The Impact of the California Utility Allowance Calculator and the Benefits of Standardization within California Title 24 Software

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Farmworker Family Housing in Woodland, CA.
All-Electric & 100% Solar Offset, with the CUAC generating a net benefit of $500,000 of additional development budget.

Introduction

This paper details how moving the California Utility Allowance Calculator (CUAC) into the California Energy Commission's Title 24 software would provide benefits to many constituencies in the State, particularly affordable housing tenants, developers and affordable housing funding agencies, while also strongly incentivizing all-electric, solar powered housing to meet the State's climate goals.

To support these positions, this white paper illustrates the role of the California Utility Allowance Calculator in building the largest portfolio in North America of all-electric, 100% solar offset residences; designing at least 53% of California's all-electric housing between 2014 and 2019; and providing an average of 5% more development budget when affordable housing is built all-electric and 100% offset.

The Origin Story of the CUAC

In 2005 the California Tax Credit Allocation Committee (CTCAC) and the CEC were hearing from affordable housing developers that there were overwhelming barriers to installing tenant-benefitting solar arrays.

The most important barrier was that the official utility bill predictions, called "utility allowances," were the same for apartments with solar electric arrays and those without, but the additional construction cost was $500k to $1.5M.

Utility allowances and rent are interrelated in affordable housing, where regulations require that the combined cost of rent and utilities must not exceed 30% of a renter's income.

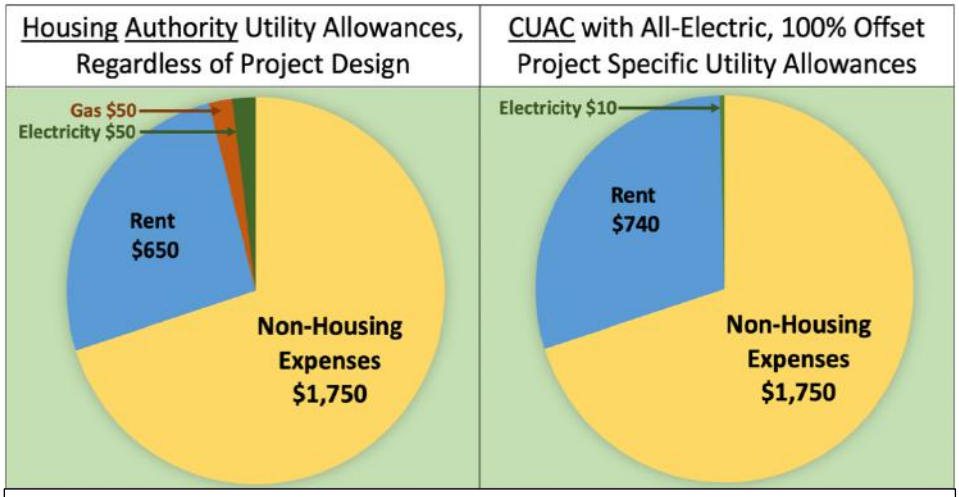


Figure 1. These charts illustrate how the CUAC incentivizes designing all-electric, 100% offset housing, shown at right. The all-electric, solar-powered development can collect $90/month more rent with $10 utility allowances, which is a strong financial incentive, and tenants have minimal utility bills with solar power and usually a better insulated apartment.

Tenants' rent pays for 60%-70% of the cost of building the apartments the tenants live in at affordable housing developments. IRS tax credit grants, state bonds and grants subsidize 30%-40% of the cost of an affordable

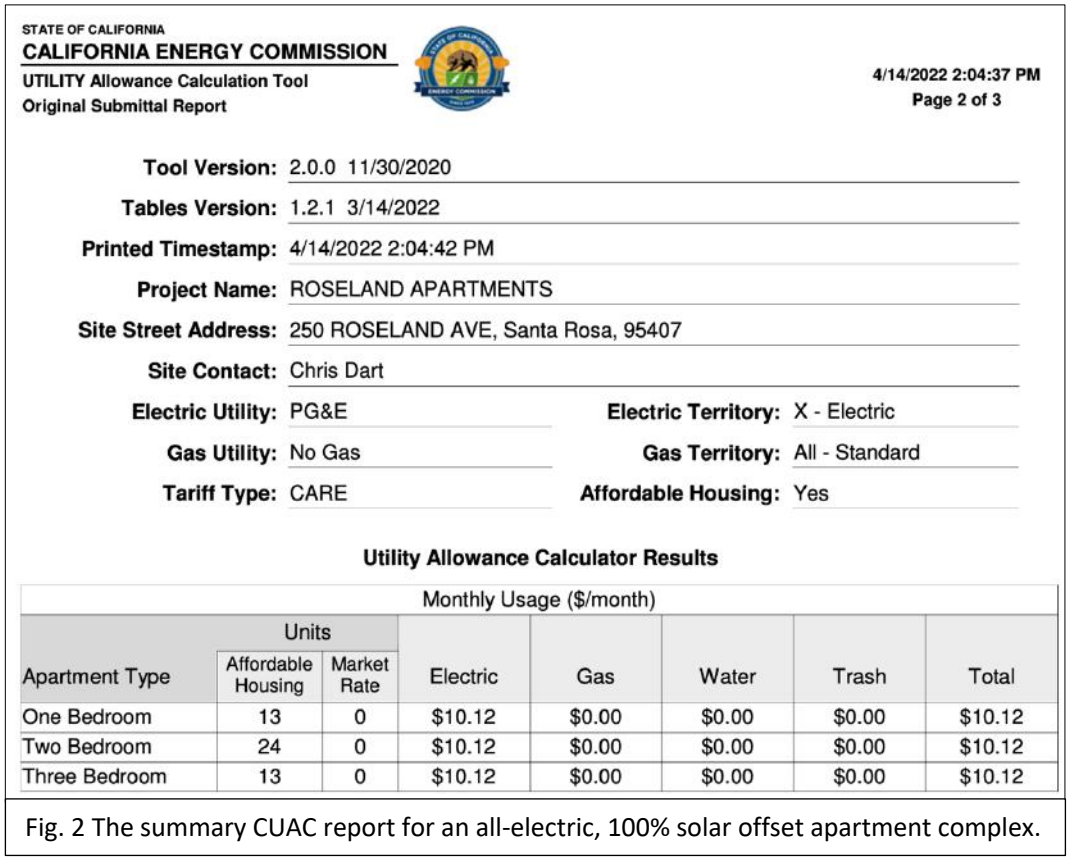
housing development, along with low-interest loans from national banks complying with the Federal Community Reinvestment Act.[1,2]

CTCAC and the CEC responded to the affordable housing community's concerns by convening two years of monthly stakeholder meetings to develop new policies to support tenants getting solar arrays. From those meetings came three important new policies:

1. **Virtual Net Metering**, which was first implemented just on affordable housing in 2007, and then all multifamily in 2011. This policy allocated a solar array at the utility's billing department rather than physically to each apartment's meter, lowering labor and materials costs.
2. **New Solar Homes Program reb**ates for affordable housing were larger and had extended timelines.
3. **The California Utility Allowance Calculator**, allowed by a new 2008 IRS policy at the request of CTCAC. This national IRS policy has also helped finance tenant-serving solar arrays in other states.

According to CTCAC, since 2011 the CUAC has been used in 15% to 25% of their developments each year, helping finance and design more than 320 total developments averaging 65 units, or roughly 20,000 solar powered apartments and houses.[3]

As discussed further below, those 320 CUAC-financed developments comprise half of all the 100% solar offset, all-electric housing documented in California, and 1 in 4 of the 100% solar offset, all-electric residences known in North America.[4]



STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION
UTILITY Allowance Calculation Tool
Original Submittal Report

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Tool Version: 2.0.0 11/30/2020
Tables Version: 1.2.1 3/14/2022
Printed Timestamp: 4/14/2022 2:04:42 PM
Project Name: ROSELAND APARTMENTS
Site Street Address: 250 ROSELAND AVE, Santa Rosa, 95407
Site Contact: Chris Dart
Electric Utility: PG&E **Electric Territory:** X - Electric
Gas Utility: No Gas **Gas Territory:** All - Standard
Tariff Type: CARE **Affordable Housing:** Yes

Utility Allowance Calculator Results

	Monthly Usage ($/month)						
	Units						
Apartment Type	Affordable Housing	Market Rate	Electric	Gas	Water	Trash	Total
One Bedroom	13	0	$10.12	$0.00	$0.00	$0.00	$10.12
Two Bedroom	24	0	$10.12	$0.00	$0.00	$0.00	$10.12
Three Bedroom	13	0	$10.12	$0.00	$0.00	$0.00	$10.12

Fig. 2 The summary CUAC report for an all-electric, 100% solar offset apartment complex.

[1] Zeto, Anthony. Recommendation for Reservation of Federal Four Percent (4%) Low Income Housing Tax Credits (LIHTC) for Tax Exempt Bonded Projects. Jan 19, 2022. https://www.treasurer.ca.gov/ctcac/meeting/2022/20220119/ebinder.pdf

[2] Federal Reserve. "What is the Community Reinvestment Act (CRA)?" Accessed April 15, 2022. https://www.federalreserve.gov/consumerscommunities/cra_about.htm#:~:text=The%20Community%20Reinvestment%20Act%20(CRA)%2C%20enacted%20in%201977%2C,%2Dincome%20(LMI)%20neighborhoods.

[3] Analysis by Mayra Lorenzo, CTCAC's Compliance Manager for the CUAC. Email correspondence to Sean Armstrong on February 23, 2022.

[4] Team Zero Inventory of Net Zero Homes in the US and Canada. Accessed Feb 27, 2022. https://teamzero.org/zero-energy-home-inventory/

The California Utility Allowance Calculator's Benefits for Tenants

One in four Californians are months behind on utility bill payments,[5] and as a proportion of their income, low-income households pay more than twice as much on their utility bills as higher income households.[6] Utility bills are the #1 cause for people using of payday loans in the U.S., with annual interest rates as high as 400% and an average repayment period of five months, roughly doubling the original utility bill cost.[7] The intent, and success, of the CUAC is to encourage building owners to invest in tenants' residences with solar power, all-electric design and greater energy efficiency. These investments increase tenants' financial health and resiliency, while reducing indoor and outdoor air pollution.

> ***"I cried when I found out that my house would come with solar panels. I had thought they were only for rich people."***
> -Maureen, senior citizen tenant of the Cottages at Cypress in Fort Bragg, CA.[8]
>
> ***"Before solar, my utility bills were over $100 month for our apartment. Now I only pay $10 a month."***
> -Pricilla Garcia, farmworker family tenant of Valley View Homes in Selma, CA.[9]
>
> ***"I was always scared when the bill would come when it was either really hot or really cold. In total for the five months we have been living here, it has come out to under $30."***
> -Farmworker family tenant of Mutual Housing at Spring Lake in Woodland, CA. This development won the 2017 Grand Prize from the United Nations for overcoming financial barriers by installing a 100% offset solar array and all-electric design, resulting in the first farmworker housing ever built in Yolo County, near Sacramento.

Tenants of new all-electric affordable housing speak movingly at ribbon cuttings and in newspaper articles about how burdened they had been by utility bills before moving into a ZNE apartment. Perhaps surprisingly, tenants also speak about how valued they feel as human beings by having a solar array, which they thought was only a luxury for the well-off (see inset box quoting tenants).[8,9]

The CUAC Benefits to the Development Budget

Summary of Financial Benefits of Using the CUAC to Set Utility Allowances for All-Electric, 100% Offset Affordable Housing						
Average residence count per affordable housing community	Average construction-only cost per 65-unit community	Average construction cost per 65 apt. community for the 100% offset solar array	Avg. 15-year gross financial gain per 100% Offset, All-Electric community	Average 15 year net benefit, after subtracting solar array costs	15 year net benefit as a percentage of average construction costs	# of CTCAC apts per avg. community built with 15 year net benefit
65	**$19,500,000**	**$405,900**	**$1,400,000**	**$995,000**	**5%**	**3.3**

Figure 3. Summary of Financial Benefits for 47 Affordable Housing Developments Using the CUAC (Redwood Energy)

A 2021 analysis (Figure 3, above) of forty-seven (47) 100% solar offset, all-electric developments in Redwood Energy's portfolio revealed the impact of the CUAC on project finances. The average cost of the 100% offset solar array was $405,900, while bringing in an average of $1,400,000 more rental revenue over 15 years, with

[5] Nikolewski, Rob. "California utility customers $1.25 billion behind on bills." Feb 23, 2021. The San Diego Union-Tribune. https://www.sandiegouniontribune.com/business/story/2021-02-23/california-utility-customers-more-than-1-billion-behind-on-bills
[6](Drehobl and Ross, 2016) Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities
[7] Levy, R. and Sledge, J. (2012) A Complex Portrait: An Examination of Small-Dollar Credit Consumers. Center for Financial Services Innovation.
[8] Marshall, Kathleen and Armstrong, Sean. "The Cottages at Cypress." Home Energy Magazine, p.20 interview with Maureen. Nov/Dec 2015.
[9] Marshall, Kathleen. "Building to Mitigate Climate Change and Address Social Justice." Home Energy Magazine, p. 4 quote from Pricilla Garcia. Winter 2016.

an average net increase of funding for the project of $995,000. The solar array was paid for in average of 4 years, and compared to the average cost of construction, the 100% solar offset design CUAC of the all-electric apartments financed a 5% net increase in construction funding. That net 5% additional funding over 15 years effectively pays the construction cost of 3 out of every 65 apartments in an average CTCAC community.

Note that increasing rental revenue does not increase the regulatorily fixed Developer's Fee—it is a financial benefit to the development and the community that lives within it, not additional profit or fees for the Ownership.

The CUAC Leads 100% Solar Powered Housing in North America

By 2015 the impact of the CUAC was seen nationally when the annual Team Zero tally of "Zero Net Energy" houses (100% solar offset) showed California's affordable housing developers were the #1 producers of Zero Net Energy housing in North America, all of which used the CUAC.[11] The bulk nature of CUAC-using apartment complexes has swamped the contributions of custom homes in the tally every year since.

Figure 4. The 2020 Team Zero Inventory shows five of the Top Ten "Zero Net Energy" producers in North America are building California's affordable housing.

The CUAC Leads All-Electric Housing in CA

CUAC-using developers have also led the construction of most of the all-electric housing in California built between 2014 and 2019. Until the 2019 Title 24 Energy Code, the CEC discouraged all-electric design.[12] So it is noteworthy that the CUAC led the development of more than half of California's all-electric residences built between 2014 and 2019. In 2020, Southern California Edison conducted an analysis of 238,000 low rise residence's construction documentation permitted between August of 2014 and December of 2019. The Home Energy Rating System databases[15] demonstrated that just 1.25% of the 238,000 residences were all-electric. Cross-referencing just with Redwood Energy's project list reveals that CUACs were used to fund at least 53% of those all-electric residences; at least 22% of the single

California All-Electric Residential New Construction HERS Registrations (2013 & 2016 Code Cycles)

	Statewide		PG&E		SCE		SDG&E	
Type of Residential All-Electric New Construction	**%**	**Total Units**	**%**	**Total Units**	**%**	**Total Units**	**%**	**Total Units**
All-Electric Single Family (CF-2Rs)	0.48%	923	0.58%	635	0.32%	228	0.56%	60
All-Electric Low-Rise Multifamily (CF-2Rs)	4.43%	2,058	6.06%	1,269	3.13%	649	0.91%	43
Average All-Electric Low-Rise RNC (CF-2Rs)	**1.25%**	**2,981**	**1.46%**	**1,904**	**0.95%**	**877**	**1.30%**	**200**

**Analysis by Will Vicent, Manager of the Buildings Standards Office of the California Energy Commission. Sept 23, 2021*

Notes

This data was generated by Southern California Edison by analyzing multiple sources of CA HERS Registry Data and includes registrations from both the 2016 and 2013 Title-24 Code Cycles

CF-2Rs are installation certificates for new construction projects, documenting what was actually built.

Numbers for IOU territories are divided and estimated based on primary electric IOU serving each CA Climate Zone

All-electric construction is conservatively inferred based on registrations that have both electric water heating and space heating

Figure 5. The above table shows just 1.25% of residences built to the 2013 and 2016 Low Rise Title 24 Code were all-electric, based on CF-2R construction documentation entered into the CALCerts and CHEERS databases and analyzed by SCE Staff.

[12] "Building Electrification Action Plan for Climate Leaders." Sierra Club. December, 2019. https://www.sierraclub.org/sites/www.sierraclub.org/files/Building%20Electrification%20Action%20Plan%20for%20Climate%20Leaders.pdf

[15] The California Energy Commission's (CEC) HERS Program addresses construction defects and poor equipment installation, including HVAC systems and insulation. The CEC has a list of approved HERS providers who train and certify raters. The two currently approved HERS providers are CHEERS and CalCERTS who are approved to train and oversees raters conducting HERS verification in residential and non-residential buildings and each provider maintains a database of compliance documentation.

family all-electric homes, and at least 67% of the all-electric multifamily homes.[16]

The Title 24 Energy Code and CUAC

As the California Title 24 Energy Code (Energy Code) drives developments to be all-electric, to include PV, and in some cases to include battery storage, the CUAC is an increasingly relevant tool for developers to finance tenant-benefitting energy efficiency paired with solar power**.**

Figure 6. Since 3019, 53 Cities and 2 Counties in California have passed local Title 24 Codes that require all-electric construction of some or all building types.

The 2022 Energy Code[17] expands on 2019 Code's mandated PV arrays for 1-3 story residential buildings and pre-wiring for electrification. The 2022 Energy Code requires electric heat pumps for space heating or water heating in all residences, but not both. It is the CUAC's incentives to completely electrify and add solar power that will shift many of those affordable housing building to all-electric.

The 2022 Code also requires multifamily housing of all heights to install a solar array, usually in combination with battery energy storage unless solar offset is close to 100%. Whether that solar array benefits the Owner's meter or benefits the Tenants' meters is a decision that is informed by the CUAC.

The 55 local governments in California that have implemented local Title 24 Codes to ban gas use in buildings have often overcome public concerns about affordable housing by citing the leadership of affordable housing in developing the majority of the state's all-electric housing.

Benefits of Integration with CEC's Code Compliance Software

Standardization of All-Electric, 100% Solar Offset Design: As discussed above, only 15%-25% of CTCAC developments fund with the CUAC each year, but that subset of affordable housing is disproportionately all-electric and 100% solar offset due to the greater rental revenue from $5-$11 CUAC utility allowances. Providing a standard CUAC report to all developers will inform design decisions and likely help standardize the practice of all-electric and solar powered buildings.

Greater Accuracy: The CUAC was designed in 2007 to predict utility bills with Tiered rates. Time of Use rates are common now in affordable housing, but the CUAC cannot accurately predict them. The State's CBECC Title 24 Code software does predict Time of Use consumption, as well as the hourly production of solar power and the benefits of batteries. Shifting the CUAC into the state's CBECC software will provide more accurate utility allowances.

[16] Analyzed by counting Redwood Energy's 2013 and 2016 all-electric developments and comparing to SCE's analysis by Will Vicent.

[17] In August 2021, the CEC adopted the 2022 Energy Code and it will be applicable to applicable to projects whose permits are applied for on or after January 1, 2023.

Simplification: Design teams already use the CEC's Code compliance would benefit from the CUAC process being wholly incorporated into the software that design teams. Currently using the CUAC is a multi-step process bridging two softwares, and more than half the steps would be eliminated by having Title 24 software perform all of the CUAC's work.

1. A Title 24 energy model is made of each apartment type, by bedroom count. **This would not change.**
2. A weighted average Title 24 results is made of each apartment type to represent all the similar designs of each apartment type. (For example, five 1 bedroom apts facing south would be weight-averaged with two 1 bedroom apts facing east.) **This would not change.**
3. The weighted average of each apartment is entered into a Microsoft Access database programmed to function as the California Utility Allowance Calculator. **This step and those that follow would become unnecessary.**
4. The lighting type, appliance efficiency and presence of laundry hook-ups or provided machines are set in the CUAC to match the apartments' actual design. **No longer necessary.**
5. A solar array can be added to the CUAC through its own multistep process, and due to a "bug" in the CUAC programming the solar array must also be manually calculated and entered for each of the twelve months according to a CTCAC-provided formula. **No longer necessary.**

Maintenance: The CEC devotes dozens of staff and consultants to maintain the CBECC Title 24 software for all types of construction, both retrofits and new construction, within a public and peer-reviewed process. By contrast, the CUAC is not updated or maintained other than entering current utility rates, there is no CEC staff dedicated to fixing its bugs, nor a public peer review process. If the CUAC is incorporated into the CBECC software, it will benefit from regular maintenance, public review and responsive CEC staff.

Which Affordable Housing Programs Use the CUAC, and Which Do Not?

Over the last 13 years, the following California funding sources implicitly or explicitly encouraged the use of the CUAC to design and fund "Zero Net Energy" affordable housing, including:

1. **Housing and Community Development (HCD) HOME** grants require the CUAC.
2. **HCD's Affordable Housing Sustainable Communities** accepts the CUAC.
3. **United States Department of Agriculture Rural Development** accepts the CUAC, but absent the CUAC the USDA requires utility allowances to be based on actual bills.
4. **CTCAC** accepts the CUAC on new construction with or without tenant-serving PV, but rehabilitation projects must provide tenant-serving solar arrays to use the CUAC.

However, some HUD funding sources allow, but do not accommodate, the CUAC's project-specific utility allowances[24], including:

1. **Section 8 Housing Choice Vouchers** are issued by HUD to local Public Housing Authorities[25] (PHA), and their total value is based on the rent and utility allowances. When a utility allowance is decreased, the voucher payment is decreased, providing no pathway to paying for tenant-serving solar or efficiency via rent.
2. **Section 811 Supportive Housing Vouchers for Persons with Disabilities** are also issued by HUD and are similarly set up to Section 8 vouchers to reduce payments if utility allowances are reduced.
3. **Veterans Affairs Supportive Housing (VASH) Vouchers** are issued by the Federal Department of Veterans Affairs, and act similarly to Section 8 and 811 vouchers.

[24] Authors' Note: The CUAC (California Utility Allowance Calculator) is an example of a project-specific utility allowance method.

[25] Also referred to as Public Housing Agencies

Often, a developer will plan for a subset of a project's apartments to receive housing vouchers from Section 8, Section 811, or VASH. Those apartments are usually not solar powered due to the lack of financial reimbursement for the increased construction cost.

Non-CUAC Utility Allowance Methodologies

This section provides a discussion the alternatives to the CUAC with a focus on how they address energy efficiency and tenant-serving solar power.

Local Public Housing Authority: One of the most widely used methods is to reference the Public Housing Authority's (PHA) utility allowance schedule. PHA utility allowance schedules are intended to represent "typical" utility costs for existing housing that in California is, on average, 28 years old, relatively inefficient and without the tenant-serving solar power. One exception is the Housing Authority of Kern County, which has a "Zero Net Energy" utility allowance, but to use it one must also run a CUAC to demonstrate the project is Zero Net Energy.

Utility Data: The USDA Rural Development Division requires utility allowances to be based on the community's actual utility bills, unless a CUAC is used. Similarly, HUD can require actual bills for setting utility allowances after the first year of operation using a modeled utility allowance.

There are several problems with using actual bills for utility allowances. First, the utility has no obligation to comply with a developer's request for the information, resulting in developers requiring tenants to save and regularly supply their bills for analysis. Second, many projects are served by multiple utilities for electricity and gas, adding complexity and effort. Third, the rents then may go up or down in unpredictable ways every six months to a year, creating uncertainty for tenants and owners.

State Housing Finance Agency: The IRS allows a state's designated Housing Finance Agency – in the California case, this is the CTCAC—to create utility allowances. There are several reasons CTCAC does not do this. If they chose to, (a) it would require them to hire additional staff with expertise in energy instead of housing, (b) it would likely slow down the application approval process, and (c) it would likely increase the cost of applications. Therefore, CTCAC chose to rely on the CUAC and not create utility allowances for developers' projects.

HUD's Utility Schedule Model: The HUD's Utility Schedule Model is a computer program that is state-specific and that generates representative utility allowance schedules for PHAs, but cannot reflect the tenant benefits of solar power, greater energy efficiency, batteries or Time of Use rates.

Energy Consumption Model (e.g., CUAC): The IRS created a policy in 2008 to address the failings of the above utility allowance strategies, particularly to reflect the tenant benefits of solar power and energy efficiency. In California, CTCAC has approved the CUAC. In other states software like EnergyGauge is used: it is RESNET certified and published by the Florida Solar Energy Center in concert with the Department of Energy. None of the other four options above encourage developers to increase energy efficiency or add PV to lower tenant utility bills.

Recommendations for Incorporating the CUAC into CBECC

To incorporate the CUAC into CBECC, there are several technical recommendations:

1. CBECC will need to be updated to include calculate utility allowances per apartment type for gas and electricity.
2. Water is not required to be sub-metered in affordable housing, unlike CA market rate housing, so it is uncommon to see water bills in affordable housing. Similarly Trash is rarely billed to tenants. Both Water and Trash should be included in the CUAC as soon as practical, or offered as a separate form that a CUAC consultant can fill out.
3. CBECC must be able to maintain up-to-date tariffs in compliance with IRS regulations.
4. CBECC must be able to produce a CUAC report with a distinction between Draft and Final, and print time stamped updates to the Final reflecting current utility rates.
5. Engagement activities with owners and energy consultants should be undertaken to increase awareness of the usage of the tool and associated owner and tenant benefits.
6. Instructional materials should be developed to support the use of the CUAC tool within CBECC.

While beyond the scope of this white paper, Appendix 5. Opportunities to Expand Use of the CUAC, includes a brief list of applications to be investigated and evaluated to support use of the CUAC. This list is intended to inform future considerations for development.

Appendices

1. Study of Local PHA Utility Allowances

The study results shown in the tables below indicate that the all-electric utility allowances are higher on average than the utility allowances with gas service available. The PHA allowances provide no pathway to allocate solar PV to offset tenant bills. On the other hand, the CUAC allows for both and creates the opportunity for rent to be recouped by the owner, who is responsible for including solar under the 2019 and upcoming 2022 Energy Codes. A ZNE CUAC leads to an average of three additional units built per development. The study reviewed 31 PHA schedules in California. The three tables below show the average utility allowance of all 31 PHA schedules, the highest utility allowance PHA schedule which is in San Francisco and San Bernardino Counties, and the lowest PHA utility allowance schedule which is in San Diego County and the City of Roseville.

Average Utility Allowances (*n*=31 Utility Allowance Structures)				
		1-bd	2-bd	3-bd
Total w/ all gas		$ 62.03	$ 82.55	$103.03
Electric w/ gas Cook		$ 69.32	$ 95.29	$119.35
All-Electric		$ 72.45	$ 99.48	$125.29

Highest Utility Allowance Structure of 31 Reviewed				
San Francisco/San Bernardino Cos.		1-bd	2-bd	3-bd
Total w/ all gas		$92	$125	$158
Electric w/ gas Cook		$132	$173	$214
All-Electric		$144	$188	$230

Lowest Utility Allowance Structure of 31 Reviewed				
San Diego County & Roseville		1-bd	2-bd	3-bd
Total w/ all gas		$42	$57	$69
Electric w/ gas Cook		$46	$61	$76
All-Electric		$46	$61	$77

Figure A-2. Summary tables comparing PHA Utility Allowance Schedules.

2. CUAC Procedures for CTCAC Program Submission

The developer will make the determination of utility allowance methodology based on project goals and funding. The steps below provide a more detailed overview of the design process when utilizing CUAC for utility allowance estimates for CTCAC program submission.

1. Funding goals are established. This phase considers competitive funding requirements and financial benefits to build or rehab a property in addition to full financial analysis. For example, does the developer want a minimum bill of $10 utility allowances applicable to all-electric apartments with 100% PV offset or $25-$50 utility allowances applicable to relatively efficient apartments with a smaller PV system.

2. Draft designs are reviewed and cost established. Heating, ventilation, air conditioning (HVAC) and domestic hot water (DHW) systems are defined. Solar PV system potential locations and areas are identified. This is estimated to inform modeling calculations completed in Step 3. Only solar contributing to tenant loads is accounted for in the CUAC.

3. A Title 24 model which includes each unit type (i.e., 2-bedroom, 3-bedroom, etc.) is created in CBECC (or other CEC-approved simulation model). The consumption results are exported to a spreadsheet (.csv file) and organized in a Microsoft Excel tool, created and approved by CTCAC, to account for estimated energy consumption by unit type and orientation of unit type. Then the HVAC and DHW consumption is aggregated by month and is uploaded to the CUAC, which is a Microsoft Access database.

4. Within the CUAC the efficiency of the lighting (high efficacy LEDs or not) and appliances (Energy Star or not) is selected, as well as the utility rate schedule.

5. The CUAC produces estimates for daily, monthly, and annual kWh consumption. Hourly for time of use analysis is not performed. This annual kWh consumption can then be paired with a compensatory PV array, such as a ZNE sizing if that is the developer-requested goal defined in Step 1.

6. In a Microsoft Excel spreadsheet, the annual solar system electricity generation is determined using outputs from a CEC-approved solar generation analysis software and is split into monthly quantities that match the consumption for each month, to approximate solar generation that will be available in that month. These monthly quantities are entered into the CUAC, offsetting monthly consumption.

7. The Draft CUAC Submittal and Print Details is generated. the developer or design team may have feedback based on the calculations for consumption and associated solar generation (e.g., not enough space for the PV array based on calculations). This may trigger redesign for efficiency or additional solar to meet goals established in Step 1.

8. The Draft CUAC is then used in an affordable housing funding application (e.g. Affordable Housing Sustainable Communities) along with additional project documentation, such Title 24 reports and preliminary PV analysis.

9. After successful funding, the project design is finalized to prepare drawing for building permit application. If the design changes in any way that impacts the CUAC analysis the CUAC is updated.

10. After completion of construction, the placed in service final report is submitted along with as-built drawings and specifications, documentation for all elements captured in the CUAC are submitted to CTCAC or other funding agency with extensive documentation—such as photos, delivery receipts for

appliances, HERS inspection reports for efficiency measures requiring Title 24 compliance verification, the PV analysis and interconnection agreements, and CBECC models.

11. Upon receipt of a $750 CUAC review fee, CTCAC's consultants complete quality control, review the CUAC report and submitted documentation, request CUAC updates or changes if needed, and provide approval of final CUAC to CTCAC.

12. The developer submits an updated utility allowance to CTCAC at least every year generated by the consultant using the CUAC and reflecting any new utility rates from the updated CUAC database maintained by the CEC.

3. Functionality to Improve Process and Accuracy of CUAC

The CUAC tool is generally very good at predicting the overall energy use from residences at a multifamily development and is the best tool available for affordable housing. There are several areas for improvement recommended for the CUAC to improve both the process and the accuracy of the tool and expand calculations.

Process Improvements. The current CUAC is a desktop tool on an outdated database platform that requires updating as well as outside calculations. An updated online tool or inclusion in CBECC can provide the following benefits and mitigate current pitfalls with a desktop application.

- Feature-specific functionality. With updated algorithms (some described below), the project-specific tool can account for energy efficiency and solar PV whereas PHA schedules are typically derived from older building stock. If integrated into CBECC the algorithms could be updated and more easily maintained.
- Consistent results. When utilized by trained and qualified analysts using accurate inputs, an online CUAC or one embedded in CBECC will provide consistent results. There is no risk of outdated applications or applications using older versions.
- Accessible information. With an online tool, it would be accessible for administrative purposes to understand the portfolio of buildings, but also allow consultants to easily rerun utility allowances as required on a yearly basis with minimal effort.
- Minimizes errors. With an online tool with integrated algorithms and error checking, mistakes and time completing outside calculations are minimized. By reducing the administrative aspects of the tool, consultants can use their time providing technical assistance to owners and developers rather than administrative efforts to complete calculations.

The level of effort required to use the CUAC and awareness among property owners is a barrier to uptake. The current process requires increased analysis time outside typical workflow for new construction, resulting in additional fees to developers. Without a clear understanding of the benefits of utilizing project specific utility allowances, these additional costs are a barrier to project-specific utility allowances over PHA schedules. The integration of CUAC into CBECC would put the CUAC in the hands of many energy consultants and should result in greater use and consultant recommendations to developers using it.

Updated Algorithms. With increasing efficiency of lighting and appliances, the CUAC would benefit from updated algorithms to properly credit newer technologies. The CUAC would benefit from CBECC software updates as warranted by technology and/or appliances.

The CUAC tool currently requires weighted averages to be manually entered from CBECC in order to calculate the tenant utility costs. This is the method used to calculate heating, cooling, and water heating loads. If CBECC was to include the CUAC in its functionality, CBECC should be programmed to automatically input the weighted averages from CBECC into a CUAC module, negating the data entry step that increases a CEA's time and review.

Currently in the CUAC, lighting, plug loads, refrigerators, laundry equipment, cooking loads, and dishwashers are all generated by an algorithm based on the bedroom type. The bedroom type, and whether the device is Energy Star rated or not, are the primary variables that determine the energy use estimate in these categories.

The CEC's RASS 2019[30] data is likely to be more accurate than the CUAC assumptions in terms of laundry equipment energy end use. However, the occupancy factors in affordable housing should be investigated relative to what the CUAC and CBECC use.

Miscellaneous loads are modeled well in CBECC, which provides an increased level of detail that the CUAC is unable to do in its current form. The current CUAC algorithm provides a fixed kWh/year estimate for each bedroom type that is not altered by square footage, climate, or any other factor besides bedroom type. Integrating the CUAC into CBECC provides the opportunity to improve upon this estimate and refine it - although it is accurate in the overall context of a given residential project, it could be improved and brought into alignment with CBECC. The current CUAC is accurate, but the individual algorithms could be refined by CBECC.

Another way to refine the CUAC is to allow for manual input of known values for refrigerator, dishwasher, and laundry energy use. An option can be made available in the CUAC as a part of CBECC to manually input energy use values for the specific Energy Star appliances in the categories of dishwashers, refrigerators, washers, and laundry dryers. This would be the same level of control as the step that occurs when a CEA selects a specific product to be used for DHW or HVAC in CBECC, so it would not increase the level of responsibility for accuracy that a CEA has. If a developer elects to claim installation of Energy Star appliances, (something that also wins them eligibility for increased tax credits), then the developer should also be rewarded for selecting even more highly efficient Energy Star appliances - because there is often a clear difference in energy use among members of that category. This would require additional HERS or energy consultant verification beyond just Energy Star and require verification of make and model.

The lighting algorithms used currently in the CUAC do not account for recent increases in lighting energy efficiency. The current algorithms use data from CFL lighting, which consumes on the order of 2.5 times more power per lumen than LEDs do. An advantage of rolling the CUAC into CBECC is that it would be able to make use of the more accurate lighting algorithms in CBECC that properly consider the efficiency of lighting today.

Including current rate structures is critical for properly estimating utility allowances. Currently, the CUAC does not include time-of-use rates due to platform and calculation methodologies. The current tool requires manual updates for utility rates on a regular basis to meet federal tax code requirements (approximately every 90 days).

Expanded Calculations. The CUAC functionality should be improved to account for GHG calculations as well as utility bills for solar projects on time of use rates.

Because the CUAC is very accurate to real-world multifamily affordable housing residential energy use, it would be benefit from GHG hourly emission profiles in CBECC to estimate emissionsand CBECC ability to account for time-of-use rates, battery storage and self generation. Currently, emissions, monthly, hourly or otherwise cannot be modeled in the CUAC, because there is no functionality yet in CUAC to compare energy use at different times. If integrated into CBECC software, the GHG hourly emission values from CBECC could be applied to CUAC calculations of tenant loads to produce estimated GHG emissions and relative avoided emissions.

[30] https://www.energy.ca.gov/publications/2021/2019-california-residential-appliance-saturation-study-rass

Both the current Microsoft Access database software and the Title 24 software have deficiencies in accurately predicting solar-supported utility bills. Specific improvements will be recommended on topics such as time-Of-use and solar energy benefits.

Redwood Energy has used the tool for years (alongside Title 24 software and a small amount of proprietary data) to estimate the required PV array size needed to offset the energy use at a site completely. The CUAC alone estimates the residential energy use very well, to the point of being a trustworthy source by itself to size a ZNE array completely for the residences. If incorporated into CBECC which utilizes PV Watts, the PV array needed to meet solar offset goals for tenants could be estimated within CBECC.

The current iteration of the CUAC does not easily allocate the benefits of an NEM (or otherwise) PV array perfectly accurately when there is excess power generated in a month. Virtual net metering allows that excess to be carried "on the books," and allocated back to the tenants at the end of the year. The method that the CEC allows,[31] to account for this is a sidebar calculation that allocates the correct proportion of one month's excess to the next month. If possible, this correction should be addressed in an iteration of the CUAC combined into CBECC software.

A new algorithm based on a time-of-use rate structure, various methods of virtual net metering, the standard utility method of allocating PV at multifamily affordable housing) and 8760-hour energy use estimates would be better able to allocate the benefits of solar to tenants evenly, using the relative proportion of energy use per bedroom type versus the site total PV array.

[31] CEC. "California Utility Allowance Calculator (CUAC) - User Guide." Sections 3.6.1 & 3.6.2.

4. Changes to Support Incorporation of CUAC into CBECC Software for Calculations and Maintenance.

Simplifying the process of using the CUAC tool by integrating it into CBECC will improve the access to affordable housing developers and make it easier for programs besides CTCAC to utilize the tool. It will reduce costs associated with needing to hire an energy consultant twice, once to run Title 24 software, and again to run the CUAC. While the individual needs of different programs will likely still require a submittal package that includes key details and verifications for the project, incorporating the CUAC into CBECC will reduce cost and streamline the process for developers. The integration into CBECC should result in a reduced review process attributed to tool improvements including reduced potential for errors over a desktop application and reduced input errors because calculations and inputs (i.e. PV sizing software and HVAC and DHW results from compliance software) would be integrated into CBECC.

CBECC has essentially all the data needed to deliver a CUAC calculation and what CBECC does not already do is relatively amenable for energy utilities. There is some additional non-energy utility information such as water, sewer and in the rare case trash that would have to be accommodated as inputs and outputs in order to estimate total utility allowances for tenants.

CBECC currently has the potential but is not currently configured to perform a CUAC calculation, and in fact has the tools needed to improve and advance the CUAC's accuracy in some key ways. CBECC models are typically built at the building level and compliance is reported at the building level. CBECC would need to be modified to create a module to run a CUAC simulation, providing unit level results. This would need to include requirements for unit level modeling in order to estimate utility allowances by bedroom type.

Tenant Energy End Uses

- The user must be able to select which end uses are associated with the tenant meter and therefore should factor into the utility allowance calculation.
- The user must be able to input rates for water and sewer and select appropriate electric and gas utility rate schedules.
- The software must have a method of providing up to date rate schedules to meet federal tax code.

Solar Photovoltaic Systems

- The module would need to include a method to allocate PV to bedroom types. This method must be able to weight PV evenly to all bedroom types according to their energy use estimate aligned with the utility allowance calculation as reported to CTCAC in the CUAC report, which informs approval of utility allowances.[32]
- The module should include an input method to allocate a percentage of the estimated PV array production to the "common load", also known as the "house meter" or "owner's bill". This is typically a simple percentage of the site total PV based on estimated common energy use.

[32] Authors' Note: The utility needs to receive an accurate allocation of PV to each unit's meter to properly bill under VNEM with a CUAC. This is the responsibility of the developer, most often subcontracted to either the Title 24 Consultant or the PV installer if not available.

Algorithms

- The appropriate algorithm(s) should be utilized for each of the end uses. This may be based on an evaluation of algorithms undertaken by the Commission, some of which has already been undertaken in the RASS 2019.[33]
- Energy consumption for the following end uses must be included and allocated at the unit level: refrigerator, dishwasher, lighting, clothes dryers, and clothes washers. It would be ideal if Energy Star vs. Non Energy Star appliances could be manually selected, but that capability is not required by the IRS.

The Title 24 Part 6 algorithms do not make a distinction between affordable housing and market rate housing. Many of the CUAC algorithms are based on historical data from affordable housing developments, except where the CUAC takes its estimate from CBECC (heating, cooling, and DHW).

It is important to note that the CUAC has been found at times to be more accurate than Title 24 Part 6 algorithms for affordable housing, including in cooking loads, which are higher in affordable housing than in market rate housing due to demographic differences in occupancy characteristics including the presence of caretakers of children, multigenerational family units, and a higher occupancy rate overall than market-rate housing typically has. Historically, affordable housing built to be ZNE has found that Title 24 algorithms alone have not delivered a cooking energy estimate that is accurate for these developments.

This would need to be evaluated to determine the best approach for implementation to support best energy consumption estimates. The most accurate version of a CBECC that has the CUAC functionality would make use of the CUAC's algorithm for cooking loads. This could result in changes to CBECC algorithms or a separate option for the CUAC. This could look like a check box that allows the CEA to option CBECC to run the CUAC with the affordable housing-specific cooking algorithms from the CUAC. In order to make this recommendation actionable, evidence that supports revisions of CBECC assumptions specifically geared towards affordable housing would need to be corroborated and publicly vetted.

The current maintenance processes for the CUAC software consist primarily of simply updating the tables to reflect the newest utility rate schedules. An updated tool could be designed to leverage the MIDAS Rate Database[34], a subscription service of utility rates or data from the modification of the CEC data collection rulemaking set out in Section 1342 to be amended to include data needed for the CUAC.

If the CUAC was moved into CBECC as a module it would be housed on a platform that is regularly updated, utilized in current new construction workflow to demonstrate compliance, mitigating many of these challenges. Reduction in review time will likely be reduced due to functionality of an online tool that minimizes need for error checking associated with a desktop application. The CUAC, as part of the CBECC software, should send data files to a central repository once a utility allowance submittal is provided to the agency responsible (e.g., CTCAC, HCD). This will simplify both checking the accuracy of the submittal and

[33] California Energy Commission 2019 Residential Appliance Saturation Study https://www.energy.ca.gov/data-reports/surveys/2019-residential-appliance-saturation-study

[34] The Market Informed Demand Automation Server (MIDAS) is a database of current and future time-varying rates, greenhouse gas (GHG) emissions associated with electrical generation, and California FlexAlert Signals hosted by the California Energy Commission (CEC). The database is populated by electric Load Serving Entities (LSEs) and other entities that are registered with the MIDAS system. https://www.energy.ca.gov/publications/2021/market-informed-demand-automation-server-midas-documentation-connecting-and

identifying common errors, so that the CUAC can be updated. This simplification could save developers nearly as much cost in plan-checking as in the CEA's initial run time costs.

5. HUD Regulations for Utility Allowances

For the energy consumption model approach, IRS has additional requirements[35], all of which CTCAC has accomplished in its approval of the use of the CUAC:

The energy consumption model must, at a minimum, take into account specific factors including, but not limited to, unit size, building orientation, design and materials, mechanical systems, appliances, characteristics of the building location, and available historical data. Because the CBECC model (which supplies the space conditioning and water heating inputs to the CUAC) includes most of the criteria above, and the CUAC itself includes the rest, the IRS requirement is met.

The utility consumption estimates must be calculated by a properly licensed engineer or another qualified professional. *If a qualified professional is not a properly licensed engineer and if the building owner wants to utilize that qualified professional to calculate utility consumption estimates, then the owner must obtain approval from the Agency that has jurisdiction over the building*. CTCAC requires that the person performing the CBECC and CUAC analyses be a Certified Energy Analyst (CEA) certified by CABEC. CABEC CEAs have been trained and tested on their knowledge of the energy code and modeling required for Energy Code compliance.

The qualified professional and the building owner must not be related within the meaning of section 267(b) or 707(b). CTCAC requires that the energy consultant not be employed by the developer, nor have a financial interest in the developer's business. The developer and the consultant have to affirm this to be true. *Further, regardless of the type of qualified professional, the Agency may approve or disapprove of the energy consumption model or require information before permitting its use.* When an application is submitted with a CUAC analysis for the utility allowance, CTCAC staff check to make sure it is complete and accurate. Additionally, CTCAC has contracted with a firm to do CUAC-specific plan checking (including examination of the model inputs) to assure that the utility allowance results from the CUAC are correct and verified.

In addition, utility rates used for the energy consumption model must be no older than the rates in place 60 days prior to the beginning of the 90-day period under paragraph (c)(1) of this section [referring to the IRS regulation section for project specific utility allowances]. The CUAC model and California utility energy bill tariff look-up tables are maintained by the CEC. The CEC staff updates the tariff tables on a regular basis to remain in compliance with the IRS regulations. Their staff also make necessary changes to the CUAC when software glitches are discovered, or new requirements come into effect. The CEC is also responsible for upkeep and maintenance of the Title 24 software.

[35] Section 42 Utility Allowance Regulations Update. [TD 9420] RIN 1545-BC22. July 29, 2009. https://www.treasurer.ca.gov/ctcac/compliance/manual/appendix3/td.pdf

6. Opportunities to Expand Use of the CUAC

With integration of the CUAC into the CEC's CBECC software, there are several opportunities to investigate to expand the use of the CUAC to applications beyond the existing scopes described above. Below are a few considerations for expanding the use of the CUAC that require additional research and evaluation:

1. Predict Green House Gas (GHG) impacts from efficiency, electrification, solar and storage. Using CBECC software engine to predict GHG impacts would benefit many programs, including Affordable Housing Sustainable Communities, the Low-Income Weatherization Program, Solar on Multifamily Affordable Homes (SOMAH), BUILD rebates and TECH rebates.
2. Estimate utility bills using time -of-use rates, which low-income customers are not usually required to use, but often do. This would help the CPUC and Low-Income Advocates better design rates for low-income households.
3. Offer CBECC- based utility bill estimates to all housing developers, not just affordable housing. This would help the California Housing Finance Agency (CalHFA) better estimate the utility bill burden of their first-time and low-income homebuyers, and the disproportionate financial benefits of electrification and solar for mortgage holders. This could apply to market rate housing to create transparency in operational costs for tenants in conjunction with rent.
4. BUILD and each of the Investor-Owned Utility rebate programs also use customized utility bill calculators that could benefit from integration into CBECC's more robust, standardized and peer reviewed calculations. This feature would need to be evaluated to understand alignment with program requirements and submittals and construction timeline in order to benefit and not overburden the program or developer.
5. Improve utilization for rehabilitation projects. Rehabilitation programs are a critical component of our strategies to achieve a lower carbon footprint in our building stock. Retrofit programs are designed to stimulate the market and close the gap in financing more sustainable housing. Low Income Housing Tax Credits (LIHTC) are typically the largest resource in the capital stack on most affordable housing projects, making them a necessary starting point for any rehabilitation project. Currently, there is limited allowable application with CTCAC to utilize a project specific utility allowance calculator to support investments in retrofits. Expanding the conditions in which a project specific utility allowance tool can be used in retrofits (beyond new tax credit projects and projects adding PV) would create additional pathways for project investments. Applicable project scope would likely be comprehensive retrofits rather than appliance replacements. The use of CUAC for utility adjustment can be made accessible at mid-cycle, at re-syndication, and after the tax credits have expired but affordability covenants remain. Utilizing the CUAC as a tool for rehabilitation projects within CTCAC and other programs requires additional policy and process evaluation to determine how the following changes could be incorporated:
    - Expansion of the eligible projects under CTCAC that could leverage the CUAC
    - Program and policy guidance on how to leverage the CUAC for retrofit applications, account for benefits, and integrate with other programs
    - Evaluate policy and methodology to layer CUAC with incentive programs without allowing owners to benefit from program investments in properties, but account for owner investments.
    - Reduced costs for leveraging CUAC and technical assistance to provide results