other sectors 2. SLTRP compared to baseline years
Air quality	November	$PM_{2.5}$, ozone and NO_2 concentration
Phase 2 – Health and equity		
Health	December/January	Mortality and morbidity effects relevant to pollutants analyzed
Equity	January	Distribution of concentration and health effects (DAC/non-DAC)
All topics	March	Final report

Work in Progress

- NREL accelerated to meet this year's SLTRP
- The analysis is still in progress, and thus results are preliminary
- Will continue to QA/QC these results
- Results can change until included in SLTRP final report

NREL's LA100 Equity Strategies Team

Dr. Garvin Heath

Sustainability analyst and air quality modeler

Dr. Vikram Ravi

Air quality, public health, and environmental justice analyst

Dr. Brian Sergi

Grid and air quality modeler

Qian Luo

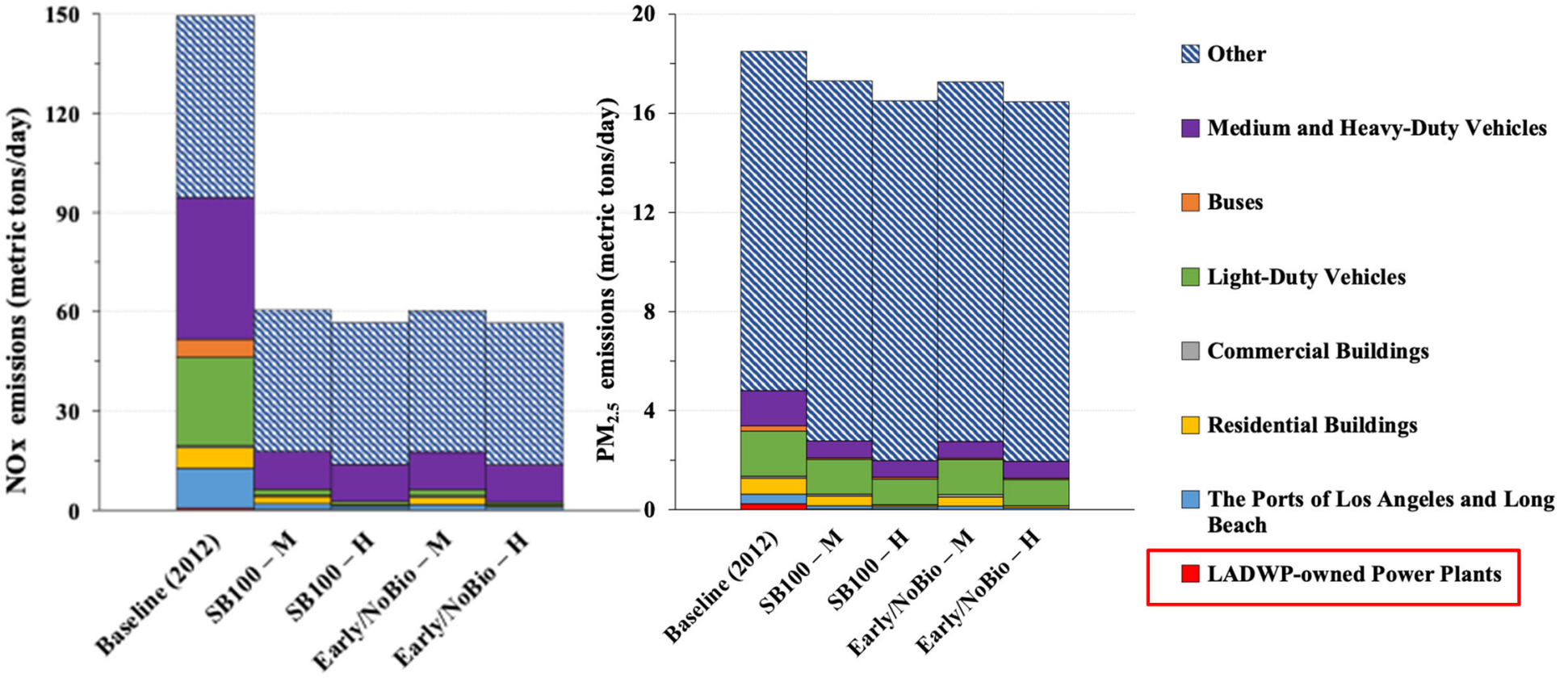
Late-stage Ph.D. student and air quality modeler

Photo from iStock - 596040774

Plus, lots of support from LADWP!

Level set: Power sector emissions in context – LA100 results

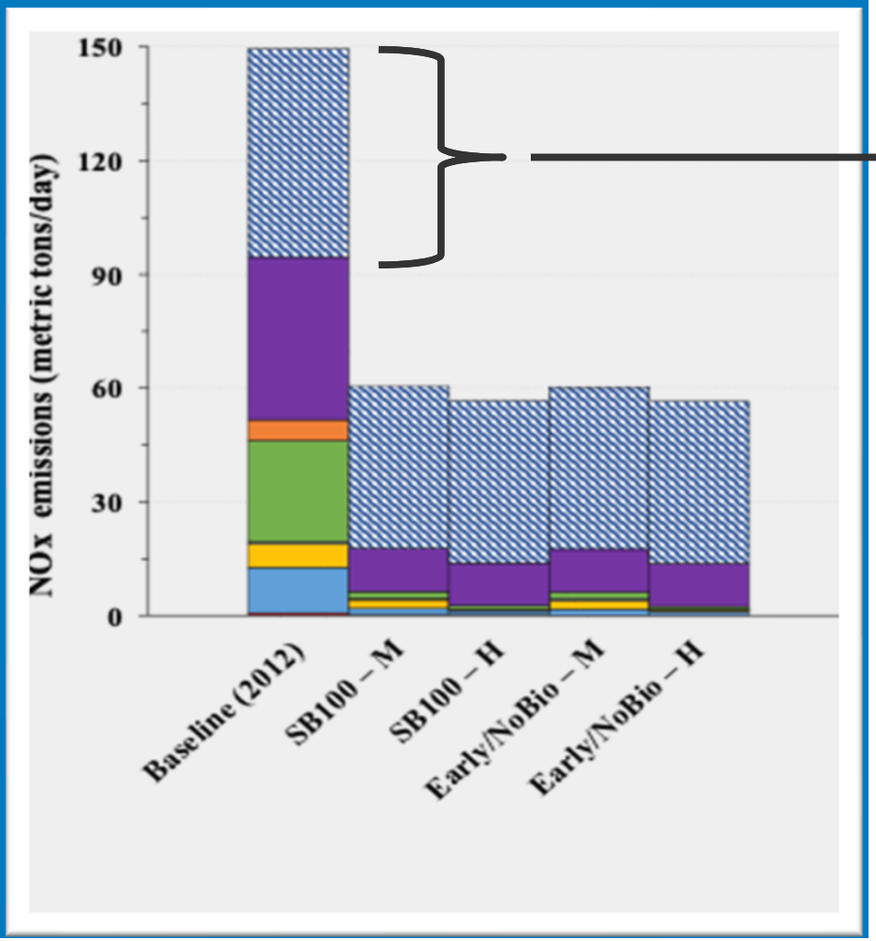
Emissions from LADWP facilities compared to other sectors are very small (<<1%) and are included even when not visible

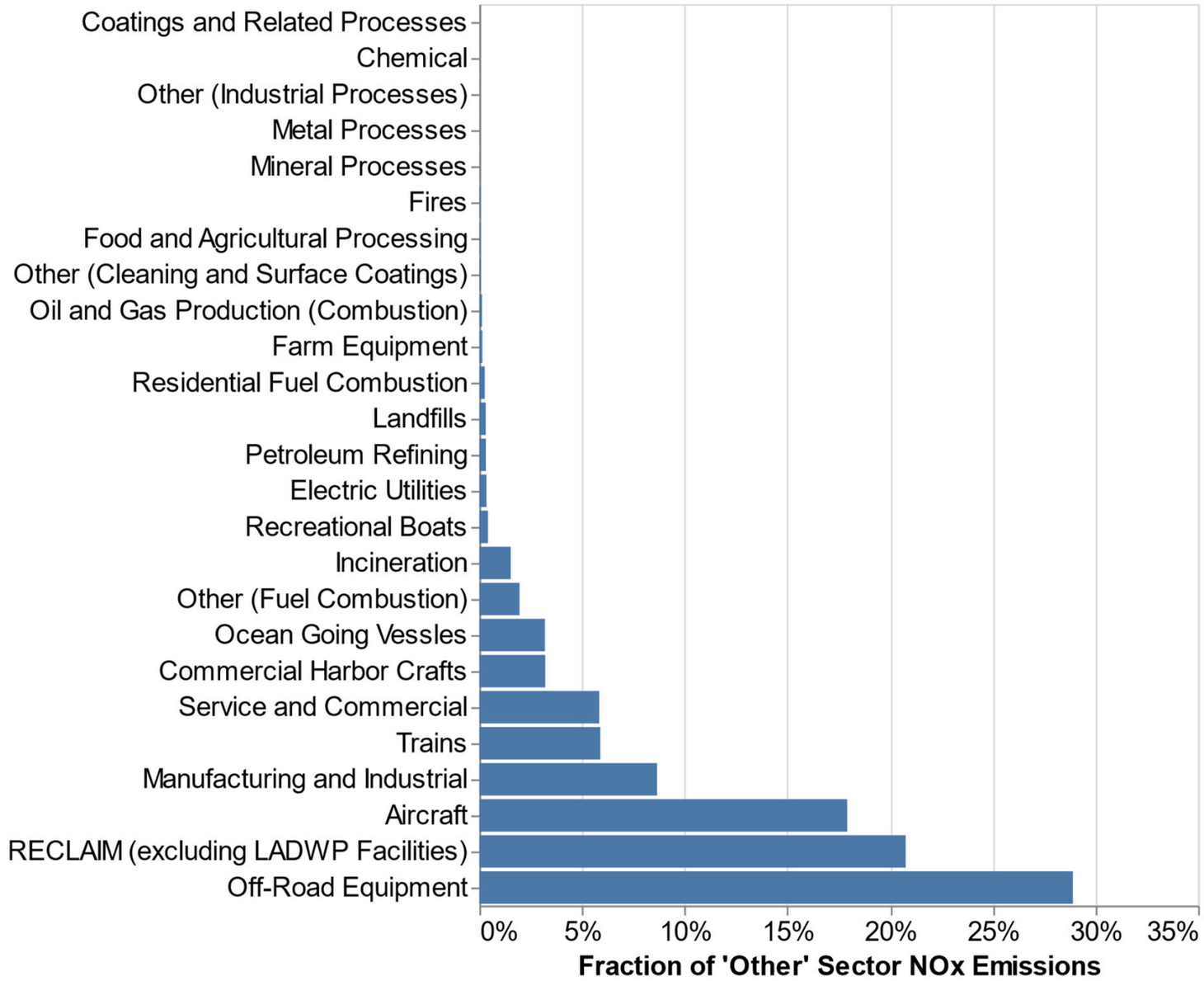


Annually-averaged daily
(a) NOx and
(b) $PM_{2.5}$ emissions from all anthropogenic sources in the City of Los Angeles for LA100 scenarios in 2045

Figure source: LA100, Ch. 9, Appendix B, figures 31 and 32

What are the major sources within ‘other' sectors?



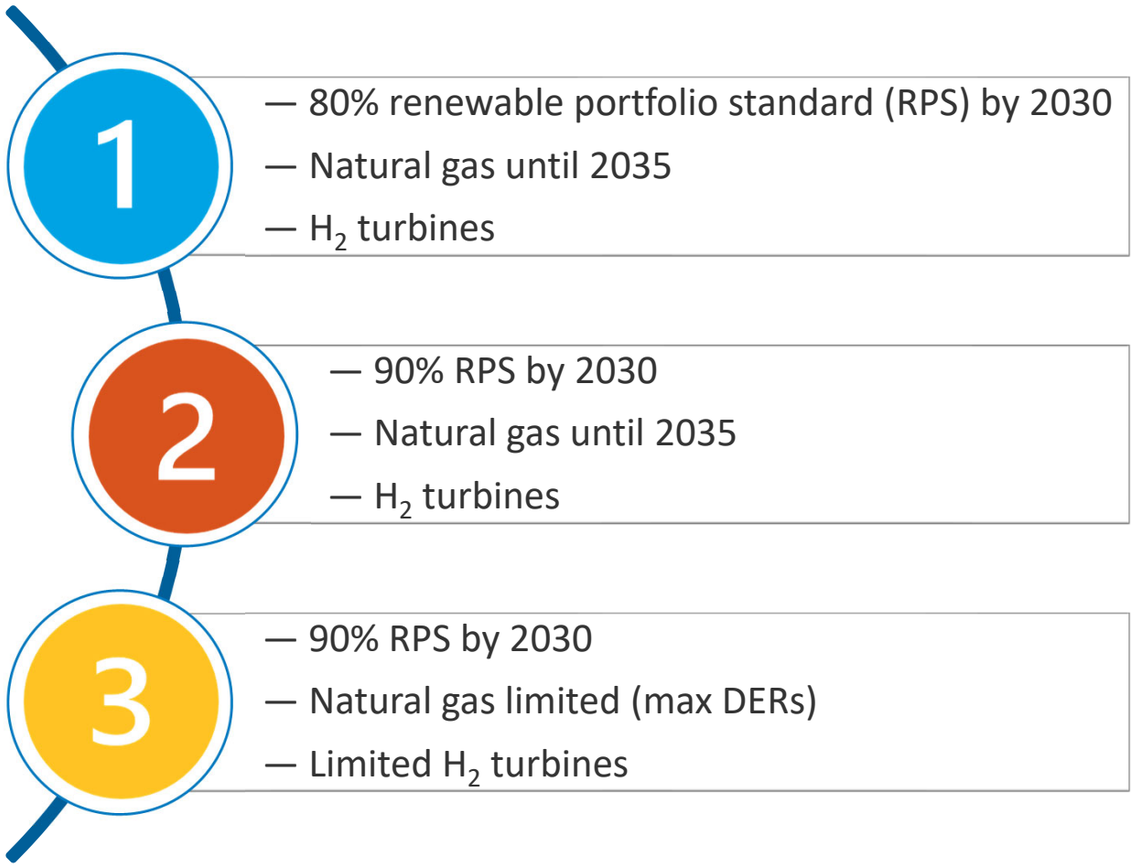


25 of the largest contributing sources are shown

Why analyze air quality in SLTRP? *NOx*

- **LA100 study found that across all scenarios, there was a need for in-basin firm, dispatchable capacity**
  - Frontline communities surrounding LADWP facilities, and other concerned stakeholders, want to know about potential air quality and health effects
- **Hydrogen combustion is cleaner than natural gas**
  - **Green H_2 is carbon free**; it's use displaces emission from natural gas and can be **part of a pathway to 100% clean energy by 2035**
  - Since H_2 has no carbon, there are **no PM, CO, VOC or air toxic emissions**
  - There can be some ammonia emissions as slip from selective catalytic reduction control technology (as occurs from any SCR system, including on gas turbines)
- **Yet H_2 combustion still emits nitrogen oxides (NOx)**
  - NOx emissions from H_2 combustion comes from nitrogen in the air, catalyzed by flame temperature
- **Hydrogen combustion** can have **higher flame temperatures**
  - But especially as used in the South Coast Air Basin, LADWP, turbine vendors and South Coast Air Quality Management District (SCAQMD) are collaborating to **ensure flame temperature is controlled, emissions control technologies can still be used and current/future NOx emissions regulations can be met**
    - We have vetted this extensively with numerous experts, e.g., see Pollutant Emissions Reporting and Performance Considerations for Hydrogen–Hydrocarbon Fuels in Gas Turbines, *J. Eng. Gas Turbines Power* (2022)

SLTRP Cases



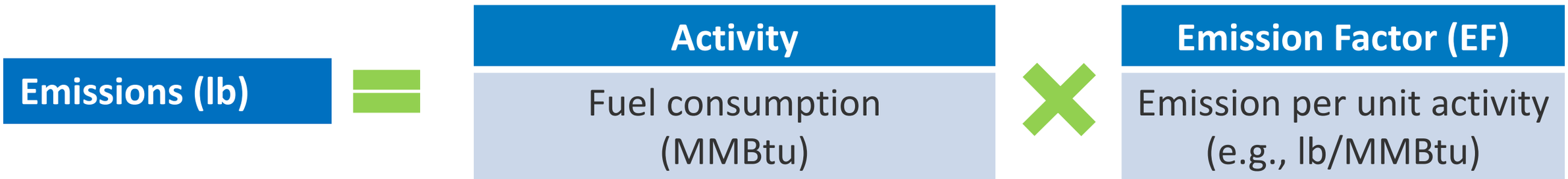
- All 3 cases achieve 100% Carbon Free Energy by 2035
- Examining **2030**, **2035**, and **2045**
- Green hydrogen starting use in 2029
  - 30% blending (by volume)
- 100% green hydrogen starting 2035
- Green hydrogen means there are *no upstream air pollutant emissions from hydrogen production* to account for

Methods

Photo from NREL

Emission calculation approach

Looks simple, actually very detailed



- Emissions can change when either activity or EF changes
  - Often, emission estimates are developed on an annual basis, assuming an average, constant EF
  - This approach would not support accurate modeling of hourly-varying pollutant concentration
- Fuel consumption relates to the generator's heat rate (efficiency), which can change in different operating modes
  - Note that fuel consumption is directly related to generation (MWh)
- EFs are also not constant throughout the year; they also differ by operating mode

Activity: Annual total generation
The most important factor modulating emissions

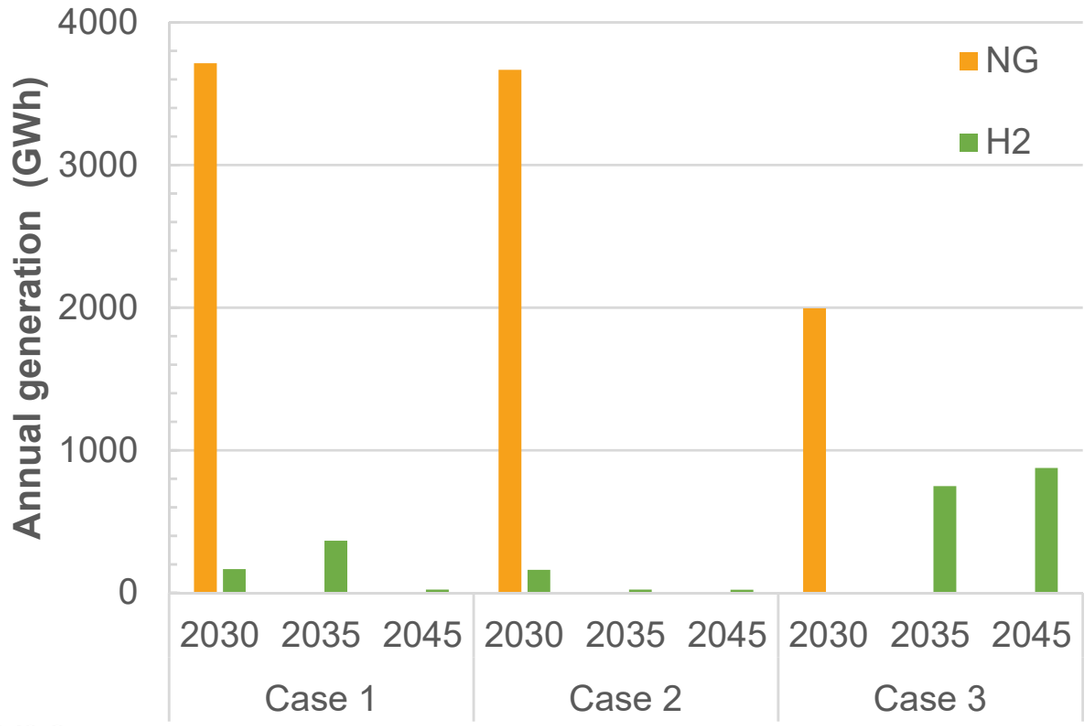
PRELIMINARY RESULTS

Generation by in-basin combustion units
Historical LADWP gross load: ~24,000 GWh

By case

GWh	2030	2035	2045
Case 1	3,881	366	24
Case 2	3,830	23	22
Case 3	1,996	749	876

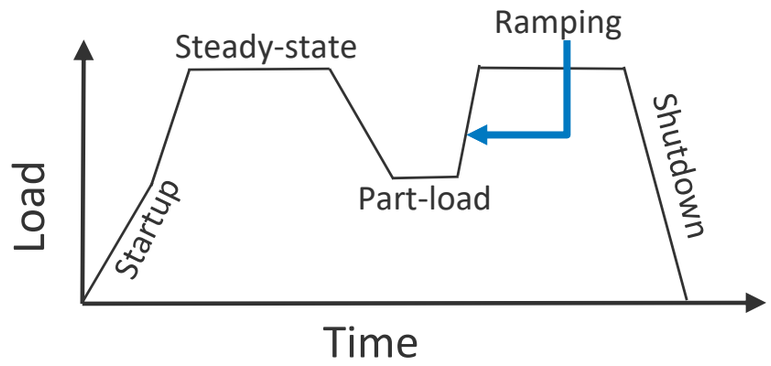
By fuel



SLTRP created multiple weather-based simulations.
We are analyzing the case representing median annual generation for emissions.

Operating modes

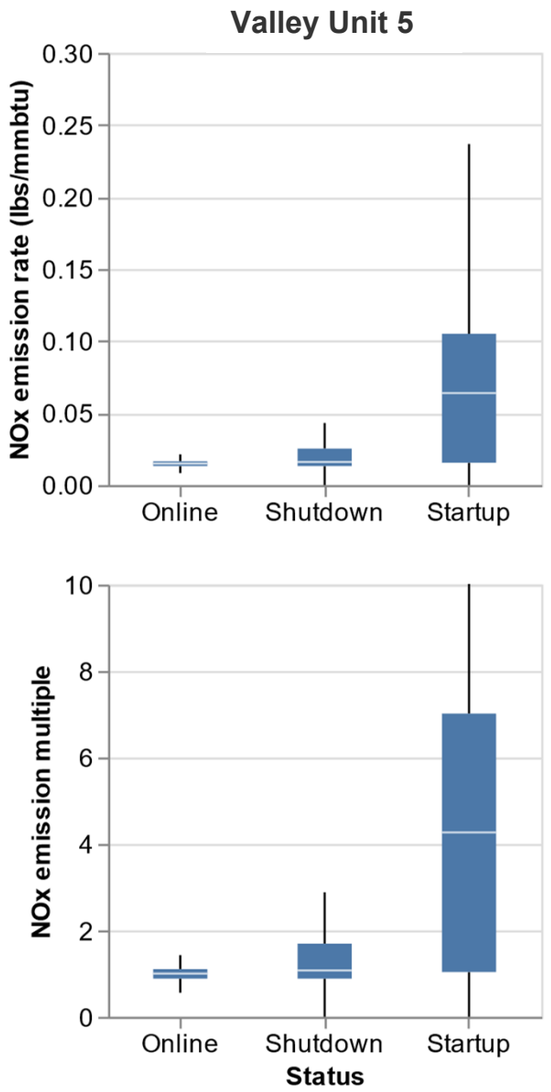
- Plants operating in steady state at full load perform best in terms of emissions
  - e.g., control technologies are operating with maximum effectiveness
- There are a few classic non-steady state conditions:
  - Startup
  - Shutdown
  - Ramping
  - Part-load (even if steady)



- These non-steady state conditions are also associated with reduced efficiency (heat rate)
  - We account for this change in estimating emission factors
- To estimate startup and shutdown emissions, we need to estimate the **emission factor and activity (count of these events and their duration)**

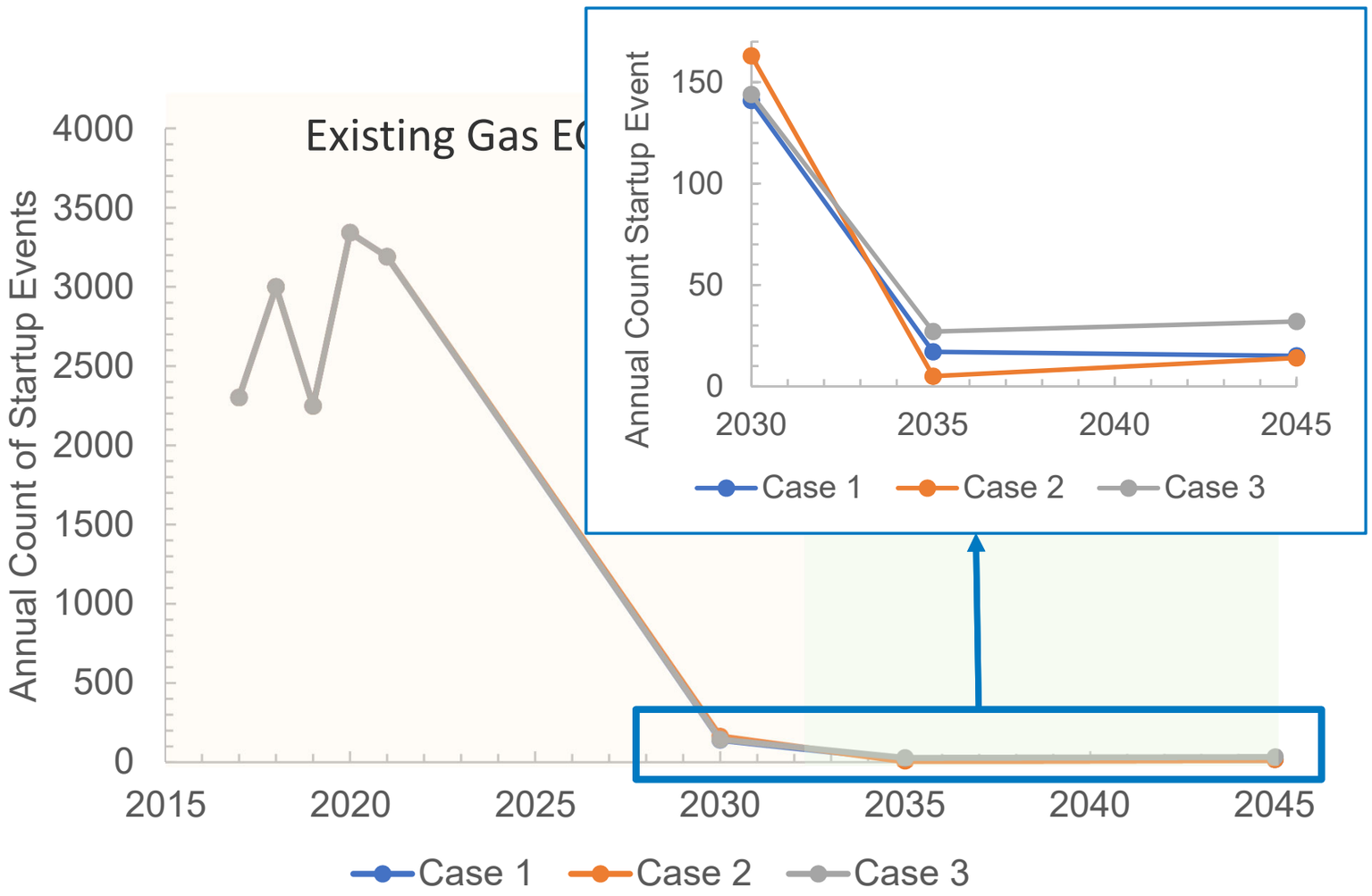
Non-steady state NOx emission factor

- Literature shows higher emissions during startup and shutdown events
  - Pollution abatement systems are less effective during startup/shutdown because they are not fully deployed
- **Startup and shutdown emissions are multiples higher than steady state emissions, across a very wide range**
  - See example figure to the right based on analysis of historical CEMS data for LADWP gas plants
- Emissions could conceivably be higher in part-load and ramping conditions
  - Upon analysis of CEMS data, this was not found to be the case for any LADWP unit
- **Therefore, we account for startup and shutdown events separate from "online" mode in our emissions analysis**



Startup frequency

PRELIMINARY RESULTS



- Startup events significantly decrease compared to historical along with total generation in SLTRP cases

Startup and shutdown duration

- Startup and shutdown events are short in duration and are limited by SCAQMD air permits
  - These durations have decreased over time

- We estimate average startup and shutdown times for existing generators based on analysis of historical CEMS data
  - For combustion turbines (CT): 10-15 min
  - For combined cycle (CC): 30-80 min

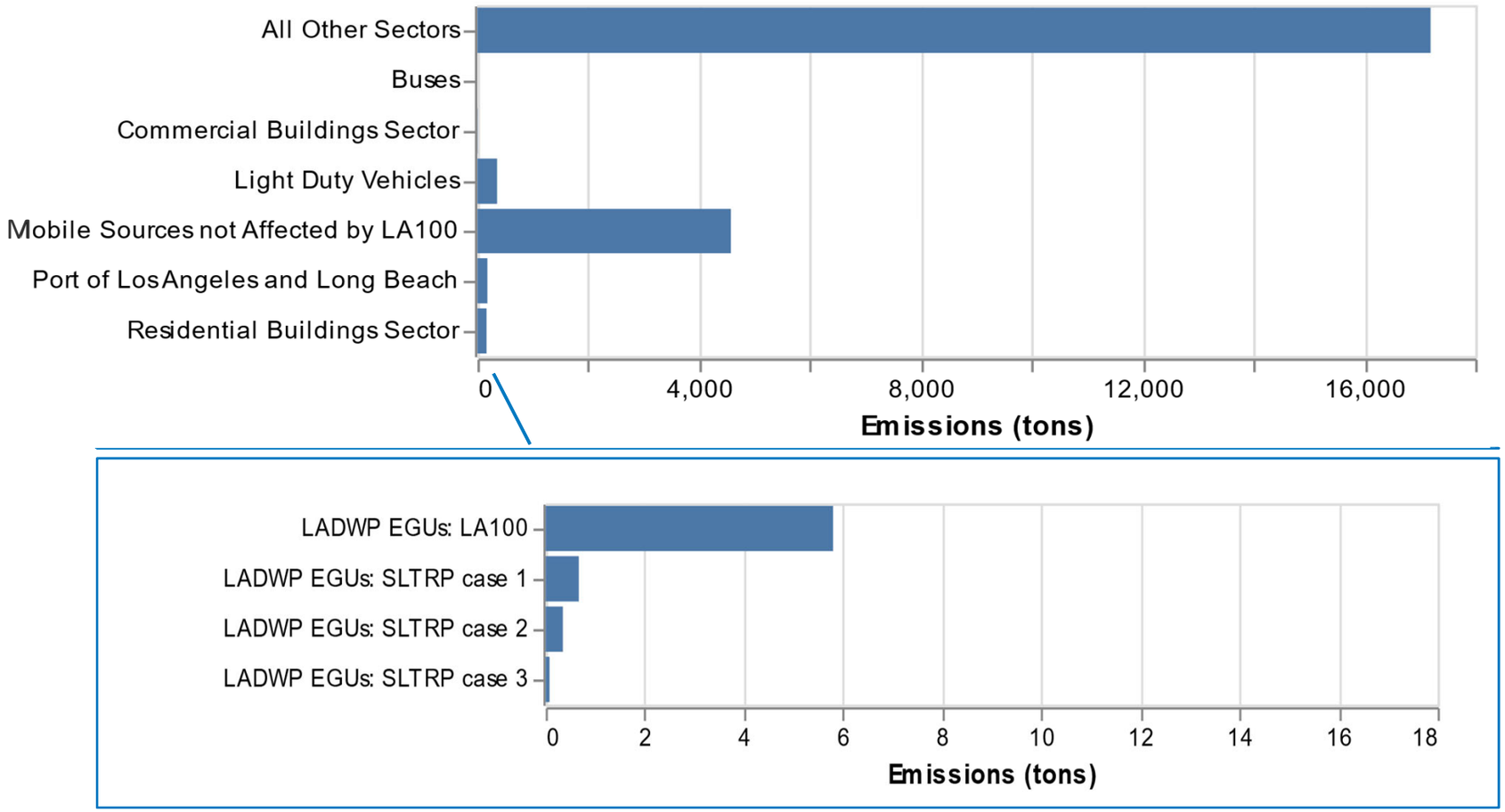
- For new units, the following assumptions are made based on historical performance of newest generator, Scattergood:
  - New CT peaker plants are assumed to have 10 min duration of both startup and shutdown,
  - New CC plants have 30 min and 10 min for startup and shutdown

NOx emissions estimation – our approach

To estimate future emissions, we make the following key assumptions:

- **Steady state:** All units will meet SCAQMD emission standards (Rule 1135)
- **Startup/shutdown**: leverage analysis of CEMS data for emissions multiplier.
  - In a **simplified analysis, we use the median estimate** from the range
  - In **more detailed emissions analyses**, to better reflect the uncertainty introduced with a wide range in emissions multiplier, we develop a **probabilistic assessment method**
    - Sample non-steady state emissions 10,000 times from 15-min CEMS data (2017–2021)
- **Natural gas and hydrogen combustion are assumed to have the same emission multipliers**

Comparison of SLTRP power sector annual NOx emissions to other sectors in 2045



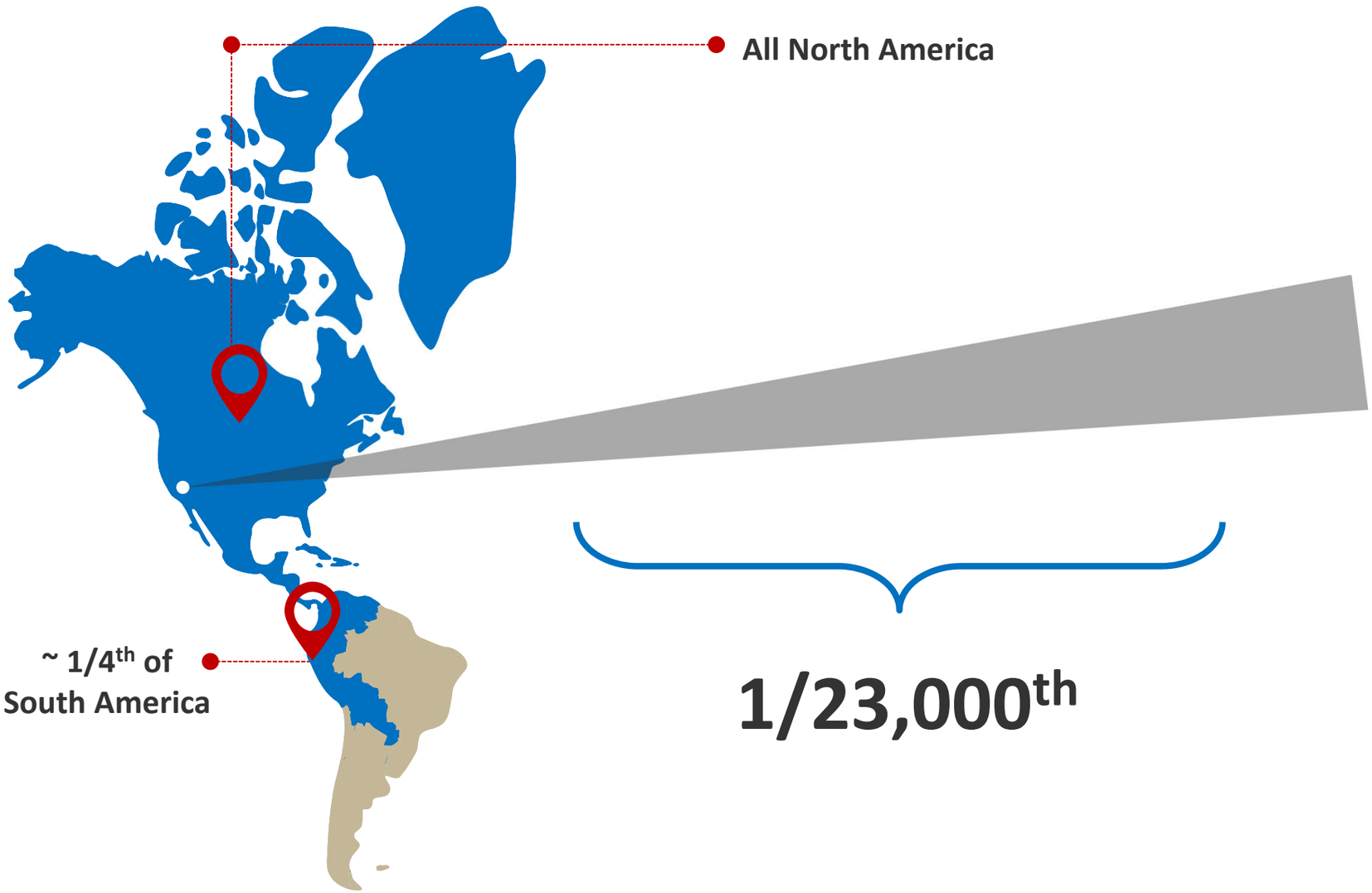
PRELIMINARY RESULTS

- SLTRP power sector emissions are ~23,000x less than total emissions from all other sectors
- Sum of emissions from all LADWP in-basin plants in the three SLTRP cases are <10% compared to LA100's Early & No Biofuels- High scenario

LA100: Early & No Biofuels - High scenario
SLTRP: median emission estimates
EGU = electricity generation unit

(note different x-axis scale)

Comparison in 2045 – A Sense of Scale



1/23,000th

Next Steps for Emissions Analyses: Three Methods

1. **Simplified annual**

   Median EFs

2. **Probabilistic annual**

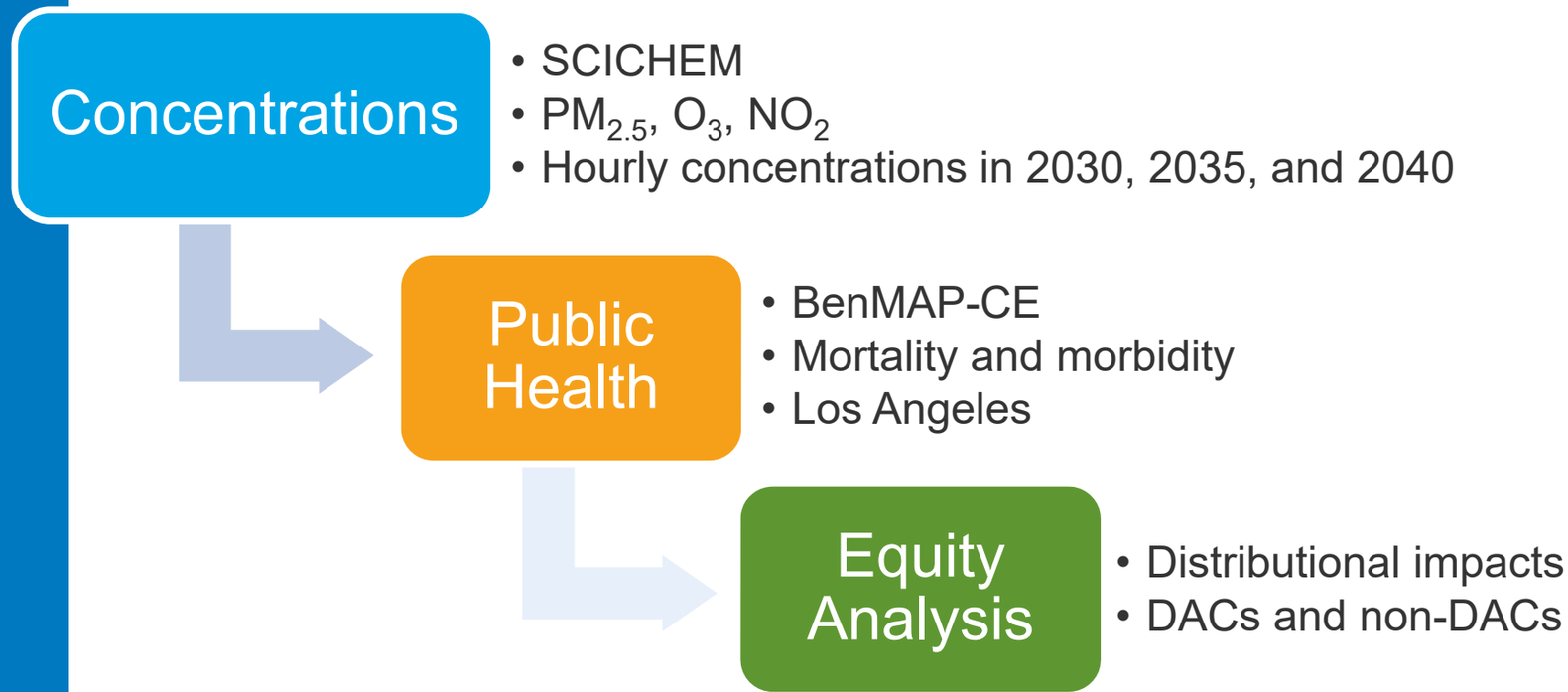
   10,000 samples from startup/shutdown EF distribution

3. **Probabilistic hourly**

   Developing best method

Photo from iStock - 1162853598

Next steps after emissions analysis



Note that for steps after the emissions analysis, we must use a single emissions estimate (median)

Q&A. Thank you!

www.nrel.gov

List of Acronyms and Abbreviations

BenMAP-CE: Environmental Benefits Mapping and Analysis Program - Community Edition

MMBTU: metric million British thermal unit

CEMS: continuous emissions monitoring system

CO: carbon monoxide

DAC: disadvantaged community

DER: distributed energy resources

EF: emissions factor

EGU: electric generation unit

GWh: gigawatt-hour

H_2: hydrogen

LADWP: Los Angeles Department of Water and Power

NREL: National Renewable Energy Laboratory

NO_2: nitrogen dioxide

Non-DAC: non-disadvantaged community

NOx: nitrogen oxide

O_3: ground-level ozone

PM: particulate matter

$PM_{2.5}$: fine particulate matter

RPS: renewable power system

SCAQMD: South Coast Air Quality Management District

SCR: selective catalytic reduction

SCICHEM: Second Order Closure Integrated Puff Model with Chemistry

SLTRP: Power Strategic Long-Term Resource Plan

VOC: volatile organic compounds

Discussion and Q&A

CLOSING REMARKS

JASON RONDOU

Director of Resource Planning, Development, and Programs

NEXT STEPS

- **Selection of the 2022 SLTRP Recommended Case by Executive Management**
- **Presentation to Board of Water and Power Commissioners (October 11, 2022)** Progress update and feedback
- **Release Draft SLTRP:** Incorporate feedback from Advisory Group, Public, and Board
- **Finalize and Approve SLTRP:** Complete resource planning cycle and prepare for future iterations
- **Prepare for Future SLTRP**: Conduct Lessons Learned and continue dynamic development to prepare for 2023 SLTRP
- **Prepare Integrated Resource Plan based on 2022 SLTRP:** Requirement to submit to California Energy Commission by end of 2023
- **Continued Analysis of SLTRP Air Quality and Health Impacts**
- **LA100 Equity Strategies Updates will feed into the SLTRP as information becomes available**

SLTRP Board Date – October 11, 2022

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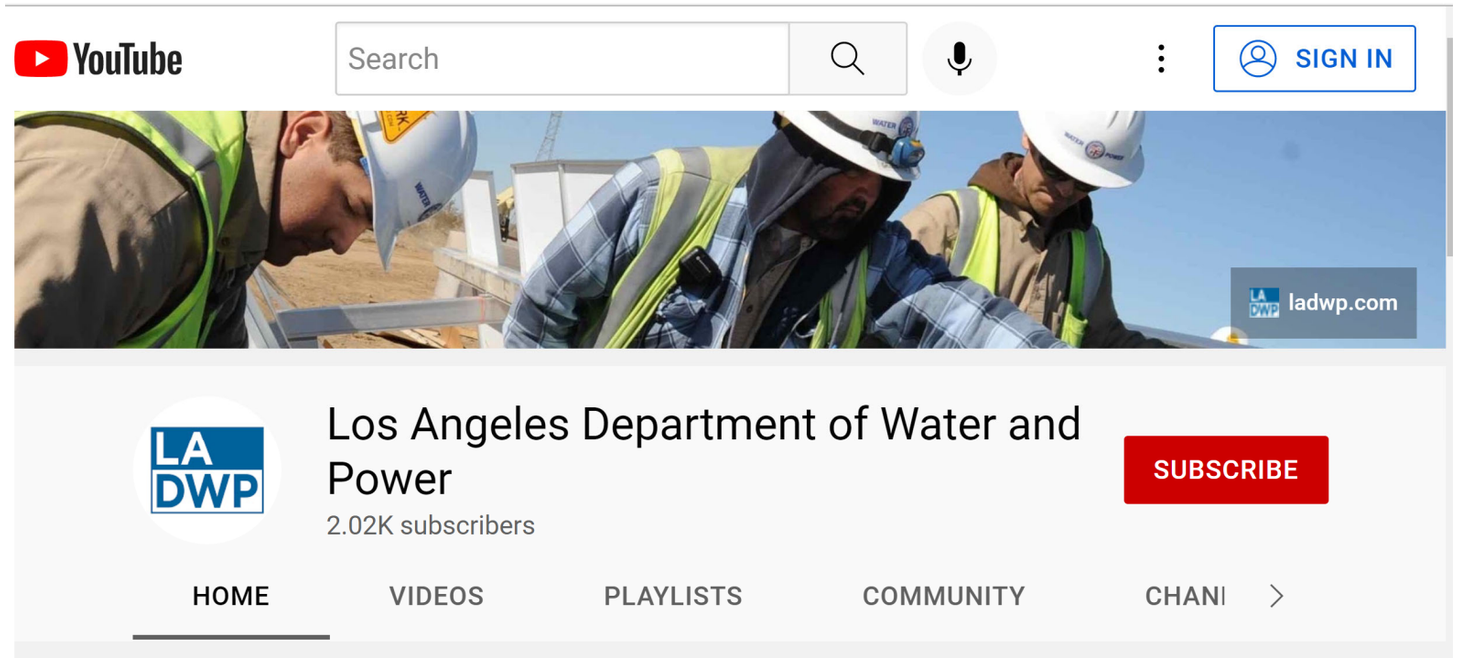

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Agenda for September 13, 2022 | Agenda for August 23, 2022 | Agenda for August 9, 2022 »

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BOARD OF WATER AND POWER COMMISSIONERS
DEPARTMENT OF WATER AND POWER OF THE CITY OF LOS ANGELES
111 NORTH HOPE STREET, Room 1555-H, LOS ANGELES, CA 90012

REGULAR MEETING AGENDA

Tuesday, September 13, 2022, at 10:00 A.M.

Board of Water and Power Commissioners

President Cynthia McClain-Hill
Vice President Cynthia Ruiz
Commissioner Jill Banks Barad-Hopkins
Commissioner Mia Lehrer
Commissioner Nicole Neeman Brady

Wrap Up

Board Presentation:
October 11, 2022

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