

# Caltech 2021 Sustainability Report



April 2022





2021 was another year of drastic interruptions caused by the ongoing COVID-19 pandemic. The promise of vaccines becoming widely available in the spring was followed immediately by the rapid spread of both the delta and then the omicron variant in the summer and fall, respectively. Caltech staff, faculty, and students persevered through a long period of restrictions by continuing to do the amazing work that makes Caltech a world leader in science and discovery.

The return of many community members to campus brought a rebound in energy consumption, water usage, and waste generation. Emissions rose, and cars returned to parking lots in significant numbers. While many aspects of life on campus return to a more normal state of operation, some things are forever changed. Remote and flexible work were shown to be viable options for certain job roles with the telecommuting technology now available, and Caltech can draw on lessons learned from air flow testing, 2020 baseline campus metabolism data, and many other key pieces of information that were unobtainable during standard campus operation. Future disruptions from climate change, utility service interruptions, earthquakes, or even other pandemics down the road are possible, and by addressing resiliency now, we can be better prepared for these challenges when they come.

John Onderdonk

Senior Director for Facilities Services and Planning  
Chief Sustainability Officer

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# 2021 At A Glance — Key Performance Indicators

<p><b>Energy</b></p> <p>Caltech exported more electricity than it imported for the fourth time in the past five years. New challenges have arisen in decarbonizing electricity and thermal systems.</p>	<p><b>↓ 5%</b></p> <p>total electricity consumption since 2016 peak but 5% higher than 2020</p>	<p><b>100%</b></p> <p>net electricity produced on-site with some export to the grid</p>	<p><b>↓ 3%</b></p> <p>energy intensity by area since 2020 and the lowest since 2015</p>	<p><b>\$14.3M</b></p> <p>in annual energy costs, a 13% increase from 2020</p>	<p><b>\$19M</b></p> <p>in cumulative energy cost reductions since 2011 despite a 17% space increase</p>	
<p><b>Water</b></p> <p>Measures to control consumption in irrigation and the utility plants were overwhelmed by domestic consumption increases in 2021 which will require further exploration.</p>	<p><b>↑ 17%</b></p> <p>water consumption since 2019 and the highest seen since 2010</p>	<p><b>↑ 55%</b></p> <p>building water use from 2020 and a 20% increase since 2019</p>	<p><b>↑ 10%</b></p> <p>water use per square foot since 2020, up 9% since 2016</p>	<p><b>\$1.3M</b></p> <p>in annual water costs, down 6% from 2016 but up 9% from 2020</p>	<p><b>↓ 26%</b></p> <p>in campus costs per gallon since 2016 and the lowest since 2011</p>	
<p><b>Materials</b></p> <p>As Caltech transitioned to a new waste vendor, differences in methodologies led to very different results on diversion. These results are likely closer to Caltech's true diversion rate.</p>	<p><b>13%</b></p> <p>campus non-hazardous waste diversion rate, down from 28% in 2014</p>	<p><b>↓ 27%</b></p> <p>municipal solid waste per capita, down to .27 tons from .38 in 2016</p>	<p><b>↓ 12%</b></p> <p>in campus hazardous waste costs since 2018</p>	<p><b>\$762K</b></p> <p>in total campus waste costs, down 3% from 2020</p>	<p><b>-\$2K</b></p> <p>in net recycling revenue in 2021, down from \$70K in 2011</p>	
<p><b>Land Use</b></p> <p>Diligent work to make the campus more sustainable continues with green building efforts and by returning the campus land cover to a more native landscape.</p>	<p><b>1</b></p> <p>building pursuing LEED certification in 2024</p>	<p><b>747K</b></p> <p>square feet of LEED building space, totaling 16% of entire campus</p>	<p><b>17%</b></p> <p>of campus covered with low-water vegetation, up from 4% in 2012</p>	<p><b>19K</b></p> <p>square feet of turf removed from campus in 2021</p>	<p><b>12</b></p> <p>campus buildings now LEED certified, up from 4 buildings in 2011</p>	
<p><b>Mobility</b></p> <p>2021 commuter data showed a marked rebound in campus drive alone rates and associated emissions while telecommuting dropped by 75% from 2020.</p>	<p><b>1.86</b></p> <p>campus occupants per vehicle, up from 1.60 in 2019</p>	<p><b>40%</b></p> <p>campus drive alone rate, equivalent to commute trends from 2008</p>	<p><b>470</b></p> <p>telecommuters in 2021, down from 2,027 in 2020</p>	<p><b>65%</b></p> <p>staff drive alone rate, down from 72% in 2019</p>	<p><b>101/4</b></p> <p>carpools and vanpools at the end of 2021, respectively</p>	
<p><b>Emissions</b></p> <p>Predictably, Caltech emissions rose from 2020 levels with a return of many campus activities in 2021. Caltech is now exploring future paths to prioritize decarbonization.</p>	<p><b>↑ 12%</b></p> <p>regulated greenhouse gas emissions since 2016</p>	<p><b>↓ 9%</b></p> <p>total greenhouse gas emissions since 2016 but a 12% increase since 2020</p>	<p><b>↓ 10%</b></p> <p>emissions intensity per capita since 2016</p>	<p><b>.88</b></p> <p>pounds of CO2e per research dollar, down 26% since 2016</p>	<p><b>↓ 65%</b></p> <p>Scope 3 emissions since 2019 due to reduced commuting and funded travel</p>	





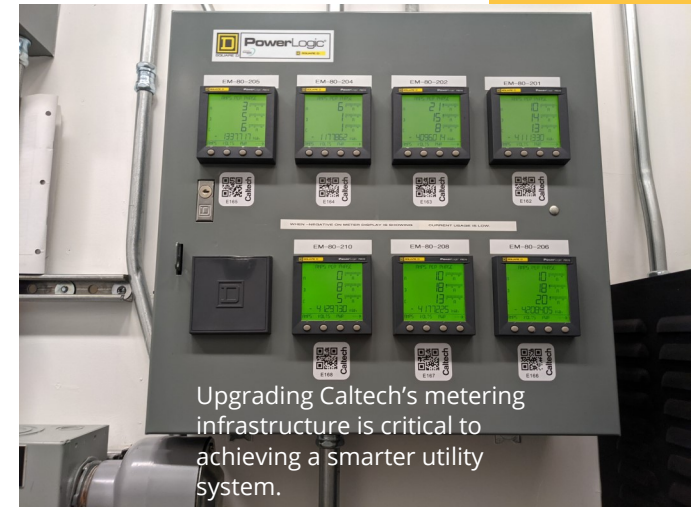
# Energy



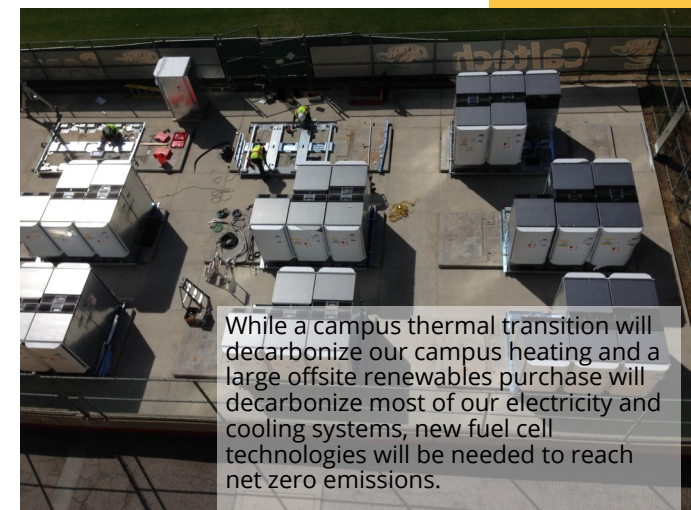
Caltech's aging electricity infrastructure has received some much needed renovation in recent years. Major feeder lines supply the campus to keep critical equipment online 24 hours a day.



Proper ventilation was a consistent theme throughout the COVID-19 pandemic.



Upgrading Caltech's metering infrastructure is critical to achieving a smarter utility system.



While a campus thermal transition will decarbonize our campus heating and a large offsite renewables purchase will decarbonize most of our electricity and cooling systems, new fuel cell technologies will be needed to reach net zero emissions.





# 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.



## 2021 Highlights

### Solar 3 Project Comes Fully Online

January 2021



With an additional 700 MW of installed capacity fully up and running, Caltech now has slightly more than 2 MW of solar. With the newest installation, Caltech is still only meeting 2% of annual electricity demand with on-campus solar. We now look towards offsite resources to decarbonize the campus.

### Caltech Completes Hot Water Building Surveys

March 2021



As part of our ongoing energy planning efforts, Affiliated Engineers continued work on our campus thermal study that had been temporarily halted by the onset of the COVID pandemic. Each building on campus was assessed for potential issues with a steam to hot water conversion.

### Electricity Consumption Inches Up As Energy Mix Diversifies

September 2021



Total campus electricity consumption increased by 5% from 2020 to 2021, including the addition of a new building to the campus. The addition of the Chen fuel cell helped to bolster non-CHP electricity generation.



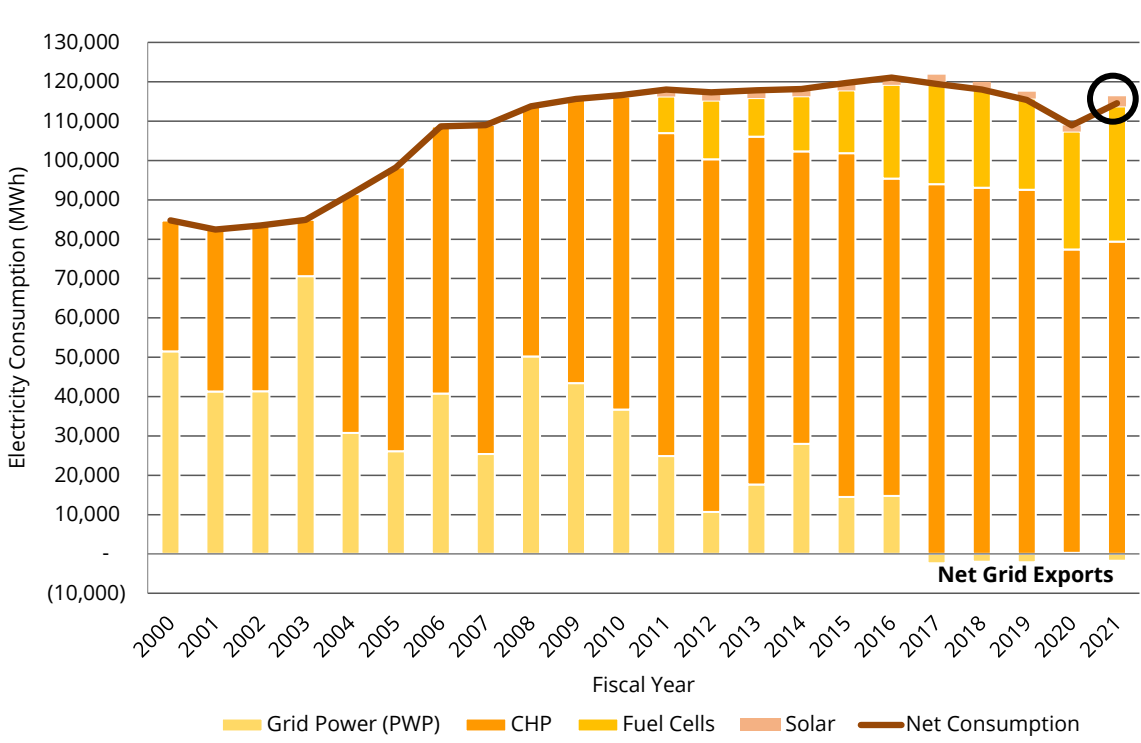
# 2021 Energy Update

**↓ 5%**

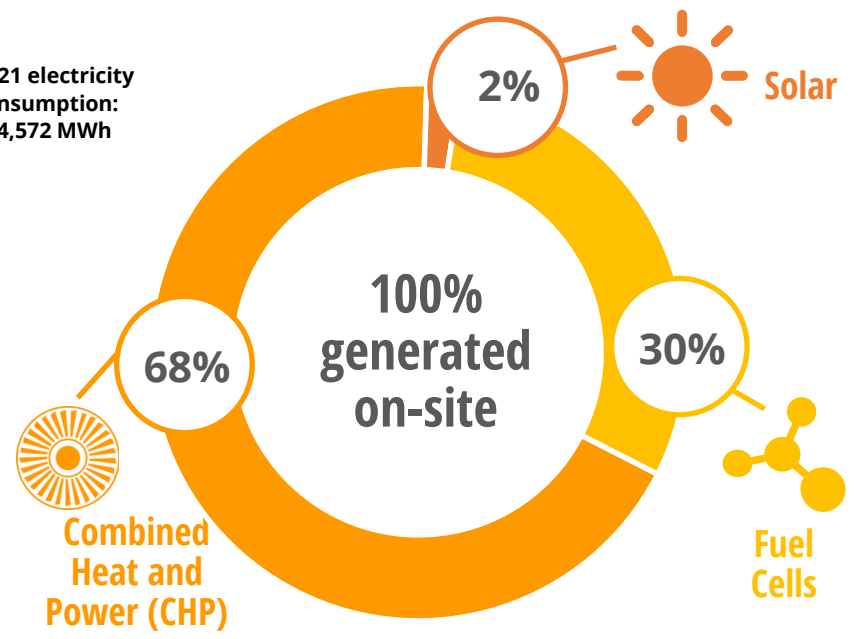
total electricity consumption from 2016 but a 5% increase from 2020

Caltech continued to power the entire campus throughout the COVID-19 pandemic as many left campus, worked from home, and then returned to onsite work and study throughout the course of FY21. Total electricity consumption rose 5% from a decade low in FY20 due to a return to campus and the addition of the new Chen Neuroscience Research Building. The Chen building's accompanying fuel cell system brought some added diversity to the campus electricity portfolio that has been dominated by the cogeneration system for the past decade. Efforts to envision the possibilities of modernizing and decarbonizing the campus will soon turn from study to action and will bring about significant change to the Caltech utility system while still supporting all research and academic needs.

## Historical Campus Electricity Consumption



## 2021 Electricity Portfolio





**100%** electricity produced on-site<sup>1</sup> with net export over course of year



**3%** energy intensity by area<sup>2</sup> since 2020 and the lowest since 2015

**\$14.3M**

in annual energy costs, a 13% increase from 2020



## Caltech Modernizes Electric Grid To Pave Way For Future State

In 2021, Caltech replaced four 60+ year old distribution substation transformers that provide electric service to 50 campus buildings. This upgrade was a part of a modernization effort for the campus's electric distribution network to increase reliability and resiliency which will furthermore prepare Caltech for a future of ever-growing electricity demands. This project is part of a multi-phased plan to upgrade Caltech's aging substations which will continue to improve its campus electric grid. The next phase is to upgrade two substations' 60+ year old distribution switchgears. These projects will serve Caltech for the foreseeable future.



## Building Modernization Continues With Beckman Institute Upgrades

As part of the Caltech Energy Conservation Investment Program (CECIP), the Beckman Institute building underwent a retrofit of its HVAC air distribution system to a more efficient and automated standard. Office zones were converted from pneumatic controls to Direct Digital Controls (DDC). In addition to improving building automation control, this project realizes further savings from a previously implemented CECIP project that converted the building to a variable air volume system. This project overall will yield savings of over 200,000 kWh of electricity, 7,500 MMBTU of chilled water, and 12,000 MMBTU of heating hot water annually.



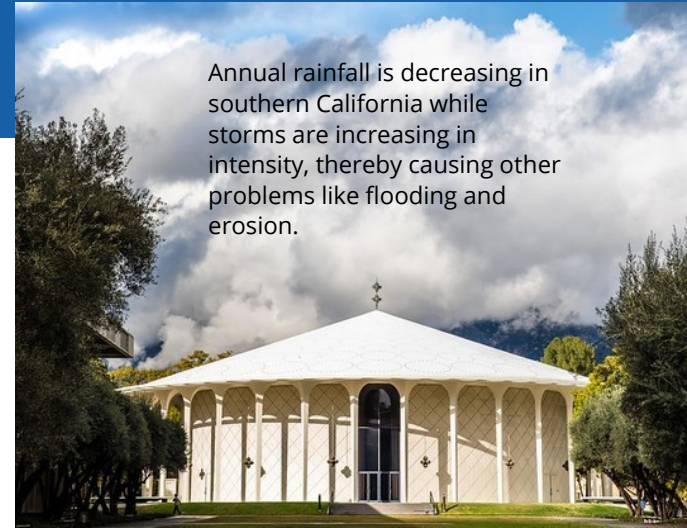




# Water



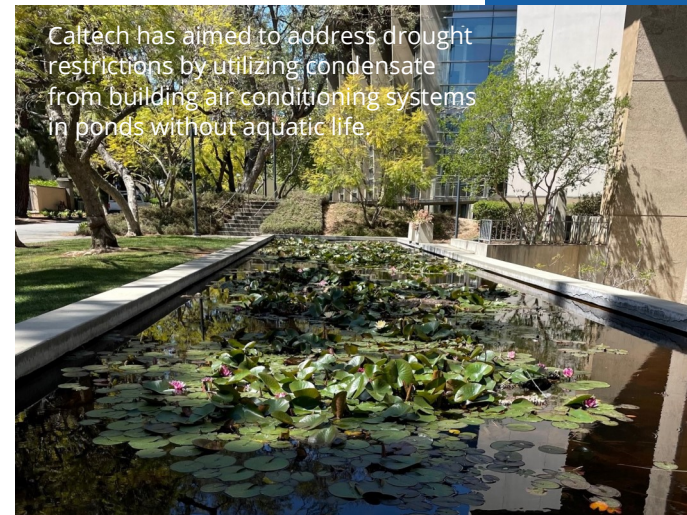
Caltech continues to replace large sections of turf both in the campus interior and along the periphery, including this section near Cahill and Keith Spalding.



Annual rainfall is decreasing in southern California while storms are increasing in intensity, thereby causing other problems like flooding and erosion.



Even areas with high rainfall and milder temperatures have been increasingly threatened by fires fueled by climate change. Sequoias like these in the Sierra Nevada were victims of a large fire complex this past summer.



Caltech has aimed to address drought restrictions by utilizing condensate from building air conditioning systems in ponds without aquatic life.





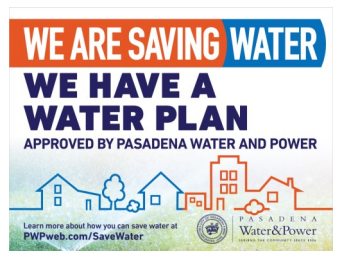
# Goals for Viability

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

## 2021 Highlights

### Level 2 Drought Restrictions Implemented Across California

August 2021



California Governor Gavin Newsom declared a drought emergency and requested a 15 percent reduction in water consumption. In response, Pasadena increased the Water Supply Shortage from Level 1 to Level 2 restrictions leading to changing irrigation practices on campus.

### Domestic Water Use Jumps Up With Return To Campus

September 2021



Domestic water use rose by 55% in 2021 compared to 2020 as Caltech students, faculty, and staff returned to laboratories and offices. However, this increase in campus activity cannot fully explain the rise in water consumption, as 2021 consumption was 20% above 2019 levels.

### Caltech Continues Push For Native Landscaping

October 2021



In 2021, as part of the campus water conservation program, the Grounds department replaced the grass in the frontage of Cahill and Keith Spalding and the east campus entrance on Hill Ave and San Pasqual Ave with native vegetation. This decreased water use by 380,750 gallons of water per year.

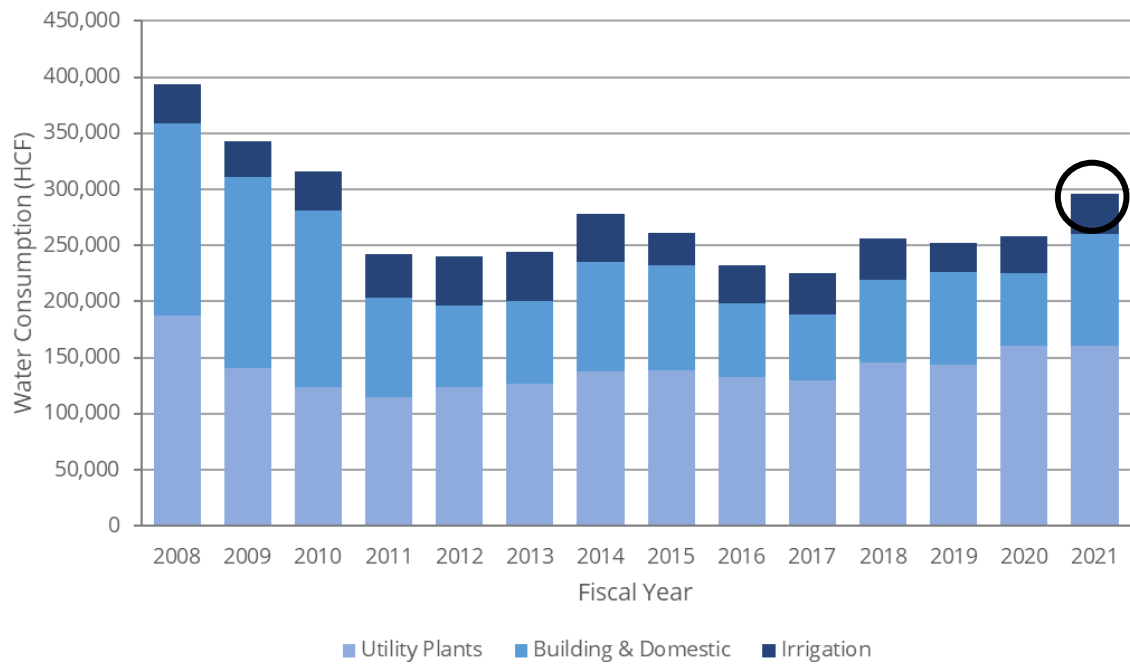


# 2021 Water Update

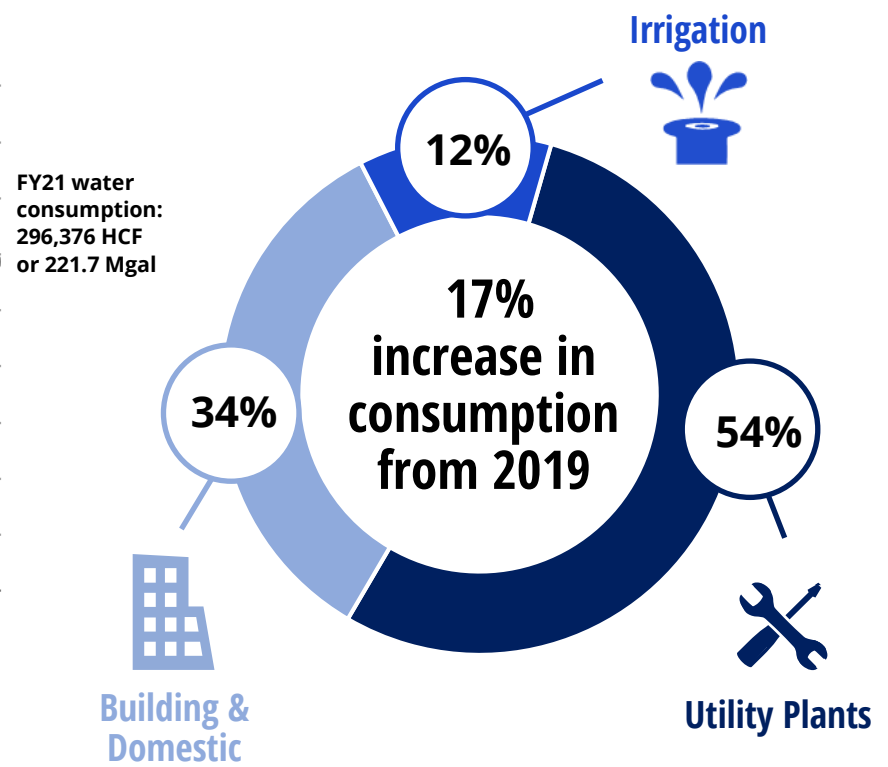
**↑17%** water consumption since 2019 and the highest seen since 2010

Water costs rose slightly, but much higher per unit costs are projected to come into effect in the next few years. With an ever growing campus, Caltech needs to continue conserving water and exploring reuse wherever possible for both cost and reliability concerns in the face of a warming climate. With irrigation and the plants centrally controlled, Caltech has made a number of recent upgrades such as new cooling towers and more land cover changes including an ongoing effort to replace high water use turf with native vegetation that's better suited for a dry climate. As normalcy returns to the campus, the behavioral aspect of building level consumption will be a primary challenge as Caltech aims to meet Level 2 drought restrictions taking place across the state.

## Historical Campus Water Consumption



## 2021 Water Use Profile







**↑ 10%** water use per square foot since 2020, up 9% since 2016

**54/34/12**  
2021 use percentages for utility plants, building & domestic, and irrigation

**\$1.3M** in annual water costs, up 9% from 2020

## Level 2 Drought Restrictions Take Effect Statewide

The City of Pasadena, in response to requirements set forth by the Governor of California, raised local drought restrictions from Level 1 to Level 2 as we entered the fall of 2021. Due to previous drought readiness actions, Caltech has so far only seen a marginal impact on campus operations including changes to irrigation frequency and reuse of building condensate in ponds without aquatic life. Efficiency measures in the campus plants have allowed Caltech to control the majority end use of incoming water. While Level 2 restrictions have occurred before from 2015-2018, state and local entities are already warning that further conservation measures will be necessary should the drought worsen towards Level 3 restrictions. Caltech and the rest of the state will likely confront unprecedented water challenges in the coming decades due to climate change.



## Building Water Consumption Rises As Labs Reoccupied

Recent gains in irrigation from drought resistant vegetation have been outpaced by a 55% increase in domestic water usage from laboratories, dormitories, kitchens, and offices. Some of this rebound can be explained by a return to the laboratories due to the loosening of COVID restrictions, but 2021 building consumption was the highest since 2010. Continued conservation in this area will be critical as Caltech works to respond to recently implemented drought measures. Building consumption is far less centrally controlled, and occupant engagement is one of the most effective ways to address this important issue. Programs such as the Green Lab Certification offer a path towards initiating behavioral changes that conserve water.







# Materials



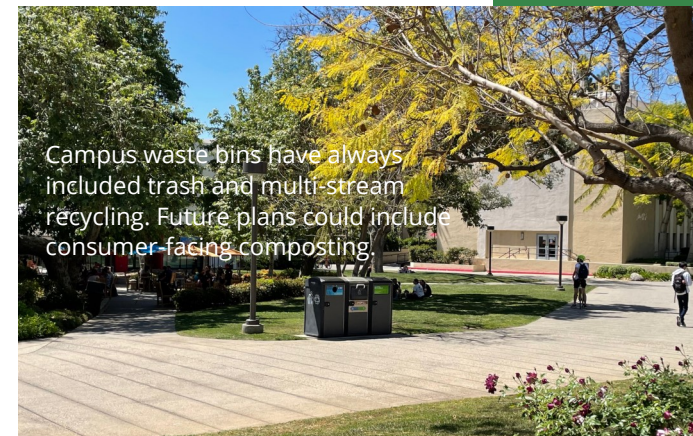
Green waste is now combined with food waste as a general compost due to new regulations. Every corner of campus generates varying amounts of both types of waste, and Caltech hopes to identify more in the coming year.

Caltech completed our first full year with Republic Services providing waste hauling services. It was an immensely challenging year with COVID waves causing unavoidable service disruptions.



REPUB  
SERVIC

888-742-5  
RepublicService



Campus waste bins have always included trash and multi-stream recycling. Future plans could include consumer-facing composting.



As the Resnick Sustainability Center rises from the ground, Caltech is working with contractors to maximize diversion of construction materials.



# Goals for Viability

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



## 2021 Highlights

### Local Composting Solutions Come To Pasadena

March 2021



Some of Caltech's neighbors including the Rose Bowl and Polytechnic School have piloted hyperlocal composting solutions that have allowed them to retain and treat food and yard waste onsite. The end product is usable compost with none of the associated waste emissions. Such a type of solution would be an ideal goal for Caltech.

### First Certified Green Labs Receive Awards

June 2021



Three Caltech labs have now achieved recognition through the Caltech Green Lab Certification. These high-achieving groups have instituted numerous energy, water, and waste saving practices throughout their physical spaces.

### Campus Groups Get Creative With Waste Reduction

July 2021



The Caltech Library staff found ways to be creative with leftover 3D printing filament by creating masks extenders for staff and students. With the pandemic causing so much more waste to be produced, this type of innovative solution is an excellent example of how we can continue to be waste-conscious.

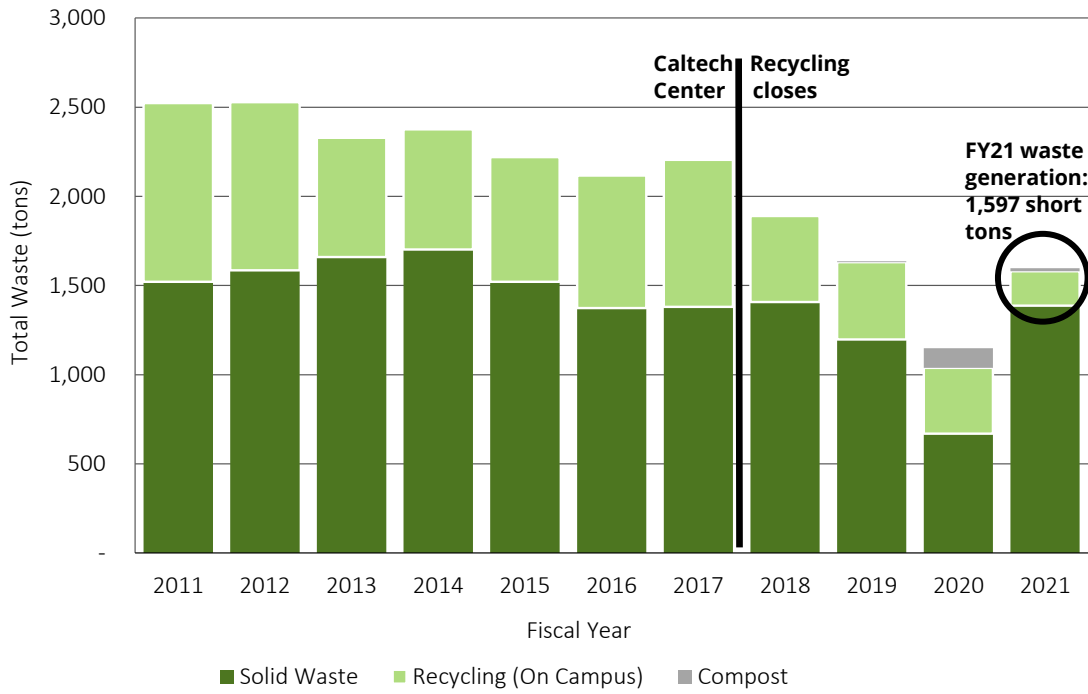


# 2021 Materials Update

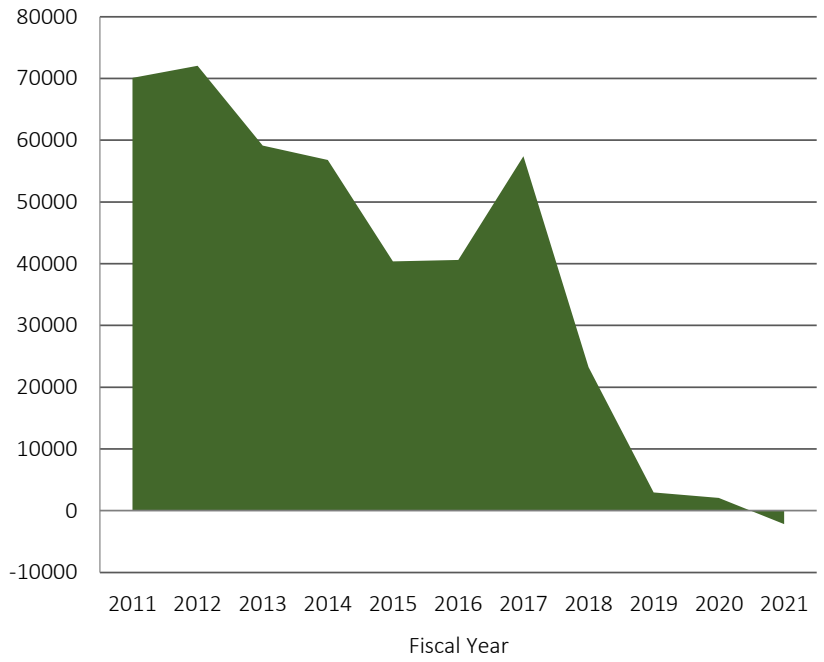
**13%** campus non-hazardous waste diversion rate, down from 28% in 2014

Due to a vendor change and more accurate diversion numbers, Caltech got a clearer picture of actual diversion rates in 2021. These results demonstrate that much work remains before Caltech in the field of waste management. About one-third of recyclable material is rejected due to contamination, and one-third of trash picked up from the campus is actually recyclable. This illustrates that Caltech has significant opportunities for improvement through education. The Caltech Green Labs Network will be a key tool to facilitate this change along with more campus communications on how to effectively reduce waste generation, maximize reuse, and ensure proper recycling procedures are followed. Changes in the market have made recycling less profitable and landfilling material more expensive. Waste will continue to be a complex challenge.

## Historical Campus Waste & Recycling Generation



## Recycling Revenue By Year



**540**

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



**12%**

in campus  
hazardous waste  
costs since 2018

**\$762K**

in total campus  
waste costs,  
down 3% from  
2020



## Caltech Diversion Demonstrates Need For Campus Emphasis

Caltech's previous waste vendors provided generalized plant averages for waste diversion. Caltech's current vendor, Republic, uses a different and more accurate methodology that has given Caltech a clearer picture of the challenges that lie ahead for waste diversion. Our campus diversion number includes recyclables sent to Republic, material that can be recycled that's recovered from campus trash, and compostable food waste. Diversion is a significant challenge for Caltech, and we lag our peers in this area. Occupant engagement in laboratories, in cafeterias, and in campus living spaces will be at the forefront of any future improvement strategies. Any positive movement in this direction will save Caltech money, as recycling remains more cost effective than trash.



## Green Labs Lead The Way On Reducing Research Impact

During the summer of 2021, a few Caltech labs took the plunge on certifying their labs. According to the Prober lab, "many of our lab members are concerned about our future. We see the environmental impact of our society, and feel it particularly keenly as biologists. Our lab feels that we have a social responsibility to care about our impact on the planet...By making sustainable choices, we not only save money and resources for our lab, we also minimize our environmental impact and advance scientific progress, all while protecting the very thing we study: life on Earth. The members of the Prober lab are extraordinarily proud to participate in and promote the Green Lab Initiatives at Caltech and other research institutions, and in our community, and look forward to a sustainable future."







# Land Use



In order to accommodate social distancing requirements and provide safer meeting, working, and eating spaces, Caltech set up a number of tents for general community use.



Caltech's campus features a wide range of hardscape, building footprint, maintained turf, beautiful trees, and native landscaping.



Caltech Facilities provides more than just energy, water, and waste collection to the campus.



Caltech now has 12 LEED certified buildings, four of which have achieved Platinum certification while the remaining eight are LEED Gold.



# Goals for Viability

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

## 2021 Highlights

### Chen Neuroscience Building Occupied

November 2020



After construction was completed and even with many community members still not returned to the campus, the Chen Neuroscience Research Building saw its first activity late in 2020 with the building becoming a lively hub for research of the brain and spinal cord by the end of 2021.

### COVID Air Balance Testing Completed

June 2021



Caltech Sustainability was heavily involved in a campuswide effort to test indoor spaces for air flow in order to mitigate risk from COVID aerosol spread. Over 500 spaces were analyzed, and the results can provide useful information beyond prevention of viral spread.

### Caltech Completes More Turf Replacements

October 2021



17% of Caltech's land is now covered with native vegetation which is a tremendous improvement over just 4% a decade ago. This ongoing effort by Caltech Buildings and Grounds helps balance the historic character of the campus with the demands of an arid landscape.



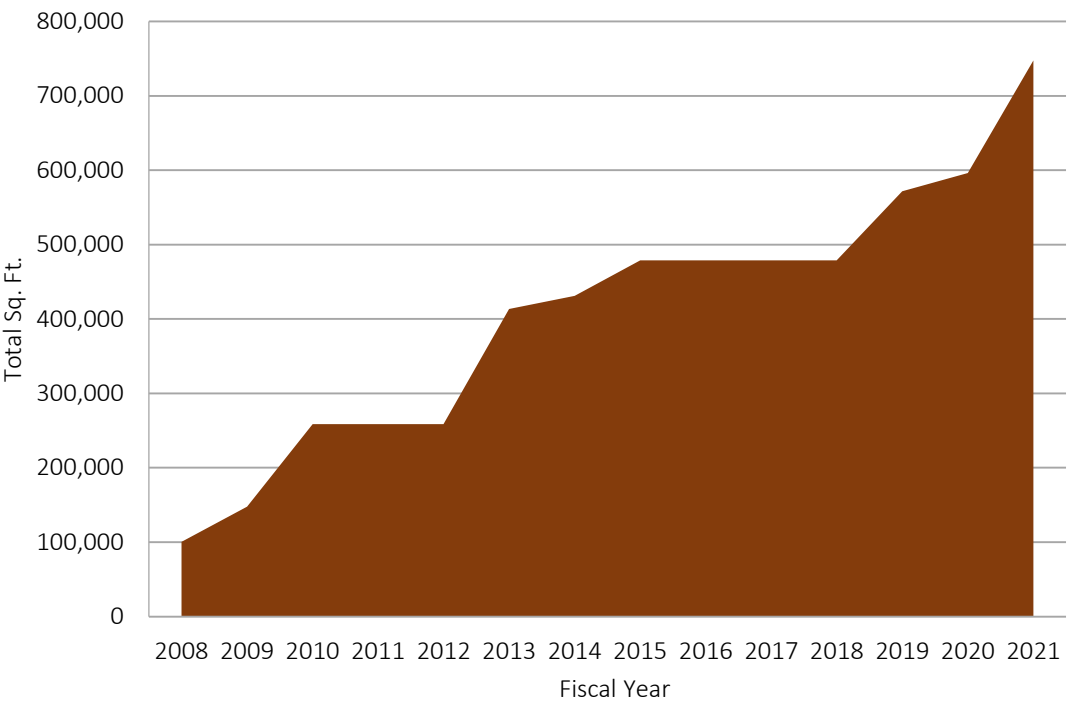


# 2021 Land Use Update

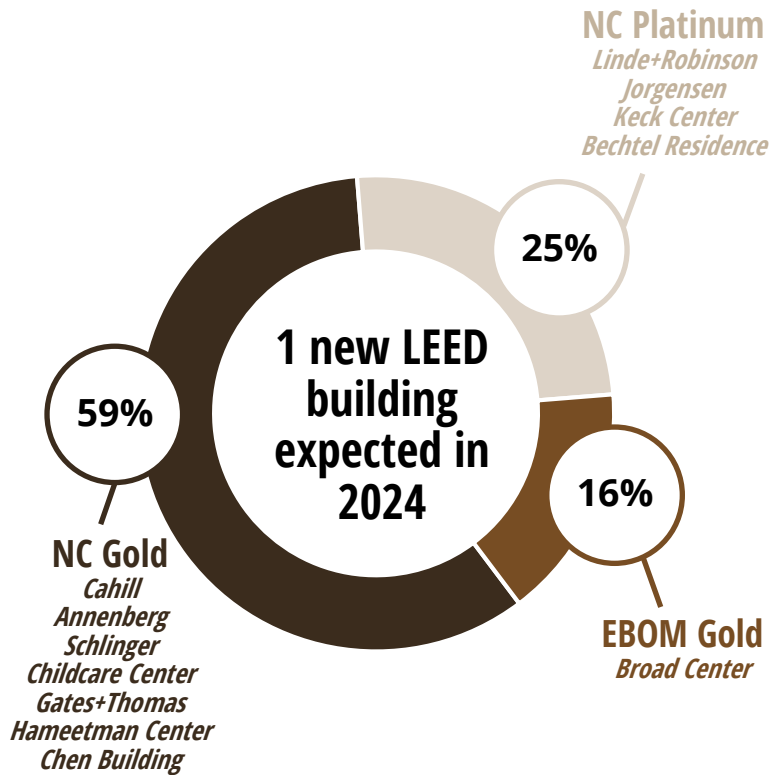
**12** LEED certified buildings,  
16% of Caltech's total  
campus space

As the Resnick building begins to rise from the ground in the area just north of the Braun and Noyes Laboratories, Caltech continues to improve the campus with more native and drought-resistant vegetation surrounding an efficient built environment. Statewide drought restrictions will have a marginal impact on campus operations due to this proactive effort, but opportunities remain to improve the campus built environment. With one-sixth of the campus building space now certified as LEED Gold or better, Caltech has made considerable progress towards a truly sustainable campus. Air flow restrictions born out of the COVID-19 pandemic will continue to be a concern for years to come, but much of the data being gathered can be utilized to meet both infection control and sustainability challenges.

## Historical LEED Building Square Footage



## 2021 LEED Square Footage Breakdown



**↑ 350%**

increase in low water vegetated campus cover since 2012

**747,000**

square feet of LEED space added since 2008

**1**

construction project pursuing LEED certification for 2024

## Sustainable Vegetation Leads Campus Land Use Transition

2021 Campus Land Use Breakdown

22% High Water Use<sup>3</sup>

78% Low Water Use<sup>4</sup>

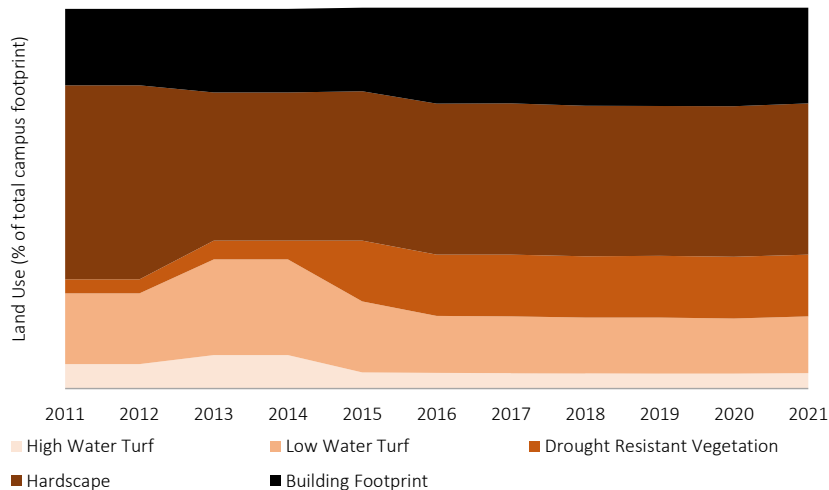
39% Hardscape

26% Buildings<sup>5</sup>

18% Turf

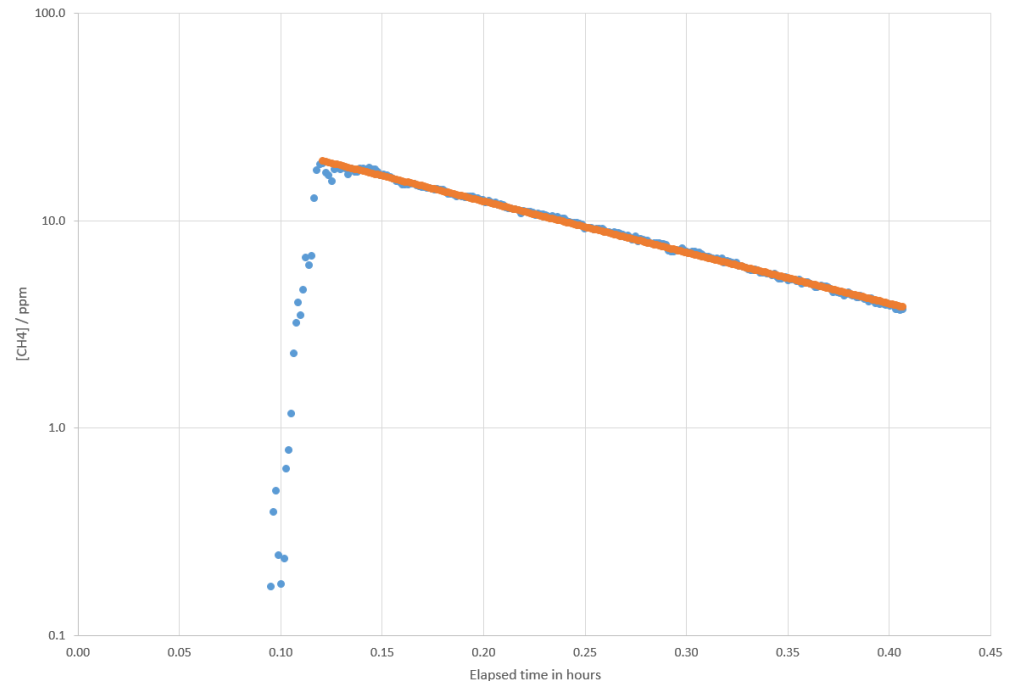
17% Vegetation

Historical Campus Land Use Change

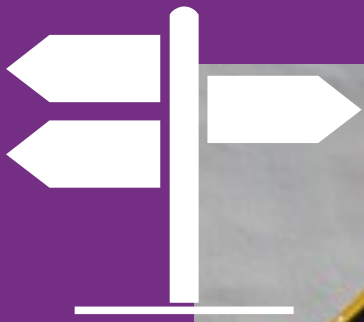


## Air Balance Tests Illuminate COVID Mitigation and Energy Opportunities

During the spring and summer of 2021, Caltech Facilities, Housing, and various academic divisions collaborated on a multi-month project to test numerous classrooms, meetings rooms, lecture halls, and offices in order to determine air flow in each of these spaces. The critical metric was air changes per hour which approximates the frequency with which the entire room's air volume is recycled with clean outside air. This testing helps determine how quickly an airborne pollutant or pathogen would be cleared out of a room through the air handling system. Methane gas was used as a proxy for the COVID-19 virus, and these results were critical as the campus was reoccupied for the fall 2021 quarter. These air balance tests can also be used to help identify critical deferred maintenance needs.

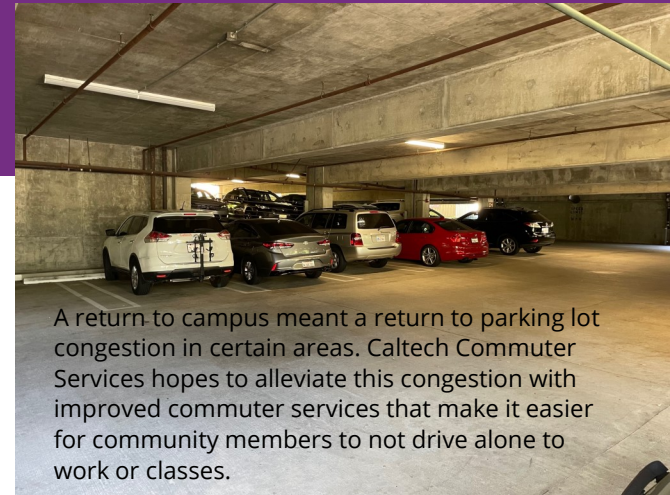




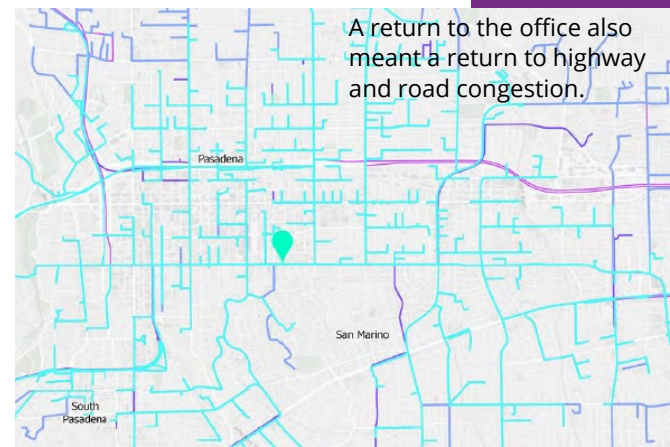
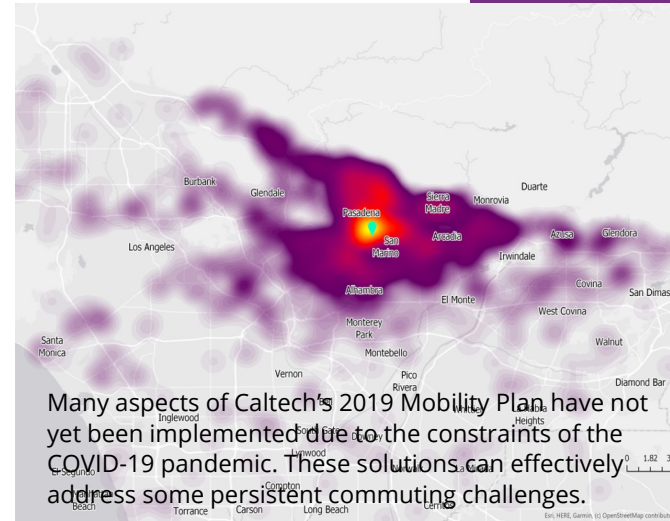


# Mobility

The need for social distancing brought some positive changes in how streets are utilized such as increased outdoor seating and widened sidewalks. Hopefully these trends will persist as we leave the pandemic era of COVID.



A return to campus meant a return to parking lot congestion in certain areas. Caltech Commuter Services hopes to alleviate this congestion with improved commuter services that make it easier for community members to not drive alone to work or classes.





# Goals for Viability

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

## 2021 Highlights

### Reduced Restrictions Provide Commuting Opportunity

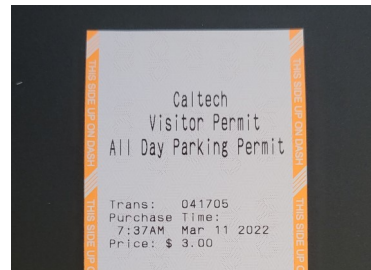
February 2021



As Caltech and the world rebounded from the winter 2021 coronavirus surge and campus activity resumed, opportunities to carpool and take public transportation were again available and safe with proper precautions such as masking. Flexible commuting without driving alone to work will continue to be a priority as Caltech works to reduce our Scope 3 emissions.

### Caltech Provides Daily Parking Passes

July 2021



A new program allows commuters to purchase discounted daily parking passes. This popular program allows telecommuters to pay for parking only on days that they actually drive instead of paying full price for an annual permit. The program now has over 250 active participants.

### Parking Lot Occupancy Rises With Return to Campus

September 2021



With the return to in-person classes in September came a predictable rise in campus parking lot occupancy. Thankfully, carpool, vanpool, and public transit utilization has also risen but hasn't returned to pre-pandemic levels. Caltech Commuter Services is exploring more ways to reduce single-occupant vehicles on campus.



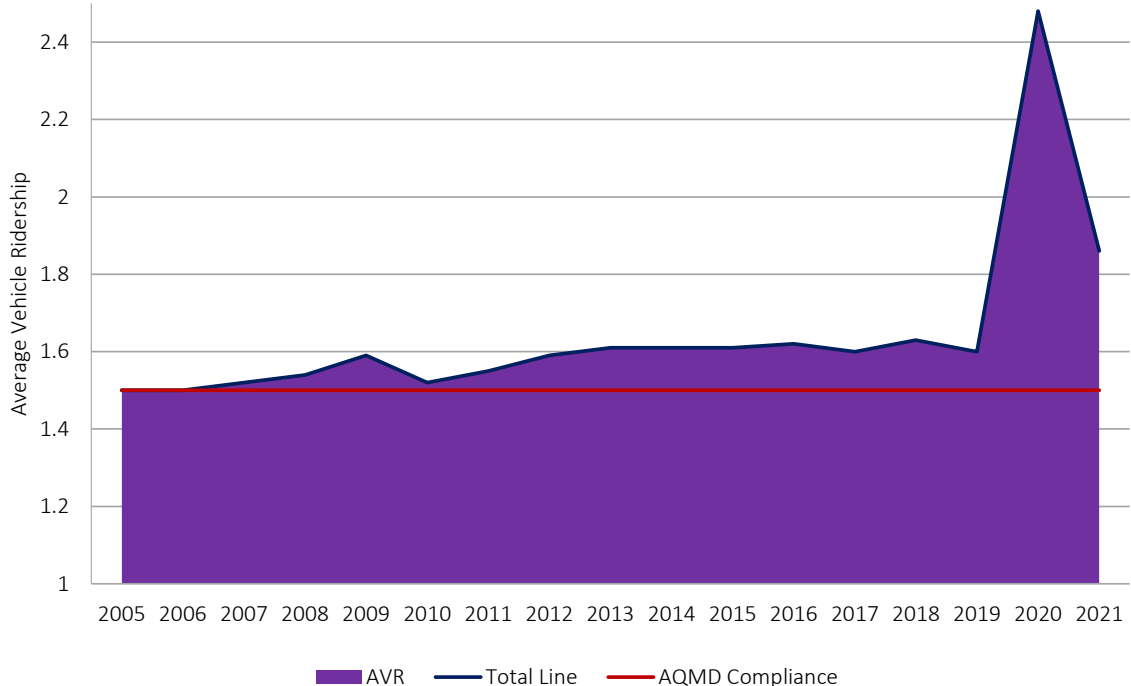


# 2021 Mobility Update

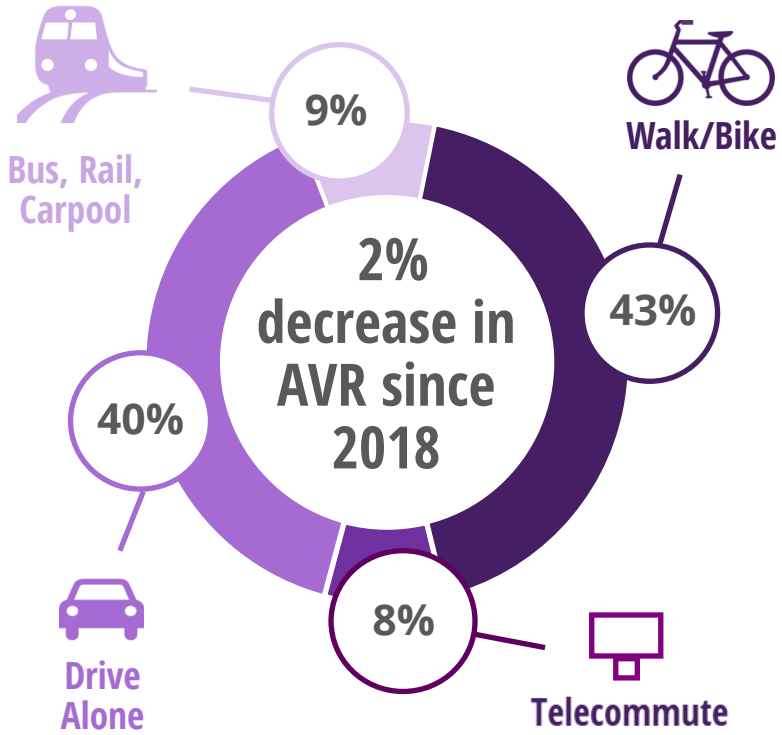
**1.86** campus occupants per vehicle, up from 1.60 in 2019

The onset of the COVID-19 pandemic saw a profound and immediate change in how we work, commute, and draw the line between work life and life outside of work. 2021 brought a return to campus for a large portion of the campus population. Regular telecommuting dropped 75% as many were called back into the office, but a sizeable contingent of telecommuters remains. This may signal a new normal in commuting for Caltech as it has for the rest of the world. With this paradigm shift, Caltech should have no concerns about meeting our target Average Vehicle Ridership (AVR). However, more work remains to be done to adequately support this more diverse commuting population where every day's commute mode isn't necessarily the same. Caltech has already begun to target commuting incentives as an employee benefit that enhances recruitment, retention, and employee satisfaction.

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



## 2021 Commuter Breakdown





# 8%

telecommuted in 2021 compared to 32% in 2020 but less than 1% in 2019

# 65%

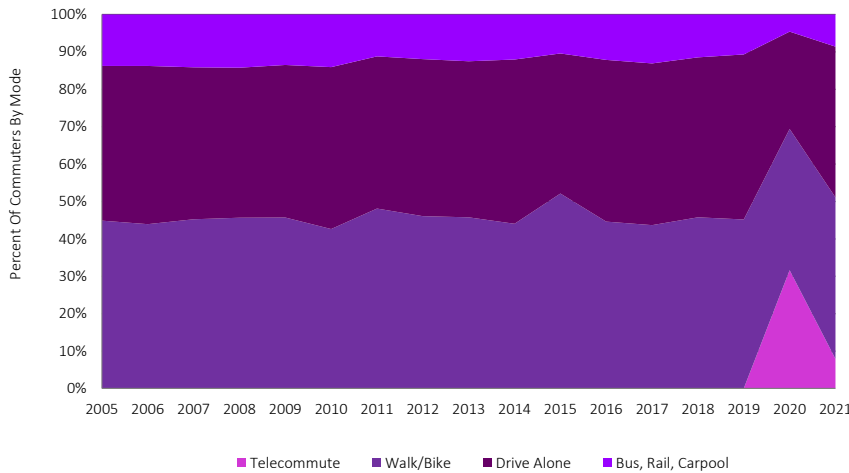
staff drive alone rate, up from 41% in 2020

# 470

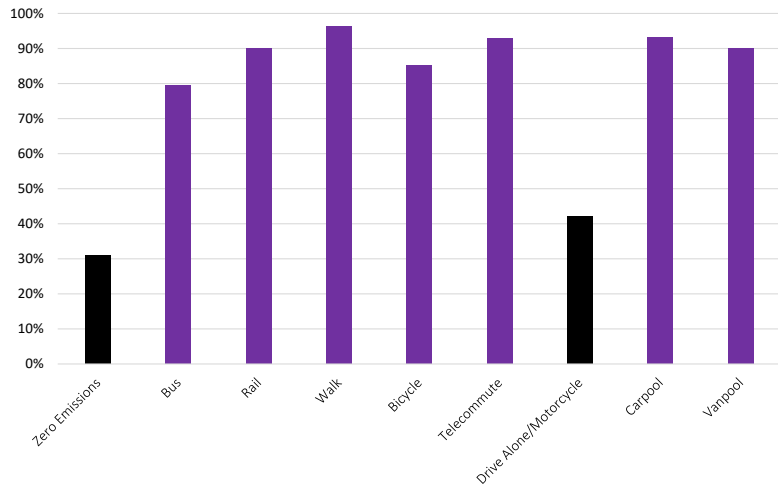
regular telecommuters in 2021, up from less than 1% of total commuters in 2019

## Post COVID Commuting Trends Come Into Focus

### Historical Commute Mode Breakdown



### Satisfaction by Commute Mode



## New Commuting Normal Highlights Opportunities and Need For Flexibility

Telecommuting utilization plunged by 75% in 2021 as many Caltech community members returned to campus offices and classrooms. While this was a welcome and expected change for typical campus operations, it forced many community members, especially staff, back into single-occupant vehicle commutes 5 days a week. Some flexibility in commuting has endured depending upon job role, but the low rates of employee satisfaction for those who drive alone to work is very telling. Recent efforts have focused on including commuter incentives as part of the overall employee benefits package. Caltech strives to make it easier and cheaper to utilize carpools, vanpools, and public transit than to drive alone. As we transition back towards a more typical campus schedule, there's some excellent lessons we've learned about the benefits of flexible commuting to employee satisfaction and maintaining a healthy work-life balance.

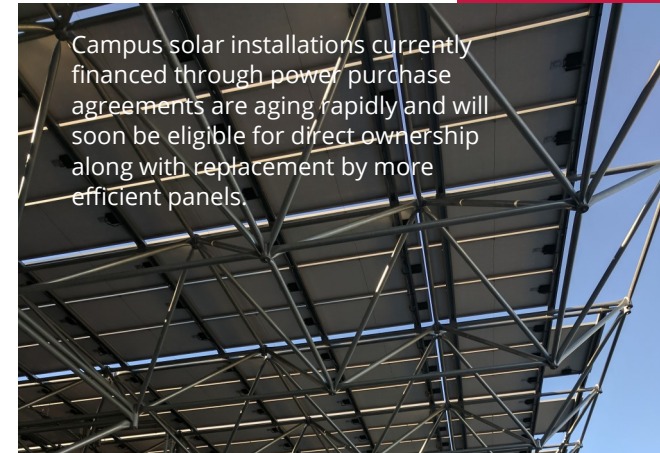




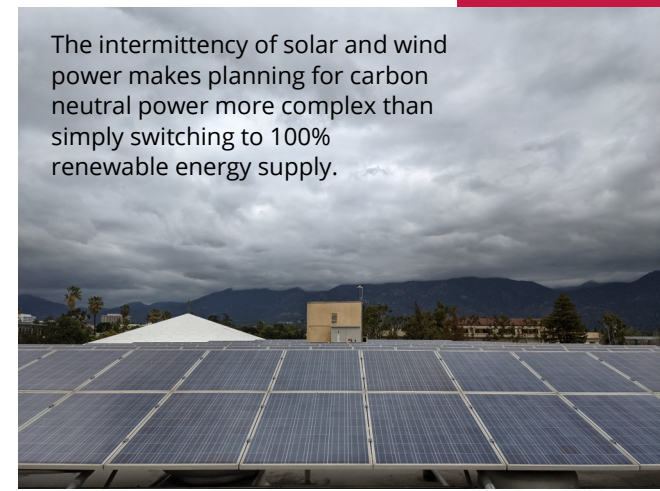
# Emissions Effluents & Waste



On-campus renewable energy systems have only made a marginal difference in lowering total emissions. Larger offsite installations of renewables and campus utility electrification are key components of a decarbonization strategy.



Campus solar installations currently financed through power purchase agreements are aging rapidly and will soon be eligible for direct ownership along with replacement by more efficient panels.



The intermittency of solar and wind power makes planning for carbon neutral power more complex than simply switching to 100% renewable energy supply.

# Goals for Viability

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

## 2021 Highlights

### Caltech Completes Utility Thermal Study

September 2021



Caltech completed the final major energy study in a series of planning documents that trace back over half of a decade. With the chilled water and electricity systems as well as campus energy sources well understood, this thermal study aimed to understand the possibility of converting the steam-based heating system to a hot water system powered by renewable electricity.

### Campus Scope 3 Emissions Continue To Stay Low

October 2021



Due to an unprecedented decrease in commuting and Institute-sponsored travel, Caltech's Scope 3 emissions have reached all-time lows over the past two years. This decrease fully obscured the increase in Scope 1 and 2 emissions in 2021. Future trends in Scope 3 emissions will be a topic of significant interest.

### Global Emissions Rebound From COVID-19

December 2021



In a full rebound from the COVID-19 pandemic and restrictions that slowed economies worldwide in 2020, energy-related emissions reached record highs in 2021. If this year was any indication, the world has resumed the same emissions path that we were on prior to COVID-19. This trend will need to quickly change for the world to meet commitments under the Paris Agreement.



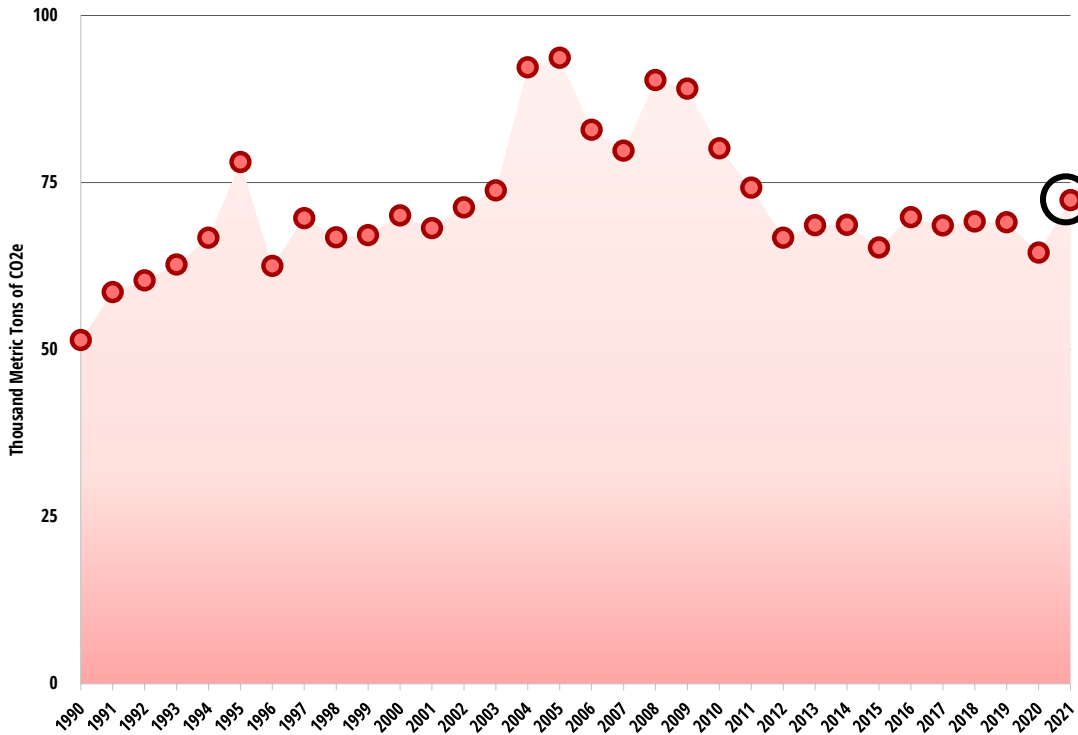


# 2021 Emissions, Effluent & Waste Update

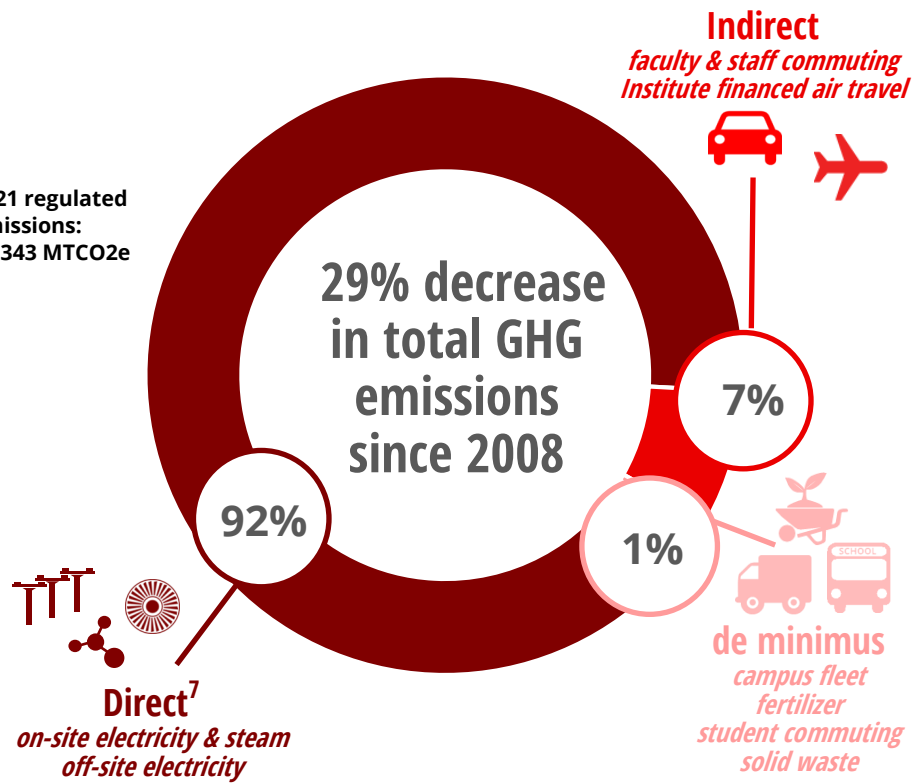
**↑12%** regulated greenhouse gas emissions since 2016

With the 2020 Climate Action Plan behind us, Caltech now looks to align our future goals with some of the most ambitious targets set by peer institutions and the State of California. Carbon neutrality and net zero are commonplace targets now whereas only the most ambitious of institutions were pursuing these goals ten years ago. Campus Scope 1 emissions rose in 2021 with the return to many laboratories and classrooms and actually reached their highest levels since 2011, but total emissions have fallen over the past decade due to a very significant drop in Scope 3 emissions. This is mostly attributable to changes in commuting and air travel. While the drop in Scope 3 emissions is promising, Caltech aims to initiate a paradigm shift in campus energy generation that will drastically decrease Scope 1 and 2 emissions.

## Historical Regulated Greenhouse Gas Emissions



## 2021 Emissions Profile



# ↓9%

total greenhouse gas emissions since 2016 but a 12% increase since 2020

# 13.4

MTCO<sub>2</sub>e per person, a 10% decrease from 2016

# .88

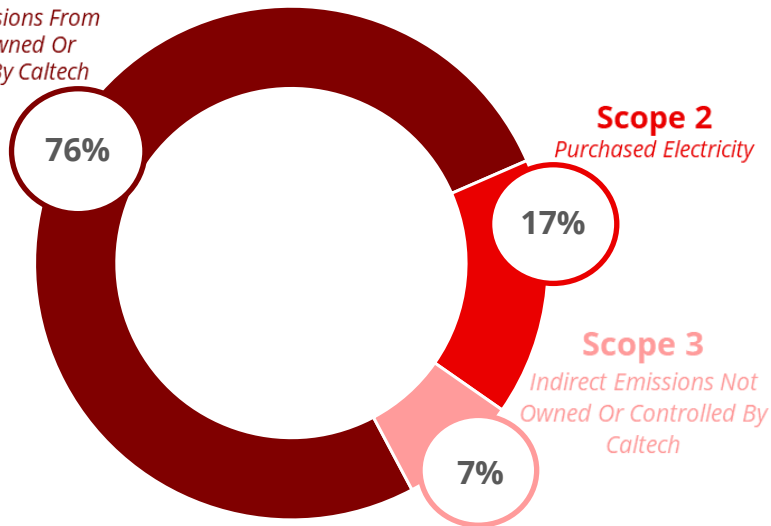
pounds of CO<sub>2</sub>e per research dollar, down 26% since 2016

## Scope 3 Emissions Stay Low

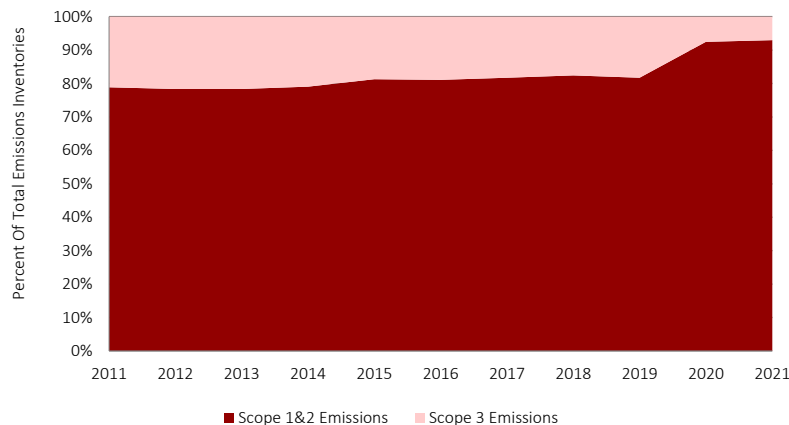
### 2021 Emission Profile By Scope

#### Scope 1

On-Site Emissions From Sources Owned Or Controlled By Caltech



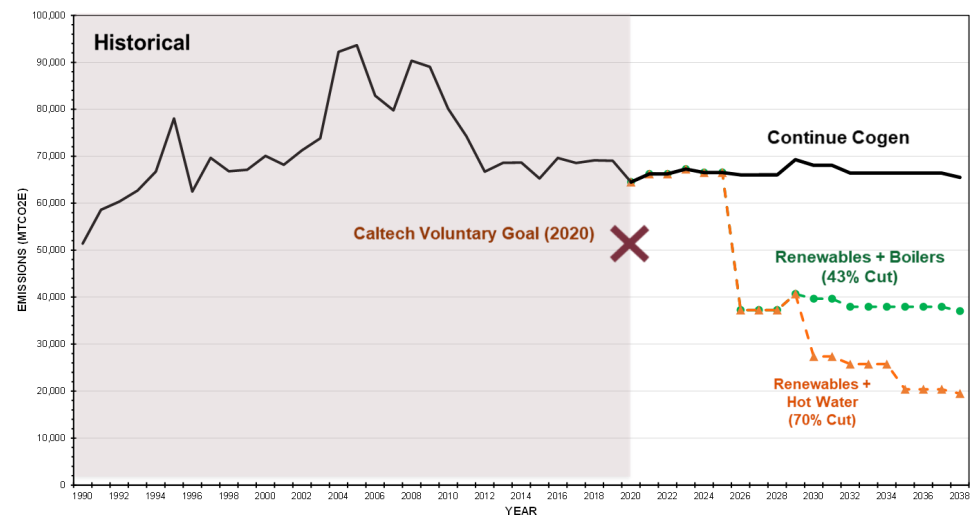
### Scope 3 Emissions Vs. Total Emissions



## Thermal Study Paves Way For Major Campus Decarbonization Effort

Caltech has spent more than half of a decade meticulously analyzing our campus utility system, energy sources, consumption, and associated emissions. This began with an Energy Resource Plan which looked at our primary energy sources and transition options; then it was followed by a Utility Master Plan to understand the campus utility distribution system and needs for the chilled water and electric distribution systems. Finally, this planning effort culminated in 2021 with the completion of the thermal study which looked at methods by which the campus could become almost completely steam-free. Switching from steam to hot water allows the campus to mostly electrify the utility heating system. Electrically sourced heat can be produced from renewable energy which would help Caltech move the needle significantly towards decarbonization. While a thermal conversion doesn't put the campus on a path to net zero, it would solve a significant portion of the challenge.

### GREENHOUSE GAS EMISSIONS PROJECTIONS





# Key Institutional Data

Metric	Unit of Measure	2021	2020	% Change
Core Campus Building Square Footage	Square Feet	4,774,854	4,548,624	+4.3%
Research Square Footage	Square Feet	2,069,425	2,008,745	+3.0%
Population <sup>9</sup>	Number (#)	5,835	5,869	-0.6%
Faculty & Post Doctoral Scholars	Number (#)	1,231	1,350	-8.8%
Staff	Number (#)	2,207	2,288	-3.5%
Students	Number (#)	2,397	2,231	+7.4%

# Acknowledgements

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# Photos and Images

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# 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.





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