LA100

The Los Angeles 100% Renewable Energy Study

Advisory Group Meeting #15

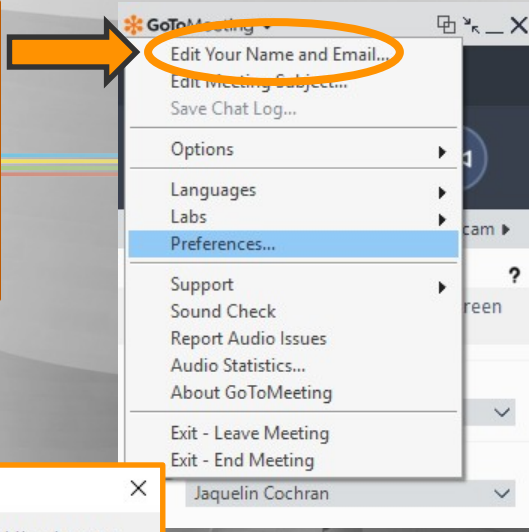
Virtual Meeting #4

LA DWP Los Angeles Department of Water & Power | NREL Transforming ENERGY

LA100

The Los Angeles 100% Renewable Energy Study

Welcome to the LA100 Advisory Group meeting!
Please consider adding your affiliation to your name identification.



Advisory Group Meeting #15

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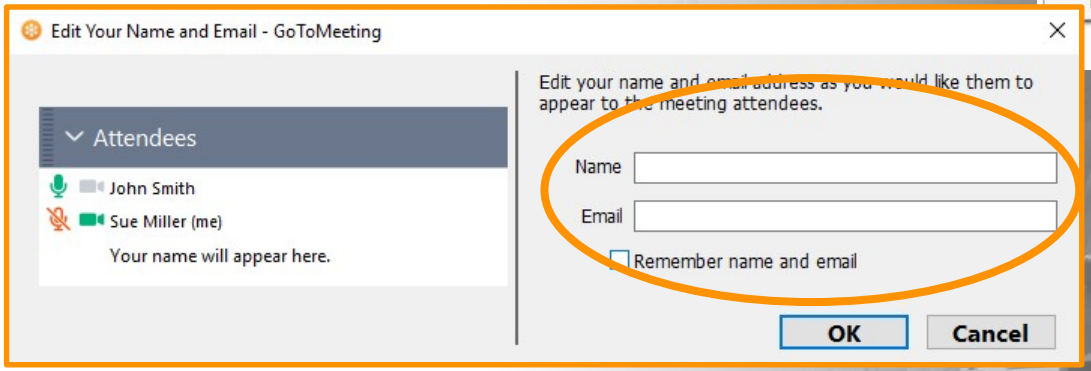

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Tips for Productive Discussions

Let one person speak at a time

Keep phone/computer on mute until ready to speak

Help ensure everyone gets equal time to give input

Type “Hand” in Chat Function to raise hand

Keep input concise so others have time to participate

Also make use of Chat function

Actively listen to others, seek to understand perspectives

Offer ideas to address questions and concerns raised by others

Hold questions until after presentations

Advisory Group #15 Agenda

March 3
- Welcome
- Final Air Quality Results
- Final Public Health Results
- Discussion/Q&A

March 4
- Environmental Justice
- Discussion/Q&A

March 11
- Economic Impact Analysis
- Workforce Analysis
- Discussion/Q&A

Today (March 19)
- LA100 Synthesis
- Summary of Key Findings
- Discussion/Q&A

Next Week (March 25)
Final NREL Q&A

April 1: LADWP hosts Advisory Group meeting on rate impacts

LA100

The Los Angeles 100% Renewable Energy Study

LA100: Synthesis

Advisory Group Meeting #15, Virtual Meeting #4

Jaquelin Cochran and Paul Denholm

March 19, 2021

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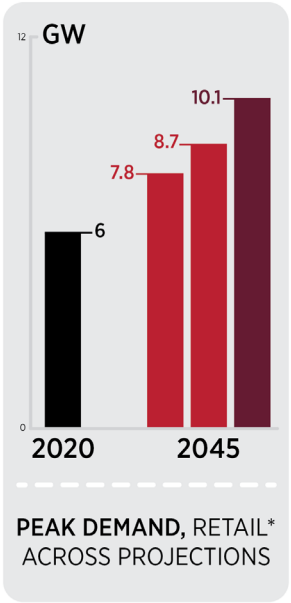
Overview

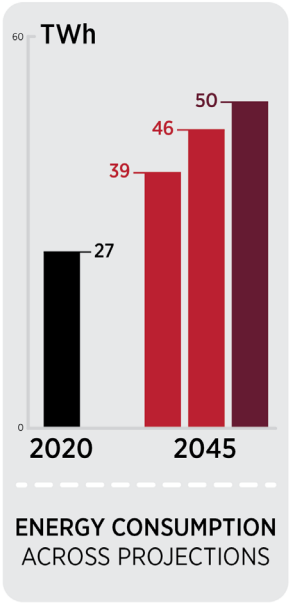
- Major Trends Across Pathways to 100%
- Distinctions Among Pathways
- Looking Ahead: Addressing Uncertainty

Major Trends Across Pathways to 100%

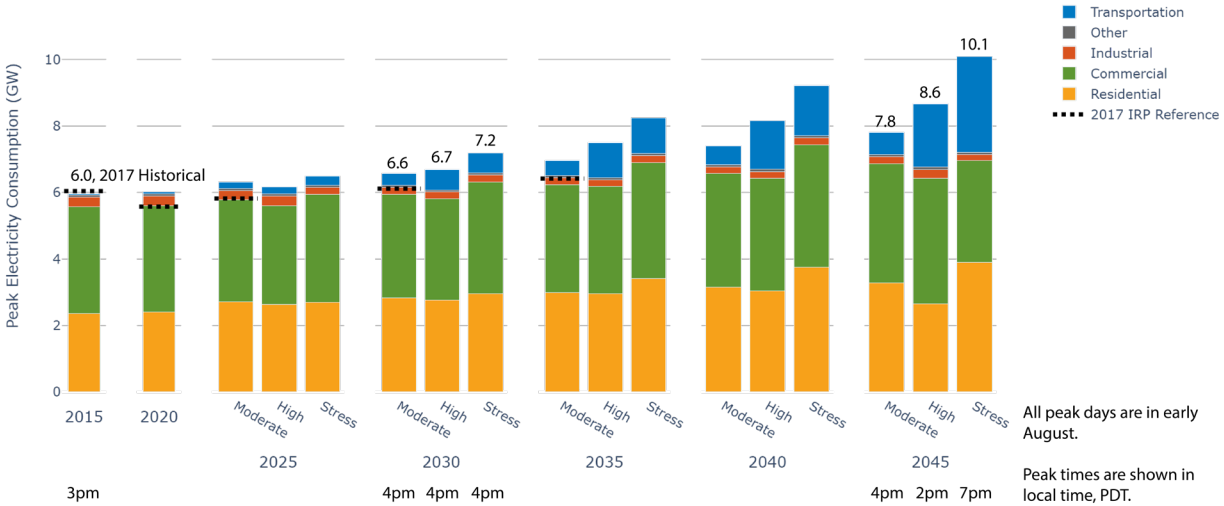
High levels of energy efficiency help offset load growth due to building electrification; transportation drives load growth



PEAK DEMAND, RETAIL* ACROSS PROJECTIONS



ENERGY CONSUMPTION ACROSS PROJECTIONS



All peak days are in early August.

Peak times are shown in local time, PDT.

SIMULATED MODERATE HIGH STRESS

*Based on customer demand at the meter and not including losses.
Totals are also prior to shifts in timing due to customer demand flexibility.

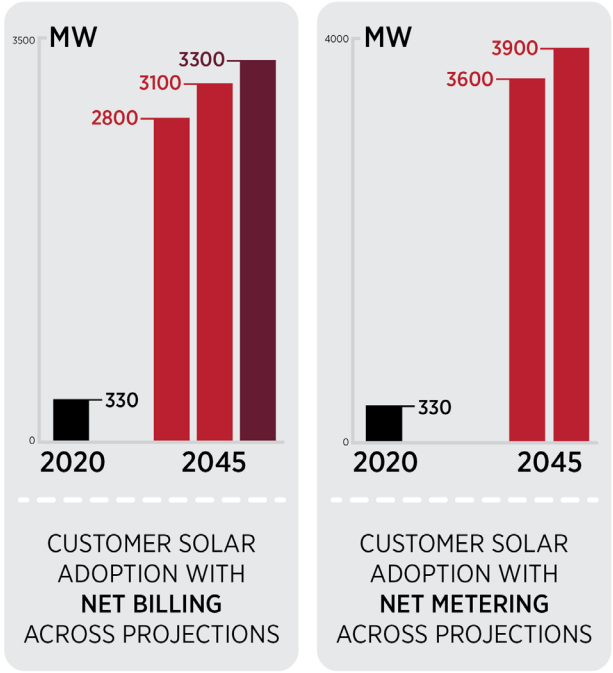
Customer-oriented actions that help complement a renewable energy transition

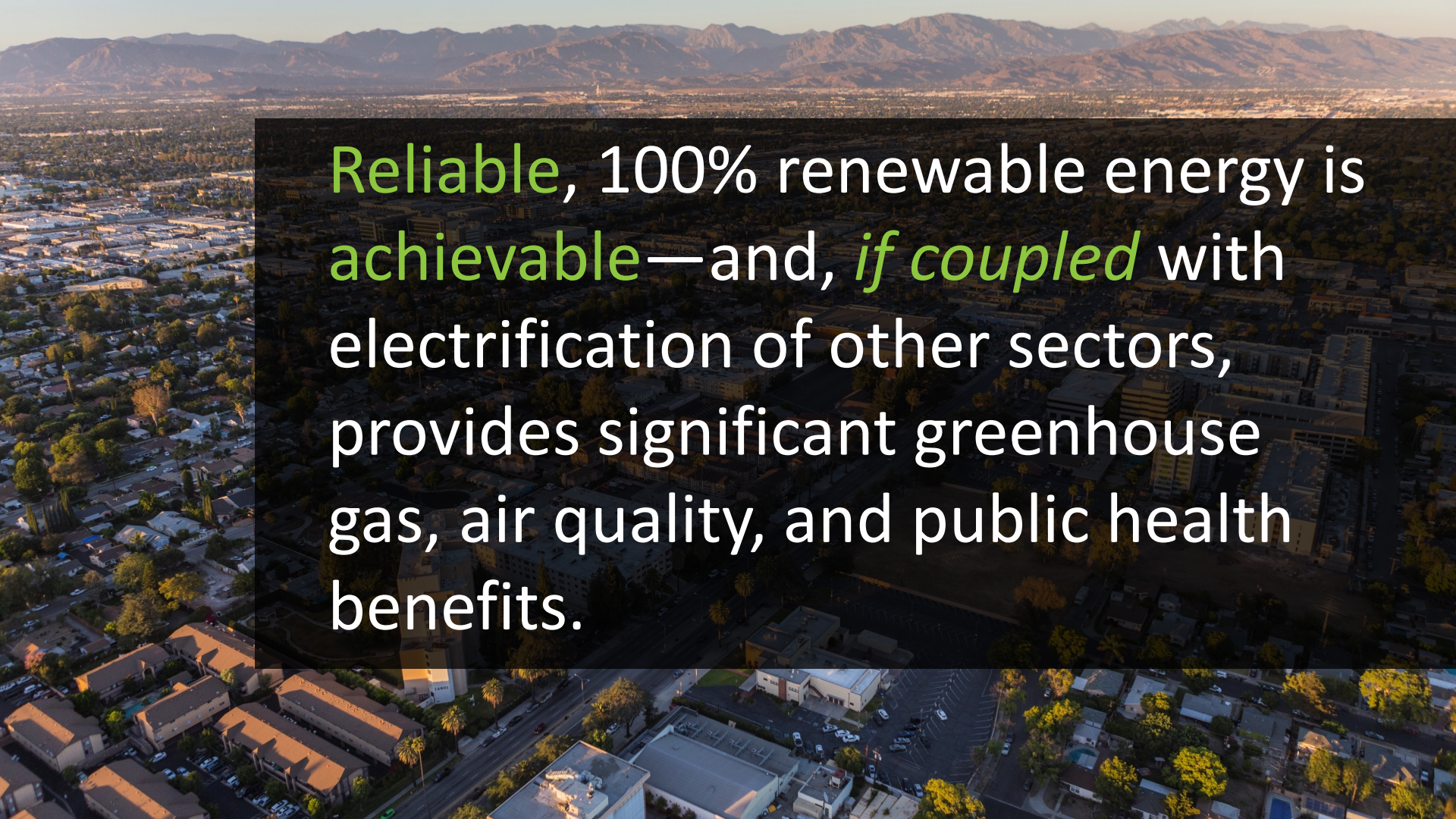
- **Energy efficiency** → helps offset climate- and electrification-driven load growth and potentially higher electricity rates; lowers energy burden for low-income residents
- **Greater electrification** → higher public health and GHG benefits; helps reduce per-unit electricity costs
- **Customer demand flexibility** → helps contain costs of adding electrification and achieving 100% renewable energy; supports reliability

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

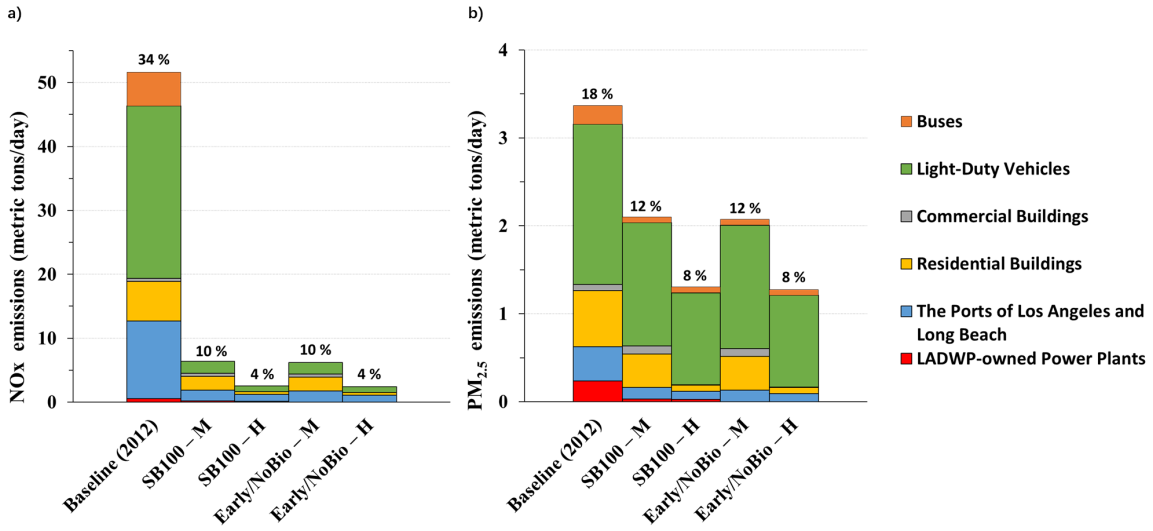
- Customers are projected to adopt between 34% and 40% of the total economic potential for rooftop solar capacity

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

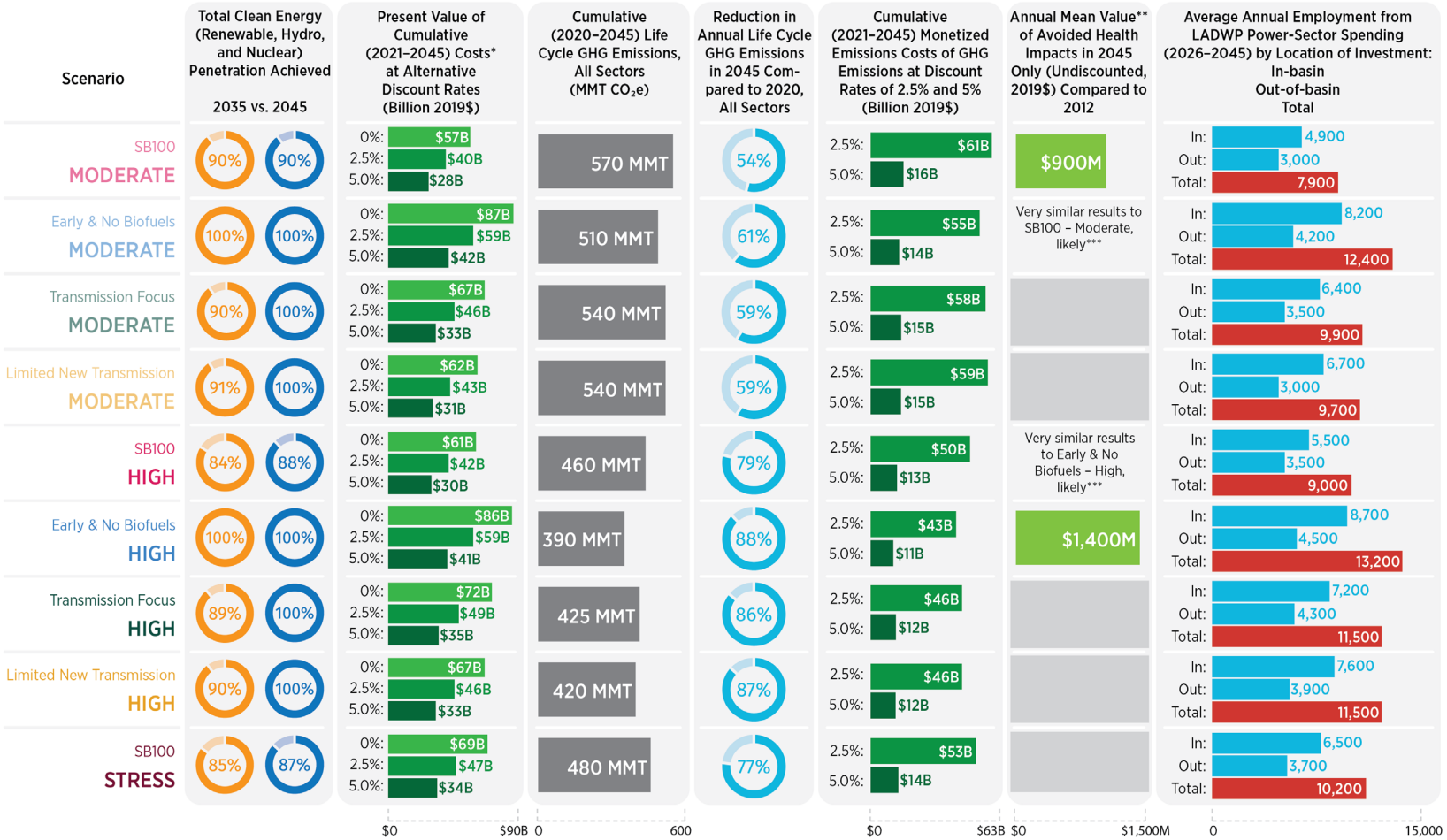



Reliable, 100% renewable energy is achievable—and, *if coupled* with electrification of other sectors, provides significant greenhouse gas, air quality, and public health benefits.

Electrification — Especially Transportation—Is a Large Driver of Air Quality and Health Benefits



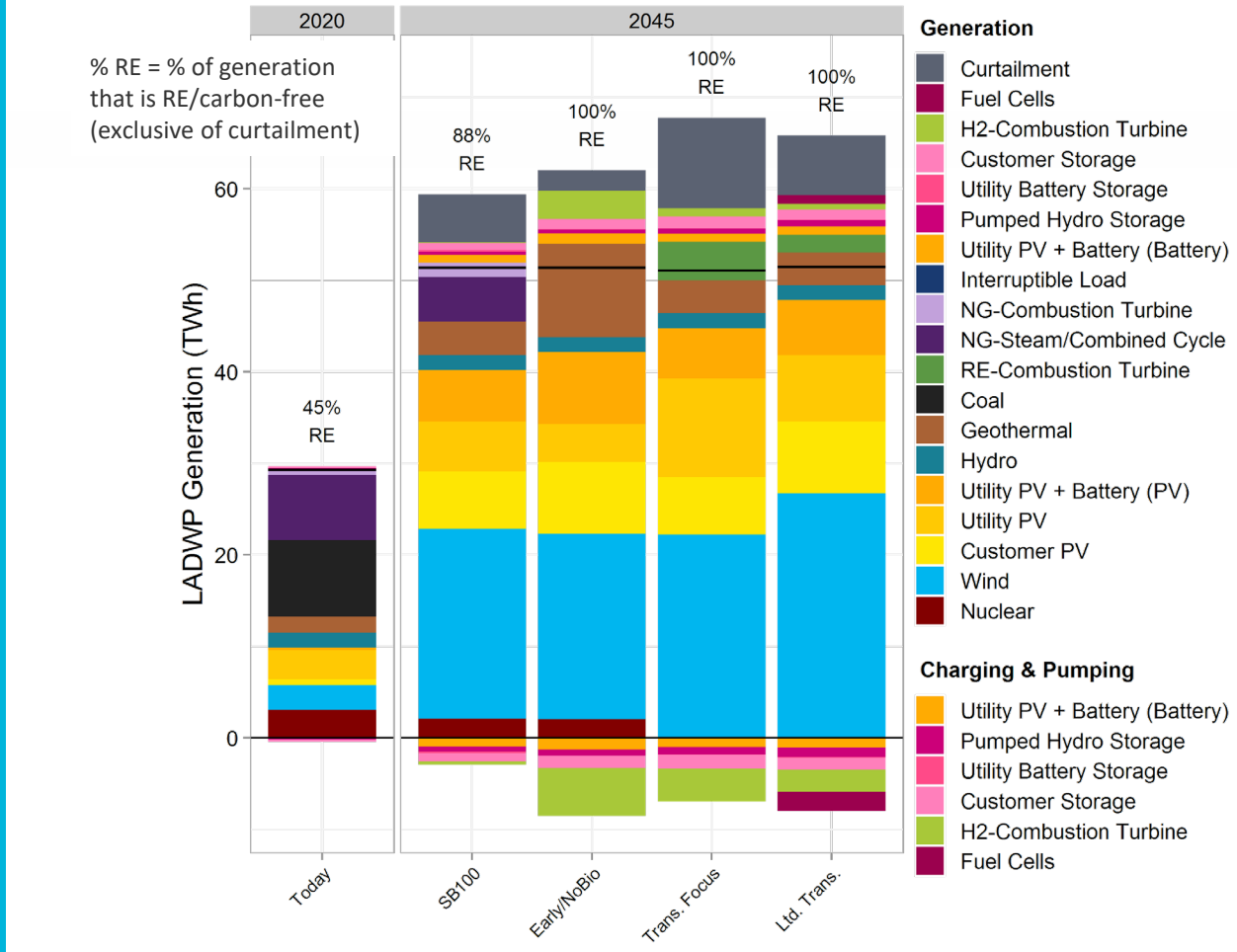
Underscores importance of managing rates of change (electrification, decarbonization) to avoid spike in electricity bills that could place public pressure against electrification



*Costs, as measured in the study, represent costs of expanding and operating of the power system from 2021. Present values calculated with a discount rate of 0% are equivalent to an undiscounted value.
**95% confidence interval of values of avoided health impacts in 2045 compared to 2012 is SB100 – M is (-$480M–$3,000M) and of Early & No Biofuels – H is (-$470M–$4,400 M).
***Because the contribution to emissions reductions from the power sector is small (ranging from 0.8%–1% for NOx among LA100-evaluated reductions), it is reasonable to qualitatively estimate the results stated.


In all scenarios, wind and solar provide 69%–87% of future load, and new renewable firm capacity is built in the LA basin to maintain reliability.

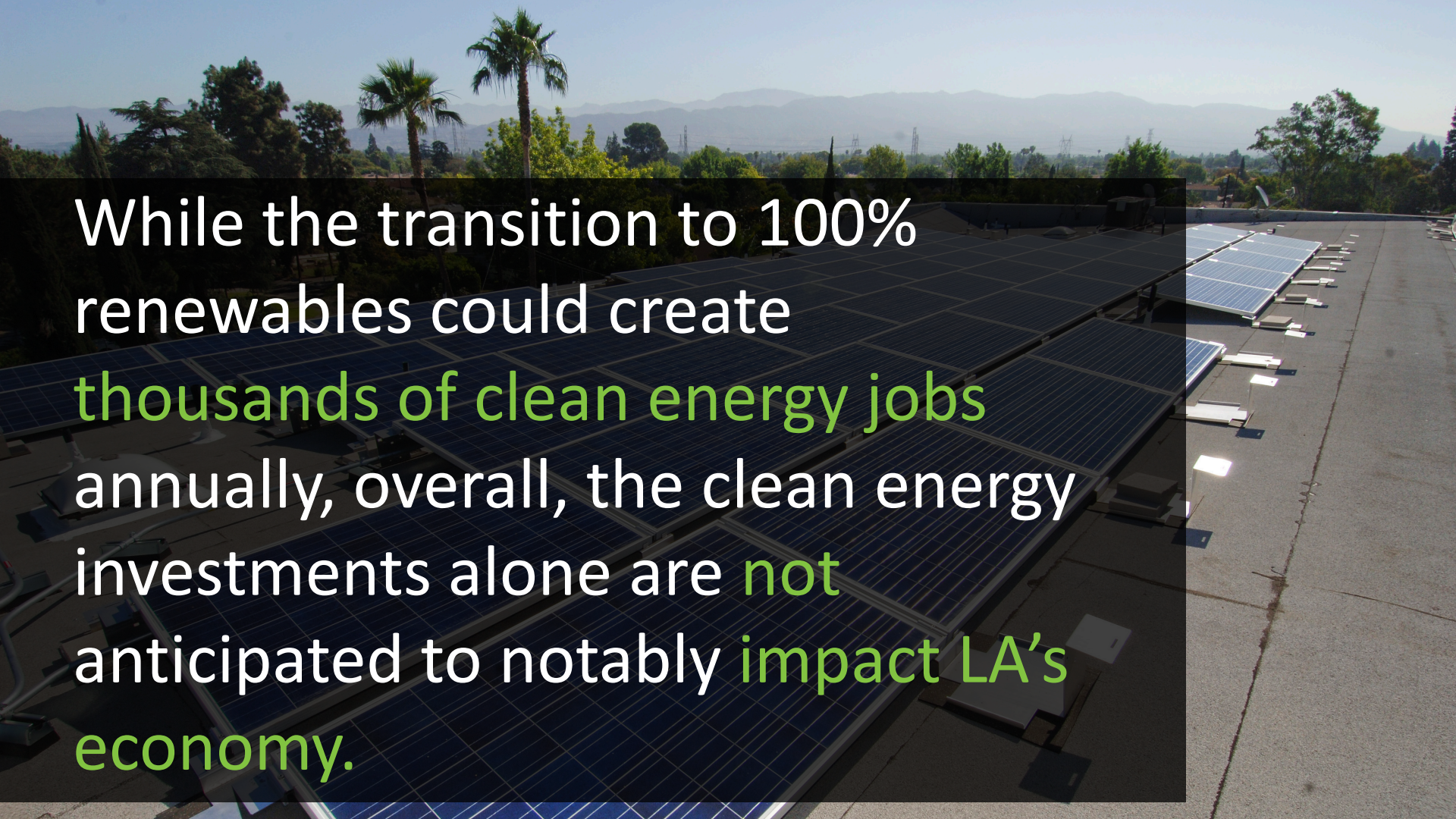
Annual generation mix in 2045 for all High load scenarios compared to 2020




All communities will share in the benefits of the clean energy transition—but improving equity in participation and outcomes would require intentionally designed policies and programs.

Actions That Could Support Prioritization of Environmental Justice—Examples

- **Participation** in decision making
- **Energy infrastructure**
  - Improved data collection to
    - Improve projections to adopt energy efficiency, electrification, demand response, and solar
    - Design incentives/regulations to better target projections to policy goals
  - More comprehensive representation of benefits
  - Improved metric-tracking tools for tracking against projected change
- **Jobs:** Facilitate programs specific to hard-to-fill and other high-quality jobs
- **Maintaining support for electrification:** Analysis of interaction among costs of decarbonization, pace of electrification, and rate design could find pacing of electricity demand/supply change that optimizes health benefits
- **Neighborhood-level health impacts**: Analysis of neighborhood level impacts (positive and negative) to establish expectations and revise protocols as needed


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


LA can get started now, with many no-regrets options that achieve significant emissions reduction (76%–99%) by 2030.

Across All Scenarios

Electrification
Efficiency
Flexible Load

Customer
Rooftop Solar

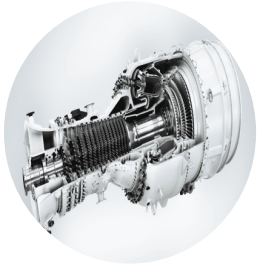
Renewable
Energy

Solar: + >5,700 MW
Wind: + >4,300 MW

Storage

+ >2,600 MW

Distribution,
Transmission



Renewably Fueled
Combustion
Turbines

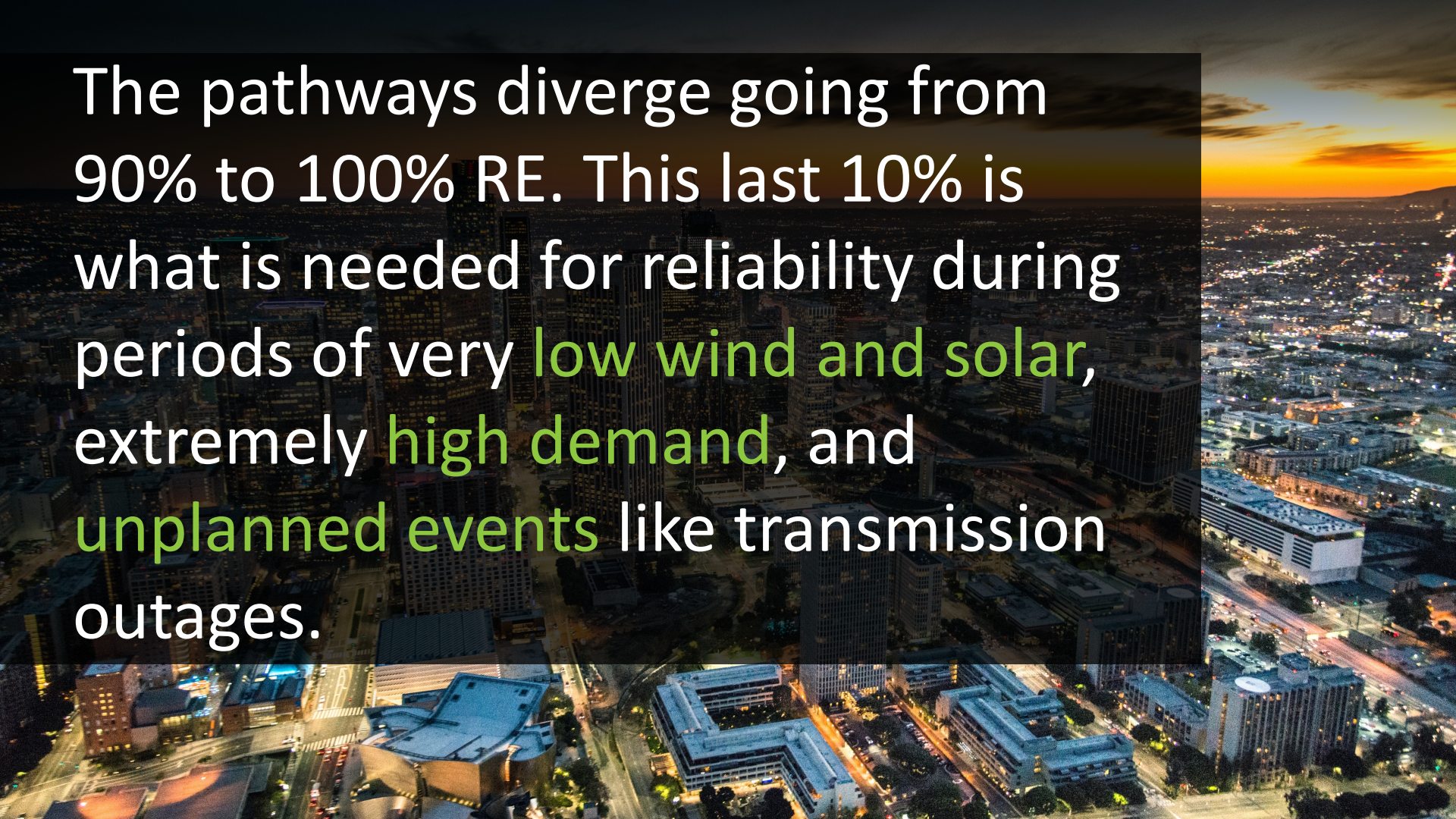
+>2,600 MW
(in basin)

Much More

New

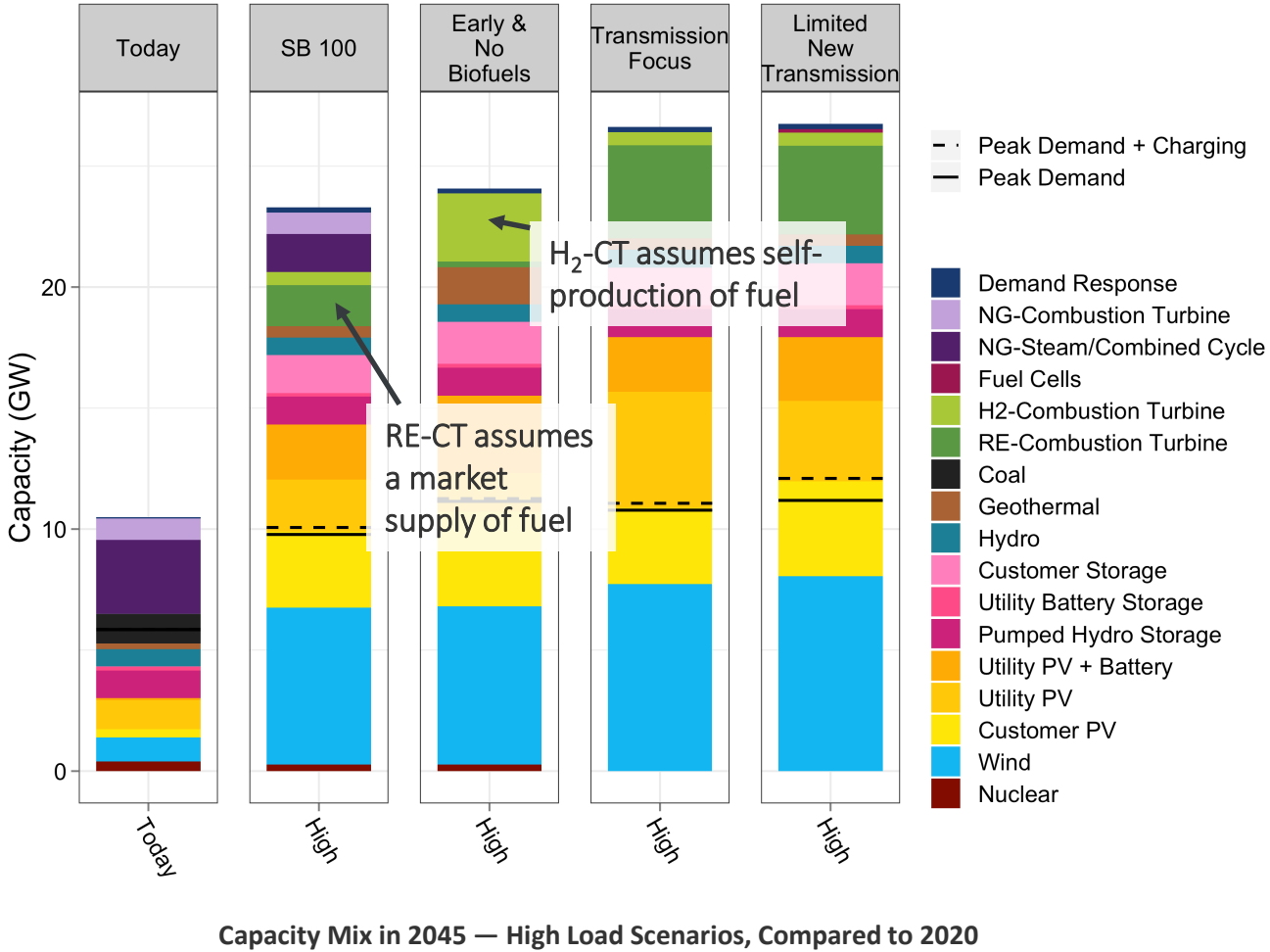
Natural gas → Biofuel/ hydrogen	
Today: Daily	**Future:** Infrequently

Distinctions Among Pathways

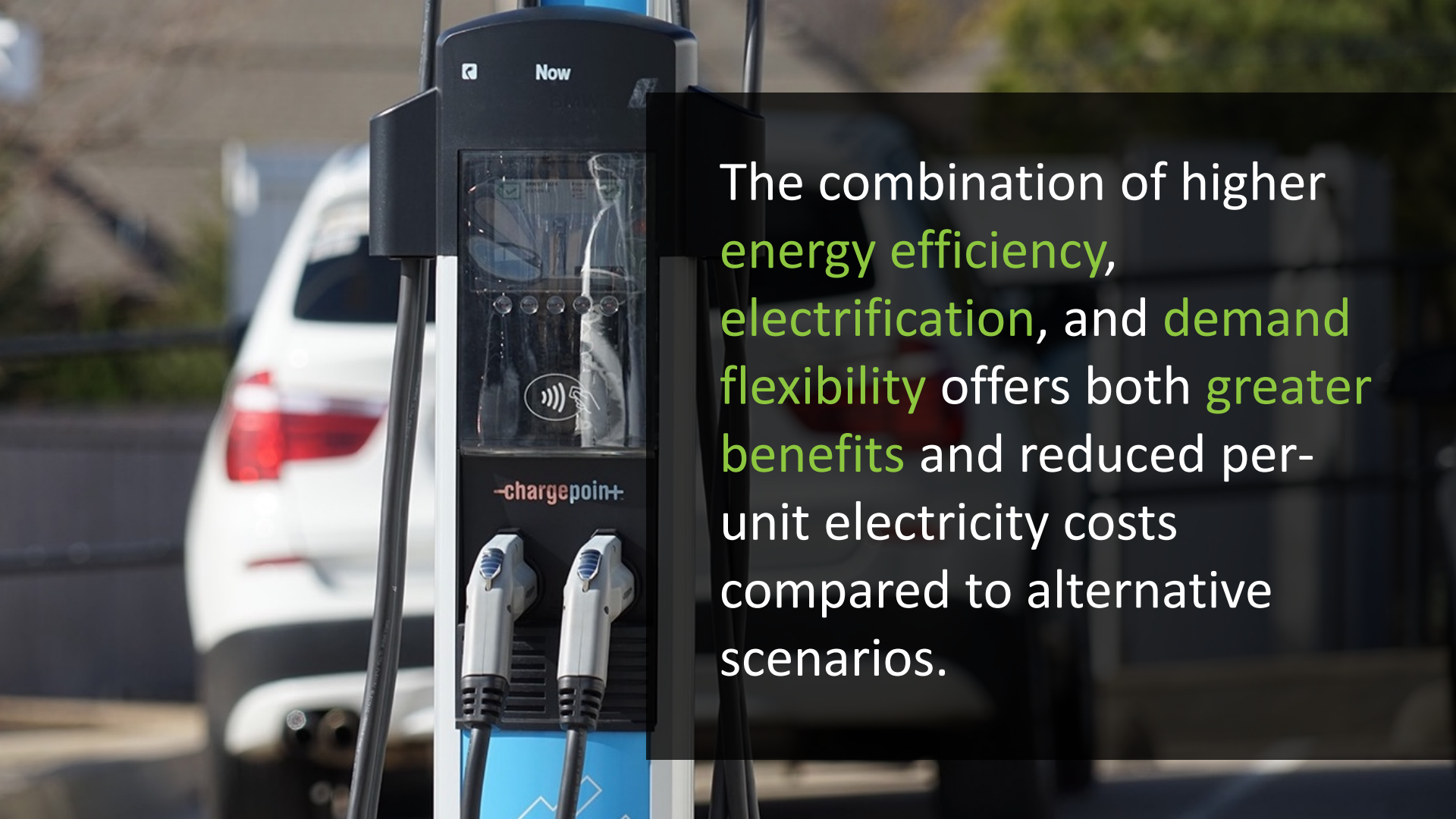

The pathways diverge going from 90% to 100% RE. This last 10% is what is needed for reliability during periods of very low wind and solar, extremely high demand, and unplanned events like transmission outages.

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

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

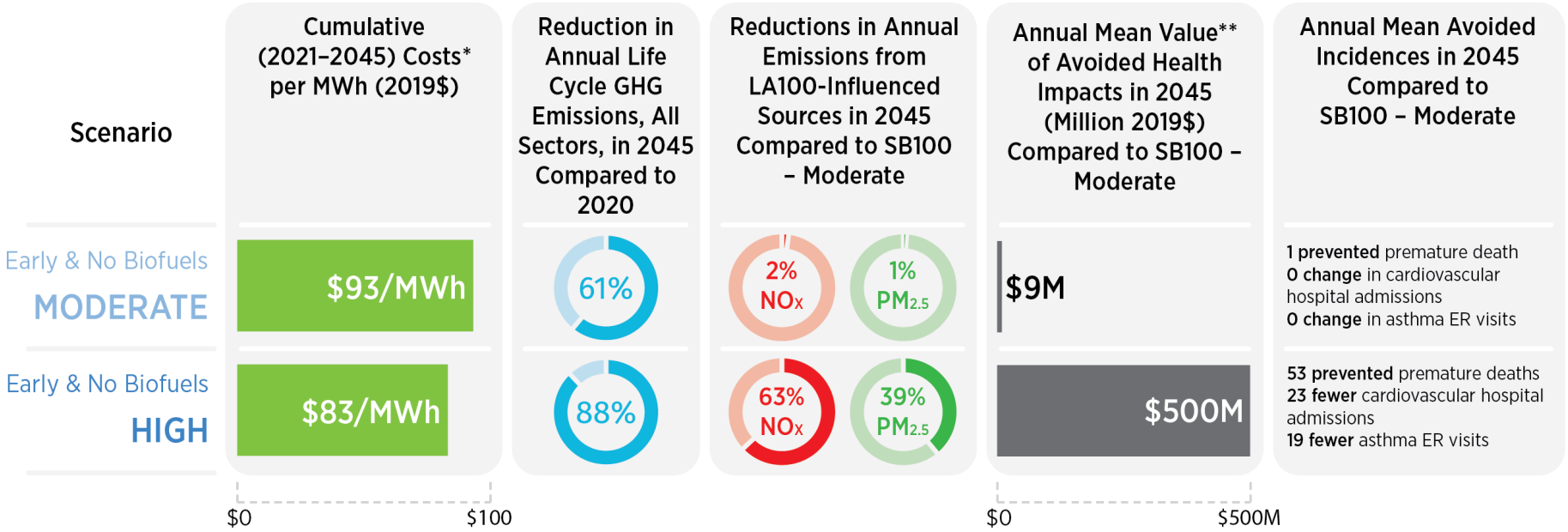


Capacity Mix in 2045 — High Load Scenarios, Compared to 2020



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

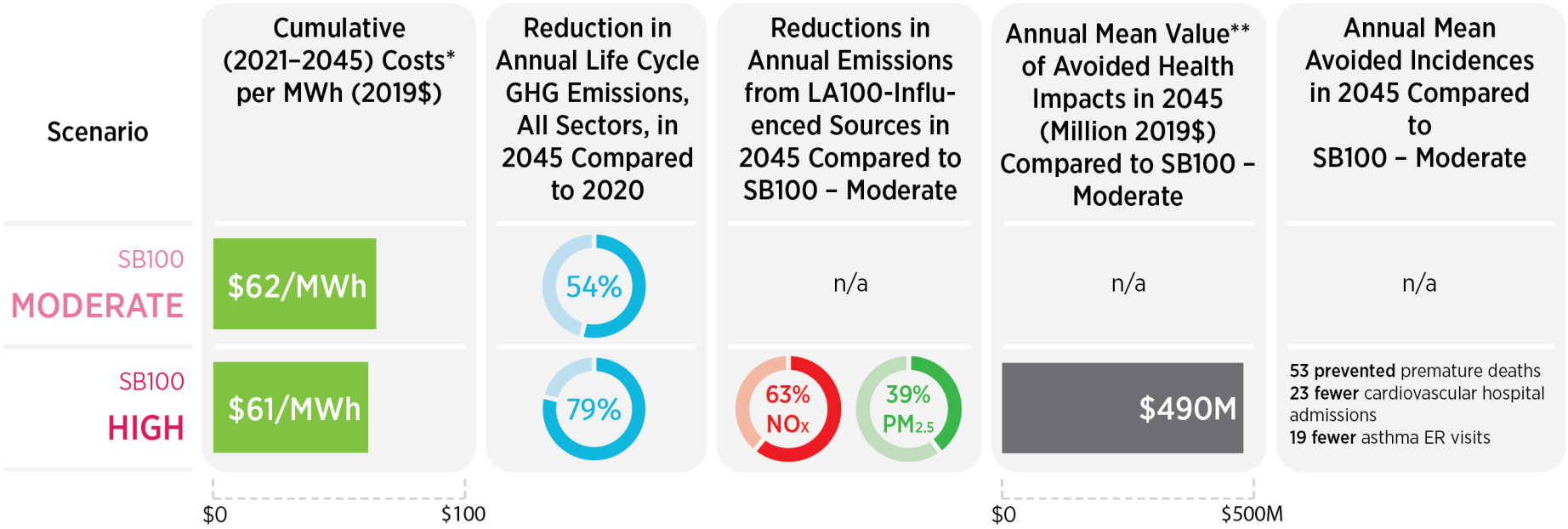
High vs. Moderate Electrification
Greater benefits, lower lower per-unit costs



*Annual per-MWh costs do not equal rates—these costs represent the revenue requirement (per unit of generation) to cover the annualized costs associated with expenditures measured in LA100.

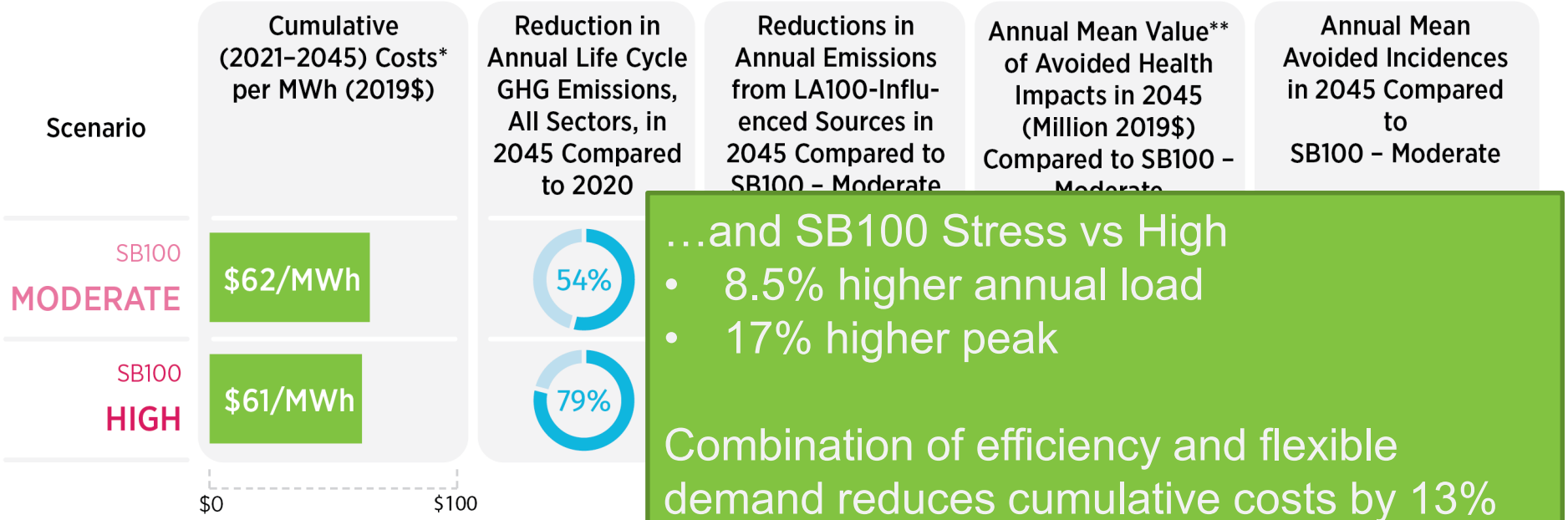
**95% confidence interval of values of avoided health impacts in 2045 compared to SB100 – M is: Early & No Biofuels – M ($1M–$24M) and Early & No Biofuels – H ($19M–$1,400 M).

High vs. Moderate Electrification
Greater benefits, lower lower per-unit costs



*Annual per-MWh costs do not equal rates—these costs represent the revenue requirement (per unit of generation) to cover the annualized costs associated with expenditures measured in LA100.
**95% confidence interval of values of avoided health impacts in 2045 compared to SB100 – M for SB100 – H is ($18M–$1,400M).

High vs. Moderate Electrification
Greater benefits, lower lower per-unit costs



…and SB100 Stress vs High

- 8.5% higher annual load
- 17% higher peak

Combination of efficiency and flexible demand reduces cumulative costs by 13% by 2045

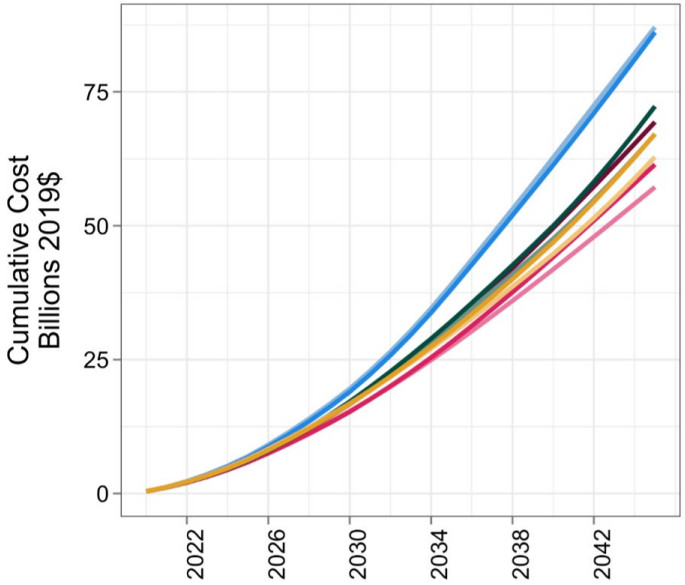
*Annual per-MWh costs do not equal rates—these costs rep
costs associated with expenditures measured in LA100.
**95% confidence interval of values of avoided health impacts in 2045 compared to SB100 – M for SB100 – H is ($18M–$1,400M).

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

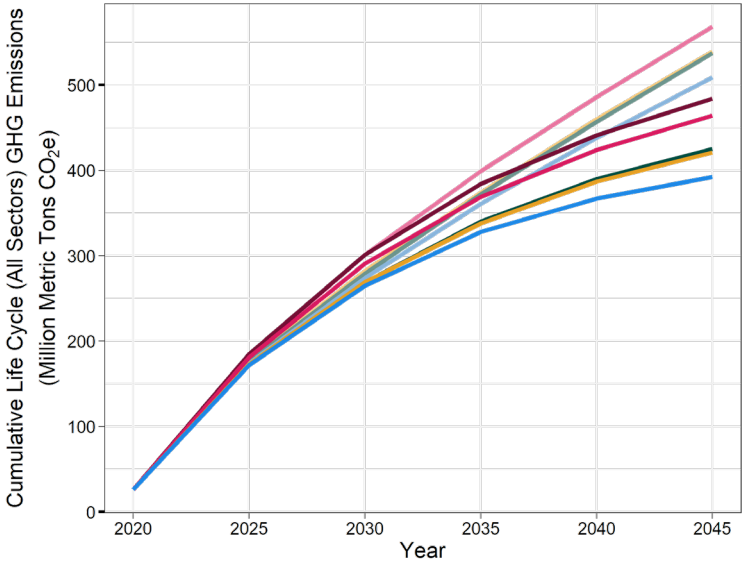
Earlier accumulation of costs
Earlier accumulation of benefits

Costs and benefits do not necessarily accrue at the same rates

Cumulative Costs



Cumulative Life Cycle GHG Emissions, All Sectors

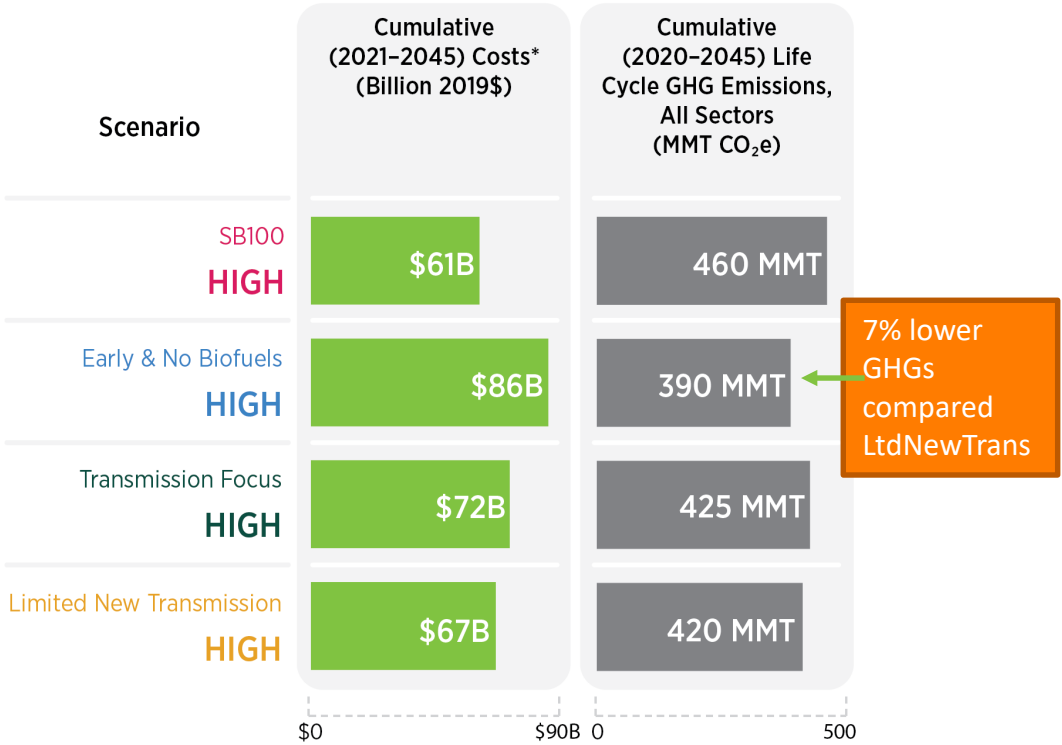


SB100 – Moderate
SB100 – High
SB100 – Stress
Early & No Biofuels – Moderate
Early & No Biofuels – High
Transmission Focus – Moderate
Transmission Focus – High
Limited New Transmission – Moderate
Limited New Transmission – High

Could capture same GHG benefits of Early & No Biofuels by accelerating target of Transmission Focus and Limited New Transmission scenarios

Cumulative impact to costs with 2035 target	
Transmission Focus	~7% increase
Limited New Transmission	~8% increase

Cumulative impact to costs with 2045 target	
Early & No Biofuels	~17% decrease

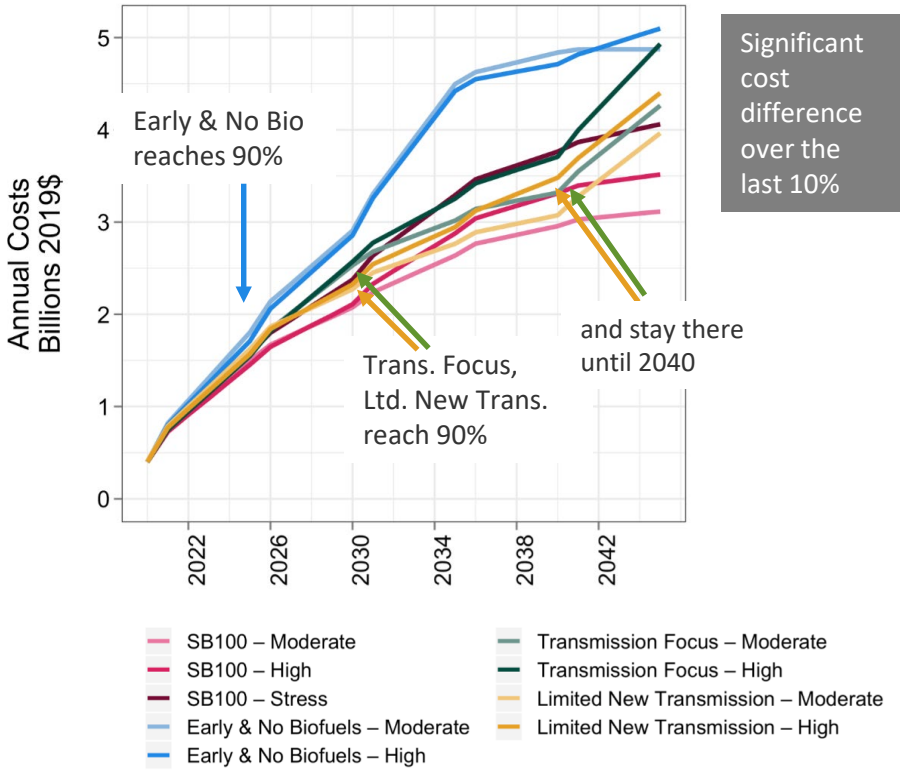


*Costs, as measured in the study, represent expanding and operating the power system from 2021–2045. See Chapter 6 for more details.

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

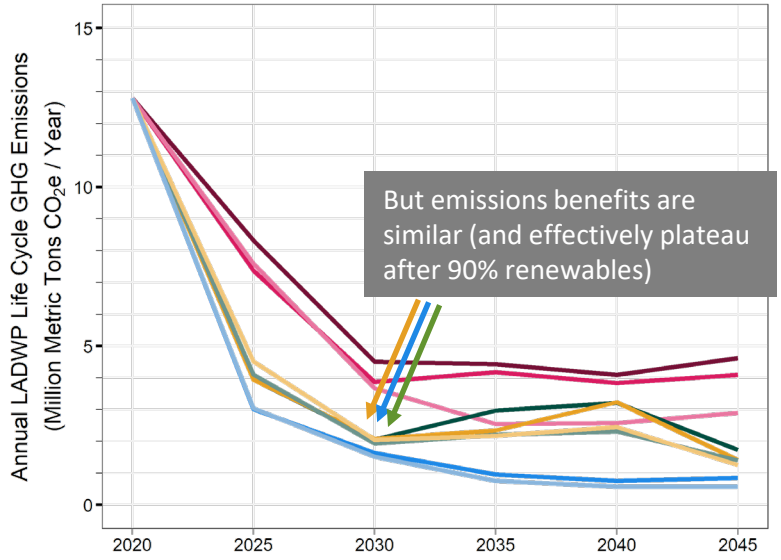
Costs and GHG trajectories are similar through 90+% RE....

Annualized Costs



Significant cost difference over the last 10%

Annual Life Cycle GHG Emissions, Power Sector

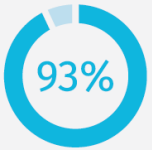


But emissions benefits are similar (and effectively plateau after 90% renewables)

All scenarios see reduction in combustion (and associated pollutants) due to both renewable energy buildout and use of inverter-based resources for reserves

For last 10%, costs diverge but benefits remain similar among paths

Natural gas plant operations associated with SB100 scenarios in 2045 do not affect regional air quality significantly compared to not allowing their use, and thus this change alone does not produce significant public health benefits.

Scenario	Reduction in Power-Sector Life Cycle GHG Emissions in 2045 Relative to 2020
SB100 HIGH	
Early & No Biofuels HIGH	

Annual Health Impacts Metrics* Compared to SB100 – High, 2045 Only

1 prevented premature death
0 change in cardiovascular hospital admissions
0 change in asthma ER visits
$6M annual mean value* of these avoided health impacts

*95% confidence interval of values of avoided health impacts in 2045 of Early & No Biofuels – H compared to SB100 – H is -$1M–$17M

But then the costs diverge approaching 100% RE, while the benefits plateau

Potential benefits not captured in the analysis:

- Neighborhood level pollutants
- Global leadership of 100% RE without RECs, biofuels
- Sustainability concerns of biofuels

Scenario	Reduction in Power-Life Cycle GHG Emi in 2045 Relative to
SB100 HIGH	68%
Early & No Biofuels HIGH	93%

Annual Health Impacts Metrics* Compared to SB100 – High, 2045 Only

1 prevented premature death
0 change in cardiovascular hospital admissions
0 change in asthma ER visits
$6M annual mean value* of these avoided health impacts

*95% confidence interval of values of avoided health impacts in 2045 of Early & No Biofuels – H compared to SB100 – H is -$1M–$17M

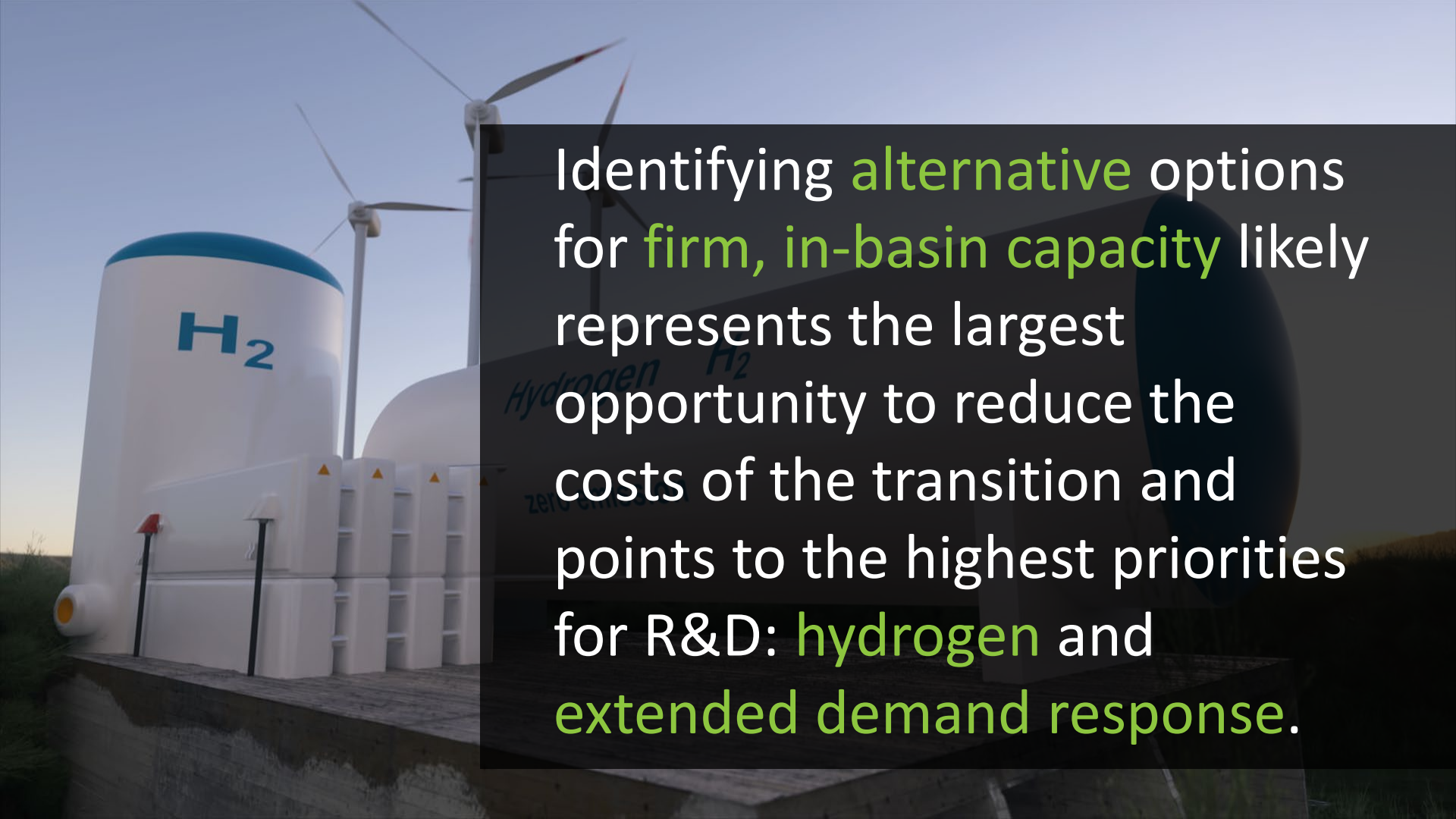
LA100 analyzed cost sensitivities on technology eligibility (Chapter 6)

Scenario	Cumulative (2021–2045) Costs* (Billions 2019$)	Cost Impacts from Changing Technology Eligibility
SB100 HIGH	$61B	Removing eligibility of natural gas by not allowing renewable electricity credits and making target based on generation (rather than retail sales) **increases cumulative costs** by: **~2.5% through 2045** **~18% through financial lifetime (2074)**
Early & No Biofuels HIGH	$86B	Allowing market-purchase of renewable fuels (i.e., biofuels through 2044) **reduces cumulative costs** by: **~21% through 2045** **~26% through financial lifetime (2074)**

0B 100B

*Costs, as measured in the study, represent expanding and operating the power system from 2021–2045. See Chapter 6 for more details.

Looking Ahead: Addressing Uncertainty



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.

Across All Scenarios

Electrification
Efficiency
Flexible Load

Customer
Rooftop Solar

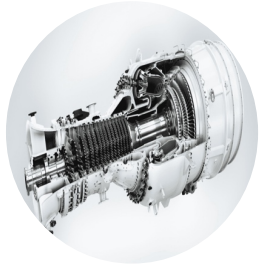
Renewable
Energy

Solar: + >5,700 MW
Wind: + >4,300 MW

Storage

+ >2,600 MW

Distribution,
Transmission



Renewably Fueled
Combustion
Turbines

+>2,600 MW
(in basin)

Much More

New

Natural gas → Biofuel/ hydrogen	
Today: Daily	**Future:** Infrequently

Managing Sources of Uncertainty

- LA100 scenarios build **new RE** (wind, solar, etc.) rapidly in the next decade on pathway to 100%
- This growth allows LA to **delay** building new RE-CTs because of the assumptions that:
  - **Energy efficiency** measures help reduce reduce needed supply investments
  - LADWP deploys new technologies and techniques to **increase capacity of existing transmission**
  - Planned **new transmission** can be built
  - LADWP and customers build **local solar** and storage
- This combination of options are considerably **cheaper** than new capacity

Managing Sources of Uncertainty

- But if **ALL** of those assumptions (previous slide) do not happen then additional **in-basin capacity** is needed compared to what LA100 is planning
- **Biofuels** are commercially available today and can serve as a transition fuel.
  - Risk: Competition from **transportation** may limit availability
- We don't know when **hydrogen** fuels will be **commercially available** or if it will be part of a larger, economy-wide transition.
- And there is uncertainty about **infrastructure** needed for hydrogen production, storage, and delivery.

Reminder from AG#11: Maintaining Reliability at 100%

We need “last 10%” technologies with specific characteristics

1. Can site *in basin*
   - Avoids dependencies on transmission from out of basin
2. Can site in *specific locations* in basin
   - More capacity needed in the southern part of the city.
3. Can operate for *extended periods* (days or more)

Maintaining Optionality

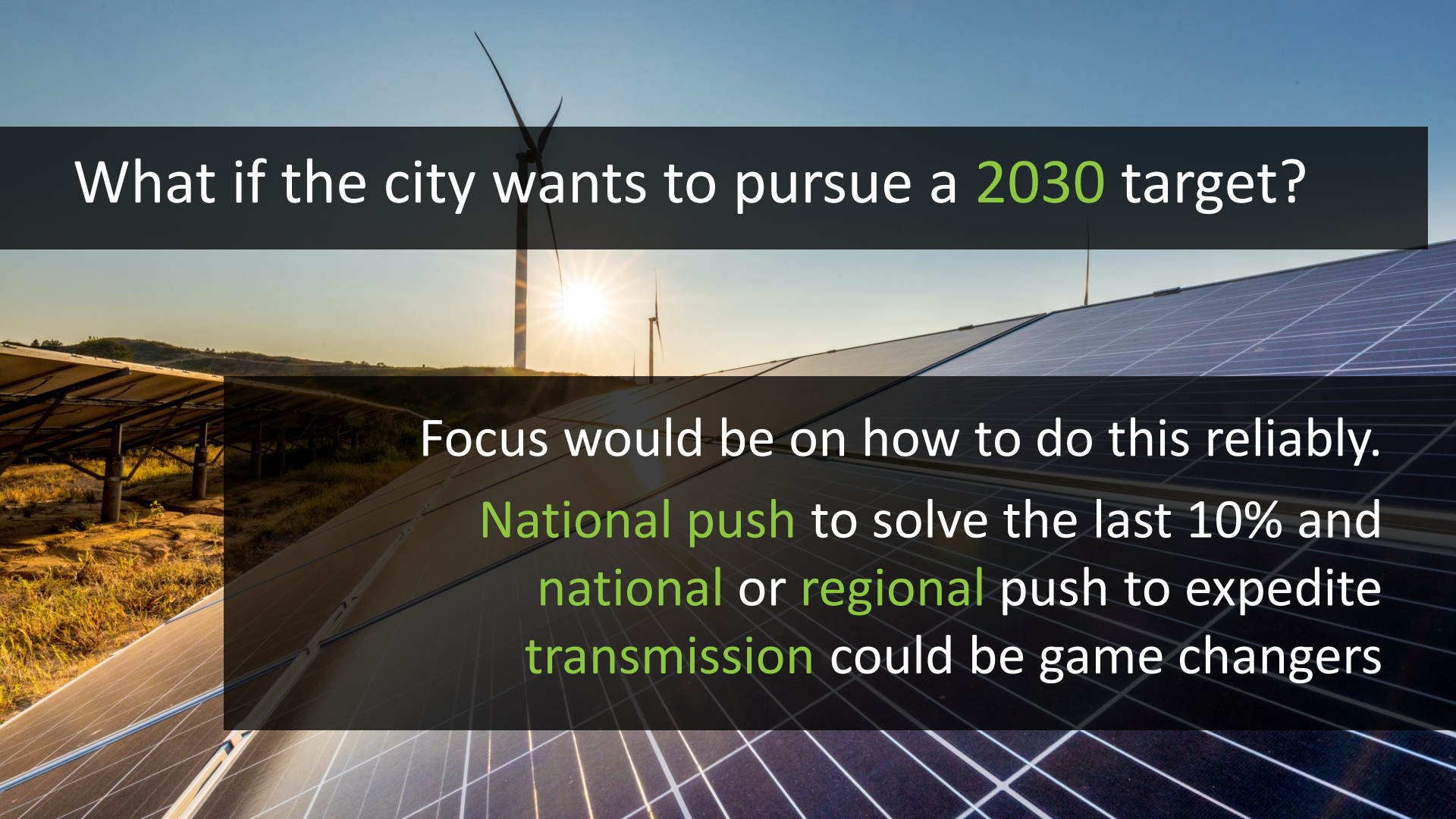
Fuel Flexibility (like SB100): Renewable Electricity Credits (RECs), Biofuels

- Can delay committing to hydrogen infrastructure until technologies advance further

What happens if biofuels aren't in sufficient supply while hydrogen market matures? Or if hydrogen infrastructure is infeasible?

Example alternatives:

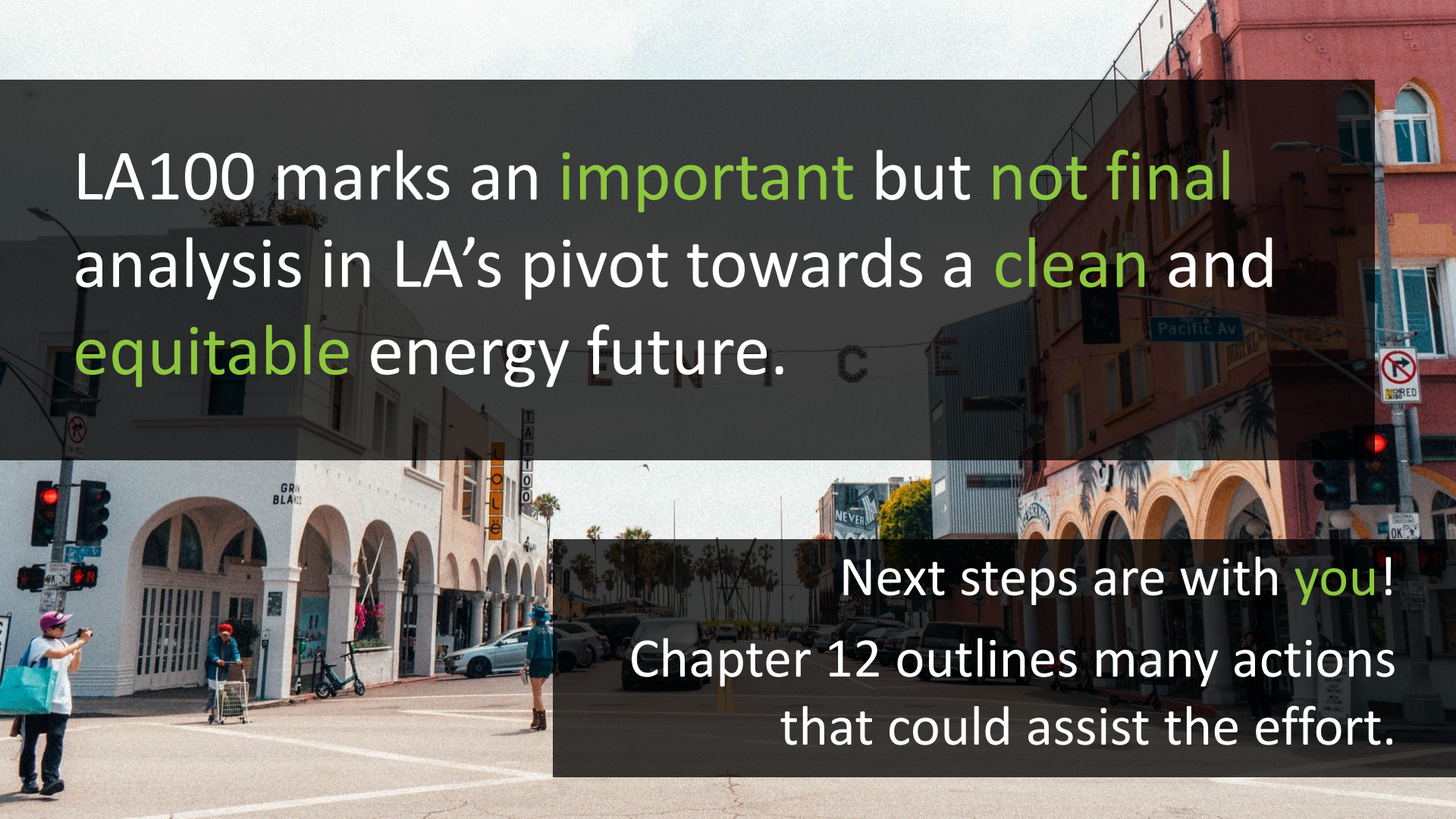
1. [Fastest]: Allow RECs but limit amount to a few percent of generation and still gain most all GHG, air quality, and health benefits
2. **Voluntary** (and **equitable**) multi-day demand response
   - Pay customers **significantly** to reduce electricity **significantly**
     - **For example, would enough customers reduce electricity if paid $5-9/kWh…and remain low for many days?**
     - How would you measure reductions? How could LADWP have confidence that this could avoid rolling blackouts? How automate? Many questions still….
   - Actions to help prepare for this
     a) Conduct marginal cost analysis of customer base and start with industries
     b) Make headway with as much traditional demand response as possible
     c) Pilot different multiday programs and test reliability of response—opportunity for creativity!



What if the city wants to pursue a 2030 target?

Focus would be on how to do this reliably.

National push to solve the last 10% and national or regional push to expedite transmission could be game changers



LA100 marks an important but not final analysis in LA's pivot towards a clean and equitable energy future.

Next steps are with you!

Chapter 12 outlines many actions that could assist the effort.

Questions? Comments?