APPENDIX H:
ZERO NET ENERGY, ZERO NET WATER AND CARBON NEUTRALITY PLANNING ASSESSMENT FINDINGS

Placer County Government Center Master Plan

Zero Net Energy, Zero Net Water and Carbon Neutrality Master Planning Support

Task 1a and 1b deliverables

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CONTENTS

1 ZERO NET ENERGY MASTER PLANNING – TASK 1A AND 1B

1.1 ENERGY POLICY AND PLANNING ISSUES IMPACTING THE PCGCMP

This section outlines some of the key energy-related policy and regulatory drivers that will impact the PCGC over the next 20+ years and which the master planning team is focused on. The single largest energy issue facing PCGCMP are the State's "Big Bold" goals of requiring all new residential construction to be zero net energy (ZNE) by 2020, all new nonresidential construction be ZNE by 2030, and 50% of all existing nonresidential construction be ZNE by 2030. These ambitious and challenging requirements fall within the PCGCMP's planning horizon. Placer County and the PCGCMP is addressing these requirements in a proactive manner.

The intent of this section is to inform the master planning team and stakeholders on key energy issues, and specifically ZNE, that need to be addressed in the master plan.

1.1.1 Energy Policy Context

California has led the nation in building energy efficiency for over 40 years. Efficiency has limited the increase in statewide electricity consumption to ~1% per year and kept natural gas use growth at near 0%. And California continues to lead the nation and world in energy efficiency.

California has embraced a dramatic plan to completely reshape its energy future over the next 30 years. This will have significant impacts on PCGC over its next 20 year master planning horizon. Figure 1 illustrates some of the key energy-related policy milestones that will impact PCGC over the next 30 years. Details are discussed in the following subsections.

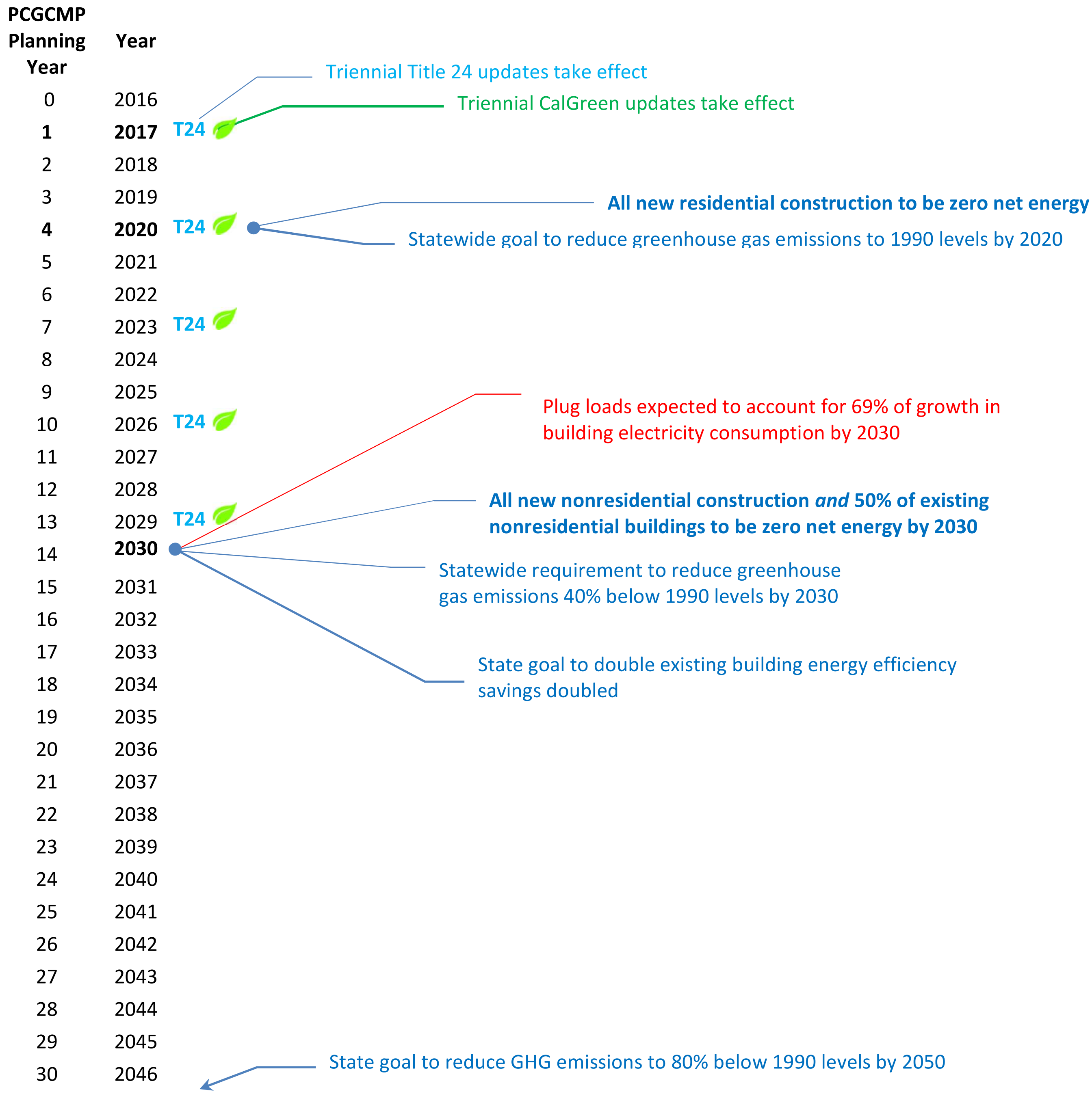

Figure 1: Key energy policy goals impacting PCGCMP's 20 year planning horizon

1.1.1.1 AB 32

California's energy policy was dramatically refocused in 2006 due to growing concerns about global climate change. California **Assembly Bill 32 (AB 32)—the California Global Warming Solutions Act of 2006**—was a game-changer with respect to energy policy.

- AB 32 requires California to **reduce its GHG emissions to 1990 levels by 2020** (a reduction of ~15% below "business as usual"). <u>**California is currently on track to meet or exceed this goal**</u>[1]. This goal date occurs during the early phases of PCGC's next planning horizon.
- AB 32's ultimate goal is to **reduce greenhouse gas emissions to 80% below 1990 levels by 2050.**
- An interim requirement to **reduce statewide greenhouse gas emissions to 40% below 1990 levels by 2030** was subsequently added by Governor Brown's Executive Order B-30-15 in April 20151. This deadline occurs during the latter period of PCGCMP's planning horizon, and will represent a significant milestone if achieved. It also will necessitate a substantial departure from business as usual.

1.1.1.2 California Energy Efficiency Strategic Plan—ZNE Goals

In response to AB 32, the California Public Utilities Commission (CPUC) adopted California's first Long Term Energy Efficiency Strategic Plan (Strategic Plan) on Sept. 18, 2008. This Strategic Plan was a roadmap to achieve maximum energy savings across all major groups and sectors in California and help meet AB 32 goals in the energy sector. The Strategic Plan was updated in January 2011.

The Strategic Plan laid out for "big bold" energy efficiency goals, as illustrated in the following figure. These include requiring all new residential construction (3 stories or less) to be zero net energy (ZNE) by 2020, and all new nonresidential construction to be ZNE by 2030.

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[11]California Office of the Governor. "New California Goal Aims to Reduce Emissions 40% below 1990 levels by 2030." 4/29/2015. http://www.gov.ca.gov/news.php?id=18938

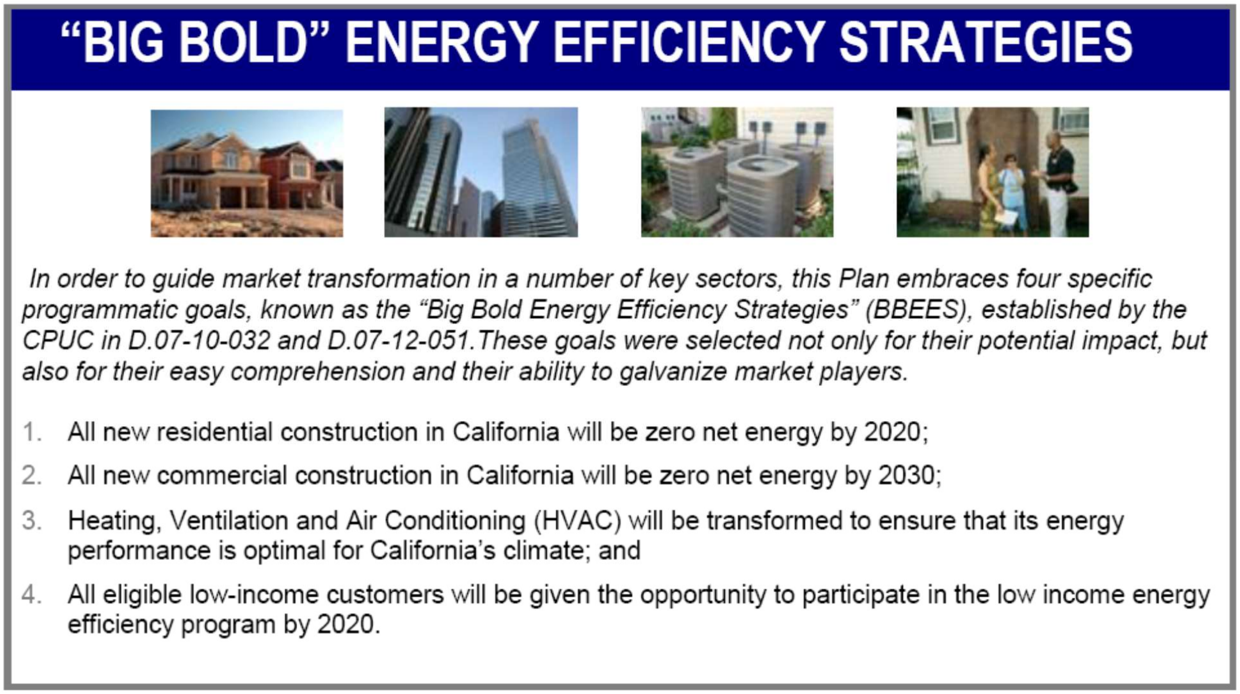


Figure 2: California Energy Efficiency Strategic Plan's "Big Bold" energy efficiency goals

The California Energy Commission (CEC) has adopted the ZNE goals as part of their long term planning through the Integrated Energy Policy Report (IEPR).

It should be noted that the Strategic Plan and IEPR's ZNE goals are aspirational. They provide long term targets for the CPUC and CEC. ZNE is not directly mandated. The CPUC and CEC must follow their mandated cost-effectiveness rules (each agency's cost effectiveness requirements are different) to achieve their ZNE goals. There is no guarantee that the ZNE goals will be achieved.

However, it should be noted that the CEC, CPUC, and a wide array of stakeholders are working hard to achieve the ZNE goals and embed ZNE, or steps towards ZNE, in key codes, standards and policy. Even if the ZNE goals are not met, the trajectory of the codes and standards are strongly moving in this direction.

The California Investor Owned Utilities (IOU) have been active in pursuing the State's ZNE goals. This includes supporting ZNE demonstrations, pilot programs, technical assistance, incentives, research, and supporting Title 24 code update efforts to achieve ZNE.

These ZNE requirements are very aggressive and coming up fast—there are only three and a half years until all new residential construction is to be built to achieve ZNE. The ZNE requirements for nonresidential construction will take effect midway through PCGC's next planning horizon.

1.1.1.3 Title 24 Part 6 (Building Energy Efficiency Standards)

California's building energy efficiency standards, or simply "Title 24" are one of the primary policy tools for realizing the State's ZNE goals. Title 24 is updated every three years. Beginning with the 2013 update to California's Title 24 Building Energy Efficiency Standards, there has been focused attention on moving the building energy code towards ZNE. One of the major changes in the 2013 update to Title 24 was the requirement that every building be "solar ready"—a specified minimum area is required to be reserved for future solar (either PV or solar water heating) on residential and non-residential roofs, along with a few other minor design considerations. This anticipates the increased drop in PV prices over time and is a key strategy to making buildings constructed today more readily converted to ZNE in the future.

The recently approved 2016 Title 24 updates (which take effect January 1, 2017) aggressively tighten up energy efficiency requirements.

- For residential construction, regulated energy use will be reduced by ~18%. Some of the most significant changes include:
  - High Performance Walls, requiring increased insulation in all climate zones;
  - High Performance Attics, requiring increased attic sealing and insulation, or moving ductwork into conditioned space;
  - High Performance Lighting, which requires high efficacy bulbs (CFL or LED) in every socket and cuts lighting energy use in half; and,
  - Tankless Water Heaters, which reduce water storage losses.

- For non-residential construction, the key highlights include:
  - Increased roof insulation in all climate zones and increased wall insulation in some climate zones;
  - Improved lighting efficiency;
  - Improved elevator and escalator efficiency; and,
  - Interlocking controls to turn on heating and cooling systems for buildings with operable windows.

This leaves one more code change cycle before the 2020 ZNE residential goals take effect. Work on this next round of updates has already commenced[2].

1.1.1.4 CalGreen

California has adopted the nation's first mandatory green building code, called CalGreen (part of California's Title 24 building codes: Title 24, Part 11). CalGreen is on a 3-year update cycle as well. CalGreen does not directly address energy—it defers to the requirements of Title 24 Part 6 (Energy Efficiency Standards). However, it does provide a mechanism for jurisdictions to adopt as mandatory "Tier 1" and "Tier 2" performance levels which exceed the code.

It should be noted that there were efforts in the 2013 CalGreen update cycle to strengthen the existing "Solar Oriented Development" requirements in CalGreen and California's Subdivision Map Act. These requirements are not currently well enforced, and there are minimum compliance and documentation requirements aside from projects to "consider" a wide variety of solar oriented community strategies. Some key energy policy stakeholders want to strengthen these requirements and require projects to more specifically consider a wide range of key planning decisions that can make significant impacts in building energy use. These planning-stage measures would impact projects even before building design teams (architects and engineers) are engaged.

It is recommended that the PCGCMP team consider a wide range of "solar oriented community" design strategies in the master planning process. This includes street/lot/building/roof orientation to maximize

[2] http://www.energy.ca.gov/title24/2019standards/index.html

desired solar heating/daylighting, minimize unwanted solar heating gains that increase air conditioning needs, and maximize rooftop solar energy generating potential.

1.1.1.5 Federal and Other ZNE Initiatives

In addition to California ZNE efforts, there are significant federal ZNE efforts. While there is no national move to require ZNE buildings, the Federal Government, through a series of executive orders and related policy, have established aggressive ZNE requirements for Federal buildings. Departments of State and Defense for example have mandated high levels of energy efficiency across vast quantities of buildings. Federal agencies as a class are actively looking at both existing building stock and new construction and continuing to ratchet up efficiency standards to a high level. Carbon constraints in the built environment have become key to Federal planning efforts, whether for the sake of national security, environmental impact or regulatory compliance.

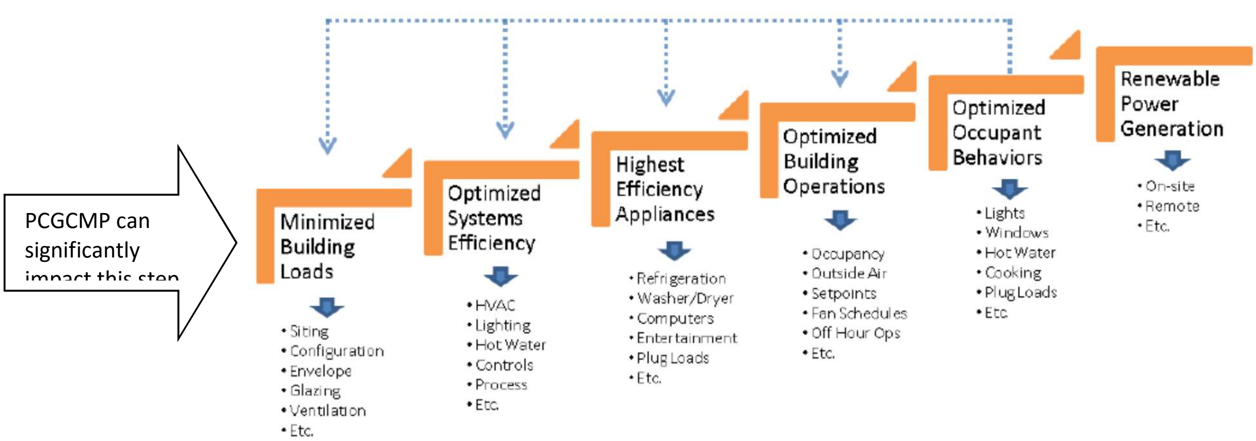
1.1.2 Technical Feasibility of ZNE and Related Research Efforts

1.1.2.1 Roadmap to ZNE

In 2012 the State of California released a roadmap for meeting its ZNE goals, "The Road to ZNE: Mapping Pathways to ZNE Buildings in California[3]". EARTH + associates personnel were involved in this study and the underlying research. This roadmap focuses on new construction.

A number of key points and data are excerpted from this study which are relevant to the PCGCMP.

One of the first items to note that is relevant to the master planning process is that there is a hierarchical "loading" order for how to best attain ZNE buildings, illustrated in Figure 3. The first, and most effective step towards achieving ZNE is to minimize building loads. Much of this is related to building siting and early phase planning efforts that often occur before the design team is on board. This includes siting, street/building/lot/roof orientation (all of these are impacted in the planning phase), massing, landscape and microclimate issues, etc.



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[3] Heschong Mahone Group, Portland State University, Energy & Environmental Economics, New Buildings Institute, and CTG Energetics. "The Road to ZNE: Mapping Pathways to ZNE Buildings in California – Appendices". 12/20/2012. Funded by PG&E. Study ID: PGE0327.02
http://www.calmac.org/publications/The%5FRoad%5Fto%5FZNE%5FReport%5FCALMAC%5FPGE0327.01.pdf

Figure 3: Steps to achieving ZNE in individual buildings[4]

The PCGCMP will have an important role in laying the groundwork for future buildings attaining ZNE. There are exciting opportunities for Placer County to demonstrate how forward thinking in master planning can significantly facilitate the ability of future buildings to attain ZNE.

Another important take away from the roadmap is the recommendation the 2030 ZNE requirement be phased in over time for different building types. Building types/uses that can more readily attain ZNE should be required to achieve ZNE prior to the 2030 deadline. Figure 4 shows the "Road to ZNE"'s proposed path to achieving ZNE in nonresidential buildings by 2030. The roadmap calls for warehouses to be built to ZNE by 2016; state buildings and schools by 2019; small offices, retail, college and lodging by 2022; large offices and food stores by 2025; and the remaining building types—including health, restaurants and refrigerated warehouses—by 2030. Similar proposals have been made by other energy policy stakeholders. While the outcome of this proposal is uncertain, the PCGCMP team should keep in mind that there is a possibility that some nonresidential building types may be required to achieve ZNE prior to 2030. The figure is also useful for illustrating the envisioned tightening of Title 24 and CalGreen standards over time to meet the 2030 goals.

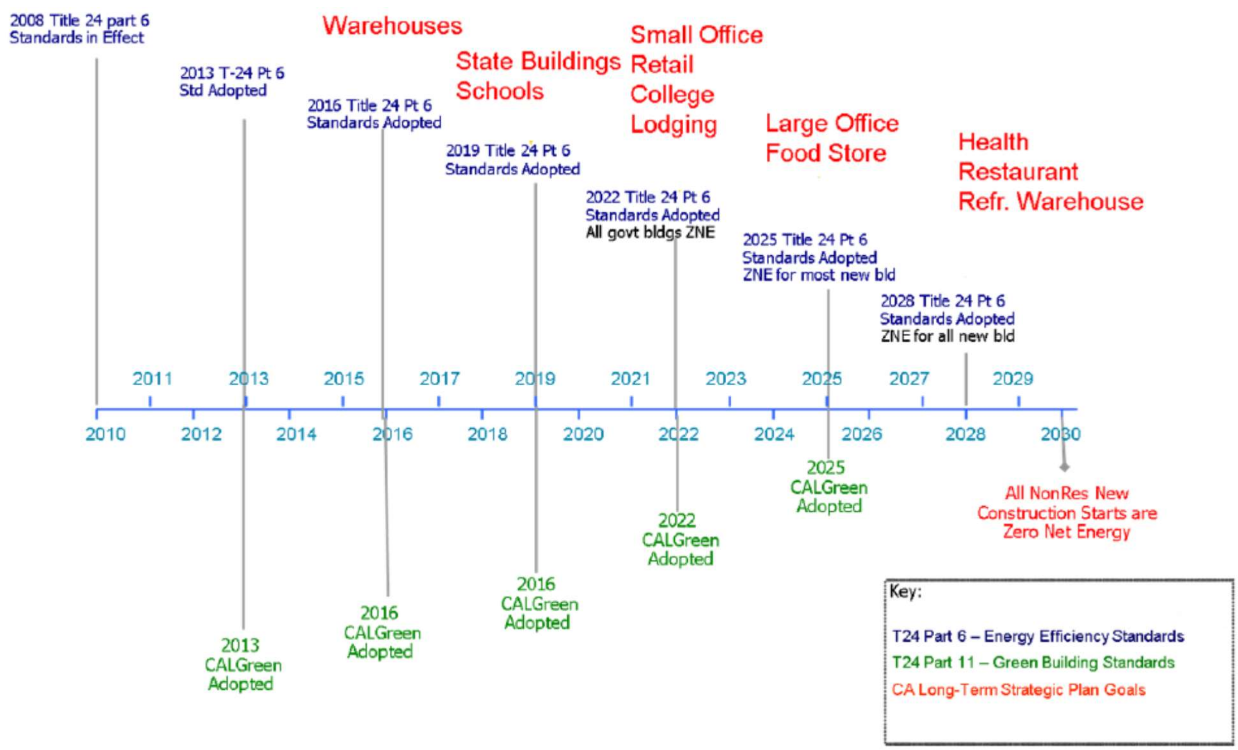

Figure 4: The "Road to ZNE"'s path to nonresidential ZNE by 2030

1.1.2.2 Technical Feasibility of ZNE in New Construction

In a companion study the "Road to ZNE" roadmap described in the preceding section,

[4]Figure from "The Road to ZNE: Mapping Pathways to ZNE Buildings in California – Appendices", page 12.

California's investor owned utilities also commissioned a technical potential study to analyze the technical feasibility of achieving its ZNE goals, "The Technical Feasibility of Zero Net Energy Buildings in California."[5]
This study analyzed the technical potential of different building types meeting the State's ZNE goals in different California Climate Zones, using currently available building efficiency technology and practices. The study found that with a few exceptions, nearly all buildings can meet the 2030 ZNE goals. The buildings that cannot achieve ZNE may be able to achieve ZNE by additional parking lot mounted PV systems. Meeting a ZNE-TDV definition (refer to section 1.1.3 for more details) versus a ZNE-site definition. Approximately 30% more PV is required for a ZNE site definition.

Table 1 summarizes the ZNE technical potential study results for three representative climate zones. The green highlighted building types are buildings that can technically achieve ZNE by 2020. Most of the likely building types that are expected in the PCGCMP fall into the ZNE achievable category.

Table 1: 2020 ZNE technical feasibility study results summary

[5] Arup North America Ltd., Davis Energy Group, Sun Light & Power, New Buildings Institute
Engineering 350, and Sustainable Design + Behavior. "The Technical Feasibility of Zero Net Energy Buildings in California." Prepared for Pacific Gas & Electric Company on behalf of Southern California Edison, San Diego Gas and Electric Company, Southern California Gas Company; The Technical Feasibility of Zero Net Energy Buildings in California. December 31, 2012

Technical Feasibility Summary — TDV$/ft^2 (30 yr)

Percent of 2020 New Build		15: Palm Springs			12: Sacramento			3: Oakland		
		Load:	*Solar:*	*Net:*	*Load:*	*Solar:*	*Net:*	*Load:*	*Solar:*	*Net:*
Single Family Home	47%	12	-12	0	10	-10	0	8	-8	0
Multi-family Low-rise	8.5%	20	-20	0	15	-15	0	14	-14	0
Multi-family High-rise	3%	30	-11	19	23	-11	12	17	-12	5
Medium Office	2.1%	24	-24	0	19	-19	0	16	-16	0
Large Office	6.9%	22	-7	15	17	-7	10	15	-8	7
Strip Mall	6.7%	27	-27	0	24	-24	0	22	-22	0
School	2.8%	32	-32	0	27	-27	0	22	-22	0
Large Hotel	1.5%	47	-14	33	41	-13	28	41	-14	27
Grocery	1.8%	69	-69	0	68	-68	0	64	-64	0
Sit-down Restaurant	1.0%	150	-95	55	132	-93	39	114	-99	15
Hospital	1.9%	64	-16	48	61	-15	46	61	-17	44
Warehouse	6.6%	9	-9	0	7	-7	0	7	-7	0
College	1.7%	41	-40	1	36	-36	0	31	-31	0
Other Commercial	7.9%	32	-22	10	28	-20	8	25	-19	6

Three prototypes that cannot reach ZNE using rooftop solar might reach ZNE using parking lot PV systems – Multi-family High-rise, Large Office, and Sit Down Restaurant. See Section 4.2.1.3 for further discussion of the potential contribution of parking lot PV systems in pursuing the ZNE goals.

The key efficiency measures that were used in many of the buildings prototypes to achieve ZNE include:

1. LED Lighting
2. Plug Load Reductions
3. Fan and Duct Efficiency
4. 95%+ Efficiency Gas Appliances
5. Natural Ventilation
6. Windows U Factor and Solar Heat Gain Coefficient
7. Heat Recovery (air, mechanical equipment, and water)

1.1.2.3 Existing Buildings Energy Efficiency Action Plan

The State of California realizes that achieving California's energy and climate goals requires radical improvement in the energy performance of existing buildings, and that this will require more than simply regulatory solutions. The State has a goal to double existing building energy efficiency by 2030. This will impact PCGC's existing buildings, and potentially new buildings constructed prior to the State's 2030 deadline for all new nonresidential construction to be ZNE.

AB 758
Assembly Bill 758 (Skinner, Chapter 470, Statutes 2009) requires the California Energy Commission (CEC), in collaboration with the California Public Utilities Commission and stakeholders, to develop a comprehensive program to achieve greater energy efficiency in the state's existing buildings. Work is to be completed in three phases:

- The first phase of this effort, completed in late 2015, included the development of an "**Existing Buildings Energy Efficiency Action Plan**[6]"—a roadmap document for achieving the State's long term existing building energy efficiency goals.
- Future phase 2 work will focus on implementing the "No Regrets Strategies" and developing the "Voluntary Pathways" necessary to scale up the efforts statewide and develop the partnerships, and markets needed, as outlined in the "Existing Buildings Energy Efficiency Action Plan."
- Phase 3 efforts will develop and institute **Mandatory Approaches** that will move energy efficiency practices into the mainstream.

Existing Buildings Energy Efficiency Action Plan
The California Energy Commission's "Existing Buildings Energy Efficiency Action Plan[6]" is a 10 year roadmap "to activate market forces and transform California's existing residential, commercial, and public building stock into high-performing and energy-efficient buildings," with goals of "accelerated growth of energy efficiency markets, more effective targeting and delivery of building upgrade services, improved quality of occupant and investor decisions, and vastly improved performance of California's buildings."

The plan has five goals, each with a series of strategies to achieve it, outlined below. The strategies in **bold red print** are strategies that are most relevant to, and/or may most likely impact the PCGCMP.

GOAL 1: INCREASED GOVERNMENT LEADERSHIP IN ENERGY EFFICIENCY
Strategy 1.1 State and School Buildings
Strategy 1.2 Nonresidential Benchmarking and Disclosure
Strategy 1.5 Building Efficiency Standards Development and Compliance
Strategy 1.6 Plug-Load Efficiency
Strategy 1.7 Local Government Leadership
Strategy 1.8 Energy Efficiency as a Clean Distributed Energy Resource
Strategy 1.9 Leadership: Existing Building Efficiency Collaborative

GOAL 2: DATA - DRIVEN DECISION MAKING
Strategy 2.1 Modern, Accessible Data Resources
Strategy 2.2 Consumer - Focused Energy Efficiency

GOAL 3: INCREASED BUILDING INDUSTRY INNOVATION AND PERFORMANCE
Strategy 3.1 Streamlined and Profitable Industry

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[6] California Energy Commission. "California's Existing Buildings Energy Efficiency Action Plan." CEC-400-2015-013-F. September 2015. http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-05/TN206015_20150904T153548_Existing_Buildings_Energy_Efficiency_Action_Plan.pdf

Strategy 3.2 Performance - Driven Value
Strategy 3.3 High - Performance Workforce and Education
Strategy 3.4 Zero - Net - Energy Retrofits

GOAL 4: RECOGNIZED VALUE OF ENERGY EFFICIENCY UPGRADES
Strategy 4.1 Real Estate Value
Strategy 4.2 Marketing, Education, and Outreach

GOAL 5: AFFORDABLE AND ACCESSIBLE ENERGY EFFICIENCY SOLUTIONS
Strategy 5.1 Foster Private Capital Market
Strategy 5.2 Asset - Based Financing
Strategy 5.3 Borrower - Based Financing
Strategy 5.4 Integrated and Streamlined Delivery of Efficiency Solutions, Finance, and Utility Incentives
Strategy 5.5 Government Building Finance Mechanisms
Strategy 5.6 Leveled Tax Playing Field
Strategy 5.7 Establish Deeper Subsidies for Full Participation by Low - Income Households

Relevant strategies and their potential impact on the PCGCMP are discussed in more detail below

Strategy 1.2 Nonresidential Benchmarking and Disclosure

- Required periodic benchmarking of commercial and multifamily buildings above 50,000 square feet in floor area, by 2017
- Energy-use metrics reported via ENERGY STAR® Portfolio Manager.
- Encourages ongoing performance monitoring and continuous commissioning.
- Public disclosure for each building at second reporting cycle; disclosure policy informs building market transactions.

While it is not clear yet if county owned buildings will be subject to the benchmarking requirements, it is likely they will be. The benchmarking and encouragement of ongoing performance monitoring and continuous commissioning strongly suggest the need for a detailed and coordinated energy management program for the PCGC. Benchmarking and related building performance monitoring is critical to long term building efficiency. This should result in long term efficiency and cost savings for the PCGC and is a 'best practice' utilized by many public and private organizations managing large portfolios of buildings.

Strategy 1.6 Plug - Load Efficiency

Strategy 1.7 Local Government Leadership

- "Local Government Challenge Program" to encourage local governments to implement innovative efficiency programs and gather relevant experience for wider application.
- Examples include:
    - Aggressive efficiency for public buildings.
    - Early implementation of nonresidential benchmarking and disclosure programs.
    - Innovation in building permitting and code enforcement systems.
    - Data - driven communitywide energy planning.
    - Energy performance districts.

There are abundant opportunities for Placer County to build upon its existing energy leadership (e.g., the mPower program, existing building energy efficiency and renewable energy systems, and the PCGCMP) and to become a state leader. The PCGCMP presents a number of opportunities to align with key State energy policies and goals. Key opportunities include: aggressive efficiency for existing buildings at the PCGC, consideration of improved benchmarking as part of the PCGCMP, and consideration of creating an "energy performance district" or "eco-district" in the PCGCMP.

Strategy 2.1 Modern, Accessible Data Resources

- Ensure the availability, **ease of access, and usability of energy consumption data** in all sectors.
- **Utilities map meters to buildings, consistent with whole-building benchmarking.**
- Adopt common data exchange protocols for energy use and building energy performance data; maintain utility tariffs in a machine-readable format on a public website.
- Provide efficiency project cost and savings data to all market actors

Ease of access and usability of PG&E's energy consumption data for the PCGC is currently challenging. The utility provided "Energy Report" provided for the PCGCMP analysis contained 536 pages of data that required extensive processing and analysis. While the data is very rich and valuable for PCGC energy management, it is currently challenging to use. This presents an excellent opportunity for the PCGC to work with PG&E (and potentially relevant CEC stakeholders implementing the Existing Buildings Energy Efficiency Roadmap Goal 2) to collaborate on ways to implement strategy 2.1. This would include working to map meters to buildings and develop more robust energy management and benchmarking tools for larger portfolios of buildings such as on the PCGC.

Strategy 3.4 Zero Net-Energy Retrofits

GOAL 4: RECOGNIZED VALUE OF ENERGY EFFICIENCY UPGRADES

Strategy 4.1 Real Estate Value
Strategy 4.2 Marketing, Education, and Outreach

GOAL 5: AFFORDABLE AND ACCESSIBLE ENERGY EFFICIENCY SOLUTIONS

Strategy 5.1 Foster Private Capital Market
Strategy 5.2 Asset-Based Financing
Strategy 5.3 Borrower-Based Financing
Strategy 5.4 Integrated and Streamlined Delivery of Efficiency Solutions, Finance, and Utility Incentives
Strategy 5.5 Government Building Finance Mechanisms
Strategy 5.6 Level Playing Field regarding Tax
Strategy 5.7 Establish Deeper Subsidies for Full Participation by Low - Income Households

1.1.3 Defining "Zero Net Energy" (ZNE)

A fundamental challenge when dealing with Zero Net Energy (ZNE) is its definition. A ZNE building is typically conceptualized as producing as much energy through renewable generation sources as it uses in the course of a year. However, a precise definition of ZNE is a little more complex:

- Does the ZNE definition include only electricity, or other fuels such as natural gas.
- Is the energy measured at the site where it is delivered or is it based on "source energy"?
- Or is it based on something else, such as "Time Dependent Valuation" (TDV) that is currently used in California's Title 24 Building Energy Efficiency Standards?
- What is the boundary? Is ZNE based exclusively on the building footprint, or a larger "project", or possibly even at a "campus" level? Must the renewable energy generation be integrated into the building, can it be ground-based on adjacent land, or possibly part of a larger centralized system in a campus setting, or even part of a larger off-campus system?
- How do you deal with non-regulated process loads such as laundries, or electric vehicle charging?

Current Definition – ZNE TDV

There has been much discussion on the specific definition of ZNE for California's ZNE goals. The current California ZNE definition was adopted by the California Energy Commission and is in the 2013 Integrated Energy Policy Report (IEPR)[7]:

"A Zero Net Energy (ZNE) Code building is one where the net of the amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single "project" seeking development entitlements and building code permits, measured using the California Energy Commission's Time Dependent Valuation (TDV) metric. A ZNE Code Building meets an Energy Use Intensity (EUIs) value designated in the Building Energy Standards by building type and climate zone that reflect best practices for highly efficient buildings."

The current definition is based on TDV. This has been an ongoing point of debate. TDV is essentially a "societal value" of energy, which includes electricity grid constraints, costs for turning on dirty "peaker" plants, air pollution and greenhouse gas costs, etc. There is a different TDV multiplier for each hour of the year. TDV was developed for use in California's Title 24 Building Energy Efficiency Standards. While the use of TDV makes sense from the policy and code perspective for new buildings, it does have some drawbacks. Difficult to conceptualize, it is not well understood by the public. It is also challenging to implement for existing buildings. There are ongoing efforts to refine how this ZNE TDV definition should be applied to existing buildings.

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[7] California Energy Commission, "2013 Integrated Energy Policy Report," January, 2014. pg. 36.

It should also be noted that the Energy Use Intensities in the current ZNE definition, “A ZNE Code Building meets an Energy Use Intensity (EUIs) value designated in the Building Energy Standards by building type and climate zone that reflect best practices for highly efficient buildings.” are not yet defined.

ZNE Definition Potential Evolution
It should be noted that there are significant stakeholders who are lobbying for different non-TDV based ZNE definitions.

The voluntary market (which is responsible for all current ZNE buildings) does use nor respond to the esoteric ZNE TDV definitions. The most prevalent ZNE definition in use is ZNE site energy. This is intuitive to the public, simple to measure and verify, and is the most commonly used metric in use today.

The “Road to ZNE” roadmap notes that there may not be one ZNE definition or metric that fits all situations, and notes that multiple definitions may be needed (i.e., a ZNE TDV metric may be appropriate for showing that a new building has been designed to meet the ZNE goals, but may not be the right definition for measuring actual ZNE performance in existing buildings). The “Road to ZNE” roadmap proposes a “taxonomy” for ZNE definitions, as shown in Figure 5. This shows a range of ZNE definitions that meet both the regulatory needs for determining whether a new building has been built to code so that it can potentially be operated to achieve ZNE (i.e., a ZNE asset rating)—note that there is a significant distinction between building an efficient building that has been designed to achieve ZNE, versus actually operating a building to achieve ZNE. Even the most efficient building can be poorly operated and miss its energy goals. This is a useful diagram to illustrate how California ZNE stakeholders are currently grappling with ZNE definitional issues.

Mandate → Voluntary

	CEC: ZNE TDV	CPUC: ZNE Equivalent*	Market: ZNE Site
Fuels Covered	Electricity + Natural Gas	Electricity + Natural Gas	Electricity + Natural Gas
Asset Value	Yes	Yes	N/A
Performance Index	N/A	N/A	Yes
Energy End Uses	Regulated Only	Regulated and Unregulated	Regulated and Unregulated
Cost-effectiveness Tests Required	CEC TDV Test	CPUC Tests (e.g. TRC)	N/A
Renewables On-Site	Yes	Yes	Yes
Renewables Off-Site	Yes	Yes	N/A
ZNE Equivalencies	Allowed	Allowed	N/A
EUI Target	TDV/sf/yr equivalent to a kBtu/sf/yr target. Will vary by building type and climate zone. Could be expressed as HERS 0 or BEARS 0.	X Btu/sf/yr **including** approved Equivalencies. Will vary by building type and climate zone.	kBtu/sf/yr Will vary by building type and climate zone.

* ZNE Capable as an alternative

Regulated End Uses → All End Uses

Figure 2: Proposed ZNE Metric Taxonomy

Figure 5: "Road to ZNE's" proposed ZNE metric taxonomy

Similarly, the Existing Buildings Energy Efficiency Action Plan (see section 1.1.2.3) notes that several ZNE definition variants are being considered, including a "ZNE-ready" (highly efficient buildings without renewable power) and "net-positive" (produce more energy than they use).

For PCGCMP purposes, the important factors to note for planning is that there is currently a ZNE definition based on TDV. This is primarily relevant to designing new buildings from a code compliance perspective. This is complex and not well applied to existing buildings. However, the public and market currently use a simpler definition of "site ZNE"—i.e., at the end of the year you can show that your building used as much energy as was generated onsite. This is a performance-based metric that is intuitive and easy to measure. It is generally easier to achieve ZNE TDV than ZNE site energy. Thus, if ZNE site energy is used as the primary planning metric, the PCGC should also likely meet ZNE TDV. It is also necessary to keep in mind that the ZNE definition has been evolving, and may continue to evolve, particularly for existing buildings.
The PCGCMP will likely find using "ZNE site" to be the most advantageous and intuitive definition.

1.2 PCGC Existing Facility Energy Analysis

PG&E provides both electricity and natural gas to the PCGC. Utility consumption data for 2015 and part of 2016 was obtained and analyzed. Some buildings are served by a single meter, and some meters serve multiple buildings. Meter data was mapped to individual buildings to the extent that it could be disaggregated from the utility billing data.

For 2015, the PCGC consumed 183,997 Therms (18,400 MMBTU) of natural gas, costing $174,750. PCGC consumed 7,468,080 kWh of electricity (25,481 MMBTU) of electricity costing $1,320,760. Total energy costs were $1,495,510 and total building energy consumption was 43,880 MMBTU. Figure 6 shows total annual building energy use for PCGC, with consumption (in kBTU/year) shown on the left and costs shown on the right.

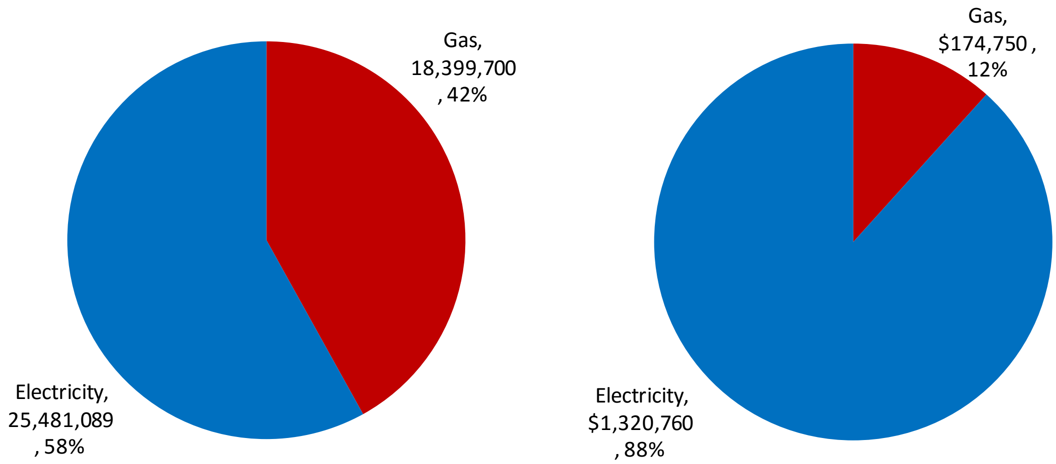


Figure 6: Annual PCGC building energy use: consumption in kBTU (left) and annual costs (right)

Sections 1.2.1 through 1.2.3 provide detailed breakdowns of building level energy consumption.

1.2.1 Building Energy Consumption

Figure 7 shows building energy consumption for 2015. Acronyms for the building names are shown in

Table 2. Electricity and natural gas consumption data are converted to a common unit (kBTU/year) to facilitate comparison. Estimated solar PV electricity generation is shown for the four buildings/complexes that have solar systems--adding the purchased electricity and solar production shows the total building electricity consumption; adding gas consumption to this shows the total building energy use. Data is sorted by building area, with the largest sized buildings on the left and smallest buildings on the right. Note that in a few cases individual buildings are shown as well as aggregated consumption for various blocks of buildings[8].

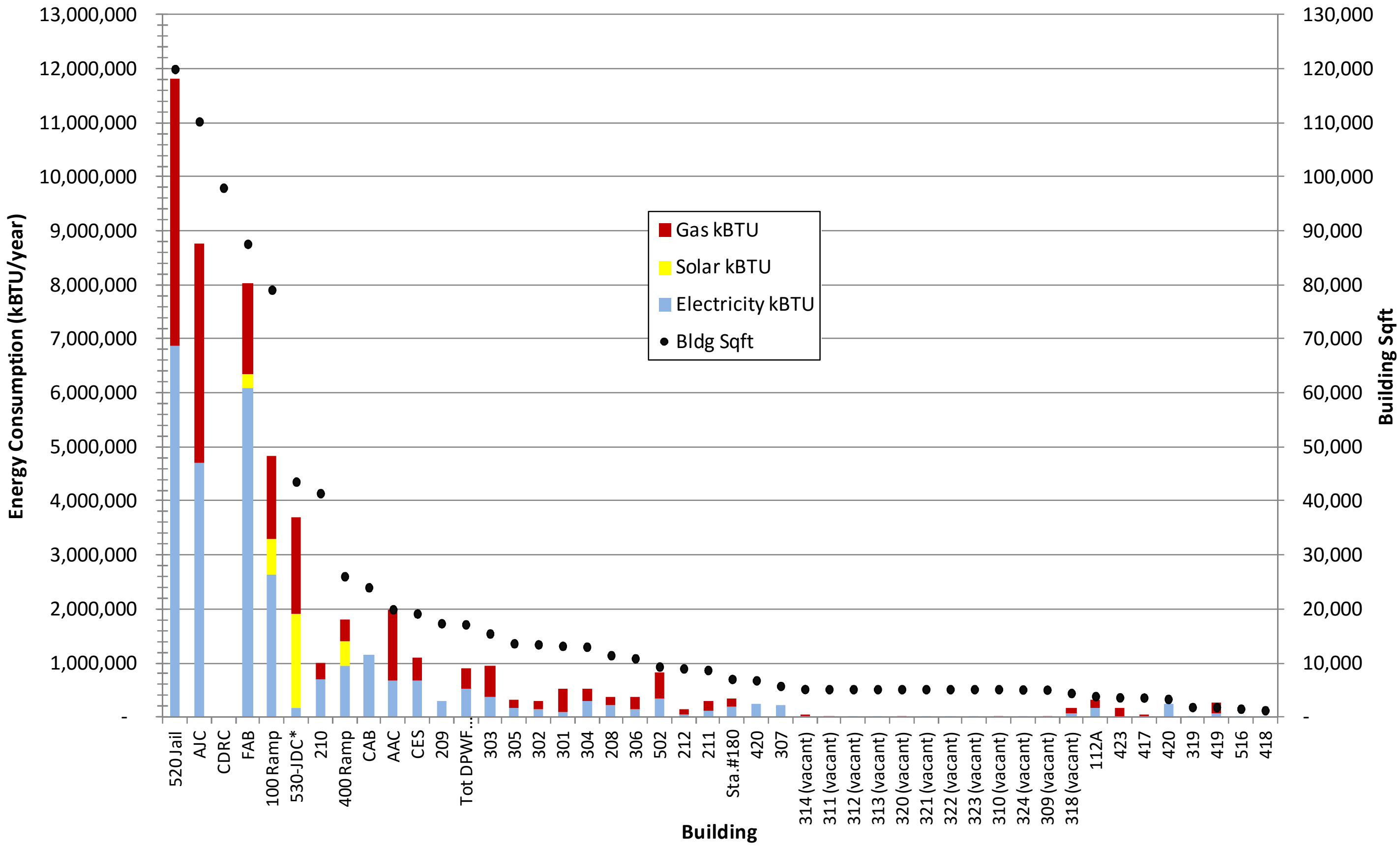


Figure 7: PCGC 2015 building energy consumption (in kBTU/year) (sorted by building size)

[8] Data is shown to the extent that electricity and natural gas billing data can be disaggregated.

Table 2: Building name acronyms

AAC	Auburn Administration Center
AJC	Auburn Justice Center
CAB	County Administration Bldg.
CDRC	Community Development Resource Center
DPW&F	Department of Public Works & Facilities
FAB	Finance Administration Bldg.
HHS	Health & Human Services
JDC	Juvenile Detention Center
OES	Office of Emergency Services
PCSO	Placer County Sheriff's Office
RHA	Right Hand Auburn

There are four larger buildings over 50,000 sqft: the Jail (Building 520) with a total area of 119,910 ft^2, The Auburn Justice Center (AJC) building with 110,200 ft^2, the Community Resource Development Center (CDRC) with 97,923 ft^2, and the Finance Administration Building (FAB) with 87,543 ft^2. Together, these four largest buildings represent 49% of the PCGC's building square footage. These four buildings consume the large majority of the PCGC's energy. Note that energy consumption data is not available for the CDRC. The three largest buildings for which energy consumption data is available for (the jail complex, AJC, and FAB) consume 58% of the natural gas and 69% of the electricity used by PCGC's buildings, and 65% of all the center's building energy.

From the energy perspective, PCGCMP efforts should focus on the larger buildings which represent a much larger percentage of the total.

There are four solar PV arrays installed at the PCGC: an 82 kW array on the 400 ramp (county maintenance), a 132 kW array on building 100/110, a 45 kW array on the FAB, and a 325 kW ground mounted array adjacent to the JDC.

Figure 8 shows similar data in a different format. The total energy consumption (in kBTU/year) is plotted against building area (in square feet). There is a strong linear correlation between building size vs. energy use—i.e., building energy use increases approximately linearly with building size. The primary exception is the Auburn Jail, which consumes significantly more energy and is an intensive energy consuming building due to the nature of the occupancy.

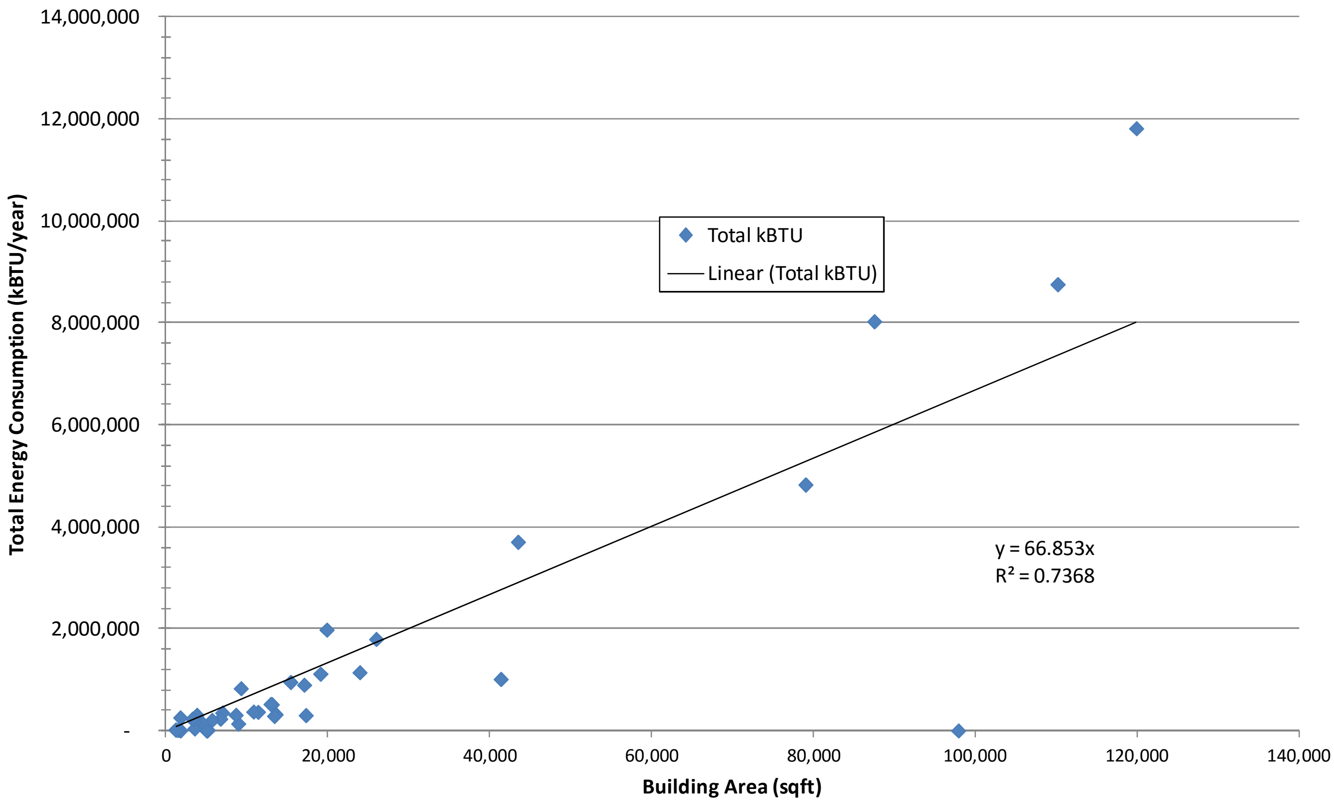


Figure 8: PCGC 2015 total building energy consumption vs. building area

1.2.2 Building Energy Costs

Figure 9 shows similar data to Figure 7, except energy costs (versus consumption) are shown.

Natural gas is significantly cheaper than electricity. The majority of the energy costs are due to electricity use. Note that the electricity costs are for purchased electricity and reflect the savings due to the PV systems on the FAB, Building 110/111, the 400 ramp, and the JDC.

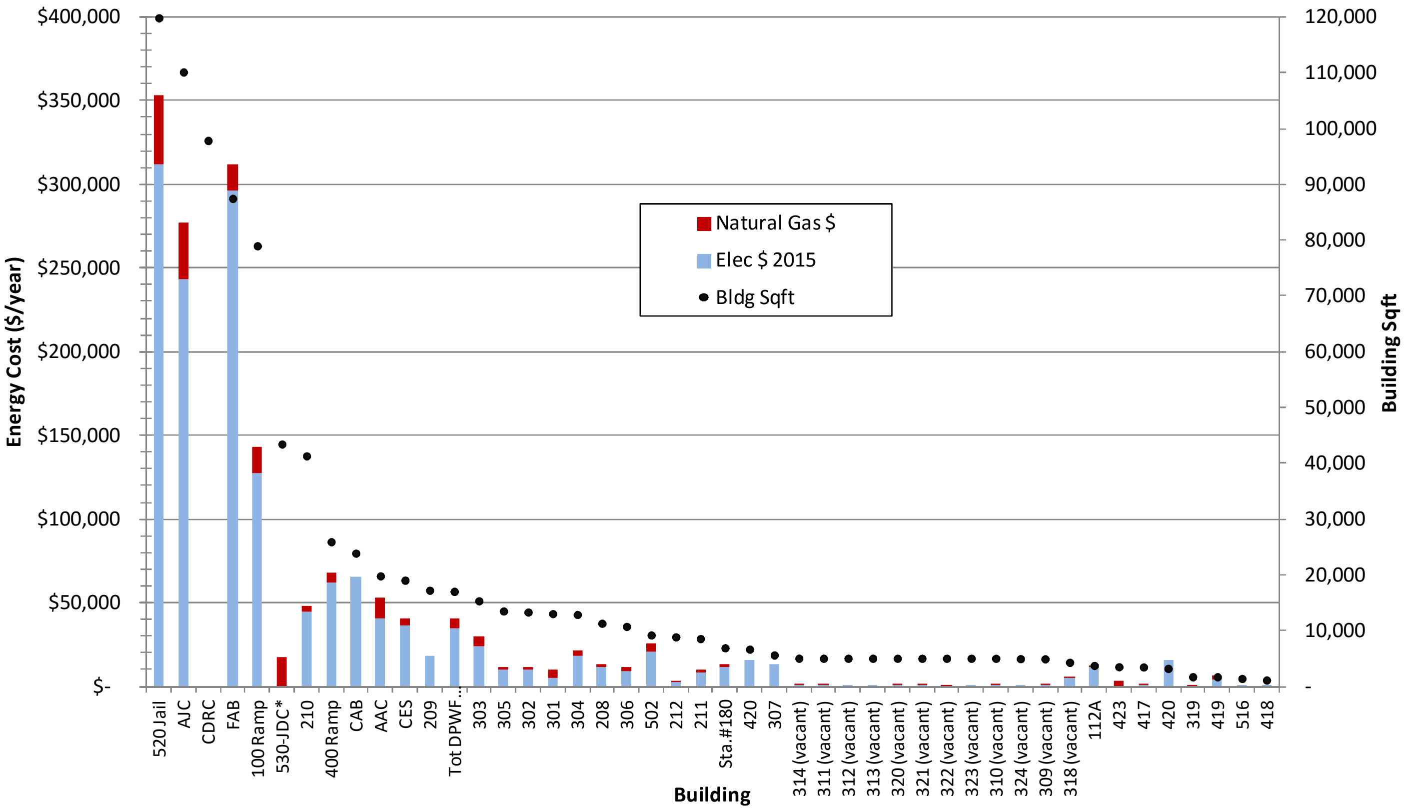


Figure 9: PCGC 2015 building energy costs (sorted by building size)

1.2.3 Building Energy Use Intensity (EUI)

Figure 10 plots building energy use intensity (EUI), measured in annual building energy use divided by building area (kBTU/sqft/year). This provides a normalized measure of building energy use intensity that can be used to compare and benchmark building energy use against different buildings. Note that the first column of data is for the total PCGC, which is not included in the preceding graphs due to graph scale/readability issues.

Also shown on this graph is a solid green line showing the average EUI for existing buildings in Auburn's climate zone, based on the U.S. Department of Energy's Commercial Building Energy Consumption Survey (CBECS)—refer to section 1.2.4.2 for more detail. The average building EUI varies with building area. Note that the average EUI for all buildings, regardless of building size, is 78 kBTU/ft^2.

Also shown on the graph is an indication of the EUI level typically expected for ZNE buildings. ZNE buildings typically have a building EUI of 30 kBTU/sf/year or lower. Buildings with an EUI of 30-40 kBTU/sqft are considered "Near-ZNE"—meaning they can achieve ZNE with relatively mild energy efficiency improvements or a larger PV array. Buildings with EUIs above 40 kBTU/SF are generally regarded as needing significant energy efficiency improvements in order to attain ZNE.

The three largest buildings for which energy consumption data is available—the Auburn Jail, AJC, and FAB—have EUIs at or above the CBECS average. The Auburn Jail is expected to have a higher EUI due to its intensive use. The JDC has a total EUI (including energy provided by its solar system) that is just above the CBECS building average. However, it should be noted that the JDC has very minimal purchased electricity use—the large ground mounted PV array supplies over 90% of the electricity used by this building. The JDC is nearly "Zero Net Electricity". A majority of the smaller buildings use less energy than the CBECS average.

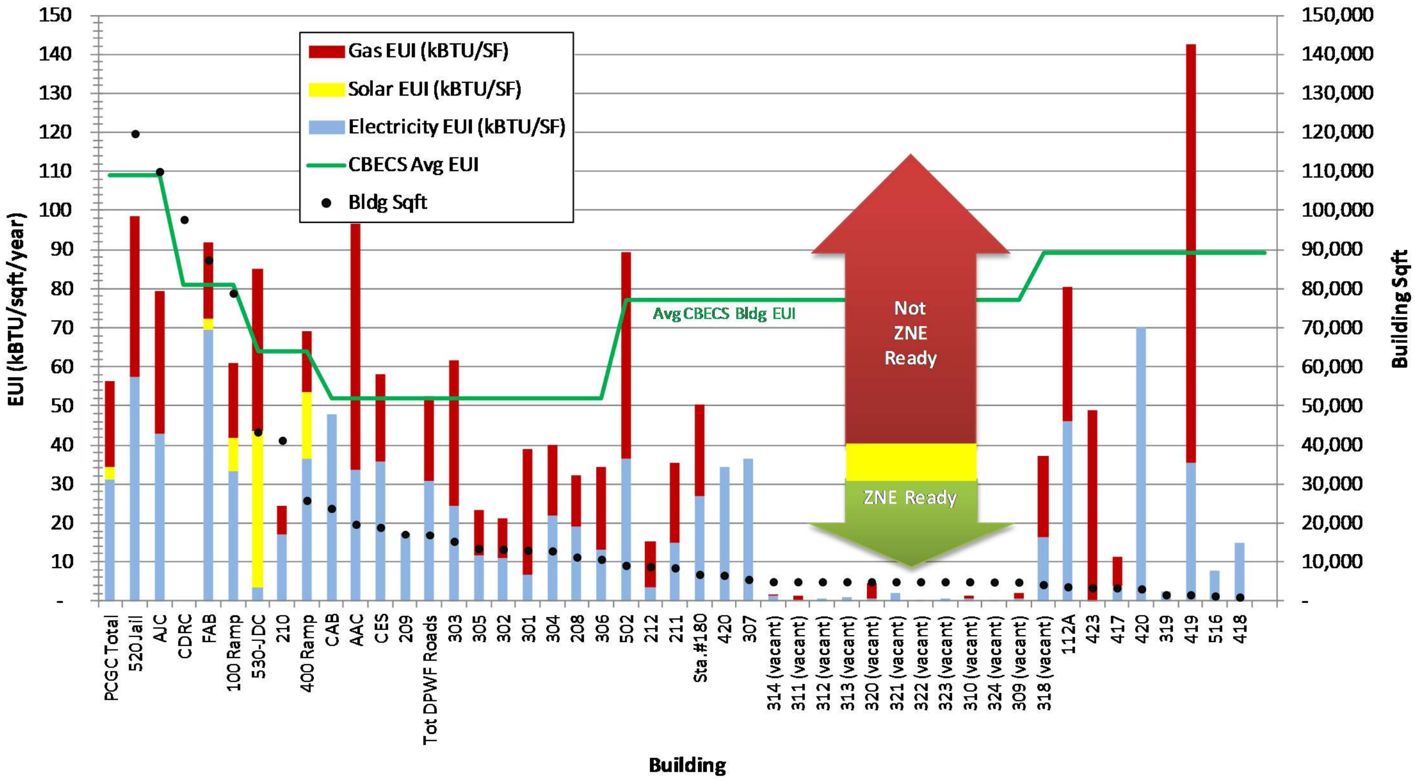


Figure 10: PCGC 2015 building energy use index (EUI) (sorted by building size)

1.2.4 Existing Building and ZNE Performance Benchmarks

1.2.4.1 ZNE Building EUI Benchmarks

There has been significant research on what building efficiency levels (as measured by their energy use intensity (EUI)), are needed for buildings to attain ZNE. While it is technically feasible for even the most inefficient building to attain ZNE if enough solar is added, the consensus (and performance of currently documented ZNE buildings)[9] is that buildings with EUI's # 30 kBTU/sqft/year are "ZNE Capable". Buildings with EUIs between 30 and 40 kBTU/sqft/year are "Near" ZNE capable and could attain ZNE with moderate efficiency improvements (in the 10-20% range) or a larger PV array. Buildings with EUIs > 40 kBTU/sf/year are not good candidates for achieving ZNE. The Technical Feasibility Study discussed in Section 9 provides additional details on specific EUIs for different building types in different climate zones which may be useful for Task 5 discussions.

Figure 10 shows PCGC building EUIs with indicators at 30 kBTU/sqft that show "ZNE capable" building performance. Excluding the vacant buildings, most buildings are consuming more energy than typical for ZNE and other high performing buildings. This indicates that there are significant opportunities for energy efficiency improvements in existing buildings.

1.2.4.2 Existing Building Benchmarks

There are two primary sources of existing building energy performance data available that are relevant to the PCGCMP.

The U.S. Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS) is the U.S. Department of Energy's primary commercial building energy end use study. CBECS obtains detailed energy consumption and building characteristic data for a sample of commercial buildings throughout the U.S. 2003 is the latest available study data. While somewhat dated, it is still a good source of data for existing buildings. CBECS climate zone 4 data is shown below. This includes Auburn's climate (<2000 CDD, <4000 HDD, and encompasses California Climate Zone 11). The average building EUI for CBECS climate zone 4 is 79 kBTU/ft^2.

[9] Refer to the "

Table 3 shows the CBECS Climate Zone 4 EUIs broken out by principal building use type. There are significant variations between different building types. Figure 11 shows CBECS Climate Zone 4 EUIs by floor space. Figure 12 shows CBECS Climate Zone 4 EUI data by year of construction.

Table 3: CBECS Climate Zone 4 Average EUI Summary

	EUI (kBTU/SF)			
Climate Zone/Building Use Type	**Average**	**Std. Dev.**	**Min**	**Max**
CBECS CZ4 / CA CZs 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	136	144	2	1,207
Education	118	114	16	593
Enclosed mall	128	8	119	134
Food sales	267	114	97	460
Food service	410	231	67	702
Inpatient health care	312	168	102	727
Laboratory	269	116	104	441
Lodging	86	48	5	173
Nonrefrigerated warehouse	41	35	4	145
Nursing	206	89	89	302
Office	120	83	9	572
Other	301	221	173	557
Outpatient health care	189	120	26	355
Public assembly	112	169	3	836
Public order and safety	103	46	54	148
Refrigerated warehouse	73	n/a	73	73
Religious worship	26	17	2	57
Retail other than mall	100	75	3	286
Service	128	295	5	1,207
Strip shopping mall	158	65	82	346
Vacant	45	53	4	151

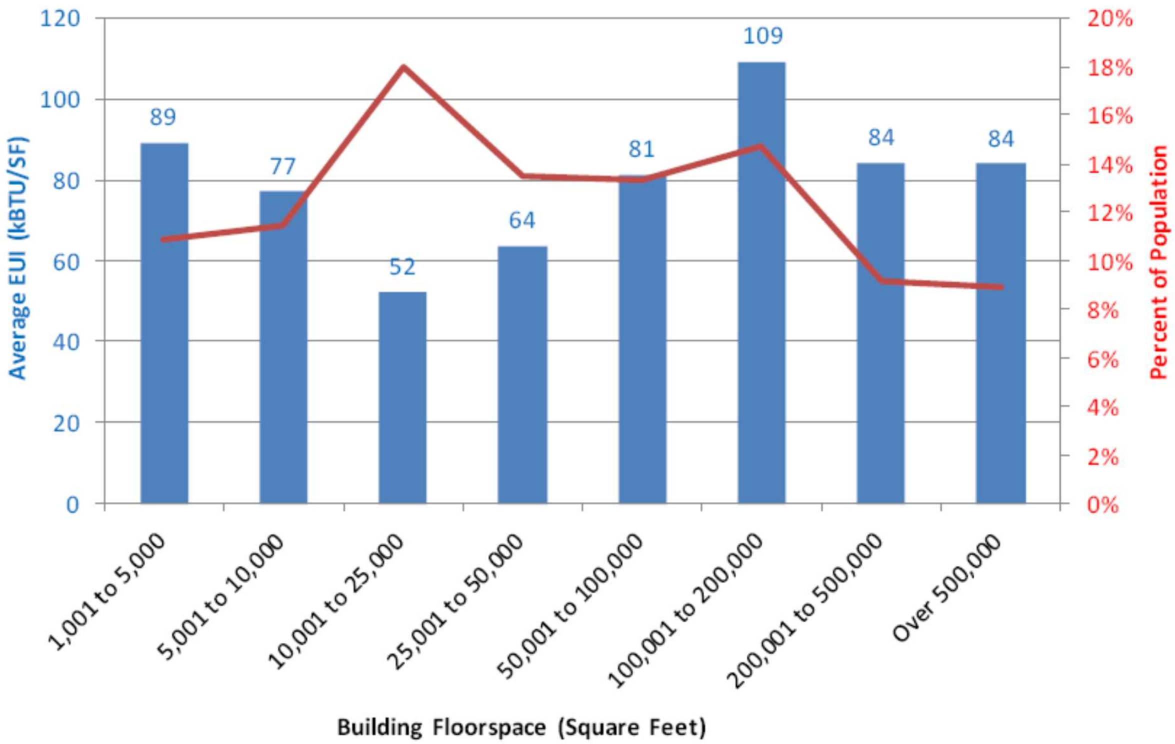


Figure 11: CBECS Climate Zone 4 EUIs by building floor space

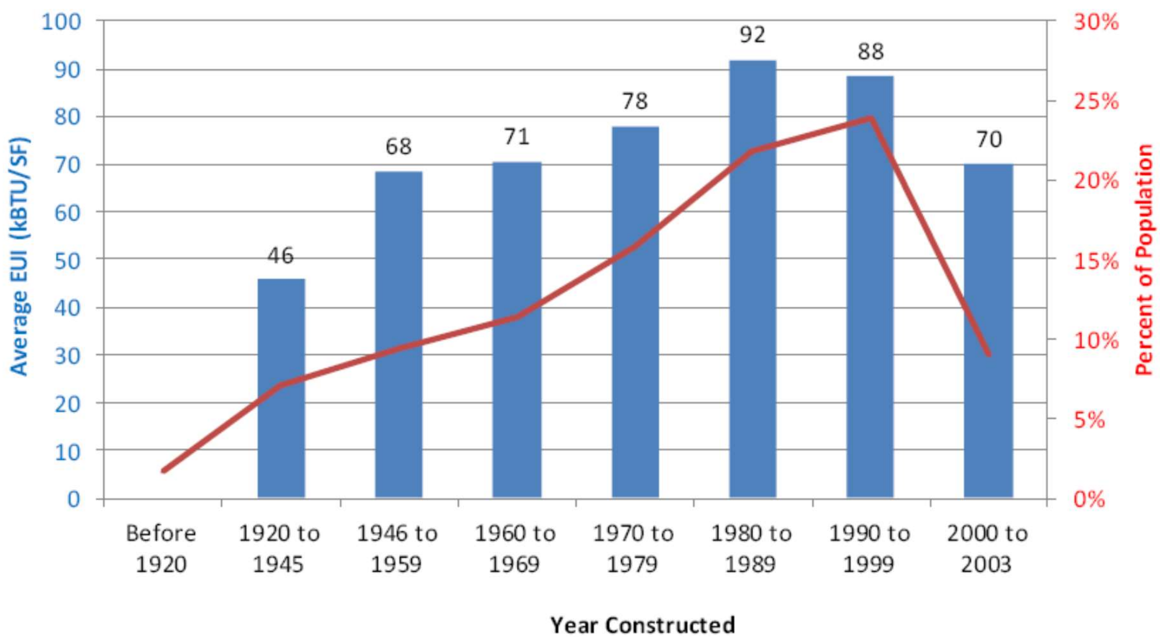


Figure 12: CBECS Climate Zone 4 EUIs by year of construction

California LEED Building EUI Comparison

For the "Road to ZNE" roadmap study, all of California's LEED rated buildings were analyzed to determine their building energy performance, based on modeled (vs. actual) energy consumption that was part of the LEED submittal. Note that this data is for buildings registered for LEED in or prior to 2011 (the latest available data). The following data tables and figures are excerpted from the “Road to ZNE” roadmap, Appendix G. Table 4 shows the building EUI data by building type. Both the base-case (code compliant) and proposed (i.e., as designed) building performance data is shown. Data is averaged by building type. One interesting thing to note is that the average building EUIs are all quite high compared to “ZNE Ready” performance levels of <30 kBTU/sqft. This indicates that simply building to a general “LEED” standard is insufficient for achieving ZNE. Planners and designers must really focus on building efficiency.

Table 4: California LEED rated building EUI summary, by building type

				EUI (kBTU/SF)											
				Proposed Building						Base-Case Buildng					
Building Type	Count	% Above ASHRAE	Avg EAc1 pts	Total	Regulated	Process/Plug		Electricity	Natural Gas	Total	Regulated	Process/Plug		Electricity	Natural Gas
Office	88	29%	6.2	85	43	42	51%	67	17	111	69	42	62%	87	23
Higher Ed	69	26%	5.4	78	54	24	69%	54	20	96	72	24	75%	68	24
Multi-Family	31	26%	5.4	65	45	20	69%	39	25	81	60	20	75%	50	29
Other	30	25%	5.3	620	324	296	52%	588	33	986	690	296	70%	937	49
Industrial	28	31%	6.8	1,717	155	1,561	9%	483	1,234	2,554	334	2,220	13%	686	2,380
Office-Mixed	28	24%	4.8	88	48	40	55%	59	27	106	65	40	62%	70	34
Assembly	23	25%	5.0	84	58	26	69%	60	23	112	86	26	77%	79	33
K-12	21	32%	7.0	96	77	20	80%	55	41	127	107	20	85%	75	52
Other-Public Order/Safety	16	25%	5.0	68	52	16	76%	40	15	90	74	16	82%	50	22
Other-Military	12	29%	6.4	64	40	23	63%	51	12	87	63	24	73%	68	19
laboratory	10	26%	5.3	170	102	68	60%	134	24	213	145	68	68%	168	29
Library	10	23%	5.0	59	43	16	73%	47	13	75	59	16	79%	61	15
Retail	9	28%	6.1	132	79	53	60%	100	32	168	115	53	68%	130	38
Lodging	9	22%	4.2	109	65	44	59%	46	59	129	84	45	65%	61	64
Library	8	26%	5.5	69	50	19	72%	52	16	98	77	21	78%	74	24
warehouse	8	32%	7.3	398	110	288	28%	391	7	571	223	348	39%	557	14
Health Care	6	21%	4.0	124	88	36	71%	92	32	165	129	36	78%	111	54
Retail	6	29%	6.2	130	53	77	41%	77	53	160	82	78	51%	99	73

Figure 13 shows a histogram of California LEED rated office building EUIs, broken down by California Climate Zone[10]. There are not many LEED buildings in Auburn’s climate zone (California Climate Zone 11). None of the buildings in California Climate Zone 11 perform below the 30 kBTU/SF “ZNE Ready” threshold.

[10] Not to be confused with CBEC’s climate zones, which are different.

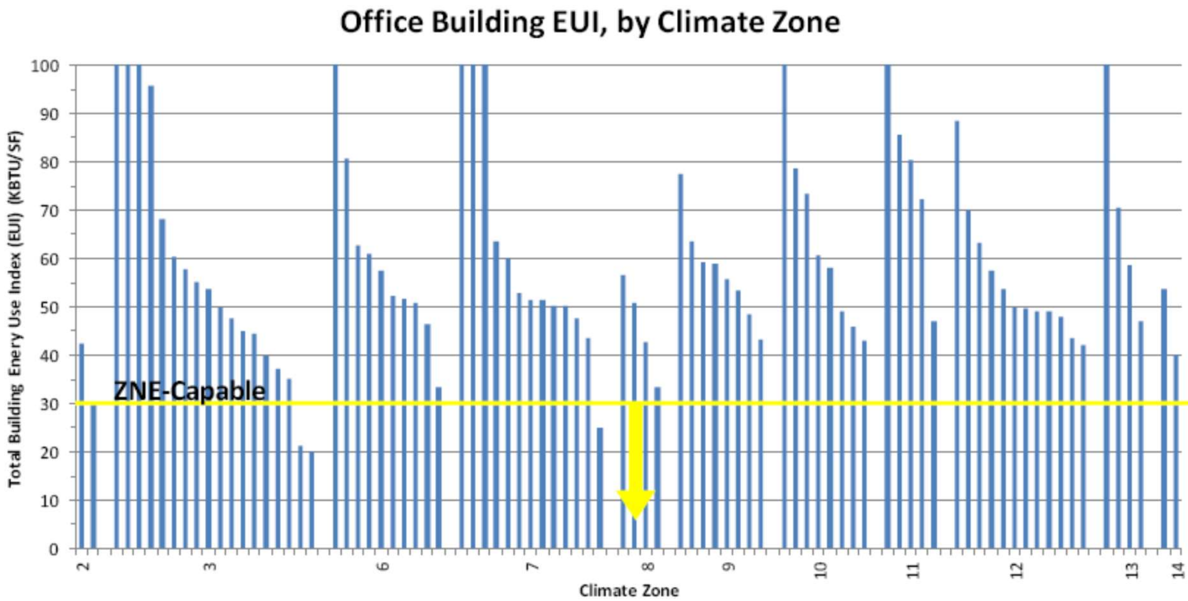


Figure 13: Histogram of LEED NC office building EUIs by Climate Zone

1.3 Existing PV System Performance

The PCGC has four solar PV systems in operation. These include a 45 kW PV System at the Finance Administration Building (FAB), a 132 kW PV system on buildings 110-111, a 82 kW system on Building 400, and a 325 kW ground mounted system serving the Juvenile Detention Center (JDC). PV system performance was analyzed for each system. The National Renewable Energy Lab's PV Watts solar analysis tool was used to estimate PV generation for each system based on system orientation (azimuth), tilt, nominal array size, typical PV losses, and local solar resources and climate data.

Table 5 shows estimated electricity generation from each PV system. The last row shows the annual purchased electricity for the systems that are on a net metering rate. Negative net metering data indicates that the system generated more electricity than was used on the meter.

Table 5: Summary of PCGC PV generation

Month	Blgd 400	Bldg 110/111	FAB	JDC
1	5,611	8,252	3,209	22,220
2	6,264	9,229	3,588	24,758
3	11,074	16,705	6,169	43,796
4	12,388	19,187	6,723	49,007
5	14,455	22,820	7,655	57,223
6	14,626	23,411	7,623	57,951
7	14,566	23,151	7,643	57,685
8	14,189	22,232	7,595	56,170
9	12,320	18,722	6,806	48,730
10	10,475	15,490	5,947	41,426
11	6,823	9,835	3,993	26,972
12	6,017	8,666	3,519	23,812
Total Solar kWh	128,807	197,702	70,469	509,750
Net energy metering total purchased kWh	(8,080.00)	(65,400.00)	n/a	46,452.00

1.3.1 FAB PV System

On March 29, 2005 the Board authorized the Director of Facility Services to negotiate and execute an Agreement for the design and installation of a 45 kilowatt PV System at the Larry Oddo Finance Administration Building.

Figure 14: FAB building PV system

The FAB PV system is not on a net metering rate.

1.3.2 Buildings 110-111 PV System

On January 10, 2006, the Placer County Board authorized the installation of a 132-kilowatt system on PCGC Buildings 110-111.

Table 6: Building 110/11 PV System Net Energy Metering Purchased/Sold Electricity

Month	On Peak kWh	Part Peak kWh	Off Peak kWh	Total kWh
Dec-15	**0.00**	**720.00**	**2,160.00**	**2,880.00**
Nov-15	-960	-1,680	1,440	-1,200
Oct-15	-3,120	120	720	-2,280
Sep-15	-3,360	480	-360	-3,240
Aug-15	-3,720	480	840	-2,400
Jul-15	-3,840	240	840	-2,760
Jun-15	-5,400	-1,440	-3,120	-9,960
May-15	-6,480	-4,680	-2,760	-13,920
Apr-15	0	-9,720	-1,800	-11,520
Mar-15	0	-6,840	-1,200	-8,040
Feb-15	0	-3,360	480	-2,880
Jan-15	0	-1,440	1,080	-360
2015Total	-26,880	-27,120	-1,680	-55,680

Figure 15: Building 110/111 PV system

1.3.3 Building 400 (County Maintenance) PV Array

Also in 2006, the PCGC authorized the installation of an 82-kilowatt system on PCGC Building 400 (County Maintenance).

Table 7: Building 400 PV System Net Energy Metering Purchased/Sold Electricity

Month	On Peak kWh	Part Peak kWh	Off Peak kWh	Total kWh
Dec-15	-	4,960	5,600	10,560
Nov-15	960	3,760	5,680	10,400
Oct-15	-	-	-	-
Sep-15	(3,040)	(560)	1,600	(2,000)
Aug-15	(3,600)	(1,120)	2,000	(2,720)
Jul-15	(3,760)	(800)	2,080	(2,480)
Jun-15	(4,160)	(1,760)	(1,280)	(7,200)
May-15	(3,920)	(4,160)	(400)	(8,480)
Apr-15	-	(7,040)	480	(6,560)
Mar-15	-	(4,800)	960	(3,840)
Feb-15	-	(2,080)	2,480	400

Jan-15	-	-	3,840	3,840
2015 Total	**(17,520)**	**(13,600)**	**23,040**	**(8,080)**

Figure 16: Building 400 PV system

1.3.4 Juvenile Detention PV Array

In a continuing effort to generate clean electrical power through renewable resources staff has looked at six additional sites at the Dewitt Center. Staff subsequently directed Solar Power, on behalf of Placer County, to submit applications to the Self Generation Incentive Program offered by the California Public Utility Commission. The County recently received Conditional Reservation Notice from PG&E for a ground array system to be located near the Juvenile Detention Center at the Placer County Government Center. Should your Board approve this recommendation, Solar Power will lease land from the County on which they will design, install, and operate a 325 kilowatt ground mounted system, including all switch gear, connections, and associated improvements.

Table 8: JDC PV System Net Energy Metering Purchased/Sold Electricity

Month	On Peak kWh	Part Peak kWh	Off Peak kWh	Total kWh
Dec-15	0	1,717	19,183	20,900
Nov-15	-941	-6,662	14,649	7,046
Oct-15	-14,113	-869	18,237	3,255
Sep-15	-17,591	-611	23,085	4,883
Aug-15	-18,962	-1,185	21,942	1,795
Jul-15	-14,564	-1,705	13,119	-3,150
Jun-15	-13,429	-2,262	13,876	-1,815
May-15	-18,856	-9,216	4,749	-23,323
Apr-15	0	-15,583	13,978	-1,605
Mar-15	0	-5,871	15,573	9,702
Feb-15	0	-9,502	15,591	6,089
Jan-15	0	3,330	19,345	22,675
2015 Total	**(98,456)**	**(48,419)**	**193,327**	**46,452**

Table 9: JDC PV system

2 ZERO NET WATER MASTER PLANNING – TASK 1A AND 1B

2.1 WATER POLICY AND PLANNING ISSUES IMPACTING THE PCGCMP

California will continue to face significant water constraints and challenges into the foreseeable future. Population and economic growth will continue to place additional demands on water, while drought, decreasing snowpack, wildfire, and other issues place unique vulnerabilities on the State's water supplies.

Placer County is uniquely situated with respect to water—its geographic reach extends up into the Sierras to the headwaters and snowpack storage and down to lower elevations with significant agricultural uses. Placer County must deal first hand with a wide variety of threats facing its water supply—from drought to extreme storm events, decreasing snowpack, wildfires, human impacts on water supply, storm water impacts, etc.

The PCGCMP is in a strategic position to both be a good steward of the county's water supply, as well as demonstrate state of the art thinking and design for how to better manage our water resources with a holistic, integrated focus.

2.1.1 Net Zero Water

Although Net Zero Water is not as well-known a goal as Net Zero Energy, California's record setting five-year drought has focused virtually every government agency, business and household on water issues. The result of the worst drought in a century--has been acute water shortages, over-pumping of groundwater, reduced water in streams and increased risk of wildfire. It touches most aspects of County life. Like much of the state, Placer County continues to experience moderate to severe drought conditions.

2.1.2 California Water Action Plan

In response to the crisis, Governor Brown mandated statewide reductions in water use—measures that have been somewhat relaxed in the aftermath of a dramatic comeback for Northern California's snowpack. In addition the State has developed The California Water Action Plan, a crucial policy guide for dealing with the statewide crisis. The Action Plan is a five-year roadmap toward sustainable water management and July 2016 marks the halfway point in the plan's implementation. Plan implementation has seen "an increase in regional self-reliance and integrated water management across all levels of government", among other successes. On the downside, the drought has caused a reduction in available groundwater, increased wildfires, decimated forest trees and reduced jobs in the agriculture sector.

Against this challenging backdrop, Placer County is well positioned to be a leader in water management and conservation. The County is home to the entire course of major water supplies. Unlike the Southern part of the state, where water is brought for long distances, Placer County lives among its water sources and residents drink local water. From the mountains to the lower elevations, water in Placer County is home-sourced. This is an aspect of water management that can tie in to the Government Center Campus.

PLANNING CAN DRAMATICALLY IMPROVE CONSERVATION

Because water shortages are a guaranteed condition of living in California, the benefits of planning are many. Although Net Zero Energy is supported by alternative generation sources, Net Zero Water is not. There is no new water being made! Thus conservation and reuse become essential tools for dealing with water shortages. The Placer County Government Center Master Plan Update not only offers an excellent opportunity to develop a strong water planning process, but also can be a platform to demonstrate wise water management practices to the entire community.

Voluntary green building programs are one option for reducing water use in buildings. Although there is currently only one LEED building at Dewitt Center, the County could mandate a green building standard for new County buildings —either its own standards or one of the accepted system such as LEED, Build It Green, Living Building Challenge etc.

DROUGHT IMPACTS AND TREE LOSS

The state's record-setting drought is part of a historic pattern that California tends to suffer cyclically. What's different now is that scientific data has confirmed the role of human activity in causing climate change. Increasing temperatures are causing secondary disasters such as loss of trees, their cooling canopy, species-protecting habitat, their carbon sequestration and anti-erosion properties as well as numerous other benefits.

Local impacts are serious: Bark beetles are infesting drought-weakened trees, killing 66 million trees statewide and 20% of forests, which comprise 30% of Placer County. The result has been dramatically increased wildfire risk. Consequently the County recently declared a local emergency. Government Center trees are of course not immune to this destruction. Moreover, even if the drought should end, history shows it will return. A potential scenario is that temperatures will continue to rise and threaten the resilience of an unprepared community.

2.1.3 Resilience Initiatives

Traditionally the County has promoted numerous campaigns and efforts related to resilience such as Wildfire Community Preparedness Day. An event like Wildfire Community Preparedness Day can be modified and adapted to other aspects of resilience, such as Emergency Water Supplies. Thus one aspect of the Master Plan could be to explore and test adaptive strategies related to resilience, which become increasingly important as temperatures continue to rise, drought continues and new environmental (and community) threats emerge.

2.2 Pre-Development Water Balance

A water balance for the PCGC's pre-development conditions has been performed. This serves as a reference point to understand the water flows prior to development. The analysis was conducted using the EPA's National Stormwater Calculator[11]. Based on adjacent and nearby undeveloped areas, this analysis assumes that the PCGC pre-development conditions were a 50/50 split between forest and meadow.

Figure 17 shows the pre-development water flows. The site has an annual rainfall of 36.48 inches. Of this rain hitting the site, 95% of it is infiltrated into the ground (charging aquifers and feeding streams), 4% runs off the site (surface runoff), and 1% of the rain is evaporated.

[11] This is a sophisticated planning-level scenario analysis tool. It uses a detailed storm water calculation engine (EPA's SWMM model), detailed soil and hourly rain and climatic data and extensive design and performance data on a range of low impact development storm water management strategies. It does not substitute for detailed civil engineering hydraulic modeling and analysis.

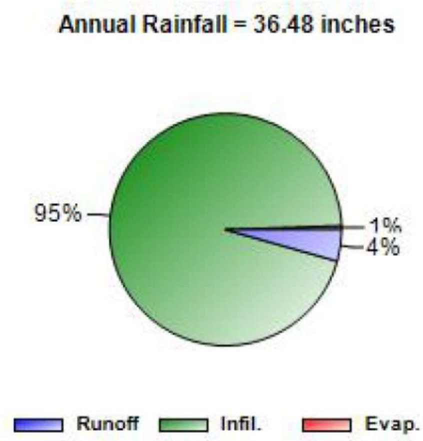


Figure 17: pre-development water flow summary

2.3 Existing Condition Water Balance

A water balance has been conducted for the existing PCGC campus to estimate water flows and uses across the site. Figure 18 summarizes the site's annual water balance. All data is shown in acre-feet (AF)[12].

The site receives just over 36" of rain per year. This equates to 608 acre-feet of water hitting the site annually. Of this rainfall, 63% (382 acre feet) hits the landscape and infiltrates into the soil to recharge groundwater and streams. 4% (23 acre feet) evaporates. The remaining 33% (203 AF) strikes roofs (49 AF) and other hardscape (155) and runs off into the storm water system. This compares to almost no runoff for predevelopment conditions (see Figure 17).

For 2015, PCGC purchased 127 AF of water. 74 AF was used for interior/domestic uses, and 53 AF was used for irrigation (which was severely curtailed in 2015 due to the drought). Irrigation would be significantly larger in a normal year. Approximately 66 AF goes into the sewer. Details of the analysis are provided in the next "Water Analysis Details" section.

[12] An acre-foot is one acre of water one foot deep.

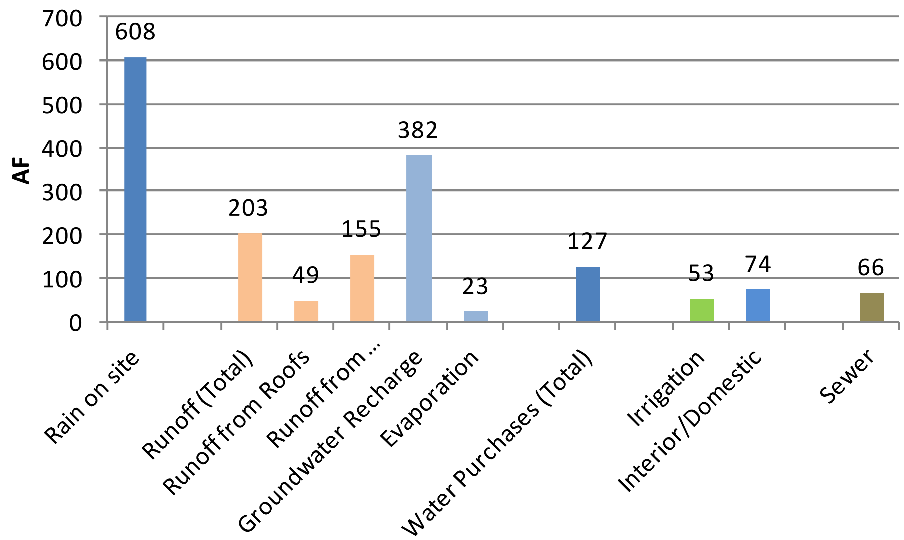


Figure 18: Existing condition water balance (2015)

This water balance illustrates a number of interesting facts. First, there is significantly more rainfall on the site than is used by the facility. In fact, unwanted storm water runoff is significantly larger than water purchases. Runoff from roofs alone nearly meet 2015 irrigation needs. While there will be challenges using all of this given the distributed nature of the site, there are nevertheless significant opportunities.

The water balance suggests significant opportunities for rainwater capture/reuse from the roofs, and opportunities for a wide range of green-infrastructure storm water management techniques.   There may also be opportunities for gray water reuse and ecological water recycling (i.e., subsurface constructed wetlands aka vegetated submerged beds).

2.4 Water Analysis Details

This section presents details of the existing conditions water analysis.

2.4.1 Existing Land Use Characterization

Table 10 shows a preliminary estimate of current PCGC land uses. This data is used to estimate storm water generation from different surfaces, rainwater capture opportunities, etc.

Table 10: Approximate land use characterization of current PCGC

Description	Area (acres)	% of Total
Roofs	16.0	8%
Streets	14.2	7%
Parking & Hardscape	37.6	19%
Irrigated	17.7	9%
Unirrigated Open Space	25.4	13%
Irrigation Ditch	0.9	0%
Detention	4.9	2%
Solar Array	1.8	1%
Pond	2.5	1%
Misc Hardscape	2.0	1%
Other Unirrigated Open Space	77.1	39%
Total	**200.0**	**100%**
Total Impervious	***72.51***	***36%***

2.4.2 Rain and Stormwater

A detailed analysis of rain and storm water generation was performed using the U.S. EPA's National Stormwater Calculator. Figure 19 compares the pre-development state to existing condition storm water generation. The site is currently 36% impervious (i.e., roofs, roads, parking lots). This results in approximately 33% of the total rainfall hitting the site to run off, compared to only 4% in pre-development conditions. Thus there are significant opportunities on the campus for low impact design (LID), aka green storm water infrastructure storm water management strategies.

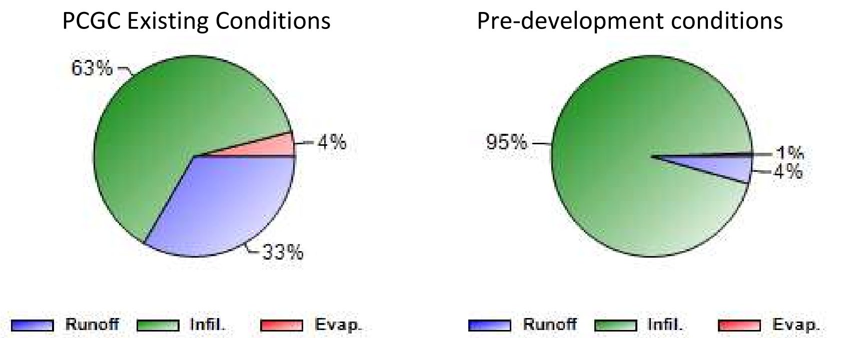
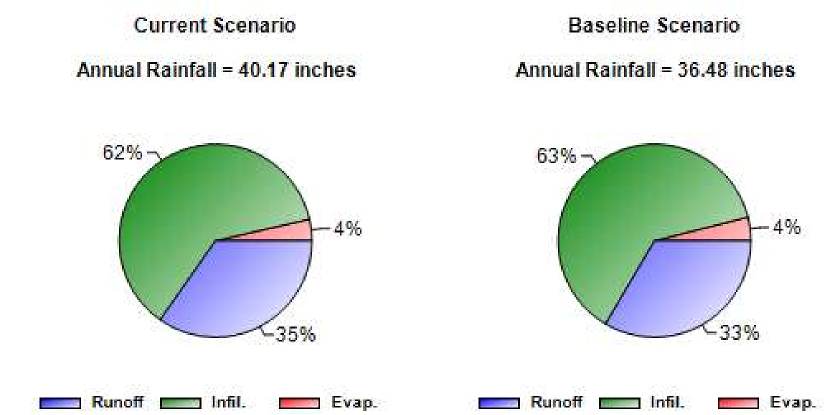


Figure 19: Existing conditions vs. pre-development storm water statistics

Impacts Due to Climate Change

The EPA's National Stormwater Calculator has the capability to analyze the storm water impacts of several different climate change scenarios. The following figure shows the potential impacts for near-term climate change impacts given a warm/wet scenario. Rainfall increases by nearly 4" per year in this condition, and runoff goes from 12.25 inches to 14 inches. This is not a significant change from existing conditions, but does help inform the design team on possible near term climate change impacts. Caution should be used in interpreting and using these results, however.



Statistic	*Current Scenario*	*Baseline Scenario*
Average Annual Rainfall (inches)	*40.17*	*36.48*
Average Annual Runoff (inches)	*14.00*	*12.25*

Figure 20: Possible climate change impacts on storm water runoff (left) vs. existing conditions (right)

2.4.3 Potable Water Consumption and End Use

Monthly water consumption data from 2006 to 2015 was analyzed. Figure 21 and Table 11 summarize the annual water consumption, water end uses, and waste water generation. Figure 22 plots monthly water consumption for the past 10 years. All data is shown in acre-feet (AF).

There are a number of trends. Total water use has been decreasing over the years, with very deep cuts in the last few years due to the drought.

Note that monthly water use in Figure 22 always drops to a minimum in the winter months. These are the months when there is minimum irrigation water use, and represents the “baseload” water use. The majority of this water use is for interior domestic purposes. The variable portion of the water use (i.e., the “spikes”, or increased water consumption during summer months) represents irrigation and cooling water. Since the majority of the buildings use air-cooled a/c equipment (except the FAB), the majority of this additional summer water use is attributed to irrigation. Evaporation from the pool accounts for some of this water use, but it is quite small compared to irrigation. Thus interior domestic water consumption can be disaggregated from irrigation water use. Note that both interior and exterior water consumption has been dropping. The PCGC has been increasingly efficient with its water consumption on all levels. Waste water generation is estimated at 90% of the interior domestic water use (a typical assumption).

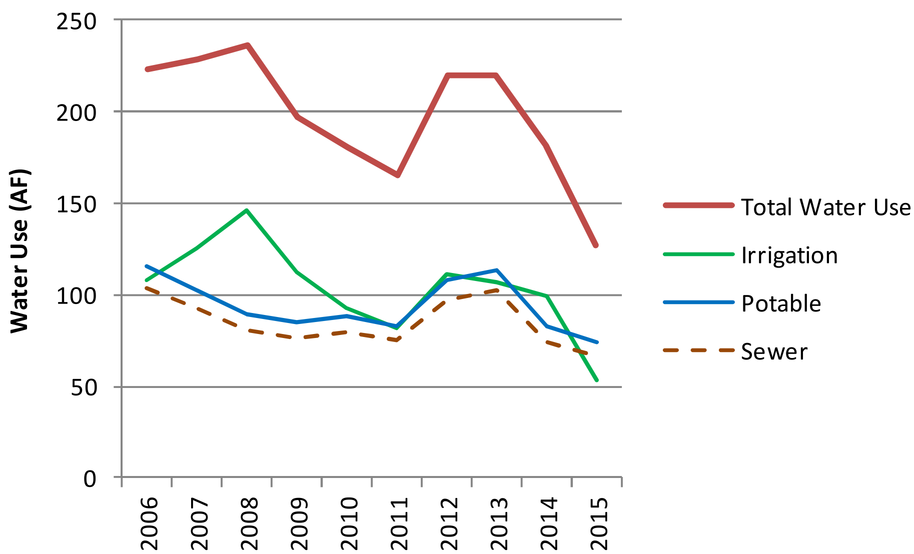


Figure 21: Annual water consumption and estimated end uses

Table 11: Annual water consumption and estimated end uses

Year	Total Water Use	Potable	Irrigation	Sewer
2006	223.4	115.6	107.8	104.1
2007	228.4	102.6	125.8	92.3
2008	235.8	89.3	146.6	80.3
2009	197.1	84.8	112.3	76.3
2010	180.5	88.1	92.4	79.3
2011	164.8	83.1	81.6	74.8
2012	219.8	108.3	111.5	97.5
2013	219.8	113.3	106.5	101.9
2014	181.9	82.6	99.3	74.4
2015	126.6	73.8	52.8	66.4

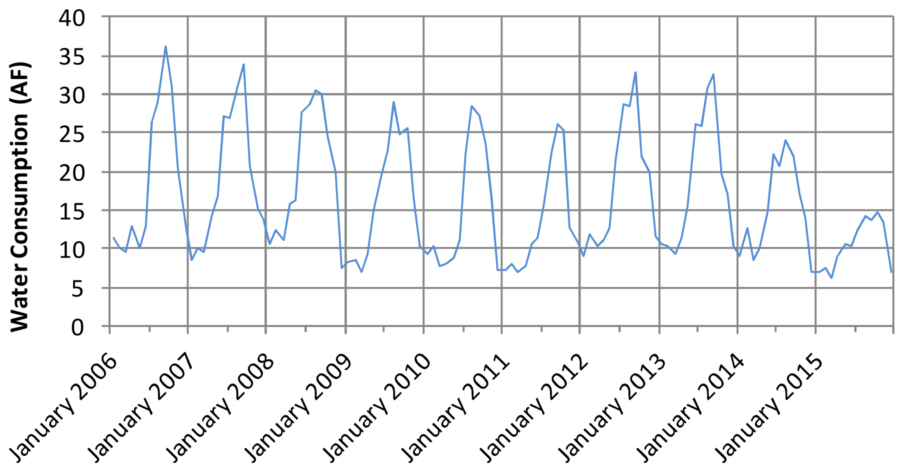


Figure 22: Monthly water consumption

3 CARBON MASTER PLANNING—TASKS 1A AND 1B

3.1 GHG EMISSIONS ANALYSIS

3.1.1 GHG Emission Factors

GHG Emission factors used in this analysis are presented below. Note the GHG emissions are typically measured in metric tons of CO_2 (MTCO2).

Electricity

Electricity is provided by PG&E. Electricity emission factors are shown in the following table. Electricity emission factors vary year to year based on the mix of fuels used to generate the electricity. California's electricity GHG emission factors are improving due to Renewable Portfolio Standards which require utilities to increase electricity generation from renewable energy sources. Emission factors through 2014 are 3rd party verified GHG emission factors; emission factors for 2015 and beyond are based on independent CPUC projections[13, 14].

Table 12: Electricity GHG emission factors

Year	Lbs CO2/MWh	MTCO2/MWh
2003	620	0.281
2004	566	0.257
2005	489	0.222
2006	456	0.207
2007	636	0.288
2008	641	0.291
2009	575	0.261
2010	445	0.202
2011	393	0.178
2012	445	0.202
2013	427	0.194
2014	435	0.197
*2015**	391	0.177
*2016**	370	0.168
*2017**	349	0.158
*2018**	328	0.149
*2019**	307	0.139
*2020**	290	0.132

[13] All data except 2014 is from: PG&E, "Greenhouse Gas Emission Factors: Guidance for PG&E Customers," November 2015.
https://www.pge.com/includes/docs/pdfs/shared/environment/calculator/pge_ghg_emission_factor_info_sheet.pdf

[14] Updated 2014 emission factor is from: PG&E, "Climate Change Vulnerability Assessment," 2016.
http://www.pgecurrents.com/wp-content/uploads/2016/02/PGE_climate_resilience.pdf

Natural Gas
Natural gas GHG emission factors do not change over time like electricity. Natural gas GHG factors are 11.7 lbs CO2/therm, or **0.00531 MTCO2/therm**[15].

Water
There is a significant amount of energy and carbon embodied in water. Over 20% of California's energy use goes toward water pumping, conveyance (i.e. aqueducts), treatment and heating.

PCGC's water is provided by Placer County Water Agency (PCWA). PCWA Conducted an Energy and Green House Gas Benchmark Study[16] to quantify the amount of energy and GHGs in its water supply. It projects for future water system build-out, that it will supply 217,200 AF of water per year with a total energy use of 68,048,500 kWh[17]. This results in a system-wide average embodied electricity factor of **313.3 kWh/AF** of water supplied. This latest data currently available is used for this analysis. This electricity emission factor is multiplied by the appropriate year's electricity GHG factor to obtain the total estimated embodied GHGs in water.

Wastewater
Specific Data for wastewater treatment energy use for PCGC was not available. Industry average data is used. Average wastewater collection energy consumption is 191.5 kWh/AF, and wastewater treatment energy is 622.7 kWh/AF[18], for a total wastewater energy factor of **814.2 kWh/AF**.

3.1.2 PCGC Existing GHG Emissions

Greenhouse gas emissions for the PCGC was estimated for 2015. Figure 23 and Table 13 summarize the results. GHG emissions are shown for building energy use, water consumption, and wastewater generation. Transportation related GHG emissions are also shown for the natural gas sold from the CNG fuel station. GHG emissions for other aspects of the campus operation (i.e., office consumables, refrigerants) are not included in this analysis. The PCGC has an estimated total annual GHG emissions of 3,048 metric tons of CO_2 (MTCO2) per year. Water and wastewater related emissions are very small compared to energy emissions. Electricity related GHG emissions make up almost half of the PCGC's annual emissions.

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[15] PG&E, "Greenhouse Gas Emission Factors: Guidance for PG&E Customers," November 2015. https://www.pge.com/includes/docs/pdfs/shared/environment/calculator/pge_ghg_emission_factor_info_sheet.pdf

[16] Placer County Water Agency, "Energy And Green House Gas Benchmark Study," July 2009. http://www.pcwa.net/files/docs/enviro/PCWA_Benchmark_Study_Summary_July_2009.pdf

[17] Placer County Water Agency, Table 2.7, "Energy And Green House Gas Benchmark Study," July 2009. http://www.pcwa.net/files/docs/enviro/PCWA_Benchmark_Study_Summary_July_2009.pdf

[18] De Monsabert, S. et. al., "Incorporating Energy Impacts into Water Supply and Wastewater Management," Table 2. 2009 ACEEE Summer Study on Energy Efficiency in Industry Proceedings. http://aceee.org/files/proceedings/2009/data/papers/6_86.pdf

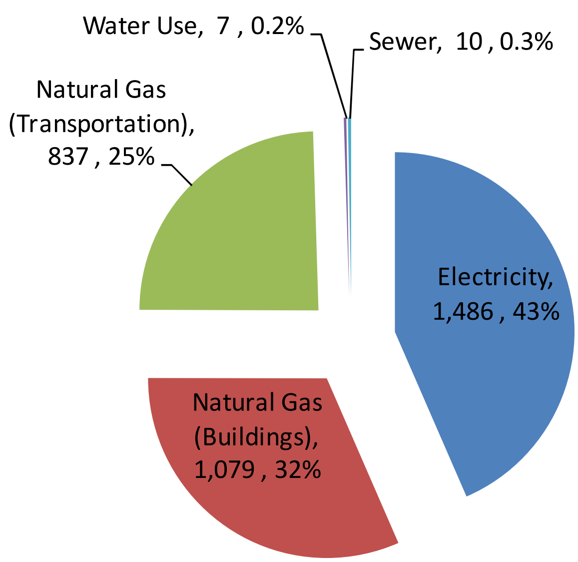


Figure 23: 2015 PCGC GHG emissions (in metric tons of CO_2)

Table 13: 2015 PCGC GHG emissions (in metric tons of CO_2)

Electricity	**Natural Gas** (buildings)	**Natural Gas** (Transportation - CNG Station)	**Water**	**Sewer**	**Total**
1,486	1,079	837	7	10	3,418
43%	32%	24%	0.2%	0.3%	100%

3.2 Life Cycle Carbon Analysis of Retaining Vs. Replacing Existing DeWitt Buildings

One of the questions that has arisen is whether it makes sense, from a carbon perspective, to keep some of the older DeWitt buildings or replace them with more efficient construction. A life cycle carbon analysis was performed to provide insight into this question.

A prototypical ~4,000 sq ft DeWitt barracks wing was analyzed. This is representative of Ramp 100 buildings (and similar buildings on other ramps) as illustrated in the following figure.

Figure 24: Ramp 100 buildings

Construction characteristics and details are taken from the PCGC Facility Condition Report. Typical foundation, wall and floor details are shown. It is a simple building.

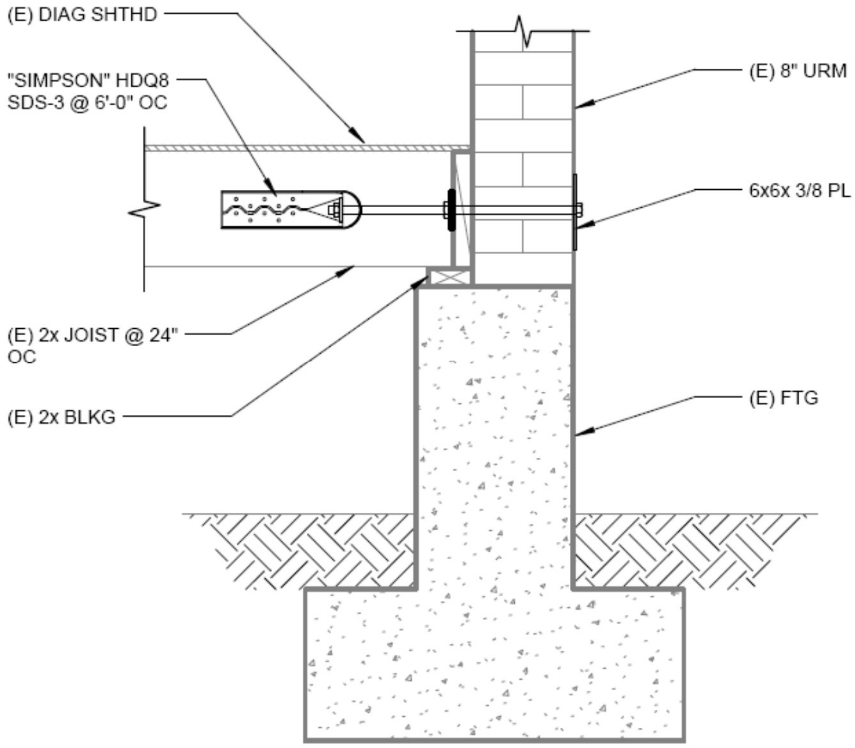


Figure 25: Typical wall and floor construction of Ramp 100 buildings

A life cycle carbon analysis was made using the Athena Institute's Impact Estimator (see below for a description of the methodology).

End-of-life (demolition, recycling/landfilling) emissions for this building are 5 metric tons of CO_2 (MTCO2). The majority of the GHG emissions for building demolition are due to transportation and onsite equipment. Much of the construction waste is recycled. The masonry does not decompose and release GHG's.

Building energy use for building 112a was used as representative of Ramp 100 and similar buildings on other ramps (note: many of the older buildings are vacant, used for storage, utility data is not disaggregated, or buildings are otherwise not representative of typical use). Building 112a has a total building energy use intensity (EUI) of 80.3 kWH/sqft/year. This is just under the average EUI of 89 KBT/sqft for this building size in this climate zone. Building 112a's gas use is 34.2 kBTU/sqft and electricity use is 46.1 kBTU/sqft. This results in annual GHG emissions of 16.1 MTCO2 from energy consumption. Note that annual energy related GHG emissions are more than the end of life (demolition) emissions.

A same sized new building[19] was also analyzed, using typical wood frame construction. The embodied GHG's in the new building's materials are 24 MTCO2. Construction results in 15 MTCO2 of emissions.

New construction building energy use is estimated at 35 kBTU/sqft/year, which is representative of a high performing, "zero net energy capable" building, consistent with the Master Plan intent. This results in 7.3 MTCO2 of emissions per year due to energy. This is significantly less than the existing building's energy consumption.

Figure 26 compares the cumulative GHG emissions for continued use of the existing building, versus replacing the building with a new more efficient building. The red columns represent the cumulative GHG emissions from the existing building. The green columns represent the new building. The first year includes the end of life GHG emissions associated with tearing down the existing building. The second year includes embodied material and construction emissions for building the new building. Subsequent years include the operational energy GHG emissions. By year 4, the savings from reduced energy use in the new building make up for the additional GHG emissions associated with replacing the existing building.

The results indicate that the life cycle greenhouse gas emissions associated with replacing the building are much smaller than the cumulative impacts of building related energy use.

There are many variants that could be explored—different construction types for the new building, deep energy retrofits for the existing building, etc. From the carbon perspective, it doesn't matter if you keep or tear down the existing buildings. What really impacts lifecycle carbon emissions for this project is building energy efficiency. It does not matter whether this is achieved through deep retrofits, or new construction.

[19] Same square footage, but with a wider aspect ratio typical of what would likely be built

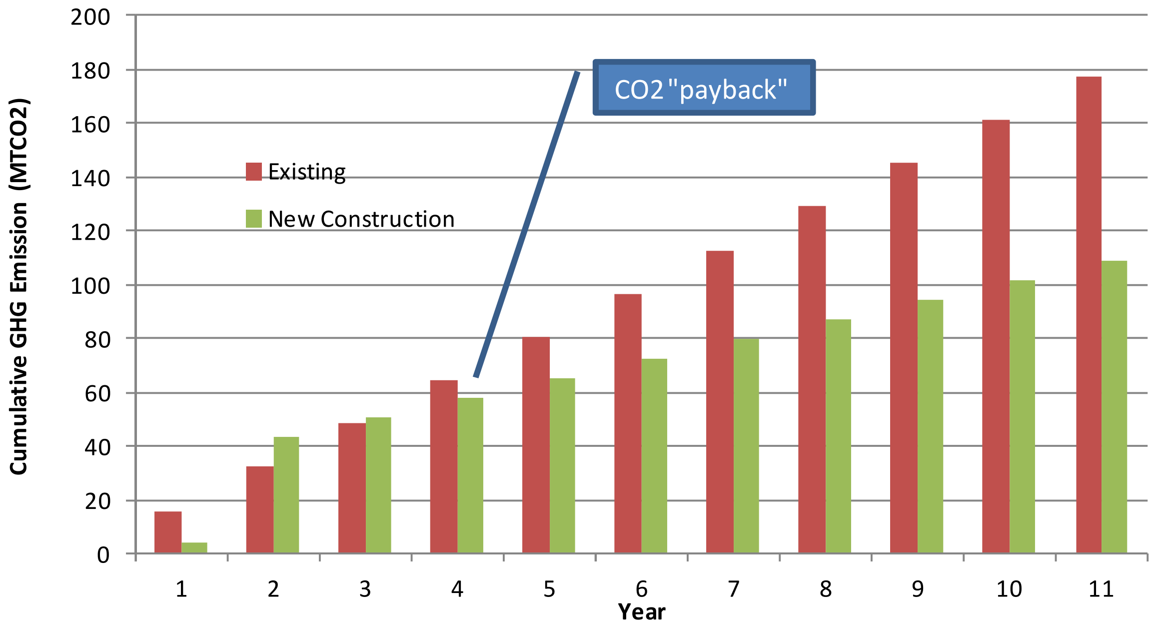


Figure 26: Comparison of cumulative GHG emissions for continued use of the existing DeWitt barrack building versus replacing it with new construction

3.2.1 Methodology and Analysis Details

A life cycle analysis (LCA) study has been performed using the Athena Institute's "Athena Impact Estimator for Buildings" software tool. This is a whole building, life cycle based environmental assessment tool that compares the relative environmental effects or trade-offs across alternative building design solutions at the conceptual design stage. The Athena Impact Estimator for Buildings is the only software tool in use in North America that evaluates whole buildings and assemblies based on internationally recognized life cycle assessment (LCA) methodology. It has extensive regional data on building material and building life cycle phase carbon and other LCA impacts. The Impact Estimator analyzes the environmental impacts of:

- Material manufacturing, including resource extraction and recycled content
- Related transportation
- On-site construction
- Regional variation in energy use, transportation and other factors
- Building type and assumed lifespan
- Maintenance, repair and replacement effects
- Demolition and end-of-life disposition
- Operating energy emissions and pre-combustion effects

Table 14 summarizes key life cycle emission sources that are included in the analysis.

Table 14: Summary of key elements included in the Life Cycle Analysis

Life Cycle Element	Supports?	Processes Included
A1 Raw material supply	Y	Primary resource harvesting and mining
A2 Transport	Y	All transportation of materials up to manufacturing plant gate
A3 Manufacturing	Y	Manufacture of raw materials into products
A4 Transport	Y	Transportation of materials from manufacturing plant to site, and construction equipment to site
A5 Construction-installation process	Y	Construction equipment energy use, and A1-A4, C1, C2, C4 IM effects of construction waste
B1 Installed product in use	N	n/a
B2 Maintenance	Partial	Painted surfaces are maintained (i.e. repainted), but no other maintenance aspects are included
B3 Repair	N	n/a
B4 Replacement	Y	Modules A1-A5 effects of replacement materials, and C1, C2, C4 includes effects of replaced materials based on expected material lifetimes
B5 Refurbishment	N	n/a
B6 Operational energy use	Y	Energy primary extraction, production, delivery, and use. Regional energy supply system carbon intensities are used.
B7 Operational water use	N	n/a
C1 De-construction demolition	Y	Demolition equipment energy use
C2 Transport	Y	Transportation of materials from site to landfill
C3 Waste Processing	N	n/a
C4 Disposal	Y	Disposal facility equipment energy use and landfill site effects
D Benefits and loads beyond the system boundary (Beyond Building Life)	Partial	Steel recycling and carbon sequestration of wood products

Additional LCA analysis details are available from the Athena Institute.

4 Climate Change, Resiliency and Vulnerabilities Assessment

4.1 Executive Summary and Key Findings

California's climate is already changing. This is resulting in noticeable and significant impacts at both local and State levels. This climatic changes will continue—and increase—during the PCGCMP planning horizon. Furthermore, many of the decisions made during this master planning effort will endure well beyond the current planning horizon and will influence how the PCGC fares in even more extreme climate changes projected for the latter part of this century. Impacts include increased temperatures, heat storms, significantly reduced snowpack, increased wildfire, insect and pest migration, stress on landscaping and greater ecosystem, impaired water supplies, etc.

The purpose of this study is to provide the master planning team and stakeholders with the most current information on projected climate change and related impacts and vulnerabilities to inform the PCGC master planning process as part of the Plan's sustainability master planning efforts.

The following key climatic changes are projected:

- Average and peak day/night temperatures are increasing. Average annual temperatures are projected to increase by 3.8 to 6.7ºF by the end of the century. Peak day/night temperatures are increasing as well. This will increase energy use and costs for A/C. It may make some passive and low energy strategies that are currently effective in the PCGC's current climate (i.e., strategies that take advantage of cool night temperatures) more challenging in the future. It will stress landscaping and the environment. It is likely that new varieties of pests and disease will appear as the climate becomes more hospitable to them. One of the most disquieting data points is that Auburn and Placer County mountain areas are projected to undergo the largest annual temperature rise of anywhere in the state!

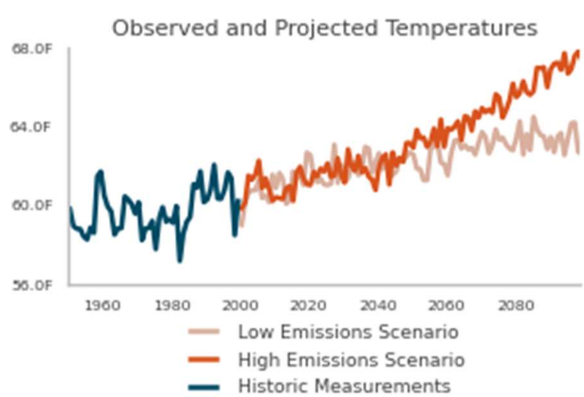


Figure 27: Average Annual temperature projections for Auburn

- Extreme heat events (heat waves, heat storms) are projected to increase significantly. The historical average of 3-5 extreme heat days is already being exceeded significantly. By 2030 there may be years with over 30 extreme heat days, and this could double in the latter part of the century.

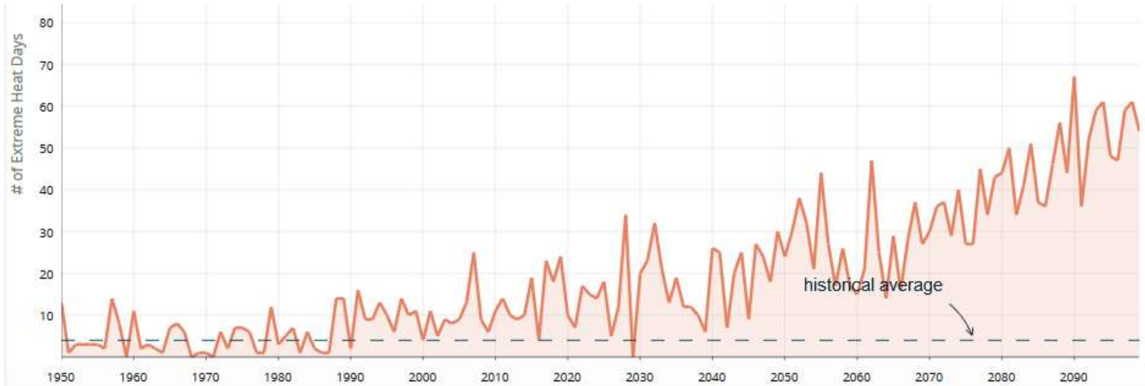
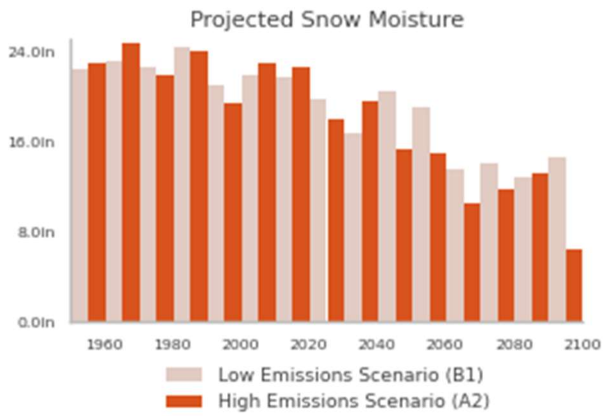


Figure 28: Projected number of Extreme Heat Days per year for Auburn

- One of the most significant climate change impacts is a large projected reduction of Sierra snowpack in Placer County, with snowpack projected to decrease by 46-65%, depending on future greenhouse gas emissions reductions. This decline in snowpack will have significant impacts on water supply, among other things.



- Relatively small changes in annual precipitation are projected, although projections show decreased summer precipitation.
- Wildfire risk is increasing.

These projected changes will have significant impacts on the region and the PCGC. The PCGC master plan update presents a unique opportunity for the County to serve in a leadership role for how the County as a whole should consider and address a wide variety of climate mitigation, adaptation, and resiliency initiatives.

4.2 Introduction and Purpose

California's climate is already changing. The purpose of this study is to provide the master planning team and stakeholders with the most current information on projected climate changes and related impacts and vulnerabilities to inform the PCGC master planning process as part of the Plan's sustainability initiatives. This will help the team understand key vulnerabilities and proactively address a range of mitigation, adaptation and resiliency issues.

Section 3 provides details on the expected climatic changes expected for Auburn and the PCGC.

4.3 Projected Climatic and Environmental Changes Impacting the PCGC

This section presents projections for PCGC's future climate change impacts through the rest of this century.

Data presented here is primarily from Cal-Adapt (www.cal-adapt.org). Cal-Adapt aggregates and synthesizes existing California climate change scenarios and climate impact research for beneficial use by local decision-makers. The site has been developed by UC Berkeley's Geospatial Innovation Facility (GIF) with funding and advisory oversight by the California Energy Commission's Public Interest Energy Research (PIER) Program, and advisory support from Google.org. The data used by Cal-Adapt have been gathered from California's scientific community, and represent the most current data available wherever possible.

It is not yet clear whether we—as a society—will aggressively reduce our greenhouse gas emissions to avoid the worst-case climate change scenarios, or whether we will continue on a business-as-usual trajectory that will take us into uncharted territory and more extreme climate change. Therefore, much of the data presented here is bracketed by "low" and "high" greenhouse gas (GHG) emissions scenarios[20]. The low emissions scenario assumes very aggressive reductions in our GHG emissions, while the high emission scenario represents a business-as-usual trajectory. Refer to Cal-Adapt.org for more details on the emissions scenarios.

[20] Note that in some cases, we present only the higher emissions scenario to simplify the interpretation and analysis. Complete data is available on Cal-Adapt.org

4.3.1 Average Annual Temperature Rise

For the PCGC, the average annual temperature is expected to rise between 3.8°F to nearly 7°F, depending on our GHG emissions. The figure below shows the projected difference in temperature between a baseline time period (1961-1990) to the end of the 21st century. Note that peak monthly temperatures and extremes may be higher than the annual average (see the next section). **Auburn and the mountains of Placer County are projected to experience the largest increase in temperatures statewide**. This will have impacts on water supply, snowpack, wildfire, energy, recreation, and other activities.

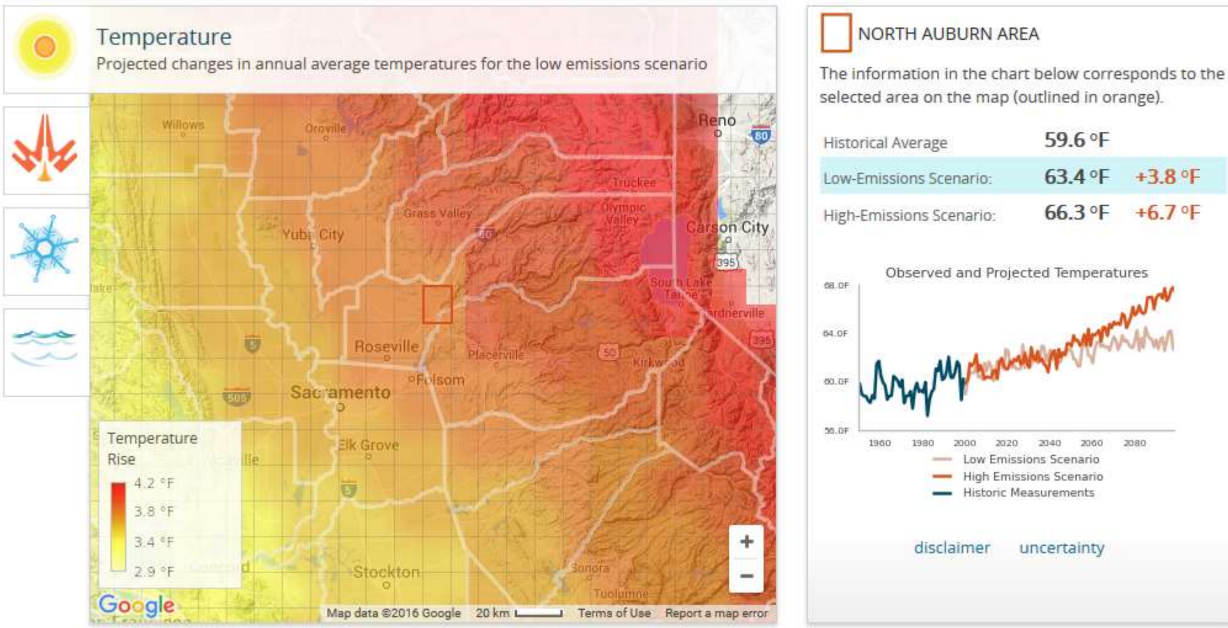


Figure 29: Annual average temperature change for the PCGC (low emission scenario)

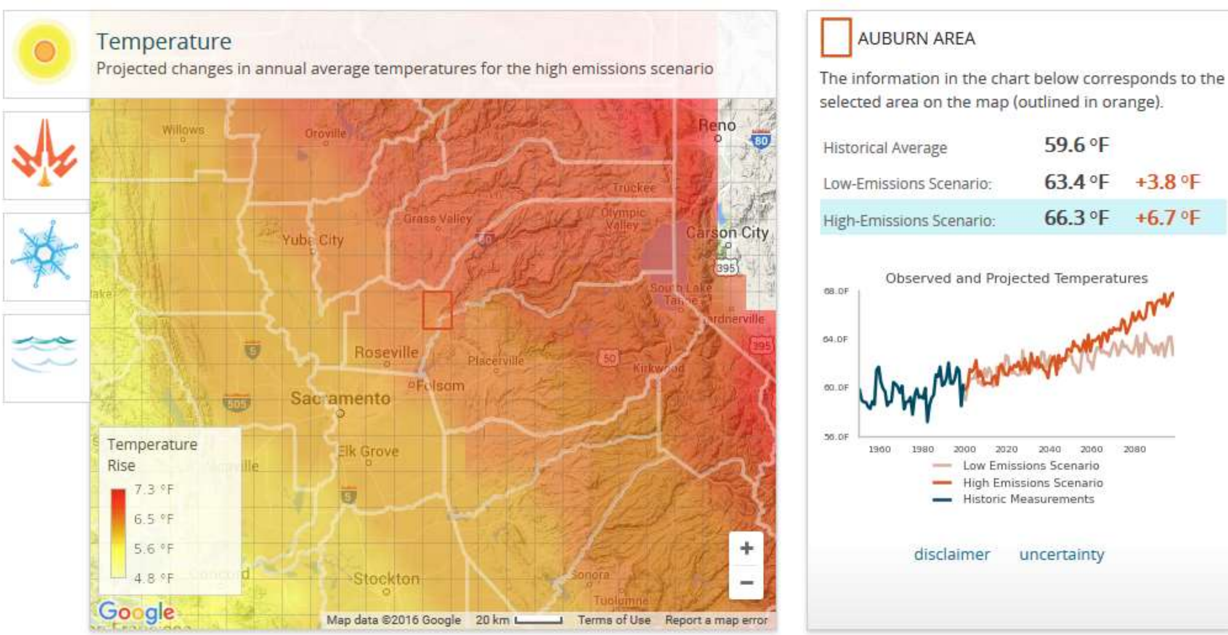


Figure 30: Annual average temperature change for the PCGC (high emission scenario)

4.3.2 Summer High Temperature Trends

The following two figures show historical (dark blue) and projected (multi-color). summer day and night monthly peak temperatures for the high emissionscenario. (The multi-color lines represent various climate models.)

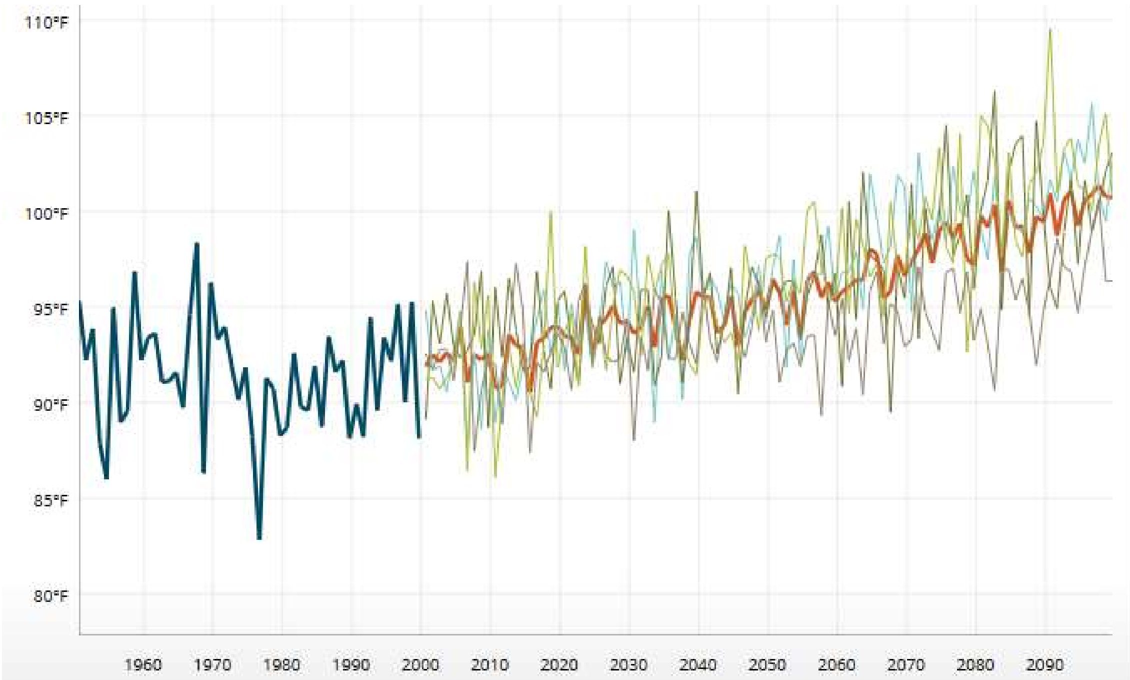


Figure 31: August daytime temperature peaks (high emission scenario) for PCGC

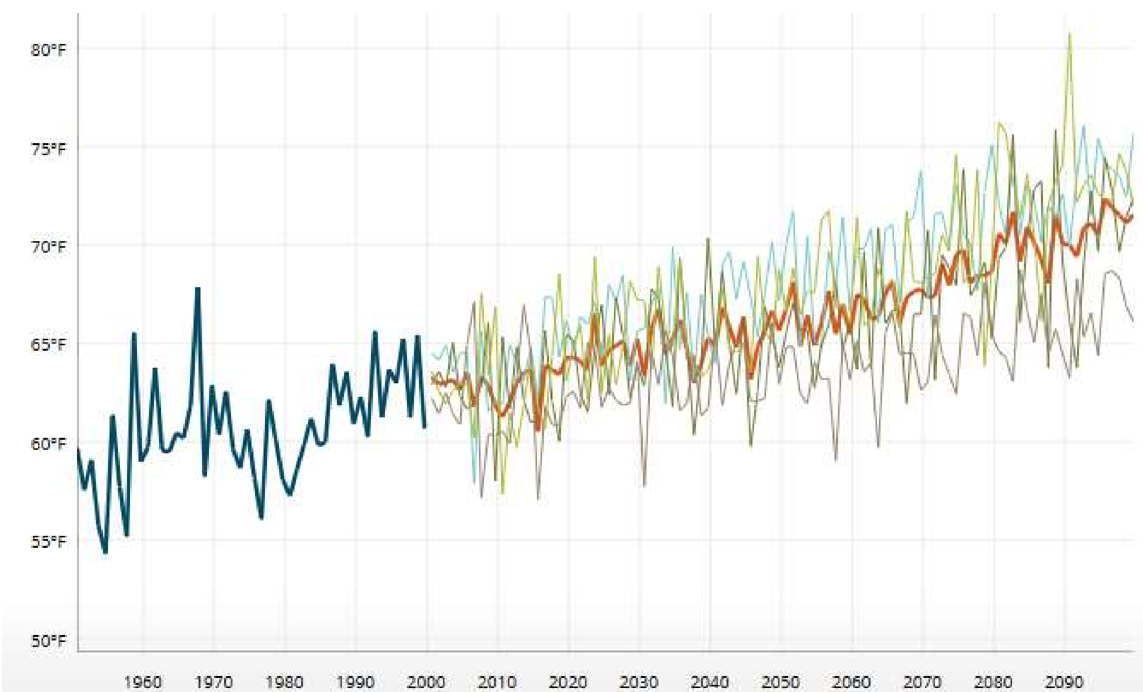


Figure 32: August night temperature peaks (high emission scenario) for PCGC

August high temperatures are projected to increase from highs of 90-95°F to over 100°F. Likewise monthly low temperatures will increase from ~60-65°F and approach 70 or 75°F. Note that these are the monthly highs, not the average daily highs. These changes will have significant impacts, including increasing daytime A/C use (and increasing related electricity consumption, peak demand; and costs); it will reduce the ability to cool homes and buildings down in the evenings and nights with natural ventilation or whole house fans (and related night time flush strategies for commercial buildings); it likely will adversely impact trees, landscaping and crops; and it will likely have human health impacts.

4.3.3 Winter High Temperature Trends

January high and low temperature projects do not change as much as summer temperatures, but do show a warming trend.

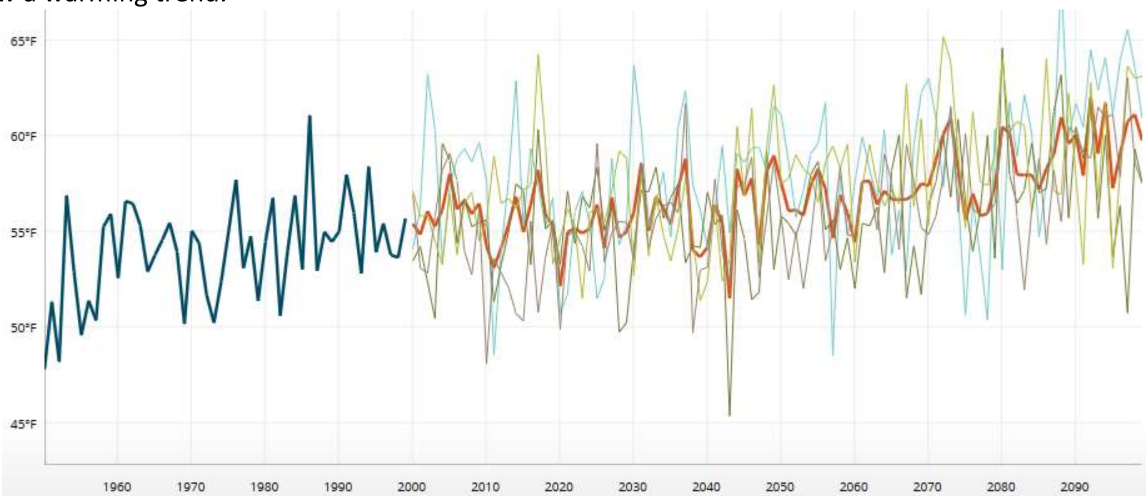


Figure 33: January daytime temperature peaks (high emission scenario)

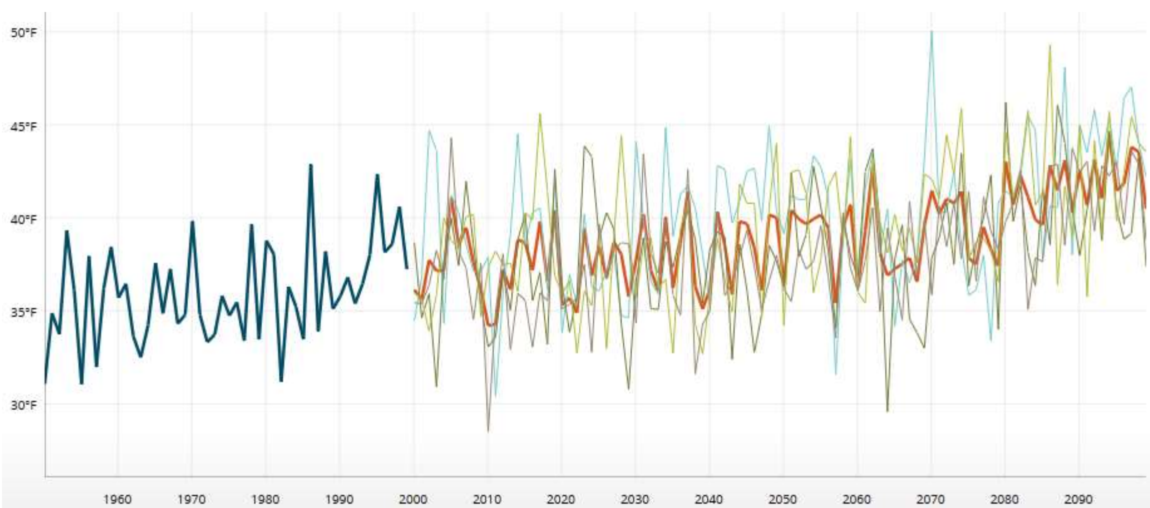


Figure 34: January night temperature peaks (high emission scenario)

4.3.4 Day and Night High Temperatures (2010 and 2030)

The following set of graphs show data similar to the preceding figures. The preceding figures show the trends for how summer/winter and day/night high temperatures are increasing over time. They show the hottest temperatures monthly. The following two graphs show daily high and temperatures (for both daytime and nighttime) for a single year, for the hottest day of the month. This provides a little more insight for how the climate is changing on a daily basis, not just the hottest days of the month. Graphs for 2010 and 2030 are shown. Overlaid on the charts are extreme heat day and warm night thresholds. These graphs provide insight into how high and low temperatures are changing throughout the entire year. The data shows that (1) there are increasing numbers of days passing the extreme heat day threshold, (2) increasing nights exceeding the warm night threshold, and (3) extreme heat days/warm nights are increasing occurring outside the typical summer warm periods.

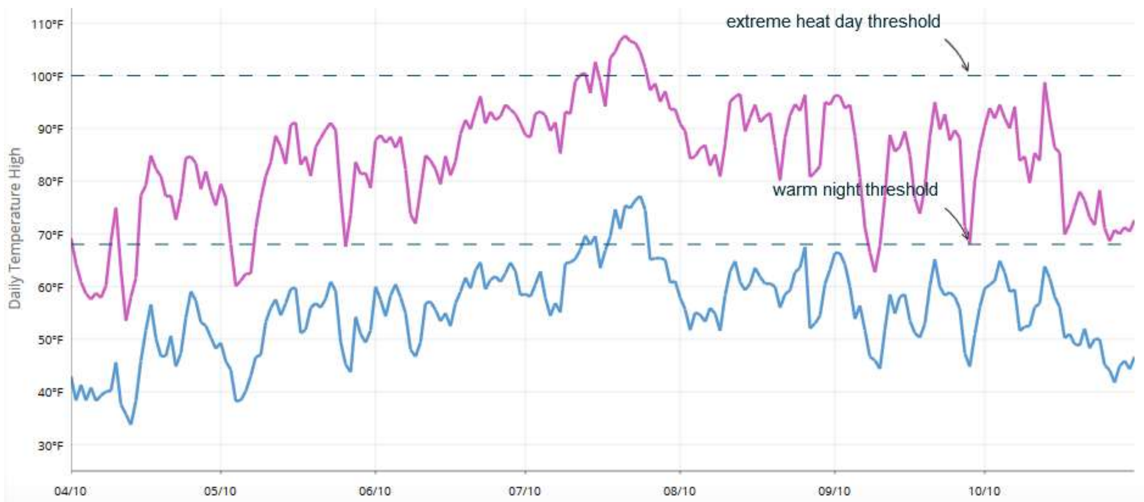


Figure 35: Daily high temperatures for daytime and nighttime, 2010 (high emissions scenario)

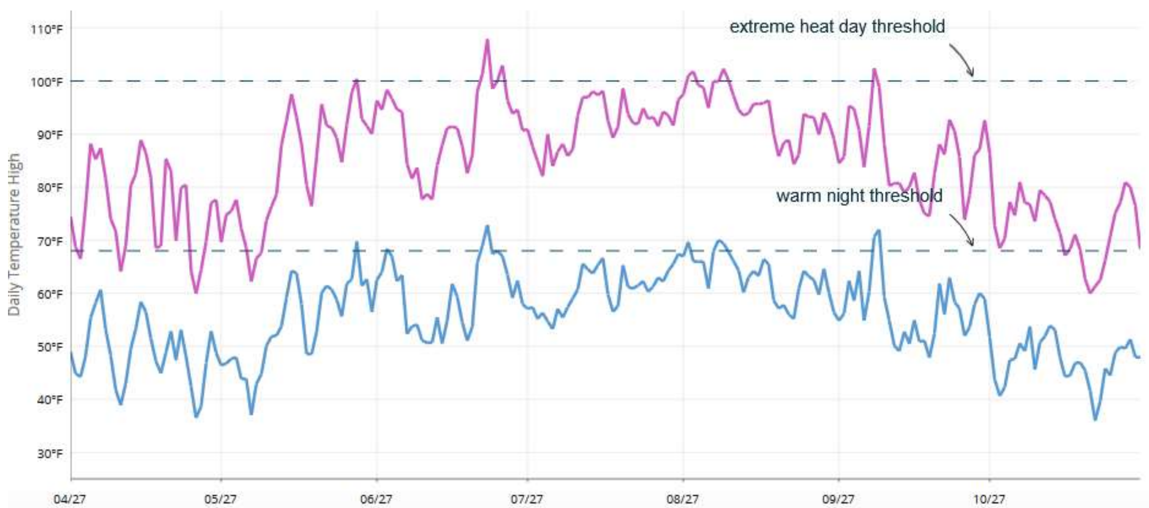


Figure 36: Daily high temperatures for daytime and nighttime, 2030 (high emissions scenario)

4.3.5 Extreme Heat

Extreme heat events are projected to increase significantly for Auburn. The following sets of graphs present a number of different ways to measure extreme heat events. Extreme heat can be deadly. It can also be costly due to increased A/C, peak demand spikes resulting in brown-outs and black-outs, etc.

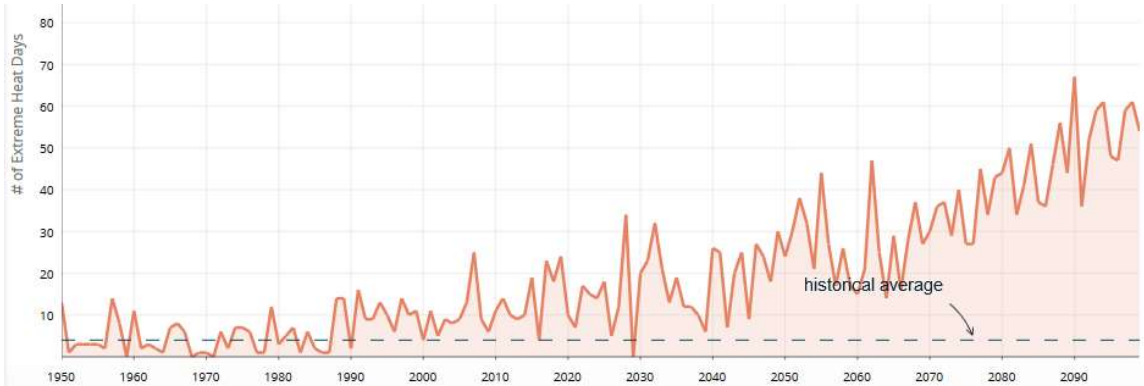


Figure 37: Number of Extreme Heat Days per year

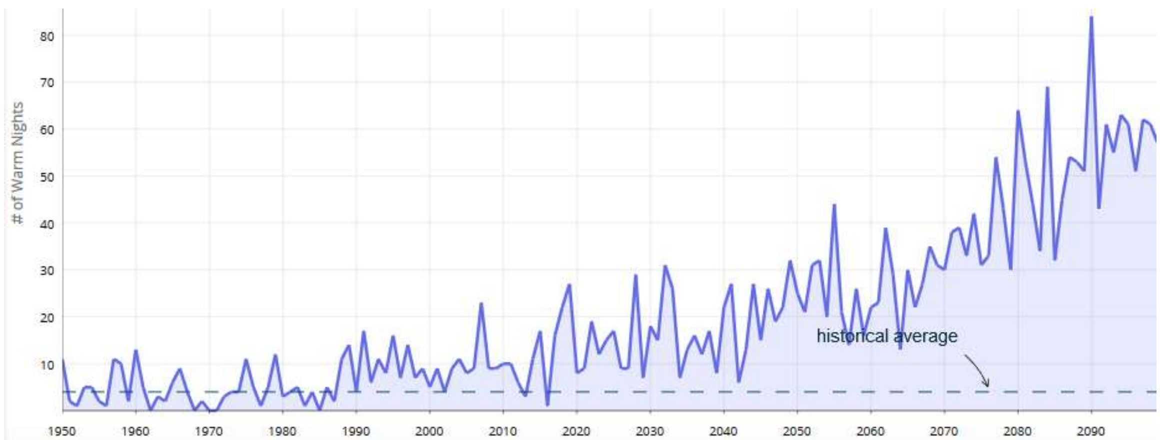


Figure 38: Number of Warm Nights per year

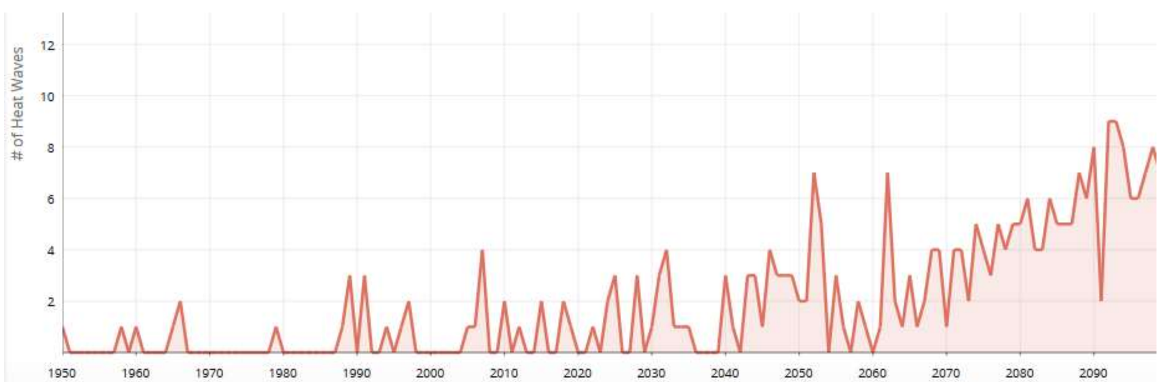


Figure 39: Number of Heat Waves by Year

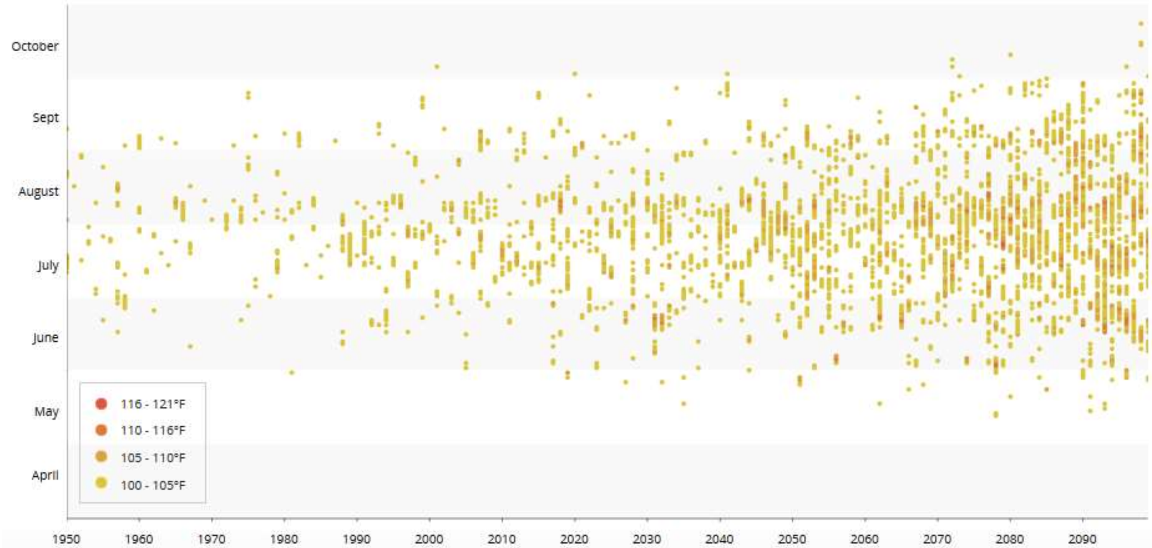


Figure 40Timing of Extreme Heat Days by year

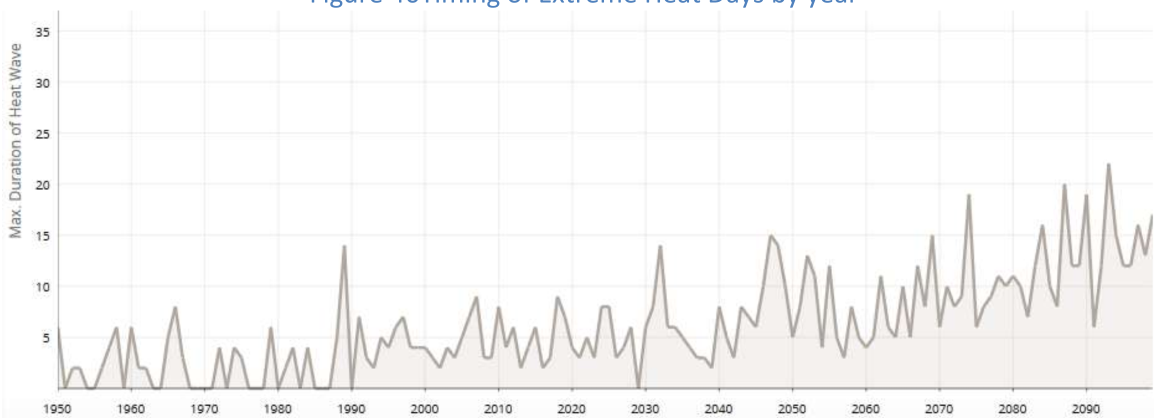


Figure 41: Maximum duration of heat waves by year

4.3.6 Snowpack

The following figure shows projected changes in Sierra snowpack, measured as a decrease in snow water equivalency from the baseline period of 1961-1990. The figure displays data for eastern Placer County in the mountain peaks. Snowpack in the high mountain region of Placer County are projected to decrease by 46-65%. This is an alarming decrease and will undoubtedly impact Placer County water supplies. Conflict with downstream communities who depend on Sierra water will likely increase as well.

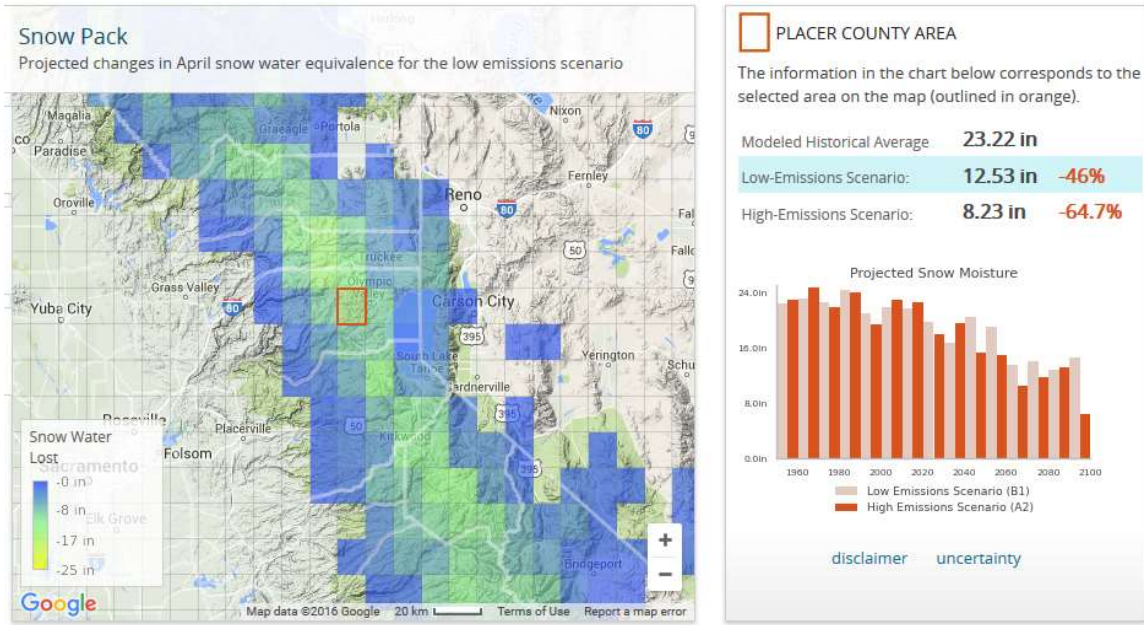


Figure 42: Projected changes in Placer County Sierra snowpack

4.3.7 Precipitation

The following figure shows projected changes in precipitation for Auburn for both the high and low emission scenario. Projections show a modest decrease in precipitation over time.

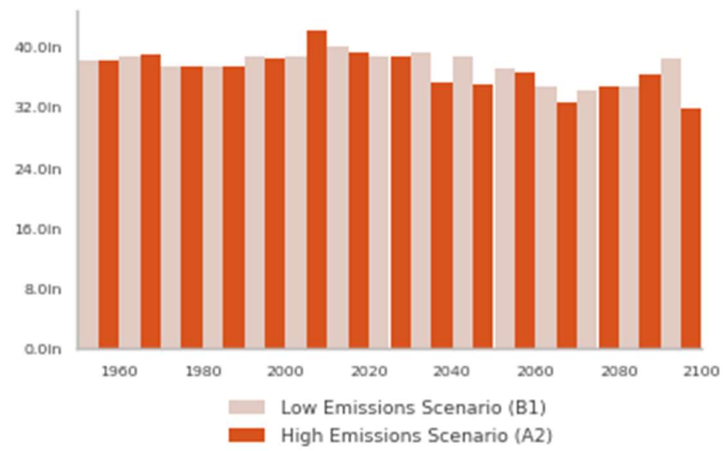


Figure 43: Projected changes in annual precipitation for Auburn

The following figure shows January precipitation projects. The projections show some variability but do not show a significant trend.

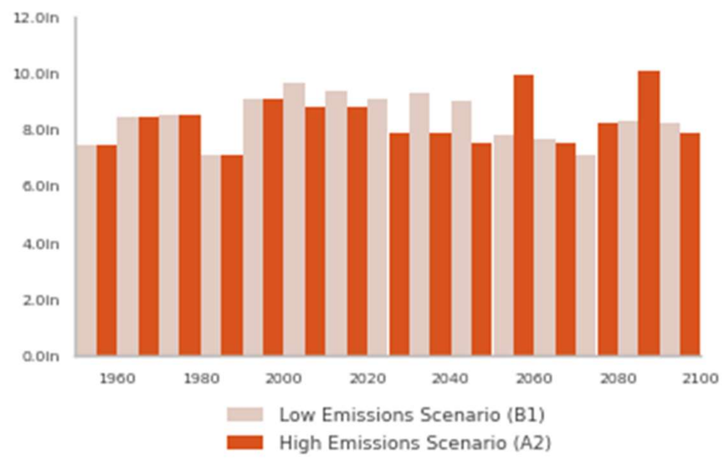


Figure 44: Projected changes in winter (January) precipitation for Auburn

The following figure shows summer (September) precipitation projections. It shows a significant precipitation reduction trend, although there is high variability.

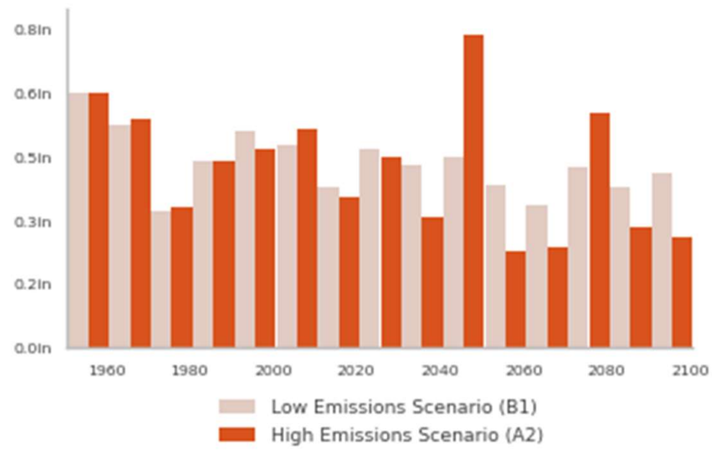


Figure 45: Projected changes in summer (September) precipitation for Auburn

4.3.8 Wildfire

Auburn and surrounding areas are projected to experience increased risk of wildfire. The following figure shows the projected increase in area burned from wildfire for the high emissions scenario for Auburn.

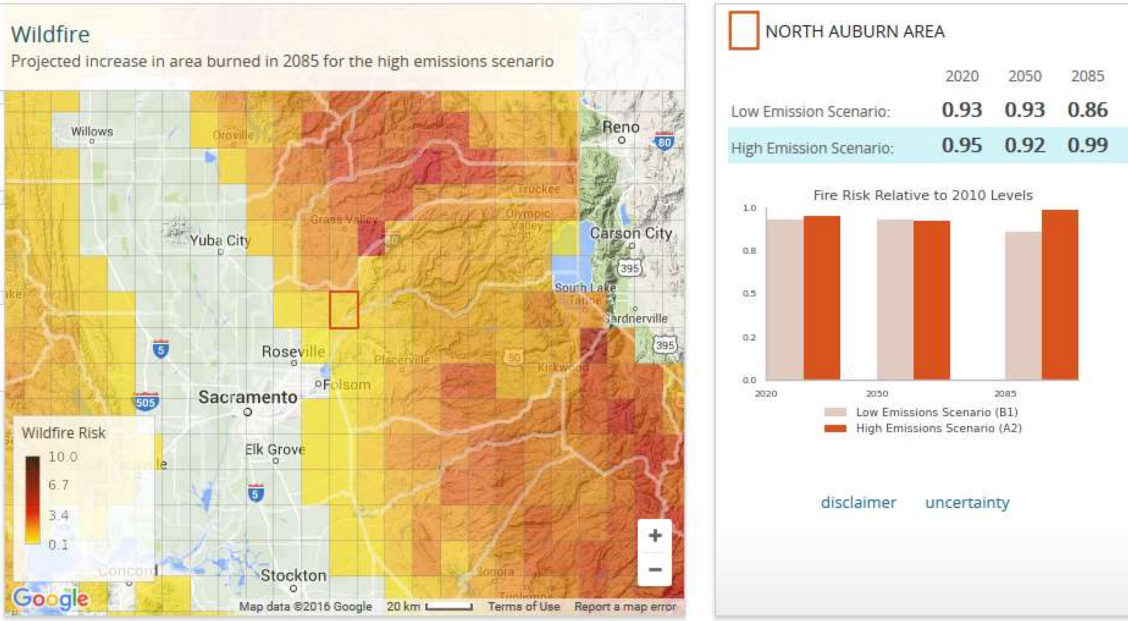


Figure 46: projected increase in area burned, low emission strategy, Auburn

Note that wildfire risk increase is very high on the northern border of Placer County in the Grass Valley vicinity. The following graph shows the increased fire risk in this area. While this may not directly impact the PCGC, it will indirectly impact the PCGC and Placer County through smoke and air pollution, impaired water catchment areas, impaired storm water, etc.

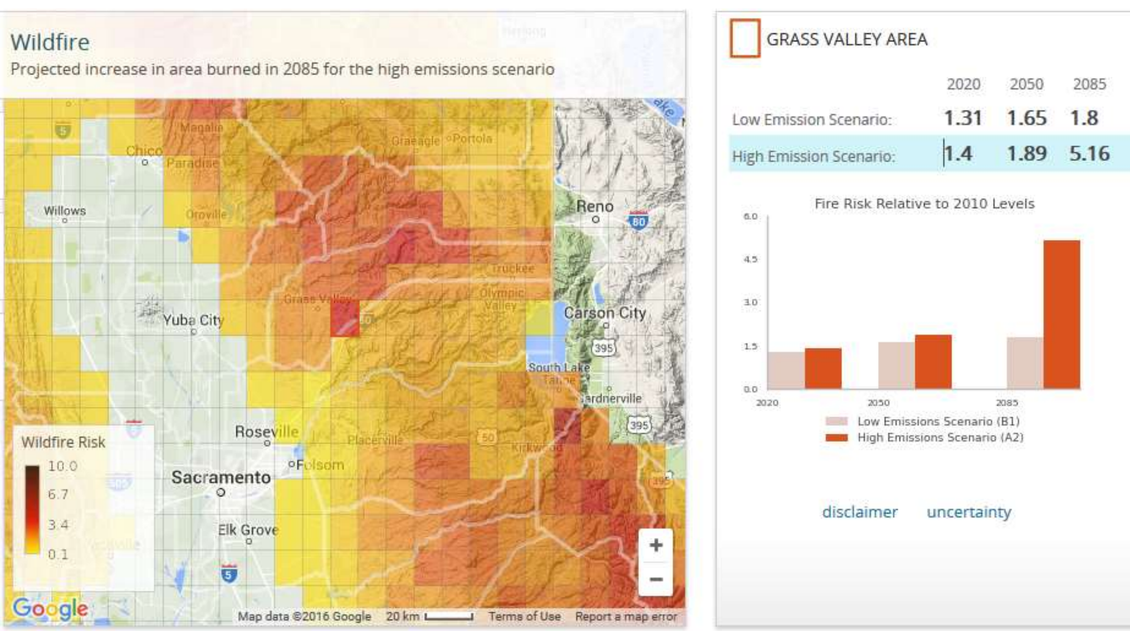


Figure 47: projected increase in area burned, high emission strategy