

Caltech 2022 Sustainability Report



April 2023



Progress on Caltech's sustainability initiatives continued, but the theme for 2022 centered on change, both unanticipated and evolving. While short-term challenges and ongoing volatility contributed to unanticipated change, the foundational elements of the program's evolution could prove transformational.

For the better part of 2022, the cogeneration plant suffered from unplanned downtime leading to a reversal of electricity generation trends, increasing costs and shifting our emissions portfolio. The timing of this downtime coincided with natural gas price volatility and the steady return to full, post-pandemic campus operations, causing uneven performance. While the changes in energy and emissions initiatives were unanticipated, the significant challenges in materials, waste, and recycling followed familiar trends. Global recycling and commodities markets, a continued tendency toward single use items, and staffing challenges confounded efforts to increase diversion rates.

Encouragingly, the fundamentals for continued progress remain sound and will be bolstered by significant milestones either achieved or set in motion in 2022. The completion of the cooling tower upgrade project and ongoing planning for water resiliency will produce long-term results for campus utilities. The green labs program grew from pilot to established program during the year setting the stage for improvements in recycling and resource efficiency. Headlining the year was the elevation of the Sustainability Council and a renewed focus on campus-wide strategic planning for the next decade of transformational progress.

We are pleased to share our progress in this report and are excited by the prospects for 2023 and beyond.

John Onderdonk
Assistant VP of Facilities Operations and Services
Chief Sustainability Officer

Table of Contents

3 Key Performance Indicators

4 Energy

8 Water

12 Materials







16 Land Use

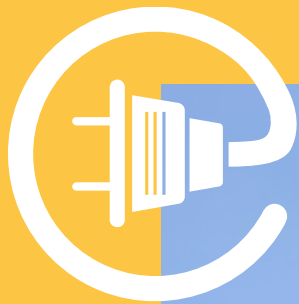
20 Mobility

24 Emissions

28 References & Acknowledgements

2022 At A Glance — Key Performance Indicators

<p>Energy</p> <p>With the cogeneration system being offline for half of the year, Caltech's energy portfolio looked different than any time in the past decade with significant PWP imports.</p>	<p>↓ 2%</p> <p>total electricity consumption since 2017 but 2% higher than 2021</p>	<p>71%</p> <p>net electricity produced on-site, highest total import since before 2010</p>	<p>↓ 6%</p> <p>energy intensity by area since 2021 and the lowest since 2011</p>	<p>\$17.7M</p> <p>in annual energy costs, a 58% increase from 2017</p>	<p>\$16M</p> <p>in cumulative energy cost reductions since 2011 despite recent rising costs</p>	
<p>Water</p> <p>In a significant drought and with changing dynamics on the energy side, total water consumption dropped across the board in 2022 although opportunities persist in buildings.</p>	<p>↓ 23%</p> <p>water consumption since 2021 and the lowest since 2017</p>	<p>↓ 8%</p> <p>plant water use since 2021 due to cogen downtime but a 5% increase since 2020</p>	<p>↓ 23%</p> <p>water use per square foot since 2021, the lowest amount in the 21st century</p>	<p>\$1.2M</p> <p>in annual water costs, down 7% from 2021 but up 22% in costs per gallon</p>	<p>↑ 22%</p> <p>in campus costs per gallon since 2011</p>	
<p>Materials</p> <p>Waste diversion continues to be the most significant challenge for campus sustainability programs. Occupant engagement through green labs remains a positive force.</p>	<p>14%</p> <p>campus non-hazardous waste diversion rate, up from 12% in 2021</p>	<p>.31 tons</p> <p>municipal solid waste per capita, up 15% from 2021 but down 18% since 2017</p>	<p>↑ 15%</p> <p>in campus hazardous waste costs since 2021</p>	<p>\$901K</p> <p>in total campus waste costs, up 59% since 2017</p>	<p>\$0</p> <p>in net recycling revenue in 2022, down from \$70K in 2011</p>	
<p>Land Use</p> <p>No new buildings were added in 2022, and campus land use cover remained much the same. Planned additions over the next couple of years will drastically change campus grounds.</p>	<p>2</p> <p>buildings pursuing LEED certification by 2025</p>	<p>747K</p> <p>square feet of LEED building space, totaling 16% of entire campus</p>	<p>17%</p> <p>of campus covered with low-water vegetation, up from 4% in 2012</p>	<p>78%</p> <p>of campus turf cover is low water varietal grasses</p>	<p>12</p> <p>campus buildings now LEED certified, up from 4 buildings in 2011</p>	
<p>Mobility</p> <p>This year's campus mobility survey showed a clear new normal for commuting as we emerge from COVID with a changed work life for some staff, faculty, and students.</p>	<p>2.03</p> <p>campus occupants per vehicle, up from 1.60 in 2019</p>	<p>36%</p> <p>campus drive alone rate, lowest since 2005 other than 2020</p>	<p>723</p> <p>telecommuters in 2022, stabilizing since 2020</p>	<p>65%</p> <p>staff drive alone rate, constant since 2021</p>	<p>120/3</p> <p>carpools and vanpools at the end of 20212 respectively</p>	
<p>Emissions</p> <p>Scope 2 emissions doubled in 2022 due to the increased reliance on PWP for imported electricity, but those increases were outweighed by the decrease in Scope 1 emissions.</p>	<p>↓ 13%</p> <p>regulated greenhouse gas emissions since 2021</p>	<p>↓ 9%</p> <p>total greenhouse gas emissions since 2021 and a 15% decrease since 2017</p>	<p>↓ 15%</p> <p>emissions intensity per capita since 2017</p>	<p>.81</p> <p>pounds of CO2e per research dollar, down 8% since 2021</p>	<p>↓ 40%</p> <p>Scope 3 emissions since 2019 due to reduced commuting and funded travel</p>	



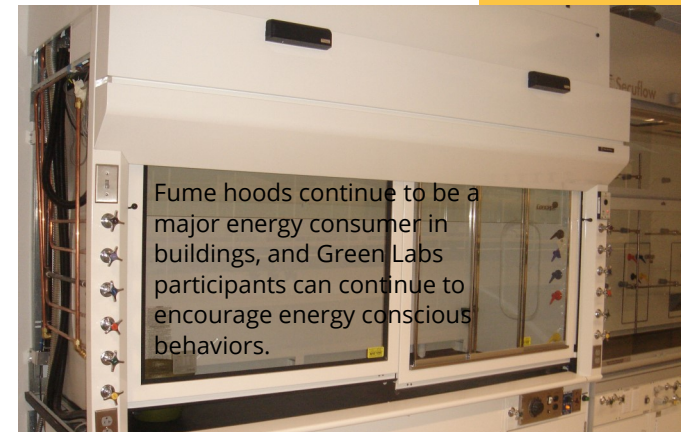
Energy



Increased cooling demands from a growing campus and the pressures of climate change require Caltech to continue building capacity. Completed cooling tower upgrades at both the utility plants will help ensure Caltech's ability to meet energy needs in the future.



The new Resnick Sustainability Center continues to rise out of the ground as construction is well underway. Resnick is designed to maximize energy efficiency opportunities.



Fume hoods continue to be a major energy consumer in buildings, and Green Labs participants can continue to encourage energy conscious behaviors.



Opportunities exist throughout the campus to conserve energy for large pieces of equipment by consolidating inventories and maximizing space.



Goals for Viability

Identify and recommend sources of high quality, reliable and environmentally preferable energy to support research and education while working with the campus community to improve efficiency and reduce demand.



2022 Highlights

Natural Gas Price Volatility Impacts Energy Planning

January 2022



With rising inflation and threats to international and regional gas supplies, Caltech battled significant price volatility in 2022. Caltech was insulated from some of these impacts by savvy bulk purchases made in preceding years.

Campus Cooling Towers Modernized And Upgraded

May 2022



Caltech has fully upgraded our cooling towers over the past few years to maximize our cooling capacity, which will prove critical during summer heat waves and other periods of high cooling needs. Recent upgrades should be sufficient for expected growth over the next decade.

First Renewables Contracts Nearing End of Life

December 2022



Caltech is approaching the end of our first energy power purchase agreements. The first to expire will be the Holliston solar array while Solar 2 projects will expire a few years later. Facilities will consider options to move forward including ownership, new panels, or removal.

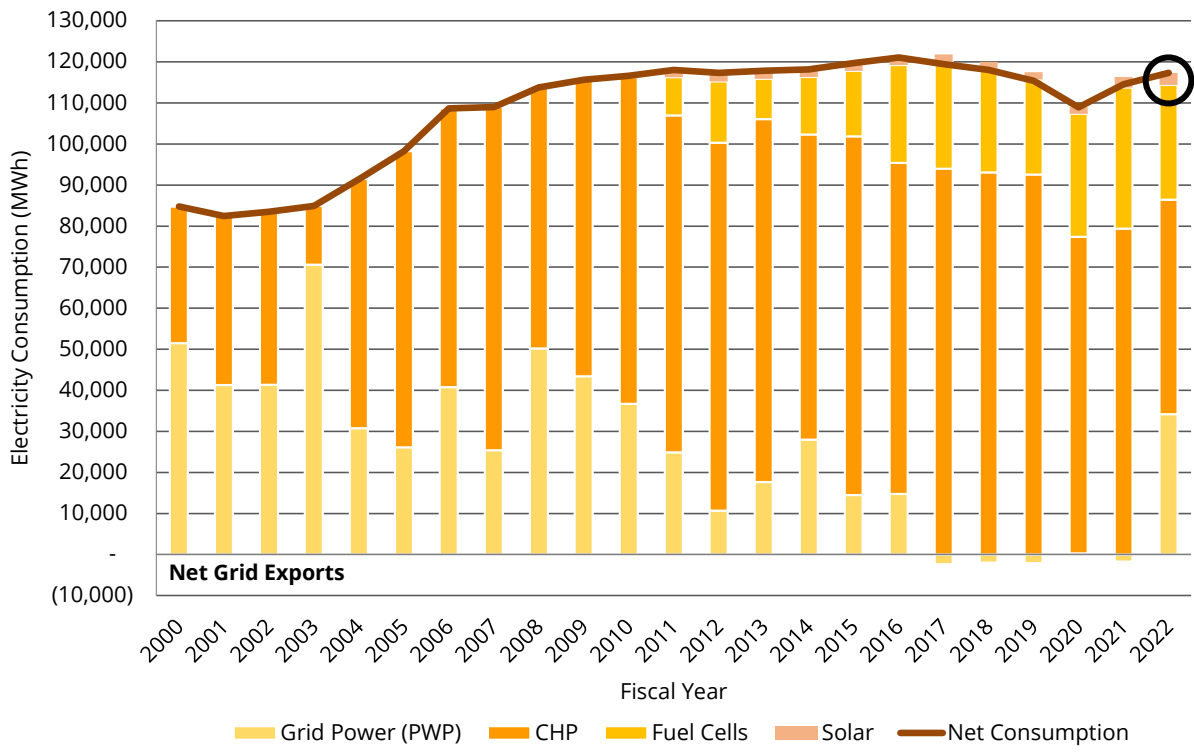
2022 Energy Update

↓ **2%**

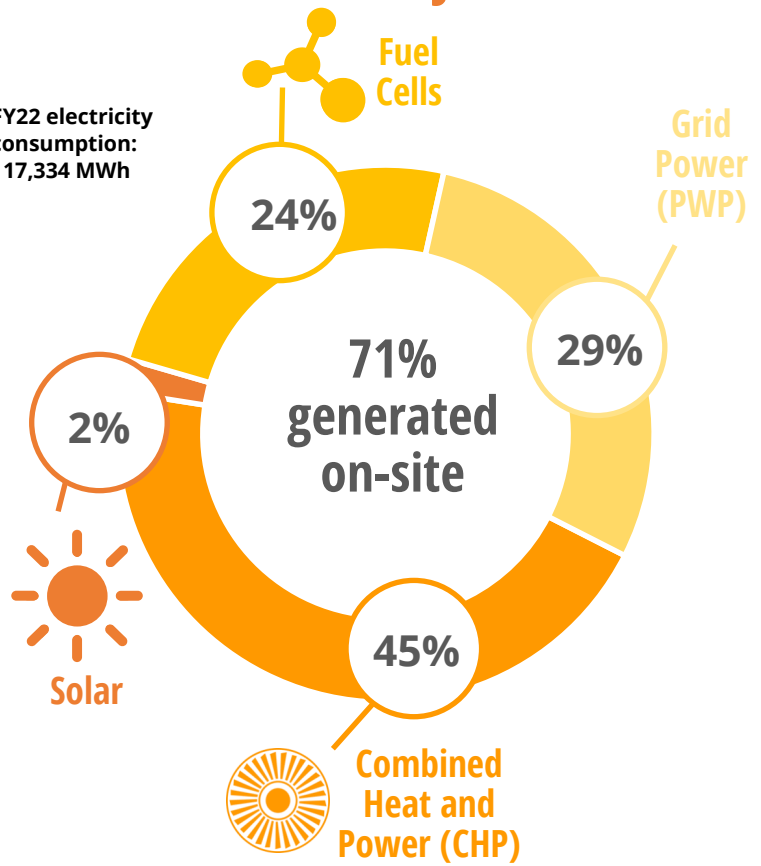
total electricity consumption since 2017 but 2% higher than 2021

Readers of past annual sustainability reports will notice that the 2022 energy portfolio looks unlike any year in recent memory. Issues with the operation of the cogeneration system caused a shutdown that persisted through approximately half of the fiscal year. As such, significant energy imports from Pasadena Water and Power (PWP) were needed to make up for the lost generation. This marks the first time since 2016 that Caltech required significant amounts of externally-generated electricity to meet demand. While natural gas volatility has increased generation costs onsite for fuel cells and the CHP system, a 29% import from PWP was the primary driver of a \$17.7 million energy budget for FY22. Future models that ensure reliable power to the campus while limiting costs are a continuing topic of discussion for Caltech Facilities.

Historical Campus Electricity Consumption



2022 Electricity Portfolio



71%

electricity produced on-site¹, highest total import since before 2010



6%

energy intensity by area² since 2021 and the lowest since 2011

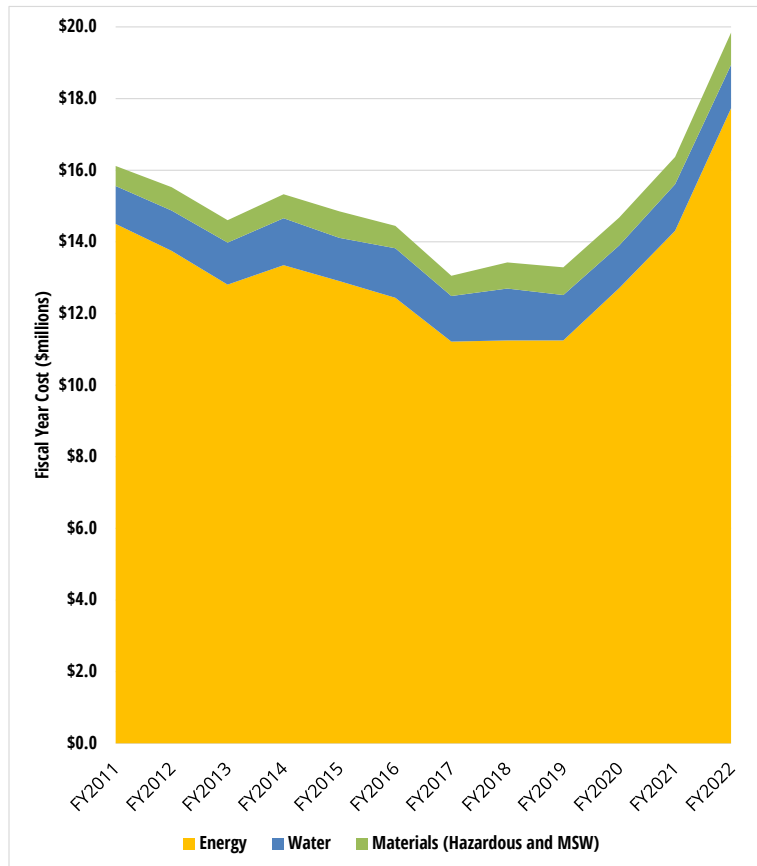
\$17.7M

in annual energy costs, a 58% increase from 2017



Energy Use Dominates Utility Expenditures

Despite volatile water and materials expenses, increased natural gas and electricity prices can dominate the utility budget as seen below. While CECIP has succeeded in controlling these costs for the past decade, new headwinds have appeared in 2022 including more restrictive permitting, enhanced emissions regulations and an industry-wide shift away from fossil fuels.



Central Utility Plant Cooling Towers Completed

As the Caltech campus grows and Pasadena's warmest days get hotter, the energy needed to cool the campus increases. Caltech produces the majority of its campus cooling from electrical chillers located in campus utility plants. The 2019 Utility Master Plan found that Caltech needed to replace its aging

central plant cooling towers to meet increased demand from buildings such as the new Resnick Sustainability Center. The existing cooling towers were installed in 1980 and no longer supported the plant's full cooling capacity. Caltech



replaced the central plant cooling towers in 2022 with modern towers that will reduce the energy needed to pump chilled water to the campus, maintain high cycles of concentration which reduce water use, and implement noise reduction measures to reduce sound pollution. The additional cooling capacity provided by the towers will increase campus resiliency overall and prepare Caltech to meet campus cooling demands in the face of intended campus growth and increased temperatures as a consequence of climate change.

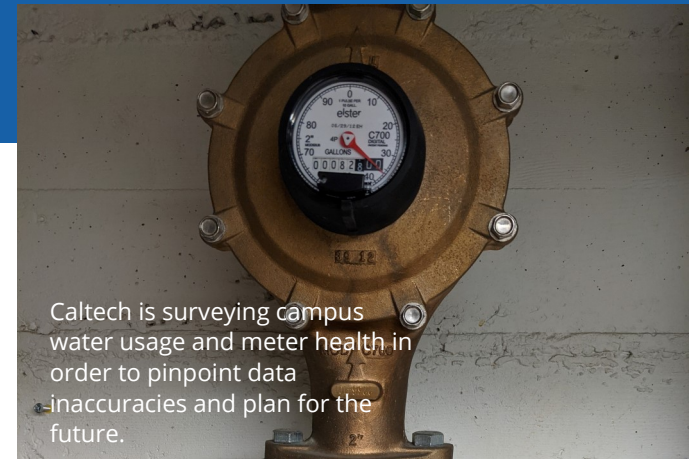




Water



The energy water nexus is well-demonstrated at Caltech, as nearly two-thirds of total campus water consumption is tied to the generation of energy.



Caltech is surveying campus water usage and meter health in order to pinpoint data inaccuracies and plan for the future.



The Sierra Nevada range, a key water source for California, continues to be impacted by opposing forces including fire threats throughout the summer and fall and damaging storms to critical water infrastructure in the winter and spring.



While non-potable water is used in a number of campus fountains, certain Caltech water features can provide habitats for local fauna.



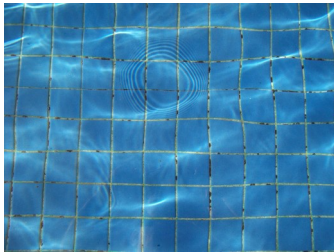
Goals for Viability

Responsibly steward water resources by focusing on efficiency, cultivating climate adapted landscape, minimizing potable water use, and maximizing use of reclaimed water.

2022 Highlights

Drought Worsens As Municipalities Limit Irrigation

July 2022



Coming off a dry winter, Level 2 drought restrictions were implemented in the spring of 2022. With little relief as summer approached, further restrictions were implemented including a ban on watering of non-functional turf. Caltech identified over 100,000 square feet of eligible spaces where watering could be restricted.

Total Water Use Falls Across All Categories

September 2022



Irrigation totals, plant consumption, and building water use all fell in 2022 from the prior year. Whether the result of operational impacts, behavioral changes, or both, maintaining this progress will be crucial as Caltech investigates our water future.

Wet Winter Highlights Importance of Rainwater Management

December 2022



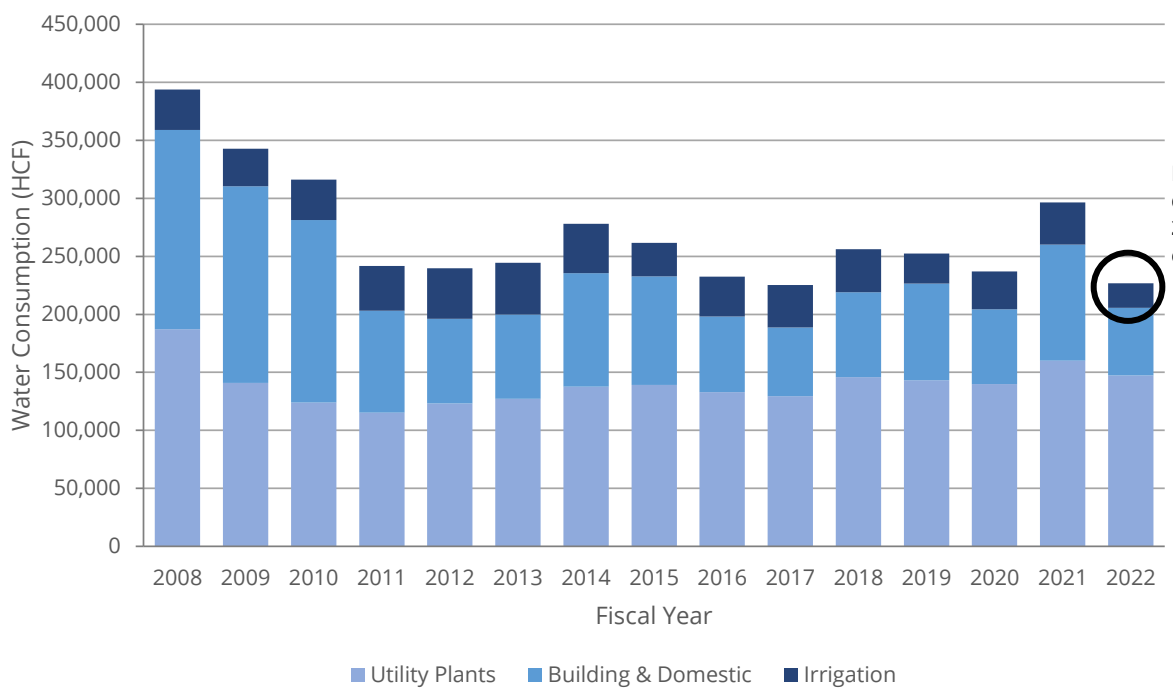
In a drastic contrast to recent dry winters, November and December of 2022 kicked off one of the wettest winters in recent memory. These types of dramatic swings from droughts to floods will become ever more common with a changing climate. Caltech is looking at rainwater management strategies to address these shifts.

2022 Water Update

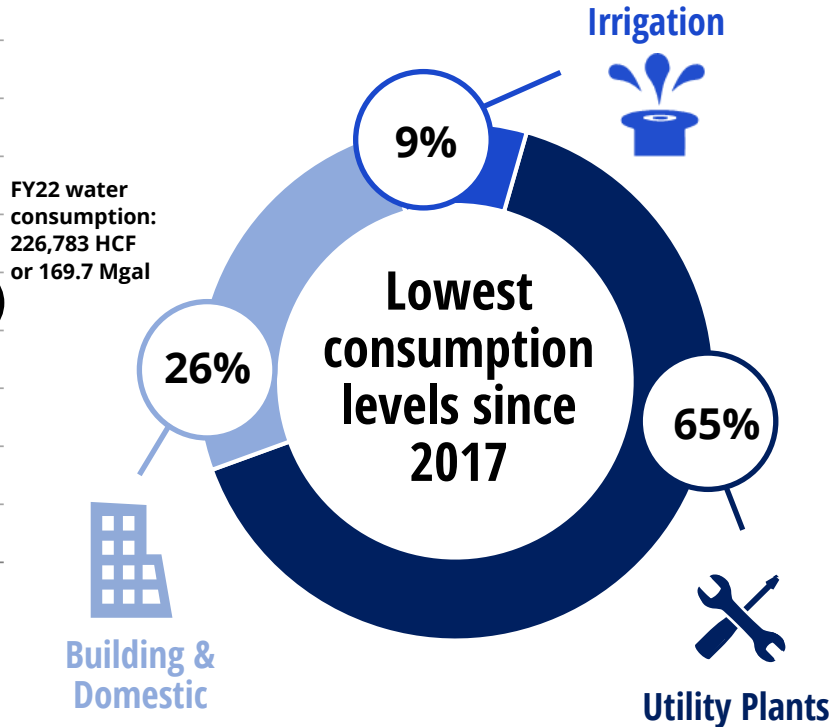
↓ 23% water consumption since 2021 and the lowest since 2017

Water consumption dropped to the lowest levels since 2017, and decreases were seen in each of the three major consumption categories: buildings, utility plants, and irrigation. While consumption dropped across the board, the decrease was most pronounced in the buildings. Caltech hasn't identified the precise causes for this rebound from high consumption levels in 2021, but completion of building projects and repair of leaks are two leading theories. Regardless of the cause, it's important for Caltech to continue conserving as drought persists throughout the southwestern United States. In order to gain a more detailed understanding of water consumption and ensure data reliability, Caltech has enlisted the services of a consultant to analyze the current state of water on campus and identify optimization opportunities for the future. Ideally, this plan will dovetail smoothly with the implementation of energy plans that have been created over the past decade.

Historical Campus Water Consumption



2022 Water Use Profile





↓ **23%**

water use per square foot since 2021, lowest in the 21st century

65/26/9

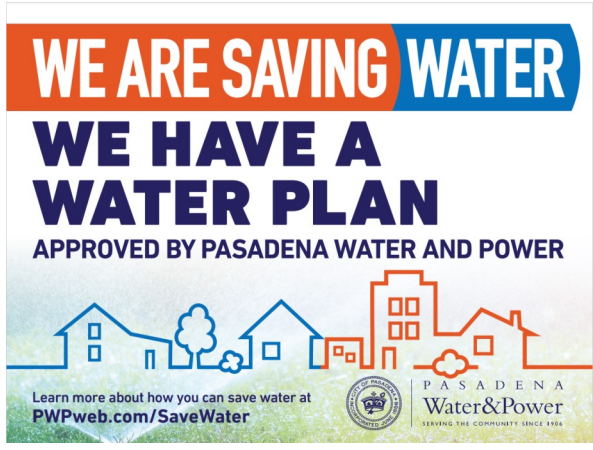
2022 use percentages for utility plants, building & domestic, and irrigation

\$1.2M

in annual water costs, down 7% from 2021 but up 22% in costs per gallon

Drought Continues To Worsen Through Spring and Summer

While not as dry of a season as 2021, this year's total rainfall continued to be below normal. Pasadena saw 16 inches of rain for the complete season that runs from July 2021 through June 2022. Normal rainfall is around 21 inches, and drought restrictions accelerated as a result. Level 2 restrictions were carried into 2022, and a reduction in eligible watering days followed. The regulations came from the state and were enforced by PWP. Caltech worked directly with PWP to come up with a City-approved plan for controlling water consumption in line with these restrictions.



Caltech is well positioned to weather the restrictions imposed on outdoor water use due to a continued emphasis on native vegetation and low water intensity development. In fact, irrigation levels dropped to their lowest levels ever in 2022, and irrigation now makes up less than 10% of Caltech's water portfolio. Over 100,000 additional feet of turf was identified to "go golden" with the complete cessation of irrigation to these non-functional turf spaces. In many cases, these areas have now become prime candidates for turf replacement which should accelerate the campus transition overall.

Water Metering and Optimization Study Paves Way For Water Future

Caltech has enlisted the services of Coho Climate Advisors to create a water metering and optimization plan for the campus to successfully guide us into an uncertain water future. Caltech and Coho have assembled a team of professionals to create a comprehensive strategy to combat water scarcity, rising rates, and aging infrastructure. This study will be exploring solutions including enhanced metering, utility treatment optimization, wastewater reuse, and alternative financing options to improve future climate resiliency.



This combination of tailored solutions will work in harmony with Caltech's future energy plans to ensure efficient operations and a modernized energy-water system. Work on this plan began in the fall of 2022 and will continue into the middle of 2023. Caltech Facilities will present these completed plans to the newly formed Sustainability Council in preparation for implementation to begin within the next few years.





Materials



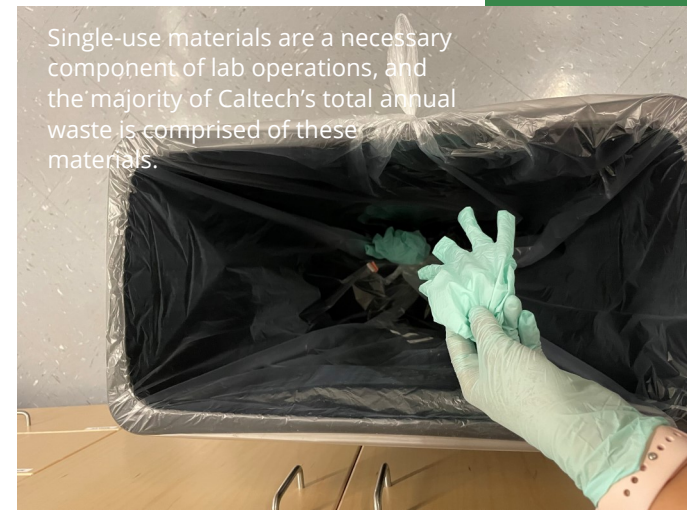
Caltech labs have limited space for waste management of the wide variety of disposable materials that have become even more common during the COVID-19 pandemic.



Caltech has over 50 collection points on campus that have to be easily accessed by our waste vendor multiple times per week to clear all waste material away from the campus.



This picture, taken over 5 years ago, represents a very different time in Caltech's waste program. In 2017, the program generated revenue for the Institute, had a publicly accessible Recycling Center, and achieved a high rate of diversion.



Single-use materials are a necessary component of lab operations, and the majority of Caltech's total annual waste is comprised of these materials.

Goals for Viability

Reduce waste through responsible procurement practices and encourage materials reuse and recycling.

2022 Highlights

COVID Surge Disrupts Campus Recycling Program

January 2022



As a result of a wave of infections from the omicron variant of COVID-19 that swept through the campus in the winter of 2022, Caltech had to pause most on-campus recycling for over a month while staff recovered to the point where collection could resume. This period demonstrated the brittle nature of the current recycling program.

Campus Laboratories Examine Chemical Waste

April 2022



Caltech Green Lab members have worked with EHS on various chemical and solvent substitutions that save the Institute money while reducing environmental impact of disposal and maintaining or enhancing occupant health.

Composting Resumes In Student Houses

September 2022



After a long hiatus, composting resumed in the undergraduate houses. Bechtel and Avery also initiated the practice so that all undergraduate living spaces have the opportunity to participate in food waste diversion. Education was provided by Dining Services staff to student leaders to ensure effective implementation and avoid contamination.

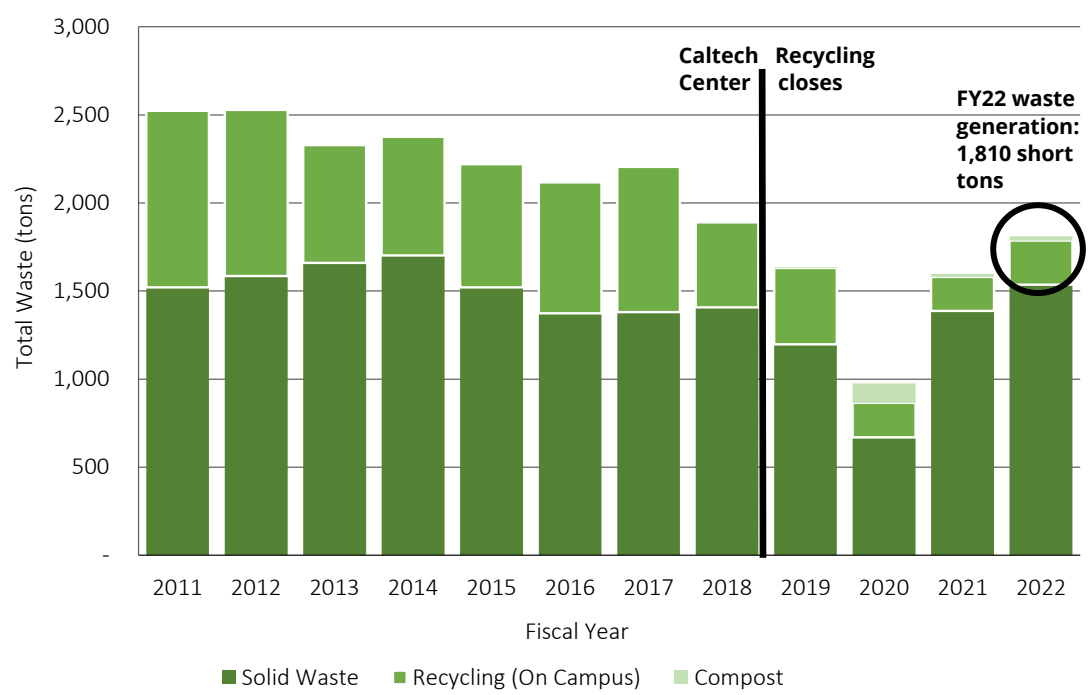
2022 Materials Update

14%

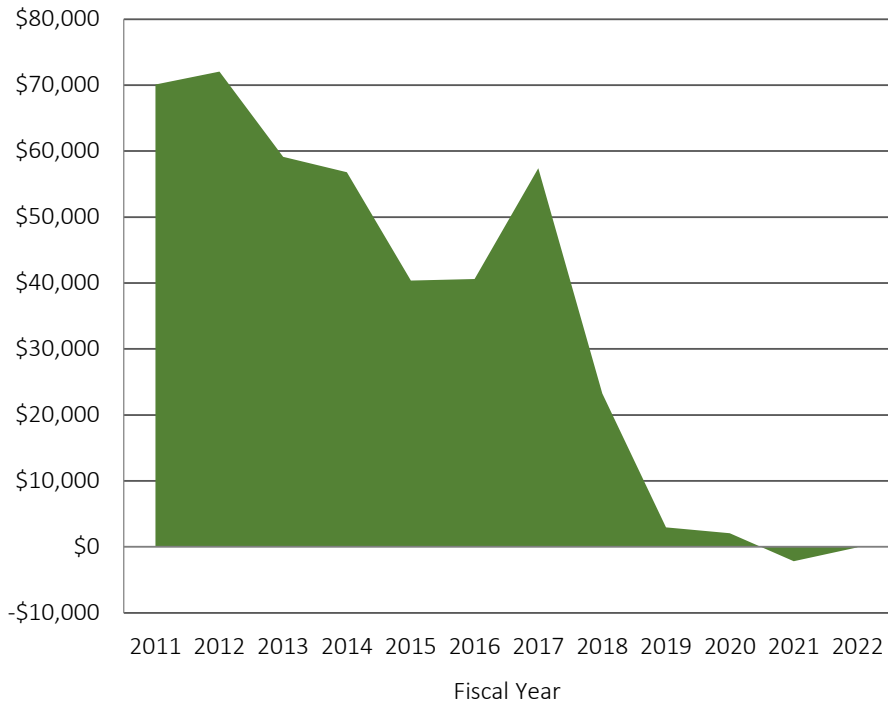
campus non-hazardous waste diversion rate, up from 12% in 2021

Materials and waste handling continues to be the most challenging sustainability area with constant financial pressures and market realities threatening the viability of recycling. Recycling revenue, after adjusting for hauling cost, was essentially \$0 in 2022. This is a decrease from \$70,000 in annual revenue ten years prior. These revenues funded recycling assistants on campus, and these positions have been subject to significant COVID-related disruptions recently. With changing markets and low diversion, Caltech is looking at these new waste and recycling realities as an opportunity to completely redesign this program. Engagement of purchasing, a focus on reducing waste production upstream, and emphasis on reduction and reuse will be key components of a new materials program that acknowledges the vastly different reality of waste and recycling in this current decade.

Historical Campus Waste & Recycling Generation



Recycling Revenue By Year



620

pounds
municipal waste
generated per
person, down
from 755 in 2017



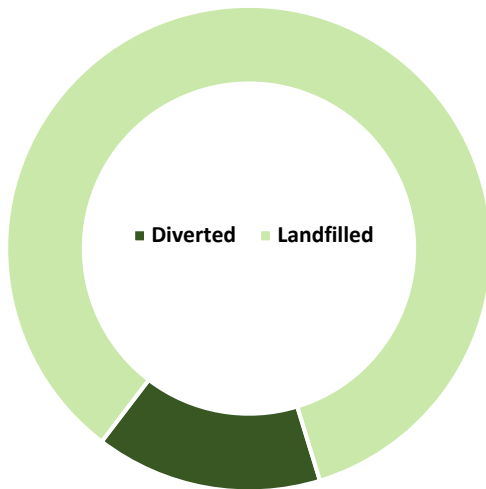
15%

in campus
hazardous waste
costs since 2021

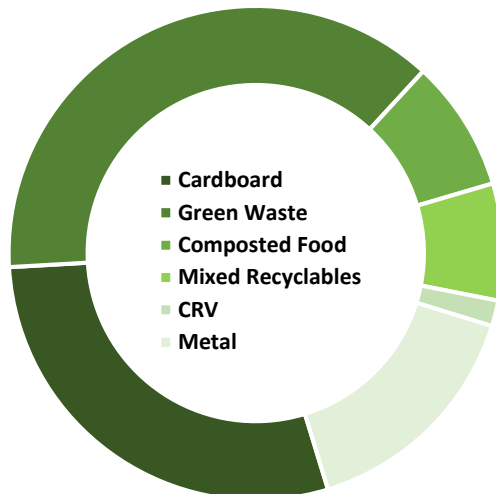
\$901K

in total campus
waste costs, up
59% since 2017

Low Diversion Rates Highlight Need For Life Cycle Thinking



2022 Diversion Breakdown By Stream



Green Labs Target Common Laboratory Wastes

Green Labs participants have begun encouraging the reduction of common lab wastes such as gloves, single-use plastics, and hazardous waste. By encouraging labs to use products such as biodegradable gloves, we are positively impacting our downstream waste, in this case by reducing the number of nitrile and latex gloves sent to the landfill. Further, Green Labs have been supporting the reduction of single-use plastics. One member is investigating ways to recycle these plastics, especially pipette tip boxes, either on-campus by redistributing them to labs that can reuse them or by encouraging vendors to help divert them from traditional waste streams. Members are also investigating reducing the use of hazardous reagents, such as exchanging toxic ethidium bromide for less toxic alternatives such as Sybr Safe. Green Labs is also working with EHS to standardize waste practices and encourage best practices including reducing waste improperly disposed of as hazardous waste.



Green Labs has also been investigating ways to run eco-friendly or zero-waste events, including utilizing vendors that have vegetarian/vegan options or biodegradable cutlery. These changes targeting lab waste benefit the campus as it reduces costs for disposal of these wastes, increases safety for EHS workers and lab members alike, and encourages innovation and collaboration within Caltech to positively benefit the community that our staff, faculty, and students live and work in.





Land Use



Paul Sternberg, Bren Professor of Biology, stands proudly next to his lab's certification plaque. All Caltech labs who fill out the green lab scorecard and receive certification will receive a plaque courtesy of Caltech Sustainability.



Athletic fields, event spaces, and common gathering areas are exempted from the functional turf watering restrictions.



Construction is a constant on a campus like Caltech.



Caltech's many diverse laboratories remain excellent venues to employ sustainable behavioral practices that improve the Institute's overall performance.

Goals for Viability

Ensure existing and future facilities meet and maintain a high level of energy, water, and resource efficiency.

2022 Highlights

Caltech Presents Energy Plans With AEI

February 2022

LEADING THE WAY CampusEnergy2022

Feb.15-18 | Westin Boston Seaport District Hotel | Boston, MA

Representatives from Caltech and Affiliated Engineers, Inc. (AEI) traveled to the IDEA Campus Energy 2022 Conference in Boston, MA to present results from recent energy planning projects. These planned improvements to these systems will drastically change subterranean components of campus.

Turf Replacements Continue

May 2022



Caltech continued to move towards a more native landscape for our campus with the replacement of turf on San Pasqual Mall with climate-resilient vegetation. While a relatively small project in this case, Caltech is also developing a comprehensive plan for the entire campus.

Resnick Building Design Submission Completed

November 2022



Caltech submitted the upcoming Resnick building for initial design review late in 2022. While the building won't be constructed and occupied until later 2024, many checks and procedures are being followed to maximize sustainability features during the design and construction phase of the project.

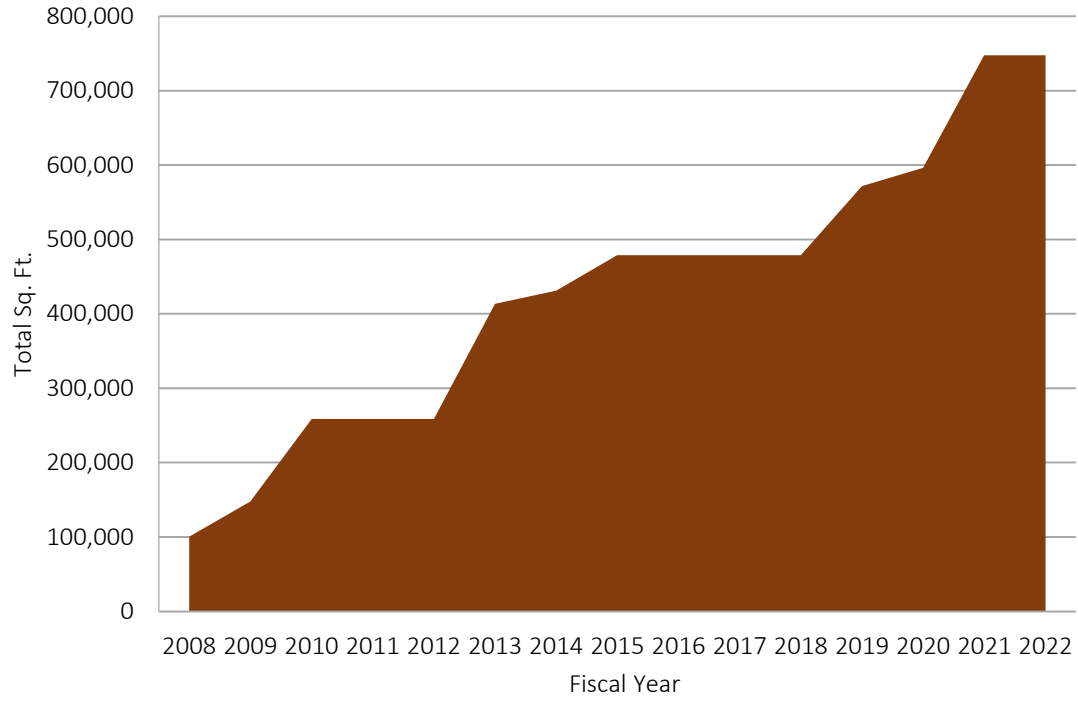


2022 Land Use Update

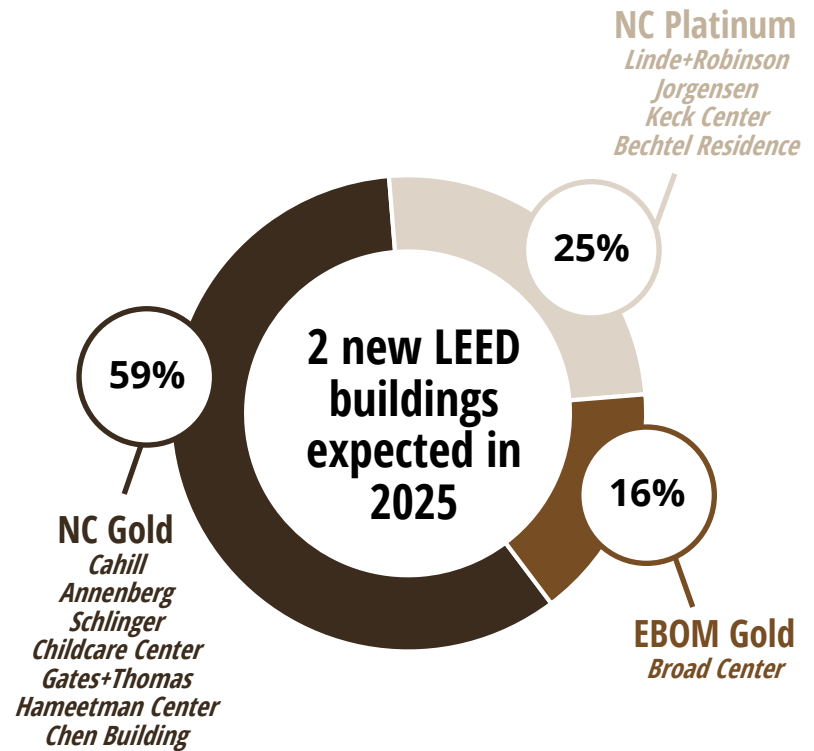
12 LEED certified buildings,
16% of Caltech's total
campus space

With no new building additions and minimal changes in campus land cover, Caltech continued to capitalize on past projects that minimize our carbon, energy, and water footprints. While designing of campus spaces and buildings can lock in significant sustainability progress, an engaged group of occupants can amplify impact and ensure that building drift is controlled. The BBE-led Green Labs group secured funding through their Division specifically for the implementation of green labs initiatives, a first for Caltech. The hard work of Tasha Cammidge, Prober Lab Research Technician, and Sarah Torres, Sternberg Lab Manager, really shined through in 2022. Their tireless efforts to promote sustainable lab practices, emphasize the importance of the Caltech Green Lab Certification, and engage occupants within and outside of BBE marks an exciting new chapter for the Institute.

Historical LEED Building Square Footage



2022 LEED Square Footage Breakdown



78% of campus turf cover is low water varietal grasses

747,000

square feet of LEED space added since 2008

2

construction projects pursuing LEED certification by 2025

Sustainable Vegetation Leads Campus Land Use Transition

2022 Campus Land Use Breakdown

22% High Water Use³

78% Low Water Use⁴

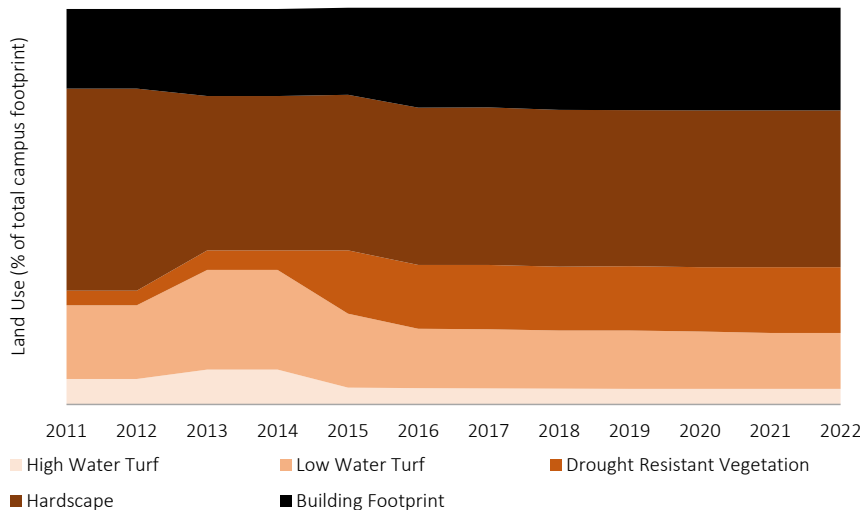
39% Hardscape

26% Buildings⁵

18% Turf

17% Vegetation

Historical Campus Land Use Change



Green Labs Initiatives Showcase Behavioral Role In Sustainability

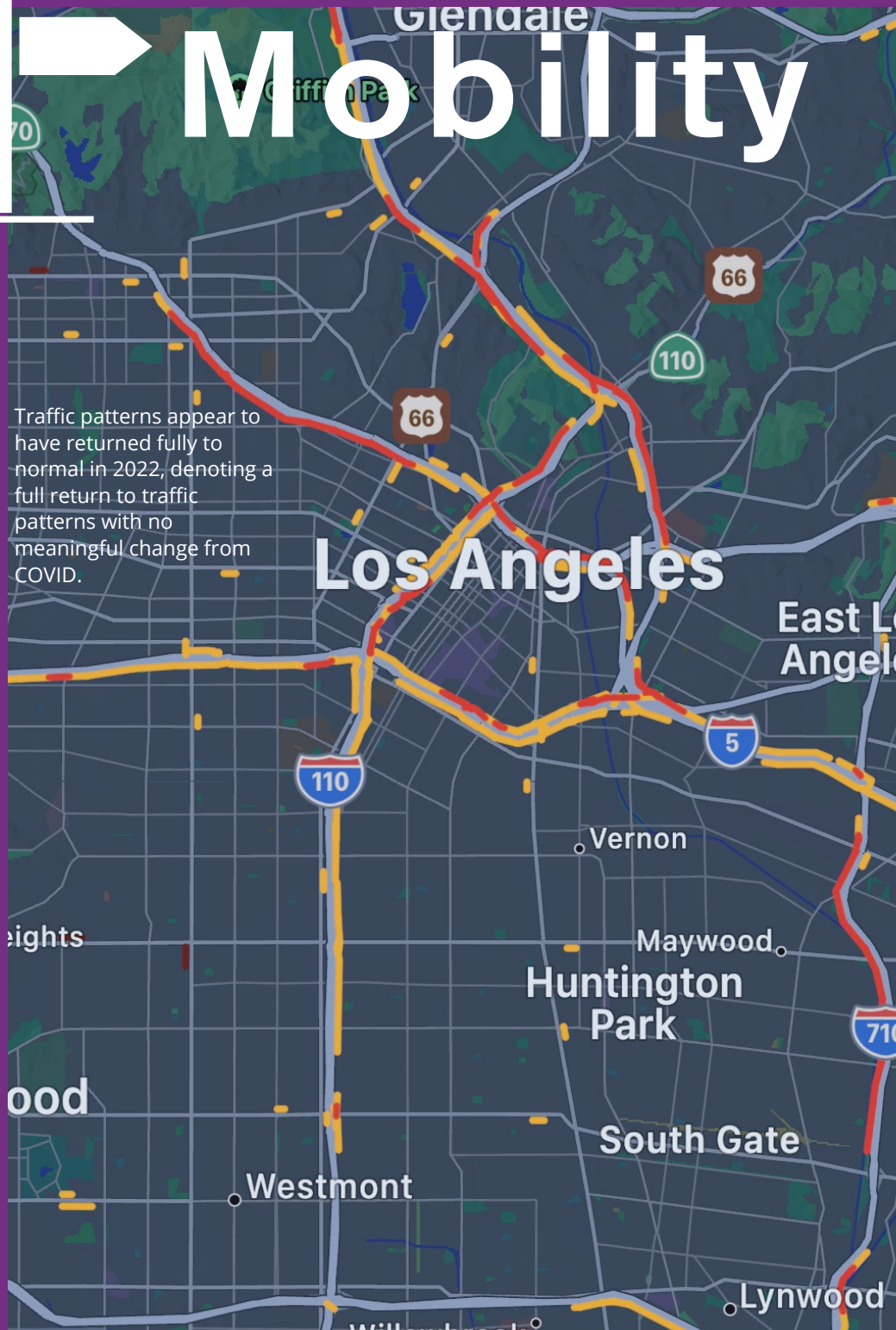
Green Labs understands that it can be difficult to ask labs to consider integrating green practices into their current research protocols, even if those adjustments do not compromise their research objectives. Therefore, the aim of Green Labs has been to encourage labs to make small changes in the hope that those small changes will encourage larger changes. Faculty and lab managers have been encouraged to pursue the Green Labs Certification, as a way to start the conversation surrounding lab sustainability. In these presentations, Green Labs has provided information and suggestions for sustainable changes that are often easy and free. The labs that complete the Green Labs Certification can also expect to receive support from the Green Labs group, their Division, as well as select vendors. Certified labs also have access to items such as free recycling bins, signage, and exclusive Green Labs events. Exposure to sustainable alternatives, especially those with empirical data supporting them, as well as knowledge of the incentives available can encourage labs to think creatively about their current lab practices.

One example of this theory in action includes asking labs to adopt a small change, such as the adoption of biodegradable gloves in lieu of traditional nitrile gloves, and then following up encouraging larger-scale changes with larger impacts, such as changing autoclaving schedules to reduce the number of loads run per day. For this initiative, labs are encouraged to run loads only on certain days of the week or only when the autoclave is full, or combine loads with neighboring labs to ensure loads are efficiently run. These changes encourage efficiency and reduce unnecessary costs, as well as minimize energy and water consumption. They also reduce time and money spent on equipment maintenance and may increase equipment longevity. As such, these behavioral changes offer a large benefit to labs and Caltech, as well as to the community that we work in.



Mobility

Traffic patterns appear to have returned fully to normal in 2022, denoting a full return to traffic patterns with no meaningful change from COVID.



Caltech welcomed two new Zipcars to the S. Wilson garage on campus. These Zipcars have dedicated spots on campus and are accessible for students, staff, and faculty.



Caltech is planning for the construction of more public bike racks as well as protected bike lockers to provide more flexibility and combat thefts.



Bike accessibility within and around campus remains a very important topic for the community.

Goals for Viability

Maintain a fuel-efficient fleet of vehicles and actively promote and enhance mobility options for the Caltech community.

2022 Highlights

Caltech Recognized As Bike Friendly University

December 2021



Renewing a nearly 10-year old certification, Caltech was recertified as a bike friendly university in late 2021. While further projects are in the works for 2023 and beyond, this helps to recognize our commitment to enhancing campus mobility.

EV Adoption Accelerating With California Regulations

November 2022



California is mandating that 35% of new cars sold be zero-emissions by 2026 and that all new cars must be zero-emissions by 2035. This drastic expansion will push manufacturers to accelerate production and require state electric grids to begin planning for the influx of charging vehicles.

Zipcar Adds More Vehicles To Campus

December 2022



Caltech added two new Zipcar vehicles to our campus in 2022. These vehicles provide enhanced mobility to the Caltech population, particularly to undergraduate and graduate students who may not have vehicles on campus. Further expansions of this program are expected in 2023.



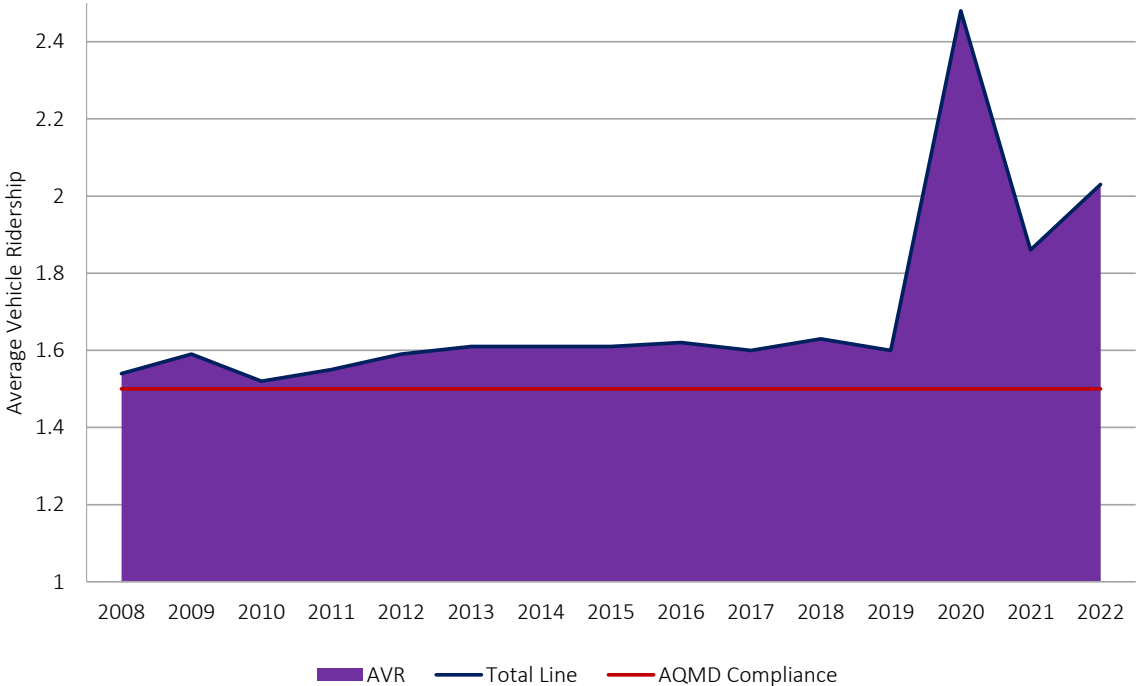
2022 Mobility Update

2.03

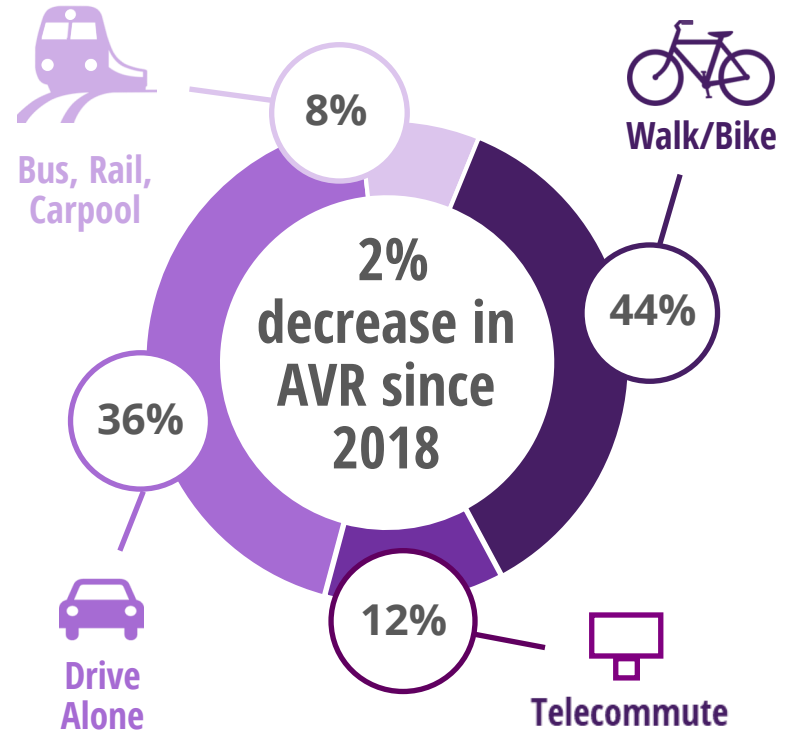
campus occupants per vehicle, up from 1.60 in 2019

Campus Average Vehicle Ridership (AVR) rebounded from 2021 after a historic high point in 2020. This seems to suggest a new normal as we emerge from COVID with a consistent mix of telecommuters spread mostly across Caltech faculty and staff. AVR also benefited from a higher survey response rate than in past years which has been made more achievable by the simplification of the interface and process for users. EV adoption continues to accelerate and future state-level mandates have assured that California will continue to lead the U.S. in this category. While public transit adoption still faces significant obstacles, Caltech strives to offer as much flexibility as possible to commuters and on-campus residents alike. Students have been particularly pleased with the continuing Zipcar expansions which saw their fleet grow from one to three vehicles with further expansion planned for 2023.

Campus Average Vehicle Ridership⁶



2022 Commuter Breakdown



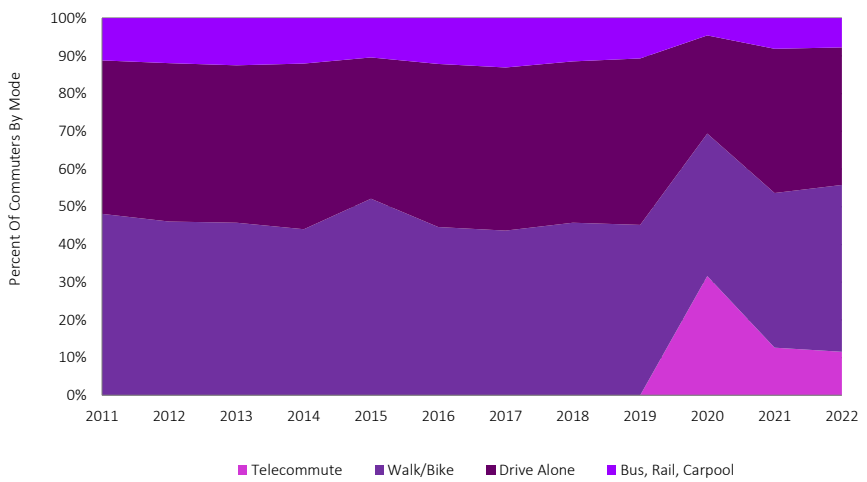
7.2 miles average commute distance, down 14% since 2017

65% staff drive alone rate, constant since 2021

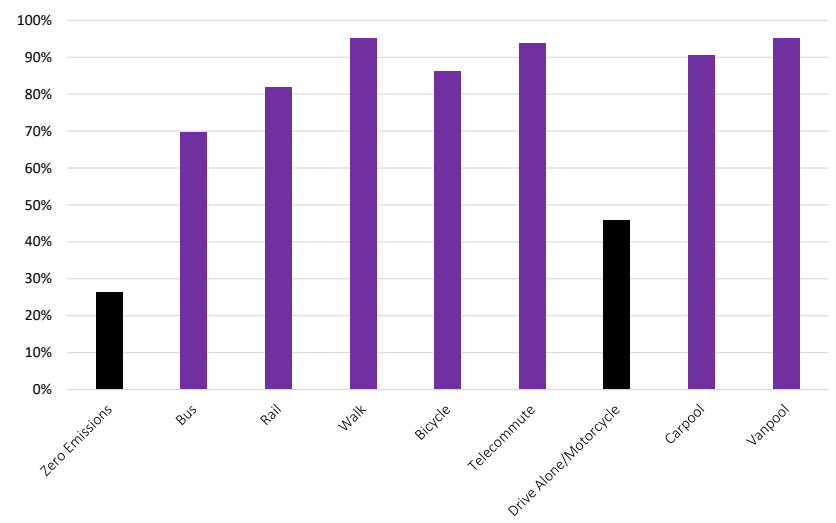
723 regular telecommuters in 2022, stabilizing since 2020

Post COVID Commuting Trends Come Into Focus

Historical Commute Mode Breakdown



Satisfaction by Commute Mode



Zipcar Expansion Provides Greater Mobility For Staff and Students

Responding directly to an expressed need by the graduate student population, Caltech expanded its Zipcar program in 2022. Zipcar is a popular program that allows staff and students to rent cars by the day or by the hour. Prior to 2022, the Zipcars were located exclusively on the east side of campus on San Pasqual Avenue. With the expansion of the program, two new Zipcars were added to the west side of campus in Parking Structure #1. The new Zipcar location will provide greater service to the Caltech community, including the residents of graduate housing.



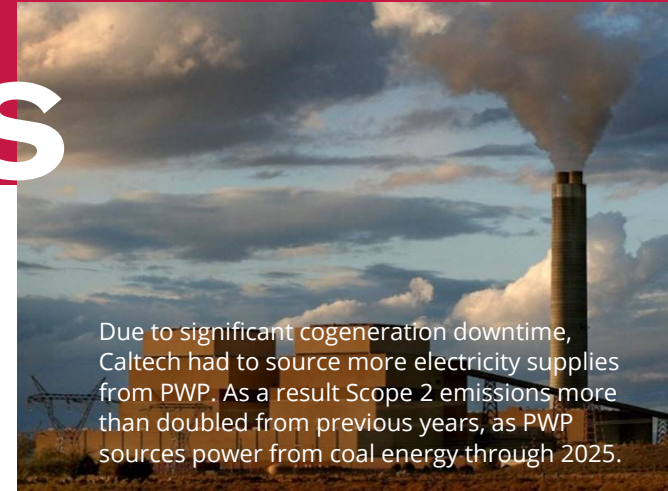
Beneficial to all, but especially those in the Catalina apartments, further expansion of the Zipcar program is anticipated in 2023. Users with a Zipcar account have access to any of these cars when available, and the vehicles can be used for anything from running errands to a weekend getaway. Zipcar adds to an ever expanding mobility program that works to maximize flexibility for the community.



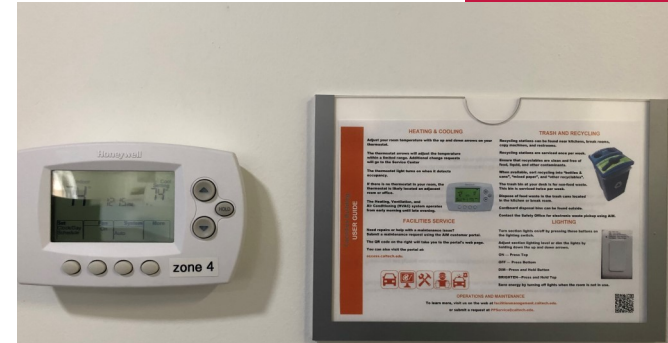
Emissions Effluents & Waste



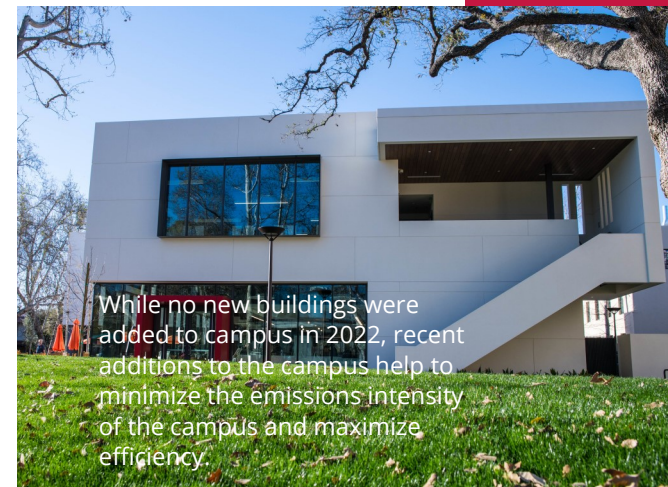
Caltech is planning to replace our standard chillers with heat-recovery chillers that can reclaim waste heat from the campus energy system and maximize the electrical efficiency, thus lowering total emissions.



Due to significant cogeneration downtime, Caltech had to source more electricity supplies from PWP. As a result Scope 2 emissions more than doubled from previous years, as PWP sources power from coal energy through 2025.



Behavioral prompts, such as these building user guides, remain powerful tools to encourage individual contributions to lowering campus carbon emissions.



While no new buildings were added to campus in 2022, recent additions to the campus help to minimize the emissions intensity of the campus and maximize efficiency.

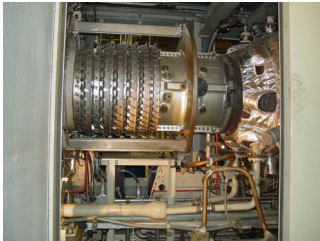
Goals for Viability

Explore, evaluate, and implement innovative techniques for minimizing the impact of campus emission, effluent, and waste streams.

2022 Highlights

Cogen Shutdown Shifts Emissions Profile

May 2022



A defect in the 10 megawatt cogeneration turbine caused a prolonged shutdown that lasted from May past the end of the calendar year. This event significantly shifted Caltech's emissions from Scope 1 to Scope 2, as PWP provided the bulk of campus electricity needs during the shutdown. This dynamic will return again as the energy system shifts towards offsite, cleaner sources of energy.

Students and Staff Petition Institute On Decarbonization

June 2022



A coalition of students led by Techers for a Sustainable Future created a petition for enhanced sustainability initiatives and action on campus. This petition was signed by a dozen faculty and over 200 students. This petition has led to the creation of a new Sustainability Council that will begin work in 2023.

Total Emissions Fall From 2021 Peak

December 2022



Total campus emissions fell in 2022, returning to levels seen over the past decade. 2021 was an anomalously high year for emissions, nearly 10,000 metric tons of CO₂ equivalent higher than 2022. While the precise reasons for this return to previous trends aren't entirely clear, a rapid greening of PWP's grid may be a contributing factor.

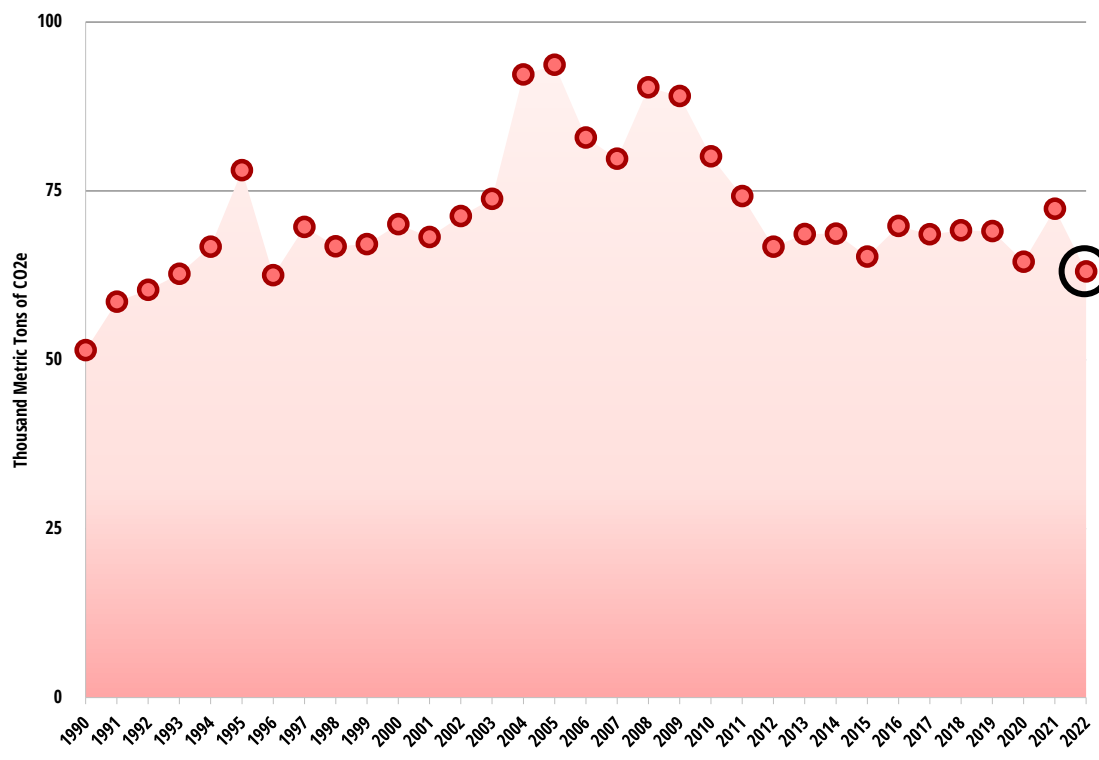


2022 Emissions, Effluents & Waste Update

↓ **13%** regulated greenhouse gas emissions⁸ since 2021

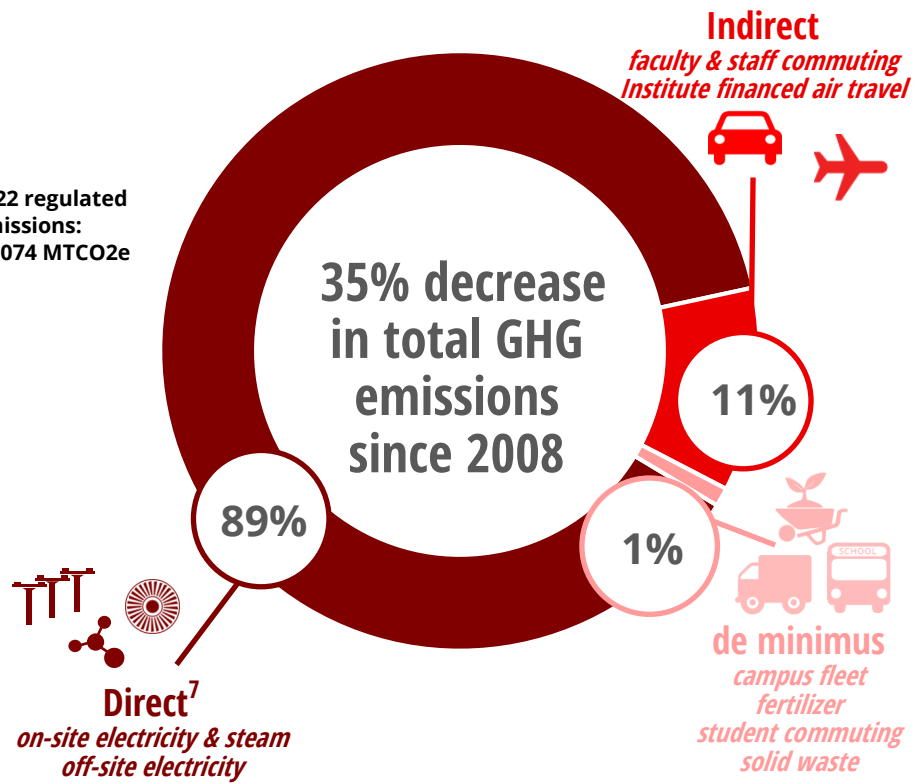
2022 was a surprisingly eventful year for Caltech's carbon emissions present and future. Scope 3 emissions rose as Institute financed air travel started to rebound from the COVID-19 pandemic, Scope 1 emissions fell as the cogeneration turbine was down for over half of the year, and Scope 2 emissions doubled as the Institute needed to import significant amounts of electricity to cover the shortfall. Heating needs that would normally be supplied by the cogeneration system's heat recovery mechanism were instead serviced by increased boiler usage. Energy planning for a resilient future recognizes the cogeneration system as an asset, but the realities of consistent fossil fuel generated supply will become untenable with rapidly accelerating carbon reduction goals. Caltech continues to participate in the Ivy+ coalition to learn how our peers are addressing these challenges.

Historical Regulated Greenhouse Gas Emissions



2022 regulated emissions: 63,074 MTCO2e

2022 Emissions Profile



↓ 9%

total greenhouse gas emissions since 2021 and a 15% decrease since 2017

12.2

MTCO₂e per person, a 9% decrease from 2021

.81

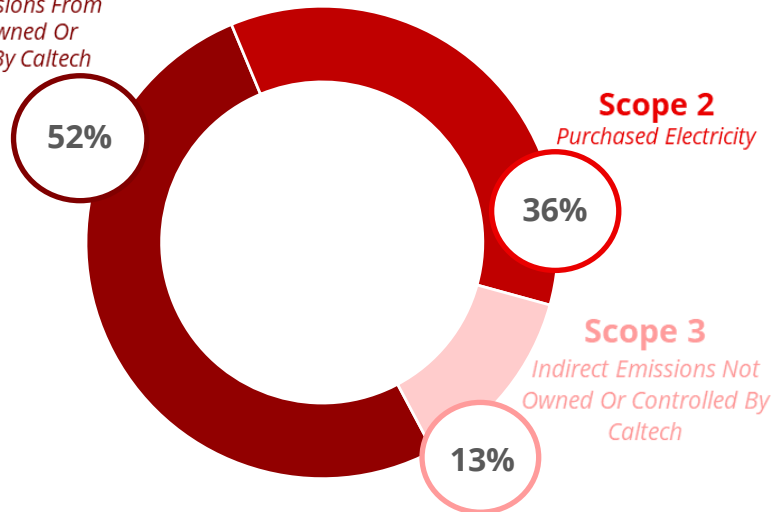
pounds of CO₂e per research dollar, down 8% since 2021

Scope 2 and 3 Emissions Rise

2022 Emission Profile By Scope

Scope 1

On-Site Emissions From Sources Owned Or Controlled By Caltech



Scope 2

Purchased Electricity

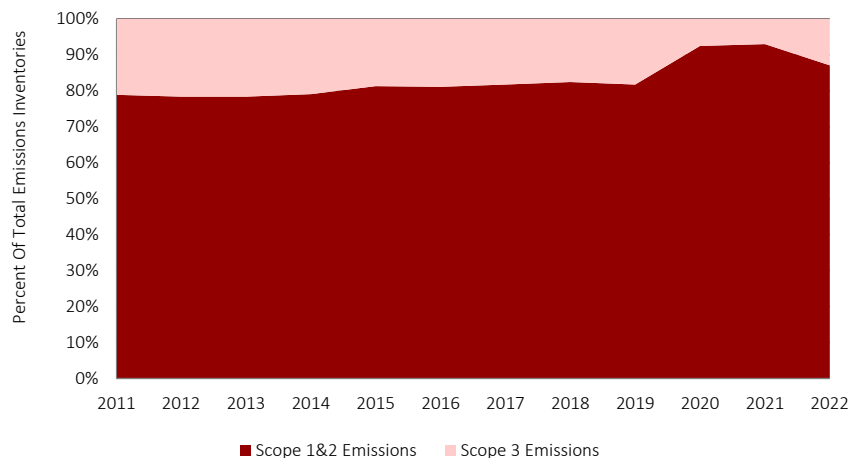
36%

Scope 3

Indirect Emissions Not Owned Or Controlled By Caltech

13%

Scope 3 Emissions Vs. Total Emissions



Student-Led Sustainability Petition Kickstarts Institute Planning Effort

A grassroots petition was launched by the leadership of Techers for a Sustainable Future. With further support from the Graduate Student Council sustainability chairs, this petition was subsequently signed by a dozen faculty and over 200 students. The petition made 4 requests:

- Carbon neutrality: Establish a carbon neutrality goal by 2050 that is consistent with national goals and is transparent, measurable, and verified by a third-party.
- Education: Affirm the commitment to environmental education integrated into relevant curriculum.
- Renewables/Efficiency: Expand off-site clean energy, and maximize on-site efficiency.
- Waste: Move away from single-use goods, and replace them with reusable alternatives.

In response, Caltech formed a new Sustainability Council that will be co-chaired by the Provost and CFO. This Council will be comprised of a dozen experts and will report directly to the President. This Council will be charged with:

- Preparing a sustainability plan, by spring 2024, which sets measurable goals and identifies initiatives to achieve progress in the areas of energy, water, materials, waste, land use, mobility, and emissions.
- Oversee and promote the implementation of the plan, track progress toward achieving the stated goals and make recommendations for resource allocation and the continued evolution of sustainability initiatives and programming.

Caltech looks forward to reporting more on this Council next year.

Key Institutional Data

Metric	Unit of Measure	2022	2021	% Change
Core Campus Building Square Footage	Square Feet	4,774,854	4,774,854	0%
Research Square Footage	Square Feet	2,069,425	2,069,425	0%
Population ⁹	Number (#)	5,828	5,835	-0.1%
Faculty & Post Doctoral Scholars	Number (#)	1,233	1,231	+0.2%
Staff	Number (#)	2,194	2,207	-0.6%
Students	Number (#)	2,401	2,397	+0.2%

Acknowledgements

Thank you to all of the people who helped assemble the data and content of this report and for their time reviewing the content of this report:

- Wayne Bottomley, Design & Construction
- Tasha Cammidge, Prober Lab
- Lynne Caver, Facilities Finance
- Michael Chuah, Environment, Health & Safety
- Tyler Durchslag-Richardson, Facilities Services and Planning
- Delmy Emerson, Building and Grounds
- Seth Fink, Energy Services
- Neil Fromer, Resnick Institute
- Michelle Gonzalez, Financial Services
- Carolann Icasiano, Human Resources
- David Kremers, Visitor in Aerospace
- Eugene Kim, Design and Construction
- Warren Midkiff, Central Utility Plant Supervisor
- Kevin Nguyen, Financial Services
- Monique Olah, Facilities Finance
- John Onderdonk, Facilities Services and Planning
- Cynthia Rowand, Procurement Services
- Caz Scislowicz, Environment, Health & Safety
- Todd Swart, Transportation and Parking Services
- Sarah Torres, Sternberg Lab
- Jocelyn Yamasaki, Caltech Library

Prepared by



Maximilian Christman,
Sustainability Manager

Photos and Images

- Caltech Bikeshare
- Caltech Dining Services
- Caltech Office of Strategic Communications
- Caltech Sustainability
- Christine Cho, Independent Photographer
- Hensel Phelps
- LA Metro
- Nature
- Pasadena Water & Power
- Smith Group
- South Coast Air Quality Management District
- The Arnold Lab
- TMS UrbanTrans
- ZGF Architects

Footnotes

1. On-site electricity generation refers to electricity produced on the core campus through the co-generation plant, solar PV and fuel cell systems.
2. Site energy use intensity is calculated by taking the total usable energy consumed (electricity and steam) on-campus and does not include fugitive energy from heat or transmission losses.
3. High water use turf is defined by any turf species with an irrigation factor of at least 20.72gallons/sqft/yr, according to the Department of Energy cool season turf regional irrigation factors.
4. Low water use turf is defined by any turf species with an irrigation factor of at most 14.64gallons/sqft/yr, according to the Department of Energy warm season turf regional irrigation factors.
5. The building footprint is the sum of the first floor area (above grade) for all buildings on the core campus; includes applicable parking structures. Additionally, this report includes the North Athletic Field artificial turf in the building footprint total, as it was installed to serve as a high-use outdoor space, drains water like a building and does not provide any habitat to biodiversity like other turf.
6. Average vehicle ridership (AVR) is calculated using the South Coast Air Quality Management District's Employee Commute Reduction Program measurement methodology. The Caltech campus is surveyed for a week each year, providing the total number of vehicle trips to campus and the average number of riders per vehicle trip. The commuter profile is determined by finding the dominant commute mode during this survey period for each respondent and extrapolating to the total campus population. Thus, AVR and drive alone trends may differ over time.
7. Direct emissions are those from sources owned or operated by the Institute. Caltech's direct emissions inventory includes on-campus stationary sources, purchased electricity and transmission and distribution (T&D) losses. Purchased electricity and T&D losses are included in this category because the amount of electricity purchased is a direct result of operational decisions and campus activities.
8. Total emissions include regulated, indirect, and de minimus emissions. Indirect emissions result from the activities of Caltech but occur at sources owned or controlled by another entity. Indirect emissions include faculty and staff commuting and directly financed air travel. De minimus emissions comprise less than five percent of the Institute's total emissions and are not traditionally inventoried on an annual basis. These emissions may be direct or indirect emissions but are tracked separately. Caltech's de minimus emissions result from university owned fleet transportation, refrigerants and chemicals, fertilizer application, student commuting and solid waste disposal.
9. Human Resources provided faculty, post doc and staff population statistics. The Office of the Registrar provided population statistics and include those seeking undergraduate and graduate degrees.



Caltech 1200 East California Boulevard
Pasadena, CA 91125

Produced by Caltech
Sustainability
sustainability.caltech.edu

