For Caltech Sustainability, 2018 was very much about strengthening the foundation of our Sustainability Programs. While the metrics suggest steady progress, our actions indicate significant strides were taken toward a more viable future. In August, Caltech added depth to the sustainability team by welcoming its second Sustainability Manager, Maximilian Christman. In addition to undergraduate and master’s degrees in sustainability, Max brings experience in implementing sustainability initiatives at the University of Wisconsin Health system which has already translated to a renewed focus on lab sustainability at Caltech. Crucial progress was also made in the planning arena where an energy and utility planning effort is charting a course to deep de-carbonization of the thermal and electric utilities and the development of a reliable and adaptive utility system. Collectively, these successes will serve as catalysts for future transformative change.

John Onderdonk
Senior Director, Facilities Services & Integrated Planning
Chief Sustainability Officer

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### Energy
Total consumption remained relatively flat (-1%) due to continued energy efficiency successes. For the second consecutive year, Caltech energy exports exceeded imports.

- **1%** total electricity demand since FY17, decreasing since peak in FY16
- **100%** electricity produced on-site, marking two consecutive years as net exporter
- **3%** energy intensity by area since FY17 but 9% increase since FY14
- **$11.2M** in annual energy costs, flat since FY17 and a 16% decrease since FY14
- **$5.6M** in cumulative energy cost reductions compared to FY14 due to smart energy management

### Water
Total consumption increased 14% due to a 20% rise in indoor domestic water and a 10% increase in plant water consumption. Caltech recognizes conservation potential on campus.

- **14%** water consumption since FY17 but a 43% decrease since FY06 peak
- **1%** irrigation water use despite 3% hotter year compared to FY17
- **11%** water use per person from FY17 but a 11% decrease since FY14
- **$1.5M** in annual water costs, up 14% since FY17 but up only 2% since FY14
- **20%** in campus water costs per gallon since FY14

### Materials
Closure of the Caltech Recycling Center brought about considerable changes in campus diversion rates, recycling revenue, and total waste costs.

- **26%** non-hazardous waste campus diversion rate, down from 37% in FY17
- **16%** municipal solid waste per capita from FY17 and down 23% from FY14
- **64%** hazardous waste campus diversion rate, down from 70% in FY17
- **$734K** in annual municipal waste costs, up 31% since FY17 but up only 10% since FY14
- **59%** in campus recycling revenue from FY17

### Built Environment
Turf removal and climate adapted species projects enhance campus drought tolerance. Anticipated LEED buildings will support campus energy efficiency efforts.

- **2** LEED certified buildings planned for 2019
- **268K** square feet of LEED building space to be added by 2021
- **16%** of campus now covered with low-water vegetation, up from 4% in 2012
- **22K** square feet of turf removed from campus since 2017
- **$8,600** saved in water and labor costs from Holliston turf removal project

### Transportation
Average vehicle ridership hit our highest level ever (1.63), but there are still significant opportunities for incentivizing commute modes for staff and faculty.

- **2%** in campus occupants per vehicle from 2017 up to 1.63
- **43%** campus drive alone rate, flat from 2016
- **8.0 miles** average commute distance, down from 8.4 in 2017 and 8.5 in 2014
- **71%** staff drive alone rate, highest recorded number above 70% in 2017
- **125/11** registered carpools and vanpools in 2018, respectively

### Emissions
Caltech saw a marginal emissions rise and general plateauing since 2012. Despite a decreasing emission intensity, we are not on target to meet our Climate Action Plan goal.

- **1%** regulated greenhouse gas emissions from 2017
- **2%** total greenhouse gas emissions since 2014
- **2%** emissions intensity per capita from 2017 and down 6% since 2014
- **1.31** pounds CO2e per research dollar, down from 1.82 in 2008
- **14.2** MTCO2e per person, a 2% decrease from 2017 and a 6% cut from 2014
Pasadena Water & Power recently stated their intent to pull out of the coal-fired Intermountain Power Project, opting to source 60% of their energy from renewable resources by 2030.

Caltech will soon have even more solar panels on campus rooftops as we complete the process started a decade ago of building out our on-site solar capacity.

Caltech’s Utility Master Plan will help determine future investments in more efficient chillers and other large pieces of equipment critical to distributing energy throughout campus.

Building user guides have been rolled to encourage proper recycling, energy efficient practices, and awareness of service request procedures.
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.

2018 Highlights

**Additional Solar Power Gets Green Light**
August 2018

710 kW of additional solar photovoltaic panels will be installed on nine buildings on campus. This brings Caltech’s total solar capacity to 2.1 MW and “maximizes the ability of the campus to generate renewable power at competitive rates,” according to Jim Cowell, AVP Facilities.

**CECIP Has Another Successful Fiscal Year**
September 2018

Caltech’s Energy Conservation Investment Program (CECIP) II continued to demonstrate success in FY 18 with this fiscal year’s implemented projects demonstrating savings over $500,000 per year for the Institute over the next decade.

**Rebate Program Provides $93K for Energy Efficient Freezers**
October 2018

In FY18, as part of CECIP, Caltech started to offer rebates for laboratories buying energy efficient freezers that perform significantly better than older models. The energy savings of these freezers will pay for the cost of the rebates over the next 8 years.
In FY18, Caltech was a net-exporter to the grid for the second consecutive year. This means that between our solar photovoltaic installations, fuel cells, and combined heat and power system, we were able to generate more electricity on-campus than we consumed over the course of the year. These on-site energy sources provide cheaper and more predictable energy costs. In fact, the recent increase in on-site power, improved energy use intensity (energy use per square foot), and long-term contracting for natural gas have provided cumulative savings of $5.6 million since FY14. Energy conservation efforts, led by CECIP, have helped Caltech decrease our total energy consumption and cost while continuing to grow and support the Institute’s mission.
Managing Energy Use & Costs

Site Energy Use Intensity²

Historical Energy Cost

Caltech’s Freezer Rebates Provide 60% Energy Savings

While Caltech’s Energy Conservation Investment Program (CECIP) has traditionally been used for large energy projects such as lighting retrofits, heating and cooling systems upgrades, and improving campus energy infrastructure, Caltech Sustainability and Caltech Energy Services collaborated on expanding CECIP to equipment in FY18. Following the defined CECIP payback criteria of 8 years, Caltech began providing rebates for purchasing new or upgrading existing ultra-low temperature (ULT) freezers, a common and energy-intensive piece of laboratory equipment.

FY18: $92,800 in rebates processed

- Total freezers purchased - 16 (14 existing, 2 new)
- Average rebate - $5,800 (47% of average cost)
- Expected annual savings - $13,800
- Savings versus non-efficient models - 60%
- Return on investment - 13.7%

Standard ULT models can consume as much energy as an average California home, and Caltech looks forward to providing further rebates in FY19 along with encouraging efficient freezer usage practices such as setting freezers to −70 instead of −80.
Spectators view Caltech’s annual ME72 Engineering Competition held in Millikan Pond.

Cooling towers consume the majority of water used in campus utility plants, and options for reusing this process water are being explored.

Caltech’s annual water consumption is equivalent to filling the Rose Bowl twice.

The iconic Throop Pond pays homage to the founder of Throop College, Amos G. Throop, which would eventually become the world-renowned California Institute of Technology.
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.

2018 Highlights

**Governor Brown Signs SB 606 and AB 1668**
May 2018

While California has exited the severe drought present from 2012-2017, water conservation measures are still of high importance to provide resiliency against future droughts. State lawmakers in 2018 set permanent water conservation goals that will go into effect in 2021.

**Caltech Guides PWP’s Water System & Resource Plan**
August 2018

Caltech is serving as a member of PWP’s Water System & Resource Plan Stakeholder Committee. As part of this group, Caltech will help make critical decisions on water supply/distribution, reuse opportunities, and conservation measures that will guide PWP’s water planning for the next decade.

**Holliston Turf Removal Saves Water and Money**
September 2018

FY18 brought more land-use change to Caltech, and efforts to remove high-water use turf continue. Replacing grass with mulched native landscaping on Holliston Ave. saved enough water to fill the gene pool 15 times and avoided nearly $9,000 in annual labor and water costs.
After reaching peak water consumption in FY06, Caltech has since cut our annual consumption nearly in half. While this trend began prior to the severe drought experienced statewide from 2012-2017, mandatory state reduction measures instilled a culture of conservation on campus. As we exited the drought in 2018, a rebound in consumption was present marked by a 10% increase in utility plant water use and 20% increase in building and domestic water use. Water rate increases are overwhelming the 40% decrease in per capita consumption seen since 2008. With climate change posing increased threats to the reliability of California’s water supply and rising local water costs, it will be environmentally and financially responsible for Caltech to encourage a paradigm shift towards water conservation.

**Historical Campus Water Consumption**

FY18 water consumption: 192 million gallons

**2018 Water Use Profile**

- Total: 14%
- Utility Plants: 57%
- Building & Domestic: 29%
- Irrigation: 14%
Recent Consumption Increases Augment Rising Water Costs

Permanent Water Reduction and The Possibility Of Reuse

After a six-year drought lasting from 2012-2017 that put severe strain on water supplies and reliability for most of California, state lawmakers have recently taken steps to ease the stress of future droughts that may be exacerbated by the effects of climate change. Signed into law on May 31, 2018, former Governor Jerry Brown enacted SB 606 which requires the state to build upon existing water use reduction goals of 20% by 2021 by requiring water suppliers to establish formal water management plans and report back on these strategies each year. Further regulation, including AB 1668, set benchmark per capita water consumption levels for indoor water use that ratchet down in 2025 and then again in 2030.

<table>
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<th>Type of Water</th>
<th>Description</th>
<th>Reuse Possibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackwater</td>
<td>From kitchens, dish washers, urinals, and toilets</td>
<td>Treated for non-potable uses</td>
</tr>
<tr>
<td>Process Water</td>
<td>From boilers, chillers, and softeners in utility plants</td>
<td>Treated and cycled back into cooling towers</td>
</tr>
<tr>
<td>Graywater</td>
<td>From showers, washers, and bathroom sinks</td>
<td>Treated for reuse in irrigation or utility plants</td>
</tr>
<tr>
<td>Rainwater/Stormwater</td>
<td>Captured on rooftops or from storm drains</td>
<td>Captured for use in irrigation or utility plants</td>
</tr>
</tbody>
</table>

Included in each of these bills is a recommendation for water reuse and recycling. While measures to decrease potable water consumption should be of high importance, the concept of reuse and recycling should be applied to water in the same way it has traditionally been applied to plastic bottles, aluminum, glass, and other solid material resources. The above chart shows some eligible water sources for reuse.
While Caltech’s recycling system continues to be successful, industry-wide changes for waste handling have made recycling more difficult and costly.

TechMart’s product flag filter can assist with green purchasing decisions that minimize waste.

Caltech students are looking at opportunities for implementing garden composting in the Catalina garden to demonstrate the principle of circularity.

The Engelmann Oak was reborn as a communal table in Hameetman Center.
Goals for Viability

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

2018 Highlights

Caltech Reduces Plastic Food Service Waste
July 2018

Amongst a national conversation about plastic waste, Caltech has made some changes in the Red Door Café and other dining settings with the goal of reducing plastic usage including switching to wood stirring sticks and paper straws.

China’s Recycling Restrictions Stress Markets
September 2018

With more stringent standards of contamination and lower rebates for materials, the recycling industry is going through a profound period of change. Caltech continues to generate revenue from recycling, but plastics have posed challenges.

Engelmann Oak Finds New Home
December 2018

After removing the 400-year old Engelmann Oak From Caltech's campus in 2017, the carpenter shop set about restoring the historic tree's place in our community. The tree now pays homage to the Institute's history as a communal table in the new Hameetman Center.
2018 was a year of big changes in materials and waste handling for the Institute and for the waste industry in general. While Caltech said goodbye to the Recycling Center at the end of 2017, we were also gearing up for the implementation of China’s National Sword Policy. The most consequential effect of National Sword has been the lowering of rebates for recyclable material which in turn raises Caltech’s overall net waste disposal cost, along with increased trash generation and hazardous waste costs. Waste generation overall and per person continues to trend downward, but this rate has been outpaced by increasing costs for all waste streams. Caltech continues to manage costs and explore new opportunities for reducing hazardous waste, composting or donating food waste, and making purchasing decisions upfront that ultimately reduce the need for waste disposal.

### Historical Campus Waste & Recycling Generation

![Graph showing historical waste generation](#)

- **FY18 waste generation:** 1,890 short tons
- **42% decrease in on-campus recycling from FY17**

### 2018 Waste & Recycling Profile

- **39%** Recycled at MRF
- **35%** Waste-To-Energy
- **26%** Recycled On-Site
- **26%** Cardboard
- **23%** Paper
- **16%** Mixed Other
- **7%** CRV Containers

- **Total - 482 Short Tons Recycled**

---


[2] 9%

[3] Hazardous waste diversion from FY17, down to 64% but up from 53% in FY11

[4] 42% decrease in on-campus recycling from FY17

[5] 39% Recycled at MRF


[7] 26% Recycled On-Site

[8] 26% Cardboard

[9] 23% Paper

[10] 16% Mixed Other

[11] 7% CRV Containers

[12] Total - 482 Short Tons Recycled
Recycling Markets Affect Caltech

While the U.S. has traditionally sent recyclables overseas to southeast Asian countries including China, this process changed dramatically in 2018 when China imposed strict restrictions on contamination and the products that they receive. This change was part of a group of policies known as National Sword. According to our recycling vendor, Allan Company, “the effect of National Sword has led to an upheaval of the global market for recyclable material that is felt throughout the entire value chain….China, under National Sword, has set a deadline to ban all recyclable material from being imported into the country beginning in the year 2021, further casting the state of the industry in doubt.” Allan Company collects the Institute’s recyclables but also provides rebates for materials such as cardboard, metals, and CRV bottles and cans.

As evidenced by the graph above, there's been a downward trend in recycling revenue for the aforementioned materials and lower value recyclables since a peak in 2013, and this trend seems likely to continue according to industry experts.
Hameetman Center, on track for LEED certification, will offer a new common space for the Caltech community.

Bechtel Residence opened to students in September, with environmental features including native planting and low water irrigation.

Caltech strives to modernize and improve buildings while maintaining the historic character and appeal of the campus.

With grass, native vegetation, non-native trees from the early 20th century, concrete, pervious surface, parking lots, and buildings, the Caltech campus footprint is anything but homogenous.
Goals for Viability

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

2018 Highlights

Bechtel Residence Welcomes Students
September 2018

The 211–bed Bechtel Residence also offers a 400-seat dining hall for students and special events. In addition to providing on-campus housing opportunities for all undergraduates, Bechtel serves productive space for collaboration and late-night study sessions.

Lawn Equipment Transitions To Greener Options
October 2018

Caltech has accelerated our transition towards equipment electrification by targeting gas-powered lawn equipment for conversion to electric models in the next few years. Leaf blowers, trimmers, and mowers will be converted in order to reduce emissions and protect occupant health.

LEED Buildings Highlight Campus Sustainability
December 2018

Bechtel and Hameetman are on target for LEED and are expecting certification in 2019. Caltech’s continued commitment to building efficient and environmentally friendly buildings complements recent utility and energy planning efforts aimed at upgrades to infrastructure and distribution.
Two major trends continue to dominate the data for Caltech's built environment: increases in LEED building space and decreases in water-intensive turf. Caltech has over a quarter-million square feet of buildings currently pursuing LEED certification, and the amount of native vegetation on campus has quadrupled since 2012. These turf removal projects have demonstrated both environmental conservation and financial success consistent with the highest priority sustainability projects. Continuing efforts to promote land-use change and efficient buildings allow for significant progress, but occupant behavior will be an increased focus for Caltech Sustainability over the coming years in order to maximize the benefit of a sustainable built environment through productive community habits such as energy conservation, waste avoidance, and water use reduction.
A More Efficient And Modern Campus Landscape

2018 Campus Land Use Breakdown

- 21% High Water Use
- 79% Low Water Use
- 40% Hardscape
- 25% Buildings
- 19% Turf
- 16% Vegetation

Lawn Equipment Upgrades

Caltech aims to be responsive to the needs of those on campus when it comes to health concerns or acute irritants, and gas-powered leaf-blowers were a source of complaints in 2018. In response, Integrated Planning, Buildings and Grounds, and Caltech Sustainability developed a phase-out plan to fully switch from gas to electric leaf blowers in the next few years. While this transition is already under way, with approximately 50% of equipment already electric-powered, the remainder is slated to be replaced by 2021. The new electric lawn fleet will possess the same capacity to maintain the appeal of our campus landscape while ensuring equipment sustainability with mobile battery packs (seen above).

Staff comfort was also addressed through ergonomic analysis for all potential new equipment. This conversion will allow Caltech to keep our campus beautiful while ensuring that the needs of the community are met and we continue progressing towards our carbon goals.
The JPL-Caltech shuttle provides critical transportation services between the two campuses with ten roundtrips per day. While the Metro Bikeshare program was discontinued in 2018, new options are on the horizon thanks to the rapidly changing mobility industry. Caltech continues to host ZipCar on campus, a program in place since 2013. Caltech is using commute data to determine the best strategies for future incentives and programs. The JPL-Caltech shuttle provides critical transportation services between the two campuses with ten roundtrips per day.
Goals for Viability

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

2018 Highlights

New Mobility Options
Flood Cities
January 2018

If you’ve taken a weekend trip down to any of the beaches in the LA area, you’ve probably noticed and perhaps even used one of the shared electric scooters. As these and other mobility options proliferate, Caltech will continue to look at opportunities for leveraging these technologies.

Caltech Begins Mobility Planning Process
September 2018

While Caltech has continued to score well in recent transportation surveys, we do boast a significant advantage over other organizations in the number of people (mostly students) who live on-campus. As such, we’ve embarked on a mobility planning process to modernize our programs and push for a best-in-class commuting and transportation program.

Caltech Achieves High Marks From AQMD
October 2018

Since the mid-1990's, Caltech has been required to submit a report to the South Coast Air Quality Management District on how employees of the Institute (staff, faculty, and students) arrive on campus. Caltech continues to encourage employees to use new transportation options, and we achieved our highest score ever from AQMD in 2018.
Caltech continues to perform well in our annual reports to the South Coast Air Quality Management District, but while our average vehicle ridership (AVR) continues to edge upwards, we recognize there is room for further improvement given the changes in mobility. When comparing ourselves to benchmarks on commute mode, Caltech has a considerable advantage on other southern California employers due to our high student population. A significant portion (71%) of our staff still drive alone despite commute distances dropping over the past decade. Coming changes including shared mobility, improvements in public transit, and potential last mile solutions will guide the Institute’s transportation demand management strategies and planning. Caltech aims to adapt to the profound changes that will take place in the transportation industry over the next decade.

**Historical Campus Average Vehicle Ridership**

2018 Commuter Breakdown

- 11% Bus, Rail, Carpool
- 43% Drive Alone
- 46% Walk/Bike

1% increase in AVR since 2014

2018 AVR: 1.63
57% of commuters used alternative transportation, flat from 2016
71% of staff drive alone, up from 70% in 2017
8.0 average miles to work, down from 8.4 in 2017
16/975 lockers and outdoor bicycle parking spaces on campus

Campus Commute Details

Commuting Continues to Change

Between proposed changes to the Metro Gold Line, Pasadena Transit expansions, the emergence of e-scooters such as Lime and Bird, the further proliferation of Uber/Lyft and other ride hailing services, and the changing of workplace trends such as increased telecommuting and alternative work schedules, there’s a lot to talk about when it comes to transportation in LA.

While Caltech continues to maintain a strong biking community, there’s been less than full utilization of public transit options including the LA Metro Gold Line, which runs from Azusa through Pasadena to East LA. We know from our data and from anecdotes provided by many on campus who are participating in our mobility planning process that there’s a desire for last mile solutions to connect nearby Gold Line stops directly to campus. These types of options will presumably become even more important with proposed extensions of the Gold Line to foothill communities including Claremont and Pomona. Caltech is developing a comprehensive plan to provide a multitude of options in the near future for the diverse commute needs of our campus population.
Emissions, Effluents & Waste

Caltech continues to install electric vehicle chargers in order to support employees and visitors with a zero-emission commute.

Fume hoods are part of the lifeblood of Caltech—they are critical for conducting research, are tested and monitored by the Environmental Health and Safety Office, and use a large amount of fan energy to keep lab users safe. Advancements in fume hood technology have reduced energy needs and the resulting greenhouse gas emissions.

Supply chain emissions for purchased items from laboratory equipment to food to water bottles represent a significant opportunity for Caltech.

Caltech’s cogeneration turbine has been the source of the majority of campus carbon emissions for over a decade.

Caltech’s community garden offers on-site food production which helps reduce the environmental impact of the thousands of meals prepared on campus every day.
Goals for Viability

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

2018 Highlights

Caltech Discusses Deep De-Carbonization
June 2018

California Continues to Lead the Way With SB 100
September 2018

Caltech Works to Integrate Long Term Energy Resource Plans
December 2018

Tyler Durchslag-Richardson, Senior Analyst for Facilities Services and Integrated Planning, joined other California higher education sustainability experts to discuss the challenges and opportunities inherent to implementing sustainability in higher education.

California signed SB 100 into law in September of 2018 committing the state to 100% renewable electricity by 2045. California and Hawaii are the only states with this ambitious goal that will be needed to meet the significant carbon challenges of the 21st century.

With a completed Energy Resource Plan and PWP’s recently completed Integrated Resource Plan, Caltech is collaborating with PWP to realize the shared goals of a decarbonized electricity supply and a cost-effective and fair rate structure.
Caltech’s regulated emissions have remained fairly flat over the past six years marking a clear end to the downward trend we saw from the inception of the Climate Action Plan in 2008 until 2012. Consequently, it seems unlikely that we will meet our 2020 goal of 51,000 metric tons of annual carbon dioxide equivalent emissions by 2020. This brings the limitations of our current energy infrastructure into focus, and it emphasizes the importance of setting more ambitious goals for 2030 and beyond. Caltech has an Energy Resource Plan which lays out a timeline for replacing our natural gas cogeneration system with offsite renewable energy, which will considerably lower our Scope 1 emissions. Ongoing planning efforts will help establish how energy is distributed on campus into the foreseeable future to meet research needs and minimize the Institute’s contribution to climate change.

**2018 Emissions Profile**

- **Indirect**
  - Faculty & staff commuting
  - Institute financed air travel

- **Direct**
  - On-site electricity & steam
  - Off-site electricity

- **2% decrease in total GHG emissions since 2014**
- **17%**
- **82%**
- **1%**

**Greenhouse Gas Goal Progress**

- **Climate Action Plan Developed**
- **Business As Usual: 108,000 MTCO2e**
- **2018 Actual: 69,149 MTCO2e**
- **Climate Action Plan Goal: 51,000 MTCO2e**

**Historic Emissions**

**Climate Action Plan Target**

**Business As Usual Emissions**

**Actual Emissions Line**

**Current Trend**

**Regulated greenhouse gas emissions from 2017**
2% total greenhouse gas emissions since 2014

14.2 MTCO2e per person, a 2% decrease from 2017 and down 6% since 2014

1.31 pounds of CO2e per research dollar, down from 1.82 in 2008

Carbon Emission Scopes

2018 Emission Profile By Scope

Scope 1
On-Site Emissions From Sources Owned Or Controlled By Caltech

Scope 2
Purchased Electricity

Scope 3
Indirect Emissions Not Owned Or Controlled By Caltech

Energy Planning For The Future

As the Intergovernmental Panel on Climate Change (IPCC) laid out in its October 2018 Special Report, humanity faces a tremendous challenge in mitigating the negative impacts of rising atmospheric carbon concentrations. Recognizing this urgency and the fact that Caltech’s carbon emissions have plateaued, Caltech will be completing an extensive energy and utility planning effort in 2019. The outcome of that effort will be an Energy Resource Plan and a Utility Master Plan that collectively will determine the best path towards decarbonizing our energy supply.

Caltech is looking at retiring our natural gas cogeneration turbine in 2024 and pursuing large scale, offsite renewables to replace that supply. Any such purchase will require a continued partnership with Pasadena Water & Power, who recently completed their own Integrated Resource Plan and share a vision for a decarbonized electric grid. While investing in renewables can solve the electricity portion of Caltech’s carbon reduction challenges, over 50% of the Institute’s energy needs are thermal. De-carbonizing thermal energy will be more complicated and will require upgrades to campus infrastructure that are being determined by the Utility Master Plan process. The carbon challenge is complex for Caltech, as it is for many organizations, but the Institute is determined to decouple our research and educational mission from the emission of carbon.
## Key Institutional Data

<table>
<thead>
<tr>
<th>Metric</th>
<th>Unit of Measure</th>
<th>FY18</th>
<th>FY17</th>
<th>% Change</th>
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</thead>
<tbody>
<tr>
<td>Core Campus Building Square Footage</td>
<td>Square Feet</td>
<td>4,193,534</td>
<td>4,079,033</td>
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<td>Research Square Footage</td>
<td>Square Feet</td>
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<td>Faculty &amp; Post Doctoral Scholars</td>
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<tr>
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<td>Students</td>
<td>Number (#)</td>
<td>2,238</td>
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</tbody>
</table>

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## Prepared by

- Maximilian Christman, Sustainability Manager
- Tyler Durchslag-Richardson, Senior Analyst, Facilities Services and Integrated Planning
- John Onderdonk, Senior Director, Facilities Services & Integrated Planning and Chief Sustainability Officer

## Photos and Images

- Caltech Bikeshare
- Caltech Dining Services
- Caltech Energy Services
- Caltech Office of Strategic Communications
- Caltech Sustainability
- Christine Cho, Independent Photographer
- LA Metro
- Pasadena Water & Power
- Smith Group
- South Coast Air Quality Management District
- The Arnold Lab
- 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. 2014 and 2015 water cost data smoothed for graphic representation.

4. Caltech’s waste hauler sends a portion of the waste collected from the core campus to the Southeast Resource Recovery Facility (SERRF) in Long Beach. This facility employs a technology generally known as “mass burn” where solid waste is incinerated with little to no pre-combustion while recovering electrical energy. This technology reduces solid waste by as much as 80 percent. The remaining ash residue can be used as top cover at landfills. For more information, please visit the SERRF facility website at http://www.covantaenergy.com/facilities/facility-by-location/long-beach.aspx

5. Includes recyclables collected from the municipal solid waste stream (e.g. CRV containers, metals, plastics, paper, cardboard etc); excludes e-waste recycling.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.