The Los Angeles 100% Renewable Energy Study (LA100):

Findings and Insights for Other Locations

Jaquelin Cochran, Ph.D.
Director, Grid Planning and Analysis Center
January 2023

Photo from iStock-1344124162

The Power System Is Changing

Video from iStock-639464770

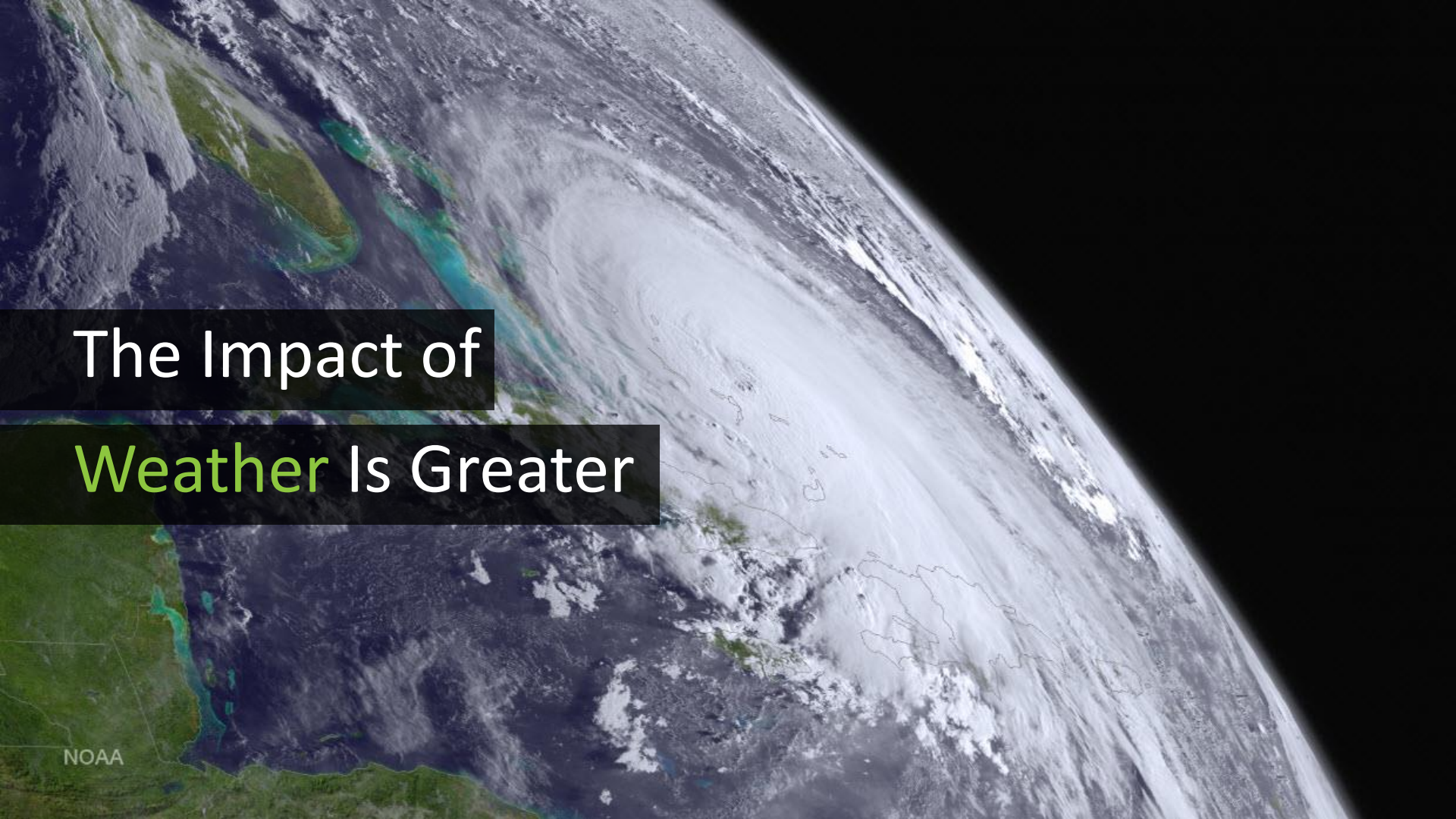

The Impact of
Weather Is Greater
NOAA


Photo from iStock-635716108
Electricity Demand
Is Growing

Reliability and Resilience Are Even More Paramount

Photos from iStock-1372140162 and Getty-1150969068

New Technologies

Enable Intelligent Operations

Graphics from NREL

New Technologies

Transform Customer Expectations

Photos from iStock-1354581999 and NREL


Photo from Rodrigo Peña
Ensuring All Communities
Benefit from These Changes


Photo from NREL
Anticipating Challenges
and Seizing Opportunities

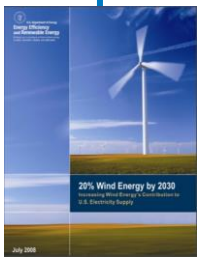

While Keeping People
At The Center of the Equation
Photo from NREL

More than a decade of visionary power sector and renewable integration analyses

2008

Now

20% Wind by 2030 (2008)

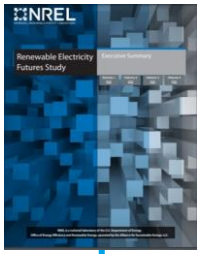


Eastern Wind Integration & Transmission (2010)

Western Wind & Solar Integration Study (WWSIS) 1 (2010)

SunShot Vision (2012)

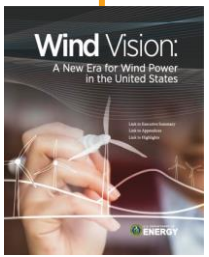
RE Futures (2012)



WWSIS 2 (2013)

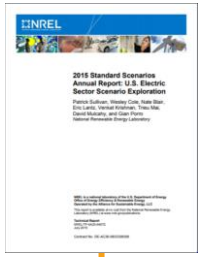
WWSIS 3 (2014)

Wind Vision (2015)



ERGIS (2016)

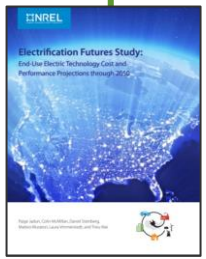
Standard Scenarios (2015 –)



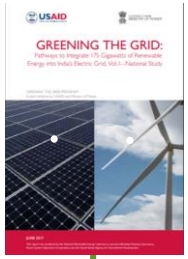
Hydropower Vision (2016)

On the Path to SunShot (2016)

Electrification Futures Study (2017 – 2021)



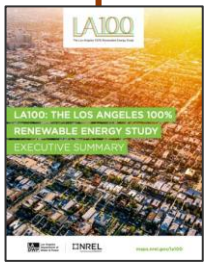
Greening the Grid (2017)



Geothermal Vision (2019)

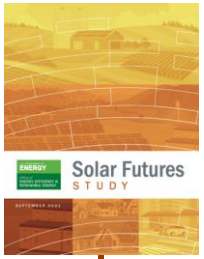
NARIS (2021)

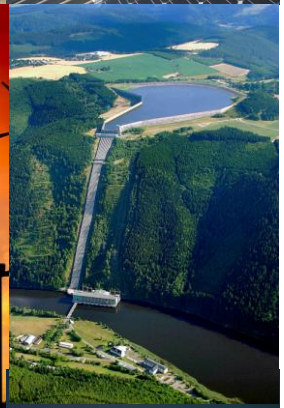
LA100 (2021)



Storage Futures Study (2021 – 2022)

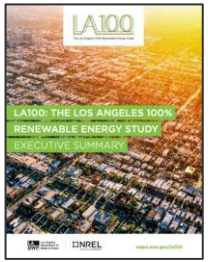
Solar Futures Study (2021)



LA100

The Los Angeles 100% Renewable Energy Study



Los Angeles Department of Water and Power (LADWP)

L.A.'s Current Power Grid

7,880 MW of Generation Capacity
Peak Load: 6,502 MW (Aug. 31, 2017)
4 million residents


Mechanix
Mechanix
Mechanix


FEDERAL RESERVE NOTE
6816 L

Scenarios

LA100 Scenarios

Each Scenario Evaluated Under Different Customer Demand Projections (different levels of energy efficiency, electrification, and demand response)

- Moderate
- High
- Stress

SB100

Evaluated under Moderate, High, and Stress Load Electrification

- 100% clean energy by **2045**
- Only scenario with a target based on retail sales, not generation
- Only scenario that allows up to 10% of the target to be natural gas offset by renewable electricity credits
- Allows existing nuclear and upgrades to transmission

Early & No Biofuels

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2035**, 10 years sooner than other scenarios
- No natural gas generation or biofuels
- Allows existing nuclear and upgrades to transmission

Transmission Focus

Evaluated under Moderate and High Load Electrification

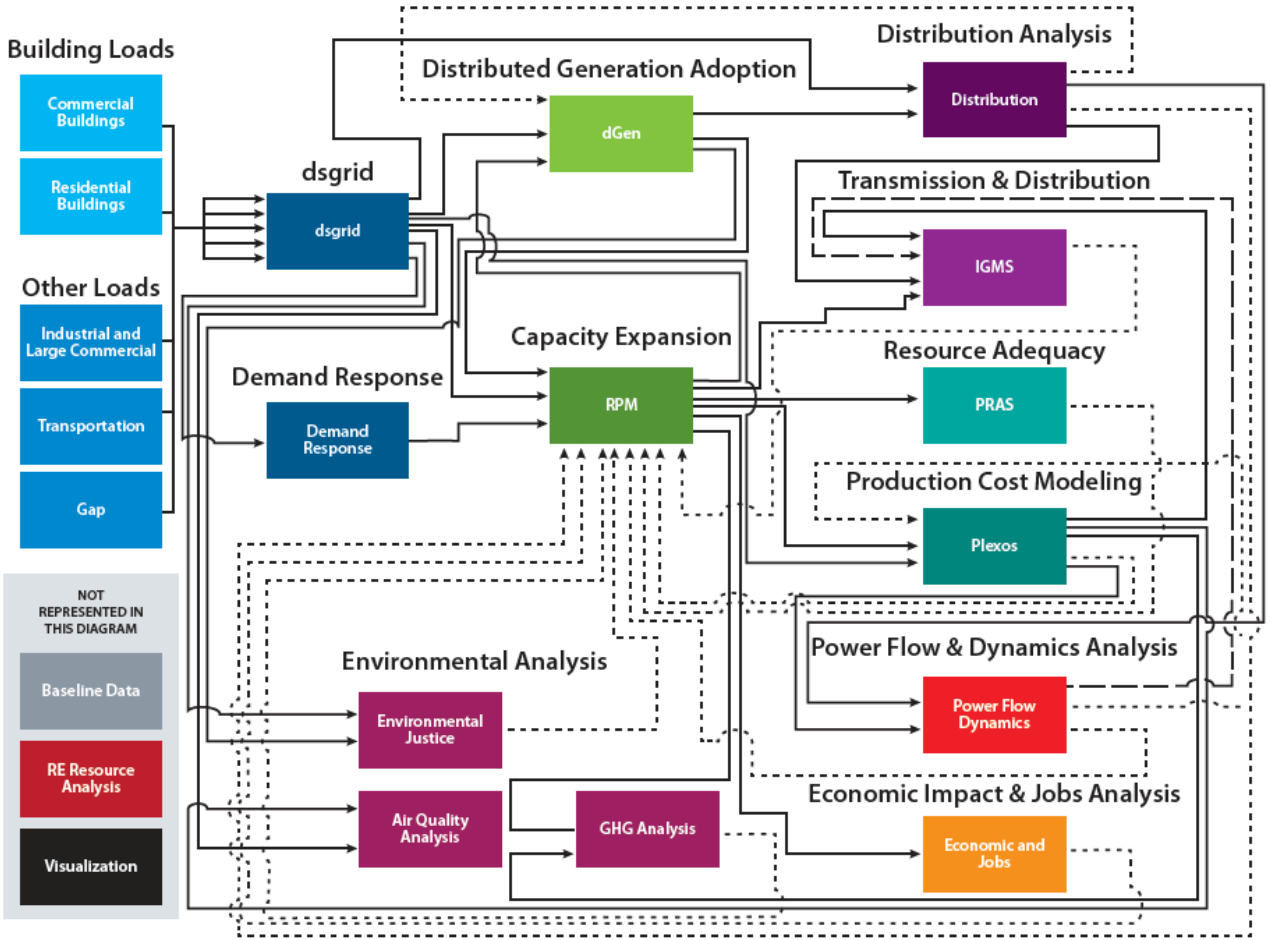
- 100% clean energy by **2045**
- Only scenario that builds new transmission corridors
- No natural gas or nuclear generation

Limited New Transmission

Evaluated under Moderate and High Load Electrification

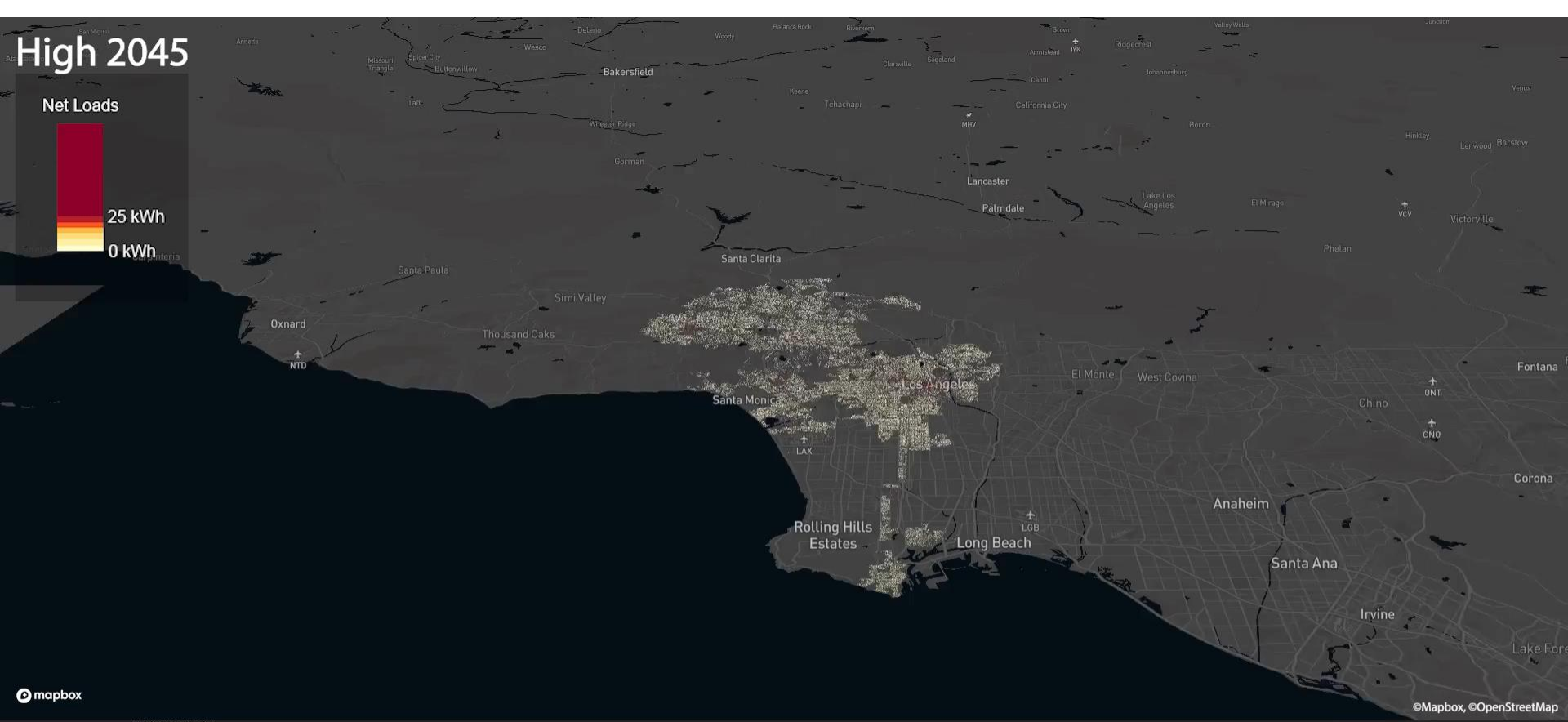
- 100% clean energy by **2045**
- Only scenario that does not allow upgrades to transmission beyond currently planned projects
- No natural gas or nuclear generation

Unprecedented Model Resolution and Integration



Over 100 million simulations

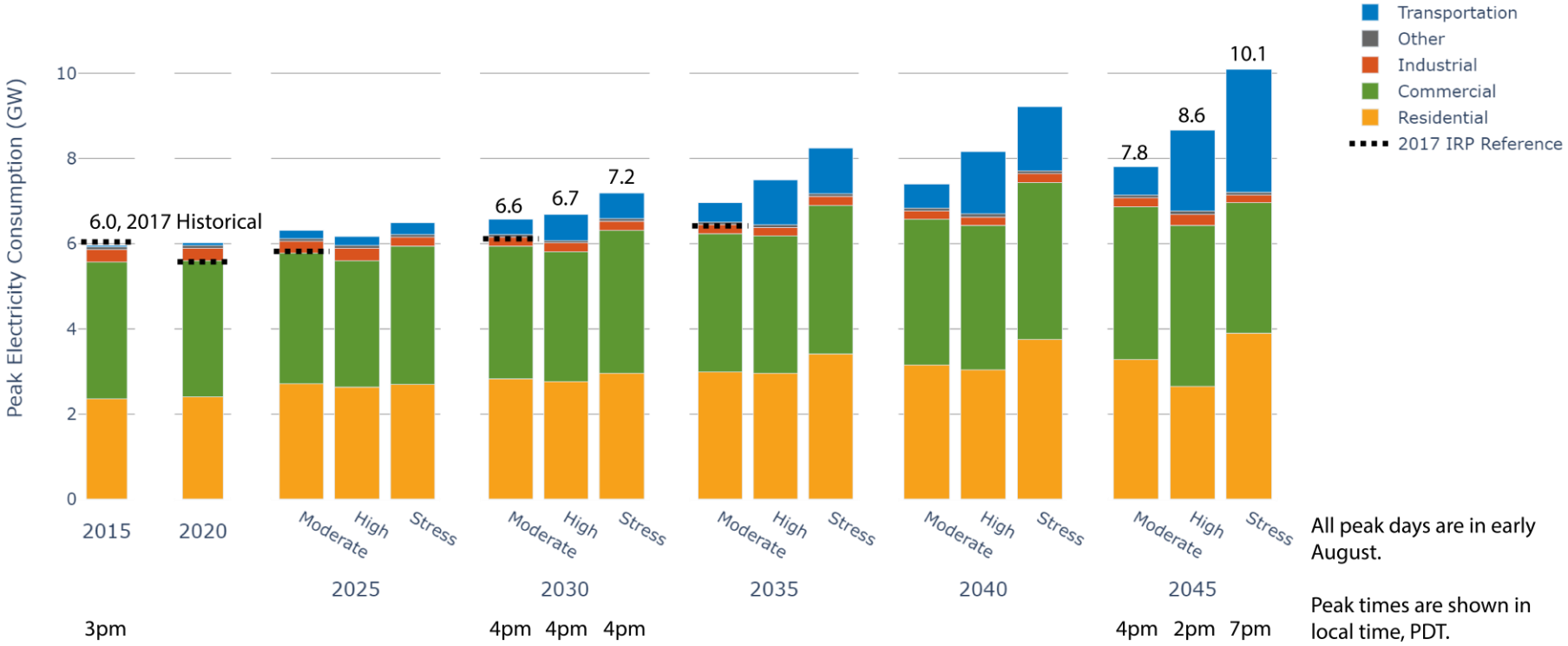
50 Terabytes of Data


High 2045
Net Loads
25 kWh
0 kWh
Bakersfield
Lancaster
Palmdale
Santa Clarita
Santa Paula
Simi Valley
Oxnard
Thousand Oaks
Los Angeles
Santa Monica
El Monte
West Covina
Chino
Fontana
Corona
Anaheim
Rolling Hills Estates
Long Beach
Santa Ana
Irvine
Victorville
LAX
LGB
NTD
ONT
CNO
VCV
mapbox
©Mapbox, ©OpenStreetMap


Fri 08/10 06:00
Load (GW)
8
7
6
5
4
3
2
1
0

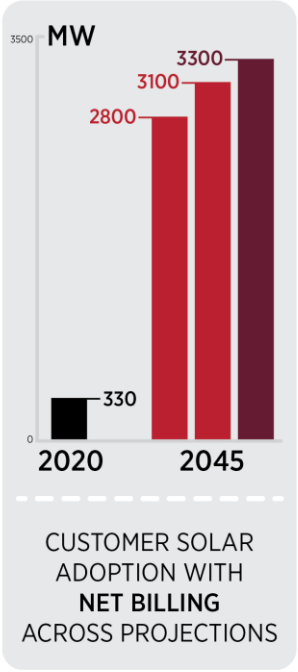
Select Results

Growth in customer demand for electricity



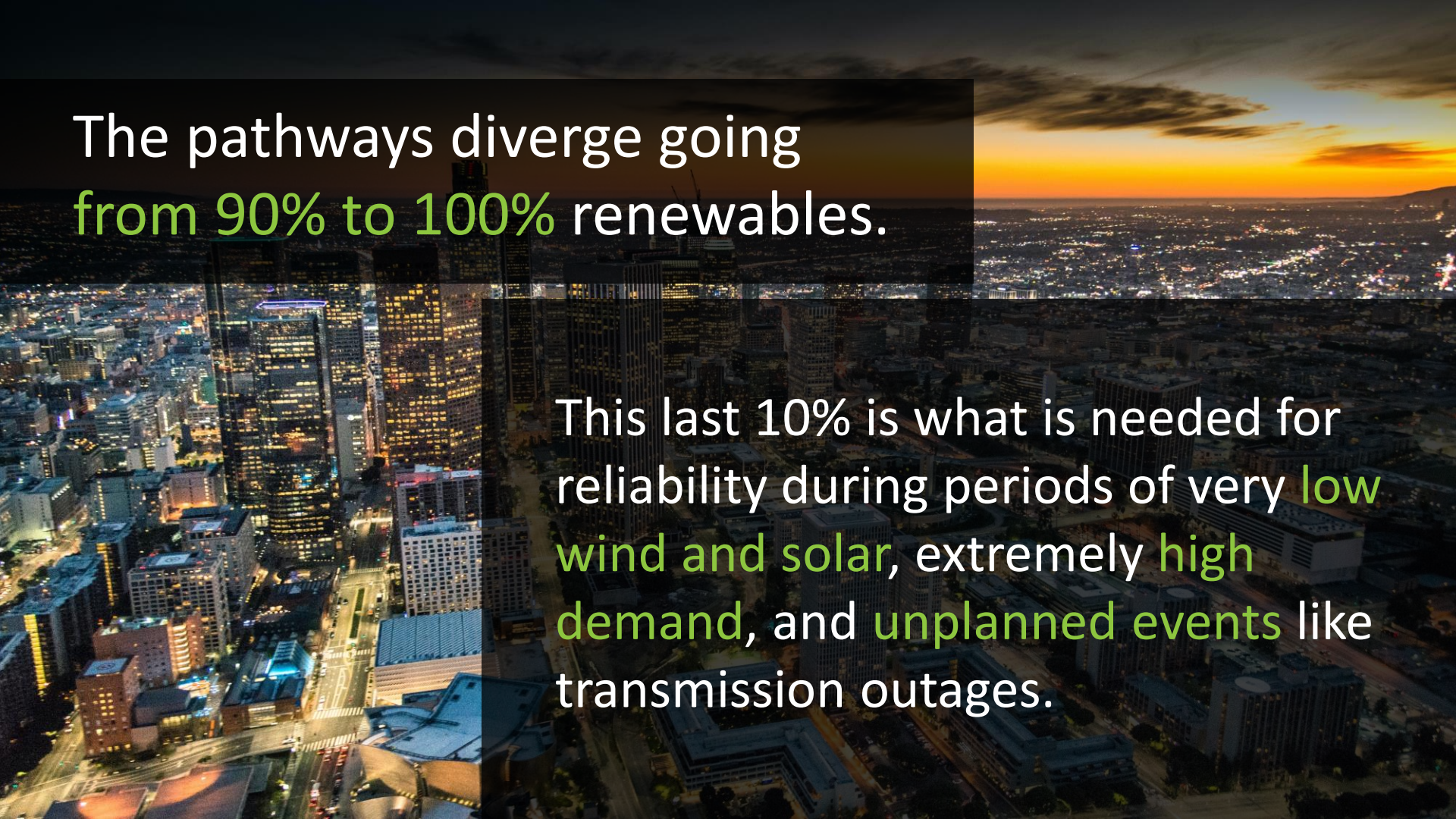
By 2045 rooftop solar would be an economic choice for nearly all households and businesses

Adoption would occur on 22%–38% of all existing single-family homes, up from 6% in 2020



2020 COMPARISON MODERATE HIGH STRESS


In all scenarios, wind and solar provide 69%–87% of future electricity demand.

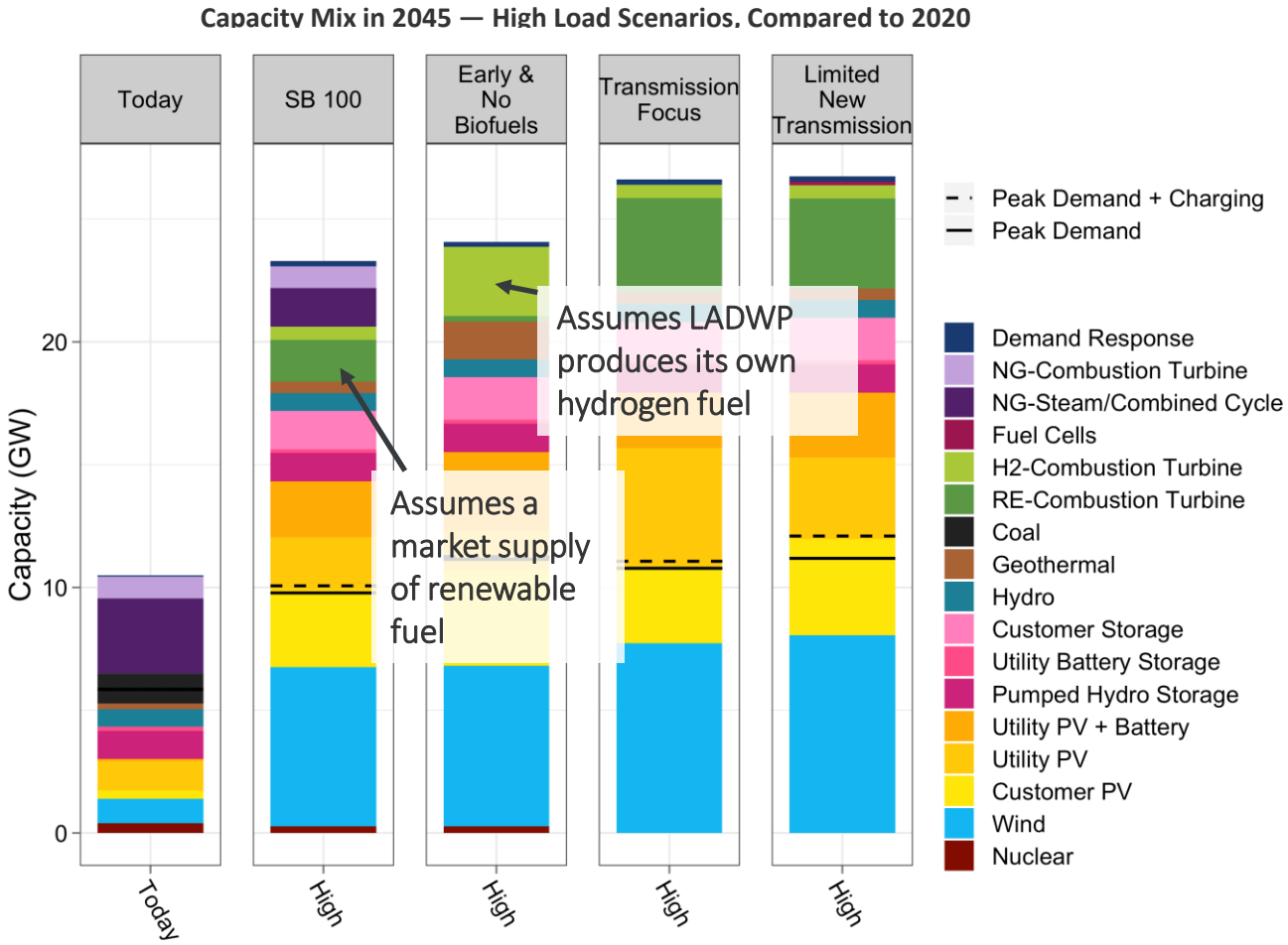


The pathways diverge going from 90% to 100% renewables.

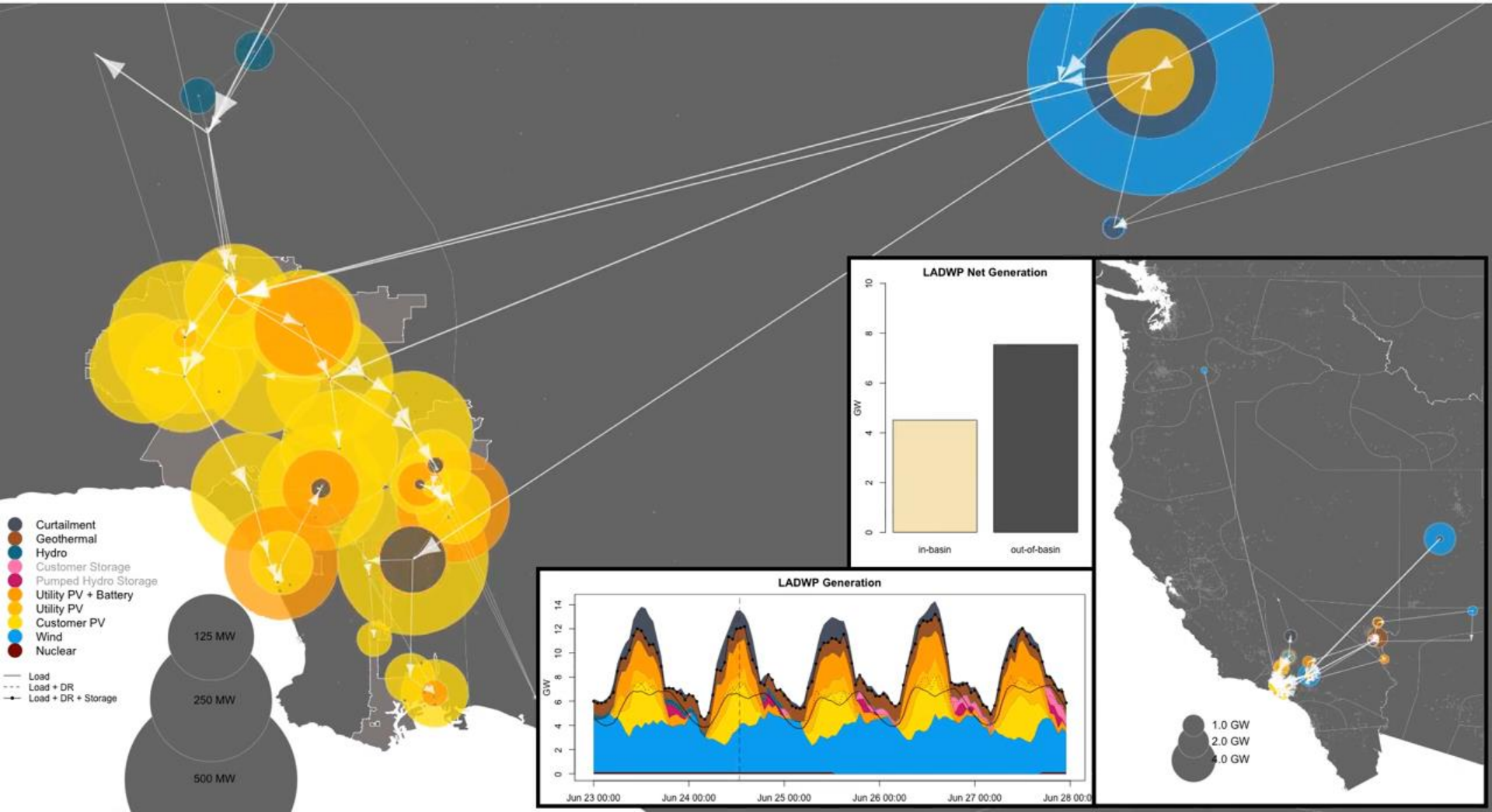
This last 10% is what is needed for reliability during periods of very low wind and solar, extremely high demand, and unplanned events like transmission outages.

Meeting the last 10% on the road to 100% renewables

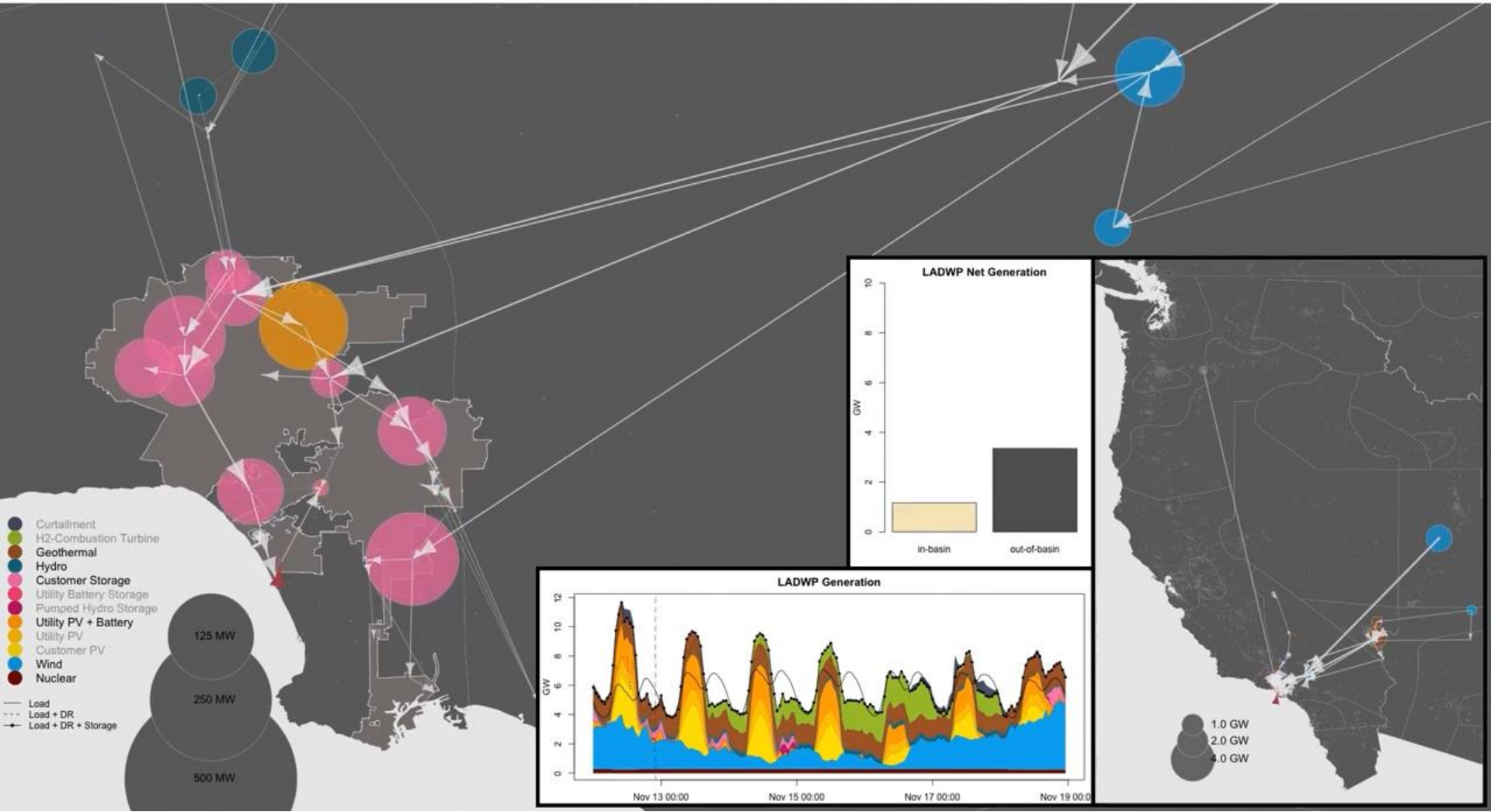
Producing hydrogen (rather than buying commercially available RE fuels) adds ~20% to cumulative costs



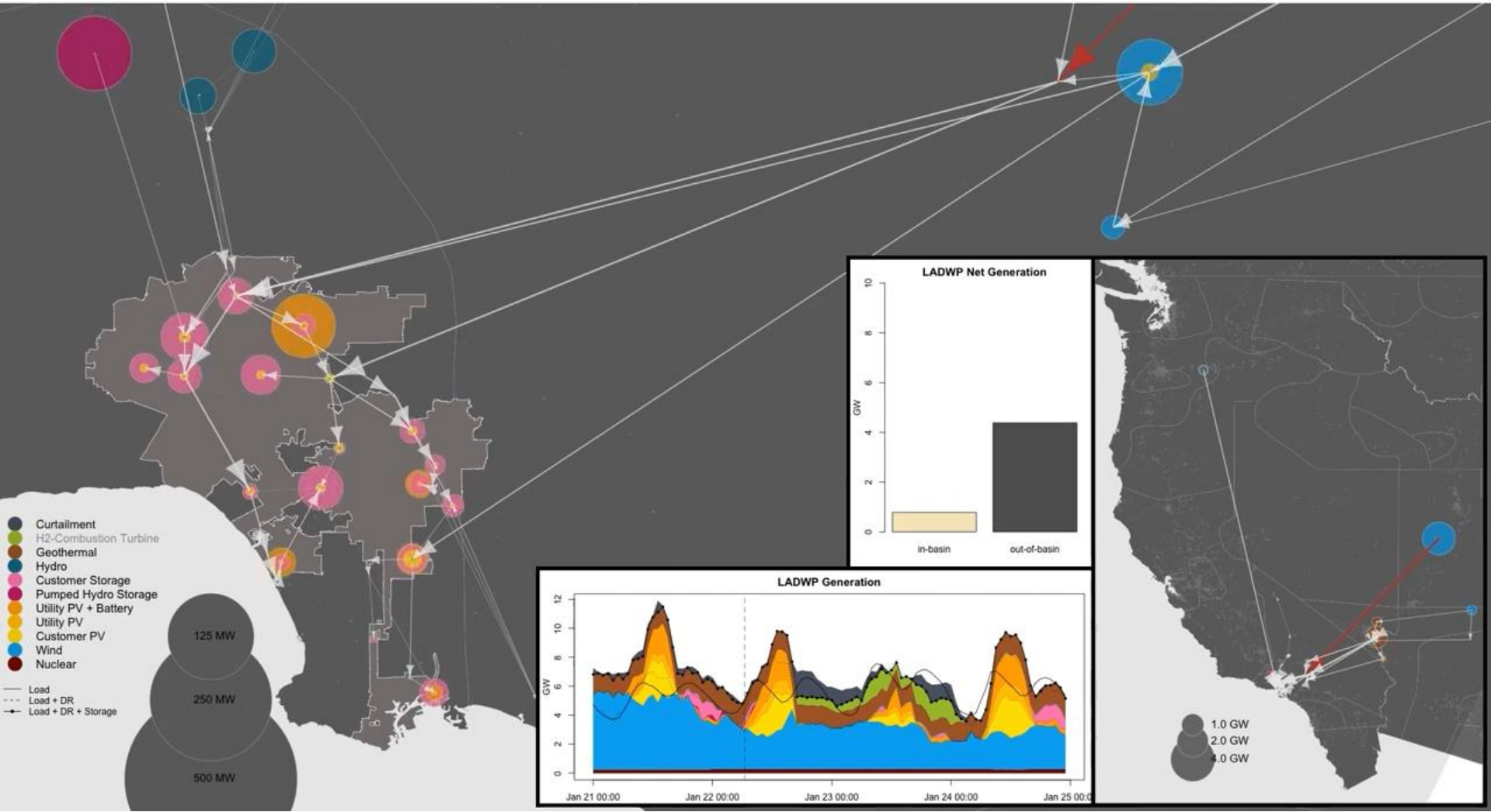
Early & No Biofuels – High 06-24-2045 12:45



Early & No Biofuels – High 11-12-2045 22:00



Early & No Biofuels – High 01-22-2045 06:30



How do we get to the 100% RE target?

Example scenario:

2035 target, no biofuels

Early & No Biofuels Scenario—High Electrification: 2020

Customer Rooftop Solar

340 MW

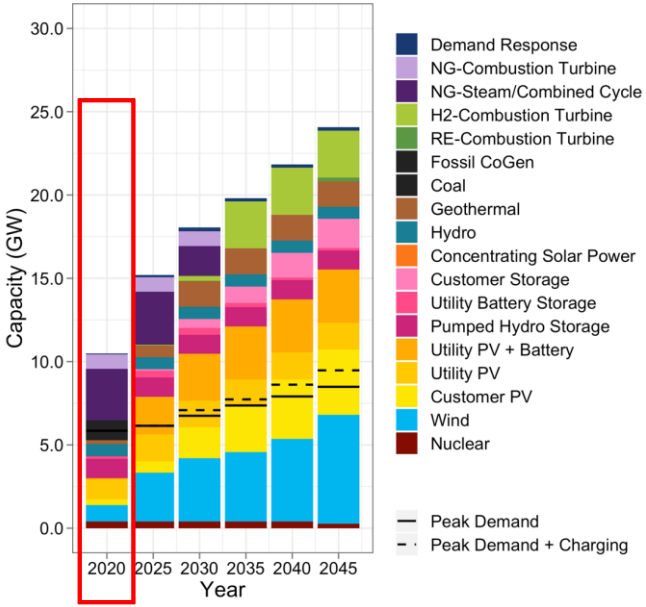
Renewable Energy (utility scale)

Storage (including coupled with solar)

1,300 MW

Solar + Battery: 90 MW
Solar: 1,200 MW
Wind: 1,000 MW
Geothermal: 230 MW

Capacity Mix



Clean Energy Generation: 45%

Early & No Biofuels Scenario—High Electrification: 2020

Customer Rooftop Solar

340 MW

Renewable Energy (utility scale)

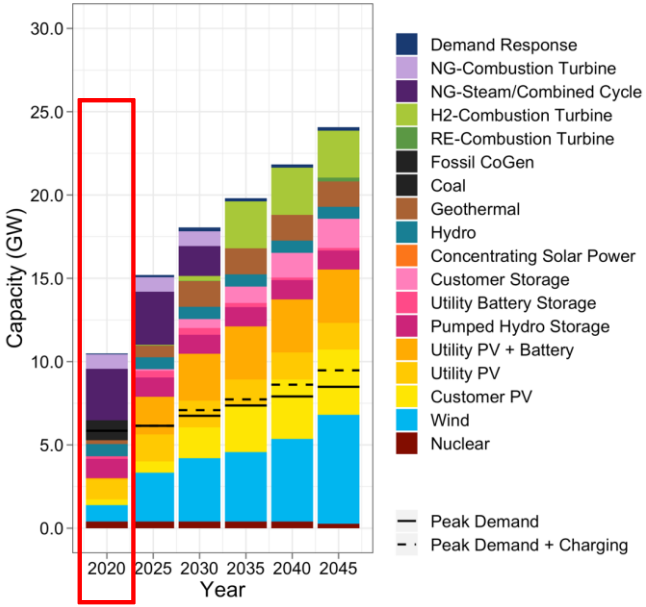
Storage (including coupled with solar)

1,300 MW

Solar + Battery: 90 MW
Solar: 1,200 MW
Wind: 1,000 MW
Geothermal: 230 MW

Clean Energy Generation: 45%

Capacity Mix



Early & No Biofuels Scenario—High Electrification: 2020

Customer Rooftop Solar

340 MW

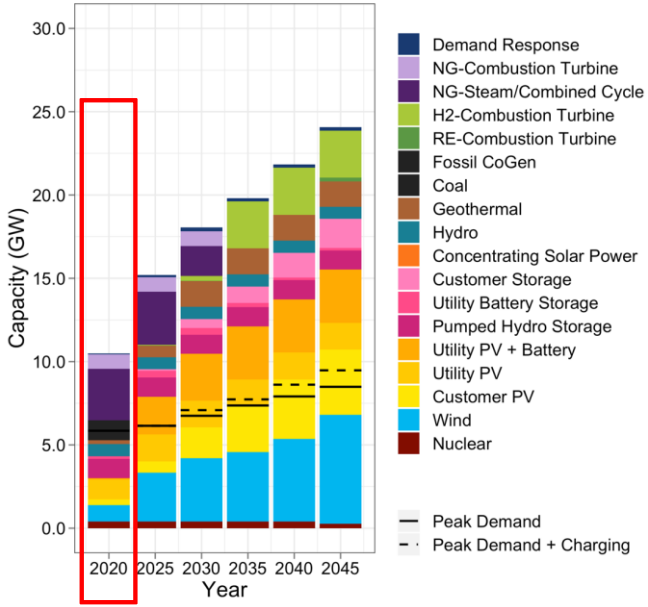
Renewable Energy (utility scale)

Storage (including coupled with solar)

1,300 MW

Solar + Battery: 90 MW
Solar: 1,200 MW
Wind: 1,000 MW
Geothermal: 230 MW

Capacity Mix



Clean Energy Generation: 45%

Early & No Biofuels Scenario—High Electrification: 2025

Customer Rooftop Solar

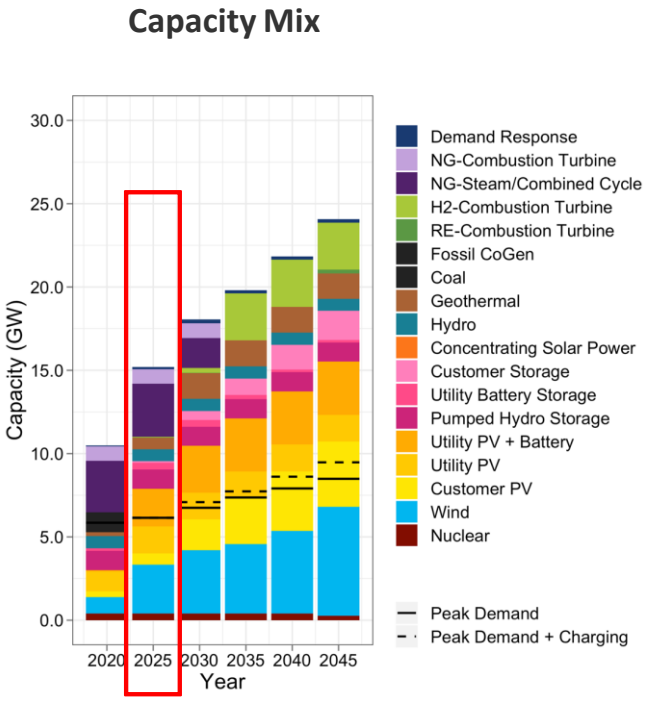
690 MW (+350)

Renewable Energy (utility scale)

Storage (including coupled with solar)

1,700 MW (+400)

Solar + Battery: 2,300 MW (+2,200)
Solar: 1,600 MW (+400)
Wind: 2,900 MW (+1,900)
Geothermal: 690 MW (+460)



Clean Energy Generation: 90%

Early & No Biofuels Scenario—High Electrification: 2025

Customer Rooftop Solar

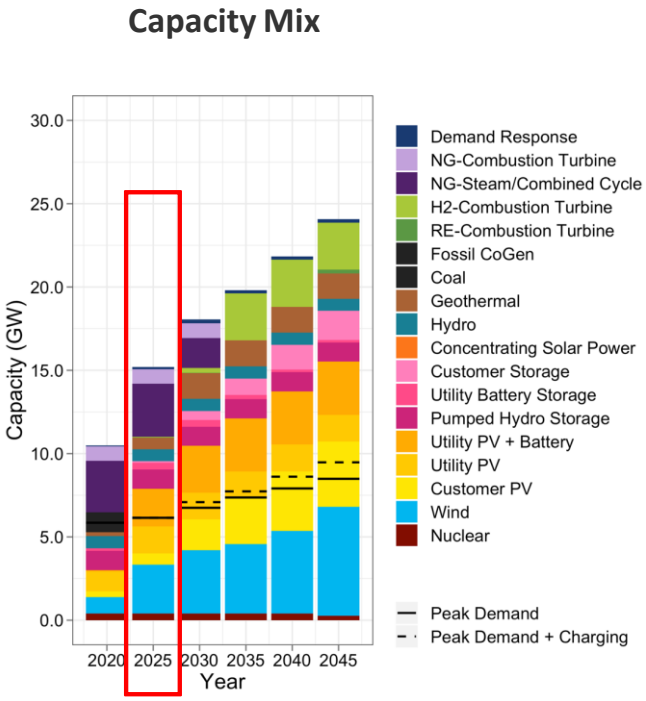
690 MW (+350)

Renewable Energy (utility scale)

Storage (including coupled with solar)

1,700 MW (+400)

Solar + Battery: 2,300 MW (+2,200)
Solar: 1,600 MW (+400)
Wind: 2,900 MW (+1,900)
Geothermal: 690 MW (+460)



Clean Energy Generation: 90%

Early & No Biofuels Scenario—High Electrification: 2025

Customer Rooftop Solar

690 MW (+350)

Renewable Energy (utility scale)

Storage (including coupled with solar)

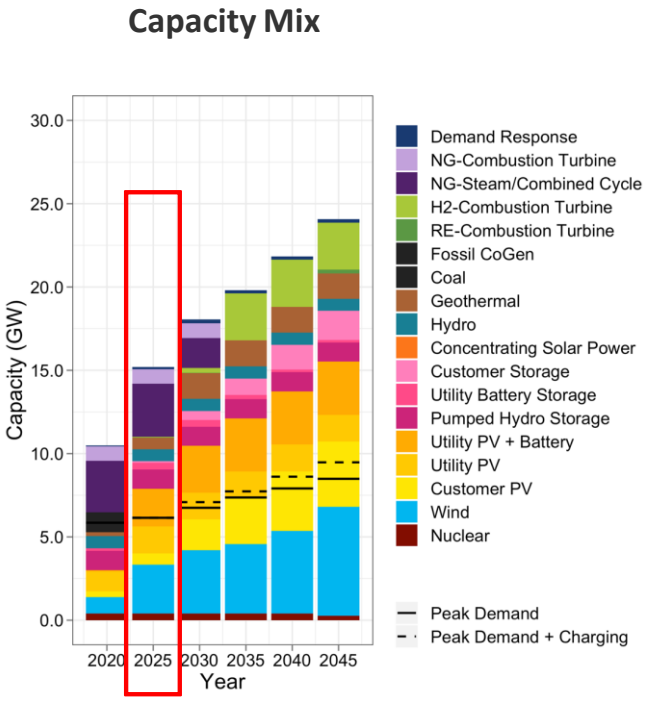
1,700 MW (+400)

Solar + Battery: 2,300 MW (+2,200)

Solar: 1,600 MW (+400)

Wind: 2,900 MW (+1,900)

Geothermal: 690 MW (+460)



Clean Energy Generation: 90%

Early & No Biofuels Scenario—High Electrification: 2030

Customer Rooftop Solar

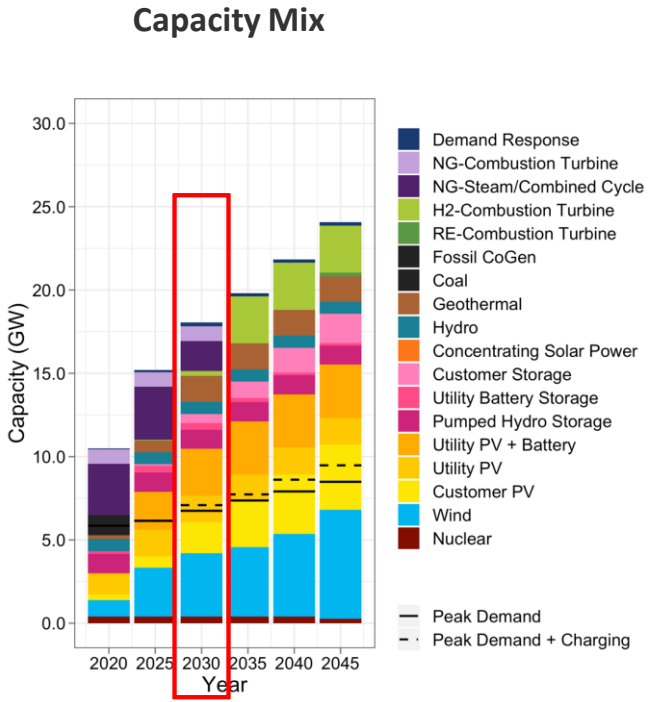
1,900 MW (+1,200)

Renewable Energy (utility scale)

Storage (including coupled with solar)

2,100 MW (+400)

Solar + Battery: 2,800 MW (+500)
Solar: 1,600 MW (+0)
Wind: 3,800 MW (+900)
Geothermal: 1,600 MW (+900)



Clean Energy Generation: 98%

Early & No Biofuels Scenario—High Electrification: 2030

Customer Rooftop Solar

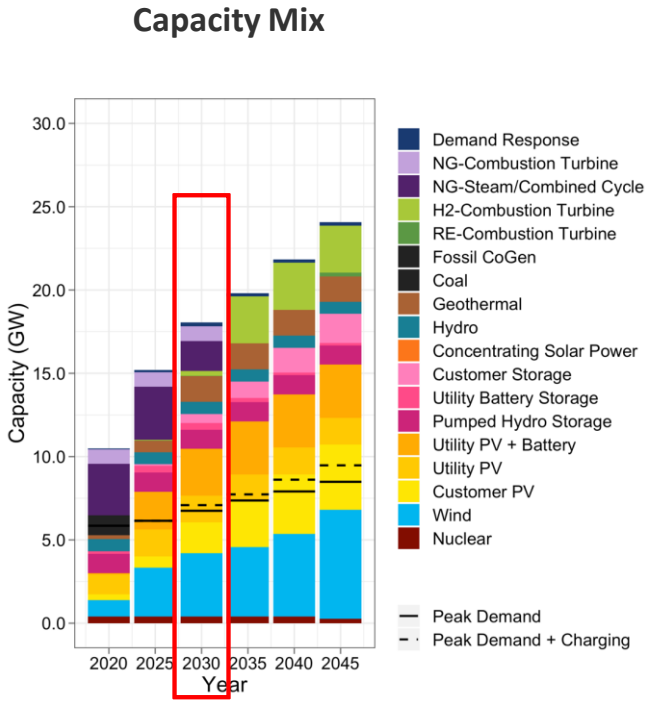
1,900 MW (+1,200)

Renewable Energy (utility scale)

Storage (including coupled with solar)

2,100 MW (+400)

Solar + Battery: 2,800 MW (+500)
Solar: 1,600 MW (+0)
Wind: 3,800 MW (+900)
Geothermal: 1,600 MW (+900)



Clean Energy Generation: 98%

Early & No Biofuels Scenario—High Electrification: 2030

Customer Rooftop Solar

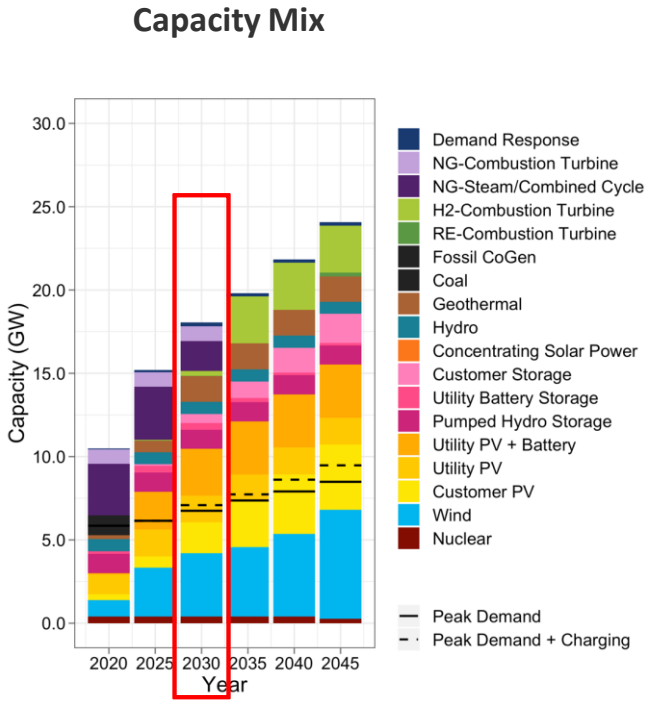
1,900 MW (+1,200)

Renewable Energy (utility scale)

Storage (including coupled with solar)

2,100 MW (+400)

Solar + Battery: 2,800 MW (+500)
Solar: 1,600 MW (+0)
Wind: 3,800 MW (+900)
Geothermal: 1,600 MW (+900)



Clean Energy Generation: 98%

Early & No Biofuels Scenario—High Electrification: 2035

Customer Rooftop Solar

2,700 MW (+800)

Renewable Energy (utility scale)

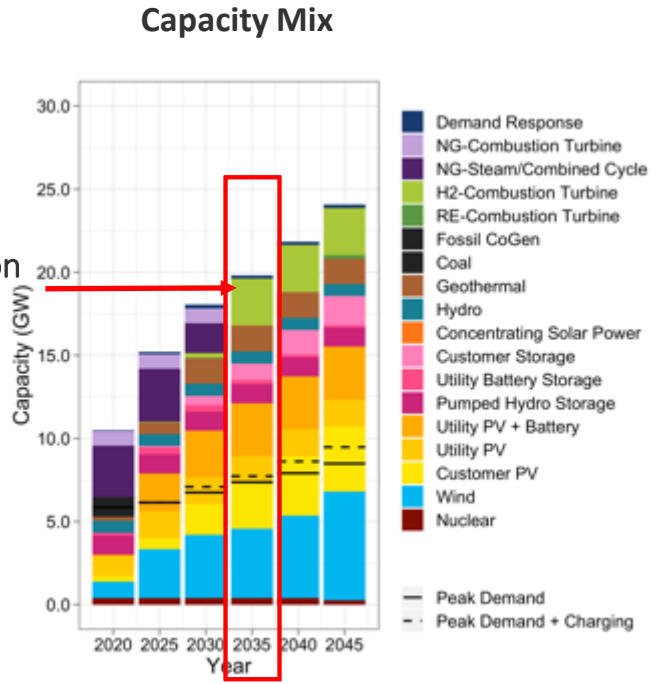
Solar + Battery: 3,200 MW (+400)
Solar: 1,600 MW (+0)
Wind : 4,200 MW (+400)
Geothermal: 1,600 MW (+0)

Storage (including coupled with solar)

2,400 MW (+300)

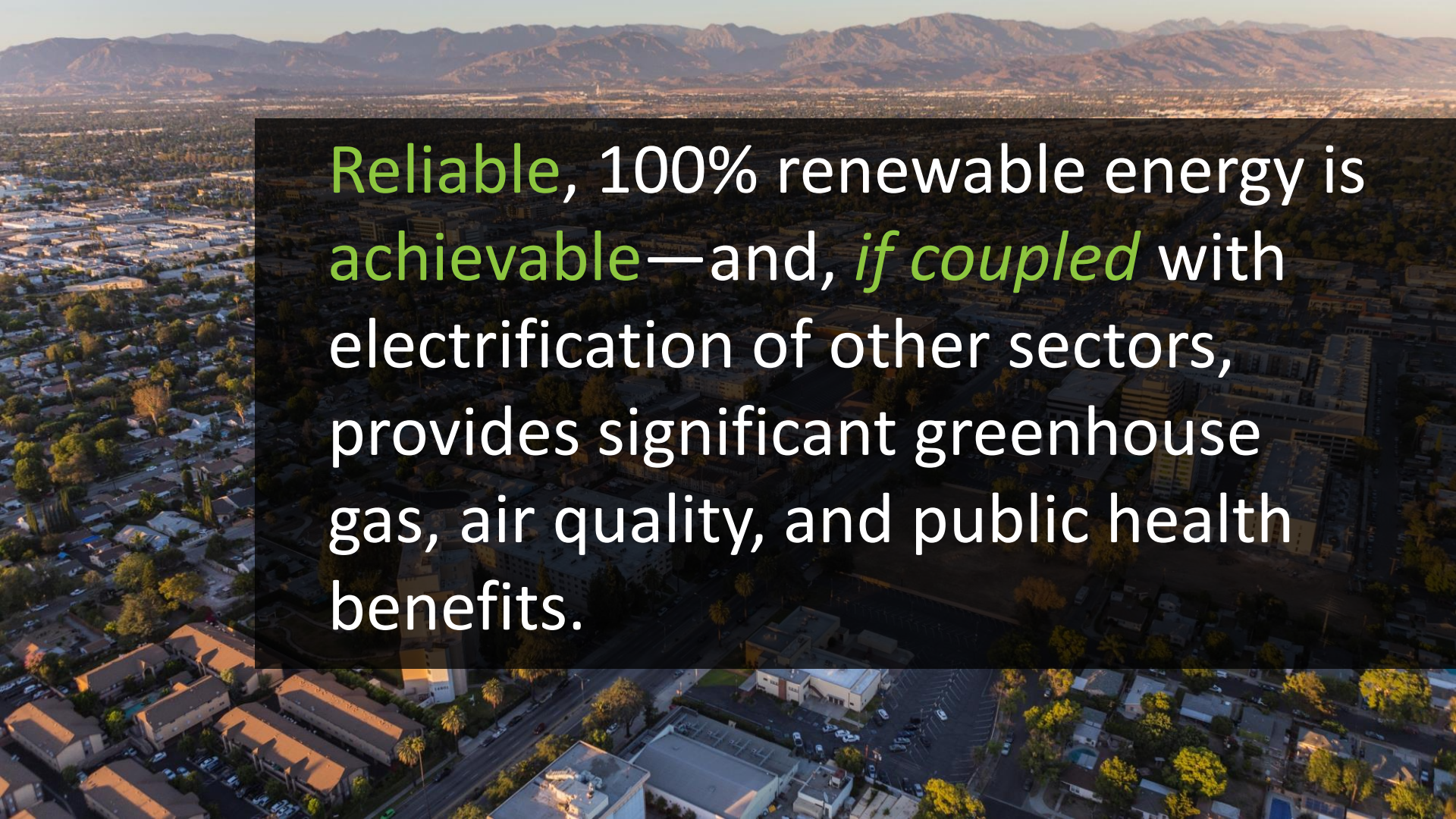
Hydrogen Combustion Turbines

+2,500 MW in LA



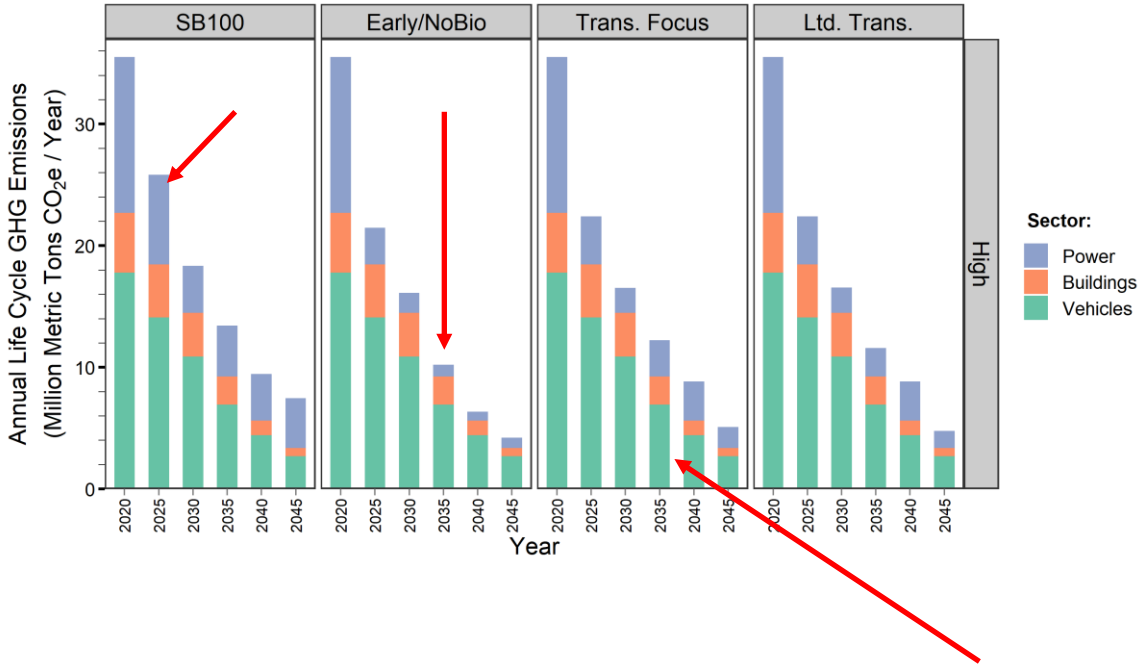
Clean Energy Generation: 100%

Identifying alternative options for firm, in-basin capacity likely represents the largest opportunity to reduce the costs of the transition and points to the highest priorities for R&D: hydrogen and extended demand response.


Reliable, 100% renewable energy is achievable—and, *if coupled* with electrification of other sectors, provides significant greenhouse gas, air quality, and public health benefits.

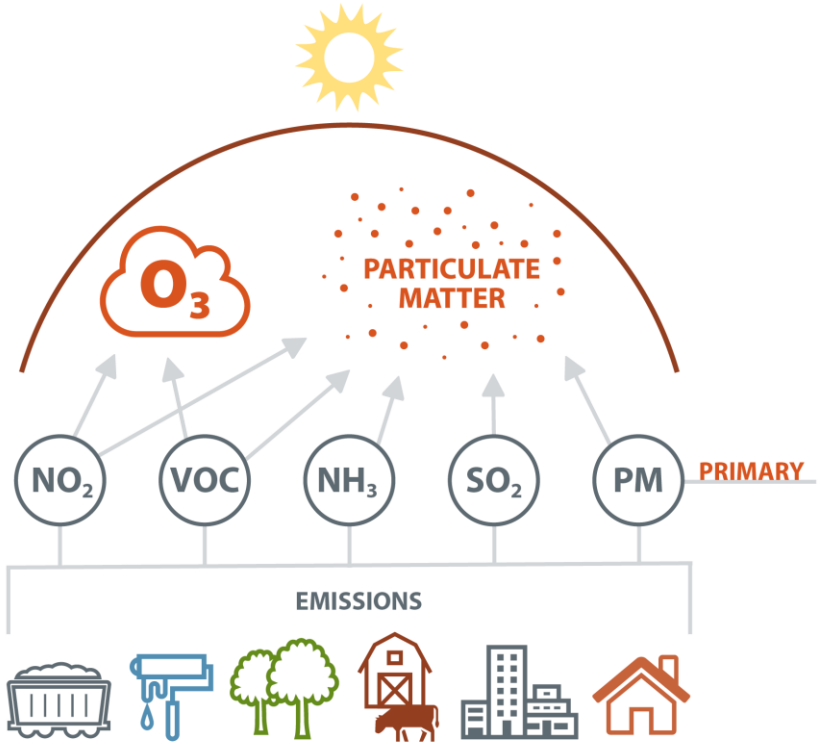
Life-Cycle Greenhouse Gas Emissions

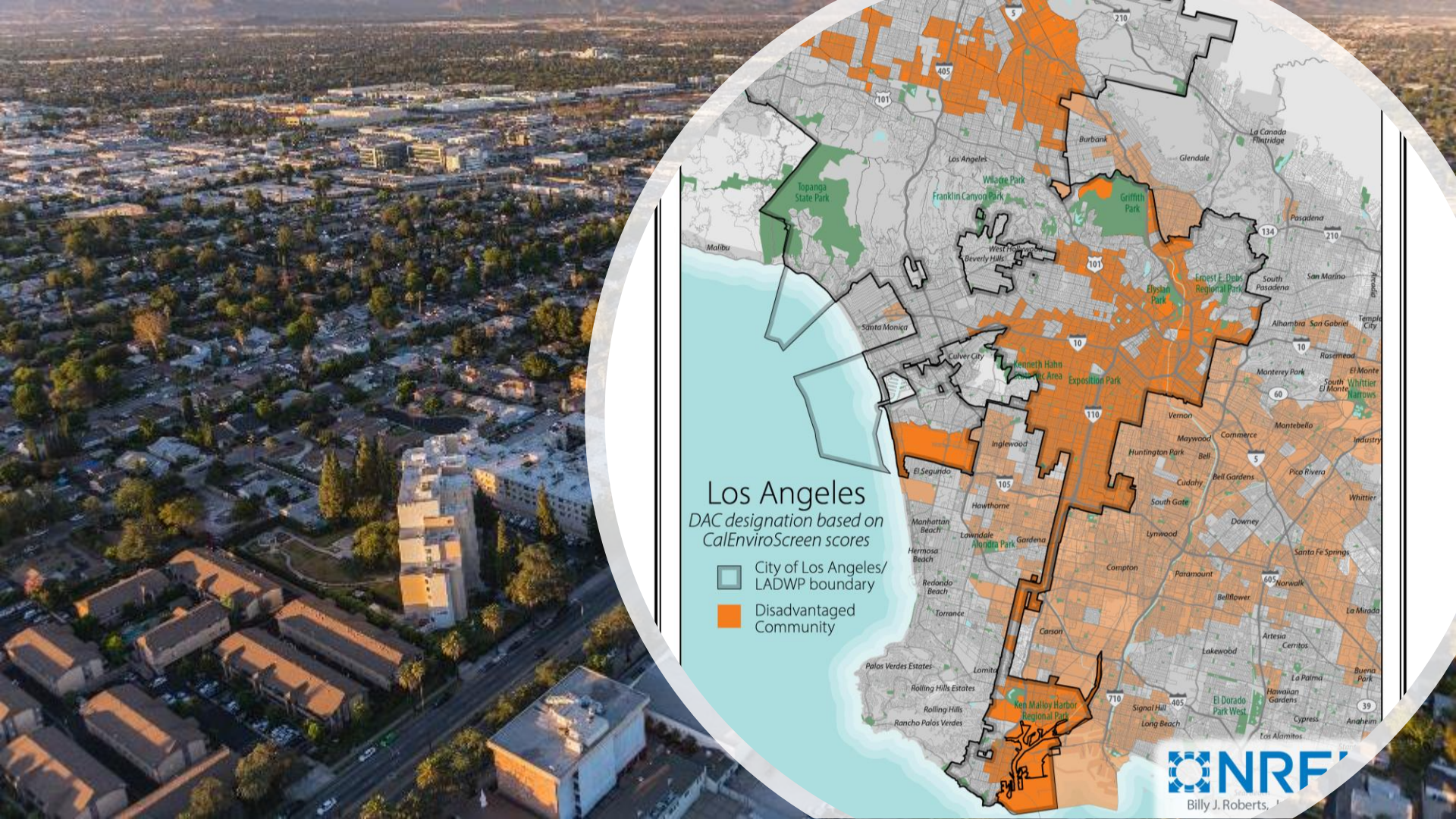
All Sectors



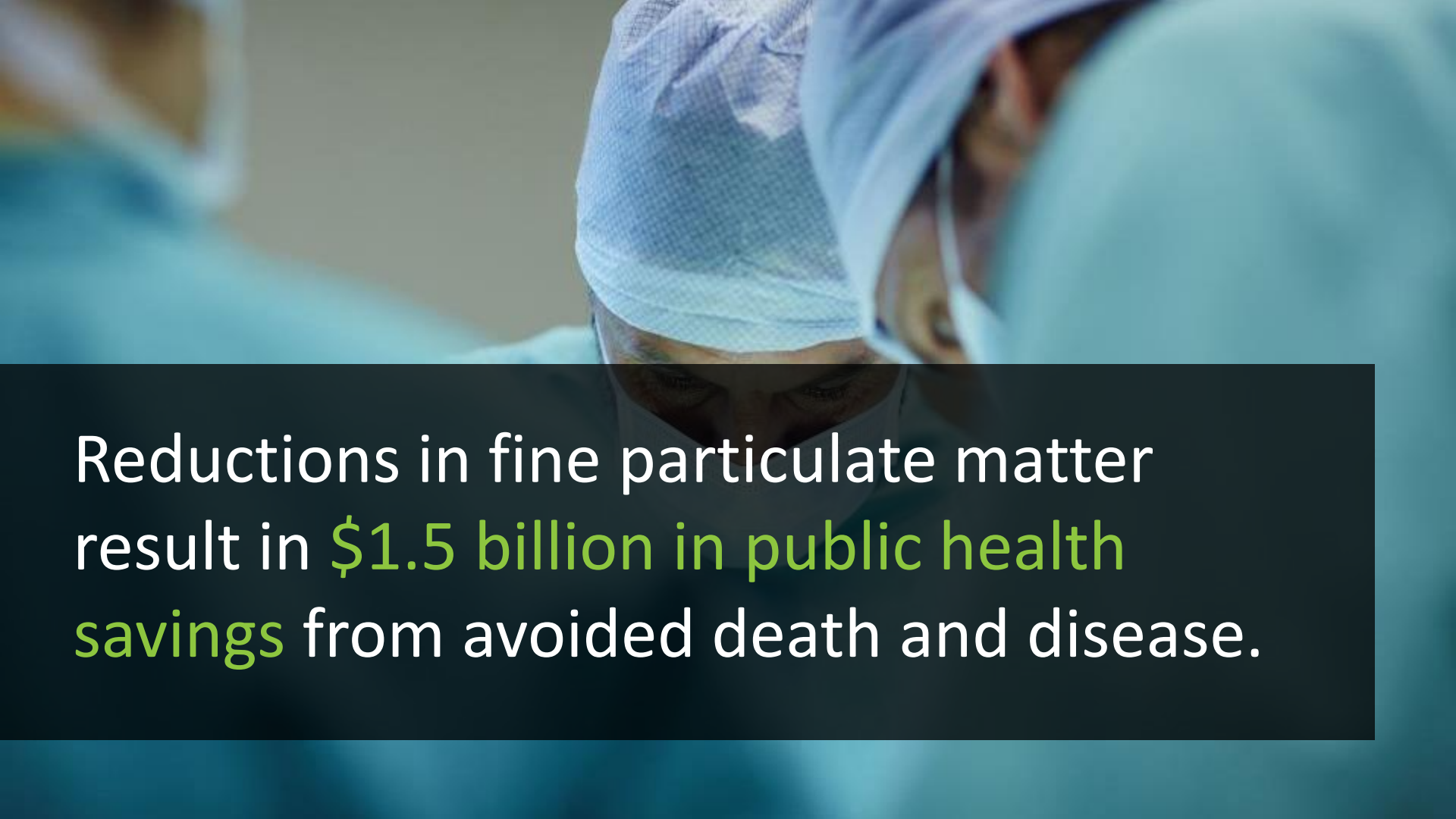
Two pollutants of concern

1. Fine particulate matter
2. Ozone



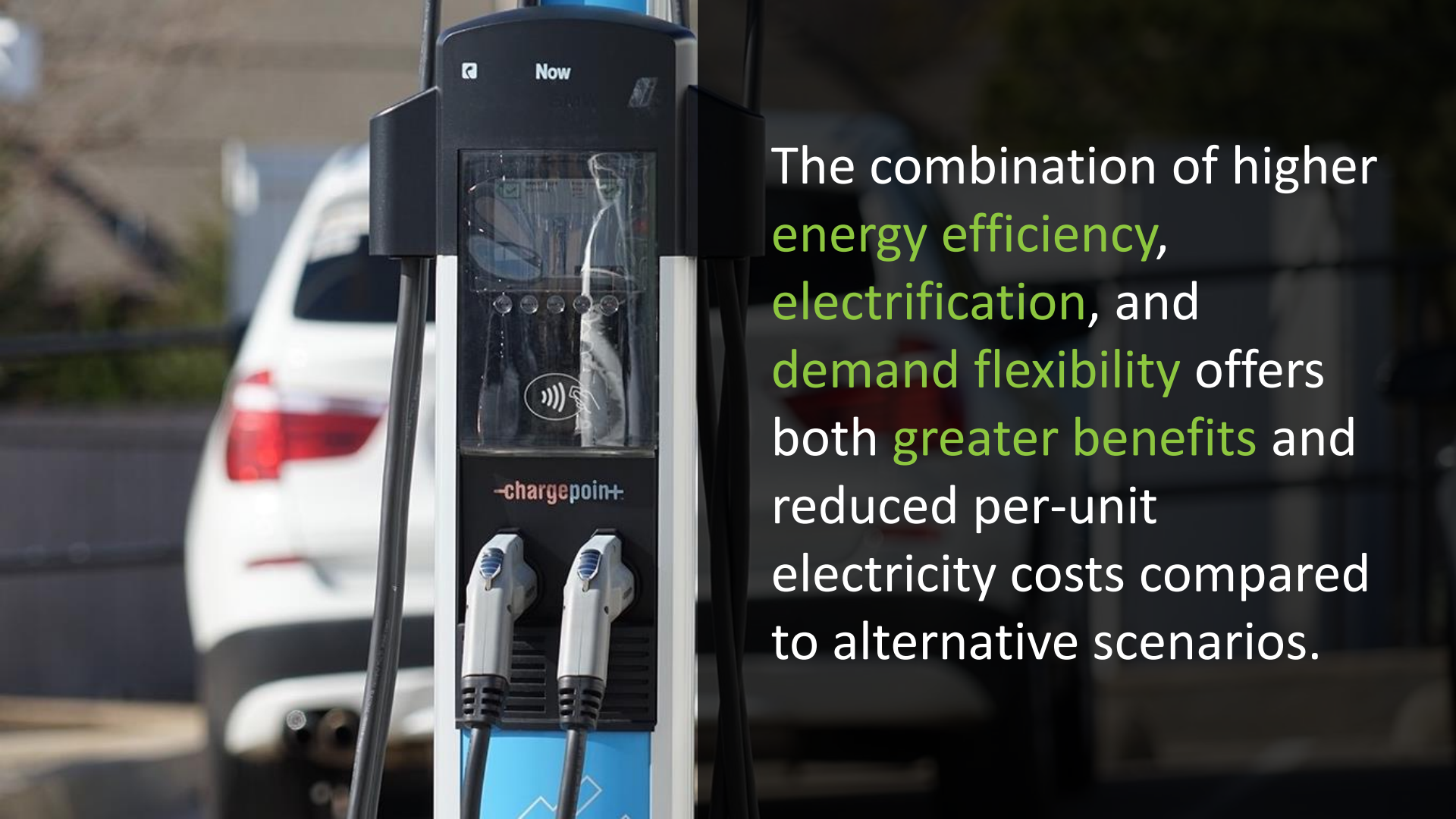

Los Angeles
DAC designation based on CalEnviroScreen scores
City of Los Angeles/ LADWP boundary
Disadvantaged Community
Topanga State Park
Franklin Canyon Park
Griffith Park
Elysian Park
Ernest E. Debs Regional Park
Kenneth Hahn Recreation Area
Exposition Park
Alondra Park
Ken Malloy Harbor Regional Park
Los Angeles
Burbank
Glendale
La Canada Flintridge
Pasadena
Malibu
Beverly Hills
Santa Monica
Culver City
Inglewood
El Segundo
Hawthorne
Manhattan Beach
Hermosa Beach
Redondo Beach
Torrance
Carson
Palos Verdes Estates
Rolling Hills Estates
Rolling Hills
Rancho Palos Verdes
Lomita
Long Beach
Signal Hill
Lakewood
Artesia
Cerritos
La Palma
Buena Park
Cypress
Anaheim
Los Alamitos
El Dorado Park West
Hawaiian Gardens
Compton
Paramount
Bellflower
Norwalk
Downey
Lynwood
South Gate
Bell
Bell Gardens
Cudahy
Huntington Park
Maywood
Commerce
Vernon
Montebello
Pico Rivera
Whittier
Santa Fe Springs
La Mirada
Industry
Monterey Park
South El Monte
El Monte
Rosemead
Alhambra
San Gabriel
Temple City
South Pasadena
San Marino
Arcadia
Whittier Narrows
Billy J. Roberts,

All scenarios achieve 6%–8% reduction in concentrations of fine particulate matter.



Reductions in fine particulate matter result in $1.5 billion in public health savings from avoided death and disease.

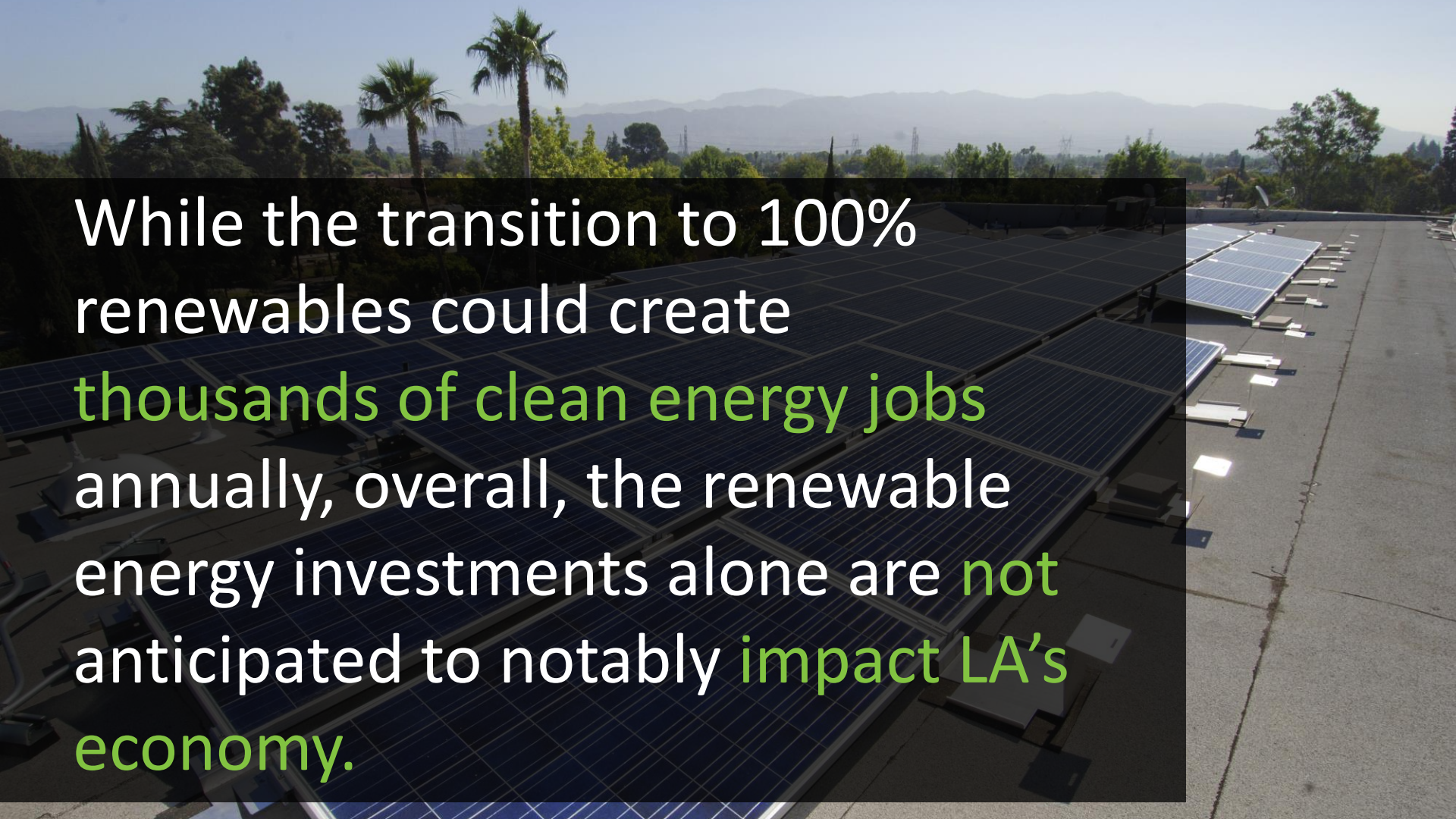
How do the scenarios compare in terms of benefits and costs?



The combination of higher energy efficiency, electrification, and demand flexibility offers both greater benefits and reduced per-unit electricity costs compared to alternative scenarios.

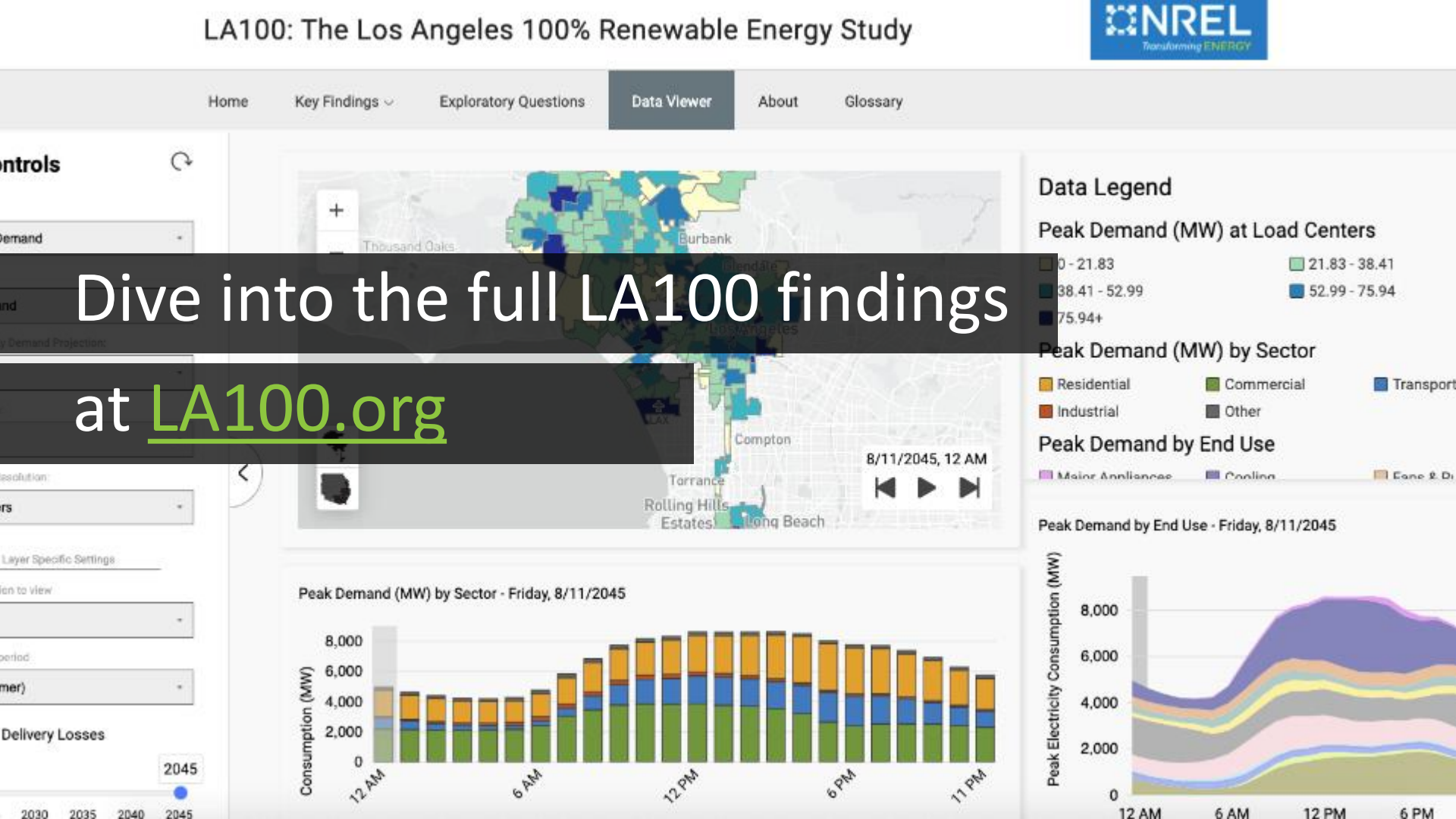
Accelerating the target date to 2035 increases both the costs and benefits of the transition.

Technology restrictions result in higher costs when it comes to meeting the last 10%–20% of energy demand—but almost no additional regional air quality or health benefits.


While the transition to 100% renewables could create thousands of clean energy jobs annually, overall, the renewable energy investments alone are not anticipated to notably impact LA's economy.


All communities will share in the benefits of the clean energy transition—but improving equity in participation and outcomes would require this to be integrated into the design of policies and programs.


LA can get started now, with many options that achieve significant reductions in greenhouse gas emissions (76%–99%) by 2030.



Dive into the full LA100 findings at LA100.org