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California Energy Commission

STAFF PAPER

Staff Review and Analysis for Trinity Public Utility District's Application for a Solar Photovoltaic Determination for Single-Family and Low-Rise Multifamily Buildings

Muhammad Faisal Saeed
Cheng Moua
Bill Pennington
Authors

Building Standards Office
Efficiency Division

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ABSTRACT

The California Energy Commission (CEC) adopted the *2022 Building Energy Efficiency Standards* (California Code of Regulations, Title 24, Part 1, Chapter 10, and Part 6; also known as the California Energy Code) that go into effect January 1, 2023. The Energy Code requires the installation of solar photovoltaic systems on newly constructed single-family and low-rise multifamily buildings in section 150.1(c)14 and section 170.2(f). The solar photovoltaic requirements for single-family and low-rise multifamily buildings were first adopted in the 2019 Energy Code and readopted with only limited changes in the 2022 Energy Code. As part of the adoptions, section 10-109(k) Photovoltaic System Requirement Determination, states, "The Commission may, upon written application or its own motion, determine that the photovoltaic or battery storage requirements in Section 150.1(a)3, Section 140.0(c), Section 170.0(a)3 shall not apply, if the Commission finds that the implementation of public agency rules regarding utility system costs and revenue requirements, compensation for customer-owned generation, interconnection fees, or other factors, causes the Commission's cost-effectiveness conclusions, made pursuant to Public Resources Code 25402(b)(3), to not hold for particular buildings."

The Trinity Public Utility District applied on June 6, 2022, for a CEC determination regarding whether the solar photovoltaic system requirements should apply to single-family and low-rise multifamily buildings in its service area under 2022 Energy Code. The Trinity Public Utility District applied for the same CEC determination for the 2019 Energy Code, and the CEC determined that Trinity's rules regarding residential rates and net energy metering compensation and participation charge for customer-owned generation cause the CEC's cost-effectiveness conclusion for low-rise residential solar photovoltaic systems not to hold. CEC staff has reviewed the application and found it complete. Staff has performed a cost-effectiveness analysis based on the public agency rules adopted by Trinity Public Utility District and recommends approval of the application.

This staff report documents the analysis completed in making the recommendation.

Keywords: Solar photovoltaic determination, 10-109(k), solar PV requirement, solar, PV, Building Energy Efficiency Standards

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Background

On August 11, 2021, the California Energy Commission (CEC) adopted the *2022 Building Energy Efficiency Standards* (2022 Energy Code), which include new solar photovoltaic (PV) requirements for all newly constructed single-family and low-rise multifamily buildings in section 150.1(c)14 and section 170.2(f) respectively. Low-rise multifamily buildings are multifamily buildings that have three habitable stories or fewer. These requirements, along with the rest of the 2022 Energy Code, go into effect on January 1, 2023.

As part of the adoption, section 10-109(k) states, "The Commission may, upon written application or its own motion, determine that the photovoltaic or battery storage requirements in Section 150.1(a)3, Section 140.0(c), Section 170.0(a)3 shall not apply, if the Commission finds that the implementation of public agency rules regarding utility system costs and revenue requirements, compensation for customer-owned generation, interconnection fees, or other factors, causes the Commission's cost-effectiveness conclusions, made pursuant to Public Resources Code 25402(b)(3), to not hold for particular buildings."

The regulations require that an applicant must provide information regarding the differences between public agency rules and the CEC's cost-effectiveness determinations, including any information requested by the CEC to enable a full review of the application. Applications from public agencies must be submitted to the CEC only after public review within the jurisdiction of the agency or service area of the utility. The regulations do not require applicants to submit a cost-effectiveness analysis.

After receiving an application and determining that it is complete, the executive director must make the application package available to interested parties and provide a 60-day public comment period. The executive director may request additional information to evaluate the application. The executive director must make a recommendation on the application and place the application package, any additional information considered, and the recommendation on the business meeting calendar for the full Commission to consider.

Trinity Public Utility District (PUD) submitted an application to the CEC on June 10, 2022, for a determination, as specified under section 10-109(k), of whether the solar PV system requirements should apply to newly constructed single-family and low-rise multifamily residential buildings, in its service area.

Trinity PUD applied for the same CEC determination under the 2019 Energy Code, for which the CEC determined that Trinity's rules regarding residential rates and net energy metering (NEM) compensation and participation charge for customer-owned generation cause the CEC's cost-effectiveness conclusion for low-rise residential solar PV systems

not to hold. Therefore, the CEC approved Trinity's application under the 2019 Energy Code.

The current regulations apply only to the buildings that are subject to the 2022 Energy Code solar PV requirements. Thus, CEC staff's analysis of Trinity's new application relates to the 2022 Energy Code's requirements.

Recommendation

CEC staff reviewed the Trinity PUD application and performed a life-cycle cost-effectiveness analysis to determine if Trinity's public agency rules would cause solar PV not to be cost-effective in its service area. Staff found that applying Trinity's residential rates and NEM rules for the analysis resulted in solar PV not being cost-effective. The results showed that the cost savings generated from having solar PV were less than the solar PV system cost, resulting in a benefit-to-cost ratio of less than 1.0.

Based on the analysis presented, staff recommends that the CEC determine that Trinity PUD's rules regarding residential rates and NEM compensation and participation charge for customer-owned generation cause the CEC's cost-effectiveness conclusion for solar PV systems not to hold for single-family and low-rise multifamily residential buildings in Trinity's service area.

CHAPTER 1:
Trinity Public Utility District

Summary of Trinity Public Utility District Application

Trinity PUD serves most of Trinity County, covering 2,100 square miles of mountain terrain and serving about 7,200 customers. It distributes and sells 100 percent hydroelectric power to its customers.

Trinity PUD divides its residential service area into two geographic zones, Geographic Zone A and Geographic Zone B, which historically have had different rates. The difference in rates between the two zones is based on which part of the Trinity PUD distribution system served each zone at the time distribution assets were acquired from investor-owned utilities. All debts associated with the purchase of the older parts of the distribution system have been paid (Geographic Zone A). The other parts of the distribution system were acquired through a bond purchase in 1993, and those bonds will be paid in March 2023 (Geographic Zone B).

As part of its application, Trinity PUD submitted its Residential Service A Rate Schedule, which includes its adopted rates for 2022-2025. In 2022, Geographic Zone A customers pay an energy rate of $0.05764, and Geographic Zone B customers pay an energy rate of $0.07472. The residential rates for Geographic Zone A will be $0.059 for 2023, $0.062 for 2024, and $0.064 for 2025; and for Geographic Zone B will be $0.071 for 2023, $0.067 for 2024, and $0.064 for 2025. These rates are considerably lower than the energy costs used by the CEC when determining the cost-effectiveness of solar PV requirements.

Under Trinity PUD NEM rules, Trinity PUD compensates customers at the full retail rate for any customer-owned generation. In addition, Trinity PUD NEM rules require customers with solar PV to pay an administrative charge of $10 per month.

The Trinity PUD application states that the 2022 Energy Code residential solar PV requirements are not cost-effective when the Trinity PUD rates are used.

Trinity PUD's application includes:

- Trinity PUD's Request for a Residential Solar PV Determination https://efiling.energy.ca.gov/GetDocument.aspx?tn=245880&DocumentContentId=80054

- Trinity PUD's residential rates specified in "Residential Service A Rate Schedule" https://efiling.energy.ca.gov/GetDocument.aspx?tn=245881&DocumentContentId=80055

Trinity PUD's request included an attachment of the minutes of the Trinity PUD Board public meeting that Trinity PUD conducted on June 9, 2022, where the Board approved

the decision to seek a determination from the CEC under Title 24, Part 1, section 10-109(k).

Staff also considered:

- Trinity PUD's NEM rules specified in "Renewable Electric Generating Facility Net Metering and Solar Power Incentive."https://www.trinitypud.com/secure/pdf/rates/Rate%20Schedule%2017%20Renewable%20Electric%20Generating%20Facility%20Net%20Metering%20and%20Solar%20Power%20Incentive%20021215.pdf

CHAPTER 2:
Staff Analysis

Staff Analysis of Trinity PUD Application

Development of the new solar PV requirement for newly constructed low-rise buildings for the 2019 Energy Code relied largely on two main sources to develop technical information and determine cost-effectiveness:

- *2019 Time Dependent Valuation Methodology Report*[1]
- *2019 Measure Proposal Rooftop Solar PV Systems*[2]

These reports describe the CEC's life-cycle cost method used to evaluate proposed changes to the 2019 Energy Code and, specifically, the energy cost-savings method used for determining the cost-effectiveness of the solar PV requirement. CEC staff used the same life-cycle cost approach to determine the cost-effectiveness of solar PV systems subject to the public agency rules adopted by Trinity PUD to establish residential rates and NEM solar PV compensation and participation charge.

Staff developed a spreadsheet to perform calculations for the Trinity PUD application.

Life-Cycle Cost-Effectiveness Determination

Staff evaluated whether the implementation of the Trinity PUD rules would cause the cost-effectiveness of the solar PV not to hold. The CEC used Trinity PUD's residential rates, NEM compensation and participation charge rules, California Building Energy Code Compliance software (CBECC-Res 2019) runs, and the inputs described below to evaluate cost-effectiveness.

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1 California Energy Commission. February 2017. *Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2019 Time Dependent Valuation (TDV) Data Sources and Inputs.* https://efiling.energy.ca.gov/getdocument.aspx?tn=216062.

2 California Energy Commission. September 2017. *Building Energy Efficiency Measure Proposal to the California Energy Commission for the 2019 Update to the Title 24 Part 6 Building Energy Efficiency Standards Rooftop Solar PV System.* file:///C:/Users/benni/Downloads/TN221797_20171116T132400_Rooftop_Solar_PV_Stystem_Report_11162017.pdf

A measure is cost-effective if the benefit-to-cost ratio is greater than 1.0. The ratio is calculated by dividing the total present value of the life-cycle cost benefits by the present value of the total incremental costs. Specific to the solar PV measure, this ratio would be the present value of the energy cost savings divided by the present value of the PV system costs.

Equation 1: Benefit-to-Cost Ratio

$$\text{Benefit-to-Cost Ratio} = \frac{\text{Present Value of Cost Savings}}{\text{Present Value of PV System Costs}}$$

Calculating PV Size and Annual Production

The 2022 Energy Code requires a solar PV system that generates the electrical output (kW_{PV}) calculated based on equation section 150.1(c)14 for single-family and section 170.2(f) for low-rise residential buildings. The solar PV size and the annual generation are calculated using CBECC-Res 2022. CBECC-Res 2022 is an open-source software program that demonstrates compliance with the low-rise residential 2022 Energy Code when using the performance approach. The National Renewable Energy Laboratory (NREL) algorithms underlying the PV Watts program are installed in CBECC-Res for PV system analysis. CBECC-Res establishes energy budget requirements, and corresponding PV system size requirements.

To determine the PV size for the life-cycle cost calculation, a weighted average from CBECC-Res runs for the CEC's two low-rise, residential, single-family prototype homes is used. These homes met all standard design requirements, including:

Energy efficiency

- High-performance attic (certain climates): R19 below deck
- High-performance walls (certain climates): 0.048 U-factor wall
- Quality insulation inspection (QII)
- High-performance windows: U-factor 0.35, SHGC 0.3 for cooling climates and 0.50 for mild climates
- Doors: U-factor 0.20
- 2016 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 62.2 ventilation rates
- Heating, ventilation, and air-conditioning (HVAC) fan efficacy: 0.40 watts per cubic feet per minute (W/cfm)
- Federal appliance standard efficiency for furnaces, air conditioners, and water heaters

Solar PV system

- 170° south-facing orientation
- 5/12 pitch roof

- 96 percent inverter efficiency
- Standard module type
- No shading

Climate Zone

Trinity PUD is almost entirely in Climate Zone 16. A small, remote area of Trinity PUD's service area could be in Climate Zone 2, but Trinity PUD service lines do not extend there at this time. For that reason, CEC staff's analysis is limited to Climate Zone 16.

CEC staff concluded, based on CBECC-Res 2019 runs for the two prototype houses used for 2019 Energy Code analysis, that an average PV size of 2.796 kilowatts (kW) is required in Climate Zone 16. This system produces 4,733 kilowatt-hours (kWh) per year.

Table 1: Weighted Average PV Size and Production for Prototype Homes (CBECC)

	2,100 Square Foot Prototype (45%)	2,700 Square Foot Prototype (55%)	Weighted Average
PV Size	2.51	3.03	**2.796**
Annual Production	4,252	5,127	**4,733**

Source: CEC staff

The CBECC-Res 2022 run reports for the 2,100- and 2,700-square-foot prototype houses are in Appendix B.

Inputs Used for Life-Cycle Cost-Effectiveness Calculation

Inputs for the following parameters in the life-cycle cost calculation were consistent with those used to determine the cost-effectiveness of the solar PV system measure proposal during the 2019 Energy Code development in 2016 except where noted. The inputs for these parameters are unchanged by Trinity PUD's public agency rules for residential rates and NEM PV compensation and participation charge.

PV Cost per Watt

The PV cost-per-watt input of $3.08 per watt was obtained from the *Measure Proposal Rooftop Solar PV Systems*[3] report. In 2016, the incremental first cost was determined to be $2.93 per watt (W) according to NREL estimate of the first quarter 2016 cost of a

3 Ibid.

5.6 kW residential solar PV system installed in California. This cost includes the PV module, inverter, structural balance of system, electrical balance of system, supply chain costs, sales tax, installation labor, permitting, inspection, interconnection, customer acquisition, general and administrative overhead, and net profit to the installer.

Applying inflation rates and NREL cost reduction forecast assumptions, the incremental cost was estimated to be $2.63/W in 2020 dollars. A lifetime incremental maintenance cost was then added to account for periodic equipment maintenance and two inverter replacements over 30 years. This addition resulted in the solar PV system cost of $3.08 per watt in 2020 dollars. Complete information regarding PV cost per watt can be found in Chapter 5 of the *Measure Proposal Rooftop Solar PV Systems*[4] report.

For the analysis for Trinity PUD's application, staff updated the value for the solar PV system cost by 1) applying the 30% federal Solar Investment Tax Credit (ITC) in the Inflation Reduction Act passed by the U.S. Congress in 2022 and 2) adjusting for inflation from 2020 dollars[5]. The resulting cost is $2.42 per watt in 2023 dollars.

Energy Escalation

Staff obtained the energy escalation input of 2.7 percent from the *2019 TDV Methodology Report.*[6] The report references the *2015 Integrated Energy Policy Report (IEPR)*, which calculates average residential rates for Pacific Gas and Electric Company, Southern California Edison, San Diego Gas & Electric, Los Angeles Department of Water and Power, and Sacramento Municipal Utility District through 2026. All cost-effectiveness analyses completed for the 2019 low-rise residential energy code requirements used a compound average growth rate of 2.7 percent per year nominal increase for forecasting residential rates. Staff has used the same percentage for the 2022 low-rise residential energy code.

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4 Ibid.

5 Office of Energy Efficiency & Renewable Energy. September 2022. Homeowner's Guide to the Federal Tax Credit for Solar Photovoltaics | Department of Energy. https://www.energy.gov/eere/solar/homeowners-guide-federal-tax-credit-solar-photovoltaics.

6 California Energy Commission. February 2017. 2019 TDV Methodology Report. https://www.bing.com/search?q=2019+TDV+Methodology+Report&cvid=45a2be216f5f4cfbbad58dc3e8de45a4&aqs=edge..69i57j0l2j69i11004.883j0j1&pglt=41&FORM=ANNAB1&PC=U531.

It is possible that the residential rates for Trinity PUD will escalate at a lower or higher rate than 2.7 percent. Staff reviewed the Trinity PUD newly published Residential Service A Rate Schedule and noted that Trinity PUD rates escalate from 2022 to 2025 at the rate of 3.9 percent. Staff did not increase the escalation rate beyond the escalation rate used for the 2019 PV requirement cost-effectiveness analysis. Also, using the 3.9 percent as the escalation rate would not change the cost-effectiveness conclusions.

Discount Rate

The real discount rate input of 3 percent was obtained from the *2019 TDV Methodology Report.*[7] All cost-effectiveness analyses completed for residential Energy Code requirements used a 3 percent real (inflation-adjusted) discount rate to calculate the net present value. It is a long-standing practice for the cost-effectiveness analysis of energy code requirements to use a 3 percent real discount rate.

Life-Cycle Period of Analysis

The life-cycle period of analysis of 30 years was obtained from the *2019 TDV Methodology Report.*[8] All cost-effectiveness analyses completed for 2019 low-rise residential California Energy Code requirements used a life-cycle period of analysis of 30 years (2023–2052). Staff kept the same cost-effectiveness requirements for the 2022 Energy Code. It is long-standing practice for the cost-effectiveness of low-rise residential energy code requirements to use a life-cycle period of analysis of 30 years.

Present Value of Cost Savings

The first-year energy cost savings were determined by the annual generation calculated from CBECC-Res 2022, the Trinity PUD's Residential Service A Rate Schedule, and the Trinity PUD's Renewable Electric Generating Facility Net Metering and Solar Power Incentive rules.

The solar PV generation calculated from CBECC-Res 2022 for the homes in the Trinity PUD service area (Climate Zone 16) was 4,733 kWh. Multiplied by the residential rates of $0.059 for 2023, $0.062 for 2024, and $0.064 for 2025 for Geographic Zone A resulted in first-year energy cost savings of $283.21 for 2023, $293.59 for 2024, and $303.97 for year 2025 for Geographic Zone A. Multiplied by the residential rates of $0.071 for 2023, $0.067 for 2024, and $0.064 for 2025 for Geographic Zone B resulted

7 Ibid.

8 Ibid.

in first-year energy cost savings of $337.10 for 2023, $320.54 for 2024, and $303.97 for 2025 for Geographic Zone B.

Staff calculated the present value of the cost savings by using an equivalent method to the standard financial equation for calculating present value of a growing annuity, as shown below. This equation calculates the present value of total future cost savings based on the annual cost savings, the discount rate, the growth (escalation) rate, and the number of periods compounded.

Equation 2: Present Value

$$\text{Present Value} = \frac{P}{r-g} \times \left[1 - \left(\frac{1+g}{1+r}\right)^{n}\right]$$

P = annual cost savings
r = discount rate = 3%
g = growth (escalation) rate per period of = 2.7%
n = number of periods of analysis period = 30 years

CEC staff used the net present value function (NPV) in Microsoft Excel® to perform the calculation for each geographic zone.

For Geographic Zone A, the first-year energy cost savings of $303.97 for 2025 was escalated over the remainder of the 30-year period. The NEM charge of $120/year ($10/month) was subtracted each year from the energy cost savings to determine a net annual energy cost savings. Staff calculated the NPV of the annual energy cost savings for the 30-year period, resulting in a present value of energy cost savings of $5,689.88.

For Geographic Zone B, the first-year energy cost savings of $303.97 for 2025 escalated over the remainder of the 30-year period. The NEM charge of $120 ($10/month) was subtracted annually from the energy cost savings to determine a net annual energy cost savings. Staff calculated the NPV of the annual energy cost savings for the 30-year period, resulting in a present value of energy cost savings of $5,767.60.

Calculations are shown following in Table 2 and Table 3 in the "Life-Cycle Cost-Effectiveness Results" section below.

Present Value of PV System Cost

The present value of PV system cost is determined by the PV size as calculated by CBECC-Res 2022 and PV cost per watt as described earlier. The solar PV production estimated by CBECC-Res 2022 for the prototype home in the Trinity PUD service area was 2.796 kW annually. Multiplied by the PV cost per watt of $2.42 resulted in a PV system cost of $6,766.32.

Life-Cycle Cost-Effectiveness Results

CEC staff developed a spreadsheet including all equations and assumptions discussed in the previous sections. Applying Trinity PUD's residential rates and NEM rules for Geographic Zone A and Geographic Zone B into the spreadsheet resulted in both cases not being cost-effective.

As shown in Figures 2 and 3, the benefit-to-cost ratios for Geographic Zone A and Geographic Zone B were 0.84 and 0.85, respectively, both lower than the benefit-to-cost threshold of 1.0. The analysis determines that the Geographic Zone A customer who installs solar PV loses $1,076.44 over the life cycle, while the Geographic Zone B customer loses $998.72.

Table 2: Results for Geographic Zone A

Inputs	
Climate Zone	16
Retail Energy Rate ($/kWh) (Year 2023)	$0.05984
Compensation for Generation ($/kWh) (Year 2023)	$0.05984
Retail Energy Rate ($/kWh) (Year 2024)	$0.06203
Compensation for Generation ($/kWh) (Year 2024)	$0.06203
Retail Energy Rate ($/kWh) (Year 2025)	$0.06422
Compensation for Generation ($/kWh) (Year 2025)	$0.06422
Monthly NEM Participation Charge	$10.00
PV Size (kW)	2.796
Annual Production (avoided kWh)*	4,733

Assumptions	
PV Cost per Watt ($/W)	2.42
Energy Escalation Rate	2.70%
Discount Rate, Real	3.00%
Life Cycle Period (years)	30

Results	
Present Value of PV System Cost	$6,766.32
First Year Energy Cost Savings (Year 2023)	$283.21
First Year Energy Cost Savings (Year 2024)	$293.59
First Year Energy Cost Savings (Year 2025)	$303.97
Present Value of Cost Savings	$5,689.88
Net Savings	$(1,076.44)
Benefit-to-Cost Ratio	0.84

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PV Savings	$283.21	$293.59	$303.97	$312.18	$320.61	$329.26	$338.15	$347.28	$356.66	$366.29	$376.18	$386.33	$396.77	$407.48	$418.48
NEM Charge	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00
Cost Savings	$163.21	$173.59	$183.97	$192.18	$200.61	$209.26	$218.15	$227.28	$236.66	$246.29	$256.18	$266.33	$276.77	$287.48	$298.48

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PV Savings	$429.78	$441.38	$453.30	$465.54	$478.11	$491.02	$504.28	$517.89	$531.87	$546.23	$560.98	$576.13	$591.69	$607.66	$624.07
NEM Charge	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00
Cost Savings	$309.78	$321.38	$333.30	$345.54	$358.11	$371.02	$384.28	$397.89	$411.87	$426.23	$440.98	$456.13	$471.69	$487.66	$504.07

Present Value of Cost Savings: $5,689.88

Source: CEC staff

Table 3: Results for Geographic Zone B

Inputs	
Climate Zone	16
Retail Energy Rate ($/kWh) (Year 2023)	$0.07122
Compensation for Generation ($/kWh) (Year 2023)	$0.05984
Retail Energy Rate ($/kWh) (Year 2024)	$0.06772
Compensation for Generation ($/kWh) (Year 2024)	$0.06203
Retail Energy Rate ($/kWh) (Year 2025)	$0.06422
Compensation for Generation ($/kWh) (Year 2025)	$0.06422
Monthly NEM Participation Charge	$10.00
PV Size (kW)	2.796
Annual Production (avoided kWh)	4,733

Assumptions	
PV Cost per Watt ($/W)	2.42
Energy Escalation Rate	2.70%
Discount Rate, Real	3.00%
Life Cycle Period (years)	30

Results	
Present Value of PV System Cost	$6,766.32
First Year Energy Cost Savings (Year 2023)	$337.10
First Year Energy Cost Savings (Year 2024)	$320.54
First Year Energy Cost Savings (Year 2025)	$303.97
Present Value of Cost Savings	$5,767.60
Net Savings	$(998.72)
Benefit-to-Cost Ratio	0.85

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PV Savings	$337.10	$320.54	$303.97	$312.18	$320.61	$329.26	$338.15	$347.28	$356.66	$366.29	$376.18	$386.33	$396.77	$407.48	$418.48
NEM Charge	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00
Cost Savings	$217.10	$200.54	$183.97	$192.18	$200.61	$209.26	$218.15	$227.28	$236.66	$246.29	$256.18	$266.33	$276.77	$287.48	$298.48

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PV Savings	$429.78	$441.38	$453.30	$465.54	$478.11	$491.02	$504.28	$517.89	$531.87	$546.23	$560.98	$576.13	$591.69	$607.66	$624.07
NEM Charge	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00
Cost Savings	$309.78	$321.38	$333.30	$345.54	$358.11	$371.02	$384.28	$397.89	$411.87	$426.23	$440.98	$456.13	$471.69	$487.66	$504.07

Present Value of Cost Savings: $$5,767.60

Source: CEC staff

CHAPTER 3:
Conclusion

Staff Recommendation

Based on CEC staff's analysis, staff recommends that the CEC determine that the public agency rules of the Trinity PUD regarding residential rates and NEM compensation and participation charge for customer-owned generation cause the CEC's cost-effectiveness conclusion for solar PV systems not to hold. This recommendation applies to newly constructed, single-family and low-rise multifamily buildings in the Trinity PUD service area subject to the 2022 Energy Code.

GLOSSARY

American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) is a professional association seeking to advance heating, ventilation, air conditioning, and refrigeration systems design and construction.

California Energy Commission (CEC) is the state agency leading the state of California to a 100 percent clean energy future for all. As the state's primary energy policy and planning agency, the Energy Commission is committed to reducing energy costs and environmental impacts of energy use while ensuring a safe, resilient, and reliable supply of energy.

CBECC (California Building Energy Code Compliance) is an open-source compliance software that may be used by code agencies, rating authorities, or utility programs in the development of energy codes, standards, or efficiency programs. Architects, engineers, and energy consultants may also use CBECC to demonstrate compliance with energy codes or beyond-code programs.

Climate zones are the 16 geographic areas of California for which the CEC has established typical weather data, prescriptive packages, and energy budgets.

Energy Code, also referred to as the California's Building Energy Efficiency Standards, used to reduce wasteful and unnecessary energy consumption in newly constructed buildings, additions and alterations. The Energy Code is updated every three years. Buildings whose permit applications are applied for on or after January 1, 2023, must comply with the 2022 version of the Energy Code.

Heating, ventilation, and air conditioning (HVAC) is the use of various technologies to control the temperature, humidity, and purity of the air in an enclosed space.

Integrated Energy Policy Report (IEPR) is the state's comprehensive energy policy report prepared by the California Energy Commission. It provides a cohesive approach to identifying and addressing the state's pressing energy needs and issues. The report, which is crafted in collaboration with a large number of stakeholders, develops and implements energy plans and policies.

National Renewable Energy Laboratory (NREL) is a government-owned facility funded through the United States Department of Energy with areas of research and development in renewable electricity, energy productivity, energy storage, systems integration, and sustainable transportation.

Net Energy Metering (NEM) is a billing mechanism that compares the amount of electricity generated by customer-owned solar energy systems to the amount of

electricity that the customer consumes and provides compensation for the amount that is consumed and the amount that is generated in excess of the consumption following rules established for the utility.

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of analysis. NPV is used to calculate the current value of a future stream of payments resulting from an investment.

Performance approach is an approach to show compliance with the California Building Energy Efficiency Standards by using an approved software program to model a proposed building and compare it to a calculated energy budget.

Photovoltaic (PV) systems are composed of one or more solar-electric panels combined with an inverter and other electrical and mechanical hardware that use energy from the sun to generate electricity.

PV Watts is a calculator developed by NREL that estimates the energy production and cost of solar photovoltaic systems.

Solar heat gain coefficient (SHGC) is the fraction of solar radiation admitted through a window, door, or skylight (fenestration) resulting in solar heat gain. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Trinity Public Utility District (PUD) is a public agency responsible for providing electrical power to a large part of the Trinity County, CA.

U-factor is the overall coefficient of thermal transmittance of a fenestration, wall, floor, or roof/ceiling component, in Btu/(hr x ft^2 x ^oF), including air film resistance at both surfaces.

APPENDIX A:
Resources

Trinity Public Utility District Solar PV Determination Application documents and other information submitted to the California Energy Commission Docket https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=22-BSTD-04.

2017 Time Dependent Valuation (TDV) and Source Energy Metric Data Sources and Inputs. https://efiling.energy.ca.gov/getdocument.aspx?tn=216062.

2017 Building Energy Efficiency Measure Proposal to the California Energy Commission for the 2019 Update to the Title 24 Part 6 Building Energy Efficiency Standards Rooftop Solar PV System.
file:///C:/Users/benni/Downloads/TN221797_20171116T132400_Rooftop_Solar_PV_Stystem_Report_11162017.pdf

2022 Building Energy Efficiency Standards
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency.

Frequently Asked Questions on the 2019 Solar PV Requirements
https://www.energy.ca.gov/sites/default/files/2020-06/Title24_2019_Standards_detailed_faq_ada.pdf

APPENDIX B:
CBECC-Res Run Reports

Figure B-1: CBECC-Res PV Size and Generation for 2,100 SF Prototype

2022_CZ16_2100ft2_Std_HP - TDSv30 2100CZ16 W14 R16 EGLASS20 HPWH PVSTD GDG6

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

EDR1 of Standard Design: 57.8 | EDR2 of Standard Efficiency: 73.5 | EDR2 of Standard Design PV: 16.0 | Total Std Design EDR2: 50.6

Std Design PV: 2.51 kW

EDR1 of Proposed Design: **57.8** | EDR2 of Proposed Efficiency: 73.5 | EDR2 of Prop PV + Flexibility: 16.0 | Total Proposed EDR2: **50.6**

	Reference Design:				Proposed Design:				Design Rating Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	507	423.2	18.23	82.88	228	337.9	14.23	63.31	4.00	19.57
Space Cooling	348		0.41	4.60	99		0.16	1.54	0.25	3.06
IAQ Ventilation	278		0.34	3.64	278		0.34	3.64	0.00	0.00
Water Heating		185.4	7.62	31.35	1,402		1.76	21.56	5.86	9.79
Self Util/Flexibility Credit								0.00		0.00
Photovoltaics					-4,250 *		-1.21	-35.46	1.21	35.46
Battery							0.00	0.00	0.00	0.00
Flexibility										0.00
Inside Lighting	2,135		3.03	33.16	506		0.75	8.09	2.28	25.07
Appl. & Cooking	930	65.4	3.83	23.33	909	43.2	2.80	18.95	1.03	4.38
Plug Loads	2,638		3.40	36.60	2,026		2.61	28.09	0.79	8.51
Exterior	298		0.53	5.03	120		0.19	1.82	0.34	3.21
TOTAL	7,133	674.0	37.39	220.59	1,317	381.0	21.63	111.54	15.76	109.05

* PV System resized to 2.51 kWdc (a factor of 2.510) to achieve 'Standard Design PV' PV scaling

Done

2022_CZ16_2100ft2_Std_HP - TDSv30 2100CZ16 W14 R16 EGLASS20 HPWH PVSTD GDG6

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Standard Design:				Proposed Design:				Compliance Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	228	337.9	14.23	63.31	228	337.9	14.23	63.31	0.00	0.00
Space Cooling	99		0.16	1.54	99		0.16	1.54	0.00	0.00
IAQ Ventilation	278		0.34	3.64	278		0.34	3.64	0.00	0.00
Water Heating	1,402		1.76	21.56	1,402		1.76	21.56	0.00	0.00
Self Util/Flexibility Credit								0.00		0.00
Compliance Total			16.49	90.05			16.49	90.05	0.00	0.00
Photovoltaics	-4,250		-1.21	-35.46	-4,250 *		-1.21	-35.46		- %
Battery							0.00	0.00		
Flexibility										
Inside Lighting	506		0.75	8.09	506		0.75	8.09		
Appl. & Cooking	909	43.2	2.80	18.95	909	43.2	2.80	18.95		
Plug Loads	2,026		2.61	28.09	2,026		2.61	28.09		
Exterior	120		0.19	1.82	120		0.19	1.82		
TOTAL	1,317	381.0	21.63	111.54	1,317	381.0	21.63	111.54		

Total PV (kWh): 4,252 Total Export (kWh): 2,428 % Export: 57.1

* PV System resized to 2.51 kWdc (a factor of 2.510) to achieve 'Standard Design PV' PV scaling

Done

Source: CEC staff

Figure B-2: CBECC-Res PV Size and Generation for 2,700 SF Prototype

2022_CZ16_2700ft2_Std_HP - TDSv30 2700CZ16 W15 R16 EGLASS20 HPWH PVSTD GDG6

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

EDR1 of Standard Design: 53.6 | EDR2 of Standard Efficiency: 66.2 | EDR2 of Standard Design PV: 15.8 | Total Std Design EDR2: 46.2

Std Design PV: 3.03 kW

EDR1 of Proposed Design: **53.6** | EDR2 of Proposed Efficiency: 66.2 | EDR2 of Prop PV + Flexibility: 15.8 | Total Proposed EDR2: **46.2**

	Reference Design:				Proposed Design:				Design Rating Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	647	540.0	18.09	82.41	255	377.4	12.37	55.09	5.72	27.32
Space Cooling	747		0.61	7.37	281		0.33	3.25	0.28	4.12
IAQ Ventilation	346		0.32	3.53	346		0.32	3.53	0.00	0.00
Water Heating		201.6	6.45	26.45	1,511		1.43	17.36	5.02	9.09
Self Util/Flexibility Credit								0.00		0.00
Photovoltaics					-5,125 *		-1.14	-33.22	1.14	33.22
Battery							0.00	0.00	0.00	0.00
Flexibility										0.00
Inside Lighting	2,615		2.89	31.59	616		0.71	7.66	2.18	23.93
Appl. & Cooking	989	73.4	3.30	19.81	1,009	46.9	2.39	16.41	0.91	3.40
Plug Loads	3,267		3.28	35.26	2,371		2.37	25.56	0.91	9.70
Exterior	328		0.46	4.30	152		0.18	1.79	0.28	2.51
TOTAL	8,938	815.0	35.40	210.72	1,416	424.3	18.96	97.43	16.44	113.29

* PV System resized to 3.03 kWdc (a factor of 3.026) to achieve 'Standard Design PV' PV scaling

Done

2022_CZ16_2700ft2_Std_HP - TDSv30 2700CZ16 W15 R16 EGLASS20 HPWH PVSTD GDG6

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Standard Design:				Proposed Design:				Compliance Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	255	377.4	12.37	55.09	255	377.4	12.37	55.09	0.00	0.00
Space Cooling	281		0.33	3.25	281		0.33	3.25	0.00	0.00
IAQ Ventilation	346		0.32	3.53	346		0.32	3.53	0.00	0.00
Water Heating	1,511		1.43	17.36	1,511		1.43	17.36	0.00	0.00
Self Util/Flexibility Credit								0.00		0.00
Compliance Total			14.45	79.23			14.45	79.23	0.00	0.00
Photovoltaics	-5,125		-1.14	-33.22	-5,125 *		-1.14	-33.22		- %
Battery							0.00	0.00		
Flexibility										
Inside Lighting	616		0.71	7.66	616		0.71	7.66		
Appl. & Cooking	1,009	46.9	2.39	16.41	1,009	46.9	2.39	16.41		
Plug Loads	2,371		2.37	25.56	2,371		2.37	25.56		
Exterior	152		0.18	1.79	152		0.18	1.79		
TOTAL	1,416	424.3	18.96	97.43	1,416	424.3	18.96	97.43		

Total PV (kWh): 5,127 Total Export (kWh): 2,955 % Export: 57.6

* PV System resized to 3.03 kWdc (a factor of 3.026) to achieve 'Standard Design PV' PV scaling

Done