



# Caltech 2023 Sustainability Report

April 2024





The theme of our 2022 annual report was one of patience in navigating volatility and short-term challenges while anticipation built for the promise of transformational change. We had all hoped that 2023 would bring the volatility and challenges to an end, but ongoing unplanned outages of the cogeneration plant and poor performance in waste management and recycling have proven to be persistent trends.

While it is easy to focus on these issues and their dampening or reversal of key performance indicators, that cursory review misses the steady progress and quick wins that portend a return to consequential change. Most importantly, the Sustainability Advisory Council began meeting in April 2023 and quickly moved to chart a path toward decarbonization of the campus energy systems. Work is already underway to source renewable electricity and more thoroughly engineer a conversion from steam to hot water. The new Resnick Sustainability Center really took shape with the completion of the mass-timber atrium, through which every Caltech undergraduate student will soon pass on their way to their introductory courses in green chemistry. This past year also saw the continued growth of the Green Labs program, the return of a reusable mug program at Caltech Dining, and the introduction of an e-bike rental program that all resulted from strong student engagement and coordination with the Sustainability Advisory Council.

The scientific method dictates that the path to breakthrough discoveries is neither linear nor predictable. The same is true of the path toward a more sustainable future. The needed reminder is that persistence, excellence, ambition, and rigor are the prerequisites.

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

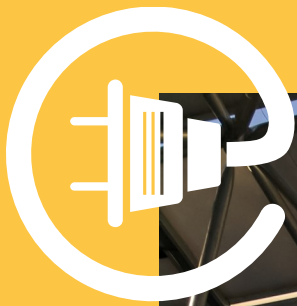
 24 Emissions

28 References & Acknowledgements

# 2023 At A Glance — Key Performance Indicators

<h2>Energy</h2> <p>Caltech's electricity portfolio the past two years has deviated from recent trends due to extended cogeneration shutdowns necessitating significant imports from PWP.</p>	<p><b>↓ 5%</b> total electricity consumption since 2022, lowest since 2020</p>	<p><b>32%</b> net electricity produced on-site, highest import since before 1990</p>	<p><b>↓ 14%</b> energy intensity by area since 2022, lowest since before 2010</p>	<p><b>\$26.9M</b> in annual energy costs, a 139% increase from 2018</p>	<p><b>&gt;\$10M</b> in cumulative energy cost savings since 2011 despite recent rising costs</p>	
<h2>Water</h2> <p>Water consumption has remained steady recently overall with high variability in buildings and predictable utility consumption. A wet winter dropped irrigation to record lows.</p>	<p><b>↑ 7%</b> water consumption since 2022 but a 6% decrease since 2018</p>	<p><b>↓ 45%</b> irrigation water use since 2022, lowest in recorded history of the Institute</p>	<p><b>↑ 7%</b> water per square foot since 2022 but a 17% decrease since 2018</p>	<p><b>\$1.2M</b> in annual water costs, up 3% from 2022 but down 14% since 2018</p>	<p><b>↑ 19%</b> in campus costs per gallon since 2011</p>	
<h2>Materials</h2> <p>Waste and recycling continues to be the most challenging area of sustainability. The Sustainability Council has focused on addressing existing and new challenges.</p>	<p><b>10%</b> campus non-hazardous waste diversion, down from 27% in 2019</p>	<p><b>.43 tons</b> municipal waste per capita, up 37% from 2018 but down 3% since 2022</p>	<p><b>↑ 40%</b> in campus hazardous waste costs since 2018</p>	<p><b>\$1.3M</b> in total campus waste costs, up 77% since 2018</p>	<p><b>-\$4K</b> in net recycling revenue in 2022, down from \$70K in 2011</p>	
<h2>Land Use</h2> <p>2023 saw minimal change in land use and the built environment, but Caltech is gearing up for significant changes with ongoing and planned new construction projects.</p>	<p><b>2</b> buildings pursuing LEED certification by 2026</p>	<p><b>747K</b> square feet of LEED building space, totaling 16% of entire campus</p>	<p><b>17%</b> of campus covered with low-water vegetation, up from 4% in 2012</p>	<p><b>78%</b> of campus turf cover is low water varietal grasses</p>	<p><b>12</b> campus buildings now LEED certified, up from 4 buildings in 2011</p>	
<h2>Mobility</h2> <p>Post-COVID trends have become clear, including a return to perceived parking constraints and long commutes. This is accompanied by the proliferation of electric vehicles.</p>	<p><b>1.81</b> campus occupants per vehicle, up from 1.60 in 2019</p>	<p><b>41%</b> campus drive alone rate, constant since 2005</p>	<p><b>255</b> telecommuters in 2023, down from over 2,000 in 2020</p>	<p><b>66%</b> staff drive alone rate, up from 41% in 2020</p>	<p><b>110/2</b> carpools and vanpools at the end of 2023 respectively</p>	
<h2>Emissions</h2> <p>Caltech's emissions portfolio is driven primarily by energy-related emissions, and the 2023 cogeneration shutdown brought a temporary and drastic change to the emissions picture.</p>	<p><b>↑ 37%</b> direct greenhouse gas emissions since 2022</p>	<p><b>↑ 39%</b> total emissions since 2022 and a 17% increase since 2018</p>	<p><b>↑ 15%</b> emissions intensity per capita since 2018</p>	<p><b>1.2</b> pounds of CO<sub>2</sub>e per research dollar, up 15% since 2022</p>	<p><b>↑ 3%</b> in scope 3 emissions since 2019 signaling a full rebound</p>	





# Energy



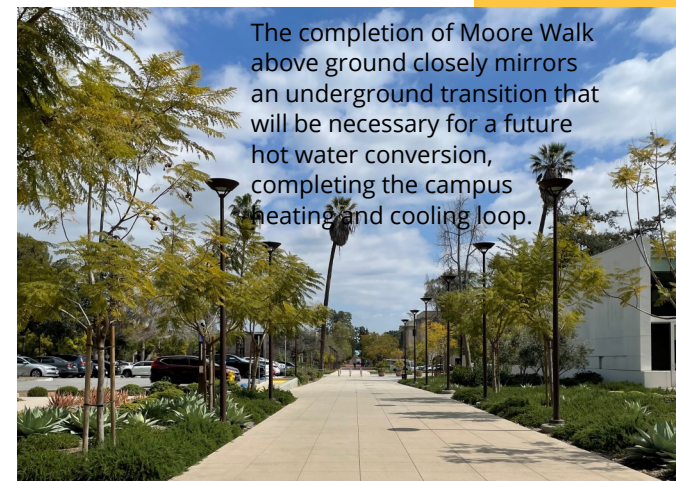
Caltech is now faced with a decision on whether to purchase this Holliston solar system or install newer and more efficient panels on the same site. Similar decisions on newer renewable and fuel cell installations will occur in the coming years.



Electrical capacity and reliability will be key as the campus targets a more resilient future through a conceptual microgrid and improved analytics.



Caltech imported a large amount of electricity from PWP during the cogeneration shutdown. PWP's supply currently has a large share of coal, but this will soon be replaced by renewable energy resources.



The completion of Moore Walk above ground closely mirrors an underground transition that will be necessary for a future hot water conversion, completing the campus heating and cooling loop.





# 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.



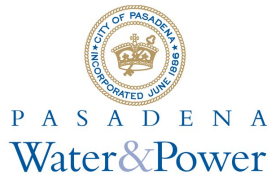
## 2023 Highlights

### Cogen Restarts and Then Shuts Down January 2023



Beginning in May of 2022, the campus cogeneration system shut down due to issues with turbine operation and meeting stricter emissions tests. The cogeneration system briefly resumed operation in January before another prolonged shutdown that lasted through the end of the year.

### PWP Unveils Updated 100% Renewable IRP September 2023



Pasadena Water and Power recently updated their Integrated Resource Plan to better define a path to achieve a 100% renewable portfolio standard by 2030 in compliance with a City Council resolution and clear stakeholder mandates.

### Sustainability Council Charts Decarbonization Path December 2023



Caltech's Sustainability Advisory Council convened in April 2023 and then set off on a multi-month deep dive into campus energy planning scenarios. As a result, the campus announced a decarbonization path approved by President Rosenbaum.

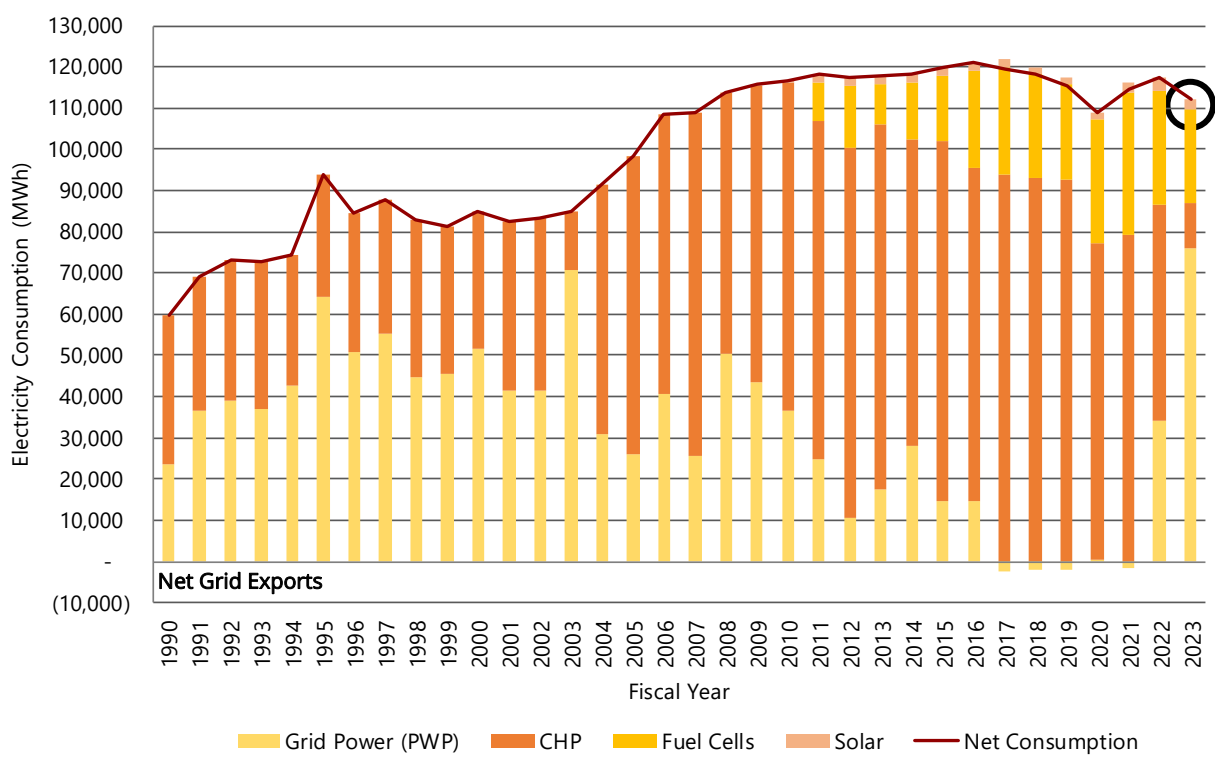


# 2023 Energy Update

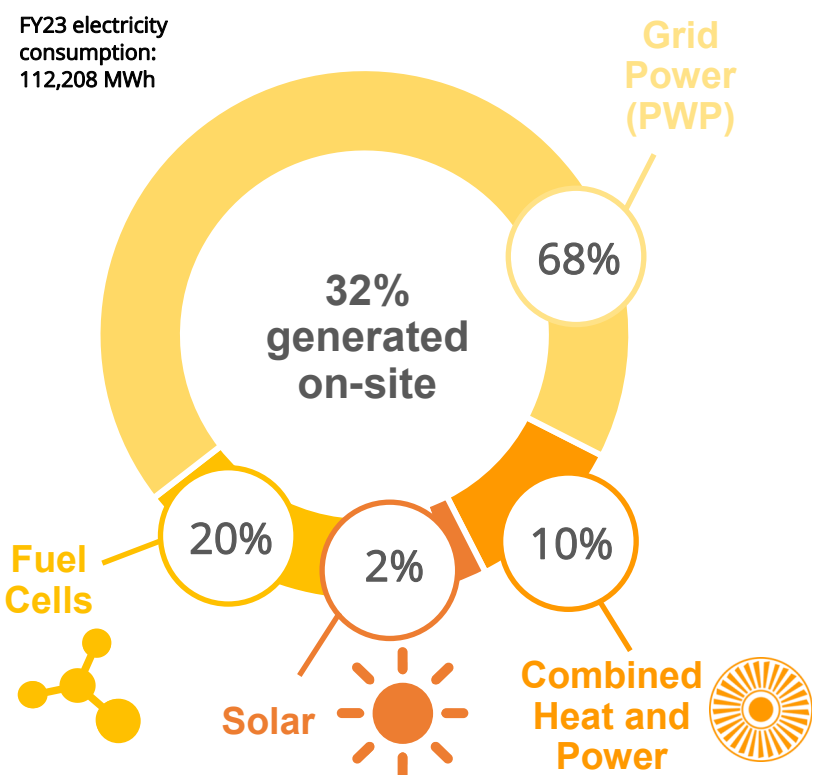
total electricity consumption since 2022, lowest since 2020

Over a half-decade of energy planning culminated in an announcement on a path forward to decarbonizing campus energy production and consumption. This decision coincided with the difficulties of continuing the status quo becoming apparent. An extended cogeneration system outage stretched from 2022 into 2023, due largely to operational and performance issues associated with the 10 MW gas turbine. This unexpected shutdown adversely affected the campus energy budget and caused a historically high import of electricity from Pasadena Water and Power (PWP). Campus planning on a shift away from this more brittle, on-site system mirrors recent planning efforts from the City to decarbonize power supply in order to meet a 100% Renewable Portfolio Standard in the coming years. Caltech has a path forward including an intended partnership with PWP and further engineering of a steam to hot water conversion.

## Historical Electricity Consumption



## 2023 Electricity Portfolio





32%

electricity produced on-site<sup>1</sup>, highest total import since before 1990



14%

energy intensity by area<sup>2</sup> since 2022, lowest since before 2010

\$26.9M

in annual energy costs, a 139% increase from 2018



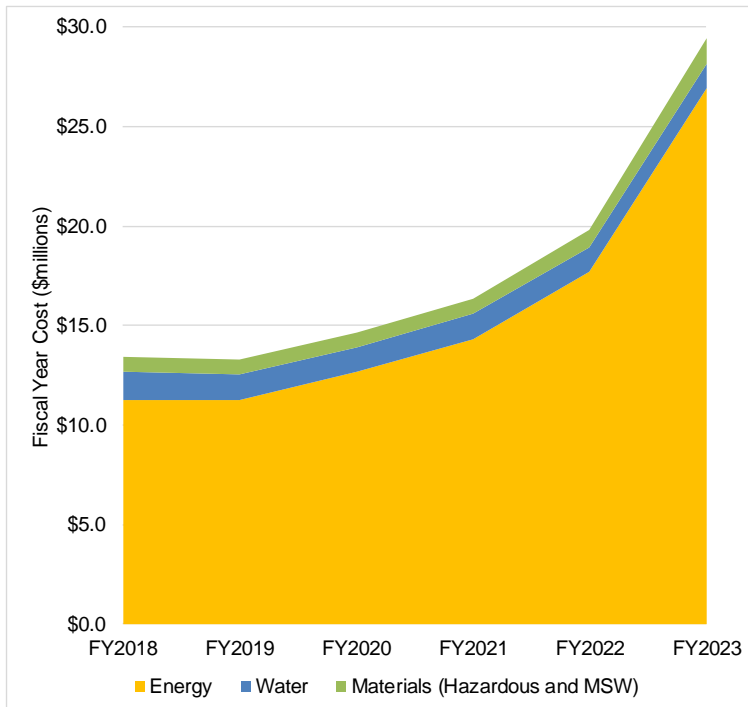
## Cogen Reliability Continues To Challenge Campus

For the second year in a row, Caltech’s energy portfolio was drastically altered by extended cogeneration system shutdowns. Without 10 MW of onsite power, Caltech imported two-thirds of our FY23 electricity from Pasadena Water and Power. This caused costs to rise significantly in

comparison to the low per unit energy cost of bulk natural gas purchases. While unplanned, these shutdowns have been related to tightening emissions standards for fossil fuel plants in California.

Caltech is subject to regulation by the California Air

Resources Board, and the clear signal from state government has been to push for decarbonization and away from natural gas, coal, or other fossil generation. This aligns with Caltech’s plans to decarbonize electricity supply by 2045, but the expected regulatory pressures have coincided with operational challenges to cause these shutdowns and budgetary impact.



## Decarbonization Announcement

President Thomas F. Rosenbaum has endorsed recommendations by the Caltech Sustainability Advisory Council to decarbonize the Institute’s energy systems. Initially, Caltech will collaborate with Pasadena Water and Power (PWP) to explore options for offsite, renewable electricity to replace baseload, fossil fuel power from Caltech's cogeneration system. This partnership will complement the City of Pasadena's efforts to achieve a 100% renewable portfolio by 2030.

The Council also recommended that staff evaluate resiliency needs and capabilities that could allow the old cogeneration infrastructure to

power the campus as a backup during blackouts as an increasingly volatile climate tests an increasingly tapped electrical grid. In addition, Caltech will further explore the conversion from steam-based heating to hot water with an eye towards near-term implementation. Further understanding disruptions to research and validation of previous work will hopefully lead to initiation of the project in the next few years.



PASADENA  
Water & Power







# Water



While once a key target for water conservation, many Caltech fountains have become minimal consumers of potable water through condensate reuse, functional shifts, or through planned new construction.



Caltech's recent cooling tower upgrades at both utility plants have allowed for more cooling capacity to accommodate campus growth, and this capacity will increase even further with expected savings from a conversion to hot water.



While irrigation and utility plant consumption can be addressed with centralized solutions, buildings will require a decentralized approach.



While more snowpack turns to rainfall in a warming climate, California's wet winter provided enough moisture to pull the state out of a drought.





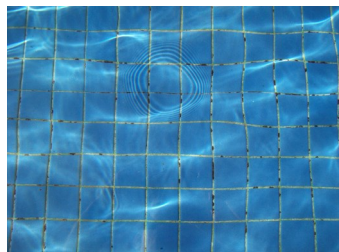
# Goals for Viability

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

## 2023 Highlights

### Heavy Rainfalls Lift Burden Of Drought Restrictions

April 2023



The State of California enacted Level 2 drought restrictions in 2022, forcing irrigation reductions after a series of dry winters. After an exceedingly wet winter in 2023, some short term restrictions were lifted while acknowledging that the southwestern United States are in a constant state of long-term drought.

### Caltech Completes Water Optimization Study

August 2023



Coho Climate Advisors wrapped up their recommendations for Caltech's campus water systems in the summer of 2023 which allowed for the Sustainability Advisory Council to weigh in later in the year.

### Data Gaps Highlight Need For Improved Water Metering

October 2023



One key finding of the water optimization study was a considerable amount of missing water when reconciling the sum of campus water bills with building-level metering data available to Facilities. Closing this data gap will allow for more targeted water solutions.



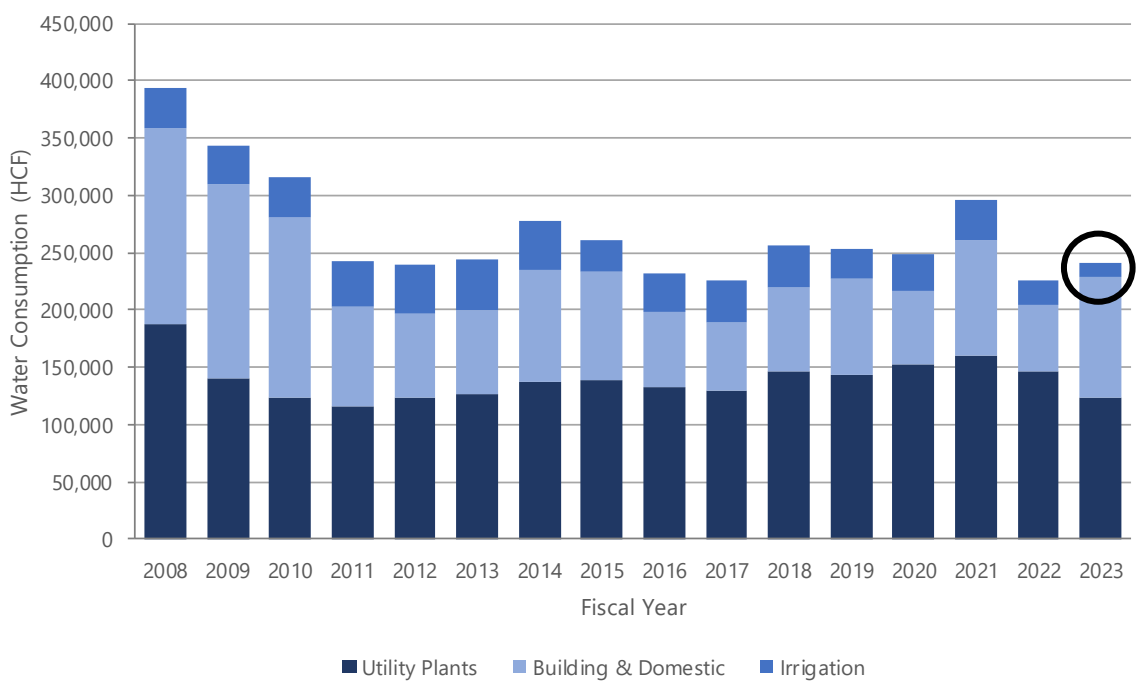
# 2023 Water Update

↓ 45%

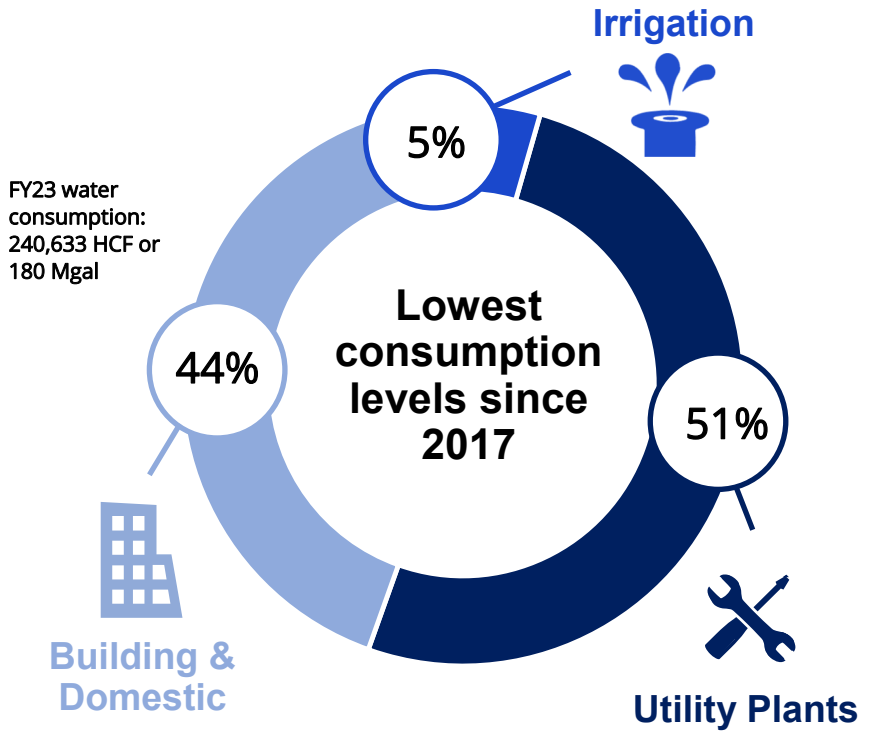
irrigation water use since 2022, lowest in the recorded history of the Institute

While the lifting of irrigation restrictions brought relief to residential users in Pasadena and a wet winter resulted in the lowest irrigation totals ever seen for the Institute, Caltech’s water challenges are more complex. The majority of consumption is related to the production of energy, and many data gaps were identified in a recent water metering and optimization study completed by the Coho Climate Advisors. Key areas of future emphasis will be closing gaps in data and further investigations into the potential of centralized water reuse at the central plant. In this future scenario, wastewater could be harvested from various collection points on campus, piped to the central plant, and treated up to the standard at which point it could be re-softened and used to recharge cooling towers. The cooling towers are the single biggest water consumers on campus and would be ideal candidates for this centralized reuse, as tens of millions of gallons of water are released to the atmosphere through the evaporative cooling process.

## Historical Campus Water Consumption



## 2023 Water Use Profile







7%

water use per square foot since 2022, but a 17% decrease since 2018

51/44/5

2023 use percentages for utility plants, building & domestic, and irrigation

\$1.2M

in annual water costs, up 3% from 2022 but down 14% since 2018



## Heavy Seasonal Rainfall Drops Irrigation Levels to Lowest Ever

43 inches of rainfall, more than double the seasonal average, hit Pasadena in the 2023 rainfall season from July 2022 through June 2023. This was the highest seasonal rainfall since 2005 and was followed by an exceedingly rare tropical storm dropping nearly 5 additional inches of rain in August of 2023, a month that typically sees less than 0.1 inches. This led to the lowest irrigation levels in recorded history for the Institute, but Caltech's irrigation amounts have been



low relative to other sources of water consumption. New buildings will continue to emphasize drought-resistant vegetation, but the efforts over the past decade to improve the built environment and reduce landscaping water needs have produced this positive result where little additional work is needed. In future droughts, Caltech will be focused mostly on buildings and utility plants to identify savings.

## Water Optimization Study Sets Stage For Sustainability Council

Caltech worked with Coho Climate Advisors throughout 2023 to analyze current campus water systems and data quality. Key findings indicated that significant improvements are needed to the campus metering infrastructure in order to provide the level of data needed to engage in building-level improvements. More immediately, Coho was able to provide key recommendations on supplemental technology to increase data quality and automate control of inputs for incoming water needing treatment. These recommendations were successfully implemented as part of the installation of new water softeners at the satellite plant.

Most relevant for future planning was an exploration of water recycling potential at the central plant. A recycling system could take graywater and blackwater from campus buildings and nearby sewer inputs along with industrial water waste from campus cooling towers and boilers that would then be transported via the campus tunnel systems back to the central plant where it could then be treated to potable standards and put back into the cooling tower systems. Coho estimated that such a system could potentially save 100 million gallons of water per year, effectively cutting campus water consumption in half. These ideas will be explored by a special working group of the Sustainability Council in 2024.



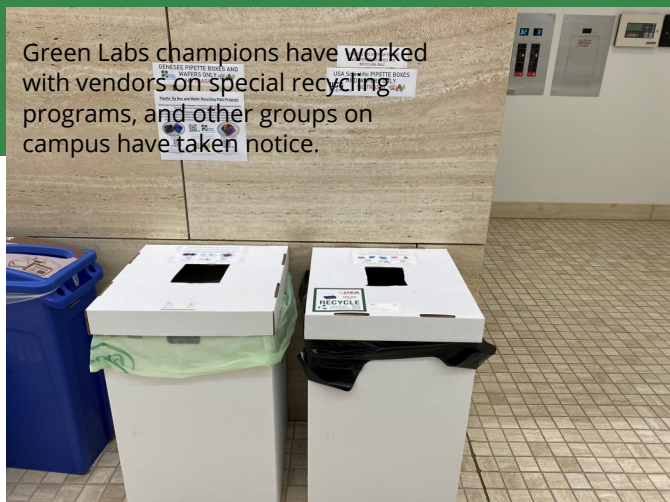




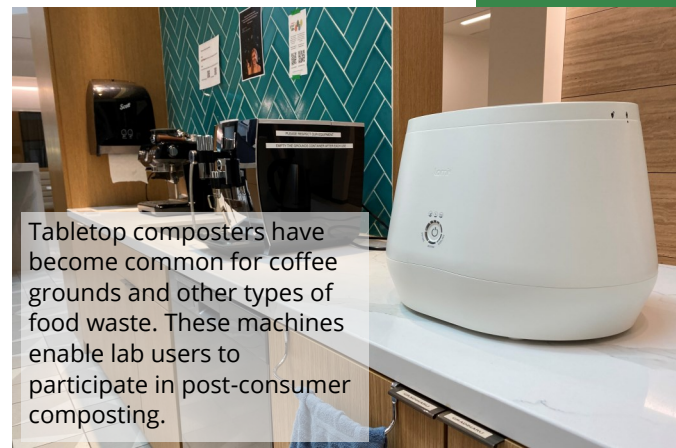
# Materials



Lomi composters have created over 200 pounds of nutrient rich fertilizer for use in the gardens throughout Caltech.



Green Labs champions have worked with vendors on special recycling programs, and other groups on campus have taken notice.



Tabletop composters have become common for coffee grounds and other types of food waste. These machines enable lab users to participate in post-consumer composting.



Pipette box recycling and other special material recovery programs thrived in 2023.

# Goals for Viability

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



## 2023 Highlights

### Staff Shortages Halts Campus Recycling Program Again

January 2023



Due to a recurring shortage of recycling staff, Caltech again had to transfer the responsibility of post-consumer recycling over to our waste hauler, Republic Services. Caltech's Sustainability Advisory Council and Facilities administration are working towards a more resilient waste program for the future.

### Green Labs Holds Lightning Talks

April 2023



As a celebration of progress, Caltech Green Labs held a series of educational talks immediately following Earth Week. Sustainability-minded lab users spoke on energy efficiency, engagement, and waste reduction topics while engaging vendors and professors.

### I2SL Conference Highlights Green Labs

October 2023



Caltech showed up well to the 2023 International Institute for Sustainable Laboratories Conference with almost a dozen attendees. As a board member of the Greater Los Angeles Chapter of I2SL, Caltech supported the conference in Anaheim while educating attendees from around the world.



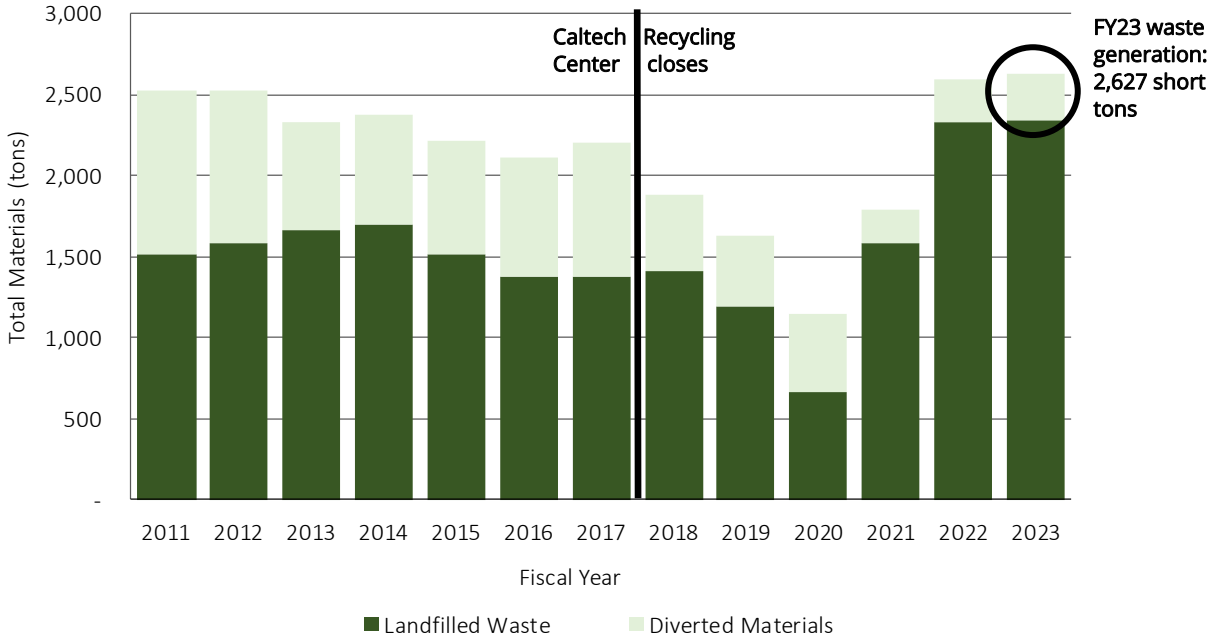
# 2023 Materials Update

10%

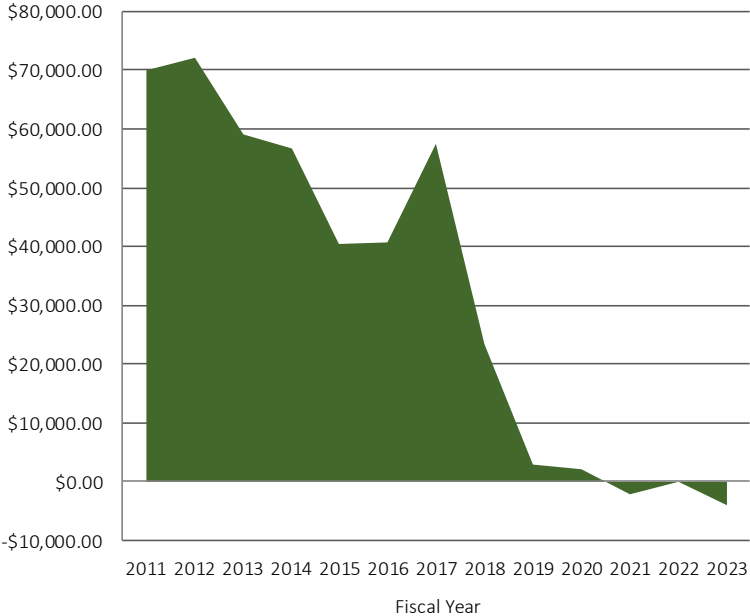
campus non-hazardous waste diversion rate, down from 27% in 2019

Waste and recycling continues to be a challenge at Caltech, as total waste generation has exceeded pre-pandemic levels, and diversion has fallen considerably since 2019. Costs continue to rise and net revenue from recycling commodities after hauling fees is barely breaking even. These challenges intersected with continued staffing shortages to further complicate Caltech’s waste handling programs and procedures. Despite these complex problems, Caltech began to prepare for a more resilient waste and recycling program through the work of the Sustainability Advisory Council. Revamping the on-campus recycling process and creating a more resilient staffing structure will be key early priorities in 2024. Further considerations into creative reuse of materials being utilized on campus as well as smart purchasing strategies to avoid waste will combine to help avoid waste and improve the overall diversion picture of the campus. Much work remains to be done.

## Historical Waste Generation and Diversion



## Net Recycling Revenue By Year



860

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



40%

in campus hazardous waste costs since 2018

\$1.3M

in total campus waste costs, up 77% since 2018

## Labs Rethink Waste With Food Waste and Recycling Initiatives

Labs produce 12 billion pounds of waste every year, and Caltech Green Labs partnered with USA Scientific and Genesee in May 2023 to reuse, redistribute, and recycle pipette tip boxes in labs. Despite only being trialed in 6 campus buildings, over 1000 pounds of plastic waste has been successfully diverted from the landfill. Future efforts will focus on scaling this initiative to other campus buildings and capturing other brands with pipette box recycling.



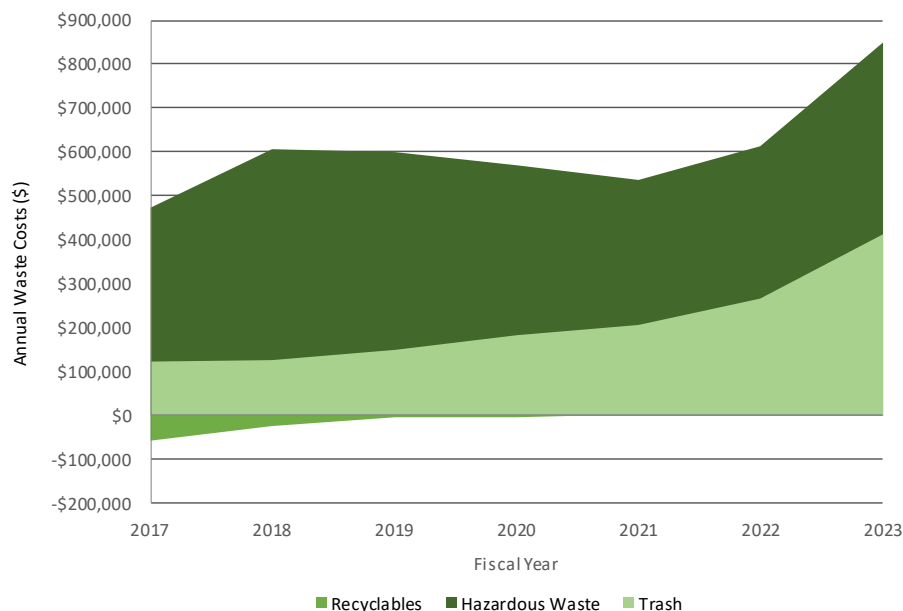
Similarly, over 66.2 million tons of food waste is generated in the United States alone, but only 5% of that is composted every year. Green Labs

decided to establish a small-scale composting program on campus in April 2023 by installing 3 Lomi tabletop composters on each floor of the Chen building. This installation was accompanied by educational programs to develop interest, show the need for composting programs, and demonstrate the function of tabletop composters. Since April 2023, Green Labs has diverted over 1000 pounds of food waste, and transformed it into 150 gallons of compost dirt that is used in gardens around the Caltech campus. The program also expanded to serve three buildings on campus and future efforts can expand this impact throughout the campus.



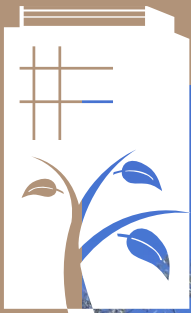
## Campus Waste Handling Challenges Necessitate Refocus

With costs soaring and diversion low, Caltech continues to struggle with waste handling and recycling. Ongoing Caltech staff shortages, continued commodity market fluctuations, rising industry prices for hazardous waste disposal, and the race to the bottom on plastics have all combined to produce a very difficult situation for the Institute and the waste industry at-large. Institute waste disposal costs crossed the \$1M per year mark for the first time while



diversion rates hit record lows. The Sustainability Advisory Council addressed this topic in late 2023 with the hopes that 2024 can begin a rebound with increased resources and campuswide emphasis.





# Land Use



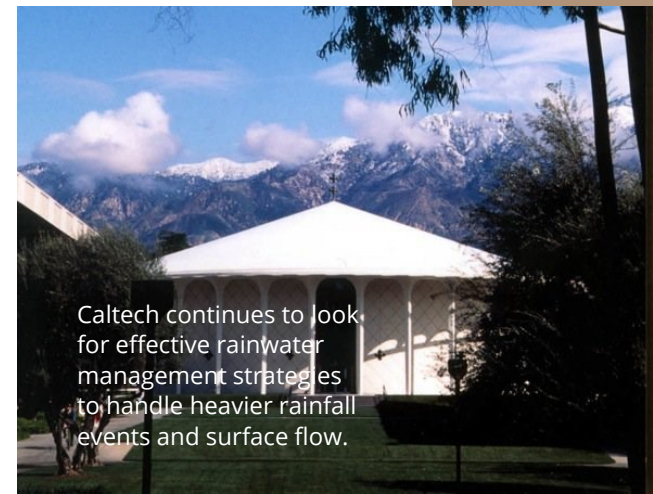
Resnick's façade was completed in late 2023 while building preparation, furnishment, commissioning and landscaping continues into 2024.



As Caltech is limited in its ability to grow outwards, future building projects will often focus on additions to existing buildings or renovation projects of older structures.



Once completed, the Resnick Sustainability Center will serve as a beacon for sustainability research and sustainable design.



Caltech continues to look for effective rainwater management strategies to handle heavier rainfall events and surface flow.





# Goals for Viability

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

## 2023 Highlights

### GCQPM Schematic Design Process Begins

October 2022



While the new Resnick building approaches completion and occupancy, another major new construction project is just beginning. Just north of California Blvd. across from the Caltech tennis courts is a construction site for the new Ginsburg Center for Quantum Precision Measurement.

### Campus Landscaping Statistics Hold Steady

September 2023



Due to a lack of new buildings being completed in the past few years and less obvious candidates for turf replacement, campus land use cover has remained remarkably steady for the past three years. This will change considerably with the completion of the Resnick Sustainability Center in 2024.

### Resnick Building Design Review Complete

November 2023



Caltech completed the lengthy process of LEED Final Design review under the rigorous LEED v4 standard. If successful, this will be the first LEED Platinum certified building under the current v4 program for Caltech. Construction submittals will be completed in late 2024.



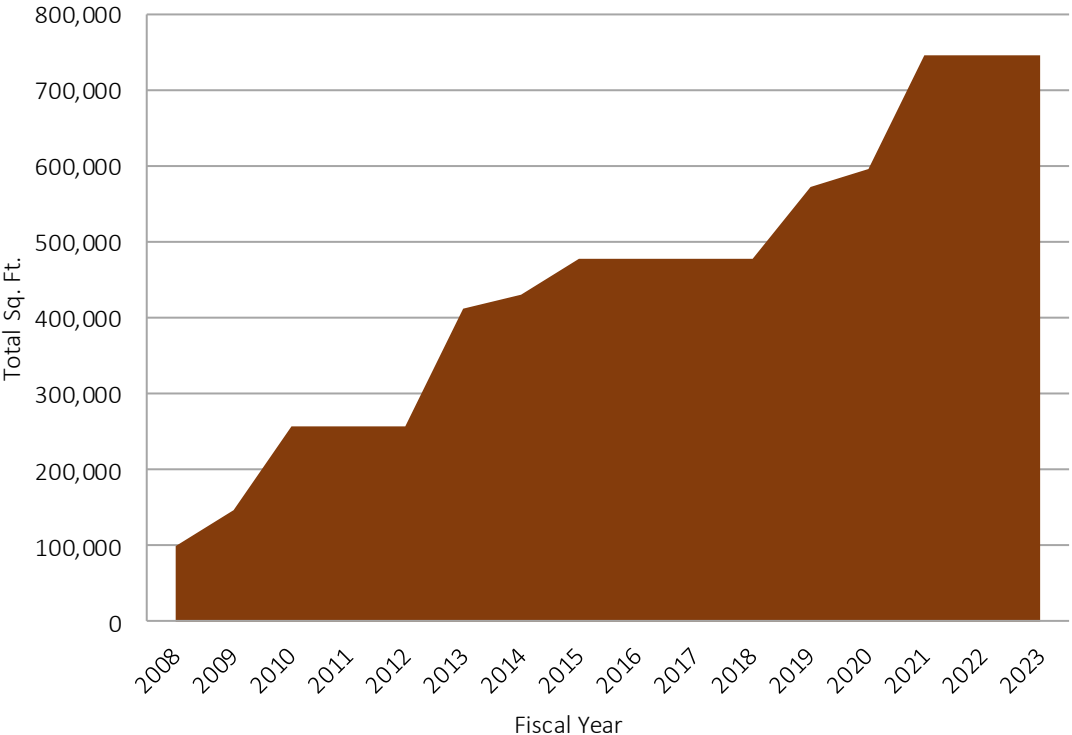
# 2023 Land Use Update

12

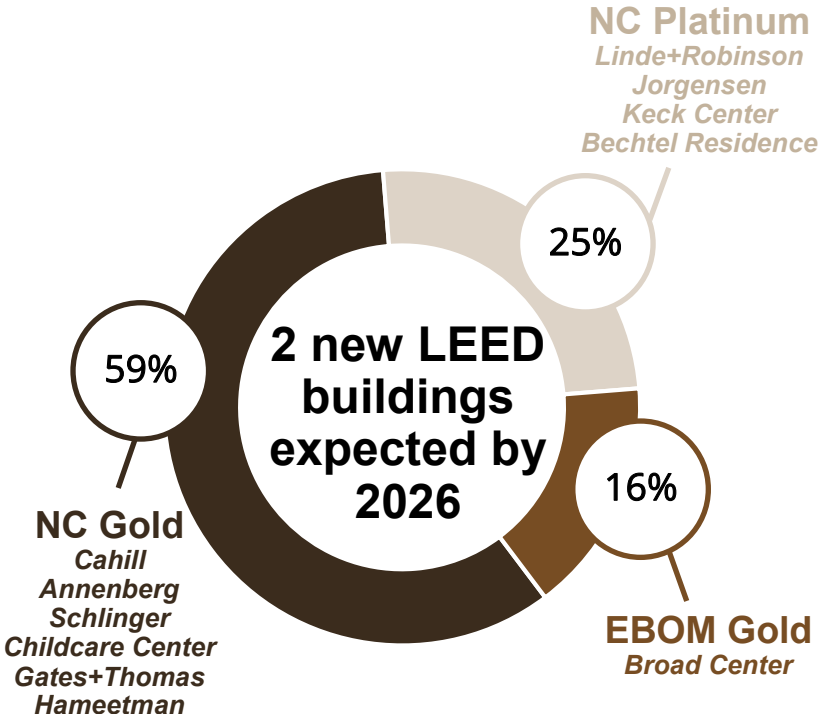
LEED certified buildings, 16% of Caltech's total campus space

Most land use statistics have remained remarkably steady for the past few years, but big changes are on the horizon with the completion of the Resnick Sustainability Center in 2024 and the expected completion of the Ginsburg Center for Quantum Precision Measurement in 2026. With those building projects in the pipeline along with others in the initial stages of design, the campus will continue to add more LEED-certified and environmentally efficient spaces whilst maintaining effective pollinator habitats, a diverse tree canopy, and climate-adapted vegetation. Recent efforts in the built environment have focused on occupant behavior and the marriage of sustainable design with sustainable operation. Caltech Green Labs continues to lead the way in establishing best practices in this space.

## Historical LEED Square Footage



## 2023 LEED Square Footage





78%

of campus turf cover is low water varietal grasses

747,000

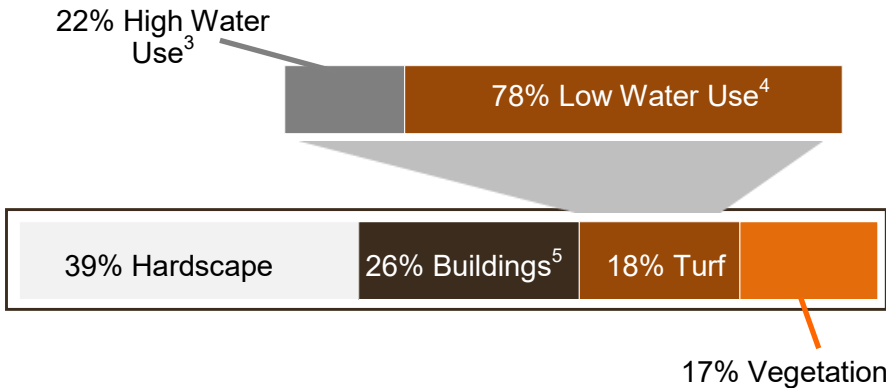
square feet of LEED space added since 2008

2

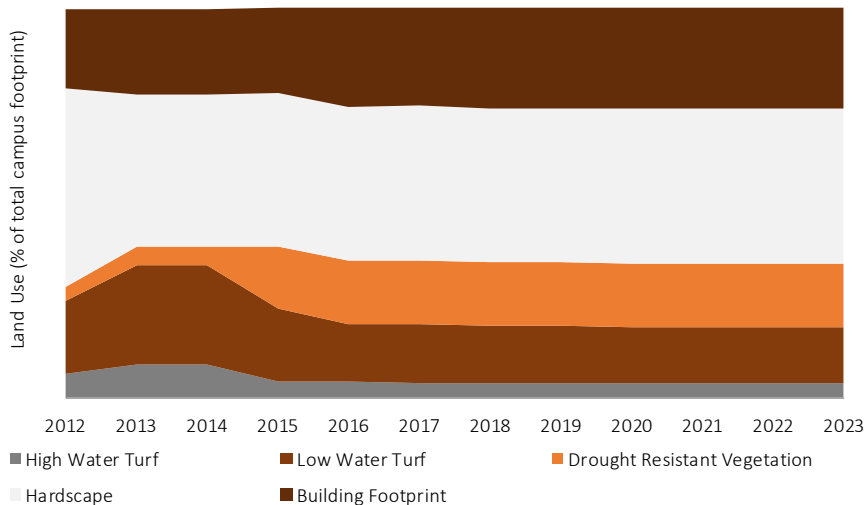
construction projects pursuing LEED certification by 2026

## Campus Land Cover Stabilizes With More Native Vegetation

### 2023 Campus Land Use Breakdown



### Historical Campus Land Use Change



## ULT Freezer “Chilling-Up” Pilots Show Success

Laboratories use 3-5x as much energy per square foot as an office building. Green Labs began encouraging best practices for both freezer and equipment energy usage in 2023. In September, 5 labs began a long-term study comparing samples kept at -70 C and -80 C. “Chilling up” freezers to -70 C has an energy savings of up to 30%. Preliminary results (as well as other Caltech case studies) suggest that -70 C is a safe temperature to store many types of samples. Green Labs developed educational tools encouraging organized and inventoried sample storage and regular defrosting of freezers. For labs that are Green Labs Certified, Green Labs has also developed energy efficiency stickers that labs can place on equipment reminding users to turn off equipment after use. Future efforts for sustainable lab use include assessing labs’ environmental footprint and finding ways to be more energy efficient.







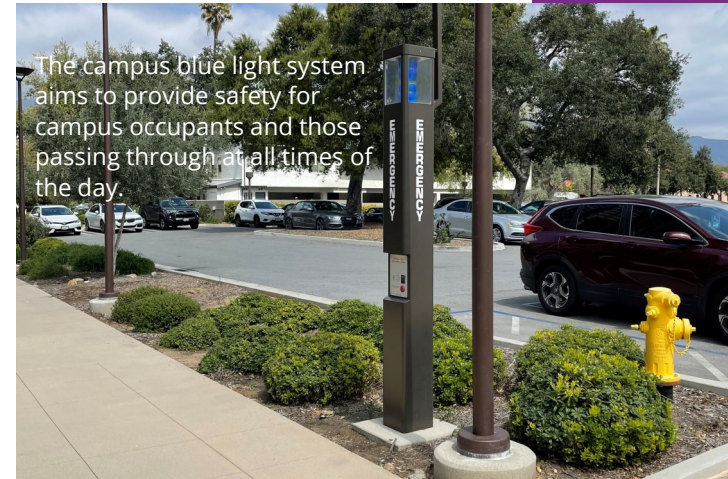
# Mobility



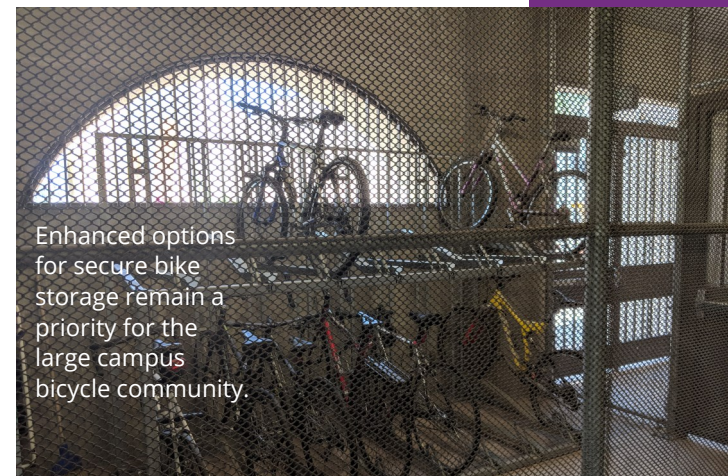
The recent completion of Moore Walk sets the stage for a formal northern entrance to the Caltech campus to be constructed in the coming years.



Caltech provides a number of valuable walking and biking corridors and not just for people.



The campus blue light system aims to provide safety for campus occupants and those passing through at all times of the day.



Enhanced options for secure bike storage remain a priority for the large campus bicycle community.



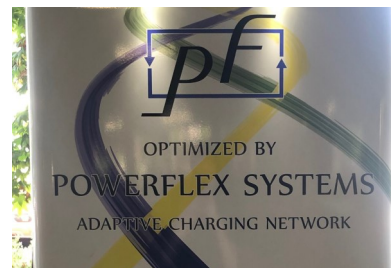


# Goals for Viability

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

## 2023 Highlights

### Caltech Examines Fleet Electrification Opportunities August 2023



As the needs arise for new vehicles within Caltech's small but important fleet, Caltech is heeding the statewide call for electric and plug-in hybrid replacements for internal combustion vehicles. Many older vehicles are eligible for replacement in the near future.

### Commuter Program Numbers Mostly Normal October 2023



In a slow rebound to COVID, it has taken three years for most transit, carpool, and other commuter programs to return to pre-pandemic levels of participation. While most of these programs are headed in the right direction, the vanpool program has seen a marked decline that will need to be addressed.

### Caltech Begins E-Bike Program December 2023



In response to student, staff, and faculty requests for easier, short-term mobility options between campus and the surrounding community, Caltech partnered with GoSGV to provide electric bikes for rental in the Sherman Fairchild Library. Early returns have shown high program utilization.

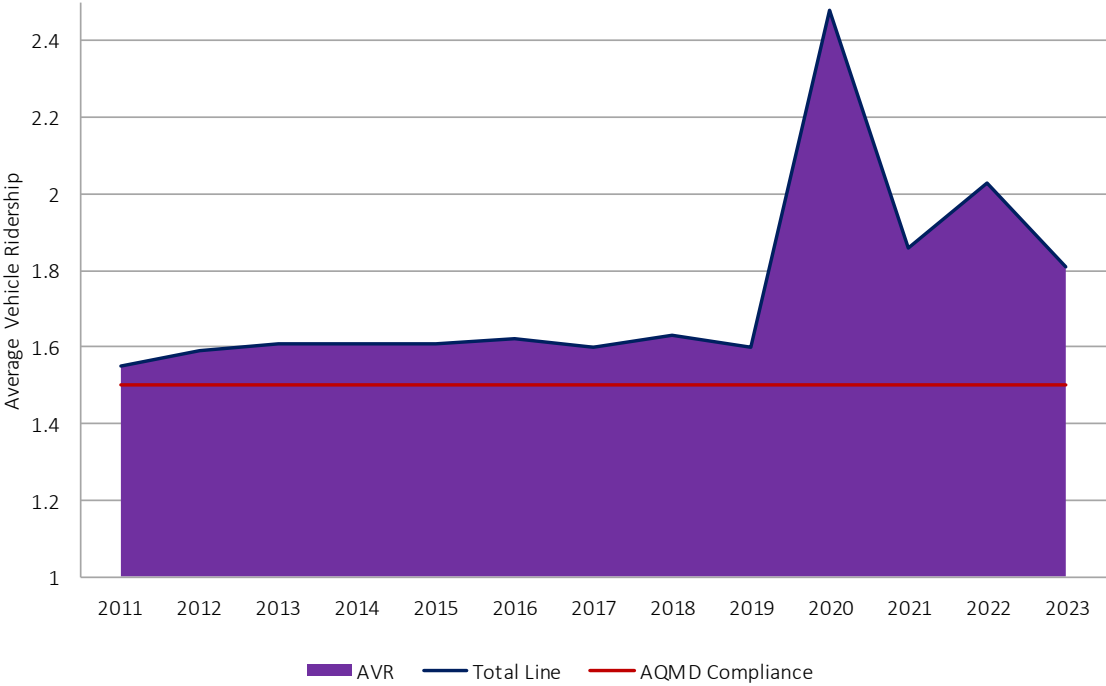
# 2023 Mobility Update

1.81

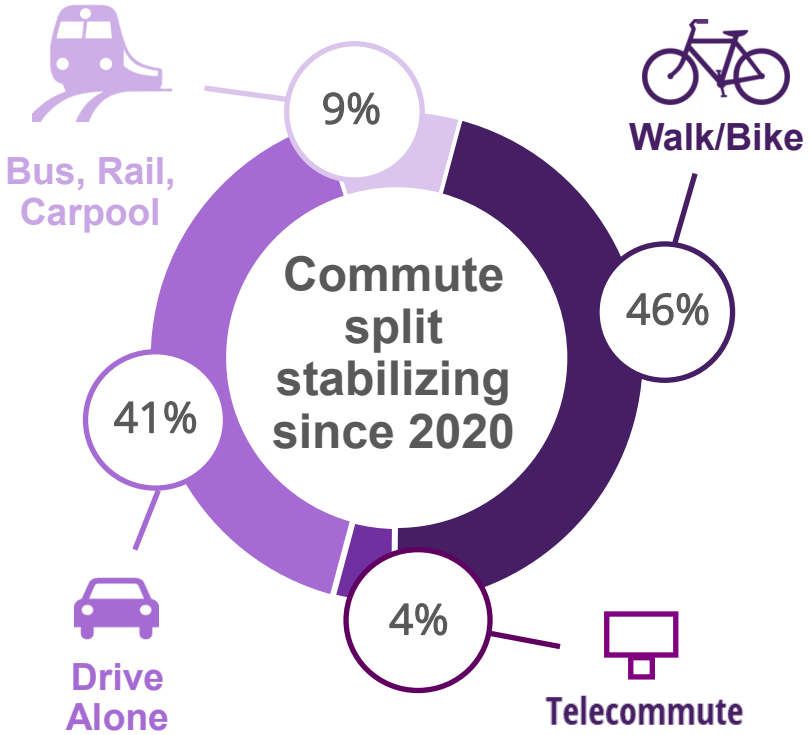
campus occupants per vehicle, up from 1.60 in 2019

Mobility trends in a post-pandemic world have taken shape over the past few years highlighted by the prevalence of telecommuting as a relatively low but steady proportion of the working population, the slow recovery of public transit and carpool programs, and the return of cities to mostly car-dominated setups. Caltech mobility trends have seemingly stabilized at a slightly higher average vehicle ridership (AVR) of around 1.81, well above the regulatory requirement of 1.5. When diving deeper into transportation metrics, commute distance has held relatively steady over the past decade which complicates efforts to further improve our AVR. Two-thirds of staff still drive alone to work, a number that has fully returned to pre-pandemic levels. Targeting this demographic for carpooling, vanpooling, transit, and flexible commuting opportunities will be key to improving performance.

## Campus Average Vehicle Ridership<sup>6</sup>



## 2023 Commuter Breakdown





7.8

miles average commute distance, down 3% since 2018

66%

staff drive alone rate, up from 41% in 2020

255

regular telecommuters in 2022, down from over 2,000 in 2020



## E-Bike Program Offers New Mobility Opportunity For Campus

Throughout 2023, Caltech Sustainability worked with the Caltech Library, GSC, and Student Affairs to put together an e-bike rental system for the campus. Beginning in early 2024, Caltech will be offering Caltech students, postdocs, faculty, and staff the ability to borrow e-bikes, helmets, and U-locks from the Sherman Fairchild Library. This program answers a common request by the Caltech community, particularly students, to provide more micromobility options originating from the campus. These bikes can travel up to 17 mph with the pedal assist, can travel 30-40 miles on one charge, and have an accompanying basket for transporting small items such as a lunch or a small amount of groceries. Every bike comes with a helmet and locks for rider and bike security, and Caltech has repair services contracted through the bike vendor, GoSGV.



## Vanpool and Carpool Trends Highlight Need For Refocus

Campus carpool numbers have been slow to recover from COVID, but total registered carpools has trended upwards steadily since 2020. Vanpool programs are in much worse shape as registered vanpools have dropped from a dozen down to two, the fewest since the program was initiated. While other commuter programs have rebounded from COVID, vanpools continue to struggle. The vanpool program was a heavy focus of the 2019 transportation demand management planning process. Due to COVID's emergence quickly after completion of this plan in March of 2020, many of these planned changes and improvements were put on hold and ultimately never implemented, due to the changing nature of commuting during the ensuing months of 2020 that persisted well into 2021 and 2022. This program will receive renewed attention from the Sustainability Council in early 2024, as the vanpool program typically serves commuters from distant origins with little public transit options. This forces a choice between high gas costs and mileage from driving alone to work or a much more convenient shared resource in the vanpool vehicle. Making vanpools the easy choice will positively benefit the campus community and increase employee retention.

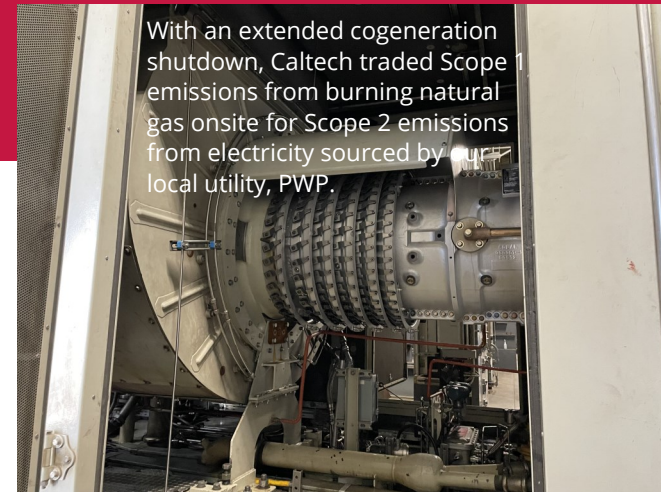






# Emissions Effluents & Waste

Refrigeration is a relatively unexplored area of Scope 3 emissions for Caltech. By pound, refrigerants are a tiny fraction of methane and carbon dioxide emissions, but their high global warming potential necessitates tracking them.



With an extended cogeneration shutdown, Caltech traded Scope 1 emissions from burning natural gas onsite for Scope 2 emissions from electricity sourced by local utility, PWP.



Purchased goods comprise the majority of Caltech's waste stream and Scope 3 emissions.



Landfill avoidance and smart purchasing decisions will contribute greatly to reducing Scope 3 emissions.



# Goals for Viability

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



## 2023 Highlights

### Extended Cogen Shutdown Alters Emissions Portfolio

February 2023



With a relatively consistent electric demand of 110-120 GWh annually, Caltech unintentionally changed its source of power from primarily on-campus power to mostly utility-sourced electricity. This dramatic shift in our energy resource portfolio led to a decrease in Scope 1 emissions and a drastic increase in Scope 2 emissions.

### Ivy+ Report Highlights Scope 3 Emissions Possibilities

November 2023



While much of Caltech's focus is traditionally put on direct emissions from energy generation onsite and recently from electricity-based Scope 2 emissions, many of Caltech's peers in the Ivy+ Sustainability Collaborative are diving into Scope 3 emissions from purchased goods, commuting, investments, food, and more.

### Emissions Rise In 2023 With Grid Purchases

December 2023



With a significant portion of PWP's energy mix still coming from the Intermountain Power Project's coal-fired generation facility in Utah, Caltech emissions rose significantly in 2023. However, with PWP's stated IRP goal of 2030 for 100% renewable energy, this portfolio will change rapidly in the next few years, and Caltech is looking to partner with PWP.

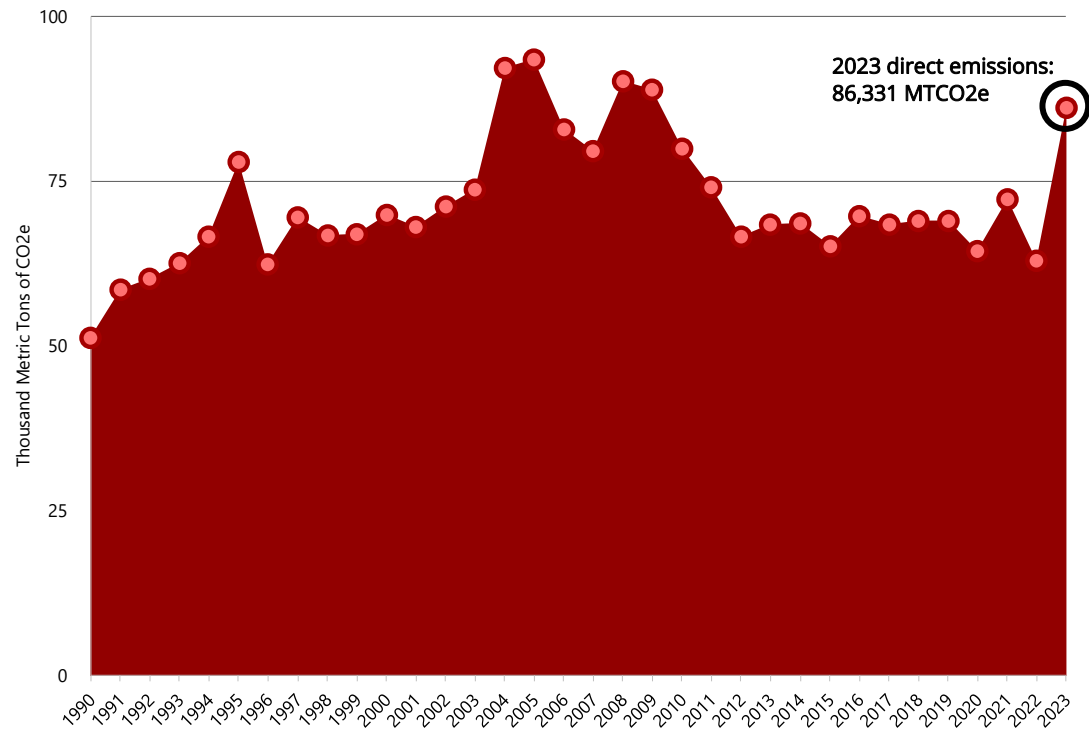
# 2023 Emissions, Effluents & Waste Update

↑ 37%

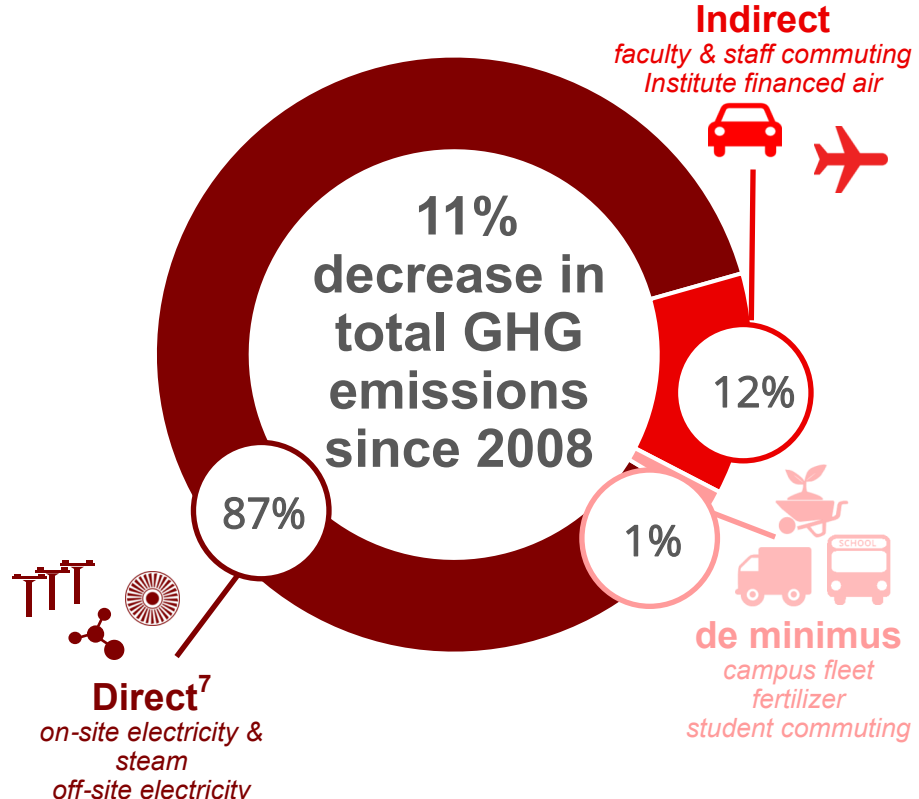
direct greenhouse gas emissions since 2022

Emissions rose in 2023, as Caltech sourced a significant portion of our electricity from the local grid, similar to a dynamic seen in the early 2000s. This shift from primarily Scope 1 based emissions was the result of an extended cogeneration shutdown brought on by ever stricter emissions standards for fossil fuel combustion in the Los Angeles area. As Caltech prepares to shift away from cogeneration as the primary source of electricity generation, plans are underway for a partnership with our local utility, PWP. Further investigation of the technical details of a conversion from steam to hot water are planned for 2024, as the campus looks to solve the majority of our Scope 1 and 2 emissions challenges. Future potential exists to pursue Scope 3 reductions as part of the work coming from the Sustainability Advisory Council, and the Ivy+ Sustainability Collaborative has provided Caltech a path to get started.

## Historical Greenhouse Gas Emissions



## 2023 Emissions Profile





**↑ 39%** total<sup>8</sup> greenhouse gas emissions since 2022 and a 17% increase since 2018

**16.3**

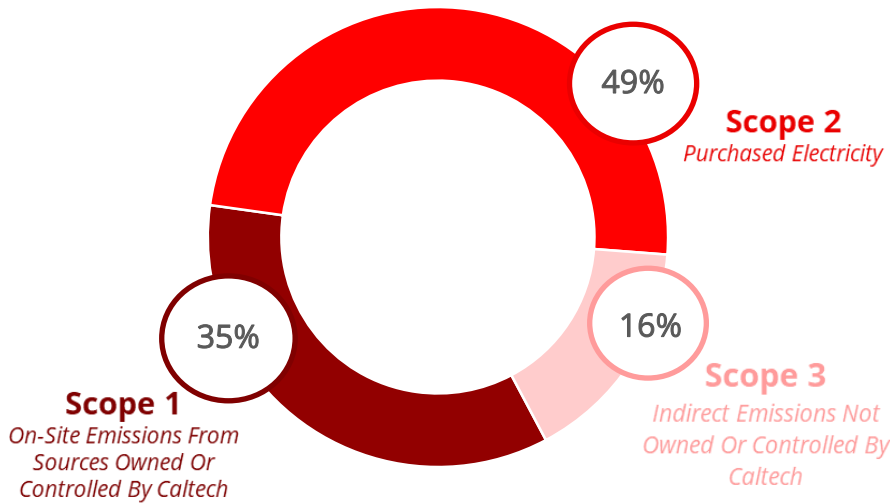
MTCO<sub>2</sub>e per person, a 34% increase from 2022

**1.2**

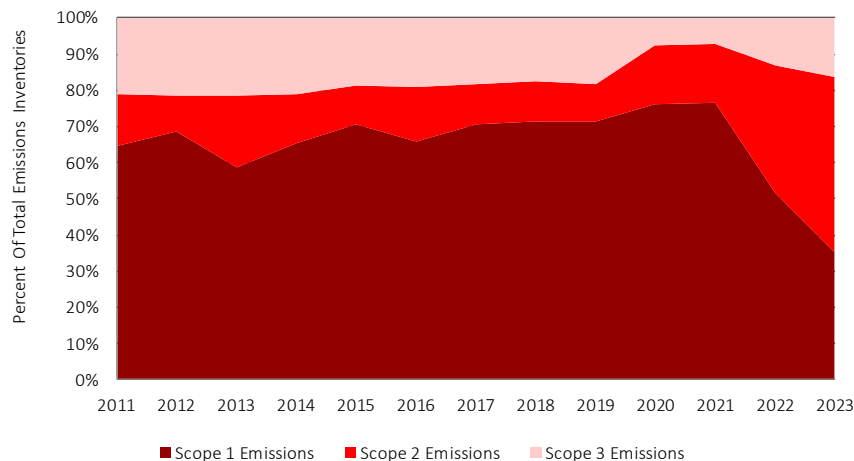
pounds of CO<sub>2</sub>e per research dollar, up 15% since 2018

## Cogen Shutdown Trades Scope 1 For Scope 2 Emissions

### 2023 Emission Profile By Scope



### Emissions by Scope Over Time



## Ivy+ Emissions Report Highlights Scope 3 Achievements From Peers

While Caltech's decarbonization plan has positioned the campus well to eliminate most Scope 1 and 2 emissions upon full implementation of the renewables agreement with PWP and conversion to hot water heating, Scope 3 emissions remain very much an unknown. Caltech's current Scope 3 tracking only includes commuting, Institute-financed air travel, and some de minimus categories. Many industry reports for large organizations with high spend, such as Caltech, indicate that Scope 3 emissions can dwarf Scope 1 and 2, particularly from

purchased goods and services. To begin to answer these questions, the Ivy+ Sustainability Collaborative chose to focus their annual report on various Scope 3 Emissions categories such as

supplier emissions, faculty and staff commuting, embodied carbon, endowments, food purchasing, and materiality assessments. While Caltech is a member of the Collaborative, other members including Harvard, Yale, and MIT submitted case studies for this year's annual report. Caltech is currently in the very beginning stages of understanding its Scope 3 footprint; the Sustainability Advisory Council will initially address this topic in early 2024. Key areas of emphasis will include working with catalog vendors and large spend suppliers with considerable resources to help inform Caltech's emissions inventory.



# Key Institutional Data

Metric	Unit of Measure	2023	2022	% 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 <sup>9</sup>	Number (#)	6,040	5,828	+3.6%
Faculty & Post Doctoral Scholars	Number (#)	1,208	1,233	-2.0%
Staff	Number (#)	2,369	2,194	+8.0%
Students	Number (#)	2,463	2,401	+2.6%

## 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:

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## Prepared by



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## Photos and Images

- Caltech Bikeshare
- Caltech Dining Services
- Caltech Office of Strategic Communications
- Caltech Sustainability
- Christine Cho, Independent Photographer
- GoSGV
- Hensel Phelps
- LA Metro
- 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.



