



REACHING NET ZERO

September 2024





FORWARD-LOOKING STATEMENTS

Statements contained in this report about future performance, plans, expectations, objectives and forecasts, and other statements that are not purely historical, are forward-looking statements. These forward-looking statements reflect our current expectations; however, such statements involve risks and uncertainties. Actual results could differ materially from current expectations. These forward-looking statements represent our expectations only as of the date of this report, and Edison International assumes no duty to update them to reflect new information, events or circumstances. Some of the factors that could cause actual results to differ materially are discussed under the headings “Forward-Looking Statements,” “Risk Factors” and “Management’s Discussion and Analysis” in Edison International’s Form 10-K for the year ended Dec. 31, 2023, and other reports filed subsequently with the U.S. Securities and Exchange Commission, which are available on our website. These filings also provide additional information on historical and other factual data contained in this report.

“Edison’s *Reaching Net Zero* is a worthy addition to its sequence of groundbreaking blueprints for California’s clean energy future. The company’s leadership in tackling the climate crisis by accelerating efficient electrification will help assure a sustainable, affordable energy future for all.”

— Ralph Cavanagh,[†] *longtime clean energy and climate advocate*

[†]. Ralph Cavanagh, a frequent reviewer of Edison’s previous white papers, reviewed this study before publication.

EXECUTIVE SUMMARY

ACCELERATING CALIFORNIA'S CLEAN ENERGY TRANSITION

Electrifying the economy with clean power is society's most effective tool for rapidly reducing carbon emissions. California depends on the electric grid and delivery of clean power by Southern California Edison and other utilities to achieve its carbon neutrality goals. The rapid, expansive development of clean energy and efficient electrification technologies requires state support and conducive policies. While this clean energy future is within reach, it is not assured; proactive planning for potential challenges remains necessary to navigate risks and capitalize on opportunities.

Last year, Edison International published *Countdown to 2045 (Countdown)*, detailing economywide actions needed for California to achieve its climate goals. *Countdown* built upon our earlier work and incorporated recent policy and market developments, expected climate change impacts and an in-depth study of electric sector reliability. This updated analysis reinforced our conclusions about the critical role of electrification on the path to decarbonization. It also showed the economic and affordability benefits of broad electrification. As customers switch from gasoline and natural gas to clean electricity, and as grid utilization increases, *Countdown* forecast that SCE's average residential customers will save about 40% on their total energy expenses by 2045, **even accounting for infrastructure investments needed to achieve a safe, clean and reliable electric grid.**

Edison International remains committed to achieving net-zero greenhouse gas (GHG) emissions across all three scopes and delivering 100% carbon-free power to customers¹ by 2045. *Reaching Net Zero (RNZ)* focuses on Edison International's direct contributions to California's clean energy transition by detailing our company's steps to reach net zero. GHG emissions from power delivered to SCE's customers make up the overwhelming majority of Edison International's emissions, which are forecast to be reduced by 95% between 2005 and 2045. To address operational emissions, SCE is engaging vendors to reduce supply chain emissions, phasing out older technology and continuing to electrify its vehicle fleet, among other actions. To reach net zero by 2045, Edison International forecasts that 2 MMT CO₂e will need to be removed or offset. The company plans to prioritize affordable, high-quality carbon removal solutions to net out remaining emissions.

1. All carbon-free power delivery targets and disclosures are in terms of retail sales. "Delivered power" and "power delivery" are both used to refer to activities associated with SCE's delivery of power to its customers.
2. Formerly known as Edison Energy, Altenex Energy and Alfa Energy, the group has unified under the new name "Trio," operating under Edison Energy, LLC, an indirect, wholly-owned, non-utility subsidiary of Edison International, to enhance its global sustainability and energy advisory services. Trio is not the same company as SCE, the utility, and Trio is not regulated by the California Public Utilities Commission (CPUC).



ABOUT EDISON INTERNATIONAL

Edison International and its subsidiaries lead the clean energy transition. We focus on clean energy, efficient electrification, the grid of the future and customer choice. With a 138-year history, Southern California Edison serves 15 million people and is one of the nation's largest electric utilities. Trio² advises the world's largest organizations on navigating the energy transition by offering advisory services in decarbonization planning, energy procurement, renewables and sustainability strategies.

Safe & Clean

- Cleaner air
- Reduced wildfire risk
- 100% clean energy delivered to customers

NET ZERO IN 2045

Reliable

- More operational flexibility
- Fewer outages
- Increased grid capacity

Affordable

- Equitable transition
- 40% savings in total energy expenses

RNZ also expands upon work in *Countdown* by examining how “challenge scenarios” (scenarios) inform the potential risks and opportunities associated with achieving California’s electric sector climate goals. These scenarios include higher electric demand, delayed deployment of clean firm technology and a combination of the two. This analysis builds on Edison International’s view from *Countdown* that investment in emerging clean firm resource generation is integral to a reliable and sustainable energy future. Clean firm resources produce constant power through any weather conditions or season with limited or no GHG emissions, such as next-generation geothermal, small modular reactors, natural gas with carbon capture and storage, and clean hydrogen. Two main findings from the analysis inform our perspective:

- **Feasibility challenges arise when clean firm resources are unavailable:** Each GW of new clean firm generation would reduce GHG emissions as effectively as 7 GW to 11 GW of new paired solar and storage as the electric sector approaches a low-emissions future in 2045. The most challenging scenario could necessitate a clean resource buildout of over 200 GW without clean firm resources, significantly higher than the 120 GW identified in *Countdown*, further accelerating the pace and expanding the scale of clean energy and infrastructure development required.
- **Until sufficient clean firm resources are deployed, natural gas generation capacity in California should be retained for reliability and affordability,³ with reduced operations.**

The risks identified in the scenario analysis have implications for SCE’s delivered power emissions and the achievement of Edison International’s net-zero commitment. The analysis highlights the importance of advancing clean firm resources and regulatory and policy reforms of planning, permitting, and transmission and distribution processes, as called for in *Countdown*.

Nearly all sectors of the economy will need to rely on clean electricity to reach net zero. As catalysts of the clean energy transition, electric utilities must provide safe, clean, reliable and affordable electric service. Though balancing each of these may be challenging, we believe it is not only possible but imperative to achieve all these objectives to reach an equitable clean energy future. Edison International is acting to create a safer, more affordable future with cleaner air and reduced risk of climate disasters; a resilient grid ready to power electrified homes, buildings and vehicles; and lower overall energy expenses as we reach net-zero GHG emissions by 2045.

3. The *Countdown* scenario included retention of approximately 17 GW of California’s current natural gas fleet in 2045. The most challenging RNZ scenario would require retention of the entire gas fleet, approximately 26 GW.

OUR CLIMATE LEADERSHIP JOURNEY

Edison International continues to lead the clean energy transformation of the electric power industry through action and thought leadership. This accelerated in 2017 with the publication of *The Clean Power and Electrification Pathway*, a comprehensive plan for climate action in California, and continues steadily. The interplay between data-driven analysis and action to put concepts into practice is critical. Our findings inform business strategy, customer programs and advocacy work to stay on track to meet net zero.

Countdown to 2045 identified what is needed to achieve the broad electrification required to meet California’s climate goals:

- Build a grid that is reliable, resilient and ready for customer needs today and in the future.
- Optimize customer programs, especially for low-income and disadvantaged community households.
- Influence statewide and national policies around planning, permitting and affordability to ensure this buildout happens at the speed and scale required.

Reaching Net Zero is the next step in this journey. While *Countdown* is the updated pathway for the entire state, *RNZ* focuses on Edison International’s net-zero plan. Since most of our emissions are associated with power delivery, it includes robust scenario analysis on the risks and opportunities for California’s electric sector in reaching its climate targets. Figure 1 describes our climate leadership journey since 2017.

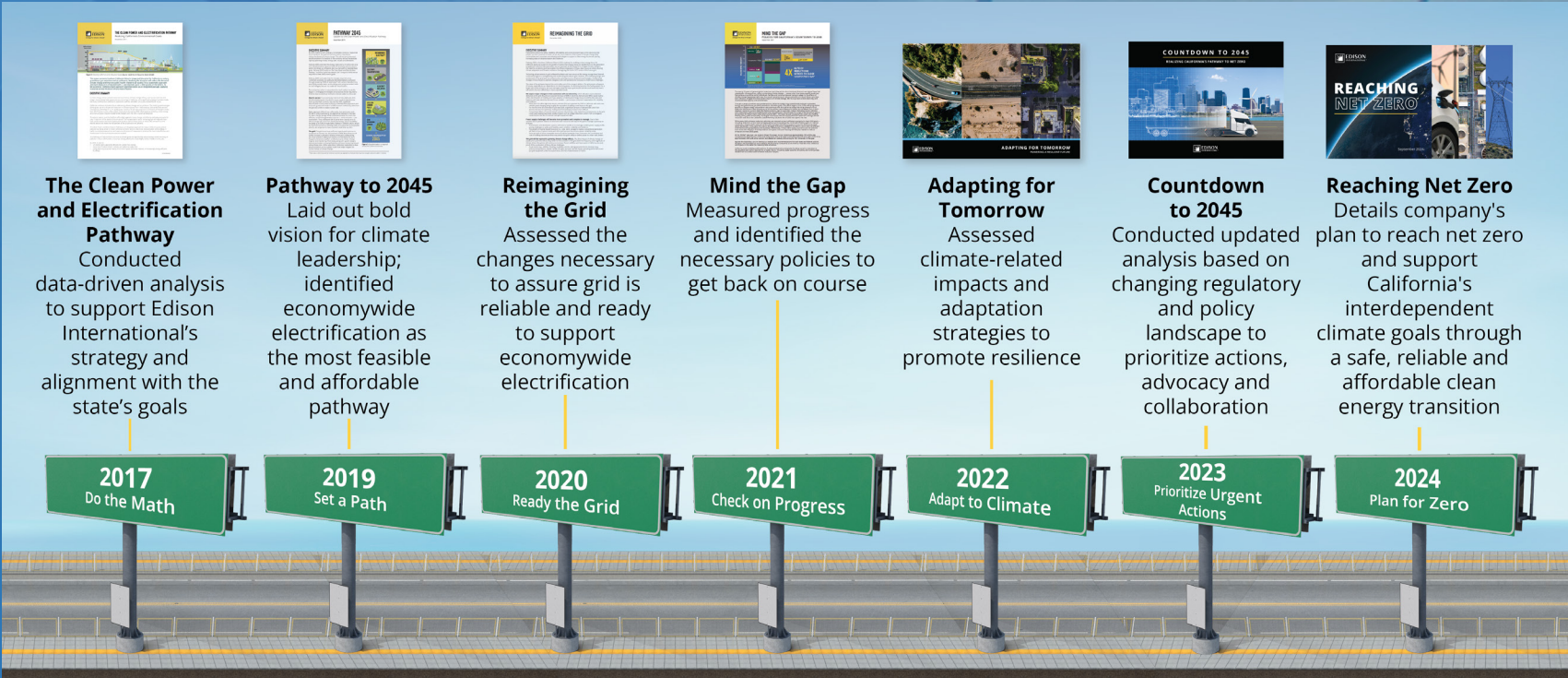


Figure 1. Edison International Climate Journey Roadmap

CALIFORNIA CLIMATE POLICY

The Global Warming Solutions Act of 2006, also known as AB 32, laid the groundwork for California’s GHG emissions reduction strategy. In 2022, AB 1279 expanded on the initial targets, enacting some of the world’s most ambitious climate change goals; California committed to a 40% reduction in GHG emissions from 1990 levels by 2030, net-zero GHG emissions by 2045 and net-negative GHG emissions thereafter. The state also established carbon-free retail power delivery goals for the electric sector through SB 100 and SB 1020. Together, these laws create interim milestones and the goal to deliver customers 100% carbon-free power by 2045.

CLIMATE CHANGE IMPACTS

Climate change is impacting California’s health, economy and quality of life. Since 1980, the state has faced 46 weather-related disasters costing over \$1 billion each. Additionally, 20 of these disasters in the last decade alone caused 783 deaths. In 2023, nine atmospheric river events led to severe flooding, power outages and mudslides, resulting in 22 deaths.ⁱ Achieving net zero by 2045 is crucial for California’s future. Decarbonizing now will benefit the U.S. economy by an estimated \$3 trillion, compared to the projected \$14.5 trillion cost of insufficient action.ⁱⁱ As the catalyst of the clean energy transition, the power sector requires 70% of the global investment needed to reach net zero.ⁱⁱⁱ Unparalleled expansion of the electric grid and supportive policy changes are needed to enable this decarbonized future.

OUR NET-ZERO ACTION PLAN

REDUCING SCOPE 1, 2 AND 3 EMISSIONS TO ACHIEVE NET ZERO BY 2045

Our GHG emissions inventory and 2045 net-zero plan^{iv} cover Scope 1, 2 and material Scope 3 sources from Edison International, SCE and Trio.⁴ The largest source of GHG emissions in Edison International's inventory is associated with SCE delivering power to customers. **Total reductions of 95% are projected through 2045, from 2005 levels, from power delivery.**^{5,6} In addition, SCE's efforts to mitigate emissions in its operations include using renewable fuels, fleet and building electrification, and efficient work practices.

Additional details regarding Edison International's GHG inventory development methodology, current emissions scopes and sources, historical emissions and future emissions projections can be found in the [Appendix](#).

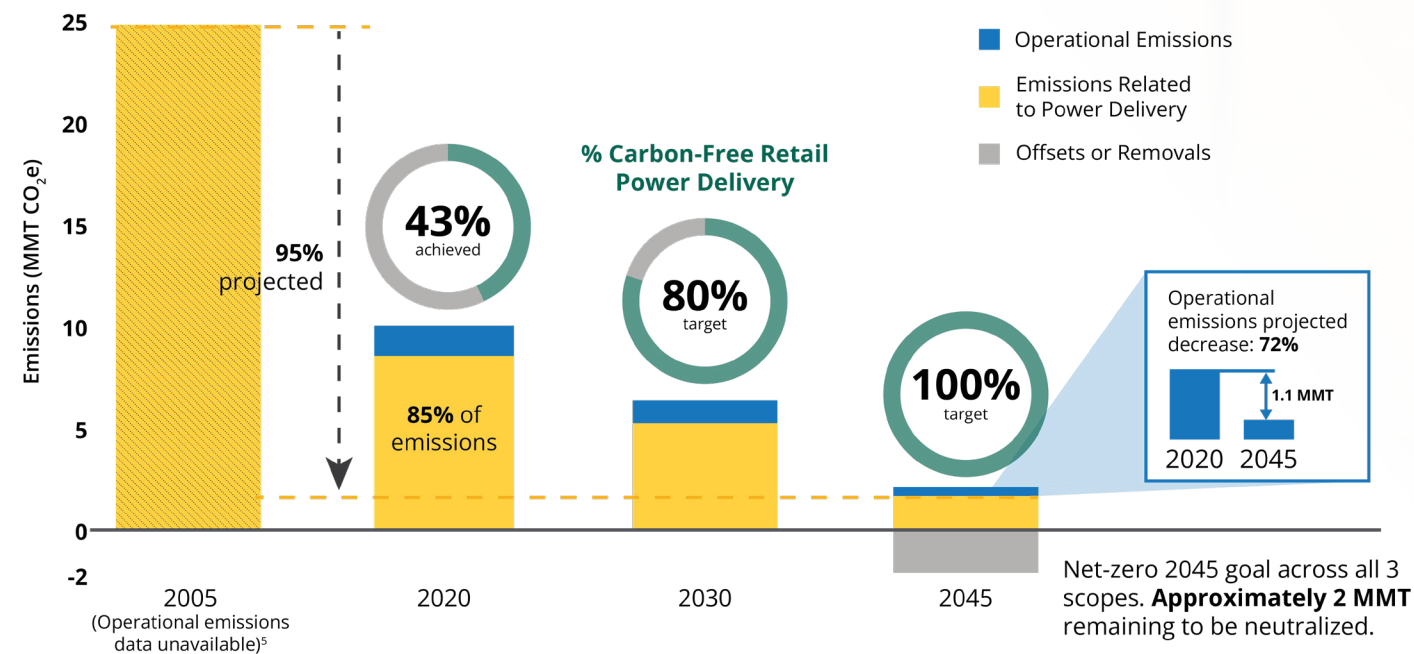


Figure 2. Edison International Climate Goals: Net-Zero GHG Emissions and 100% Carbon-Free Delivered Power by 2045

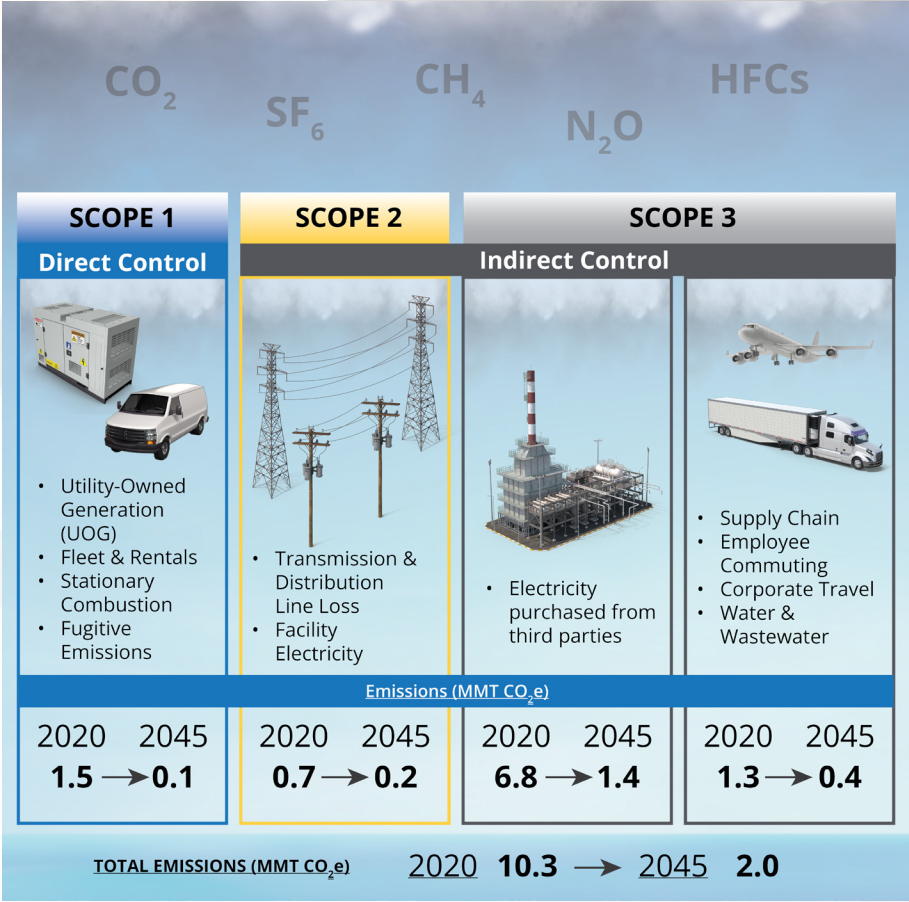


Figure 3. Scope 1-3 SCE Emissions Sources

4. Trio is not the same company as SCE (the utility), and Trio is not regulated by the California Public Utilities Commission (CPUC). Trio's emissions across all scopes are de-minimis.

5. The 2005 GHG emissions data is based on the best available historical data and only includes power delivery because operational data was unavailable. Unless otherwise specified, 2020 serves as the baseline year. Regulatory and methodological changes in recent years may cause slight differences between the 2005 data and the 2022 and 2023 calculations.

6. Emissions from power delivery include the power generated at SCE facilities and the power SCE purchases and delivers to customers, including line losses.

HISTORICAL AND 2045 GHG EMISSIONS PROJECTIONS

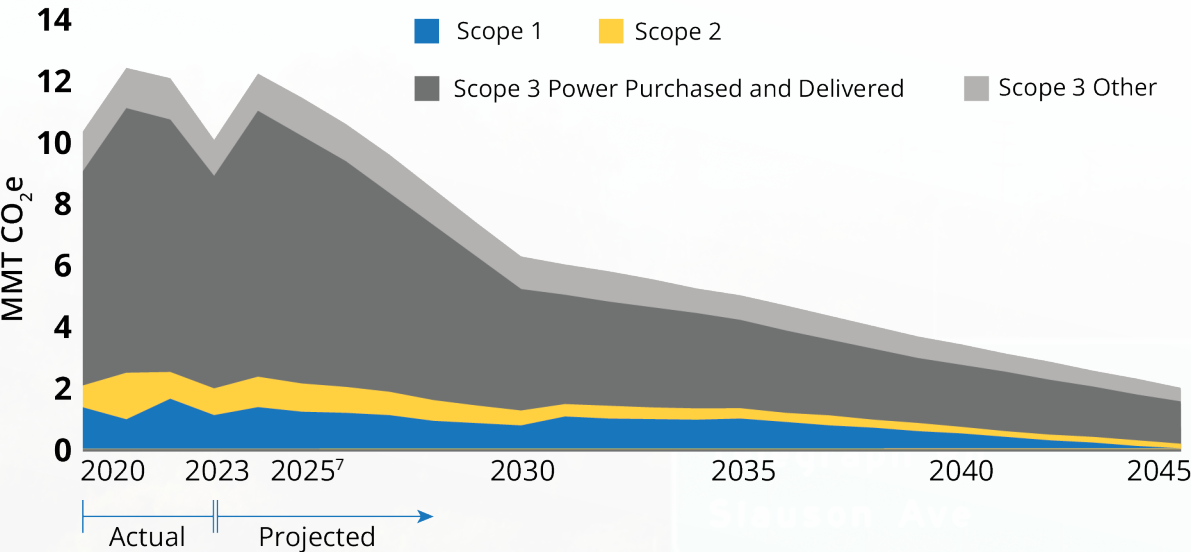


Figure 4. Edison International Historical and 2045 GHG Emissions Projections

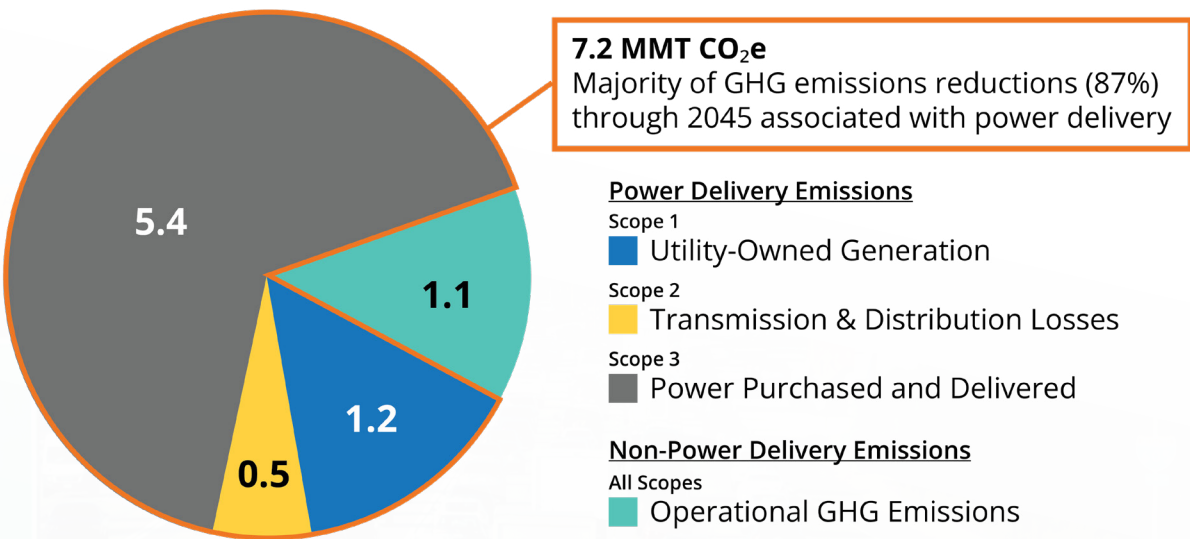


Figure 5. 2020-2045 GHG Emissions Reductions in MMT CO₂e

ACTIONS TO REACH NET ZERO: DELIVERING CARBON-FREE POWER TO SCE’S CUSTOMERS

In 2023, SCE delivered 51%⁸ carbon-free power to its customers while recording one of the lowest delivered power GHG intensities among investor-owned utilities, based on an industrywide benchmarking.⁹ To meet carbon-free power delivery goals and reduce delivered power portfolio emissions, SCE will increase clean power procurement and decrease natural gas generation. The projected GHG emissions reductions associated with power delivery (see Figure 5) represents 87% of Edison International’s total reductions by 2045.⁹ This projection is in line with California’s policies and SCE’s commitment to deliver 100% carbon-free power by 2045. The remaining emissions from power delivery in 2045, approximately 1.5 MMT CO₂e, reflect dependence on natural gas for reliability and affordability.

Achieving these GHG emissions reductions will be heavily influenced by decisions and actions beyond SCE’s control, including types and affordability of clean resources available to procure on behalf of SCE’s customers. That, in turn, depends heavily on commercialization of clean firm resources and other clean resources and sufficient transmission and distribution (T&D) buildout occurring both within and outside California. Given the importance of delivered power to Edison International’s plan to reach net zero, Edison International analyzed scenarios to identify potential risks and opportunities associated with achieving California’s electric sector climate goals. The implications for SCE and Edison International’s emissions trajectory are discussed on Page 10 and detailed further in the *Appendix*.

7. Emissions between 2020 and 2025 reflect the transition from actual to projected emissions data. Historical data reflects factors such as hydro availability during droughts, natural gas pricing affecting resource dispatch and weather-driven load variation. Projected emission increases in 2024/25 reflect load growth projections and a return to normal load levels. More details can be found in the *Appendix*.
8. The carbon-free power percentage is reflective of SCE’s final Power Source Disclosure Program report filed with the California Energy Commission (CEC) on June 28, 2024.
9. Consistent with the definition of retail sales in SB 100, wholesale transactions, losses due to energy storage operations and T&D lines losses are not included in the clean power targets. California and SCE can meet 100% clean power delivery to retail customers while using some natural gas generation for system reliability.

REDUCING SCE'S OPERATIONAL GHG EMISSIONS

In addition to delivering carbon-free power, SCE is focused on reducing emissions from operational sources, which constitute approximately 13% of total emissions reductions projected by 2045. The table below reflects actions that will reduce emissions, in decreasing order of impact, along with key barriers SCE faces and other considerations for the future.

ACTIONS, BARRIERS AND SOLUTIONS	
Scope 3	SUPPLY CHAIN REDUCTIONS — 0.9 MMT CO₂e Projected supply chain GHG emissions reductions are based on economywide actions and drivers. SCE is taking additional actions to reduce supply chain emissions through supplier engagement and the following steps: - Performing GHG emissions hot spot analysis to identify highest priority areas for reduction - Engaging top-emitting suppliers on reducing GHG emissions; line construction is about 28% of 2023 supply chain inventory - Serving as a founding member of the SSACA¹⁰ and offering suppliers GHG emissions inventory trainings SCE's ability to measure improvements in supplier emissions is limited by the current spend-based GHG calculation methodology (EPA's US EEIO).^{vi} By using new tools to capture supplier-specific data, SCE can accurately track emissions reductions and reduce reliance on the EEIO model. Supportive policy and technological innovations are needed to realize the emissions reductions projected throughout SCE's supply chain.
Scope 1	SF₆ EMISSIONS REDUCTIONS — 0.1 MMT CO₂e SCE aims to phase out T&D assets (e.g., circuit breakers, switchgear equipment) containing sulfur hexafluoride (SF₆), a potent greenhouse gas, in alignment with statewide regulation.¹¹ To avoid fugitive emissions in existing equipment, SCE maintains a robust leak mitigation plan. SCE works with peers and manufacturers to identify and pilot alternatives to SF₆, especially for higher-voltage applications where no viable replacement technologies are currently available.¹²
Scope 1	USE OF RENEWABLE DIESEL (R99)¹³ — 0.04 MMT CO₂e SCE is progressively phasing out the use of traditional diesel and transitioning to R99 for on-road and off-road vehicles and portable and emergency generators. Effectively managing risks associated with the cost and availability of R99 or other future renewable fuels is important.
Scope 3	EMPLOYEE VEHICLE MILES TRAVELED (VMT) REDUCTIONS — 0.02 MMT CO₂e To reduce emissions from employee commutes, SCE encourages use of low-emitting transportation modes such as carpooling, vanpooling and public transit; encourages hybrid work options where compatible with business needs; and provides on-site amenities like bike lockers, showers and EV chargers. SCE continues to advocate for policies that support VMT reduction and continues to expand its EV charging infrastructure.

Table 1. Actions, Barriers and Solutions for GHG Emissions Reductions in MMT CO₂e

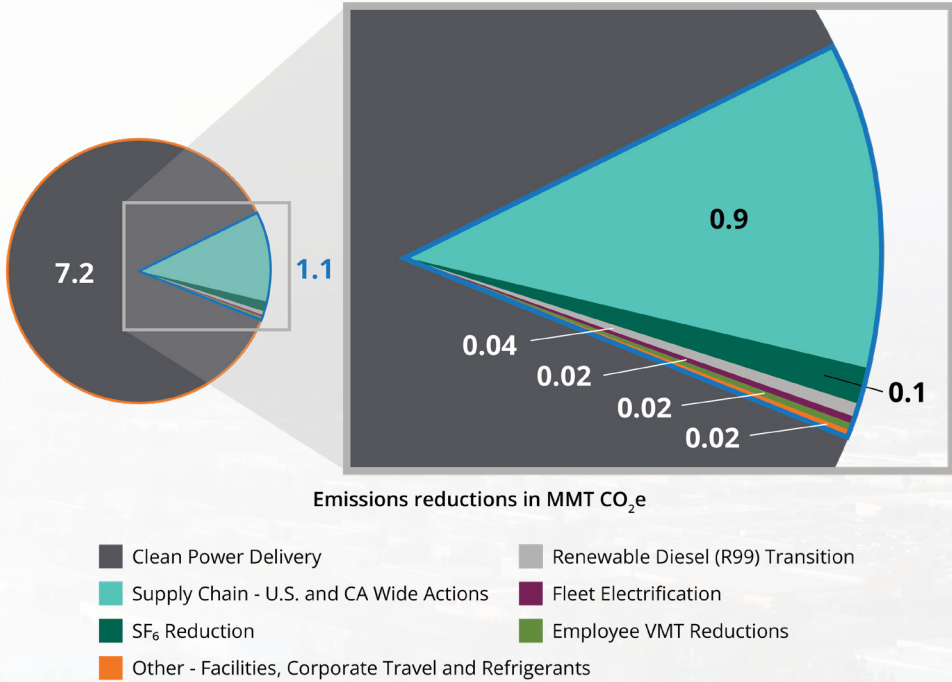


Figure 6. SCE Operational GHG Emissions Reductions 2020 to 2045 by Category

Scope 1	VEHICLE FLEET ELECTRIFICATION — 0.02 MMT CO₂e SCE is on target to meet or exceed its 2030 fleet electrification goals: 100% Light-Duty Vehicles (LDV); 30% Medium-Duty Vehicles (MDV); 8% Heavy-Duty Vehicles (HDV) and 60% Forklifts.^{vi} SCE's fleet electrification plan is aligned with and expected to exceed <i>Countdown's</i> transportation electrification vision of 90% LDV and MDV and 54% HDV by 2045. Future availability of EVs is not guaranteed for all utility vehicle categories, and other zero-emission fuels such as hydrogen may be needed.
All Scopes	ADDITIONAL ACTIONS (NOT MODELED) <u>Asset Electrification, Energy Efficiency and Asset Retirements (buildings):</u> More than 99% of SCE buildings by count and 79% by total building square footage use electricity as the primary energy source. As fossil-fuel equipment reaches end of life, SCE replaces it with high efficiency electric solutions assuring cost-effective deployment of customer funds. <u>Efficient Work Practices:</u> SCE is refining work procedures to remove redundant tasks, implementing automated systems to decrease expenses and optimizing efficiency in essential maintenance tasks, which can reduce companywide emissions. <u>Grid Efficiency Improvements:</u> As the amount of clean energy increases and grid efficiency technologies are deployed, emissions from line loss across SCE's T&D infrastructure are expected to be reduced.

10. Sustainable Supply Chain Alliance. <https://www.thessca.org/>.
11. California Air Resources Board (CARB) mandates a purchase phaseout for lower-voltage equipment beginning Jan. 1, 2025, progressing to a final phaseout of highest-voltage equipment purchases on Jan. 1, 2033.
12. CARB's SF₆ phaseout allows for exemptions in cases where technology is not available or compatible with existing connections. If exemption requests are approved by CARB, SCE will continue the use of SF₆ for those applications until viable alternatives are available.
13. Emissions from R99 are considered biogenic and are not included in our anthropogenic GHG inventory per GHG protocol guidance.

NEUTRALIZING REMAINING EMISSIONS IN 2045

Edison International's 2045 net-zero plan is projected to achieve approximately 95% emissions reductions from delivered power between 2005 and 2045. Scope 1 direct emissions are projected to be reduced by approximately 94% (from a 2020 baseline). The primary focus of our work between now and 2045 is continued reductions from all sources. Currently, about 2 MMT CO₂e of GHG emissions are projected to remain across all scopes in 2045. 1.5 MMT of those emissions are from natural gas generation supporting grid reliability and affordability, which aligns with the state's 2045 electric sector emission projections as identified in CARB's *Scoping Plan for Achieving Carbon Neutrality* and CPUC's *Integrated Resource Plan*.¹⁴

To fully decarbonize, remaining carbon emissions in 2045 will need to be neutralized. Our preference is to utilize affordable, high-quality carbon removal solutions (e.g., carbon capture and storage and natural and working lands carbon sequestration).¹⁵ The commercial viability of carbon removal technologies and the availability of high-quality voluntary carbon credits are existing barriers that must be addressed. If carbon offsets are used to reach net zero, we will prioritize high-quality offsets anticipated to represent at least the following attributes: additional (i.e., would not have occurred otherwise), exclusively claimed, permanent, measured and verified.^{viii} We will transparently share information to substantiate any future carbon offset purchases and work with the state to provide consistency with future guidance.

CLIMATE GOVERNANCE AND RISK MANAGEMENT

Reaching net zero by 2045 is a core pillar of our climate-related risk management. Strategies to address climate risks are integrated into long-term planning overseen by the Edison International board of directors, managed by the Edison International Managing Committee^x and advised by an executive-level sustainability steering group. We are committed to reviewing and continuously improving our climate governance, including use of scenario analysis as shown in this paper, to prepare the business to address climate risks and opportunities.

CLIMATE TARGETS ALIGNED WITH SCIENCE

By aligning with California policy, Edison International's climate goals align with science. Approximately 90% of our GHG emissions are covered under CARB's *Scoping Plan for Achieving Carbon Neutrality*. Our plan to reach net zero by 2045 is based on economywide analyses to support California's ambitious climate goals, which are consistent with a 1.5°C warming scenario.^{xxi} In addition to aligning with the state's 100% carbon-free power delivery goals by 2045 and associated interim milestones, SCE has adopted a voluntary target of 80% carbon-free power delivery by 2030.

14. CPUC *Integrated Resource Plan 2023 Preferred System Plan*. <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials>

15. Through an inter-agency working group, California is seeking to unify natural and working lands programs to move the state toward its goal of maintaining a resilient carbon sink and improved air and water quality, water quantity, wildlife habitat, recreation and other benefits. *Draft California 2030 Natural and Working Lands Climate Change Implementation Plan*. CARB. <https://www2.arb.ca.gov/resources/documents/nwl-implementation-draft>

16. Formerly known as Edison Energy, Altenex Energy and Alfa Energy, the group has unified under the new name "Trio," operating under Edison Energy, LLC, an indirect, wholly owned, non-utility subsidiary of Edison International, to enhance its global sustainability and energy advisory services. Trio is not the same company as SCE, the utility, and Trio is not regulated by the California Public Utilities Commission (CPUC).



GLOBAL IMPACT THROUGH TRIO¹⁶

Although Trio accounts for less than 0.1% of Edison International's emissions, Trio contributes to Edison International's vision of leading the clean energy transition by partnering with large, global organizations, including 50 of the Global Fortune 500 and Fortune 500 companies, to accelerate the transition to a net-zero future. With its global reach, Trio helps these companies meet their climate change goals through renewable energy contracts, decarbonization strategies, energy optimization programs and comprehensive sustainability strategy work, including establishing net-zero goals and science-based targets. Trio has advised on more than 12 GW of renewable power-purchase agreements, enabling their clients to avoid over 280 MMT of CO₂ emissions. Trio applies a strategic, data-driven approach to empower its clients to set ambitious goals, establish implementation roadmaps, check on progress, adapt to climate change and achieve net zero.

SMARTargets

In 2023, Edison International joined as an anchor institution with the Electric Power Research Institute (EPRI) and other stakeholders in a two-year, science-based research project titled, *SMARTargets: A Methodology for Grounded and Actionable Climate Targets Aligned with Global Goals*. It aims to develop a methodology to help companies establish GHG targets that consider uncertainty and risk, recognize unique opportunities and constraints, and account for multiple societal objectives such as affordability, equity and reliability.

SCENARIO ANALYSIS

INSIGHTS INTO THE RISKS AND OPPORTUNITIES IN CALIFORNIA'S ELECTRIC SECTOR ON THE ROAD TO NET ZERO

Countdown analysis found that California could achieve its carbon neutrality goals, deliver savings to SCE's customers and invest in the electric grid, while underscoring that transformative efforts and collaboration are required from utilities, regulators, policymakers and stakeholders. However, success is not guaranteed. California is not on track to meet its interim 2030 climate goals.^{xii} As of 2021, California would have had to approximately triple its pace of average annual GHG reductions to achieve the 2030 milestone of nearly 260 MMT CO₂e of reductions.^{xiii}

Countdown identified that significant numbers of vehicles and buildings must be electrified to best achieve California's decarbonization goals, with economywide electrification driving an 80% increase in demand.¹⁷ Since then, SCE has already begun to experience higher-than-expected demand growth, with 10-year electricity demand projected to be 35% higher across SCE's service area compared to projections from just two years ago. *Countdown* also highlighted the need for urgent investment in the development of emerging clean firm resources, given their ability to provide uninterrupted power that

EMERGING CLEAN FIRM RESOURCES	DESCRIPTION AND COMMERCIAL FEASIBILITY BARRIERS
Next-generation geothermal	Recent advancements in drilling techniques and subsurface exploration are creating opportunities to capture more and deeper energy resources than traditional geothermal. Barriers are mainly technical. ^{xv} Policy support is needed to incentivize commercialization at scale.
Small modular reactors (SMR)	SMRs are advanced nuclear reactors with a small footprint and flexibility to be sited close to load. California law has effectively put a moratorium on new nuclear power plants until the federal government establishes a permanent site for the disposal of nuclear fuel. State and federal support is necessary for these technologies to scale, resolve permitting issues and safely address the interim and permanent disposal of nuclear fuel.
Natural gas paired with carbon capture and storage (CCS)	CCS includes capture of carbon emissions produced by power generation with transport to underground facilities for permanent storage. Significant challenges must be addressed, including inequitable air pollution impacts, defining and managing liability concerns, safe and cost-effective transportation, and long-term storage.
Clean hydrogen ¹⁸	Hydrogen can be used as a fuel for clean firm electricity generation and as a form of long-duration energy storage. Dramatic cost reductions for low- and zero-carbon hydrogen and further innovations are needed in transport, storage and combustion to safely realize its full value.

Table 2. Emerging Clean Firm Resources: Description and Feasibility Barriers

17. *Countdown* identified that 90% of light- and medium-duty, over 50% of heavy-duty vehicles and 95% of residential and commercial space and water heating would be electric in 2045 to best meet California's climate goals; increase in demand is between 2022 and 2045.
18. Clean hydrogen is produced using processes that result in little or no GHG emissions (4 kg of CO₂e/kg of hydrogen produced or less according to the U.S. Department of Energy) such as electrolysis powered by renewable electricity, natural gas with CCS or other zero-emission sources.

DEMAND-SIDE EFFICIENCY IMPROVEMENTS
The Reference Case includes energy-efficiency improvements consistent with the CEC's 2021 Integrated Energy Policy Report case. Additional improvements could affect the pace and reduce the scale of buildout requirements. A study by EPRI and the Natural Resources Defense Council (NRDC) found the transition to electric vehicles could lead to even greater consumer savings and reduced infrastructure investments if vehicle system efficiency and lightweighting steps are cost effectively implemented.^{xiv}

complements variable wind and solar resources. These technologies face challenges to achieving commercial feasibility, such as those described in Table 2, before they can help enable a clean, reliable and sustainable energy future.

New RNZ challenge scenarios (scenarios) examine the emissions and power-mix implications of futures with higher demand, delayed deployment of emerging clean firm resources and a combination of the two. Starting with the *Countdown* scenario as a reference case, we examine four other plausible futures that would make achieving a clean, safe, reliable and affordable energy future more difficult. These scenarios are not forecasts. They were selected to help us understand how dynamic changes in the electric sector could impact the achievement of climate targets for both California and Edison International. For a full analysis of the insights from each of the scenarios, see the *Appendix*.

RNZ SCENARIOS	DESCRIPTION OF SCENARIOS
<i>Countdown</i> (Reference Case)	Significant increase in electricity demand (80%+) from 2022 levels driven by transportation and building electrification. Reliant on existing generation technologies, emergence of new clean firm resources and expansive transmission and distribution buildout.
Updated Reference Case	Significant infrastructure and clean generation coupled with strict emissions target, modified by adding an additional 20 TWh of data center demand growth and other new sources of load. 20 TWh represents a 5% increase from original <i>Countdown</i> demand.
Delayed Technology	Emerging clean firm resources are not available by 2045, limiting generation options.
High Demand	Adds an additional 28 TWh of demand or 7% on top of the modified <i>Countdown</i> demand. Total increase of 48 TWh or 12% from original <i>Countdown</i> demand.
High Demand & Delayed Technology (HDDT)	Combination of both Delayed Technology and High Demand scenarios.

Table 3: RNZ Reference Case and Challenge Scenarios

IMPLICATIONS FOR CALIFORNIA'S ELECTRIC SECTOR

Countdown identified that an ambitious amount of new clean energy resources, approximately 120 GW, is required to achieve California's clean energy vision, which would more than double the 86 GW of resources on the system in 2022. To serve load reliably¹⁹ while maintaining low electric sector emissions of 7 MMT CO₂e across the *RNZ* scenarios, between 152 GW and 202 GW of clean energy resources would be required, predominantly through increased solar and storage buildout. Figure 7 shows the clean resource buildout and natural gas retention required in the HDDT scenario. If clean resource buildout were constrained to the 120 GW identified in *Countdown*, additional load would need to be served by natural gas generation, which would raise electric sector GHG emissions up to 15 MMT CO₂e. Futures with high levels of paired utility-scale solar and battery storage would present feasibility challenges stemming from the pace and scale of the clean energy resource and T&D buildout required. Feasibility challenges that would arise from the HDDT scenario include:

- 1. Solar and storage buildout could require land about the size of the entire Los Angeles metro area.
- 2. The buildout required would surpass the solar capacity identified in the CAISO 20-year transmission outlook by nearly 28 GW.^{xvi}
- 3. If the clean resource buildout were limited to 120 GW, total energy resources available to the grid would not be sufficient to serve load during more extreme weather events. If load growth continues beyond 2045, solar and storage would struggle to provide reliability without new natural gas capacity or clean firm resources.

Reducing emissions to near zero in the electric sector hinges on developing clean firm resources to replace natural gas. **As the electric sector nears a low-emissions future, the analysis found that replicating the GHG emissions reductions of 1 GW of clean firm resources would necessitate between 7 GW and 11 GW of paired solar plus storage and require additional retention of natural gas resources to maintain reliability.** As shown in Figure 7, the availability of 10.5 GW of clean firm resources could replace the need for 82 GW of solar and storage deployment and 8 GW of gas retention identified under an HDDT future.

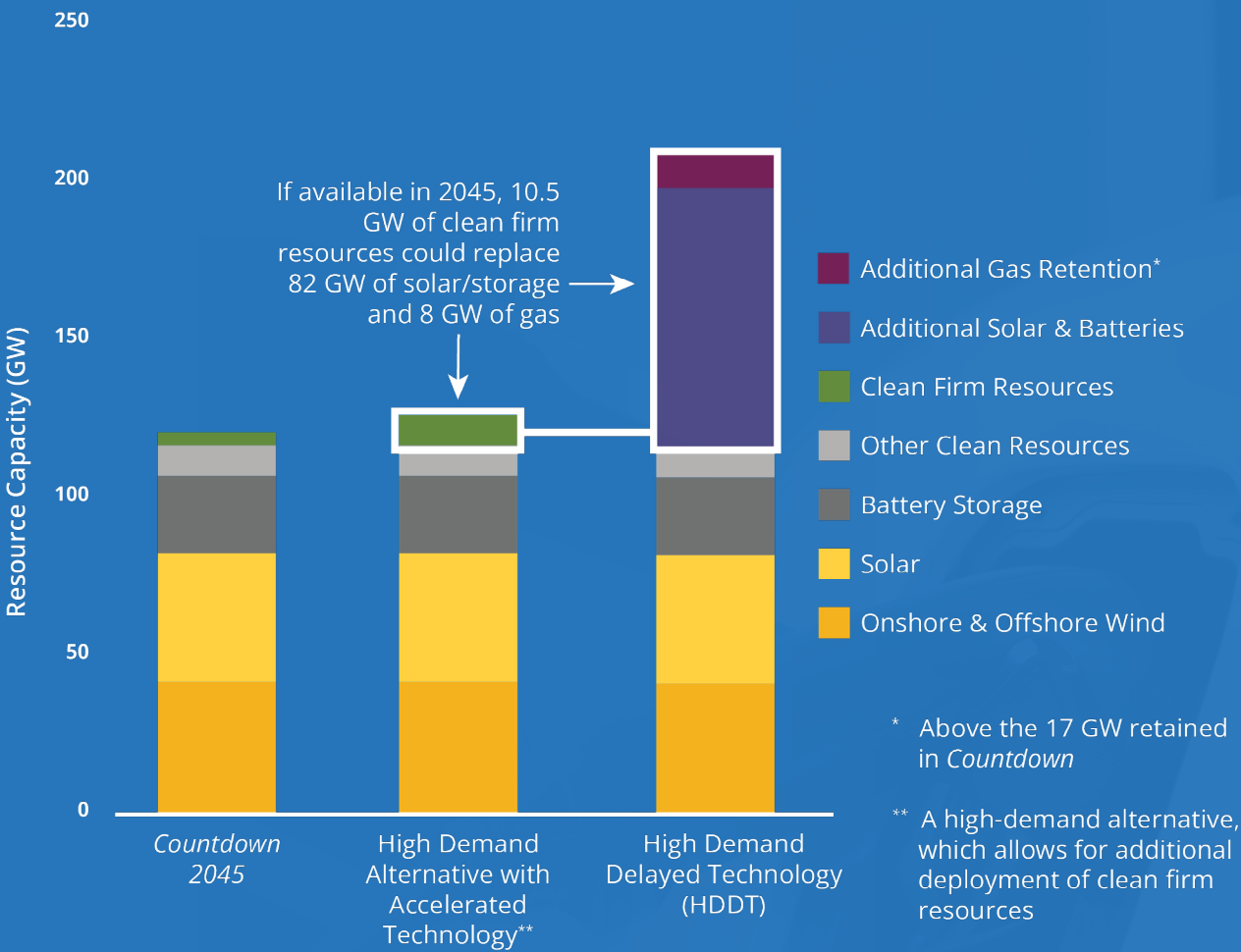


Figure 7. Incremental Capacity Growth in 2045 from 2022 to achieve 7 MMT CO₂e

19. All scenarios underwent a simplified reliability analysis. A more detailed description of the methodology can be found in the *Appendix*.

In 2045, the modeling shows that reliability challenges that require gas generation would often occur during multiday winter storm events when solar and storage perform poorly. While gas generation would rarely be used outside of these critical winter months, further reducing gas would require clean resources that can provide power during such winter storm events. Additional clean firm resources could provide energy during winter storm events and other times of the year, offsetting significant amounts of solar, storage and gas generation needs. To make these emerging clean firm technologies commercially viable by 2045, investment, commercialization and deployment are critical.

All scenarios analyzed would require additional retention of California’s existing gas power plants above the *Countdown* analysis,²⁰ between 18 GW and 26 GW in total. This retention would help ensure that load would be reliably served in 2045, especially during periods of high stress on the electric system. While more natural gas generating capacity would be retained, the plants would operate less frequently than today, reducing localized air quality impacts while allowing a reliable, low GHG emissions future for the electric sector. Operation would generally be limited to days with high load and insufficient renewable production to meet demand, with around a 20% capacity factor during winter months and less than 5% during summer months in the HDDT scenario. California must regularly evaluate how the natural gas fleet can help maintain reliability and affordability during the clean energy transition, especially if there is a shortfall in deploying new clean firm technologies as demand rises.

IMPLICATIONS FOR EDISON INTERNATIONAL

Insights from the scenario analysis have clear implications for SCE’s delivered power emissions, with the potential to alter the trajectory of Edison International’s emissions projection. In the interim period leading up to 2035, scenarios analyzed show the potential for significant variability in statewide electric sector emissions ranging from 25 MMT to 48 MMT CO₂e, depending upon the pace of transmission infrastructure deployment. The narrow timeframe to plan and construct transmission infrastructure by 2035 could constrain the amount of available in-state and regional clean energy resources, as this process typically takes more than a decade. A limited supply of clean resources for SCE to purchase on behalf of its customers could increase costs, affect customer affordability and lead to little to no GHG emissions reductions in 2045 compared to 2023 emissions levels.

In 2045, when limited to the *Countdown* buildout, the scenarios show electric sector emissions would vary between 7 MMT and 15 MMT CO₂e depending on load growth and the type and availability of clean resources. Associated emissions projections for SCE’s power delivery would vary between 1.5 MMT and 3.2 MMT CO₂e, reflecting the continued reliance on natural gas generation across the electric sector-wide scenarios. Mountainview Generating Station (MVG), the primary driver of SCE-owned generation emissions, could operate up to six times more frequently than currently projected, with emissions ranging between 0.05 MMT and 0.30 MMT CO₂e, which is still lower than the emissions recorded in 2023.

DOE GRID RESILIENCE AND INNOVATION PARTNERSHIP (GRIP) PROGRAM GRANT

SCE is partnering with the CPUC, CEC, CAISO and PG&E to implement a \$600 million federal grant to upgrade more than 100 miles of electric transmission lines with grid-enhancing technologies. This initiative aims to improve reliability and deliver clean, affordable electricity to customers faster. It will expand transmission capacity and improve interconnections to accelerate equitable customer access to clean energy resources. Statewide, the project will support more than 300 jobs, deliver more than \$200 million in customer savings, generate economic and community benefits for disadvantaged communities and invest in workforce training programs.

STRATEGIC INVESTMENT IN CLEAN FIRM RESOURCES

Edison International continues to make targeted strategic investments in, and develop collaborations with, early stage companies focused on innovative clean energy technologies. In June 2024, SCE signed the world’s largest geothermal PPA with Fervo Energy, totaling 320 MW. These 15-year deals will supply 24/7 reliable and affordable carbon-free energy to power 350,000 homes in Southern California. SCE will buy the power from Fervo Energy’s 400 MW Cape Station project in Utah, with the first 70 MW phase operational by 2026 and the rest by 2028.

20. The *Countdown* scenario included retention of about 17 GW of California’s current natural gas fleet in 2045. The most challenging *RNZ* scenario would require retention of the entire gas fleet, about 26 GW.

POLICY SOLUTIONS TO ADVANCE THE CLEAN ENERGY TRANSITION

As a central pillar of our net-zero strategy, Edison International proactively engages with California and federal policymakers, regulators, utilities and other stakeholders to support policy changes to enable a rapid and equitable clean energy transition. *RNZ* demonstrates that robust and ongoing scenario analyses are essential for Edison International and the state to guide planning processes for California to meet its electric reliability and climate goals.

As detailed in earlier Edison International papers, including *Mind the Gap* and *Countdown*, achieving net zero as a company and a state by 2045 depends on urgent and thoughtful updates to statewide policies that impact planning, permitting, affordability and workforce to ensure the clean energy transition happens at the speed and scale required while remaining affordable. A 2024 Boston Consulting Group report, developed in consultation with California's investor-owned utilities including SCE, elaborated on specific planning, execution and funding solutions needed to accelerate California's clean energy transition.^{xvii} Recommendations include extending planning horizons (to 2045 or beyond), reforming siting and permitting, and increasing funding to support early clean firm resource deployment.

Clean Firm Resources: The *Countdown* and *RNZ* analyses underscore the importance of advancing clean firm resources to achieve a reliable and clean electric grid on the path to net zero. *Countdown* called for measures to de-risk the development of clean firm resources and consider incentives or other mechanisms to foster the affordable commercialization of these technologies.

Additionally, a single, unified Western power market has the potential to enhance cost savings, renewable energy integration and grid reliability.^{xviii} The expansion of the Western Energy Imbalance Market with a day-ahead market and a new independent governing authority can open significant opportunities for customer benefits.

In addition to development of clean firm resources, we remain focused on three priority areas to address some of the biggest barriers to the clean energy transition:

Planning: Transitioning from a just-in-time grid to one that is reliable, resilient and ready to enable customers to electrify quickly enough to achieve net zero necessitates a proactive grid buildout. This starts with adjusting California's many planning processes to utilize policy-aligned forecasts to plan for required electrification. Introducing a more flexible cost recovery framework also enables new technologies and grid buildout approaches to be fully leveraged. Implementing more zonal planning for both generation/transmission and load growth can accelerate interconnections to a more rapidly expanding grid.

Permitting: Reducing timelines for major infrastructure projects is critical to meet policy goals on schedule. Today's project timelines, which can span over a decade from start to finish, are incompatible with a transition that must be completed in 20 years. Streamlining federal and state permitting processes through programmatic permits, expanded exemptions and reduced handoffs while limiting appeals with 'shot-clock' style deadlines can most effectively accelerate these timelines. Increasing staff resources across agencies supports more timely reviews and approvals.

Affordability and Workforce Development: Managing electricity rates to reduce electrification barriers while educating customers and stakeholders about electrification benefits continues to be essential. Efforts to relieve near-term affordability pressures must be prioritized (e.g., energy efficiency, rate design, off-bill funding for public purpose programs). As electrification reduces the need for natural gas, the costs of transitioning the gas infrastructure must be appropriately and equitably allocated using new financial mechanisms. In the long-term, as evidenced by the *RNZ* scenarios, emerging grid and generation technologies are key components to assure a feasible and cost-effective transition.

A just transition to a clean energy economy presents workforce opportunities and challenges. Expansion of the electric grid requires significant growth of a skilled clean energy workforce as the shift away from fossil fuels means certain jobs will become obsolete. The emerging clean energy economy necessitates coordinated efforts, such as standardized training to develop skilled workers (including adequate funding for the training), outreach to communities for job/training opportunities, and cross-sector collaboration to foster green job creation and related economic growth.

CONCLUSION

Edison International and its subsidiaries, SCE and Trio,²¹ remain committed to reaching net zero. SCE's promise to deliver carbon-free power to its customers by 2045, and our forecast that the average SCE customer will save 40% on their total energy expenses through broad adoption of electrification, are contingent upon two critical elements discussed in this paper:

- 1) Sufficient affordable, carbon-free resources to meet growing customer demand, including both renewables paired with storage and emerging clean firm generation resources.
- 2) Effective collaboration among utilities; local, state and federal government; and other stakeholders to meet timely infrastructure deployment to meet increasing loads.

Until sufficient clean firm resources are available, California's existing natural gas generation capacity should be maintained, with reduced operations, for the reliability services and affordability benefits these plants provide. Edison International and our subsidiaries are distinctly positioned as key facilitators of California's most effective strategy for decarbonization — efficient electrification powered by clean energy. We expect that insights from Edison International's integration of data-driven analyses, cross-sector collaboration and policy advocacy can inform others striving to reach net-zero goals. An urgent, united effort is critical to achieve California's climate goals while securing an affordable and reliable energy future.

21. Formerly known as Edison Energy, Altenex Energy and Alfa Energy, the group has unified under the new name "Trio," operating under Edison Energy, LLC, an indirect, wholly owned, non-utility subsidiary of Edison International, to enhance its global sustainability and energy advisory services. Trio is not the same company as SCE, the utility, and Trio is not regulated by the California Public Utilities Commission (CPUC).

ENDNOTES

- i. *Billion-dollar weather and climate disasters*. National Centers for Environmental Information (NCEI). (2024). <https://www.ncei.noaa.gov/access/billions>, DOI: [10.25921/stkw-7w73](https://doi.org/10.25921/stkw-7w73)
- ii. *The Turning Point: A New Economy Climate in the United States*. Deloitte. (2022, January). <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/about-deloitte/us-the-turning-point-a-new-economic-climate-in-the-united-states-january-2022.pdf>
- iii. *Financing the Transition: How to Make the Money Flow for a Net-Zero Economy*. Energy Commission. (2023, March). https://www.energy-transitions.org/wp-content/uploads/2023/03/ETC-Financing-the-Transition_MainReport.pdf
- iv. Meeting this net-zero goal is contingent on approvals from SCE's regulators and the availability of viable technologies in 2045 to adequately offset or remove remaining carbon from our enterprisewide footprint. Edison International does not align with any specific net-zero definitions (e.g., SBTi) but is aligned with California goals and policies that are consistent with limiting warming to a 1.5 degree Celsius (°C) warming scenario. Approximately 90% of Edison International's emissions are covered under *California's Scoping Plan for Achieving Carbon Neutrality*.
- v. The list of peers for this internal benchmarking is based on the *2023 Annual Utility Decarbonization Report*. Values were sourced from 2022 EEI ESG Reports, using CO₂e values. Certain peers were excluded due to the inability to closely match NPUC data with historical EEI datasets. Differences may arise due to additional information that the NPUC may obtain while directly working with the utility company. See *Appendix* for more information.
The Annual Utility Decarbonization Report. Decarbonization Channel. (2023, September). <https://decarbonization.visualcapitalist.com/decarbonization-annual-report/>
Finance & Tax ESG/Sustainability. Edison Electric Institute (EEI). (2024). <https://www.eei.org/en/issues-and-policy/esg-sustainability>
- vi. *US Environmentally Extended Input-Output (USEEIO) Models*. United States Environmental Protection Agency. (2023, October). <https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models>
- vii. SCE's transportation fleet electrification goals align with *Countdown* and are based on the proportion of plug-in EVs, including plug-in hybrids, in SCE's transportation fleet. Vehicles with plug-in, battery-powered, anti-idle job site work systems, such as electric power take-off units, are also counted as part of the heavy-duty goal. Forklifts exclude rough-terrain forklifts and telehandlers. Vehicle weight classifications are as follows: Light-Duty Vehicles (DOT Class 1, ≤ 6k GVW), Medium-Duty Vehicles (DOT Classes 2 and 3, > 6k to ≤ 14k GVW) and Heavy-Duty Vehicle Class (DOT Classes 4-8, > 14k GVW). Goals contingent on original equipment manufacturer vehicle availability and funding approval through the CPUC.
- viii. *The Role of Natural Climate Solutions in Corporate Climate Commitments: A Brief for Investors*. Ceres. (2021, May). <https://www.ceres.org/resources/reports/role-natural-climate-solutions-corporate-climate-commitments-brief-investors>
- ix. The Edison International Managing Committee consists of the most senior Edison International, SCE and Trio executive officers.
- x. Scientists agree limiting global warming to 1.5 degrees Celsius (°C) or less is critical to averting the worst impacts of climate change. Achieving this with high confidence requires, globally, about a 45% reduction in CO₂ emissions from 2010 levels by 2030 (which is proportionate to the scale of California's goal of a 40% reduction from 1990 levels by 2030) and reaching net-zero emissions by mid-century.
Global Warming of 1.5°C. IPCC. (2018). <https://www.ipcc.ch/sr15/>
- xi. *Achieving Carbon Neutrality in California*. Energy+Environmental Economics, Inc (2020, October). https://www2.arb.ca.gov/sites/default/files/2020-10/e3_cn_final_report_oct2020_0.pdf
- xii. CARB reported a 2.4% drop in emissions from 2021 to 2022. The 2023 *Green Innovation Index (2023 GII)* indicated that California's GHG emissions rose by 3.4% from 2020 to 2021 after an 8.8% plunge in 2020 due to COVID-19. Overall, the 2023 *GII* reported California has reduced GHG emissions by 1.5% annually from 2010-2021, a faster rate than *Mind the Gap's* 1% previously reported reduction trend (2006-2019).
California greenhouse gas emissions decline across most sectors. CARB. (2024, September 20). <https://www2.arb.ca.gov/news/california-greenhouse-gas-emissions-decline-across-most-sectors>
- xiii. *California Green Innovation Index*. Next10. (2023). <https://greeninnovationindex.org/2023-edition>
- xiv. This study from EPRI and the NRDC explores the necessary role of vehicle efficiency improvements to support electrification. Findings include potential savings of up to \$200 billion annually for on-road transportation by 2050.
Valuing Improvements in Electric Vehicle Efficiency. NRDC (2024, April). <https://www.epri.com/research/products/000000003002030215>
- xv. *Enhanced Geothermal Systems (EGS): Frequently Asked Questions*, Congressional Research Service (2024, June). <https://crsreports.congress.gov/product/pdf/R/R48090>
- xvi. *2024 20-Year Transmission Outlook*. California ISO. (2023, August). <https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024>
- xvii. *Unlocking California's Climate Ambition*. BCG (2024, July). <https://web-assets.bcg/37/f5/7685135144d38912ab9623dfaf6e/ca-decarbonization-reoirt-2024-07-12.pdf>
- xviii. Gales, R. *SCE Details Investments to Advance Electric Grid Reliability, Resilience and Readiness*. Energized, Edison International. (2023, May). <https://energized.edison.com/stories/sce-details-investments-to-advance-electric-grid-reliability-resilience-and-readiness>