01
Worksession Item

Office of the City Manager

WORKSESSION
December 6, 2018

To: Honorable Mayor and Members of the City Council

From: Dee Williams-Ridley, City Manager

Submitted by: Timothy Burroughs, Director, Planning and Development Department

Subject: Climate Action Plan Update

SUMMARY
Since adoption of the Berkeley Climate Action Plan (CAP) in 2009, the City of Berkeley, in partnership with community organizations, residents, and businesses, has been working to achieve the CAP goals of reducing greenhouse gas (GHG) emissions 33% below 2000 levels by 2020 and 80% by 2050. This annual report to City Council shares the latest and best available data on that progress: Berkeley's 2016 community-wide GHG emissions, including emissions from transportation, building energy use, and solid waste disposal, are approximately 15% below 2000 baseline levels, despite a population increase of approximately 18% in that same time period.[1]

While this achievement in community-wide GHG emissions reductions is significant, there is more work to be done to achieve our CAP goals and create a resilient community that is able to adapt to the impacts of climate change. New strategies and resources are required to accelerate the rate of GHG reductions and to reach the increasingly ambitious goals recently proposed by the Mayor and City Council including:

- Achieving net zero carbon emissions (carbon neutrality) by 2050, as pledged by Mayor Arreguin at the Global Climate Action Summit
- Becoming a Fossil Fuel Free City
- Reaching 100% renewable electricity citywide by 2035

In addition to continuing successful efforts, the City is focused on strategic planning efforts to identify measurable and achievable programs to further:

- ***Reduce energy use*** in building construction and operation, in transportation by shifting travel to walking, biking, and transit, and by minimizing landfilled waste
- ***Clean the electricity*** used in Berkeley
- ***Electrify transportation and buildings*** to significantly reduce natural gas and petroleum use

[1] See Attachment 1 for complete detail on Berkeley's community-wide GHG inventory

CURRENT SITUATION AND ITS EFFECTS

Each year, Office of Energy & Sustainable Development (OESD) staff calculate community-wide GHG emissions to understand which sectors and fuels are contributing the most emissions within Berkeley, track progress toward the community's climate goals, and provide data that can be used for prioritizing programs and policies. The emissions inventory for 2016, the most recent available data shown in Figure 1 below, shows a breakdown of GHG emissions similar to past years; transportation accounts for over half (60%) of the community's emissions and buildings account for over a third (37%).

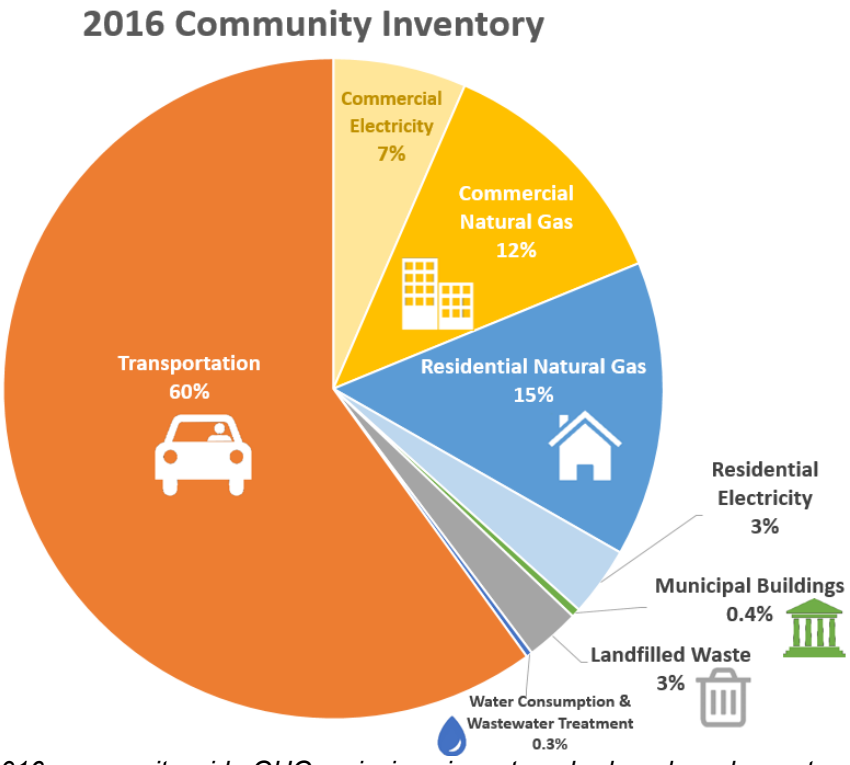

Figure 1: Pie chart of 2016 community-wide GHG emissions inventory, broken down by sector and fuel.

According to 2016 data, Berkeley reduced GHG emissions by 15% below year 2000 levels, even as its population grew by 18%. The community accomplishments are impressive; however, more is still needed to achieve Berkeley's ambitious goals. More detail on the GHG inventory can be found in Attachment 1, including an introduction into a consumption-based inventory approach that accounts for the greenhouse gases released to produce, transport, sell, use, and dispose of goods and services consumed in Berkeley.

UC Berkeley and the Berkeley Lab are not included in Berkeley's GHG emissions inventory since their campuses are outside the City's jurisdiction. However, both institutions track their own emissions reduction goals and are engaged community partners in addressing climate change. The Lab has partnered directly with the City on

several innovative sustainability projects including the Berkeley Energy Assurance Transformation (BEAT) microgrid project, building data management tools, and zero-net energy analysis of municipal buildings. UC Berkeley has collaborated on the Berkeley Climate Action Coalition and has provided research and technical assistance on a variety of projects. Please see Attachment 2 for progress reports from both UC Berkeley and the Berkeley Lab on their individual climate goals, programs, and policies.

Achieving deeper reductions will require additional and accelerated action. The City is undertaking a series of comprehensive analyses to understand how best to transform Berkeley's energy needs. These strategic planning initiatives will determine the most valuable and achievable programs and policies to create for Berkeley's path to a clean energy future (see Figure 2).

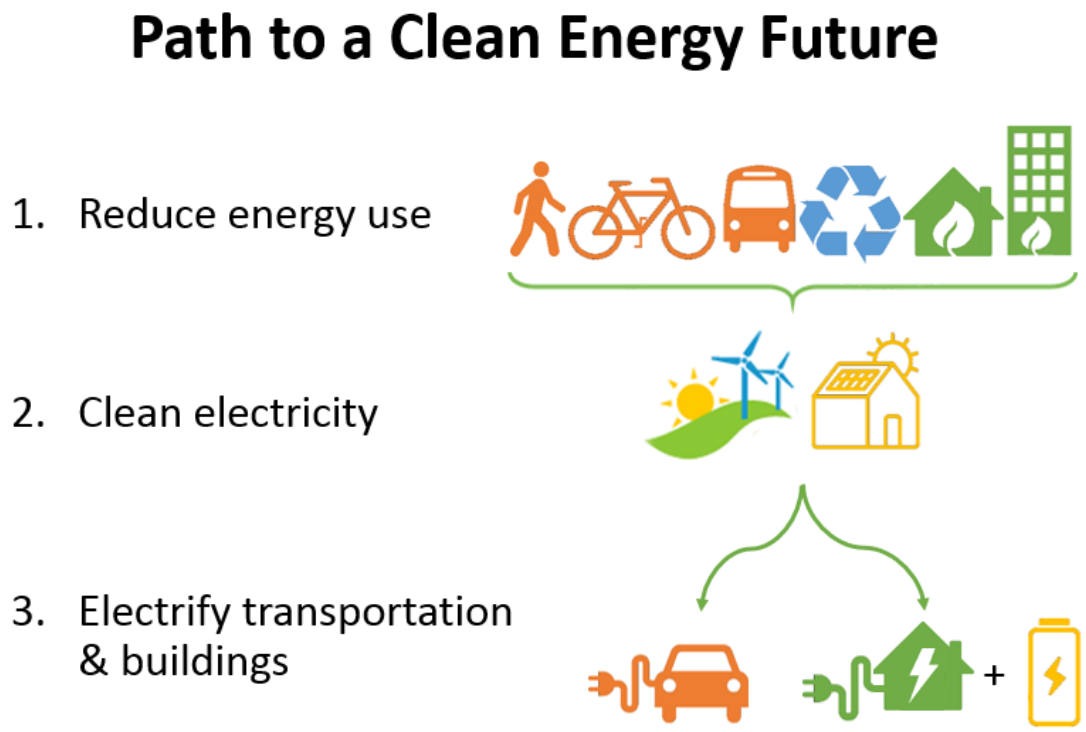

Figure 2: Path to a Clean Energy Future in Berkeley

Reduce energy use - The foundation of our efforts starts with reducing consumption and minimizing waste. Energy can be reduced in building construction and operation through green building and energy efficiency upgrades. In the transportation sector, energy can be reduced by shifting travel from cars to walking, biking, and public transit. Energy can also be reduced by making conscious choices about materials and consumption, in addition to diverting recyclable and compostable material from landfills.

Clean electricity - As energy reductions are made, the power we use must become cleaner. Clean electricity can refer to sources that do not burn fossil fuels, like large-scale hydropower, which do not create carbon emissions, or renewable energy, which is both carbon-free and was derived from sources that are naturally replenished. California mandates that the utilities have an ever-growing percentage of their electricity come from renewable sources, such as solar and wind, and much of the GHG emission reductions to-date have been attributed to the increasing supply of clean electricity in the power mix. In addition to installing solar on their rooftops, Berkeley residents and businesses can now opt-up to 100% clean electricity through East Bay Community Energy (EBCE).

Electrify transportation and buildings - As the electrical supply becomes cleaner, it is critical to transition Berkeley's energy needs away from fossil fuels, like gasoline and natural gas, to clean electricity instead. Currently, fossil fuel powered vehicles account for 60% of emissions, and natural gas is responsible for an additional 27% of the community's GHG emissions. Gasoline-powered cars can be replaced with electric vehicles and electric public transportation. Natural gas can be phased-out of buildings by transitioning to ultra-efficient electrical appliances. Rooftop solar systems with battery storage support electrification and the resilience goal of accelerating access to reliable clean energy.

A description of the City's actions and upcoming activities to reduce energy use, clean electricity, and electrify transportation and buildings to achieve a clean energy future follows.

Reduce energy use

Reduce Energy Use: Transportation

Transportation accounted for 60% of Berkeley's total GHG inventory in 2016. The City continues to work on getting people out of cars and into less-polluting modes of transportation which reduces vehicle miles traveled and improves quality of life. Strategies in this area include the goBerkeley parking management program, which reduces vehicle travel associated with searching for parking; car sharing service options, including one-way car share; transit infrastructure investments to increase ridership by reducing transit travel time and delay; and safe, abundant pedestrian and bicycle infrastructure. In addition, the City continues to focus new compact, mixed-use development along public transit corridors in designated Priority Development Areas, particularly in or near Downtown Berkeley.

Strategic work in this sector includes updating and implementing transportation plans. The Pedestrian Master Plan is scheduled for completion mid-2019, and implementation of the Berkeley Strategic Transportation (BeST) Plan is underway, including Vision Zero work to end traffic deaths on Berkeley streets. Traffic safety improvements and housing density near jobs have contributed to Berkeley having the highest walking commute rate in California (among cities with populations over 5,000), and the 2nd highest in the nation among mid-sized cities.

Implementation of the Berkeley Bicycle Plan (2017) supports bicycle travel and commuting by reducing traffic stress experienced by existing and potential bicyclists. Low stress bikeways encourage biking. Nearly 10% of Berkeley residents bike to work; as a result, Berkeley has the highest bicycle commute rate in the nation among cities with populations over 100,000. Recent accomplishments supporting biking, as well as walking and transit, include the Bancroft Bikeway and Pilot Transit-Only Lane and the Hearst Complete Street Project. The first phase of Berkeley's bike share (Ford GoBike) station network was completed in July 2018, and Berkeley currently leads the East Bay in daily rides per shared bike. A new protected bike lane is being evaluated for Milvia Street. The new Center Street Garage now provides a new permanent home for the Bike Station with secured bike parking, rentals and repairs.

Several recent actions highlight Berkeley's Transit First policy, including the installation of a bus-only lane as part of the Bancroft project and a bus stop consolidation project on Telegraph Avenue, both of which support transit travel time and reliability. In addition, over $7 million in federal funding will be used to support the Southside Complete Streets project which will include transit time reliability improvements.

Reduce Energy Use: Waste

Although waste is a small contributor to Berkeley's community-wide GHG emissions in comparison to transportation and buildings, reducing the amount of waste produced can directly save energy and emissions related to producing and transporting goods.[2] In addition, reducing the amount of waste that ends up in a landfill reduces methane emissions, a powerful greenhouse gas released as organic materials decompose in a landfill.

The Zero Waste Division is strategically planning and implementing programs and services to bring the City closer to its zero landfilled waste goal. Since 2016, Berkeley's zero waste efforts have included:

- **Expanding Commercial Service -** On March 1, 2018, the City expanded service to approximately 400 commercial accounts previously serviced by non-exclusive franchised haulers. This Council-led effort will increase control of recycling-

[2] See Attachment 1 for a consumption-based emissions approach that considers the whole life cycle impact of goods and services consumed by Berkeley residents.

related activities, reduce vehicle emissions, traffic congestion, and negative impacts to City streets.

- **Senate Bill 1383** - On September 19, 2016, SB 1383 was signed into law. This State legislation is designed to reduce short-lived climate pollutants and requires 75% organic waste reduction by 2025, and a 20% increase in recovery of edible food that is currently disposed by 2025. California local jurisdictions have significant new requirements to implement new waste-reduction programs and enhanced reporting and enforcement protocols to comply with the state legislation.
- **Single Use Foodware and Litter Reduction Ordinance** - On April 24, 2018, City Council referred a proposed Single Use Foodware and Litter Reduction Ordinance to the Zero Waste Commission to invite input from key stakeholders, including restaurants and other food retailers and zero waste, plastics, oceans and other environmental experts, and hold public meetings to obtain input on the proposed Ordinance. The Zero Waste Commission approved their recommendations on September 24, 2018, and will report to Council this year.
- **Zero Waste Strategic Plan** - Based on a Council-approved Zero Waste Commission recommendation, staff plans to release a Request for Proposals (RFP) for a Zero Waste Strategic Plan in early 2019 to better understand what programs and policies will help the City reach its goal effectively.
- **Zero Waste Transfer Station Rebuild Feasibility Study -** The City is hosting a series of workshops, open houses and other events to solicit community input about how to develop the nearly 8-acre West Berkeley site, the hub where the City sorts and transfers garbage, recyclables, compost and other materials, into a state-of-the-art zero waste facility to meet current and future needs and achieve the City's goal of zero waste.

Reduce Energy Use: Buildings

Berkeley has been very successful in reducing the amount of energy used in buildings, achieving a 35% reduction in GHG emissions below 2000 levels. Despite these efforts, buildings remain a major source of GHG emissions in Berkeley (37%). Berkeley's innovative approach to address energy use in existing buildings is through the Building Energy Saving Ordinance (BESO).

Adopted by the City Council in 2015, BESO requires Berkeley building owners to complete energy efficiency opportunity assessments and publicly report the building's energy efficiency information. It is designed to provide individualized and comparative energy data to building owners and potential buyers so that they can make smart energy investments in their buildings. The program is designed to link building owners to incentive programs for energy efficiency upgrade projects, such as Energy Upgrade California. Staff will come back to Council in 2019 with a full evaluation of the ordinance, identifying potential improvements to ensure it promotes electrification goals.

While using policy to address building energy usage throughout the community, the City also has opportunity in our municipal buildings to showcase innovation and best practices in energy efficiency, renewable energy, water efficiency, and green building practices. By investing in energy efficiency, Berkeley has reduced municipal energy use by 10% from the 2000 baseline despite a 17% increase in square footage of City facilities. Berkeley, like many local governments, is working to create a resilient and clean energy building portfolio. Please see Attachment 3 for a comprehensive report on municipal energy and water efficiency improvements through 2017.

Clean Electricity

Clean Electricity: East Bay Community Energy

East Bay Community Energy (EBCE), our locally governed electricity supplier, is now serving commercial and residential customers in Berkeley and throughout Alameda County. EBCE offers a pivotal opportunity to reduce GHGs via equitable access to clean electricity.

PG&E will continue to deliver electricity and gas, maintain the power lines, respond to outages, and provide billing and customer service. EBCE will purchase electricity from clean, renewable sources such as solar and wind on behalf of Alameda County residents and business (see Figure 3).

Figure 3: Graphic depicting EBCE and PG&E's role in providing electricity to customers[3].

EBCE began serving businesses and institutional organizations in June 2018. Residential service began November 2018 and solar customers will transition in 2019. All customers are automatically enrolled in EBCE's *Bright Choice* standard electricity service which is less expensive than PG&E. Customers also have the choice to opt up

[3] Graphic from EBCE's website: www.ebce.org.

to either *Brilliant 100* or *Renewable 100* (see Figure 4), or can continue to purchase electricity directly from PG&E by opting out of EBCE.

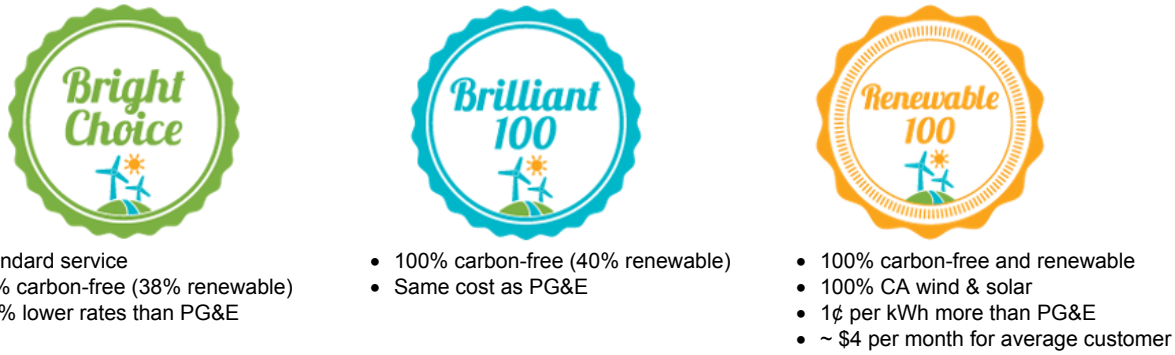

Figure 4: Comparison of EBCE's three electricity products available in Alameda County.

Customers in special programs, such as the high usage Medical Baseline Allowance or low-income CARE and FERA, can participate in EBCE and will continue to receive discounted rates.

Table 1: Summary of EBCE's Non-Residential Customer participation as of 10/8/2018. Service began June 2018.

EBCE's Berkeley Non-residential Customers	
Accounts Served	5,502
Opt outs	75
Opt out percentage %	1.4%
Brilliant 100 opt ups	353
Brilliant 100 opt up percentage %	6.4%

On April 24, 2018, Berkeley City Council voted to opt-up its municipal accounts to EBCE's 100% carbon-free electricity service – *Brilliant 100* – reducing municipal GHG emissions by more than 50%. Any future reductions in municipal building emissions will only be achieved by reducing demand (energy efficiency), and electrifying our heating and cooling. Actively encouraging residential and commercial opt-ups to either *Brilliant 100* or *Renewable 100* will help accelerate community-wide reductions to help meet climate and other goals.

Clean Electricity: Solar

In addition to the clean electricity now available through EBCE, Berkeley continues to support opportunities to increase rooftop solar access. In recognition of these efforts, including streamlined permitting, inspection, and other best practices for solar

photovoltaic (PV) installation, Berkeley is receiving a SolSmart Gold designation, the highest award level. SolSmart is a national designation program which brings no-cost technical assistance to further Berkeley's efforts to increase equitable access to solar.

For the third consecutive year, the City is participating in the Bay Area SunShares program. SunShares pools the buying power of residents, vets the contractors, and provides neutral information about clean energy (rooftop solar and community choice energy) and vehicle options at free community workshops. These discounts, along with education and a streamlined process, help to overcome market barriers to residential rooftop solar, battery storage, and EVs.

In 2016-17 Bay Area SunShares installed 350 solar systems in the Bay Area, and 34 installations in Berkeley for a total of 130 kWs of additional renewable energy.

Table 2: Two Year Summary of Berkeley SunShares Program Outcomes

Year	Sign-ups	Solar Contracts Signed	Kilowatts (kWs)
2016	104	11	43
2017	141	23	97

Of the 50 outreach partners last year, Berkeley had the second highest number of installations.

Electrify Transportation and Buildings

Electrify Transportation and Buildings: Transportation

In addition to the efforts to get people out of cars into less-polluting modes of transportation including active mobility, the City also recognizes that transitioning vehicles away from fossil fuels and towards clean electricity is essential to removing the 60% of GHG emissions that are associated with the transportation sector. Nearly three-quarters of these emissions come from gasoline-powered passenger vehicles. Berkeley has been encouraging electric vehicle (EV) adoption since 2011 through activities such as education and outreach, streamlined permitting, technical assistance on EV charging to the business community, a Pilot for residential curbside EV charging, and the provision of public charging stations on municipal property including those in the new Center Street Garage. In 2017 there were 2,175 EVs registered in Berkeley, compromising 3% of Berkeley's total vehicle registrations. Nearly 17% of Berkeley's new vehicle registrations in 2017 were EVs.

The City is currently developing a comprehensive action-based EV Roadmap to find opportunities to increase equitable access to EVs within Berkeley's diverse community.

This project, to be completed in 2019, will identify specific EV goals and strategies to support Berkeley's climate, resilience, and equity goals with timelines, estimated costs, and opportunities for funding. Along with automobiles, the EV Roadmap project will research opportunities to utilize EV car sharing, EV Transportation Network Companies, electric bicycles, electric scooters, and other shared electric mobility options including autonomous vehicles. In addition, the City is currently working to create a franchise structure for a shared electric scooter program.

The City is also working to incorporate additional EVs into the City fleet. Ten plug-in EVs are being ordered in 2018 and procurement of an additional 15 EVs for the City fleet is planned for 2019, utilizing the Climate Mayors Electric Vehicle Purchasing Collaborative.[4]

Electrify Transportation and Buildings: Existing Buildings

Combustion of natural gas within Berkeley buildings accounted for 27% of total GHG emissions in 2016 and 73% of building sector GHG emissions. Achieving Berkeley's GHG emission reductions goals requires phasing natural gas out of our existing buildings. This means that furnaces, gas-fired water heaters, gas stoves, and clothes dryers must be swapped for ultra-efficient electric heat pump technology as they are replaced at end of life or through voluntary upgrades.

The City of Berkeley is leading by example through work to incorporate electrification and achieve zero-net energy in retrofits of municipal buildings. For example, a clean energy retrofit of the historic Mental Health Clinic at 2640 MLK Jr Way will include envelope insulation and draft sealing, replace natural gas applications with high efficiency heat pumps, and add natural light and LEDs to brighten dark work spaces. This project, like the West Branch Berkeley Library, the City's first Zero Net Energy building which was completed in 2013, is expected to generate zero net emissions.

Heat pump water heaters (HPWHs) are an ultra-efficient technology that use electricity rather than burning fossil fuel. HPWHs play an important role in transitioning water heating to clean energy. As part of implementing the Deep Green Building Initiative, staff is working to promote heat pumps through education and training for contractors, City staff, and the public, highlighting the benefits, challenges, and permitting requirements to installing this technology in Berkeley homes. This year, Berkeley participated in a pilot program financed with rate-payer funds to install HPWHs, with a large rebate for market-rate homes and cost-free installation for income-qualified households.[5] The pilot has installed 10 HPWHs in Alameda and Contra Costa Counties

[4] Climate Mayors Electric Vehicle Purchasing Collaborative: https://driveevfleets.org

[5] The Alameda County and Contra Costa County Heat Pump Water Heater Pilot Program was funded by East Bay Energy Watch (EBEW), a Local Government Partnership funded by California utility ratepayers. It was administered by CESC in collaboration with StopWaste and input from local government sustainability staff. All rebate funds for the pilot have been allocated, but Community Energy Services Corporation, the program administrator, will continue to offer HPWH installation services in the future.

as of October 2018, including one income-qualified and one market-rate home in Berkeley. This pilot has highlighted barriers and identified potential solutions to support broader scale adoption of HPWHs.

Berkeley has shown commitment to electrification through the Deep Green Building Initiative, staff leadership within Green Cities California and other regional and state forums, and City Council pledges to achieve zero net carbon emissions and pursue becoming a Fossil Free City. This dedication has attracted the attention of the newly-formed Building Electrification Initiative, a program of the Innovation Network for Communities. The City of Berkeley has been invited to join New York City (NY), Boulder (CO), Burlington (VT), and Washington DC as one of the inaugural cities in this Initiative. Participation, kicking off in late 2018, brings foundation-supported technical assistance to provide market segmentation analysis, regional supply chain analysis, assessment of local barriers and opportunities, and support for equitable implementation to dramatically accelerate the market growth of HPWH and heat pumps for space heating and cooling.

In addition, in October 2018, the City released an RFP for a “Pathways to Clean Energy Buildings Report: Existing Building Program Evaluation and Recommendation.” This project will include an evaluation of the BESO ordinance, including recommendations to improve its effectiveness and incorporate electrification, and will identify and analyze policy alternatives and develop long-range strategy with short-term measures to transition to 100% clean energy in existing buildings within Berkeley. The project will be completed in 2020 and will identify policy and program options to transition Berkeley’s existing building stock to efficient, clean energy buildings and ensure equitable access to opportunities. Along with the Building Electrification Initiative assistance, the project will provide the City with strategic opportunities for bold advancements for electrification in existing buildings to reduce the GHG emissions currently associated with their operations.

Electrify Transportation and Buildings: New Buildings

As a built-out city, concentrating on electrifying the existing building stock in Berkeley is critical. New infill development, particularly near transit, is also encouraged and is occurring. As a result, ensuring that new buildings in Berkeley are energy efficient, utilize renewable power, and minimize or avoid the use of natural gas, is vital to meeting climate goals.

As part of the work to implement the Berkeley Deep Green Building Initiative, Berkeley provided leadership to successfully incorporate electrification-supportive elements into the 2019 State Building Codes, specifically the 2019 Energy Code and 2019 CALGreen (California Green Building Code). As of January 1, 2020, these Codes will require deep energy efficiency improvements, and rooftop solar electricity generation in most residential buildings, resulting in new residential buildings that use about 53% less energy and new nonresidential buildings that use about 30% less energy than required

under current Codes. In addition, the 2019 Energy Code includes for the first time an all-electric baseline for new low-rise residential construction, removing past barriers to this type of construction.

Berkeley has worked with other local governments to create a joint cost-effectiveness study request for the California Codes and Standards Program, seeking the maximum cost-effective efficiency for mixed-fuel and all-electric new construction over a representative sample of building sizes and uses. Any local amendments (or "reach codes") to the State Energy Code must show cost-effectiveness in order to be approved by the California Energy Commission. The findings from this cost-effectiveness study request are expected in early 2019 and will be shared with the Energy Commission and other stakeholders, to evaluate options and opportunities for local amendments to promote deep energy savings and electrification.

Beyond building operation emissions, the Berkeley Deep Green Building Initiative is also concerned with the emissions related to construction and raw materials of a new building, termed "embodied carbon." To address this, Berkeley is monitoring the State's Buy Clean California requirement for low-carbon and climate-friendly supply chain solutions for applicability to City projects. Buy Clean California is a campaign to reduce the embodied carbon that goes into public-sector buildings and infrastructure, and influence the market to encourage the private-sector to do the same. Berkeley is watching this effort for opportunities for City-sponsored building projects and other advancement within Berkeley.

Electrify Transportation and Buildings: Solar + Storage

As Berkeley's population continues to increase and energy use shifts from natural gas and petroleum to electricity, the electricity load in Berkeley will increase. This will require innovative strategies to ensure that the grid will remain clean, reliable, and resilient, at times when solar is not available, during peak energy demands, and in the event of natural disasters. One solution is battery storage or a battery storage combination, as in solar + storage. Battery storage acts like a generator that can be used on a daily basis to shift load from one time to another or be used as back-up power. Solar + storage combines clean energy generation (solar) with batteries to capture and store solar energy that is produced during the day. The stored energy can be used after the sun goes down, when energy needs are at their highest and energy prices peak, or as clean back-up electricity in the event of a power outage. This combination of solar + storage supports electrification and resilience efforts.

Equity

Equity is an essential consideration within strategic planning initiatives to determine the most valuable and achievable programs and policies to create Berkeley's path to a clean energy future. Climate change affects everyone, but its impacts are not felt equally. Programs and policies that address climate change must prioritize the communities that have been subject to structural and institutional racism and are disproportionately affected by climate change. It is important to recognize that the path to a clean energy future is associated with new technologies that may change the needs of the local workforce. This transition will require strategic investments in both buildings and people.

Staff is incorporating an equity-centered approach to evaluate who benefits from City sustainability programs and policies, as part of the City's commitment to increasing inclusiveness, accessibility, and equity. To ensure that equity is embedded and operationalized into sustainability efforts, all OESD staff participated in the five-part Equity Foundations Training Series through the Urban Sustainability Directors' Network.

Additional examples of equity work include:

- **Equity in Energy Transformation -** In partnership with the City of Burlington, Vermont, Berkeley collaborated on the development of *A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners*.[6] This Guidebook, published in 2018, provides direction for creating clean energy programs, promoting solar, EVs, and battery storage, which are accessible and beneficial to low- and moderate-income households, communities of color, and indigenous communities.
- **Applied Equity Analyses** - Staff is using lessons learned from the Equity in Energy Transformation project to further inform our strategic planning including incorporating equity analyses for both the recent *EV Roadmap* and the *Pathway to Clean Energy Buildings* RFPs.
- **Equity in Climate Adaptation Training -** Berkeley staff, in partnership with equity and adaptation leaders, will be hosting an all-day regional Equity in Adaptation Training for local government staff to build capacity and operationalize equity in the context of adaptation planning.
- **Berkeley Climate Action Coalition (BCAC) -** BCAC provides a platform to support and mobilize residents, non-profits and others interested in joining

[6] A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners: https://www.usdn.org/public/page/22/Social-Equity#BurlingtonEquityEnergy

together to help implement Berkeley's CAP. The Ecology Center, in partnership with the City of Berkeley, convenes the BCAC. Its events and initiatives highlight the voices of marginalized populations; topics of have included climate refugees, smart and just growth, activism to stop refinery expansion in African American and Latino communities, the health and climate justice nexus, green jobs, urban agriculture in food deserts, equity in climate adaptation, and intergenerational climate action and community organizing. BCAC has advocated for free youth bus passes, energy solutions for renters, community choice energy, and solar for all.

Adaptation and Community Resilience

The impacts of anthropogenic climate change are imminent and already happening today. Berkeley will face many climate change hazards, including sea level rise, extreme heat, extreme storm events, drought, and wildfire. For example, sea level rise in Berkeley is expected to be anywhere between 2 to 8 feet by 2100.

In order to continue building a resilient and equitable community, Berkeley is advancing work to better prepare for the impacts of climate change and other hazards as was articulated in Berkeley's Resilience Strategy.[7] This includes planning for reliable clean energy, creating buildings that use less energy and can withstand disasters, improving infrastructure, landscapes and neighborhoods to become more resilient to the effects of climate change, and fostering resilience in the community through community engagement and regional collaboration.

Examples of adaptation and community resilience work include:

- **Berkeley Energy Assurance Transformation Project (BEAT)** - Staff completed a research and feasibility analysis for a microgrid for renewable back-up power for City buildings and critical facilities. A fully-connected microgrid was deemed too expensive, but an "islandable" solar + storage solution for individual critical facilities is now being explored. Solar + storage would co-locate solar panels and battery storage so that solar energy could be used even when it was dark outside, and could be separated from the grid during a power outage and be deployed as clean back-up power for critical needs in the case of an emergency. Berkeley staff is currently investigating different ownership and financing options for solar + storage systems.

[7] Berkeley's Resilience Strategy: www.cityofberkeley.info/Resilience

- **Local Hazard Mitigation Plan (LHMP) -** The LHMP, currently under review for a 2019 Update, identifies climate change as a hazard that will affect the Berkeley community. The LHMP is the main document that houses the City's climate adaptation work. This includes hazards such as extreme heat, sea-level rise and flooding, and water security.
- **Bay Area Climate Adaptation Network (BayCAN) -** Berkeley was a founding member of BayCAN, a network of local government staff helping coordinate an effective and equitable response to the impacts of climate change. BayCAN works to share best practices, develop opportunities for collaboration and program implementation, and secure funding and resources for climate adaptation. Berkeley is partnering with BayCAN for the upcoming Equity in Climate Adaptation Training.
- **Berkeley Climate Action Coalition (BCAC) -** Berkeley and the Ecology Center created the Berkeley Climate Action Coalition in 2012 to engage residents, nonprofits, and interested community members in implementing Berkeley's CAP. The BCAC initiates events, community projects and advocacy that address climate change and works to create a resilient future that includes clean air and water, energy efficient housing, and food, energy and transportation that is local, affordable, accessible and safe.
- **Urban Agriculture -** A new set of zoning and permitting rule changes were enacted to allow small-scale and larger-scale community gardens on both public and private land. The ordinance also allows for the sale of the produce and lightly processed foods from these gardens. The Berkeley Climate Action Coalition championed this initiative as one of their community projects.
- **Community Outreach Events** Berkeley is committed to community engagement and education. Event topics have included green and healthy homes, solar, access to clean energy (East Bay Community Energy), electric vehicles, and professional and workforce development training on electrification.

BACKGROUND

Since 2009 when the Climate Action Plan was approved by City Council, Berkeley's main climate goals were identified as reducing 80% of greenhouse gas emissions below 2000 levels by the year 2050, a goal nicknamed "80 by 50". In recent years, a new wave of momentum to address the climate crisis has come from the State and local community leaders, bolstered by the Global Climate Summit hosted by San Francisco in September 2018, and in response to changes in federal protections and efforts to address climate change. This has led to several recent local and State actions impacting the path to a clean energy future, including:

Berkeley Climate Commitments

Mayor's Commitment to Net-Zero Carbon Emissions

In September 2018, City of Berkeley Mayor Arreguin set a goal to reach 100% renewable electricity by 2035 and achieve net-zero carbon emissions by the year 2050.

Fossil Fuel Free Berkeley

In June 2018, Berkeley City Council referred a proposed resolution[8] to the Energy Commission and Transportation Commission to further implement the Climate Action Plan and establish a goal of becoming a Fossil Fuel Free City.

Berkeley Deep Green Building Initiative

On February 28, 2017, the Berkeley City Council referred to the City Manager and Berkeley Energy Commission the development of a comprehensive, integrated Deep Green Building Program[9] to improve the energy efficiency and sustainability of Berkeley buildings based on the Berkeley Deep Green Building proposal and other cutting edge green building initiatives. The City Manager provided a referral response on the staff and Energy Commission work to date and planned future actions on June 26, 2018.[10]

In addition, on April 24, 2018, the Berkeley City Council[11] allocated $50,000 to conduct an analysis to identify and develop a set of programs and policies consistent with the Climate Action Plan to incentivize residential energy efficiency and electrification investments, based on a cost benefit analysis to determine highest value energy-saving measures in support of the Deep Green Building Initiative referral from Council to the Energy Commission. This funding is supporting the Pathways to Clean Energy Buildings RFP, released in October 2018, which includes identification and analysis of policy alternatives, strategies, and measures to transition to 100% clean energy in existing buildings in Berkeley.[12]

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[8] Fossil Fuel Free City proposed resolution:
https://www.cityofberkeley.info/Clerk/City_Council/2018/06_June/Documents/06-12_Annotated_Agenda.aspx

[9] Deep Green Building Program:
http://www.cityofberkeley.info/Clerk/City_Council/2017/02_Feb/Documents/2017-02-28_Item_27_Berkeley_Deep_Green_-_Rev.aspx

[10] Referral Response: Berkeley Deep Green Building Initiative:
https://www.cityofberkeley.info/Clerk/City_Council/2018/06_June/Documents/2018-06-26_Item_52_Referral_Response_Berkeley_Deep.aspx

[11] Allocation of funds for cost-benefit analysis of sustainability measures:
https://www.cityofberkeley.info/Clerk/City_Council/2018/04_Apr/Documents/04-24_Annotated.aspx

[12] Pathways to Clean Energy Buildings RFP:
https://www.cityofberkeley.info/uploadedFiles/Finance/Level_3_-_General/19-11256-C%20-%20RFP%20Pathway%20to%20Clean%20Energy%20Building%20Report_revd%201017.pdf

Vision 2050

Vision 2050, supported by Measure R in the November 2018 election, is an effort to develop a framework for a 30-year sustainable infrastructure plan. The goal of the Vision 2050 plan is to ensure that Berkeley is prepared for climate change by identifying and guiding the implementation of a climate smart, technologically advanced, integrated, and efficient infrastructure system.

California Climate Commitments

SB100: The 100% Clean Energy Act of 2018

Governor Brown signed into law SB 100[13] which requires California to obtain 60% of its electricity from renewables by 2030 and 100% carbon-free electricity by 2045.

Assembly Bill 3232

Signed into law on September 13, 2018, AB 3232[14] charges the California Energy Commission with assessing how to reduce GHG emissions from the State's building stock by at least 40% below 1990 levels by 2030.

Senate Bill 1477

SB 1477[15] authorizes the California Public Utilities Commission to allocate up to $50 million annually to provide incentives for energy storage, solar thermal, and other technologies to create near-zero emission homes. SB 1377 includes specific support for low-income residents.

Executive Order B-55-18 to Achieve Carbon Neutrality

Governor Brown's authored an Executive Order for California to become carbon neutrality by 2045[16] and be net negative on GHG emissions thereafter. Achieving carbon neutrality will be statewide and economy-wide, including carbon emissions from the transportation and building energy sectors. Any emissions will need to be offset by equivalent net removals of carbon dioxide from the atmosphere, including through sequestration in forests, soils and other natural landscapes.

Low Carbon Fuel Standard (LCSF)

The California Air Resources Board recently approved a requirement that fuel producers cut the carbon intensity of their fuels 20% by 2030, as part of a policy called the Low Carbon Fuel Standard.[17] The previous target, which still applies, had been 10% by 2020.

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[13] SB100 The 100% Clean Energy Act of 2018: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

[14] AB 3232: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB3232

[15] SB 1477: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1477

[16] Executive Order B-55-18: https://www.gov.ca.gov/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf

[17] The Low Carbon Fuel Standard can be found at https://ww2.arb.ca.gov/news/carb-amends-low-carbon-fuel-standard-wider-impact.

ENVIRONMENTAL SUSTAINABILITY

The Climate Action Plan, Resilience Strategy, Local Hazard Mitigation Plan, and new strategic plans all contribute to advancing the community closer to a clean and reliable energy future that successfully meets Berkeley's climate goals. Mitigation of GHG emissions within Berkeley and planning for the impact of climate change are interrelated and, with careful strategic planning, can address environmental concerns and achieve a sustainable future.

POSSIBLE FUTURE ACTION

This report and presentation provide the City Council with an update on GHG emission trends to date, an overview of associated activities, and the planning efforts underway to develop strategies to accelerate the rate of GHG emission reductions to reach Berkeley's increasingly ambitious climate goals. The current strategic planning efforts for transportation, waste, and buildings will provide a pathway for concentrated reductions in energy use, clean electricity, and electrification of the building and transportation sectors. Staff will return to Council for direction on prioritization and funding based on the findings of these strategic plans.

FISCAL IMPACTS OF POSSIBLE FUTURE ACTION

Current climate action priorities are funded by existing grants, enterprise funds, and General Fund allocations. Staff continues to seek additional grants and other sources of funding to accelerate existing efforts. The fiscal impacts of accelerating CAP implementation are currently unknown, but are expected to be significant, and are dependent on Council's policy choices.

Strategic electrification is key to achieving our community's ambitious climate goals. However, current rate structures and programs in place often impede electrification efforts, making electrification a costly option. Moving forward, close collaboration and cooperation with our utilities, PG&E and EBCE, will be necessary to create rates that are equitable and provide a pathway to fossil-free energy sources for Berkeley residents and businesses and ensure a resilient and safe electricity grid. An equitable transition to clean electricity will require strategic investment in buildings and people.

CONTACT PERSON

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Attachments:
Attachment 1: 2016 Berkeley Community-wide Greenhouse Gas Inventory
Attachment 2: Progress Report from UC Berkeley & the Berkeley Lab
Attachment 3: Progress Report on Municipal Facilities

Attachment 1: Berkeley's Community-Wide Greenhouse Gas Emissions Inventory

Introduction

In order to understand the sources of community-wide greenhouse gas (GHG) emissions, the Office of Energy & Sustainable Development conducts an annual GHG emission inventory. Data is gathered from regional entities on sector-specific activities, and is then converted to metric tons of carbon dioxide equivalent (MT CO2e). The inventory utilizes the best available data (despite challenges arising this year regarding access to accurate, consistent datasets) and follows a global protocol which allows the City to report consistently to the community and to other agencies, such as the Global Covenant of Mayors for Climate & Energy. This inventory focuses mainly on emissions that are created within Berkeley's border, considering sectors like transportation, the built environment, landfilled solid waste, water consumption, and wastewater usage. A newer inventory methodology called a 'consumption-based inventory' accounts for the impacts of goods and services consumed by Berkeley residents and businesses, even if the related emissions were created elsewhere. These two approaches can help paint a more holistic picture of the Berkeley community's carbon footprint and how reduction strategies should be prioritized.

Community-Wide GHG Emission Inventory

Creating and updating a consistent GHG emissions inventory helps to define the extent to which certain sectors and fuels contribute to GHG emissions, and helps to track progress toward the community's climate goals over time. This type of inventory focuses on emissions that have occurred within Berkeley's jurisdictional boundaries, which includes the following emissions sources: transportation modeled from traffic analysis, building electricity usage, building natural gas consumption, landfilled solid waste, as well as emissions from water consumption and wastewater treatment. Although this inventory does not include UC Berkeley and Lawrence Berkeley National Lab, as they are outside the City's jurisdiction, they continue to be valued partners in efforts working to improve our shared community and combat climate change. 2016 is the most recent full year of available data.

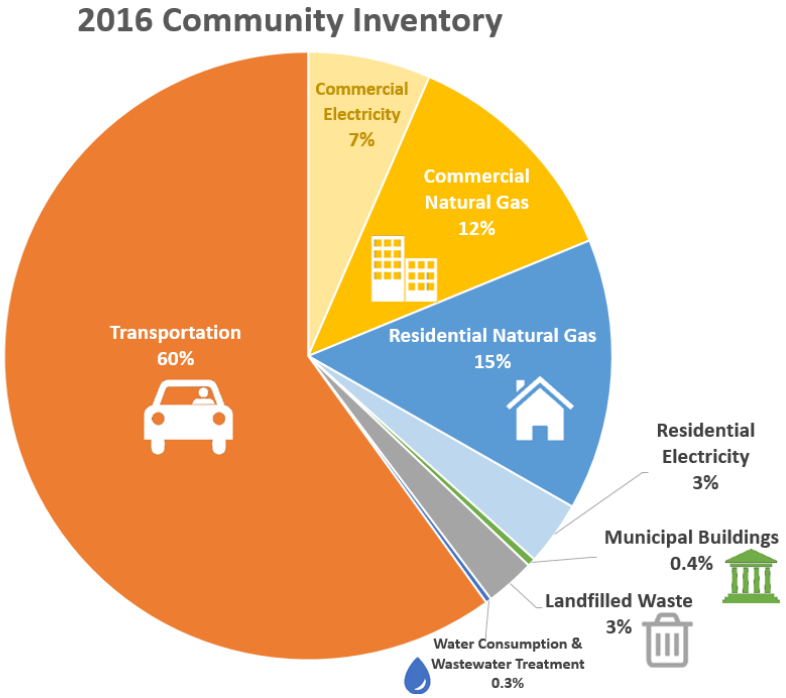

Figure 1: Pie chart of 2016 community-wide GHG emissions inventory, broken down by sector and fuel.

Creating an emissions inventory that tracks each sector and fuel individually informs policies and programs that may provide the biggest impact to achieving the Climate Action Plan (CAP) emission reduction goals. The distribution seen in Figure 1 is similar to inventories conducted in the past, with over half of emissions coming from the transportation sector, calculated from a regional traffic analysis model conducted by the Metropolitan Transportation Commission.

Energy usage data in Berkeley buildings is provided by PG&E, and is broken down into residential, municipal, and commercial (including industrial) buildings—for both electricity use and natural gas combustion. The built environment is the second largest source of emissions at 37%.

Other sectors include landfilled waste, water consumption, and wastewater treatment. These sectors, although seemingly small based on this community inventory, represent much broader environmental concerns, such as the impact on water management systems as California experiences more frequent and intense droughts. Solid waste, particularly organic material, emits methane when landfilled, which is accounted for in this inventory. However, the impacts related to the production, transport, and consumption of goods and services, long before reaching a landfill, must also be considered. Please see the section on consumption-based inventories for more detail.

Current Community-Wide GHG Emission Trends

The most current community emissions are compared to the CAP baseline year of 2000, to identify reductions achieved thus far. A historic summary of Berkeley's annual emissions inventories from 2000 to 2016 is provided in Figure 2.

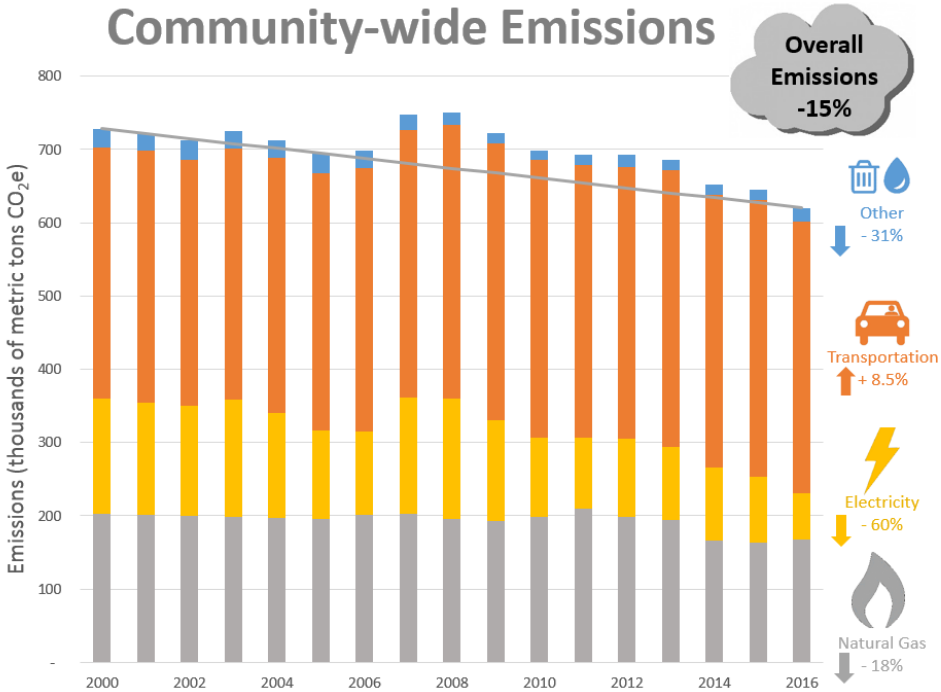

Figure 2: Historic Berkeley emissions inventories back to 2000, broken out into building natural gas and electricity, transportation, and other (water, wastewater treatment, and landfilled solid waste).

Community-wide emissions were 15% below 2000 levels in 2016, even though Berkeley's population increased approximately 18% during that same time period. This is an impressive feat, with reductions resulting from a combination of state, regional, and local efforts including:

- Reduction in building energy use: See Table 1 for a breakdown of electricity and natural gas reductions in each building sector since 2000. Energy efficiency measures contribute to these savings, including those reached through rebate programs such as Energy Upgrade California, more efficient lighting and appliances, and improved building envelopes. Reducing the energy needs of a building first reduces the cost and feasibility of renewable energy and electrification efforts.

	Residential	Commercial / Industrial / Municipal	All Buildings
Electricity Usage	-19%	-24%	-22%
Natural Gas Usage	-27%	-3%	-18%

Table 1: Summary of 2016 trend in electricity and natural gas usage within each building sector—residential, commercial (including industrial buildings), municipal, and overall—compared to 2000 baseline year.

- Increased rooftop solar: According to data from the California Solar Initiative, Berkeley businesses and residents collectively installed over 2,090 solar photovoltaic (PV) systems from 2000 to 2016, increasing solar capacity to approximately 8,560 kW, providing renewable energy to power buildings and adding any excess clean electricity back into the grid.

- Cleaner electricity mix: State laws like the Renewables Portfolio Standard (RPS) require PG&E to increase the amount of renewable energy on the grid, causing the GHG emissions produced per kilowatt-hour of electricity consumed to decrease. PG&E increased their renewable content from 30% to 33% over the course of 2016, as well as doubled their large hydroelectric power. Therefore, with a 22% electricity *usage* reduction since 2000, *emissions* actually decreased by 60%, due to the increased RPS. Participation in East Bay Community Energy, particularly the *Brilliant 100* and *Renewable 100* products, which contain more carbon-free and renewable energy than PG&E's product, will further accelerate the Berkeley community toward emissions-free electricity.

- Water consumption*:* The community reduced its water consumption in buildings by 30% below 2000 levels, and conservation continues to be critical as the Bay Area is expected to experience further drought in the coming years.

- Reduction of landfilled waste: The community has significantly reduced the amount of waste sent to landfills since 2000 through the expansion of recycling and composting services. Further reductions could be achieved through source reduction, preventing waste by reusing items or avoiding disposable, single-use products.

- Transportation: Transportation is the largest source of community-wide emissions, and modeled data shows an increase of 8.5% from 2000 to 2015 due mostly to population increase. The municipal vehicle fleet decreased emissions by 13% due to cleaner and more efficient vehicles.

In 2016, statewide emissions decreased approximately 9% since 2000[1], compared to the 15% reduction achieved in Berkeley. Statewide emissions reductions are expected to accelerate with the recent passing of SB 350, which sets a goal for 50% of the electricity in California to come from renewable energy by 2030, and doubling the energy efficiency of buildings in the next 15 years. A Bay Area regional inventory completed by the Bay Area Air Quality Management District (BAAQMD) shows a 29% increase in emissions between 1990 and 2011, driven mainly by a 23% increase in the region's population during that time period[2].

Future Considerations for Tracking Progress

Natural Gas Emissions: It is important to note that emissions from natural gas may be much larger than what is depicted in this inventory. Recent research, including a study done by San Francisco Department of the Environment indicates that current emissions methodology may severely underestimate the impact of leakage throughout the entire natural gas system. Not only do natural gas leaks pose a health and safety threat to the community (e.g. the San Bruno pipeline explosion), but they also release methane (the main component in natural gas) into the atmosphere, which traps 80 times more heat than carbon dioxide. Methane is a short-lived climate pollutant, and current methodology uses longer-terms that underestimate methane's short-term impacts to the atmosphere. In addition, natural gas leakage is estimated to be approximately 1.4%, whereas new independent studies average that leakage could be 4.52%, with estimates seen up to 12%, which could make natural gas essentially as polluting as coal.[3] Originally seen as a clean 'bridge fuel', California is on the leading edge of analyzing the full effects of natural gas on the atmosphere and on local communities, which will include finding a path to transitioning away from natural gas to clean, renewable electricity. A methodology to integrate this into local government emissions tracking is not yet available; however, staff is working with leading experts to address this underestimation in the current inventory, to better tell the story of reducing community-wide emissions.

Data Access & Accuracy: A CPUC ruling regarding data privacy has severely hindered staff's ability to attain accurate and consistent building energy usage data from PG&E for the GHG emissions inventory. The ruling dictates certain thresholds a dataset must meet in order to protect individual customer usage data from being disaggregated from the total. The data that conforms with the new ruling is not consistent with Berkeley's 2000 baseline, and therefore conducting the inventory using the same methodology that staff has used since the CAP was adopted in 2009 may no longer be feasible beginning early next year. Staff is investigating alternative options in order to continue tracking progress toward Berkeley's ballot proposition goal of achieving 80% reductions below 2000 levels by the year 2050 (also known as "80x50").

Consumption-Based GHG Emissions Inventory

Although the more traditional emission inventory that Berkeley uses—known as a 'production-based' or 'sector-based' inventory, like the one described above—lays a foundation for key climate policy and program planning, taking a look at the emissions beyond Berkeley's borders can be beneficial to addressing the climate crisis as a regional or global issue. An individual's impact on the environment does not end at its city's boundaries, but extends to imported and exported goods consumed by that individual.

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[1]. https://www.arb.ca.gov/cc/inventory/data/data.htm Please note methodologies between state, regional, and local emissions inventories may vary slightly.

[2] http://www.baaqmd.gov/about-air-quality/research-and-data/emission-inventory/climate-forcing-pollutants. Please note methodologies between state, regional, and local emissions inventories may vary slightly.

[3] Methane Math: How Cities Can Rethink Emissions from Natural Gas, San Francisco Department of the Environment (November 2017) https://sfenvironment.org/download/methane-math-how-cities-can-rethink-emissions-from-natural-gas

Consumption-based inventories take into account the entire life cycle of a specific product to calculate its GHG emissions. Included are goods and services such as air travel (even if, as for Berkeley, the airport is located outside of a jurisdictional boundary), food, appliances, and construction of buildings.

For example, a T-shirt that is manufactured in China, shipped to the US, and purchased by a Berkeley resident normally would not appear in a sector-based inventory, as the T-shirt is not emitting greenhouse gases once in Berkeley. However, a consumption-based approach would allocate emissions related to materials extraction, manufacturing, and transport to the Berkeley household as the ultimate consumer of the product. See Figure 3 for a diagram of the relationship between consumption- and sector-based approaches.

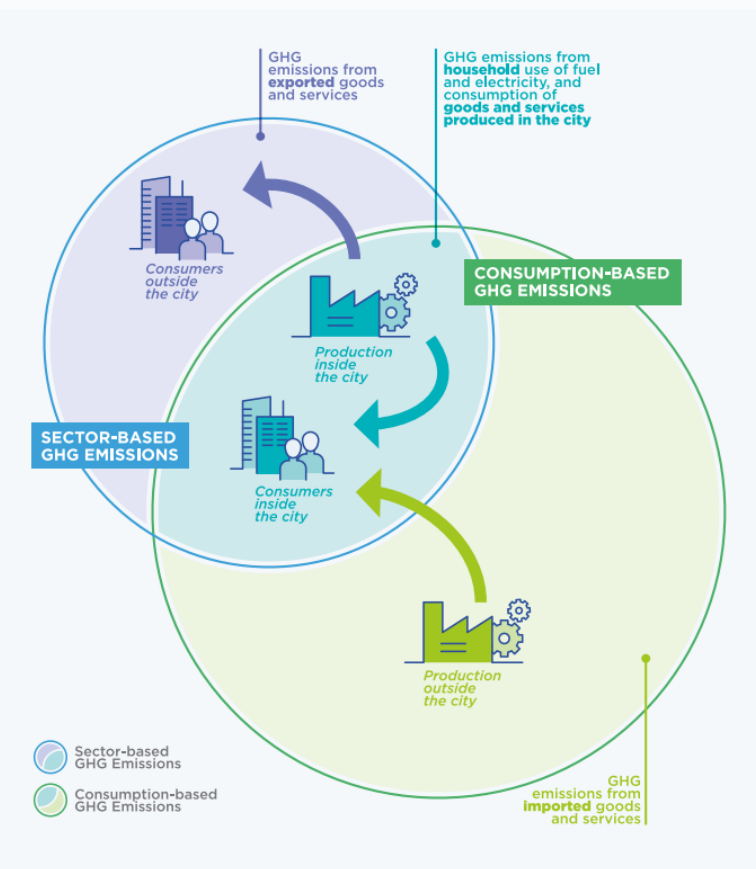


Figure 3: A diagram depicting the relationship between sector- and consumption-based approaches to GHG emissions tracking. [4]

While this inventory would be an ideal way of tracking Berkeley's complete carbon emission profile, capturing this data accurately has been proven very complex. Currently no standardized or accurate methodology across cities has yet been adopted. However, several studies have begun to create a methodology. The CoolClimate Network, a research partnership including UC Berkeley, has created a consumption-based inventory for every city in Alameda County. Local data was used where possible, but the model has a lot of underlying assumptions based on sources such as consumer survey responses, census information, or state data. This inventory corresponds with calendar year 2013, and due to overlapping categories with the sector-based approach (as shown in Figure 3), cannot be added directly into Berkeley's sector-based inventory. However, a separate analysis of both inventories provides a more

[4] C40 Cities, Consumption-Based GHG Emissions of C40 Cities. https://www.c40.org/researches/consumption-based-emissions

accurate picture of how Berkeley residents and businesses, as global consumers, can address their carbon footprint. The outcome of the consumption-based study can be found in Figures 4 and 5 below, as well as on an interactive online SF Bay Area Carbon Footprint Map[5], where specific sectors can be isolated and compared across Berkeley zip codes.

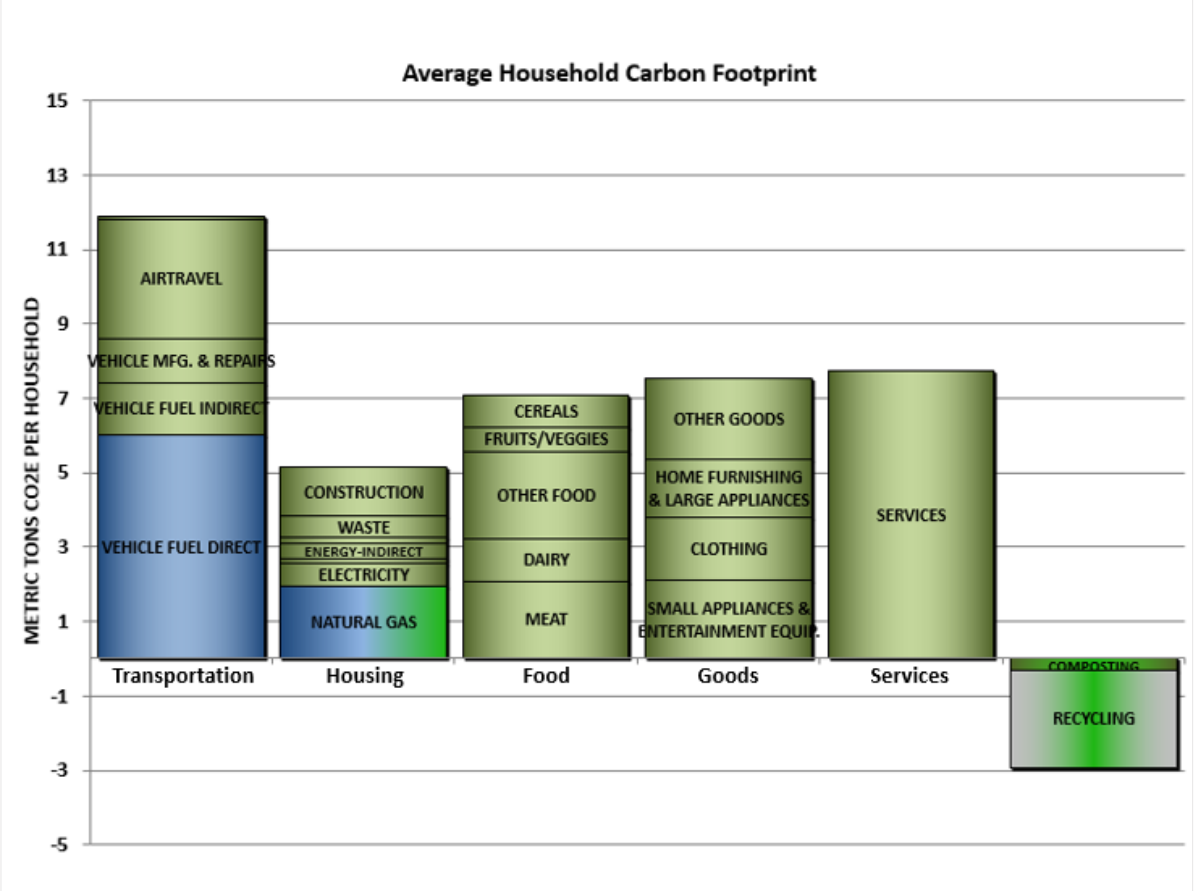


Figure 4: An average Berkeley household's carbon footprint, from a consumption-based approach.

[5] Bay Area Air Quality District, SF Bay Area Carbon Footprint Map.
https://baaqmd.maps.arcgis.com/apps/MapSeries/index.html?appid=94b9eff6547f459fba27a6853327e1a2

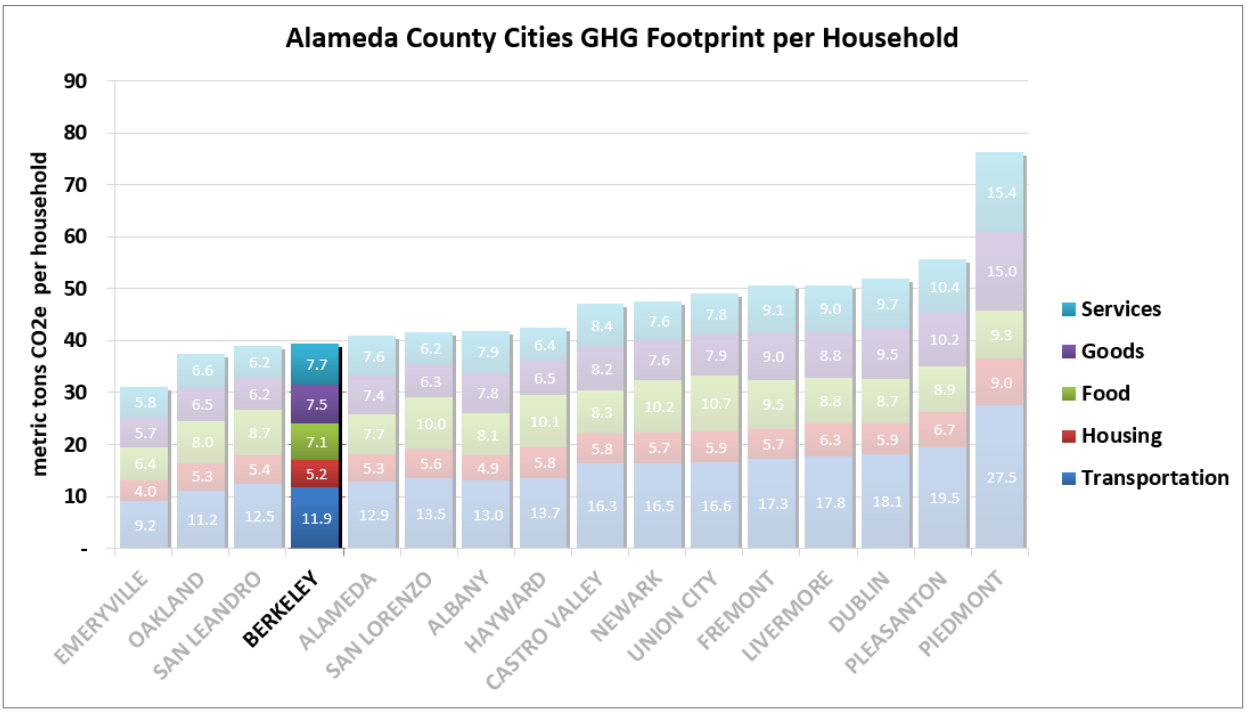


Figure 5: A comparison of Berkeley's carbon footprint per household to other Alameda County cities.

Insights from the consumption-based approach include:

- **Transportation** is still the largest contributor to GHG emissions in Berkeley, whether analyzed from a sector-based or consumption-based approach. This consumption based approach, however, also factors in air travel from nearby airports.
- **Locally produced goods and services** including clothing, furniture, personal care products, health care, and entertainment should be encouraged, and made accessible to all in the Berkeley community, in order to reduce a significant amount of consumption-based emissions, while also supporting a thriving local economy.
- **Embodied carbon** in the built environment should be considered for new construction, to reduce emissions from construction and building materials.
- **Low-carbon diets** could be a key way for individuals to personally reduce their emissions, such as eating less dairy and meat, which are both high producers of greenhouse gases. One limitation of the inventory was assuming a similar diet across the Bay Area, which may not reflect Berkeley specifically.
- **In comparison**, Berkeley has a relatively low carbon footprint per household, in comparison with other Alameda County cities. This could be due to Berkeley's denser housing, transit service, and biking and pedestrian infrastructure. Berkeley must continue to foster a sustainable local culture and economy to further reductions and continue to be a leading example. Great progress has been made but additional advancement is needed.

Both inventory methods help gain insight to what programs and policies may be most effective in reducing Berkeley's carbon footprint, within the role of local government. Although the City cannot mandate people's consumer choices, this is an area for further research to see what local governments can do to ensure Berkeley's economy and culture foster low-carbon strategies and solutions.

Attachment 2: Progress Report from UC Berkeley & the Berkeley Lab

UC Berkeley Climate Action Progress Report
Prepared by: Kira Stoll, Director of Sustainability, UC Berkeley, Oct 2018

UC Berkeley Climate Action Goals
GOAL: By 2014, reduce greenhouse gas emissions to 1990 levels.
STATUS: Achieved
GOAL: Achieve climate neutrality from building and fleet use by 2025. Achieve carbon neutrality from commute, air travel, waste and water by 2050.
STATUS: In Progress
In 2013, the University of California system announced the Carbon Neutrality Initiative and pledged to be carbon neutral by 2025 from scope 1 and 2 carbon emission sources. For Berkeley to get to carbon neutrality, or zero-net carbon emissions from building and fleet energy use, the campus is aiming to reduce emissions by about 80%. The remaining 20% of Berkeley's emissions outside of the 2025 goal are associated with the campus commute, business air travel, waste, and water. A neutrality date for these scope 3 emissions is currently 2050.

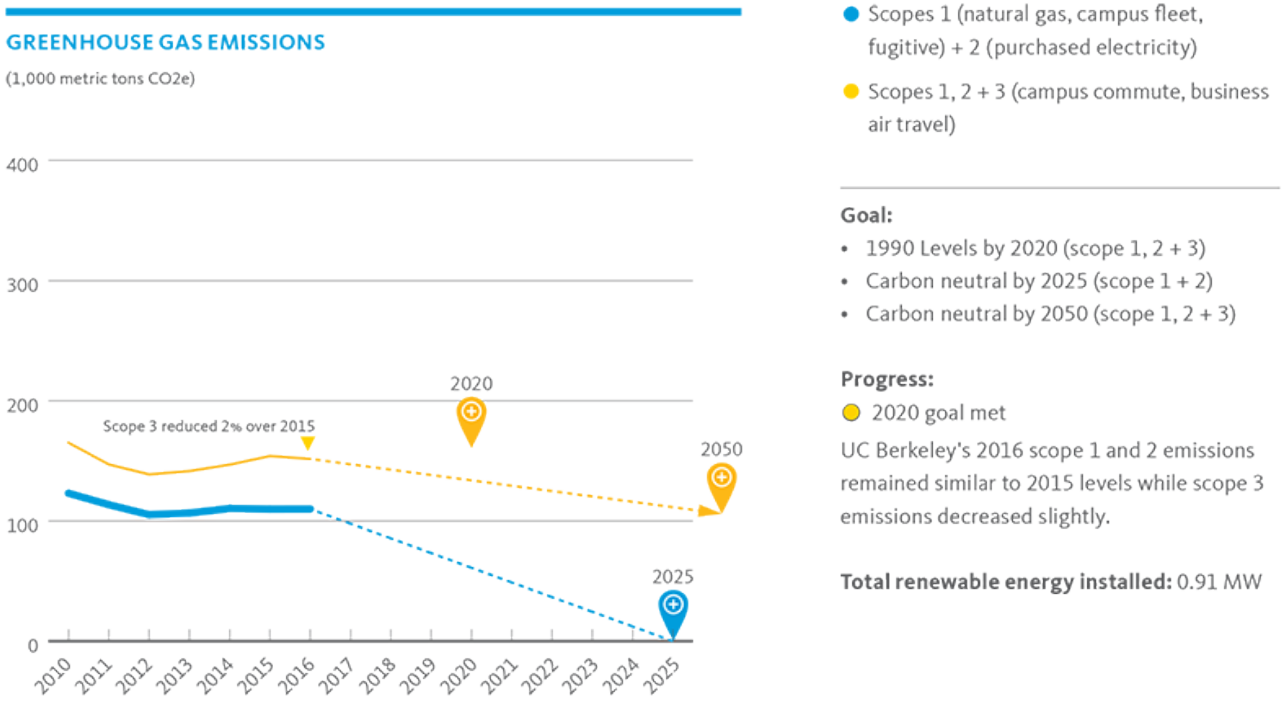
UC Berkeley Climate Action Progress
UC Berkeley has produced three climate action planning documents, with the most recent published in 2016 providing a high-level course of action and strategies to meet the 2025 carbon neutrality target. Annually, the campus conducts a complete greenhouse gas emissions inventory to track progress and reports these publically. In 2016, the campus total emissions from scopes 1, 2 and 3 were 152,166 metric tons CO2e; the 2016 emissions are 20% lower than they were in 2008.

The campus has taken the first steps toward carbon neutrality by reducing emissions to 1990 levels, faster than required by California and UC guidelines. UC Berkeley's climate mitigation accomplishments include:

- Since 2008, UC Berkeley has implemented energy efficiency measures that have reduced carbon emission by 15,000 tons and saved millions of dollars.
- In the last decade, UC Berkeley has added nineteen (19) LEED certified building projects with energy reduction features, representing over 12% of the total square footage.
- Energy intensity per square foot has been reduced by 15% since 1990, while building space has grown.
- Over 100 campus buildings have **real-time energy use dashboards** to visualize cumulative impact of individual energy savings and identify anomalies and malfunctions quickly.
- Today, 35% of the Berkeley vehicle fleet is green, either hybrid or powered by alternative fuels.
- In 2016, solar power was added at five campus locations.
- In 2018, UC Berkeley moved eligible electricity accounts (6 million kWh annually) to the East Bay Community Energy Brilliant 100 program.

- Berkeley faculty, staff and students are also actively engaged in the carbon reduction programs. Berkeley spearheaded the UC system Cool Campus Challenge, engaging 20,000 UC community members in carbon saving actions on campuses, and a number of Berkeley faculty contributed to Bending the Curve, an international report on ten scalable solutions to climate change.
- Campus fuel use from fleet and commute remains over 25% below 1990 levels.
- There are now over 5,500 people commuting by bicycle to campus on a typical school day. The campus transportation survey found that over 12% of all campus commuters ride a bike to campus – nearly 21% of faculty, 9% of staff, 27% of graduate students, and 7% of undergraduates commute by bike.

Looking forward to carbon neutrality the campus will continue the combination of the current strategies, with a particular focus on increasing renewable energy supply, will be the basis of our carbon neutrality program. Strategies include expanding the use of low and non-carbon energy supply for power and thermal needs, reducing energy use through building efficiency and behavior change, curbing growth-related emissions through zero-net green building and improved space utilization**,** increasing the alternative fuel fleet, and utilizing carbon offset mechanisms.



Berkeley Lab Greenhouse Gas Emissions Summary

Prepared by: John Elliott, Chief Sustainability Officer, Berkeley Lab, Oct 2018

Sustainability Goals

Berkeley Lab pursues three broad initiatives to reach sustainability goals. These initiatives, listed below, are described in greater detail at sbl.lbl.gov.

- Climate: Improving buildings, greening the energy grid, and low-carbon commutes
- Waste: Rethinking waste through composting, recycling, and smart purchasing
- Water: Upgrading fixtures, stopping leaks, and encouraging conservation

Our sustainability goals are driven by requirements of the federal government, California state law, and University of California policy. These goals are continuously updated and summarized here. The primary sustainability goals include:

- **Efficiency and Climate**
  - Improve energy efficiency 2% annually
  - Reduce overall GHG emissions 30% by 2025 (2015 baseline)
  - Procure or produce at least 7.5% of electricity use from renewable sources
- **New Construction**
  - Limit new construction energy use to 35% of an existing building baseline
  - Outperform energy code by 30%
  - Eliminate on-site fossil fuel use in new construction by 2020
  - Meet additional requirements in the Berkeley Lab Sustainability Standards for New Construction
- **Waste Minimization**
  - Achieve Zero Waste by 2020 (>90% waste diversion)
  - Reduce solid waste per capita 50% by 2030
- **Water Conservation**
  - Reduce per capita water consumption 36% by 2025 (2005-7 baseline)

Greenhouse Gas Emissions

Total Berkeley Lab greenhouse gas emissions for fiscal year 2017 (ending in September 2017) were 48,035 MTCO2e. These emissions are 33% below 2008 levels and 24% below 2015 levels. Emissions are updated annually in December and shared in the data section of the Sustainable Berkeley Lab website (see "Greenhouse Gas (GHG) Emissions | Total" at sbl.lbl.gov/data.)

These emissions are reported according to a federal greenhouse gas reporting protocol and include:

- **Scope 1 greenhouse gas emissions**: Direct emissions of carbon dioxide, methane, and nitrous oxide associated with on-site combustion of natural gas, fuel use in vehicle fleets (gasoline, diesel, and E85 ethanol fuel blend), as well as fugitive emissions of gases used for refrigeration (hydrofluorocarbons, perfluorocarbons) and scientific research (SF_6).

- **Scope 2 greenhouse gas emissions:** Indirect emissions of carbon dioxide, methane, and nitrous oxide associated with the consumption of purchased energy. Scope 2 electricity emissions reflect emissions from all energy used at the electricity-generating power plant, but exclude transmission and distribution losses, which are reported as Scope 3 emissions.
- **Scope 3 greenhouse gas emissions**: Indirect emissions of carbon dioxide, methane, and nitrous oxide not covered in Scope 2. At Berkeley Lab, Scope 3 emissions include greenhouse gas emissions from employee commuting, business air and ground travel, electricity transmission and distribution, off-site wastewater treatment, and off-site municipal solid waste disposal.

Strategies

While Berkeley Lab continually makes advances in many areas of sustainability, its key current sustainability strategies include:

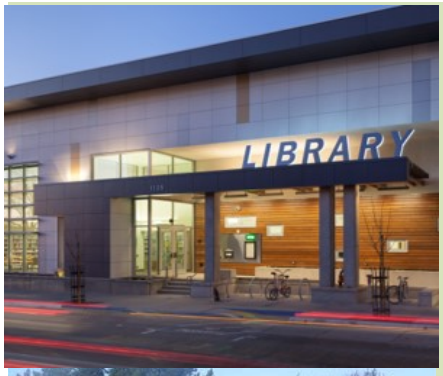
- **Improving building operations with ongoing commissioning** to generate and sustain significant energy and water savings
- **Optimizing the efficiency of high-performance computing** by tuning cooling systems at the Lab's NERSC computing center
- **Demonstrating deep savings in lighting** through a comprehensive, visible, LED lighting modernization effort
- **Leading the way with sustainable new construction** driven by Berkeley Lab's Sustainability Standards for New Construction
- **Making energy and water management standard practice** by implementing ISO 50001, an international energy management standard
- **Working towards zero waste** through better data and engagement

Highlights

Recent highlights include:

- As of fall 2018, Berkeley Lab is maintaining annual energy savings of 6.7 million kWh and water savings of 19 million gallons. The Lab has paid particular attention to reducing natural gas and water waste. Natural gas use is reduced 9% since fiscal year 2015. Maintained efficiency savings are updated monthly at sbl.lbl.gov/data.
- The Lab is completing an initial two years of ongoing optimization of its high-performance computing center and has verified annual maintained savings of 2.2 million kWh - a reduction of the energy used for cooling by more than 60% - and 250,000 gallons of water.
- The Lab is now half-way through a two-year project to align energy and water management activities to ISO 50001, and international energy management standard. This is key strategy to ensure that energy and water management at the Lab is strategic, effective, and persistent.
- The Lab has introduced new tools to reach zero waste including a mobile-friendly website to help staff improve waste sorting (wasteguide.lbl.gov) and expanded waste audits to better target activities.

- The Lab swapped out ten of its leased gas-powered fleet vehicles for nine EVs and one plug-in hybrid.
- The Lab has continued to expand its staff electric vehicle charging program, now with over 135 permit holders and over 80 regular users.
- The Integrated Genomics Building will complete construction in summer 2019 and is designed to meet deep energy efficiency targets (consuming less than 30% of the energy used by the future tenants at their current facility in Walnut Creek), use no natural gas, and offset about 15% of its total energy use with rooftop photovoltaics.



City of Berkeley
Climate Action Plan:
2018 Progress Report
on Municipal Facilities

Municipal Water and Energy Consumption
And Greenhouse Gas Emissions through 2017

Prepared by the

Office of Energy & Sustainable Development

September 2018

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Executive Summary

This report details the City's progress toward the reduction of greenhouse gas (GHG) emissions and water use at municipal facilities. The Climate Action Plan established a GHG reduction goal of 80% by 2050 from baseline year 2000, and an interim 33% reduction by 2020. East Bay Municipal Utility District (EBMUD) established a water reduction goal of 20% from baseline year 2013. The following findings are based on 2017, the most recent calendar year of data, water and energy use:

- GHG emissions for all municipal facilities in 2017 are 6% lower than 2016. GHG emissions are 31% lower than the baseline year 2000 and 2% below the 2017 GHG emissions target.
- Municipal energy use decreased 10% below the 2000 baseline despite a 17% increase in square footage of City facilities and the addition of 7 dual-port Level 2 electric vehicle charging stations during the same period. This is largely due to efficiency projects such as streetlight replacements.
- The decrease in emissions despite an increase in consumption is a result of the cleaner electricity due to California's requirements for renewable energy on the grid.
- Natural gas use dropped 2% from the previous year, in part due to energy efficiency improvements and variations in weather.
- Energy costs have increased 30%, from $1.66 million in 2000 to $2.16 million in 2017.
- Water consumption at municipal facilities is 35% lower in 2017 than the baseline year of 2013. Water costs have not decreased due to new fees and rate increases that have raised the cost of water 12% from 2013 to a total of $866,849 in 2017.

In pursuit of the GHG and water reduction goals, City staff is focused on water and energy efficiency retrofit projects, renewable energy in conjunction with battery storage, and preventative maintenance to buildings and irrigation equipment, along with leak detection and bill data tracking.

Introduction

The Berkeley Climate Action Plan established a greenhouse gas (GHG) emissions reduction goal of 80% by 2050 from baseline year 2000, and an interim 33% reduction by 2020. East Bay Municipal Utility District (EBMUD) established a water reduction goal of 20% from baseline year 2013. This report details the City's progress toward the reduction GHG emissions and water use at municipal facilities.

The following tables summarize the status of emissions, energy and water consumption, and costs compared to baseline years.

2017 All Municipal Consumption Trends						
	Baseline*	**2017**	**Change from Baseline**	**Change from Previous Year**	**2017 Target**	**% Above or Below 2017 Target**
Emissions (metric tons)	4,737	3,299	-30%	-6%	3,360	-2%
Energy Use (MWHe)	20,635	18,550	-10%	-6%	14,637	27%
Water Use (gallons)	92,444,426	60,440,293	-35%	6%	73,955,541	-18%
* GHG and Energy baseline year is 2000; water baseline is 2013						

2017 All Municipal Floor Space and Cost Trends			
	2000	**2017**	**Change from 2000**
Building Area (sq. ft.)	912,092	1,062,888	17%
Energy Costs	$1,665,712	$2,162,492	30%
Water Costs	$771,123	$866,849	12%

While emissions are currently below the 2017 target, actual energy use is 27% above the target. The lower emissions are a result of some energy reduction projects and a cleaner electricity mix.

Emissions and Energy

Performance Trends

As of 2017, GHG emissions from municipal facilities are 31% lower than 2000 and 2% below the 2017 GHG emissions target.

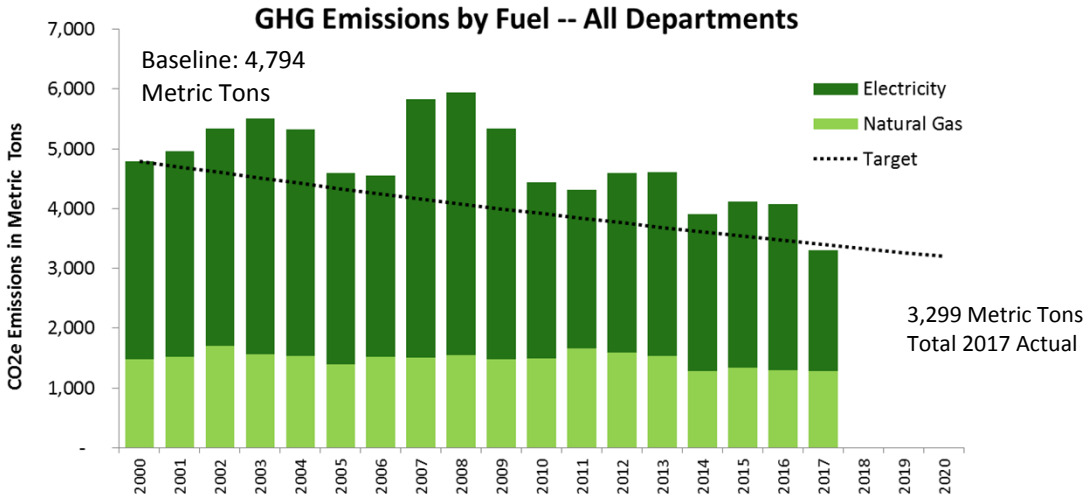

Figure 1: Greenhouse gas emissions by fuel type, all departments

Municipal energy consumption decreased 10% compared to 2000. This is notable, since the City has increased the amount of building space by 17% during the same period. 2017 electricity use declined 8% from 2016 levels. This is primarily due to the replacement of high pressure sodium street lighting with LED street lighting throughout the city.

Natural gas use dropped by 2% from 2016 levels. Natural gas represents about 38% of municipal GHG emissions. The chart below illustrates the status of energy consumption compared to the target.

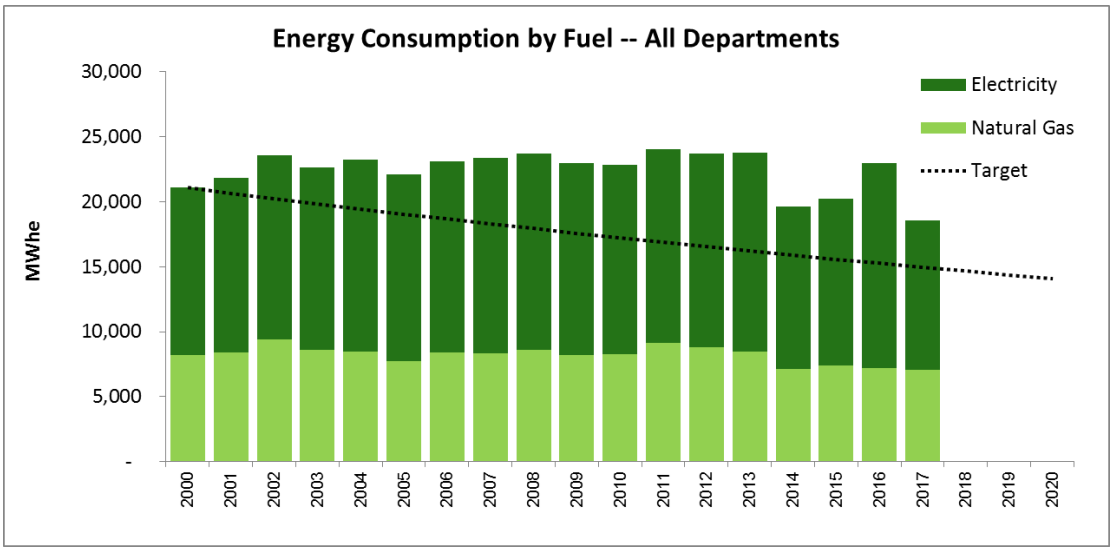

Figure 2: Energy consumption by fuel type, all departments

Total building area has increased 17% (108,480 ft^2) since 2000. The major increases in floor area include the acquisition of 1947 Center Street (98,800 ft^2), the expansion of the Main Library (45,000 ft^2), additions to the four Branch Libraries and the new Hills Fire Station. The City also added 13,207 square feet in July 2014 to its energy portfolio when Parks, Recreation & Waterfront assumed ownership of the two-story office building at the Marina. Public Works assumed the utility costs and greenhouse gas emissions for operating the Winter Shelter at the Premier Cru site. The City lost 8,800 square feet of building area in the 2013 Yosemite fire.

There is a temporary decrease in building area between 2016 and 2017 of 137,000 ft^2, when the old Center Street parking garage was demolished for replacement with 8-story parking garage on the same site which will provide significantly more parking spaces, for cars and bicycles, and electric vehicle charging. The energy increase will be offset in part by solar energy.

Figure 3 illustrates how total energy use is influenced by changes in building area.[1]

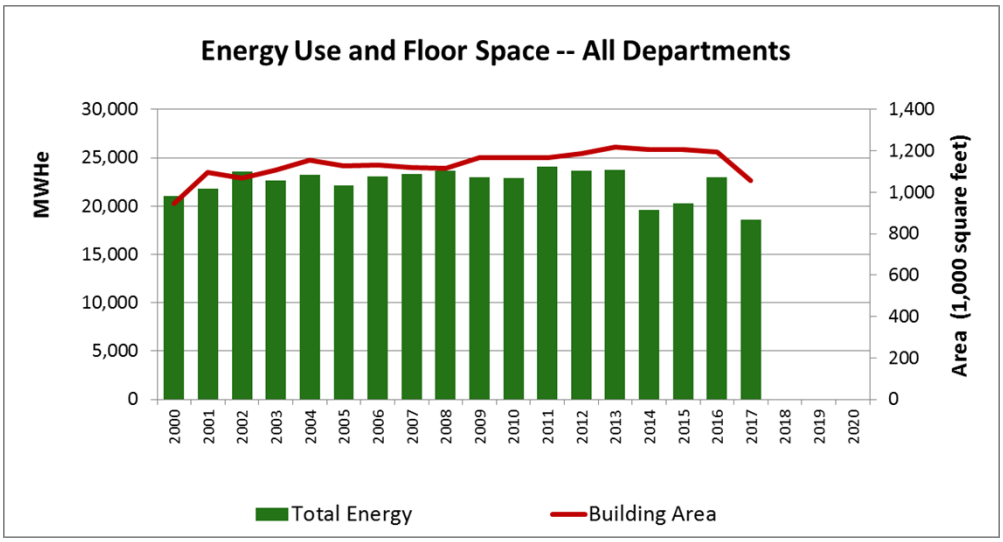

Figure 3: Energy use and building area, all departments

Energy cost per square foot has increased from $1.80 in 2000 to $2.03 in 2017. Note that the cost per square foot is not readily comparable to privately-owned facilities since it is inclusive of infrastructure with no floor area, such as traffic signals, street lights, park lights, pumps, pools, and marina docks.

Another factor in lower utility costs are a result of the partial lighting retrofit inside 1947 Center St. Four floors had most of the lighting retrofit to LED, with dimming controls, which allows building occupants to adjust the lighting to their comfort levels and to dim lighting during

[1] The floor area in the graph is the annual weighted average, that is the product of the square footage and the proportion of each year that it is in use.

Peak Energy Events. The building also had an energy management software installed to better control the heating and cooling systems.

Street Lighting Analysis

Street lighting is the largest single use of electricity, comprising 19% of the electric load prior to the retrofit. Replacement of City streetlights had a significant impact on energy costs and consumption. The chart below shows the changes in use and cost savings over the two years, which resulted in just under $700,000 in savings in 2016 compared to 2014. This savings is being used to repay the California Energy Commission 1% interest loan that financed this project.

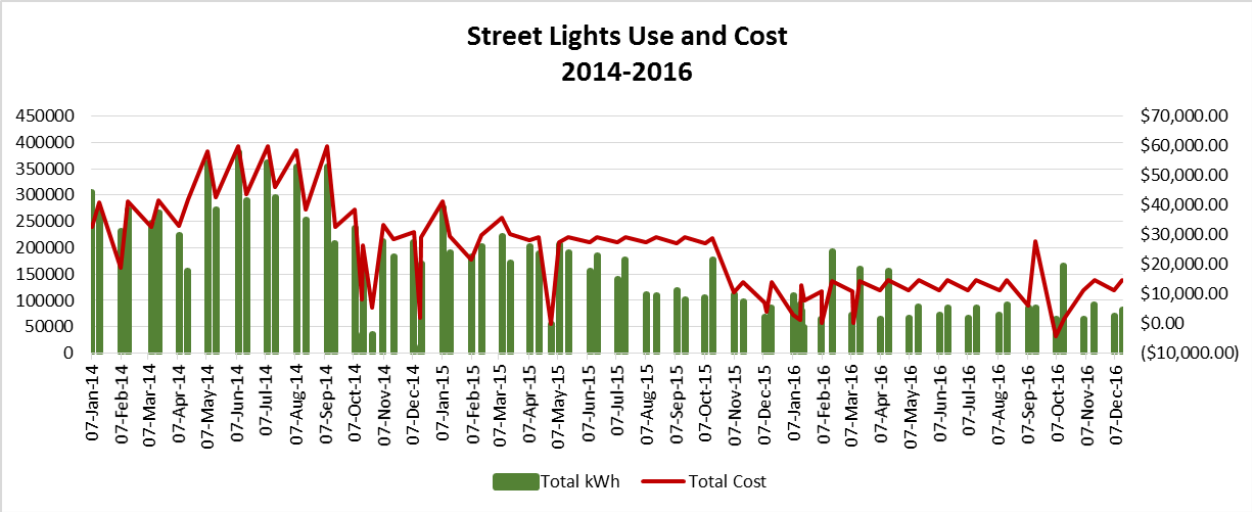

Figure 4. Streetlight Use and Cost, during retrofit period to LED

National Comparison in Energy Star's Portfolio Manager

The US EPA's Portfolio Manager is an online tool that compares commercial building performance to national averages. The Portfolio Manager Score compares buildings of similar use types to one another on a scale of 1 to 100, 100 being the best.

Portfolio Manager uses an Energy Use Intensity (EUI) report, which identifies energy use per square foot, for buildings that do not have a comparison building type. Municipal buildings in this category include the Public Safety Building, all fire stations, libraries and recreation centers, senior centers, and swim centers. Under the City's new Building Energy Savings Ordinance (BESO), an energy performance disclosure is required for all buildings over 25,000 square feet.

The table below reports all available Portfolio Manager Scores for municipal buildings. Three facilities have met the criteria for EnergyStar certification by having a score of 75 or better. 1947 Center St. improved from 64 to 71, as a direct result of the lighting retrofit, and participation in

Peak Day Events to reduce energy.

Site	Portfolio Manager Score
1947 Center St.	71
Veteran's Building	87
Marina Admin	90
Civic Center	92

The following chart shows total energy use (dark green) and energy use intensity, or EUI, (light green) for the top twenty municipal sites. As expected, the largest buildings consume the most energy, but the pools and showers are more energy intensive on a square footage basis. The light green shows this intensity level.

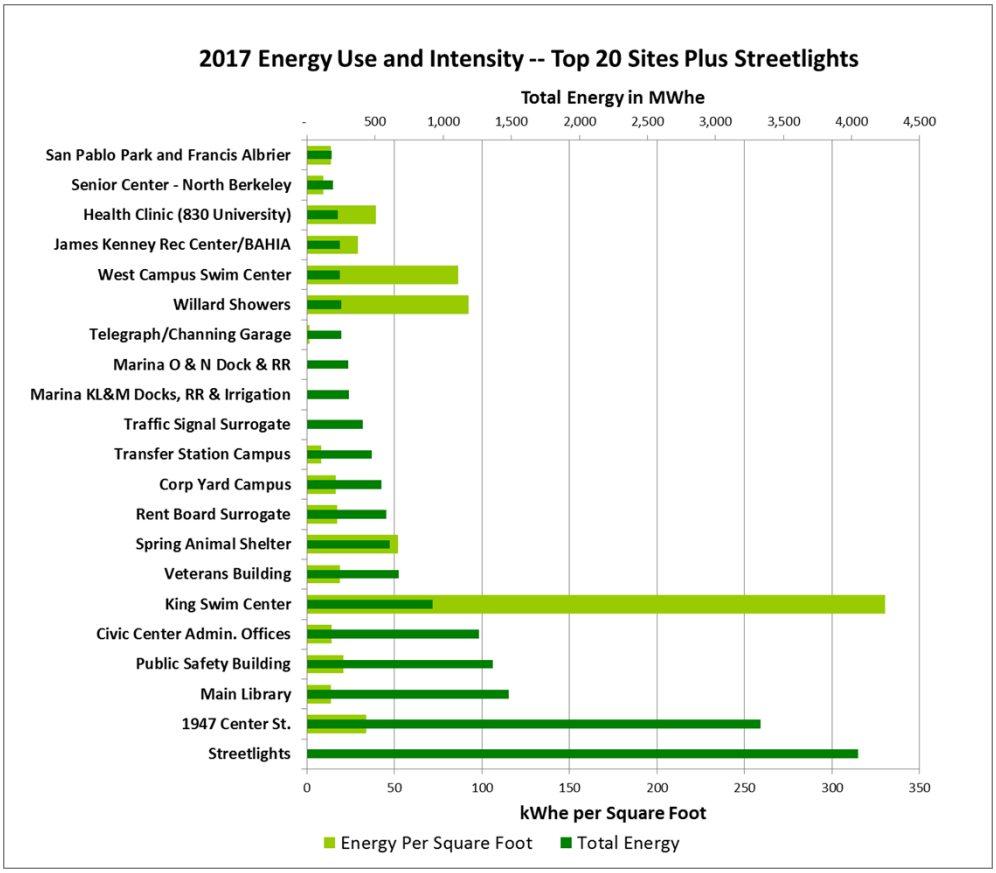

Figure 5: Total energy use and use per square foot, top 20

Energy Use from Municipal Electric Vehicle Charging Stations

The City of Berkeley operates 14 electric vehicle public charging ports at four locations in Berkeley: Telegraph-Channing Garage, Oxford Garage, the West Berkeley Library, and the Berkeley Marina. The new Center St. Garage, which is designed to accommodate up to 57 Level 2 EV charging spaces, will open with 20 charging spaces in fall of 2018.

As shown in the following graphs, the City's current charging stations have a modest impact on energy costs and therefore emissions. However, as the number of municipal charging stations increases, this will become a concern, such that their energy use and related emissions will need to be offset by onsite renewable energy or other means. Expected changes in the utility rates, to shift peak pricing until later in the day (when solar onsite solar is limited) and apply the peak rates at all times of year will make demand management, including battery storage, increasingly important.

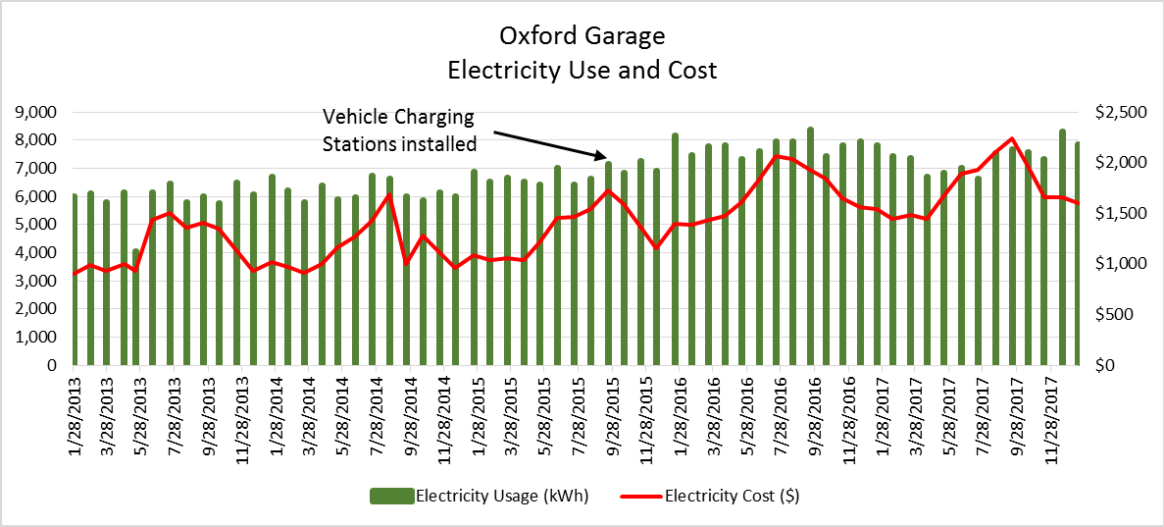

Figure 6: Oxford Garage, energy use pre- and post-EV charging stations

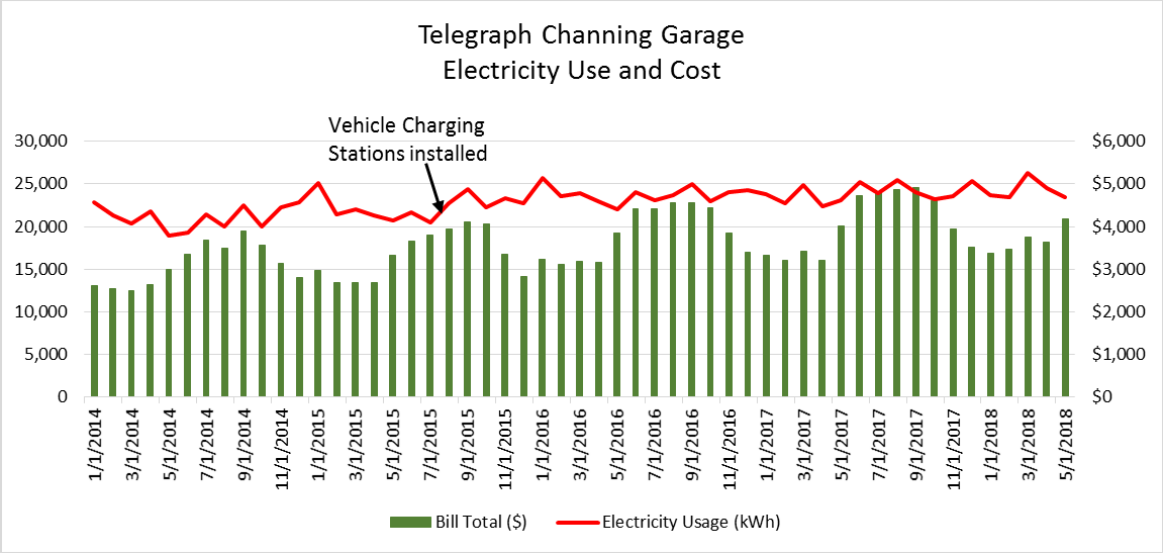

Figure 7: Telegraph Channing Garage, pre- and post-EV charging stations

The total amount of energy used for vehicle charging in 2017 is approximately 40 MWh. For these existing charging stations, the annual emissions offset by using electricity versus gasoline, is about 46,500 lbs, or 21 metric tons. The actual emissions from PG&E electricity is less than 12,000 lbs using PG&E's fuel mix.

Water

Performance Trends

In response to Governor Brown's historic mandate for cuts in potable urban water use, the East Bay Municipal Utility District (EBMUD) set a goal to reduce water use by 20% compared to 2013 levels.

Since the Governor's mandate in March 2014, consumption for 2017 is just under 61,000,000 gallons, 12% lower than the first year of the drought. The City is currently using 48% less water than in 2013; however, this may have a long-term effect on the City's landscaping, if sufficient water is not provided to major infrastructure, including trees.

Water costs increased by $68,000 in 2017, up 12% from 2013, due to EBMUD rate increases and new drought fees. Because EBMUD increased the fixed fee portion of the rates, changes in the total bill are not proportional to the water consumption, so even a small building saw an increase in costs. Water costs also are higher for large buildings which have a fire service (sprinkler system), since there is a monthly fee for this service, even if no water is used.

Water use was reduced through significant reductions in irrigation, leak detection and repairs, and updated water-efficient appliances throughout municipal facilities.

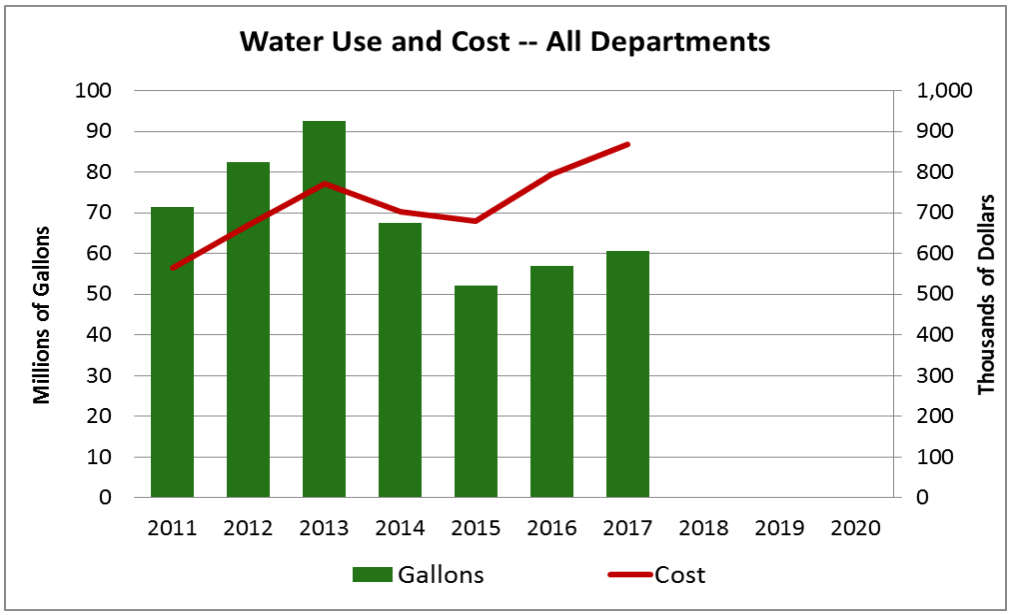

Figure 8: Water use and cost, all departments

The City is working to maintain its water use reduction efforts and to implement the EBMUD restrictions, which include eliminating use of potable water for irrigating medians and limiting landscape watering to two non-consecutive days per week.

Six municipal buildings, including Civic Center, Martin Luther King, Jr. Park, and all four branch

libraries have received EBMUD's *WaterSmart* awards for exceptional water efficiency. Water audits have been conducted on nine additional buildings, and certification is pending. Parks is also designing a *WaterSmart* central irrigation controller system, to be installed in early 2019. Going forward, the City will strive to achieve permanent reductions with investments in water conservation equipment, leak repair, improved irrigation systems, and conversion to more drought-tolerant landscaping.

While most sites use about the same amount of water in 2017 as 2016, several actually used more. Figure 9 shows fifteen sites which had a greater than 5% +/- change in water consumption over 2016. Significant changes in irrigation accounted for both the water savings, and the water increases. Sites with little or no change, or no use at all, are not included here. Note that the James Kenney Recreation Center water increase from 2016 to 2017 is due to the Recreation Center being closed for most of 2016 for a remodeling and seismic improvement project, so it is not reflective of normal use for the building.

The legend at the bottom reads from top left to bottom right, with the highest increase at the left, and the greatest decrease on the right. Spring Animal Shelter had an 8% decrease.

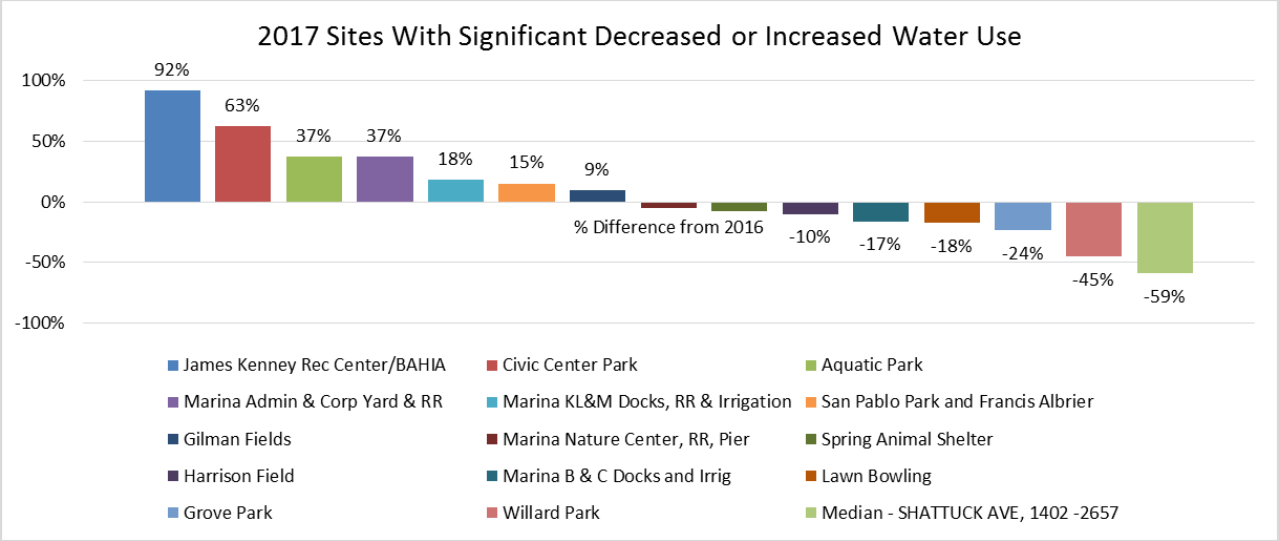

Figure 9: Sites with increased water use in 2017

Future Energy Needs and Costs

In July 2018, The City of Berkeley changed most of its electric accounts to emission free electricity through our community energy provider, East Bay Community Energy (EBCE). As a result of this, the City's actual greenhouse gas emissions will meet or exceed the emissions targets for 2020. Remaining emissions from Municipal buildings are from the combustion of natural gas for space and water heating, as well as cooking and clothes drying in a limited number of facilities. As resources become available, assessments are being conducted on city buildings undergoing renovation to identify opportunities to transition from fossil fuels like natural gas to emissions free electricity.

Transitioning to heat pump technology that uses electricity to move heat rather than burning fossil fuels requires significant investment in existing buildings. In contrast to energy efficiency projects that offer a clear payback scenario, switching to electric space and water heating systems increase capital costs and may increase operating costs, depending on rates and tariffs.

PG&E has proposed a new Time of Use rate structure to the California Public Utility Commission, moving the current peak rates (noon - 6 PM) to later in the day (4-9 PM). PG&E's proposal is to apply this rate year-round instead of just during the summer, and to apply this rate seven days a week, instead of just on weekdays. The target date for implementation is late 2020.

This proposed rate structure may have a positive financial impact on most the City's buildings, but it will be significantly more costly to operate exterior lighting, including the sports fields and courts, as most of the practice time and game time occurs on evenings and weekends. In addition, energy costs associated with EV charging at municipal stations is expected to increase due to the year-round application of peak rates in the late afternoon/evening.

The installation of solar photovoltaics and energy storage can help manage these energy costs, especially during times of peak pricing, and provide resilience benefits. However, these technologies also require a substantial investment.

Glossary

Amps, or Amperes: The rate at which an electric current travels through a conductor.

Battery Storage (Advanced Energy Storage, or AES): This is the term commonly used for large battery storage for whole buildings or facilities. The use of energy storage batteries, commonly applied to critical facilities to ensure that power is maintained after some kind of event, such as a weather- or seismic-related disaster. These large batteries are most useful when paired with a renewable energy system, such as solar electric or wind. Battery storage has two main benefits, the first being able to provide energy during Peak Energy events, thus reducing energy costs for the facility, and the second being already installed and available before the emergency event, to be ready to immediately provide power to the facility.

Btu: British thermal unit, a measure of energy. One Btu is equivalent to the heat energy in a single wooden kitchen match. A Therm is 100,000 Btu.

Climate Action Plan: Adopted in June 2009, the Berkeley Climate Action Plan outlines the strategy by which Berkeley businesses, residents and local government will reduce greenhouse gas emissions.

CO_2e or **Carbon Dioxide equivalent**: A term used to describe the mixture of greenhouse gasses that are the byproduct of combustion or decomposition, expressed in the amount of CO_2 which has the equivalent global warming impact.

Energy Resilience: The ability of a building or a facility to continue to function with some, or all energy-consuming appliances and systems after an event. The event may be weather or geophysical in nature. The resilience strategy typically includes a renewable energy resource and battery storage system and associated software which can operate without needing additional power from the grid. It may also include diesel powered generators, or other fuel sources.

Energy Use Intensity (EUI): EUI is the ratio of energy consumption to building area, in terms of kWhe per square foot. The more energy used per square foot, the higher the EUI.

Greenhouse Gas (GHG) or CO_2e: The carbon dioxide equivalent (CO_2) of the emissions from burning a fossil fuel, or industrial by product, such as biomass

kWh or Kilowatt Hour: The unit of measure for one thousand watts used over one hour of time.

kWhe or Kilowatt Hour Equivalent: The unit of measure when another fuel, such as natural gas or propane which is normally measured in Btus, is converted to kilowatt hours. One Btu is equivalent to ~ 0.293 Watt hours.

Metric Tonne, or Ton: A unit of measure equal to 1,000 kilograms, or 2,240 lbs. US.

MW or Megawatt: One thousand kilowatts

MWh or Megawatt hour: One thousand kilowatts used over one hour of time.

MWhe or Megawatt hour equivalent: Used when converting Btus to kilowatts.

Peak Day Pricing: A program of investor-owned utilities, including Pacific Gas & Electric, which is currently available for accounts on commercial Time of Use tariffs, and sets premium costs on energy used when demand is highest from 2-6 PM on weekdays from May 1 to October 31, and provides incentives during the year to offset these premium costs.

PV or Photovoltaic: Solar electric energy derived from the electrochemical interaction from sunlight in solar panels.

Solar Thermal: Direct heat energy from the sun, captured in a liquid, and used to pre-heat water for space heating or domestic hot water (hot tap water), usually through a heat exchanger.

Square Feet, or ft^2: The common terminology for measuring the floor area of a building. This is needed in order to calculate the energy use intensity (EUI) of a facility.

Tariff (for electricity or natural gas): The rates that are charged by a utility for a fuel, based on the type of fuel, the time of day that the fuel is used, and the total amount of fuel used by a facility. Tariffs for electricity in Northern California are set by the CPUC.

Time of Use Energy Pricing (TOU): A program for a utility rate that adjusts the cost of energy based upon the time of day that it is used. Typically, energy used between the peak hours is the most expensive energy, while energy used during off-peak is the least expensive. Peak hour usage usually coincides with the highest demand times for energy. Utilities apply to the CPUC to have their peak energy hours set.

Volts: This is the force with which electric current travels through a conductor.

Watts: The unit of power measured by multiplying Amps by Volts. (W= A x V) As an example, an appliance which is rated at 110 volts and 0.5 amps is a 55-watt appliance.

Zero Net Energy: In a building or other facility, where the total sum of energy consumed is offset by the equivalent amount of renewable energy produced on site. The "net" is the difference between the energy consumed compared to the amount produced. A true ZNE building will produce slightly more energy than it consumes, which will help compensate for things like increased future loads, or solar panel degradation.