TRI-COUNTY
REGIONAL ENERGY NETWORK

SAN LUIS OBISPO • SANTA BARBARA • VENTURA

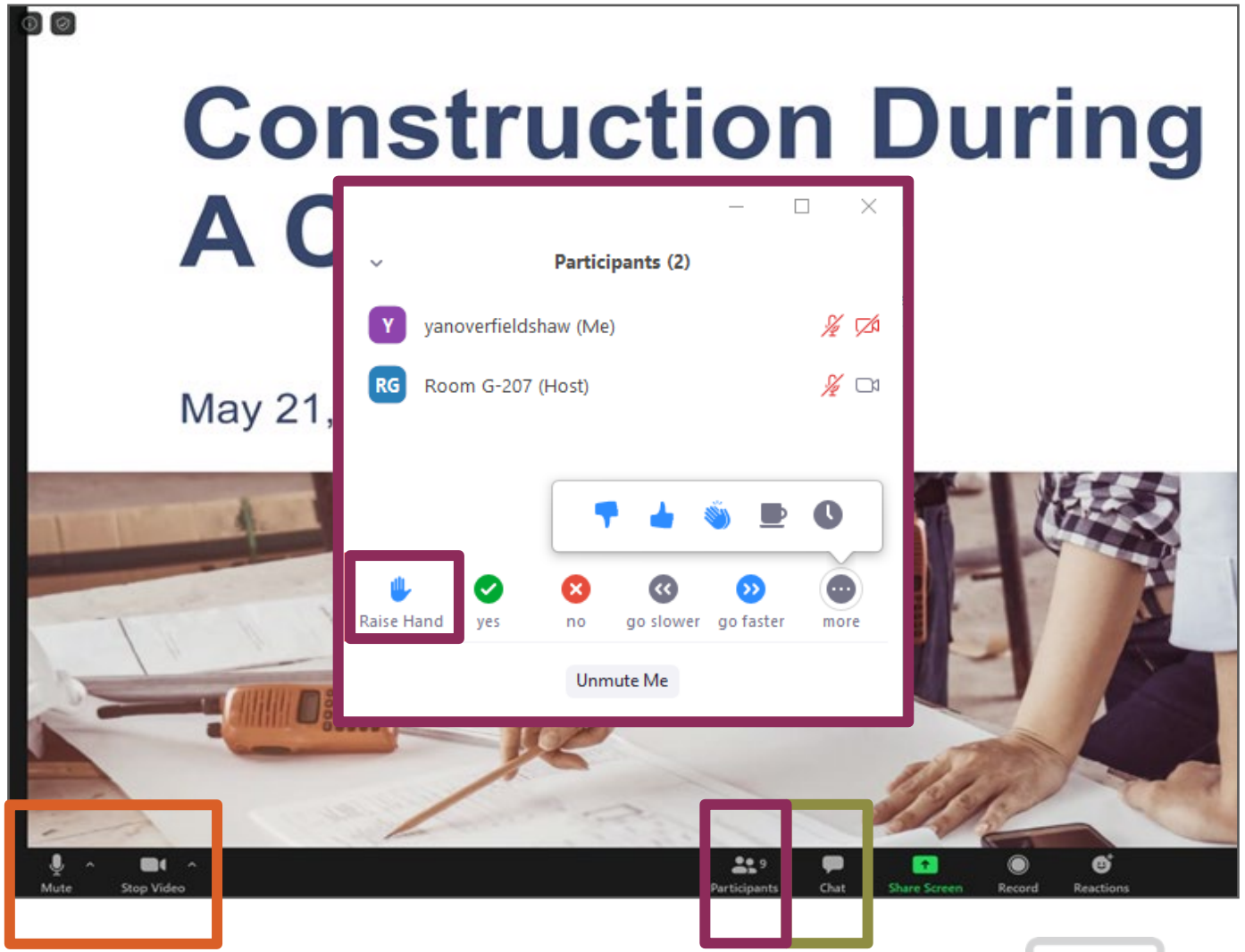
High Performance Buildings: Designing for Utility Costs & Carbon Emissions

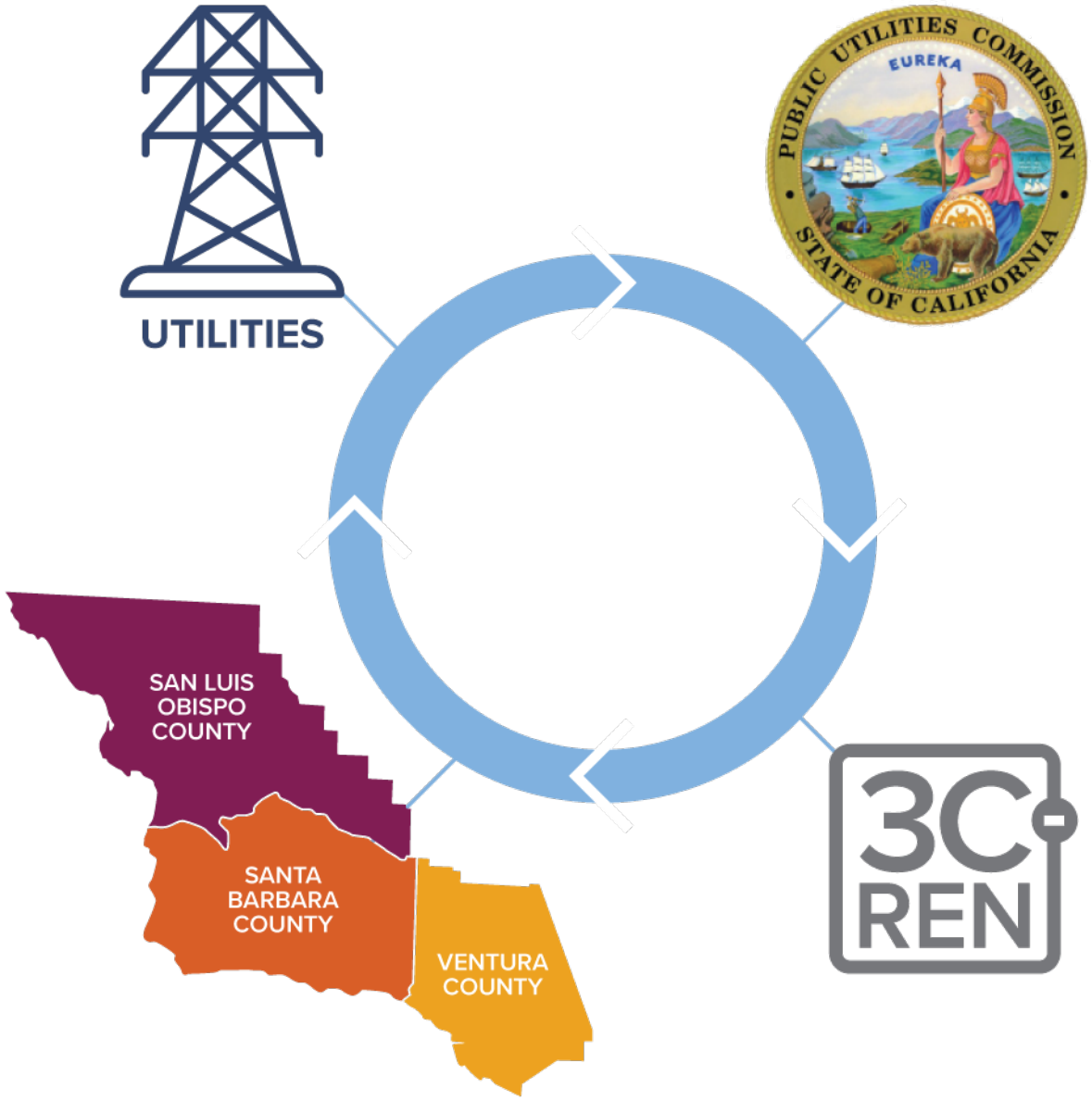
Nick Brown – Build Smart Group

February 19, 2025

Zoom Orientation

- Add an **introduction** in the chat.
  Be sure **full name** is displayed.
- Did you call in? Please **share** first and last name with us.
- Please **mute** upon joining
- Use the "**Chat**“ to share questions or comments
- Under "**Participant**" select "**Raise Hand**" to share a question or comment verbally
- Session may be **recorded** and posted to 3C-REN's on-demand page
- Slides/recording are **shared** after most events





Tri-County Regional Energy Network

3C-REN is a collaboration between the tri-counties

Our programs reduce energy use for a more sustainable, equitable and economically vibrant Central Coast

Our free services are funded via the CPUC, bringing ratepayer dollars back to the region

Our Services

Incentives

HOME ENERGY SAVINGS

3c-ren.org/for-residents
3c-ren.org/multifamily

COMMERCIAL ENERGY SAVINGS

3c-ren.org/commercial

Contractors can enroll at
3c-ren.org/contractors

Training

BUILDING PERFORMANCE TRAINING

3c-ren.org/events
3c-ren.org/building

ENERGY CODE CONNECT

3c-ren.org/code

View past trainings at
3c-ren.org/on-demand

Technical Assistance

AGRICULTURE ENERGY SOLUTIONS

3c-ren.org/agriculture

ENERGY ASSURANCE SERVICES

3c-ren.org/assurance

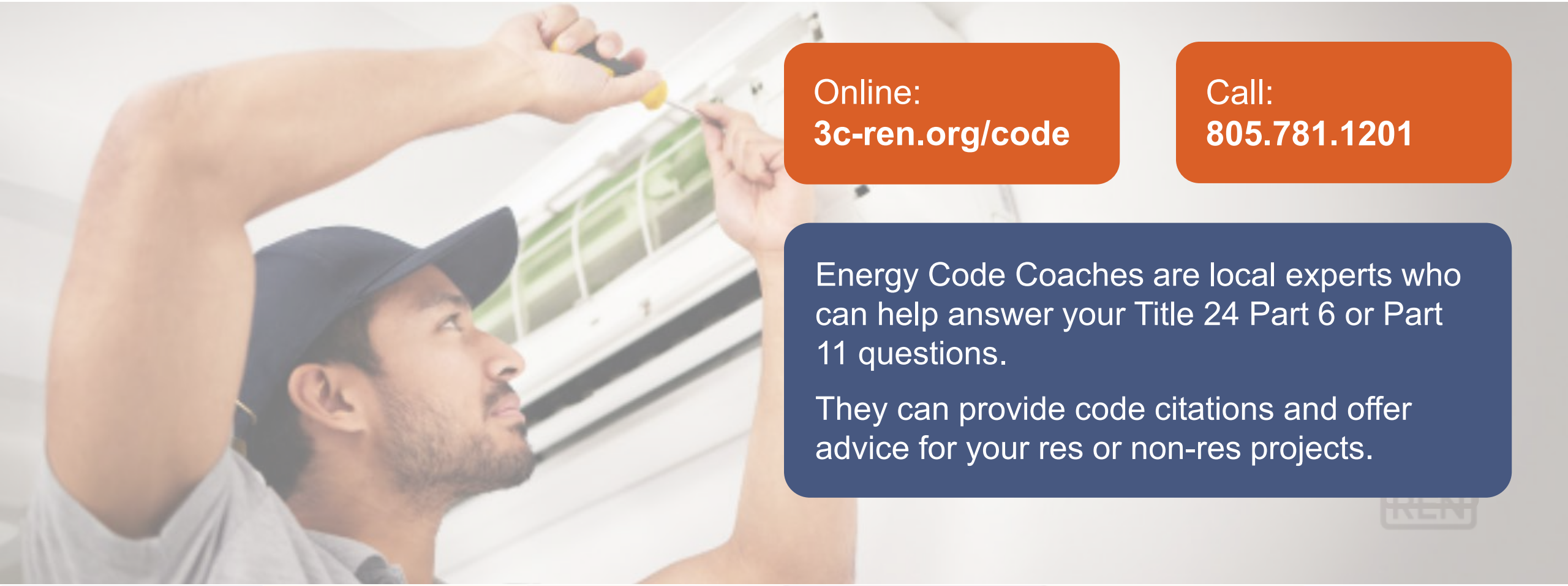
BUILDING PERFORMANCE TRAINING

- Earn while you learn: Heat Pump Water Heater Installs
  - Hands on, in the field training
  - **Earn $300 when you participate**

Learn More: https://www.3c-ren.org/building-performance-training

Questions about Title 24?

3C-REN offers a *free* Code Coach Service



Online:
3c-ren.org/code

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 Part 6 or Part 11 questions.

They can provide code citations and offer advice for your res or non-res projects.

Heat Pump HVAC
Incentive Programs

~~**TECH Clean CA**~~
~~**$1,000/$1,500**~~
~~**switchison.org**~~
Available throughout California.

Home Energy Savings
~ $2,000-$10,000
3c-ren.org
Available for Tri-County residents.

3CE Electrify Your Home
$2,000-$4,000 (paired w/TECH)
3cenergy.org/rebates
Available for customers of Central Coast Community Energy (3CE).

Santa Barbara Clean Energy
$ TBD
Coming later in 2025
Available for SB Clean Energy customers, i.e. City of SB residents.

HEERHA
$4,000/$8,000 for income qualified
switchison.org
Available throughout California, funded by Inflation Reduction Act.

IRA Federal Tax Credit
30% of project cost, max $2,000
energystar.gov/about/federal-tax-credits

All programs can be combined with each other except 3CE and SBCE.
Higher incentives reflect equity, hard-to-reach, and project-specific adders.

3C-REN

High-Performance Buildings

Designing for Utility Costs & Carbon Emissions

Nick Brown, February 20, 2025

LEARNING OBJECTIVES

1) Learn how to use compliance modeling software to make informed design decisions on envelope, mechanical, and renewable systems

2) Understand how utility costs are calculated with solar systems

3) Use case studies to show how to calculate return on investment for typical building features

4) See how Zero Net Carbon design can be achieved

NICK BROWN

President
Build Smart Group
Long Beach
nick@buildsmartgroup.com

BUILD SMART

House in Santa Maria

$745,000 asking price

- **What if it were High Performance?**
- **With PV and Battery?**
- **How much would utility cost savings be?**

OUR TIME TOGETHER

Introduction

Why home improvement is like a fine wine

Utility Costs

How PV & Battery lower your bills

Financial Analysis

For home energy projects

What Features Help Most

Compliance
Energy
Utility Costs
GHG Emissions

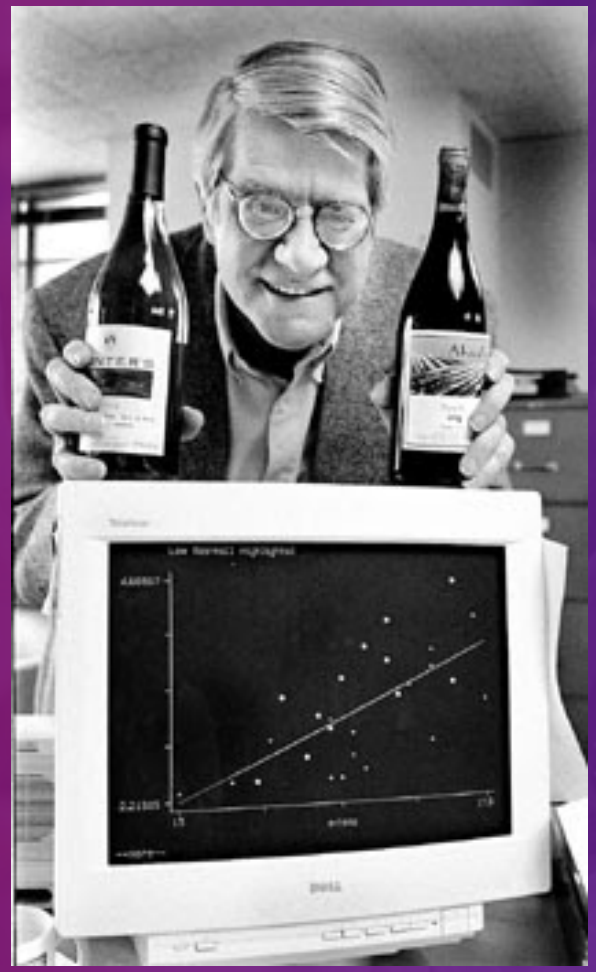
Case Studies

CZ5: Santa Maria
CZ10: Corona
CZ12: Walnut Creek

FINANCIAL DECISIONS ARE NOT ALWAYS MADE RATIONALLY

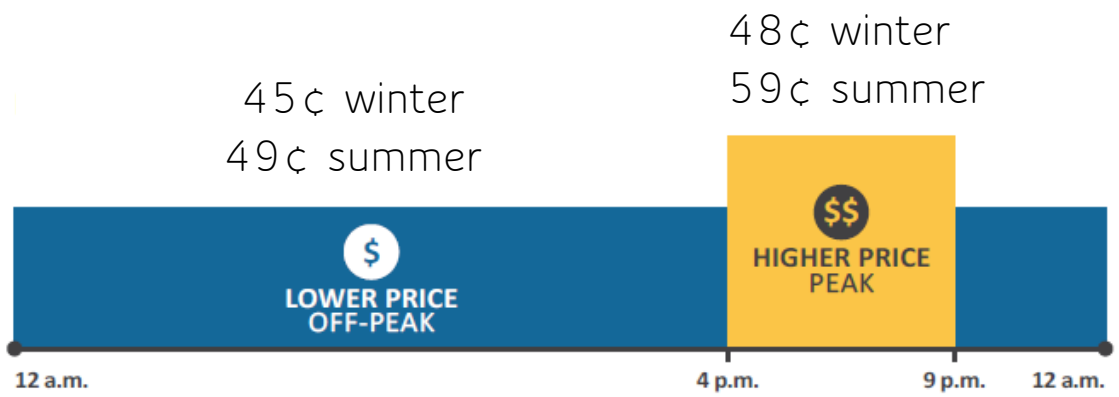
Orley Ashenfelter
Economics Professor
Princeton University
Behavioral Economics pioneer

Shown here with his model predicting price of Bordeaux based on weather in France each year

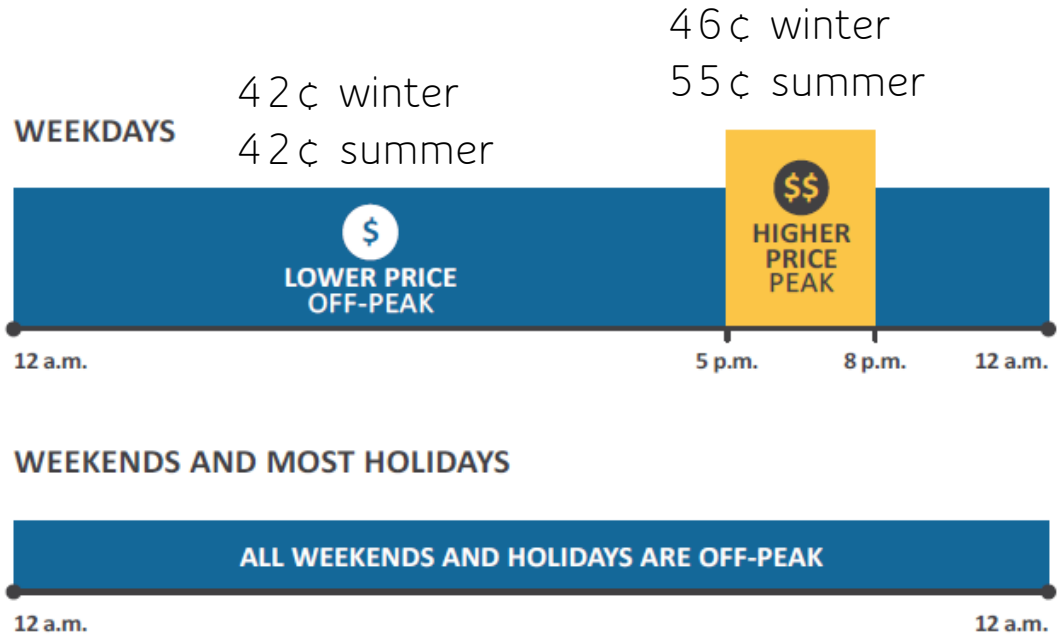


UTILITY COSTS

How Energy Efficiency, Solar, & Battery Storage Lower your Bills



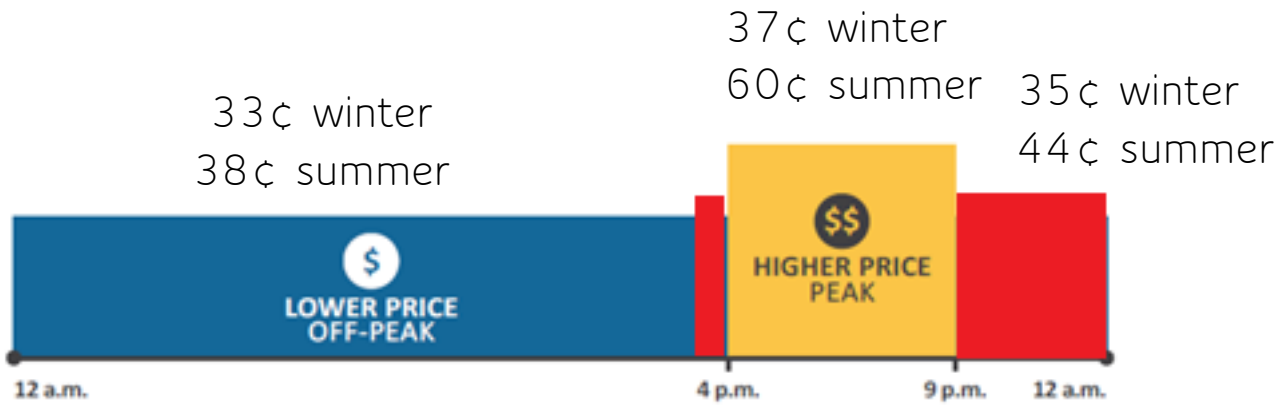
E-TOU-C Rate



E-TOU-D Rate

PG&E Time-of-Use Electric Rates

Rates updated August 2024



E-ELEC Rate

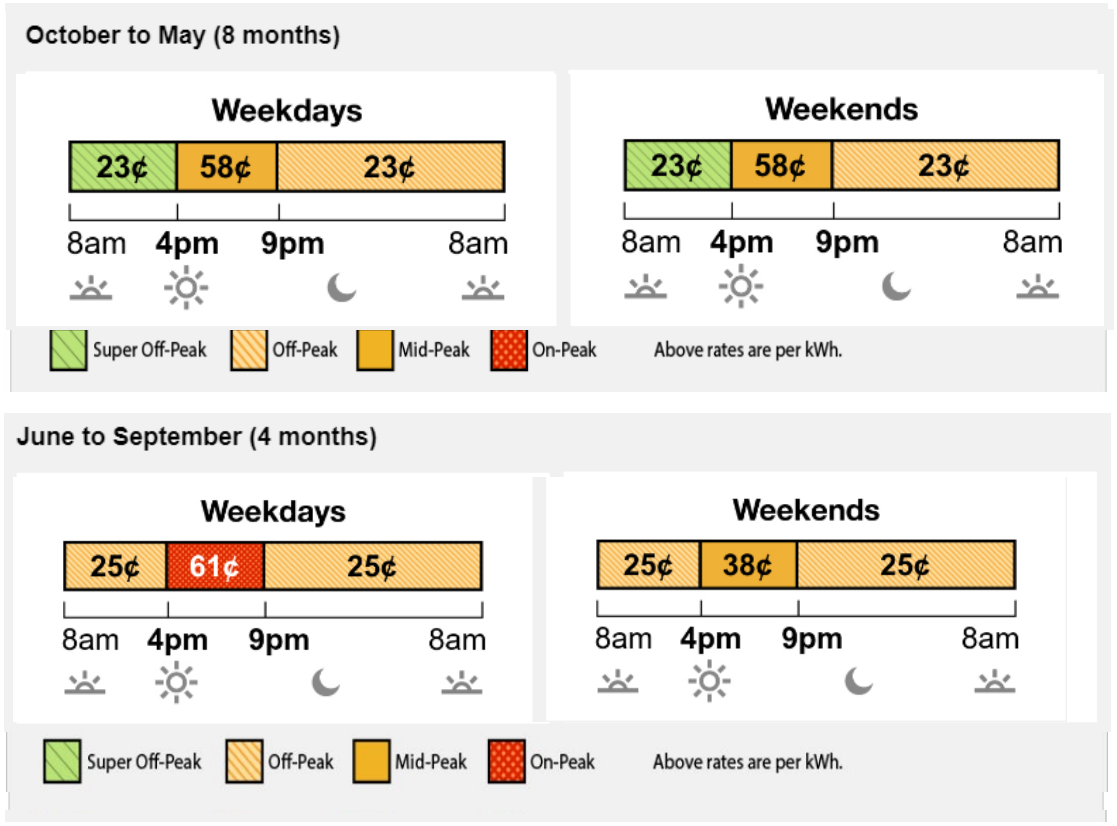
The Rate to Support Electrification

- Discounted rates for Electric customers with Heat Pumps, HPWHs, and EVs
- Lower off-peak kWh rates
- 22 ¢ lower off-peak kWh rates
- New part-peak periods (in red)

*Rates subject to change

Rates updated August 2024

Residential Time of Use Rates: SCE TOU-PRIME



The Rate to Support Electrification

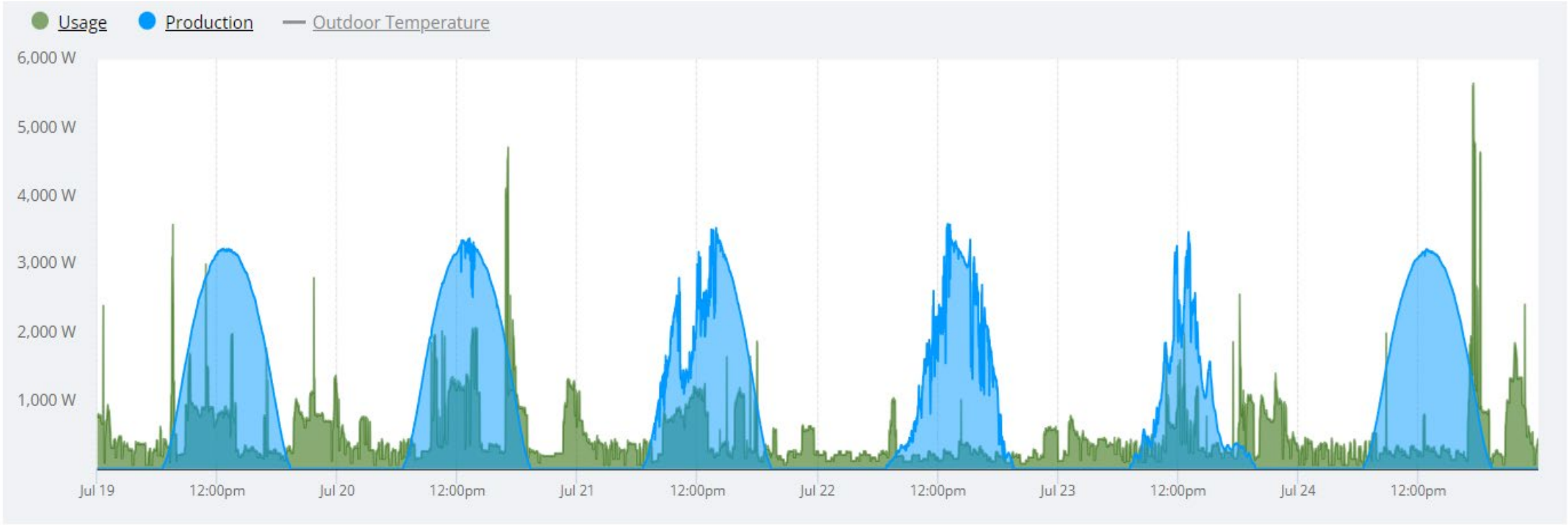
- Discounted rates for Electric customers with Heat Pumps, HPWHs, and EVs
- 35 ¢ lower off-peak kWh rates

*Rates subject to change

Rates updated September 2024

ELECTRICITY USED UNDER THE MOUNTAIN

It's Free!



SOLAR & BATTERY ARE COMPLICATED

Solar Project Financial Analysis

- Usage data is hard to obtain
- Solar production needs to be subtracted from usage data to get net usage that the meter sees
- Solar exports need to be treated separately from normal usage
- Rates vary by season and time of day
- Time value of money, growth rates, future changes in energy use

Add in a Battery

- Tracking inflows and outflows is complicated
- Need to account for round-trip efficiency due to inverting between ac and dc
- How much capacity are you using to save money and how much for power outage backup?
- 10-year useful life

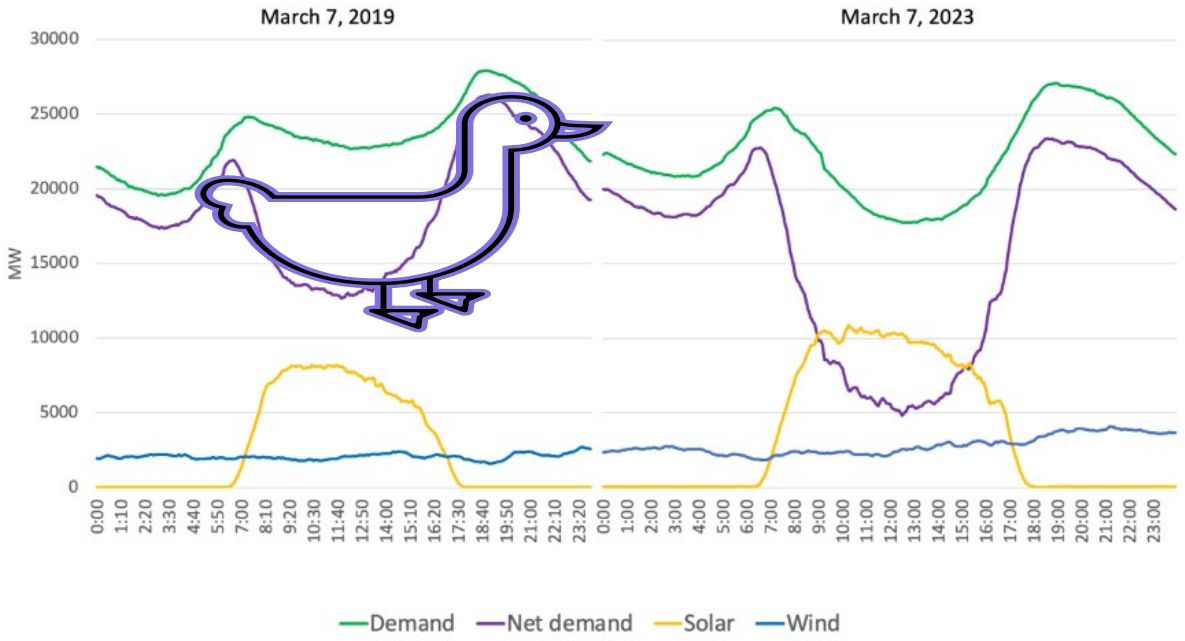
HOW UTILITY BILLS ACCOUNT FOR SOLAR

Net Metering 1-2-3 & Net Billing

Net Metering

Solar exports to grid were credited at full retail rates; now at much lower rates

- NEM 1.0: customers were credited at normal rate for any exported PV
  - Until annual net usage reached zero – then exports were compensated at a lower rate
- NEM 2.0: customers still credited at normal rate for any exported PV
  - also charged a monthly fee and peak rates were moved later in the day (4-9 pm)
- NEM 3.0: exports will be compensated at lower rate
  - Also known as "Net Billing"
  - Monthly fees expected to be higher



Implications of NEM Changes

- PV only systems oversized relative to usage make no sense
- Batteries make more sense
  - *Reduce PV exports in favor of self-utilization*
- Paybacks slightly longer than before
  - *But PV & battery costs continue to come down*
- Usage patterns matter more
  - *What time do you charge your EV?*
  - *Do you set your thermostat to go easy 4-9 pm?*
  - *Do the laundry and run dishwasher before 4 pm*

CANARY MEDIA

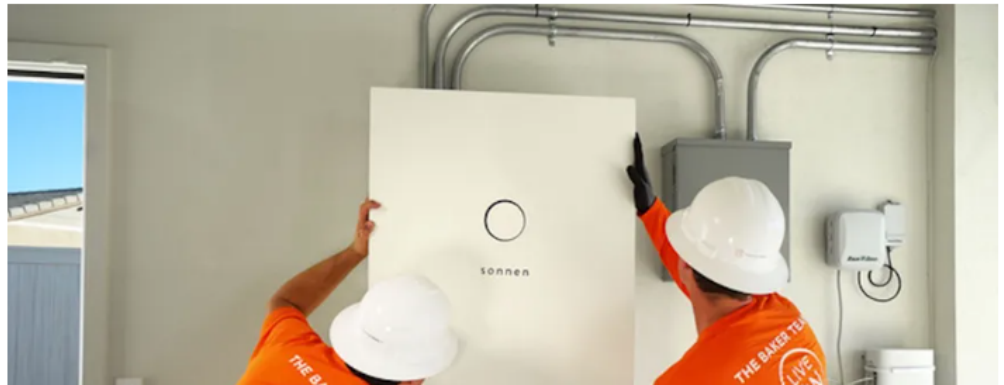
Clean energy journalism for a cooler tomorrow

Solar Heat pumps Electric vehicles Batteries Hydrogen Electrification Guides and how-tos

As California guts solar net metering, batteries emerge as a moneymaker

Rooftop solar alone will earn less under new California policy, but firms are developing programs to make it lucrative to add home batteries that help the grid.

By **Jeff St. John**
13 December 2022



How Your Utility Bill is Affected by PV-NEM

Time	Usage	PV production	Net Usage	Rate	Cost
Midnight-6 am	9 kWh	0	9 kWh	$0.42	$3.78
6 am-12 noon	18 kWh	24 kWh	-6 kWh	$0.42	($2.52)
12 noon-3 pm	16 kWh	18 kWh	-2 kWh	$0.42	($0.84)
4 pm-7 pm	12 kWh	8 kWh	4 kWh	$0.64	$2.56
7 pm-9 pm	10 kWh	2 kWh	8 kWh	$0.64	$5.12
3 pm-4 pm & 9 pm-midnight	4 kWh	0	4 kWh	$0.48	$1.92
Totals	69 kWh	52 kWh	17 kWh		$10.02

This Day Would Cost $39.02 without Solar

How Your Utility Bill is Affected by PV-NEB

Time	Usage	PV production	Net Usage	Rate	Cost
Midnight-6 am	9 kWh	0	9 kWh	$0.42	$3.78
6 am-12 noon	18 kWh	24 kWh	-6 kWh	$0.08 exports	($0.48)
12 noon-3 pm	16 kWh	18 kWh	-2 kWh	$0.08 exports	($0.16)
4 pm-7 pm	12 kWh	8 kWh	4 kWh	$0.64	$2.56
7 pm-9 pm	10 kWh	2 kWh	8 kWh	$0.64	$5.12
3 pm-4 pm & 9 pm-midnight	4 kWh	0	4 kWh	$0.48	$1.92
Totals	69 kWh	52 kWh	17 kWh		$12.74

Solar Export Compensation Rates

Month

Hour of Day	1	2	3	4	5	6	7	8	9	10	11	12
1	$0.09	$0.09	$0.07	$0.07	$0.07	$0.08	$0.08	$0.09	$0.09	$0.09	$0.09	$0.09
2	$0.09	$0.08	$0.07	$0.07	$0.07	$0.07	$0.07	$0.09	$0.09	$0.09	$0.09	$0.09
3	$0.09	$0.08	$0.07	$0.08	$0.07	$0.07	$0.07	$0.08	$0.09	$0.08	$0.08	$0.08
4	$0.09	$0.08	$0.07	$0.07	$0.07	$0.08	$0.07	$0.08	$0.08	$0.08	$0.08	$0.08
5	$0.09	$0.08	$0.07	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.08
6	$0.09	$0.08	$0.07	$0.07	$0.07	$0.08	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09
7	$0.09	$0.08	$0.07	$0.07	$0.07	$0.08	$0.07	$0.08	$0.08	$0.08	$0.08	$0.09
8	$0.09	$0.08	$0.07	$0.07	$0.06	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	$0.08
9	$0.07	$0.06	$0.05	$0.02	$0.03	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.07
10	$0.06	$0.04	$0.02	$0.01	$0.02	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
11	$0.06	$0.04	$0.02	$0.01	$0.01	$0.04	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
12	$0.06	$0.04	$0.02	$0.01	$0.02	$0.04	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06
13	$0.06	$0.03	$0.02	$0.01	$0.01	$0.04	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06
14	$0.06	$0.03	$0.02	$0.01	$0.01	$0.04	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06
15	$0.06	$0.03	$0.02	$0.00	$0.01	$0.04	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06
16	$0.06	$0.03	$0.02	$0.00	$0.01	$0.04	$0.05	$0.07	$0.06	$0.06	$0.06	$0.07
17	$0.08	$0.06	$0.03	$0.00	$0.01	$0.12	$0.14	$0.16	$0.07	$0.06	$0.09	$0.09
18	$0.10	$0.10	$0.06	$0.01	$0.03	$0.23	$0.32	$0.83	$0.13	$0.09	$0.09	$0.09
19	$0.10	$0.09	$0.08	$0.08	$0.08	$0.27	$0.36	$0.93	$0.37	$0.10	$0.09	$0.09
20	$0.09	$0.08	$0.08	$0.08	$0.08	$0.26	$0.45	$1.03	$0.50	$0.10	$0.08	$0.09
21	$0.09	$0.08	$0.08	$0.07	$0.07	$0.18	$0.28	$0.99	$0.29	$0.09	$0.09	$0.09
22	$0.09	$0.08	$0.08	$0.07	$0.07	$0.08	$0.09	$0.72	$0.14	$0.09	$0.09	$0.09
23	$0.09	$0.09	$0.07	$0.07	$0.07	$0.08	$0.08	$0.70	$0.14	$0.09	$0.09	$0.09
24	$0.09	$0.09	$0.07	$0.07	$0.07	$0.07	$0.07	$0.09	$0.09	$0.09	$0.09	$0.09

PG&E 2025 interconnection weekday export compensation rates

WHAT THE BATTERY DOES FOR YOU

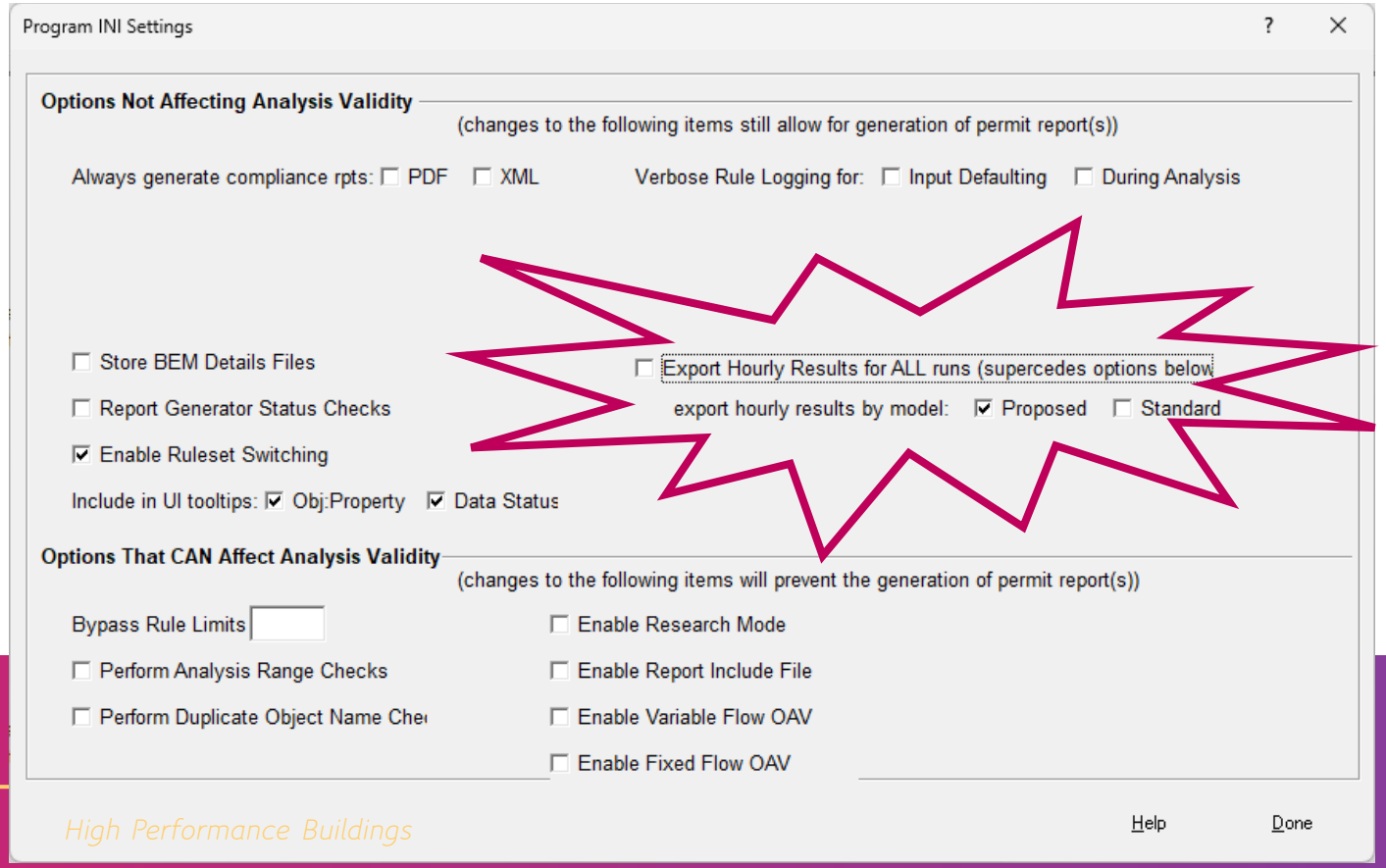
	No Renewables	PV Only	PV & Battery
Total Usage	6,693 kWh	405 kWh	674 kWh
Peak Usage 4-9 pm	2,354 kWh	1,525 kWh	456 kWh
Exported energy	--	249 kWh	211 kWh
Annual utility bills	$4,916	$3,546	$2,481

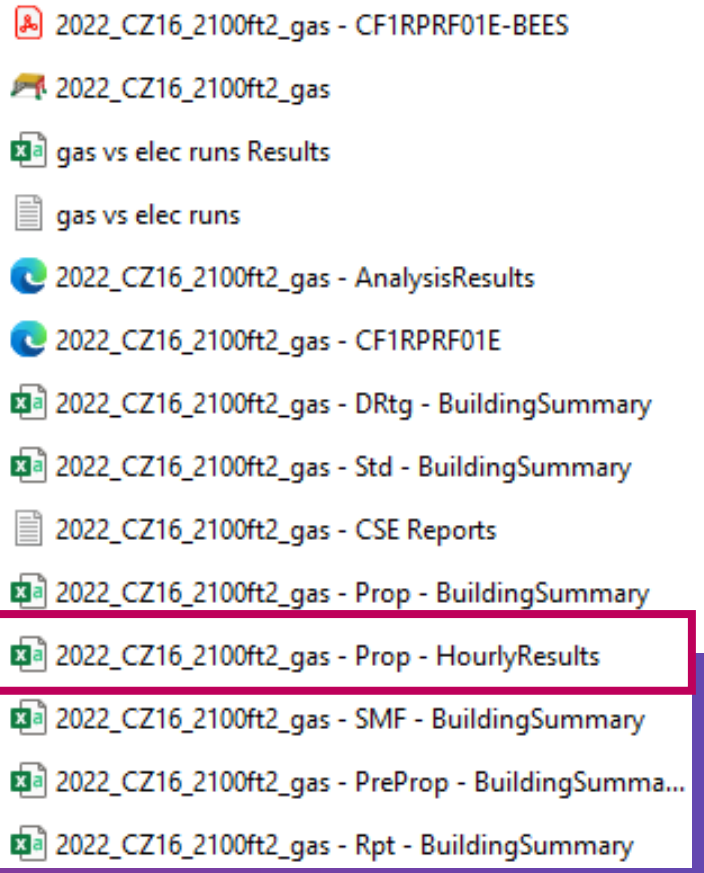
Modeling performed using CBECC-RES 2-story CEC prototype in CZ 12 (East Bay/Sacramento) as mixed fuel home. Solar system is 4 kW and battery is 13.5 kWh modeled using Basic control.

HOW TO CALCULATE UTILTY COSTS

Use Hourly Data from CBECC-RES

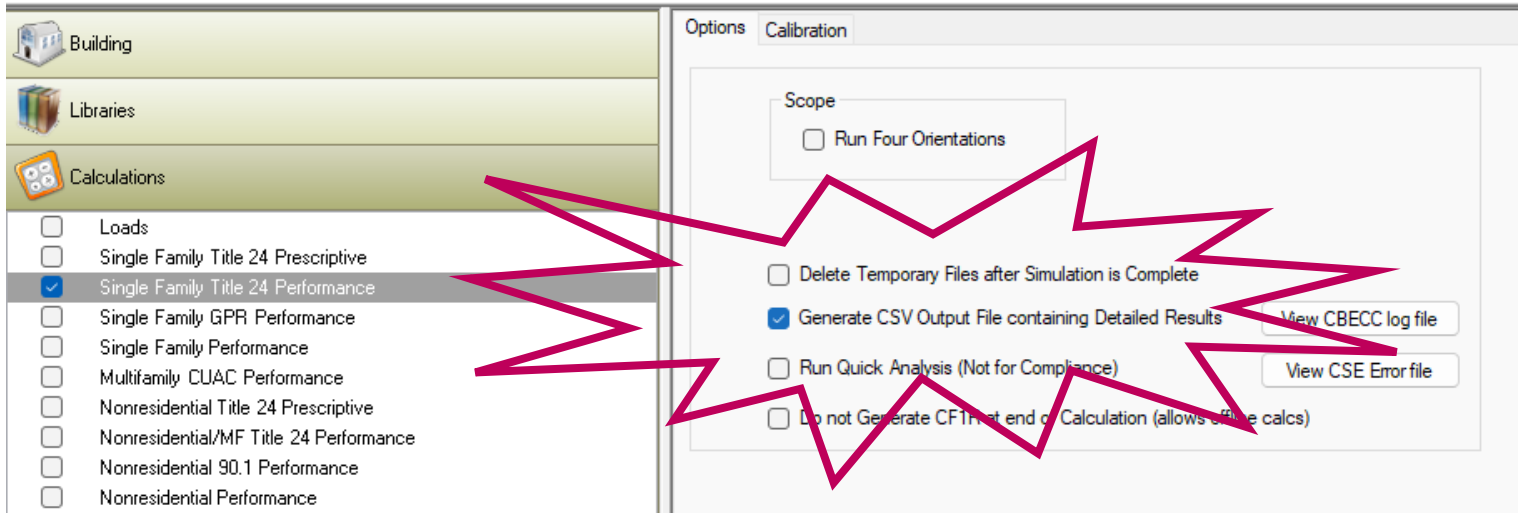
Can be downloaded from your utility or pulled out of modeling software





Use Hourly Data from Energy Pro

Can be downloaded from your utility or pulled out of modeling software



Use Hourly Data

Calculate utility costs in spreadsheet

	A	B	C	D
2				
3		Hourly values to be filled in by user		
4		Rates to be updated as needed		
5				
6				
7	Case #1		Case #2	
8	Current Usage		With prescriptive PV	
9			2.85	
10	(kWh)	(Therms)	(kWh)	(Therms)
11	0.302271	0.000149863	0.223575	0.000149863
12	0.274168	0.000119891	0.208641	0.000958062
13	0.194206	8.99179E-05	0.198756	0.00283311
14	0.214296	8.99179E-05	0.198001	8.99E-05
15	0.232084	8.99179E-05	0.194149	8.99E-05
16	0.204472	0.000149863	0.209032	0.00236282
17	0.254962	0.0439793	0.259719	0.0496852
18	0.410394	0.090739	0.305711	0.101382
19	0.412993	0.0429407	0.358858	0.0656021
20	0.192184	0.045981	0.354372	0.0612696
21	-0.0708488	0.0174644	0.327068	0.0267345
22	-0.425373	0.00699758	0.226285	0.0175449
23	-0.103899	0.00188828	0.364533	0.0118683
24	-0.121263	0.0055719	0.222707	0.0153721

cz5 PG&E | cz4 PG&E | cz3 PG&E | cz2 PG&E | cz1 PG&E

Electricity Long Run Emissions (CZ12; tonnes CO2-e/kWh)	Natural Gas Long Run Emissions (CZ12; tonnes CO2-e/th)	Mo	Da	Hr
0.000286905	0.0058475	1	1	1
0.0002865	0.0058475	1	1	2
0.000286146	0.0058475	1	1	3
0.000280729	0.0058475	1	1	4
0.000285173	0.0058475	1	1	5
0.000287611	0.0058475	1	1	6
0.000288342	0.0058475	1	1	7
0.000287789	0.0058475	1	1	8
0.000282493	0.0058475	1	1	9
0.000236857	0.0058475	1	1	10
0.000215477	0.0058475	1	1	11
0.000198306	0.0058475	1	1	12
0.000187088	0.0058475	1	1	13
0.000192922	0.0058475	1	1	14
0.000193456	0.0058475	1	1	15
0.000231192	0.0058475	1	1	16
0.000290488	0.0058475	1	1	17
0.000291741	0.0058475	1	1	18
0.000291729	0.0058475	1	1	19
0.000291673	0.0058475	1	1	20
0.000291115	0.0058475	1	1	21

water

uction

Utility Cost Calculator Results

E-TOU-C (with baselines)								
Current Usage			With prescriptive PV			Case #3		
Electric	Gas	Total	Electric	Gas	Total	Electric	Gas	Total
$ 3,280.76	$ 1,661.46	$ 4,942.22	$4,014.51	$ -	$ 4,014.51	$2,807.34	$ -	$2,807.34
CO2 tons			CO2 tons			CO2 tons		
1.06	2.95	4.02	1.89	0.00	1.89	1.52	-	1.52
E-TOU-D (no electric baseline)								
Electric	Gas	Total	Electric	Gas	Total	Electric	Gas	Total
$ 3,254.99	$ 1,661.46	$ 4,916.45	$3,992.90	$ -	$ 3,992.90	$2,922.15	$ -	$2,922.15
CO2 tons			CO2 tons			CO2 tons		
1.06	2.95	4.02	1.89	0.00	1.89	1.52	-	1.52
E-ELEC								
Electric	Gas	Total	Electric	Gas	Total	Electric	Gas	Total
$ 3,098.84	$ 1,661.46	$ 4,760.30	$3,592.10	$ -	$ 3,592.10	$2,557.66	$ -	$2,557.66
CO2 tons			CO2 tons			CO2 tons		
1.06	2.95	4.02	1.89	0.00	1.89	1.52	-	1.52

Compliance & Energy Usage Analysis

			Compliance TDVbtu	Standard	Deficit	Deficit %		
Modeled Energy Use per plans, Site Basis	39.0	mmbtu/yr	29.66	23.73	5.93	25.0%		
Electric	3,959	kWh/yr	14					
Gas	255	therms/yr						

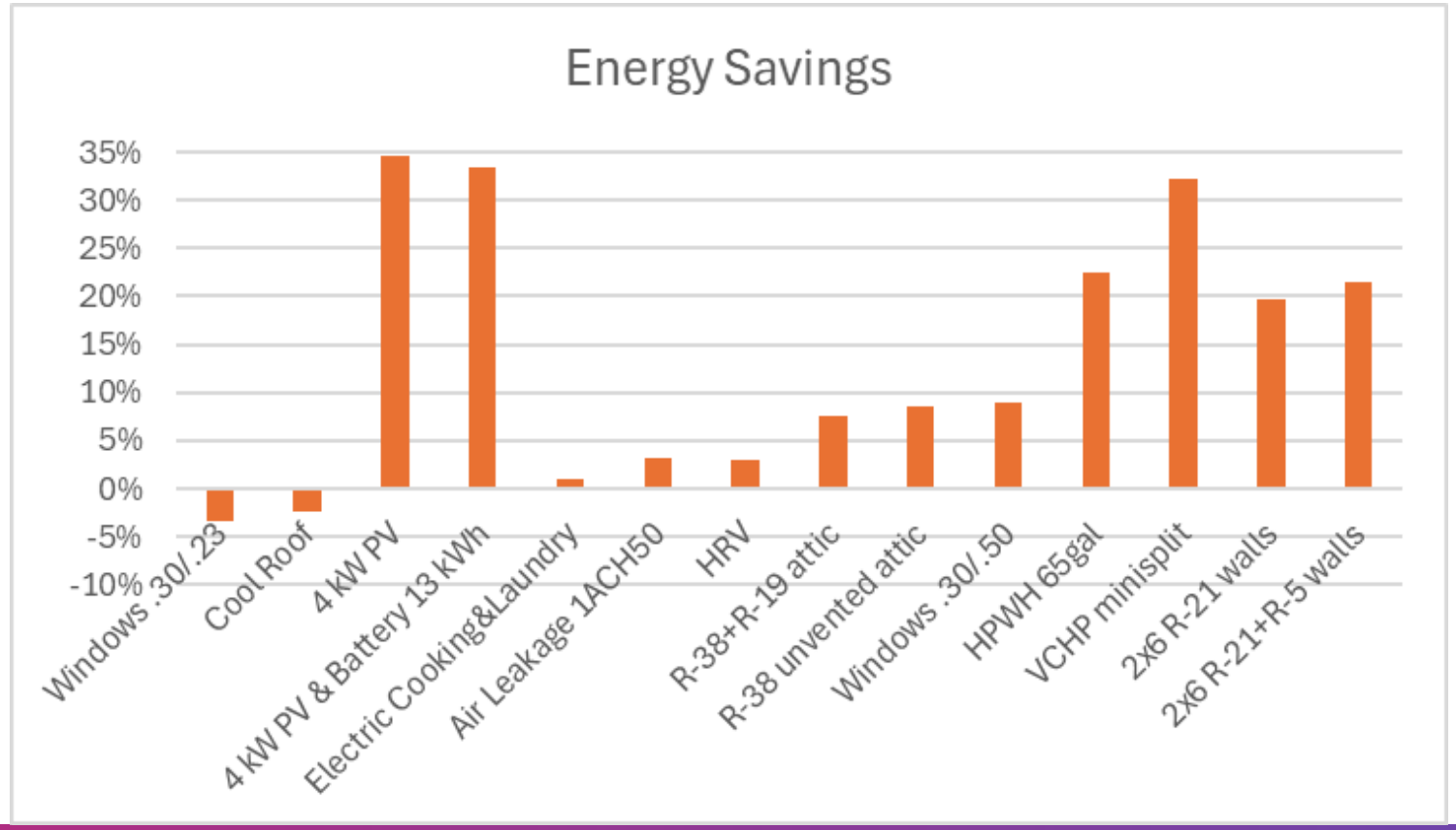
Percent Energy Savings Report

Feature	Contribution to Energy Savings	Savings (mmbtu/yr)	New kWh	New therms	elec savings	gas savings	Compliance savings	
Electric heat pump water heater	18.8%	(7.3)	4914	149	3.3	(10.6)	(0.6)	-2.4%
High efficiency tankless water heaters (ef=0.95)	3.8%	(1.5)	3959	240	-	(1.5)	1.1	4.5%
Solar thermal water heating @ 25% solar thermal fraction w/ tankless	5.9%	(2.3)	3959	232	-	(2.3)	1.7	7.0%
QII HERS inspection	4.1%	(1.6)	3934	240	(0.1)	(1.5)	1.8	7.7%
Refrigerant charge verification HERS inspection	0.2%	(0.1)	3939	255	(0.1)	0.0	0.8	3.3%
Add R-4 continuous insulation under exterior cladding	5.6%	(2.2)	3939	234	(0.1)	(2.1)	2.1	9.0%
Install above roof deck insulation R-4 (sloped and flat)	2.3%	(0.9)	3901	248	(0.2)	(0.7)	2.8	11.7%
Install below roof deck insulation R-19 (attic only)	2.6%	(1.0)	3896	247	(0.2)	(0.8)	3.1	12.9%
Upgrade from SEER 14 to SEER 16 HVAC, 93% afue furnace	4.1%	(1.6)	3926	240	(0.1)	(1.5)	2.3	9.8%
Ducts in conditioned space	5.2%	(2.0)	3893	237	(0.2)	(1.8)	3.9	16.4%
Air sealing to 3 ACH	2.6%	(1.0)	3957	245	(0.0)	(1.0)	0.8	3.4%
Upgrade from exhaust mechanical ventilation to 2 ERVs (38cfm,85%,1	1.9%	(0.7)	3980	247	0.1	(0.8)	0.6	2.5%
Upgrade from exhaust to central fan integrated ventilation x2 (1,000 c	-6.9%	2.7	4980	247	3.5	(0.8)	0.8	3.2%

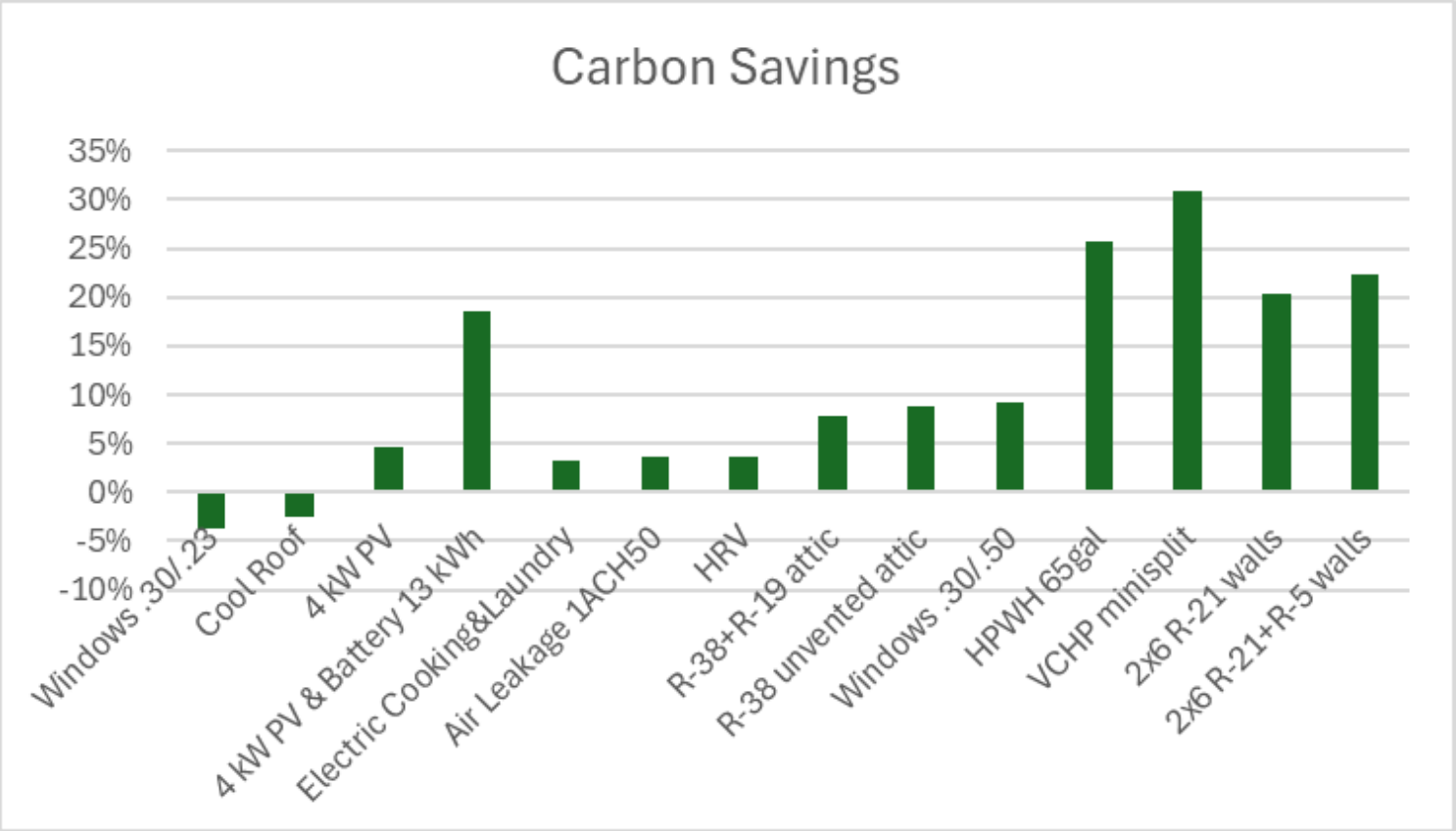
What Helps Compliance Most (CZ 5)?

Existing House: R-0 walls, R-11 vented attic, Air sealing 15 ACH 50, Default windows U/SHGC .99/.74, Gas furnace 80 AFUE w/ AC 11 SEER, ducts in attic, Gas tank WH 50 gal .60, exhaust ventilation, gas cooking and laundry, no Solar, no Battery

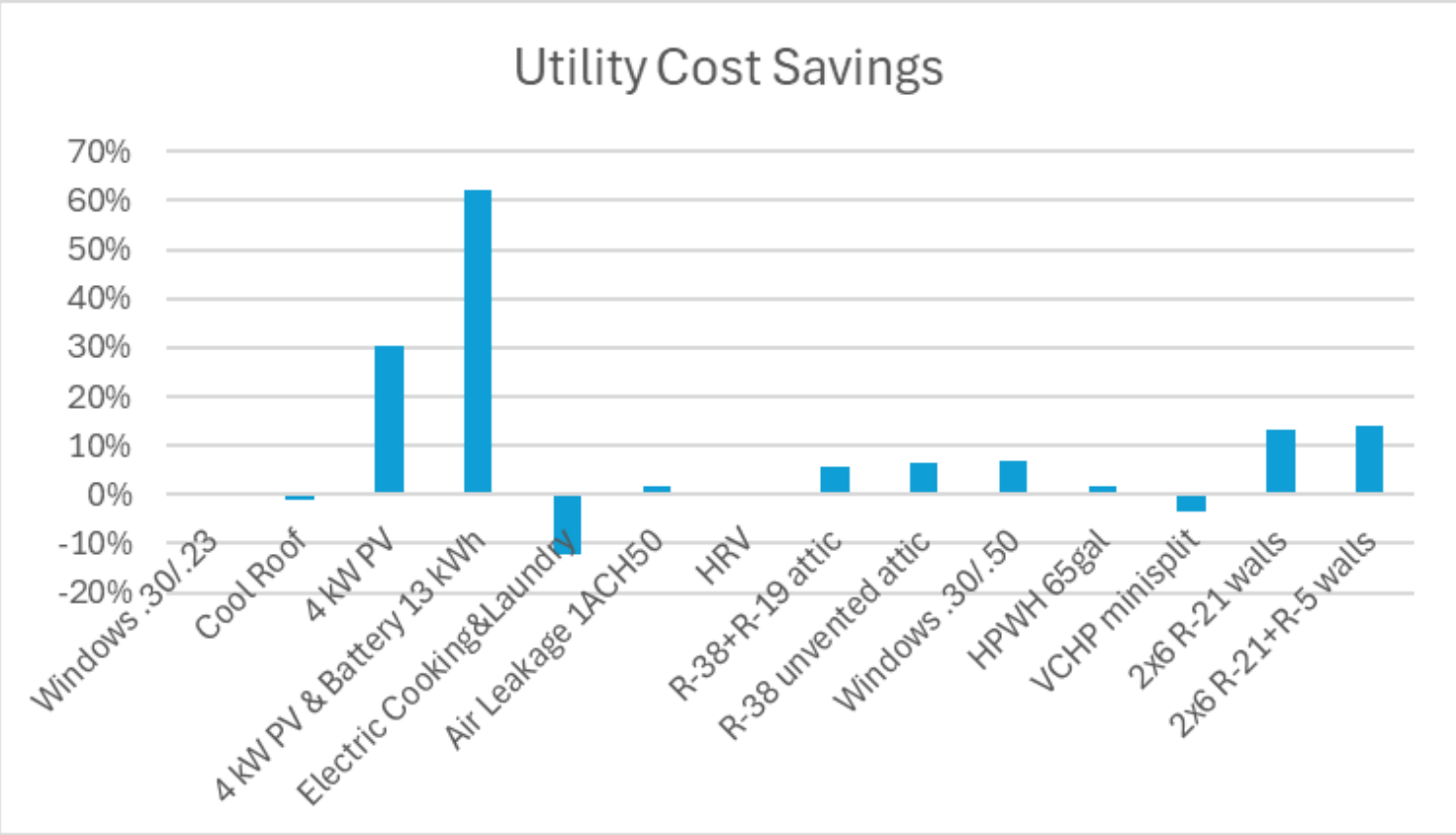
What Saves Energy Most (CZ 5)?



What Reduces Carbon Emissions Most (CZ 5)?

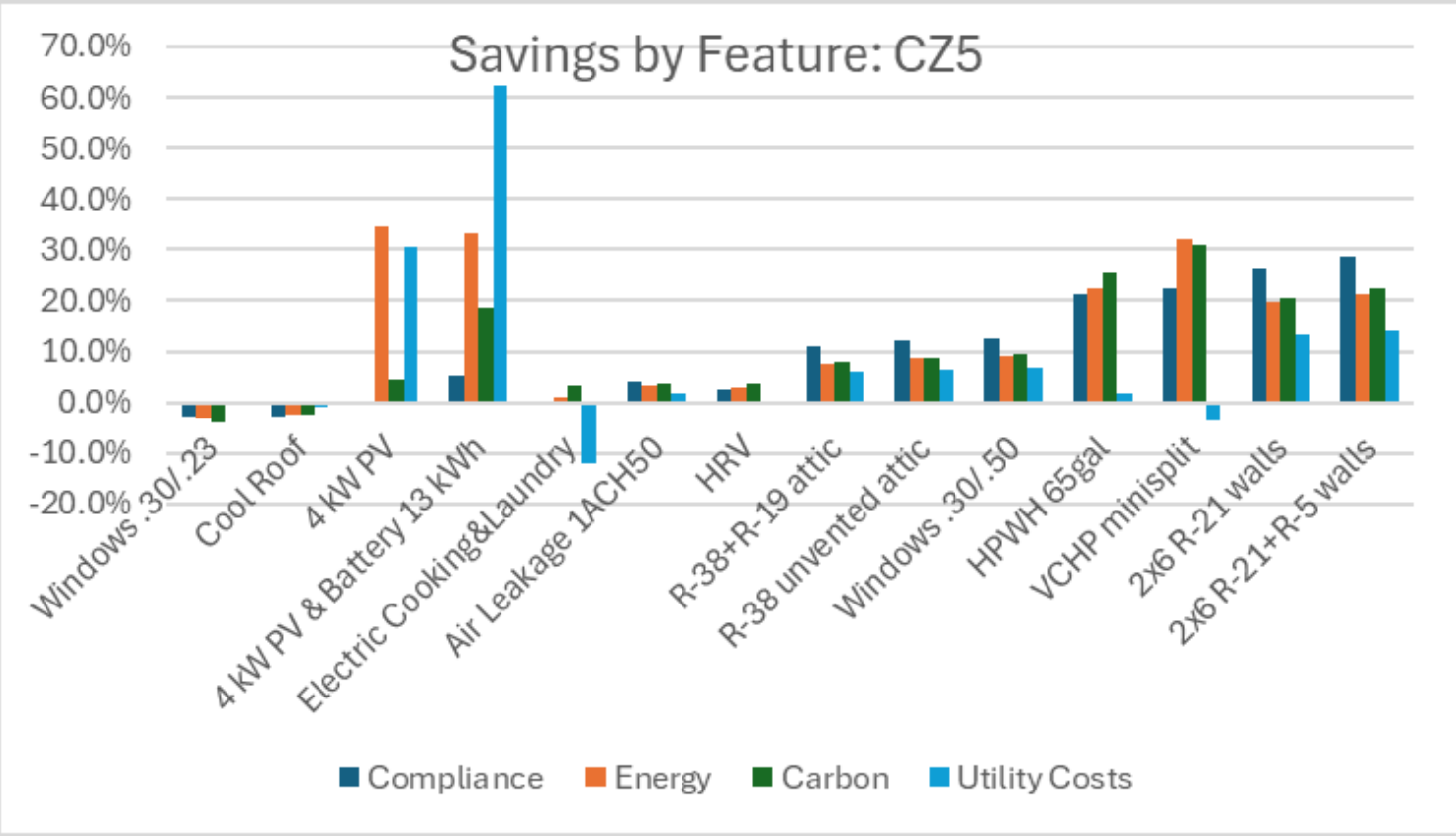


What Saves Utility Costs Most (CZ 5 PG&E)?



Note: Software assumes electric resistance cooking and laundry; heat pump and induction will be lower cost

All Together Now. What Stands Out?



FINANCIAL ANALYSIS BASICS

How to Analyze Projects

HOW SHOULD WE LOOK AT BUILDING REMODEL PROJECTS?

1) Get proposals from contractors, compare them, and choose one
2) Read posts on Reddit, Yahoo Finance, Green Building Advisor, etc
3) As many panels as the roof can fit
4) The rule of second cheapest
5) Perform rigorous financial analysis to optimize features and prove payback

A Project is a Set of Cash Flows

Buy something for $4,000 that lasts 5 years and saves you $1,000 per year on utility bills													
	YEAR												
Straight Cash Flows	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***		Totals
Purchase	$ (4,000)												$ (4,000)
Savings		$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000		$ 10,000
Replacement						$ (4,000)							$ (4,000)
End of Life											$ (500)		$ (500)
Totals	$ (4,000)	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ (3,000)	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 500		$ 1,500

ROI = 18.8%
Payback = 4.0 years

Cash Flows Need to Reflect Time Value of Money

	Cost of Capital	5.0%											
	YEAR												
Add in cost of capital	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***		Totals
Purchase	$ (4,000)												$ (4,000)
Savings		$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000		$ 10,000
Replacement						$ (4,000)							$ (4,000)
End of Life											$ (500)		$ (500)
Totals	$ (4,000)	$ 952	$ 907	$ 864	$ 823	$ (2,351)	$ 746	$ 711	$ 677	$ 645	$ 307		$ 281

ROI = 1.4%
Payback = 9.1 years

Cash Flows May Change Over Time

	Annual growth	3.0%											
	YEAR												
Add in future growth	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***		Totals
Purchase	$ (4,000)												$ (4,000)
Savings		$ 1,030	$ 1,061	$ 1,093	$ 1,126	$ 1,159	$ 1,194	$ 1,230	$ 1,267	$ 1,305	$ 1,344		$ 11,808
Replacement						$ (4,637)							$ (4,637)
End of Life											$ (672)		$ (672)
Totals	$ (4,000)	$ 981	$ 962	$ 944	$ 926	$ (2,725)	$ 891	$ 874	$ 857	$ 841	$ 413		$ 964

ROI = 4.5%
Payback = 8.3 years

We Need to Factor in Incentives

	YEAR												
Add in $500 rebate & 20% tax credit	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***		Totals
Purchase	$ (4,000)												$ (4,000)
Savings		$ 1,030	$ 1,061	$ 1,093	$ 1,126	$ 1,159	$ 1,194	$ 1,230	$ 1,267	$ 1,305	$ 1,344		$ 11,808
Incentives	$ 500	$ 800											
Replacement						$ (4,637)							$ (4,637)
End of Life											$ (672)		$ (672)
Totals	$ (3,500)	$ 1,743	$ 962	$ 944	$ 926	$ (2,725)	$ 891	$ 874	$ 857	$ 841	$ 413		$ 2,226

ROI = 13.6%
Payback = 2.9 years

Should I Invest in Stocks or Solar Panels?

ROI = 2.6%
Payback = 14.1 years

	Discount rate:	5.0%											
Play the Market: Invest $8,000 with 10% annual returns, 5% discount rate													
	YEAR												
	0	***1***	***2***	***3***	***4***	***5***		***16***	***17***	***18***	***19***	***20***		Totals
Purchase	$ (8,000)													$ (8,000)
Earnings		$ 800	$ 800	$ 800	$ 800	$ 800		$ 800	$ 800	$ 800	$ 800	$ 800		$ 16,000
Totals	$ (8,000)	$ 762	$ 726	$ 691	$ 658	$ 627		$ 366	$ 349	$ 332	$ 317	$ 302		$ 1,970
Put on 3 kW PV @ $9,000, save $900 a year on utilities with 3% growth rate, 5% discount rate, 30% tax credit														
	YEAR													
	0	***1***	***2***	***3***	***4***	***5***		***16***	***17***	***18***	***19***	***20***		Totals
Purchase	$ (9,000)													$ (9,000)
Savings		$ 927	$ 955	$ 983	$ 1,013	$ 1,043		$ 1,444	$ 1,488	$ 1,532	$ 1,578	$ 1,626		$ 24,909
Inventives		$ 2,700												
Totals	$ (9,000)	$ 3,454	$ 866	$ 850	$ 833	$ 817		$ 662	$ 649	$ 637	$ 625	$ 613		$ 8,371

ROI = 10.0%
Payback = 7.7 years

Sound Financial Analysis

- Cash flows need to be accurate
- Future cash flows need to be discounted
- The time horizon of analysis needs to match the asset's useful life (or show replacement)
- End of useful life disposal costs should be shown
- The more ways you look at it, the more confident you can be

Solar & Storage Proposals Look Like This

Your Future Utility, With Solar

Utility Details			Savings Details		
Utility Company	Post-solar Rate Schedule	Annual usage	Total Savings	Total Solar Production	Avg blended savings
SCE	TOU-D-PRIME	8,350 kWh	$3,053	10,950 kWh	$0.153 /kWh

Monthly Utility Bills, Post-Solar

Time Periods	Energy Use (kWh)				Charges			
Bill Ranges & Seasons	On Peak	Mid Peak	Off Peak	Super Off Peak	Other	NBC	Energy	Total
1/1/2024 - 2/1/2024 W	-	40	269	-29	$16	$9	$82	$106
2/1/2024 - 3/1/2024 W	-	15	191	-77	$15	$6	$50	$70
3/1/2023 - 4/1/2023 W	-	-44	198	-196	$16	$6	$45	$67
4/1/2023 - 5/1/2023 W	-	-108	70	-401	$15	$2	$13	$30
5/1/2023 - 6/1/2023 W	-	-126	17	-433	$16	$1	$9	$7
6/1/2023 - 7/1/2023 S	-96	-35	-428	-	$15	$1	$34	$18
7/1/2023 - 8/1/2023 S	-87	-41	-443	-	$16	$1	$45	$29
8/1/2023 - 9/1/2023 S	-53	-17	-278	-	$16	$3	$23	$4
9/1/2023 - 10/1/2023 S	-28	-9	-129	-	$15	$4	$13	$32
10/1/2023 - 11/1/2023 W	-	-12	99	-137	$16	$3	$18	$37
11/1/2023 - 12/1/2023 W	-	14	117	-80	$15	$4	$30	$49
12/1/2023 - 1/1/2024 W	-	23	159	-35	$16	$5	$46	$67
Total	-264	-300	-158	-1,388	$188	$42	$6	$225

Solar Production Offset %:

Utility -2,600 kWh (0.00%)

Solar PV 10,950 kWh (100.00%)

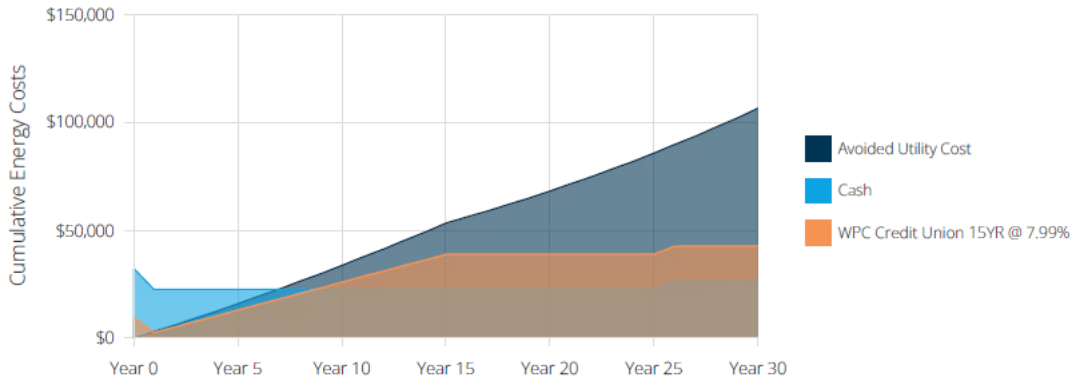
Avoided Cost calculation:

Pre-solar utility bill:	$3,279
Post-solar utility bill:	$225
Savings:	$3,053

Financing Summary

Payment Options	Cash	WPC Credit Union 15YR @ 7.99%
IRR - Term	13.8%	31.1%
LCOE PV Generation	$0.074 /kWh	$0.128 /kWh
Net Present Value	$65,751	$52,428
Payback Period	6.9 Years	1.0 Years
Total Payments	$32,310	$48,575
Total Incentives	$9,693	$9,693
Net Payments	$22,617	$38,882
Electric Bill Savings - Term	$106,807	$106,807
Upfront Payment	$32,310	$9,693
Term	-	15 Years
Monthly Payment	-	$216

Cummulative Energy Costs By Payment Option



ANALYZING SOLAR & BATTERY PROJECTS

With all the complexity

Proposals from Solar Contractors

Your Utility Today, Without Solar

Utility Details			Cost Details		
Utility Company	Current Rate Schedule	Utility Escalation Rate	Total Utility Bill	Total Usage (kWh)	Avg blended cost
SCE	D	4.0%	$3,279	8,350 kWh	$0.393 /kWh

Monthly usage & billing data:

Time Periods	Energy Use (kWh)	Charges			
Bill Ranges & Seasons	Total	Other	NBC	Energy	Total
1/1/2024 - 2/1/2024 W	810	$1	$22	$300	$323
2/1/2024 - 3/1/2024 W	690	$1	$19	$253	$273
3/1/2023 - 4/1/2023 W	800	$1	$22	$296	$319
4/1/2023 - 5/1/2023 W	660	$1	$18	$240	$258
5/1/2023 - 6/1/2023 W	600	$1	$16	$214	$231
6/1/2023 - 7/1/2023 S	650	$1	$18	$234	$253
7/1/2023 - 8/1/2023 S	690	$1	$19	$250	$269
8/1/2023 - 9/1/2023 S	810	$1	$22	$299	$322
9/1/2023 - 10/1/2023 S	780	$1	$21	$288	$310
10/1/2023 - 11/1/2023 W	630	$1	$17	$226	$244
11/1/2023 - 12/1/2023 W	600	$1	$16	$215	$232
12/1/2023 - 1/1/2024 W	630	$1	$17	$226	$244
Total	8,350	$11	$226	$3,042	$3,279

Your Future Utility, With Solar

Utility Details			Savings Details		
Utility Company	Post-solar Rate Schedule	Annual usage	Total Savings	Total Solar Production	Avg blended savings
SCE	TOU-D-PRIME	8,350 kWh	$1,670	10,950 kWh	$0.153 /kWh

Monthly Utility Bills, Post-Solar

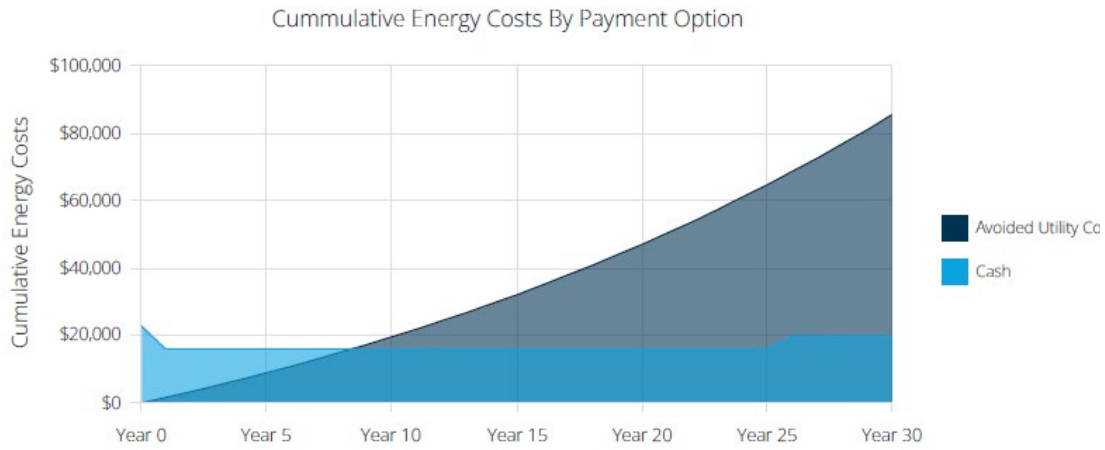
Time Periods	Energy Use (kWh)				Charges			
Bill Ranges & Seasons	On Peak	Mid Peak	Off Peak	Super Off Peak	Other	NBC	Energy	Total
1/1/2024 - 2/1/2024 W	-	253	297	-307	$16	$15	$196	$227
2/1/2024 - 3/1/2024 W	-	182	254	-343	$15	$12	$149	$176
3/1/2023 - 4/1/2023 W	-	102	325	-502	$16	$13	$151	$181
4/1/2023 - 5/1/2023 W	-	-17	255	-723	$15	$10	$101	$126
5/1/2023 - 6/1/2023 W	-	-53	214	-747	$16	$8	$68	$92
6/1/2023 - 7/1/2023 S	-40	-13	-549	-	$15	$8	$38	$62
7/1/2023 - 8/1/2023 S	-36	-15	-563	-	$16	$8	$24	$48
8/1/2023 - 9/1/2023 S	35	15	-440	-	$16	$11	$62	$89
9/1/2023 - 10/1/2023 S	74	39	-320	-	$15	$11	$106	$133
10/1/2023 - 11/1/2023 W	-	134	221	-448	$16	$10	$113	$139
11/1/2023 - 12/1/2023 W	-	186	207	-381	$15	$11	$134	$160
12/1/2023 - 1/1/2024 W	-	203	224	-318	$16	$12	$148	$176
Total	33	1,016	125	-3,769	$188	$129	$1,291	$1,608

Courtesy of Solar Source, Inc.

Solar Only

Financing Summary

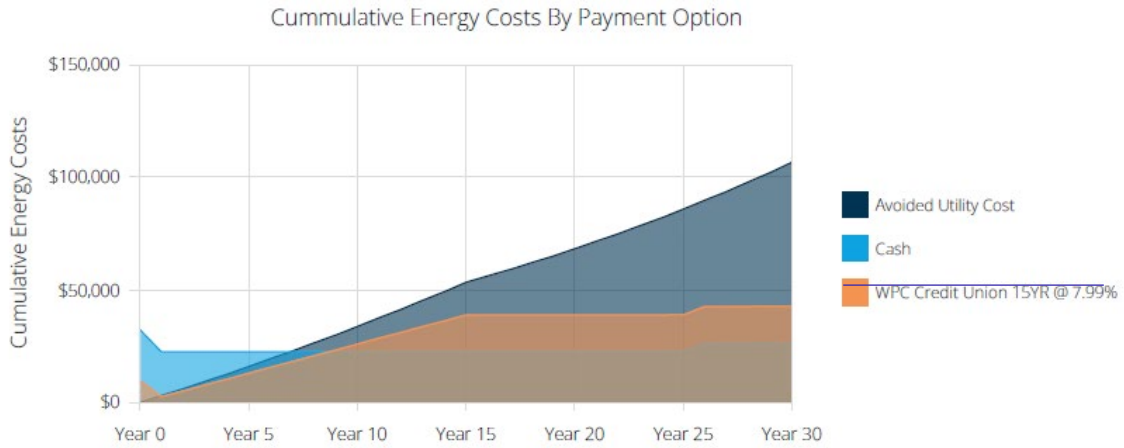
Payment Options	Cash
IRR - Term	12.5%
LCOE PV Generation	$0.053 /kWh
Net Present Value	$52,726
Payback Period	8.4 Years
Total Payments	$22,870
Total Incentives	$6,861
Net Payments	$16,009
Electric Bill Savings - Term	$85,534
Upfront Payment	$22,870



Solar & Battery

Financing Summary

Payment Options	Cash	WPC Credit Union 15YR @ 7.99%
IRR - Term	13.8%	31.1%
LCOE PV Generation	$0.074 /kWh	$0.128 /kWh
Net Present Value	$65,751	$52,428
Payback Period	6.9 Years	1.0 Years
Total Payments	$32,310	$48,575
Total Incentives	$9,693	$9,693
Net Payments	$22,617	$38,882
Electric Bill Savings - Term	$106,807	$106,807
Upfront Payment	$32,310	$9,693
Term	-	15 Years
Monthly Payment	-	$216



Does PV + Battery Outperform PV Alone?***

	Discount rate:	5.0%														
	Growth rate:	4.0%														
PV Only																
	YEAR															
	0	***1***	***2***	***3***	***4***	***5***	***16***	***17***	***18***	***19***	***20***		Totals			
Purchase	$ (22,870)												$ (22,870)			
Earnings		$ 1,670	$ 1,737	$ 1,806	$ 1,879	$ 1,954	$ 3,008	$ 3,128	$ 3,253	$ 3,383	$ 3,518		$ 49,729			
Incentives		$ 6,861											$ 6,861			
Totals	$ (22,870)	$ 8,125	$ 1,575	$ 1,560	$ 1,545	$ 1,531	$ 1,378	$ 1,365	$ 1,352	$ 1,339	$ 1,326		$ 12,754		6.2%	10.7 years
PV & Battery																
	YEAR															
	0	***1***	***2***	***3***	***4***	***5***	***16***	***17***	***18***	***19***	***20***		Totals			
Purchase	$ (32,310)												$ (32,310)			
Savings		$ 3,053	$ 3,175	$ 3,302	$ 3,434	$ 3,572	$ 5,498	$ 5,718	$ 5,947	$ 6,185	$ 6,432		$ 90,912			
Inventives		$ 9,693											$ 9,693			
Totals	$ (32,310)	$ 12,139	$ 2,880	$ 2,852	$ 2,825	$ 2,798	$ 2,519	$ 2,495	$ 2,471	$ 2,448	$ 2,424		$ 30,101		9.6%	8.3 years

*** According to this Solar contractor's proposals

What We Need to Evaluate Financials

Put on 3 kW PV @ $9,000, save $900 a year on utilities with 3% growth rate, 5% discount rate, 30% tax credit														
	YEAR													
	0	***1***	***2***	***3***	***4***	***5***		***16***	***17***	***18***	***19***	***20***		Totals
Purchase	$ (9,000)													$ (9,000)
Savings		$ 927	$ 955	$ 983	$ 1,013	$ 1,043		$ 1,444	$ 1,488	$ 1,532	$ 1,578	$ 1,626		$ 24,909
Inventives		$ 2,700												
Totals	$ (9,000)	$ 3,454	$ 866	$ 850	$ 833	$ 817		$ 662	$ 649	$ 637	$ 625	$ 613		$ 8,371

1) Amount of investment required
2) Useful life of asset
3) Cash inflows as result of investment

   With solar & storage, this is annual utility bill savings
4) Discount rate & Growth rate

1) ~$3,000 per kW solar; $1,200 per kWh battery
2) 20 years life for solar; 10 years life for inverters & batteries
3) Need to calculate based on hourly usage & TOU rates

   Plus incentives
4) 5% & 4% (?)

How Can We Feel Sure About Our Decision?

Questions to Answer

- What about a different size PV system?
- What about a different size battery?
- Are the calculated utility bill savings accurate?
- What if my future usage is different?

Tools to Help

- Wattplan
- Spreadsheets
- Energy modeling software – CBECC-RES & Energy Pro

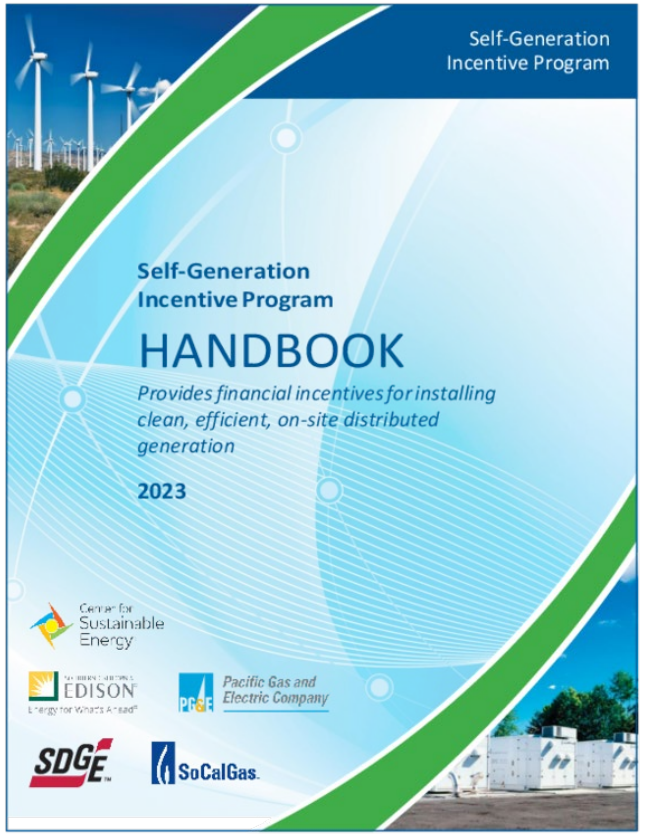
Build the Financial Model Step by Step

1) Look up incentives for solar & storage: Federal tax credit & California SGIP (battery)
2) Build utility bill savings calculation
    1) *Get hourly usage*
    2) *Adjust for future changes*
    3) *Add in PV production*
    4) *Account for battery load shift*
    5) *Calculate utility bills before and after*
    6) *Savings is annual cash inflow (with growth)*
3) Evaluate payback and ROI vs your personal requirements

Put on 3 kW PV @ $9,000, save $900 a year on utilities with 3% growth rate, 5% discount rate, 30% tax credit													
	YEAR												
	0	***1***	***2***	***3***	***4***	***5***		***16***	***17***	***18***	***19***	***20***	Totals
Purchase	$ (9,000)												$ (9,000)
Savings		$ 927	$ 955	$ 983	$ 1,013	$ 1,043		$ 1,444	$ 1,488	$ 1,532	$ 1,578	$ 1,626	$ 24,909
Inventives		$ 2,700											
Totals	$ (9,000)	$ 3,454	$ 866	$ 850	$ 833	$ 817		$ 662	$ 649	$ 637	$ 625	$ 613	$ 8,371

Step 1: Incentives for Solar & Storage

1) Solar: only the federal investment tax credit applies (30%)
2) Storage: SGIP provides $0.15 per Wh for all customers
   - *$0.85 per Wh for equity customers*
   - *$1.00 per Wh for equity resiliency customers*
   - *Storage also qualifies for federal tax credit 30%*



Step 2: Interval Usage Data

Hourly (or 15-minute) usage data is a good way to get accurate TOU utility cost estimates

- Solar contractors' bids will not be based on hourly data unless you give them your data

Get interval data from:

- Modeling software like CBECC-RES
- Your utility's data download portal
- A home energy monitoring system

Adjust for future changes:

- EV charging
- Heat pumps

Energy Consumption time period	Usage (Real energ
2023-08-01 00:00:00 to 2023-08-01 00:15:00	0.84
2023-08-01 00:15:00 to 2023-08-01 00:30:00	0.85
2023-08-01 00:30:00 to 2023-08-01 00:45:00	0.84
2023-08-01 00:45:00 to 2023-08-01 01:00:00	0.84
2023-08-01 01:00:00 to 2023-08-01 01:15:00	0.84
2023-08-01 01:15:00 to 2023-08-01 01:30:00	0.84
2023-08-01 01:30:00 to 2023-08-01 01:45:00	0.84
2023-08-01 01:45:00 to 2023-08-01 02:00:00	0.84
2023-08-01 02:00:00 to 2023-08-01 02:15:00	0.84
2023-08-01 02:15:00 to 2023-08-01 02:30:00	0.84
2023-08-01 02:30:00 to 2023-08-01 02:45:00	0.84
2023-08-01 02:45:00 to 2023-08-01 03:00:00	0.84
2023-08-01 03:00:00 to 2023-08-01 03:15:00	0.84
2023-08-01 03:15:00 to 2023-08-01 03:30:00	0.91
2023-08-01 03:30:00 to 2023-08-01 03:45:00	1.06
2023-08-01 03:45:00 to 2023-08-01 04:00:00	0.84
2023-08-01 04:00:00 to 2023-08-01 04:15:00	0.84
2023-08-01 04:15:00 to 2023-08-01 04:30:00	0.84
2023-08-01 04:30:00 to 2023-08-01 04:45:00	0.84
2023-08-01 04:45:00 to 2023-08-01 05:00:00	0.84
2023-08-01 05:00:00 to 2023-08-01 05:15:00	0.84
2023-08-01 05:15:00 to 2023-08-01 05:30:00	0.83
2023-08-01 05:30:00 to 2023-08-01 05:45:00	0.85
2023-08-01 05:45:00 to 2023-08-01 06:00:00	0.82

Step 3: Add in PV system production

Many tools can provide this:

- PV Watts (from NREL's website)
- CBECC-RES
- Wattplan

- Be sure to accurately model orientation, tilt, and shading
- Try different size PV arrays

Month	Day	Hour	DC Array (	AC System
1	1	0	0	0
1	1	1	0	0
1	1	2	0	0
1	1	3	0	0
1	1	4	0	0
1	1	5	0	0
1	1	6	0	0
1	1	7	78.507	71.762
1	1	8	139.091	130.199
1	1	9	68.421	62.033
1	1	10	191.339	180.595
1	1	11	168.398	158.467
1	1	12	70.267	63.813
1	1	13	67.344	60.994
1	1	14	115.804	107.737
1	1	15	103.848	96.205
1	1	16	0	0
1	1	17	0	0
1	1	18	0	0
1	1	19	0	0
1	1	20	0	0
1	1	21	0	0
1	1	22	0	0
1	1	23	0	0

Step 4: Account for Battery Load Shift

Some tools can provide this:

- CBECC-RES
- Wattplan
- Energy Toolbase

- Be sure to accurately model kWh reserved for load shifting and not use kWh saved for blackouts
- Try different size batteries

Step 5: Calculate Utility Costs

- Use first year savings and extend them out
- Add other cash flows to generate financial metrics

E-TOU-C (with baselines)

Current Usage			With 4 kW PV		
Electric	Gas	Total	Electric	Gas	Total
$ 3,280.76	$ 1,661.46	$ 4,942.22	$ 1,841.74	$ 1,661.46	$ 3,503.20
CO2 tons			CO2 tons		
1.06	2.95	4.02	0.86	2.95	3.82

E-TOU-D (no electric baseline)

Electric	Gas	Total	Electric	Gas	Total
$ 3,254.99	$ 1,661.46	$ 4,916.45	$ 1,965.42	$ 1,661.46	$ 3,626.88
CO2 tons			CO2 tons		
1.06	2.95	4.02	0.86	2.95	3.82

E-ELEC

Electric	Gas	Total	Electric	Gas	Total
$ 3,098.84	$ 1,661.46	$ 4,760.30	$ 1,884.52	$ 1,661.46	$ 3,545.98
CO2 tons			CO2 tons		
1.06	2.95	4.02	0.86	2.95	3.82

CASE STUDY #1

Santa Maria House, CZ 5

3 bed, 2 ba, 2021 sf

$745,000

1) What Efficiency Features have good payback?
2) How much can we reduce utility bills?
3) Now add battery

Suggested Optimal Design – CZ 5

- 2x6 R-21 walls
- Unvented R-38 attic
- Air sealing 1 ACH 50
- High Solar Gain Windows U/SHGC .30/.50
- Ductless/Ducted Minisplit Heat Pump (VCHP credit)
- 65 gallon Heat Pump Water Heater in garage
- Heat Recovery Ventilator 90%
- Electric cooking and laundry
- 4 kW Solar
- 13 kWh Battery

	Starting Value	Final Value	Improvement %	New Code Home
Compliance (Efficiency TDV)	93.7	13.8	85%	46.4
Energy (mmbtu)	65.1	-0.4	100%	19.0
Carbon (mt/yr)	3.7	0.2	95%	1.5
Utility Costs	$3,557	$ 296	92%	$2,172

Existing House: R-0 walls, R-11 vented attic, Air sealing 15 ACH 50, Default windows U/SHGC .99/.74, Gas furnace 80 AFUE w/ AC 11 SEER, ducts in attic, Gas tank WH 50 gal .60, exhaust ventilation, gas cooking and laundry, no Solar, no Battery

How Much More is it Worth Now?

- $3,261 in utility cost savings per year
- $20,000 in incentives

- $100K in Net Present Value over 30 yrs
- $200K in absolute value

HVAC system 3 tons instead of 8 tons

CZ 5 Value Added									
	Discount rate:	5.0%							
	Growth rate:	4.0%							
Optimal Design Package									
	YEAR								
	0	***1***	***2***	***3***	***4***	***5***	***30***		Totals
Purchase	$ -								$ -
Earnings		$ 3,261	$ 3,391	$ 3,527	$ 3,668	$ 3,815	$ 10,170		$ 182,893
Incentives		$ 20,000							$ 20,000
Totals	$ -	$ 22,153	$ 3,076	$ 3,047	$ 3,018	$ 2,989	$ 2,353		$ 100,426

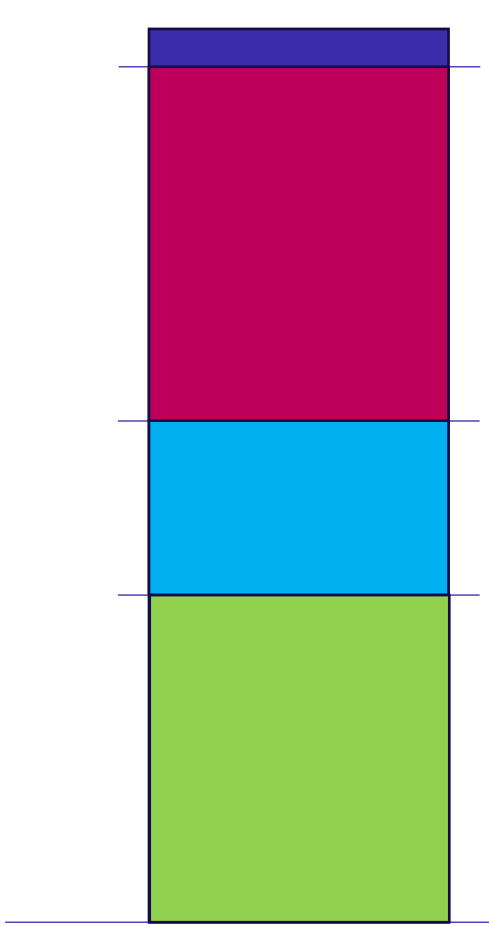
$20,250 - $23,450

$250 EV Charger

~$4,000 PV panels
$2,000 Heat Pump
$2,000 HPWH
$1,200 Efficiency
$600 Elec panel

$1,000-$1,500 Heat Pump
$1,100-$3,800 HPWH
$2,000 Electrical

$4,250 Whole House base incentive
+$250 HP dryer
+$1,000 Elec panel
+$600 Advanced HP bonus



South Coast AQMD

IRS Tax Credits

TECH CLEAN CALIFORNIA

CALIFORNIA ENERGY-SMART HOMES

CASE STUDY #2

Corona House, CZ 10

3 bed, 2.5 ba, 2380 sf

$840,000

1) What Efficiency Features have good payback?
2) How much can we reduce utility bills?
3) Now add battery

Suggested Optimal Design – CZ 10

- 2x6 R-21 walls
- Unvented R-38 attic
- Air sealing 1 ACH 50
- Low Solar Gain Windows U/SHGC .30/.23
- Ductless/Ducted Minisplit Heat Pump (VCHP credit)
- 65 gallon Heat Pump Water Heater in garage
- Heat Recovery Ventilator 90%
- Electric cooking and laundry
- 4 kW Solar
- NO Battery

	Starting Value	Final Value	Improvement %	New Code Home
Compliance (Efficiency TDV)	160.0	31.6	80%	52.7
Energy (mmbtu)	87.5	3.7	96%	17.0
Carbon (mt/yr)	4.1	0.9	77%	1.57
Utility Costs	$6,108	$1,435	77%	$1,834

CASE STUDY #3

Walnut Creek House, CZ 12

4 bed, 3 bath, 2700 sf

$1,400,000

1) What Efficiency Features have good payback?
2) How much can we reduce utility bills?
3) Now add battery

Suggested Optimal Design – CZ 12

- 2x6 R-21 walls
- Unvented R-38 attic
- Air sealing 1 ACH 50
- Low Solar Gain Windows U/SHGC .30/.23
- Ductless/Ducted Minisplit Heat Pump (VCHP credit)
- 65 gallon Heat Pump Water Heater in garage
- Heat Recovery Ventilator 90%
- Electric cooking and laundry
- 4 kW Solar
- 13 kWh Battery

	Starting Value	Final Value	Improvement %	New Code Home
Compliance (Efficiency TDV)	226.7	32.1	86%	73.4
Energy (mmbtu)	125.5	8.7	93%	31.2
Carbon (mt/yr)	6.9	0.8	89%	2.4
Utility Costs	$7,536	$1,193	84%	$3,046

SUMMARY

1) With complexity of utility bills with renewables, the best options can be unpredictable
2) It is worth doing energy modeling and financial analysis to determine payback and IRR
3) Pull hourly utility meter data out of CBECC/CBECC-RES/Energy Pro
4) High-performance homes can lower energy use and utility costs 80-90% compared to existing homes

Closing

Continuing Education Units Available

- Contact ian.logan@ventura.org for AIA LUs

Coming to Your Inbox Soon!

- Slides, Recording, & Survey – Please Take It and Help Us Out!

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Any phone numbers who joined? Please share your name!

Thank you!

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