



# The Path to Net Zero

A DECARBONIZATION ROADMAP FOR CALIFORNIA



# THE PATH TO NET ZERO OVERVIEW

SDG&E recommends a diversified approach to decarbonization utilizing clean electricity, clean fuels and carbon removal to achieve the state's 2030 and 2045 GHG goals

## SDG&E's Diversified Approach to Decarbonization

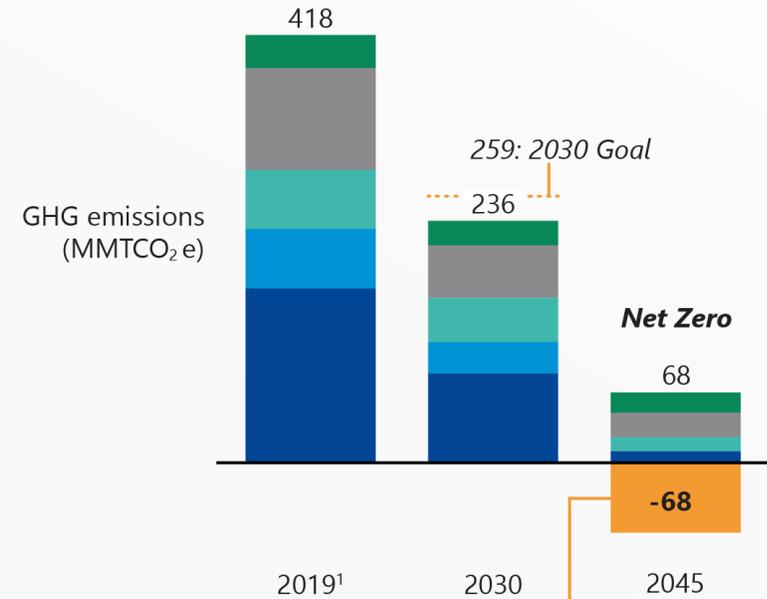
CLEAN ELECTRICITY

CLEAN FUELS



CARBON REMOVAL

## California GHG Emissions



Roadmap envisions a role for carbon removal technology in addressing the **68 MMTCO<sub>2</sub>e** that remain in 2045

- Transportation
- Electric Power
- Buildings
- Industrial
- Agriculture
- Carbon Removal

1) Actual emissions are based on CARB's 2019 Inventory (2021 Edition). California Senate Bill (SB) 32 requires a 40% reduction of 1990 economy-wide emissions by 2030. EO B-55-18 established a statewide goal to achieve carbon neutrality by 2045.

# Key Takeaways

## Clean & Reliable Electricity

- 1** This study is the first publicly available analysis to model California decarbonization through 2045 using the NERC<sup>(1)</sup> industry standard for evaluating electric system reliability, yielding new insights about the generation capacity, grid investments and technologies required to decarbonize reliably
- 2** A reliable, clean and diverse electric portfolio is critical to help enable economywide electrification. The pace of utility-scale solar and wind development is expected to significantly increase.
- 3** Significant electrification of transportation and buildings will need to occur, doubling SDGE's electricity consumption and increasing net peak demand to 1.8 times by 2045

## Clean Fuels

- 4** A diverse approach is essential to reliable, affordable and equitable decarbonization. Clean electricity and clean fuels both play critical roles in every sector of the economy.
- 5** Clean fuels, especially hydrogen, will play a critical role in decarbonizing the electric sector, medium-duty and heavy-duty vehicles and portions of the industrial sector that cannot feasibly be electrified

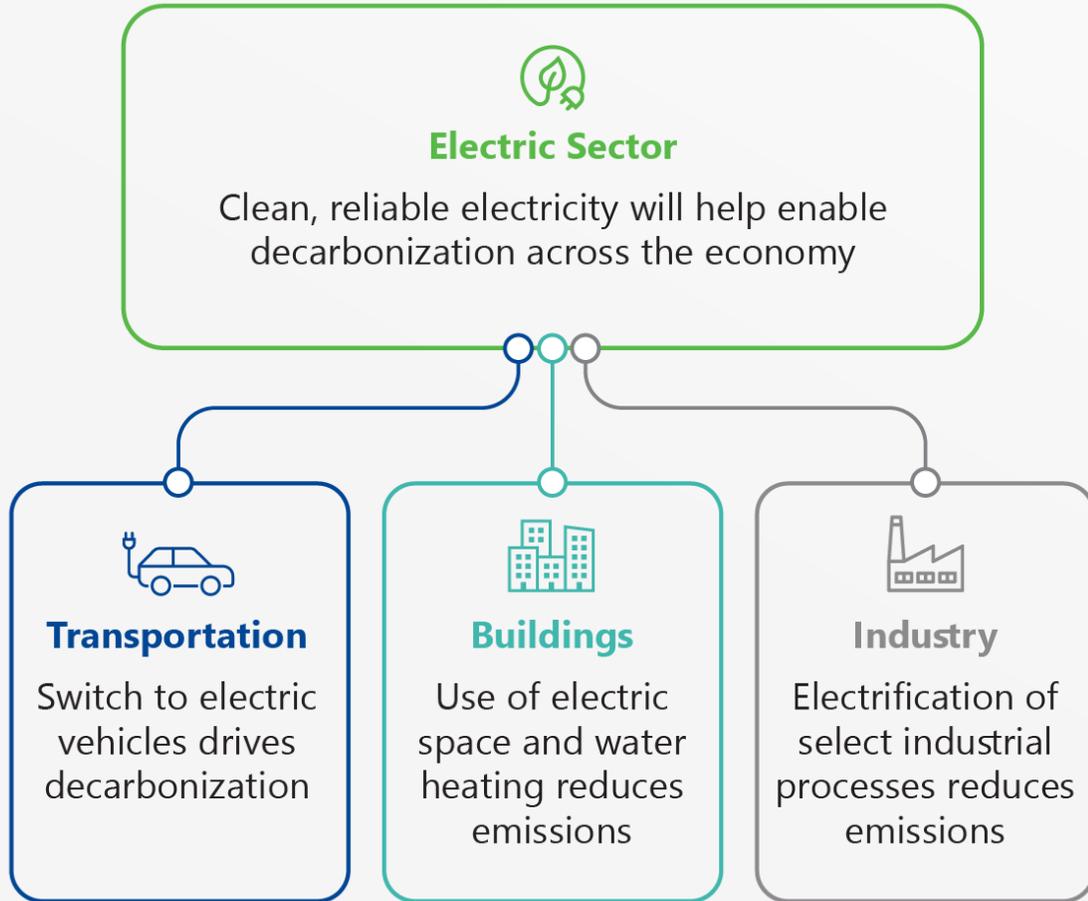
## Affordability

- 6** Customers that electrify according to our Roadmap are projected to have similar ongoing energy costs in 2045.<sup>(2)</sup> Successful decarbonization should ensure disproportionate costs are avoided and that everyone is able to adopt decarbonization technologies and benefit from the clean transition.

1) North American Electric Reliability Corporation  
2) Does not account for impacts of inflation

# CLEAN & RELIABLE ELECTRICITY

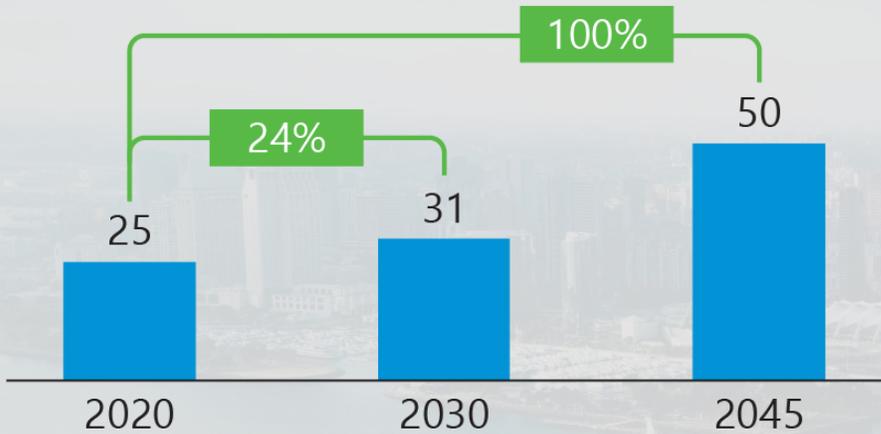
The electric sector is a key enabler to decarbonizing the California economy



# ELECTRICITY CONSUMPTION & DEMAND

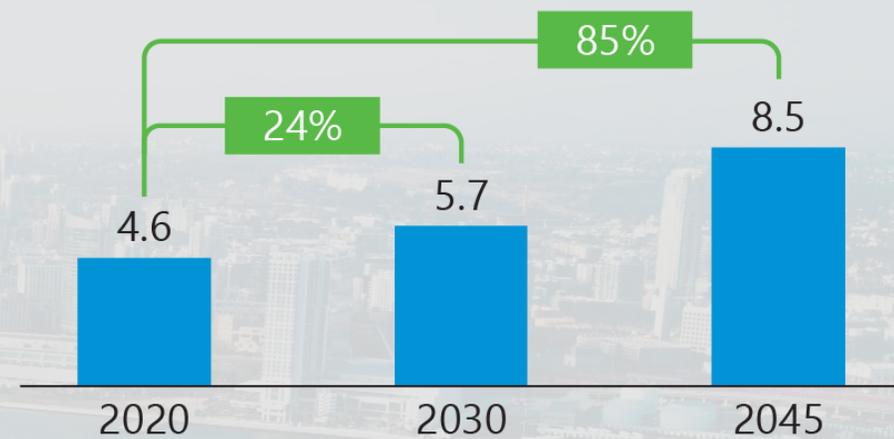
Electricity consumption & net peak demand are expected to increase significantly

### SDG&E Electricity Consumption (TWh)



SDG&E's projected electricity consumption doubles from 2020 to 2045, primarily driven by transportation electrification

### SDG&E Net Peak Demand (GW)<sup>(1)</sup>

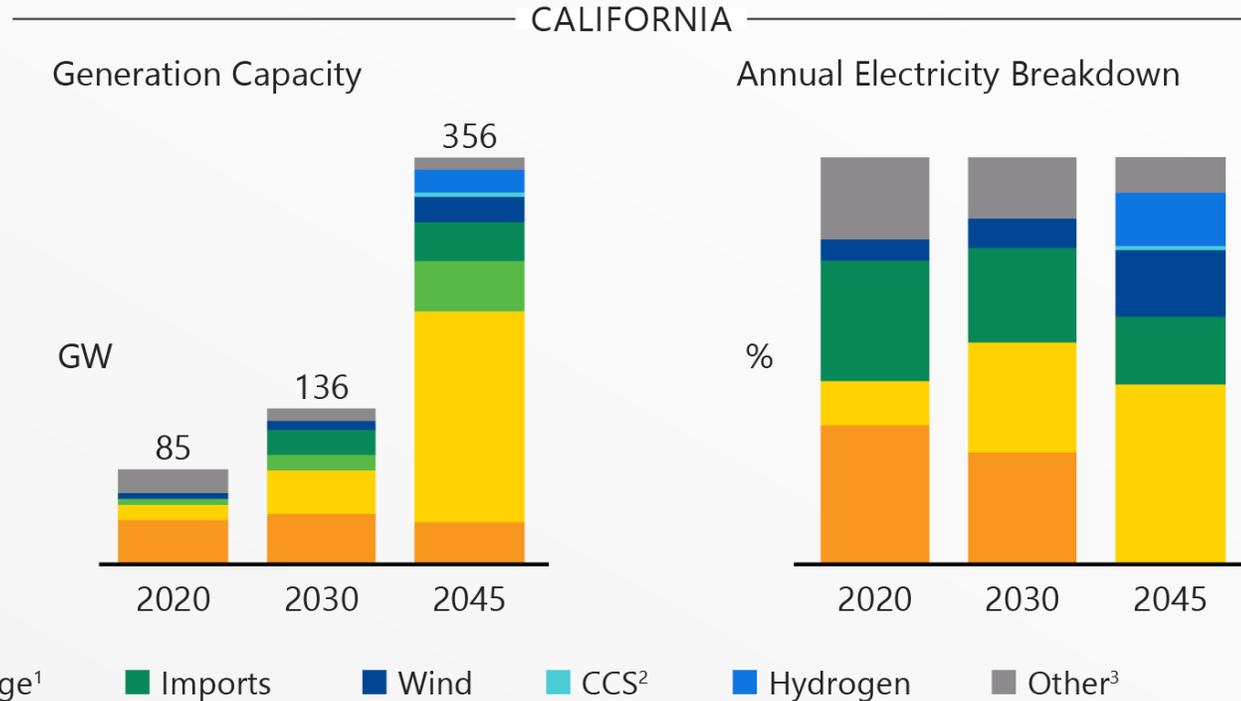
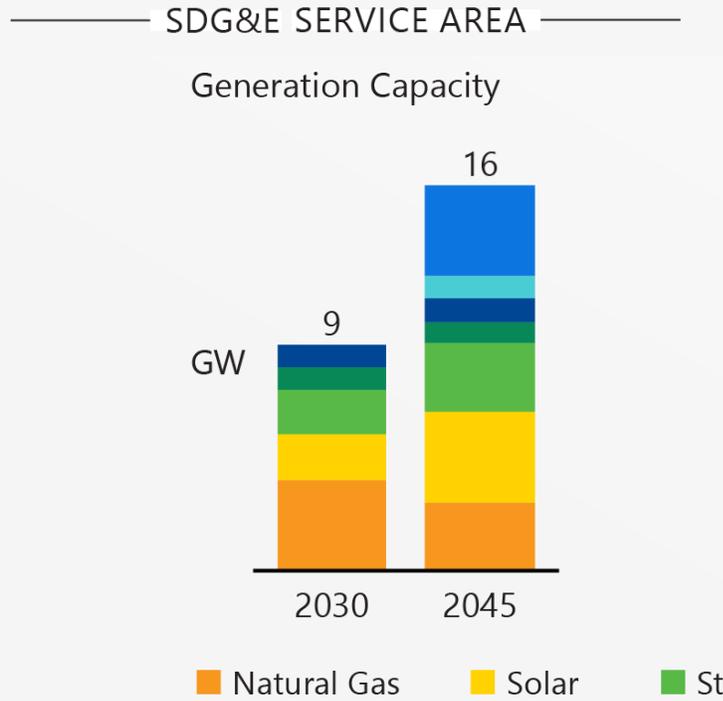


SDG&E's projected electric net peak demand grows by 85% from 2020 to 2045

1) Net peak demand = base load – behind the meter generation  
2) See slide 14 for California electricity consumption and net peak demand

# ELECTRIC SUPPLY PORTFOLIO

Incorporating robust reliability modeling reveals a greater need for clean dispatchable generation

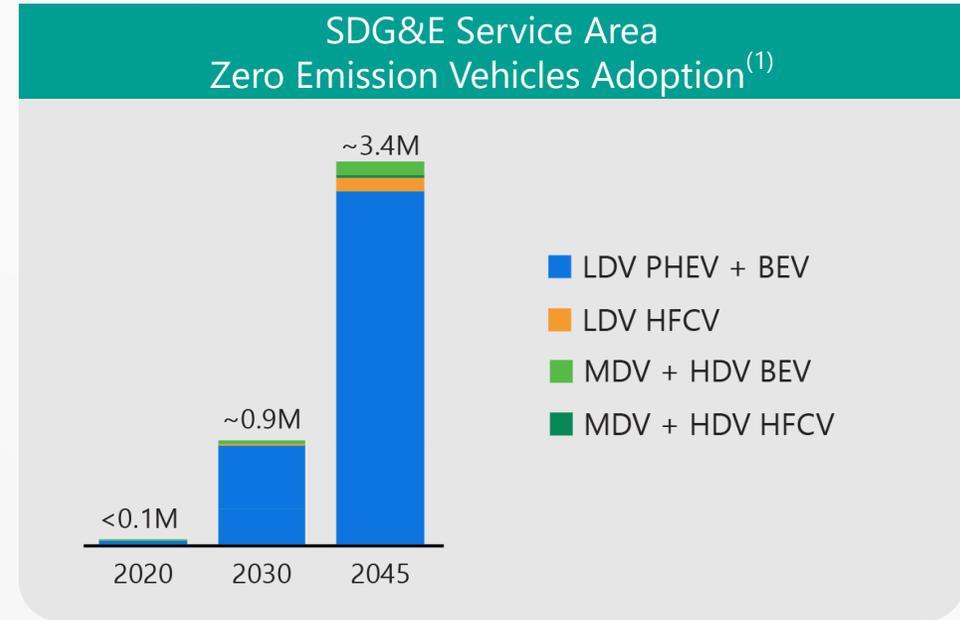
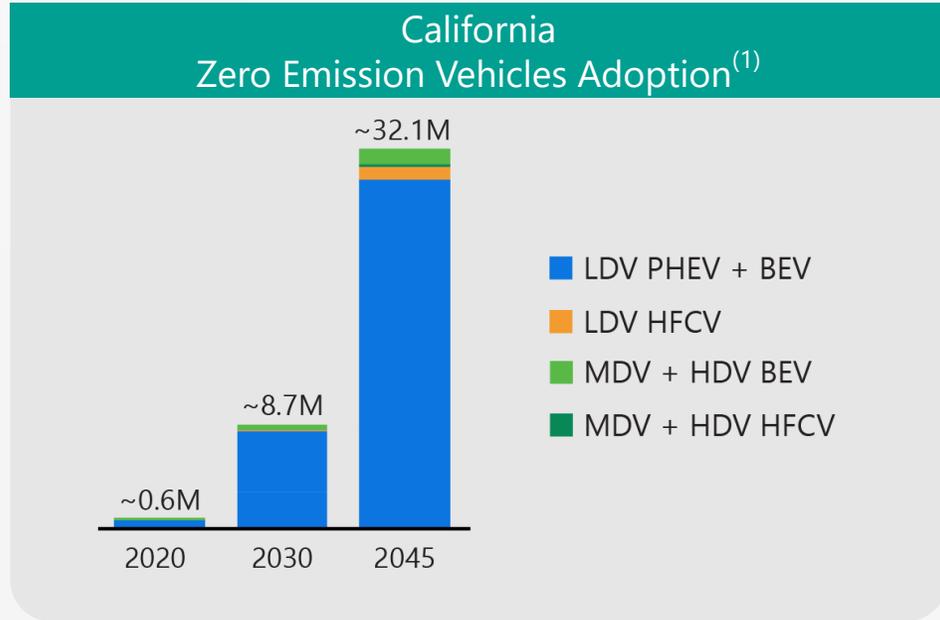


- The Path to Net Zero is the first in California to use the NERC industry standard for reliability through 2045
- A decarbonized and reliable electric sector is achieved through a combination of renewables, energy storage, and 100% clean hydrogen generation
  - While our modeling selected hydrogen-based generation to provide electric reliability, we support a technology inclusive approach
- Statewide, average annual growth ~8 GW of solar, and ~2 GW of battery storage, beginning in 2023

1) Includes both short- and long-duration battery energy storage and pumped hydro storage  
 2) Natural gas generation with CCS. Includes new builds and retrofits  
 3) Other includes oil, coal, geothermal, biomass, hydro, and nuclear

# ELECTRIFYING TRANSPORTATION

A monumental transition to electric vehicles will be needed to decarbonize the transportation sector



### SDG&E Service Area Chargers<sup>(2)</sup>

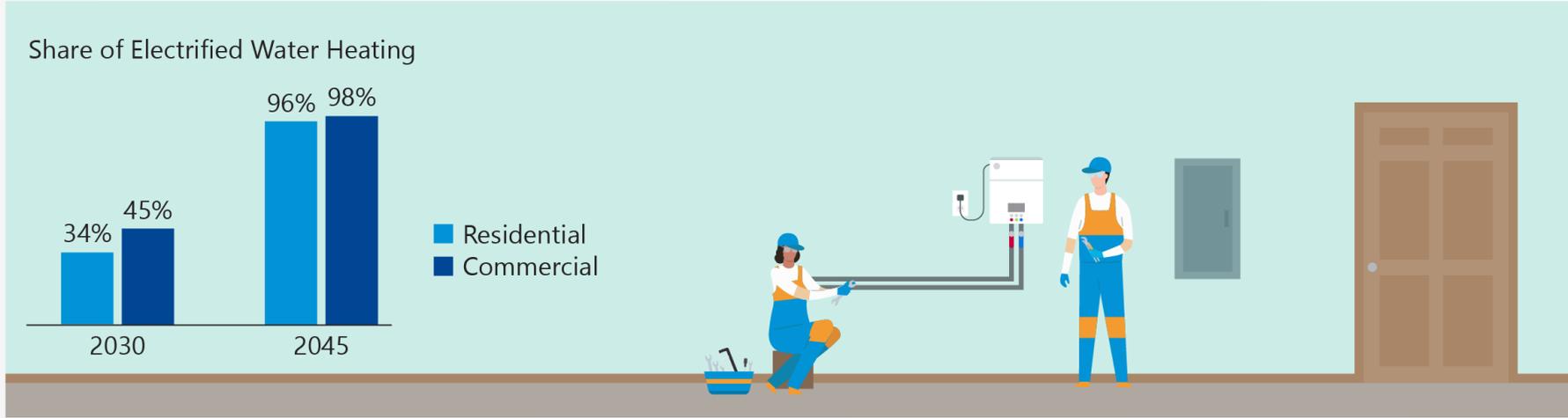
	2020	2030	2045
EV chargers	~7K	~180K	~640K

1) 2020 represents actuals based on CEC ZEV and Infrastructure Statistics (YE-2020, updated April 2021) for light-duty only, within California and the SDG&E service area. 2030 + 2045 shown are projected ZEVs for light-duty, medium-duty, and heavy-duty.

2) 2020 chargers represent actuals based on SDG&E's Accelerate to Zero study (San Diego County Only, reflects light-duty, medium-duty, and heavy-duty). 2030 + 2045 shown are projected for light-duty, medium-duty, and heavy-duty.

# DECARBONIZING BUILDINGS

Building emissions can be decarbonized by electrifying space and water heating equipment or substituting the burning of natural gas with clean fuels



The share of electrified water heating appliances grows to 96% or higher for both residential and commercial applications



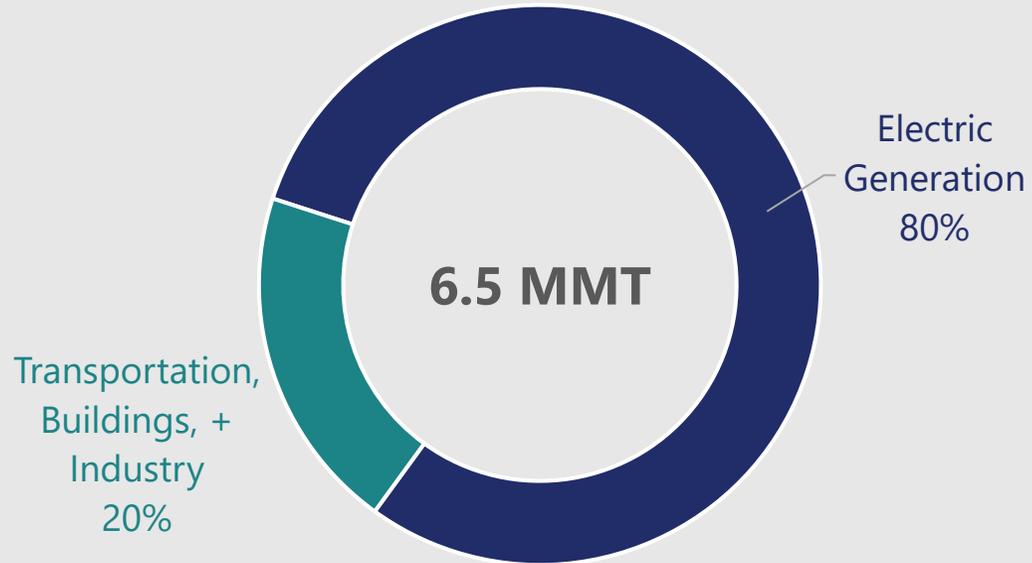
Electrified space heating grows substantially, albeit at a slower pace due to longer useful lives of gas furnaces



# CLEAN FUELS ARE INTEGRAL

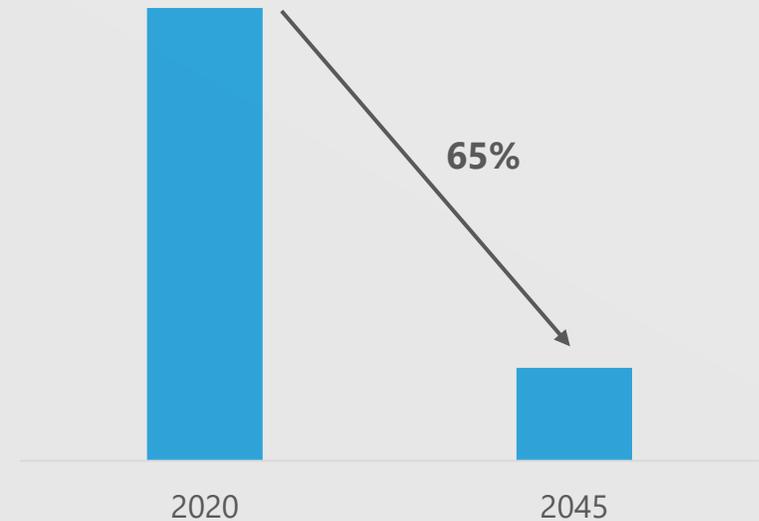
Clean fuels, in particular clean hydrogen, must be leveraged as a key decarbonization tool

## 2045 California Consumption of Clean Hydrogen



This amount of hydrogen represents 65% of U.S. hydrogen production today, which is not carbon free<sup>(1)</sup>

## Gas System Throughput<sup>(2)</sup> (by Volume)



While gas system throughput is projected to decline 65% by 2045, the composition of the pipeline changes significantly, leveraging ~42% clean hydrogen and renewable natural gas

1) ~10MMT of hydrogen is produced nationally [Energy.gov hydrogen production estimates]  
2) Pipeline mix serves residential + commercial buildings, the industrial sector, and natural gas electric generation

# AFFORDABILITY & EQUITY CONSIDERATIONS

Decarbonization may have disproportionate impacts on different customer types



**Overview** | Annual Household Energy Spend is a snapshot of ongoing SDG&E residential customer energy costs, incorporating utility bills (electricity and natural gas) as well as gasoline costs



**Key Findings** | The state, energy providers and others will need to ensure customers are able to adopt and electrify to avoid disproportionate impacts and benefits from decarbonization

## Customer Type Overview

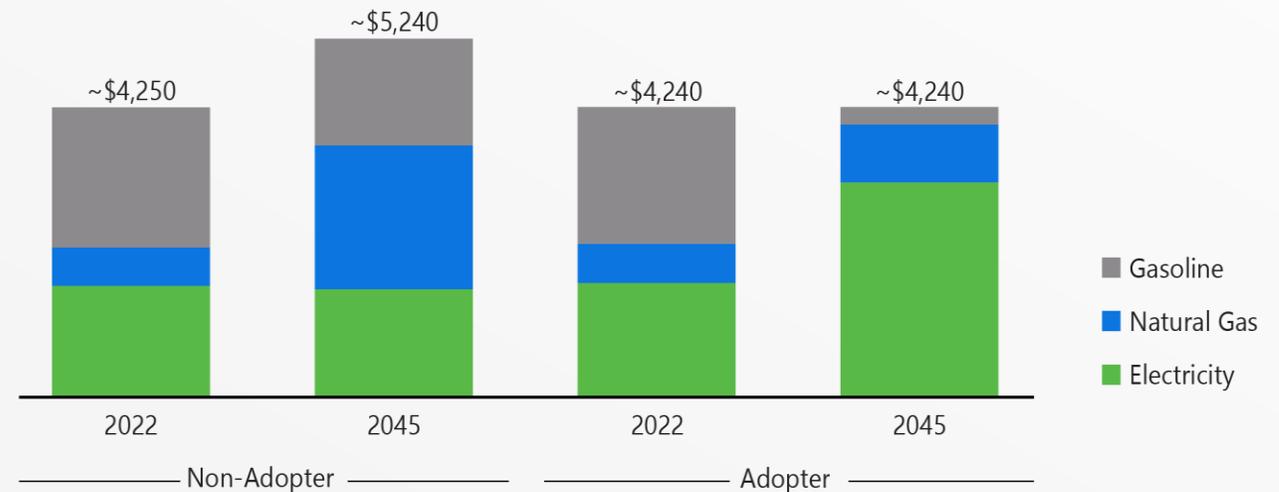
**Non-Adopter** makes no changes to their base 2022 electricity and natural gas consumption and owns gasoline vehicles

**Adopter** electrifies appliances + vehicles at the average rate of the Roadmap

## Annual Household Energy Spend<sup>(1),(2)</sup>

### Key Assumptions:

- Figures shown are in real \$2021 (excludes future inflation effects)
- No changes in rate design (electricity + gas)
- Reflects ongoing costs only, excludes upfront costs to purchase electric appliances or vehicles

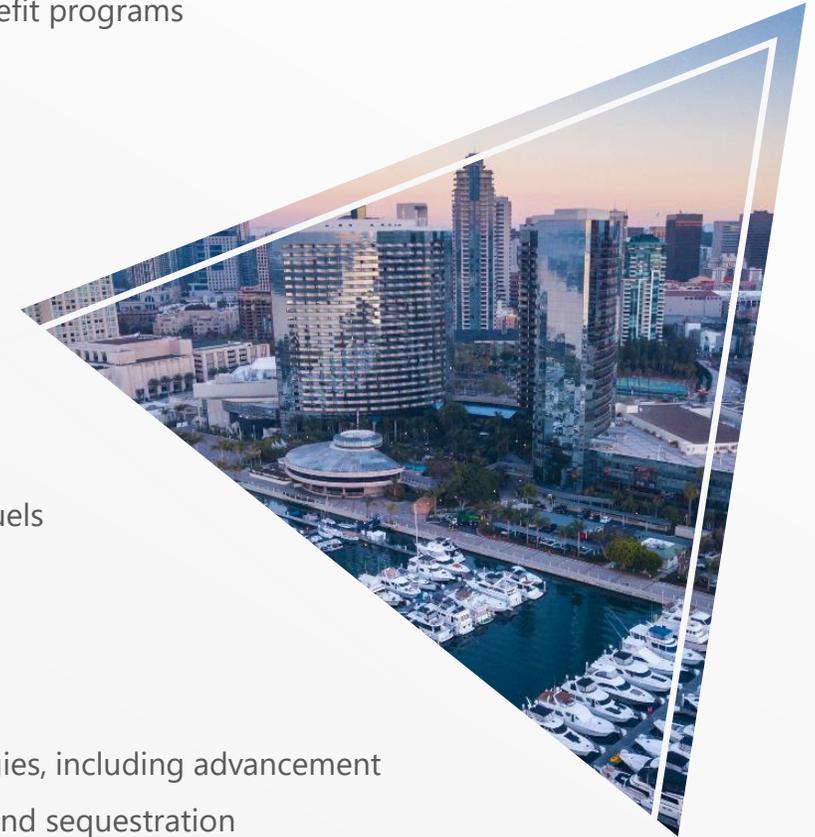


1) 2022 figures based on SDG&E approved 1/1/22 residential average rates, 2045 are projected. All figures represent an illustrative SDG&E bundled residential customer (delivery + commodity).  
 2) Gasoline pricing methodology; Utilizing 2021 CEC data, gasoline pricing components were broken out (crude oil + other) for forecasting purposes. Crude oil prices are based on a real growth forecast utilizing 2021 EIA AEO data (consistent with economywide cost analysis). Other gasoline components were held constant.

# POLICY & REGULATORY SUPPORT

The successful implementation of our Roadmap requires the following regulatory and political support:

- 1 Maintain Affordability and Enhance Equity**
  - Reform electric and gas rates and explore alternative funding and recovery mechanisms, including utilizing the state budget for funding state priorities, such as public purpose programs, net energy metering and other societal benefit programs
  - Pursue only the most cost-effective energy efficiency and demand response programs
  - Support low-income households so they can benefit from the clean energy transition
  - Support an equitable transition for affected workforces
- 2 Prioritize Electric System Reliability**
  - Incorporate more robust electric sector reliability into long-term state planning
  - Implement a regional transmission organization
- 3 Enable Deployment of Decarbonization Infrastructure**
  - Enable faster infrastructure development by updating planning efforts for clean electricity and clean fuels
  - Simplify and accelerate regulatory reviews
  - Centrally authorize land use for decarbonization technologies
- 4 Incentivize Innovation and Adaptability**
  - Encourage research, development and demonstration efforts for emerging decarbonization technologies, including advancement of clean hydrogen infrastructure, and developing the policy framework to encourage carbon capture and sequestration





# Appendix

# INFORMATION REGARDING FORWARD LOOKING STATEMENTS

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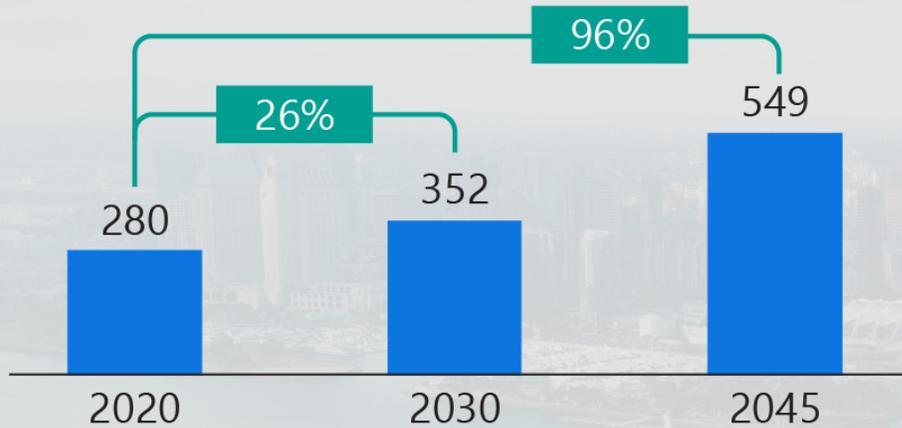
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# ELECTRICITY CONSUMPTION & DEMAND

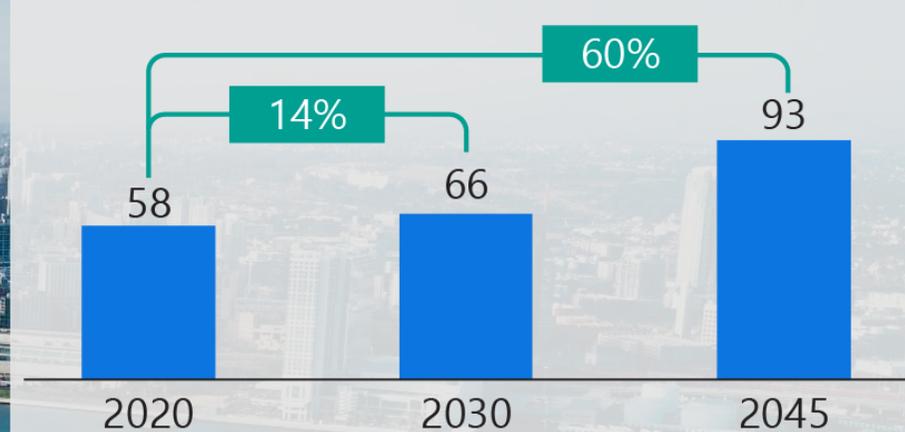
Electricity consumption & net peak demand is expected to increase significantly

## California Electricity Consumption (TWh)



California's projected electricity consumption nearly doubles from 2020 to 2045, primarily driven by transportation electrification

## California Net Peak Demand (GW)<sup>(1)</sup>



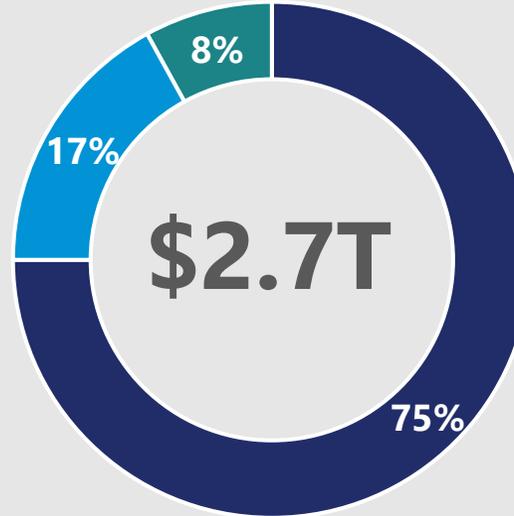
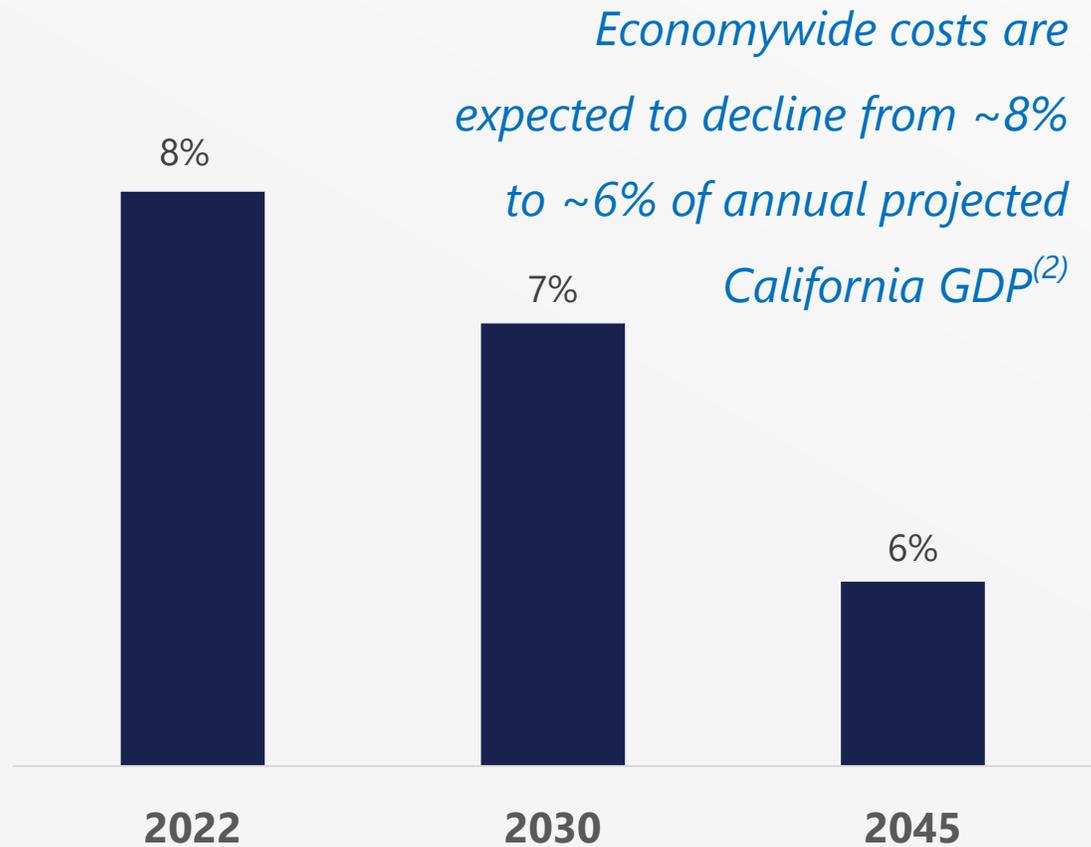
California's projected electric net peak demand grows by 60% from 2020 to 2045

1) Net peak demand = Base Load – BTM PV – CHP

# CALIFORNIA ECONOMYWIDE COSTS<sup>(1)</sup>

The Roadmap estimates California will need a relatively small share of state GDP on an annual basis through 2045 to reliably achieve its decarbonization goals

Economywide Costs % of CA GDP<sup>(2)</sup>



## California Economywide Costs

**Equipment Stock Costs** | End-use technologies including zero-emission vehicles and electric appliances

**Fuel Costs** | Including hydrogen, gasoline, natural gas, etc.

**Electric Generation** | Including capital-related investments, related transmission and annual production costs

1) ~\$2.7T represents the Net Present Value (NPV) of costs calculated by utilizing cumulative full costs (stock costs, fuel costs, and levelized electric costs) in 2021 real dollars through 2045, discounted back to 2021 (utilizing a real discount factor of 10%, consistent with the factor used in PATHWAYS to levelized costs). Full costs represent all costs related to a scenario (not incremental to a reference case) so therefore include costs that are likely to be spent regardless of decarbonization efforts (e.g., purchasing a car or appliance, etc.)

2) California GDP was forecasted by using 2021 figures and applying a real growth rate of 2.7% annually through 2045. 2.7% represents 10-year historical real growth rate per U.S. BEA GDP by State.