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Project Title:	2022 Energy Code Photovoltaic and Battery Storage Cost Effectiveness Determinations
TN #:	254575
Document Title:	Staff Review and Analysis of Benjamin Apartments Project Application for a Solar Photovoltaic Cost-Effectiveness Determination
Description:	On June 7, 2023, C Note Limited Partnership (C Note LP), property developer, submitted an application to the CEC requesting a determination regarding whether the solar photovoltaic (PV) system requirements should apply to the Benjamin Project, a 108-unit low-rise multifamily project located within the City of Lodi permitted under the 2019 Energy Code. Staff has performed a cost-effectiveness analysis based on 1) the public agency rules adopted by the City of Lodi, and 2) PV system costs estimated in bids from electrical and solar contractors to install the PV system designs that C Note LP developed to comply with City of Lodi PV and electrical system regulations. Based on that information, staff finds that the solar photovoltaic system requirements are not cost-effective for the newly constructed 108-unit low-rise multifamily of Benjamin Project within the City of Lodi. Staff recommends that the CEC determine that the 2019 Energy Code solar photovoltaic system requirements do not apply to this project.
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CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

STAFF REPORT

Staff Review and Analysis of Benjamin Apartments Project Application for a Solar Photovoltaic Cost-Effectiveness Determination

January 2024 | CEC-400-2024-002

California Energy Commission

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ABSTRACT

California's *2019 Building Energy Efficiency Standards* (Energy Code) went into effect January 1, 2020. The 2019 Energy Code requires the installation of solar photovoltaic systems in newly constructed low-rise multifamily buildings. In conjunction with those requirements, Section 10-109(k) of the 2019 Energy Code states, "The Commission may … determine that the photovoltaic requirements … 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, or interconnection fees, causes the California Energy Commission's (CEC's) cost-effectiveness conclusions, made pursuant to Public Resources Code 25402(b)(3), to not hold for particular buildings."

On June 7, 2023, C Note Limited Partnership (C Note LP), property developer, submitted an application to the CEC requesting a determination regarding whether the solar photovoltaic (PV) system requirements should apply to the Benjamin Project, a 108-unit low-rise multifamily project located within the City of Lodi (San Joaquin County) permitted under the 2019 Energy Code. Staff has performed a cost-effectiveness analysis based on 1) the public agency rules adopted by the City of Lodi, and 2) PV system costs estimated in bids from electrical and solar contractors to install the PV system designs that C Note LP developed to comply with City of Lodi PV and electrical system regulations. Based on that information, staff finds that the solar photovoltaic system requirements are not cost-effective for the newly constructed 108-unit low-rise multifamily of Benjamin Project within the City of Lodi. Staff recommends that the CEC determine that the 2019 Energy Code solar photovoltaic system requirements do not apply to the newly constructed low-rise multifamily buildings of the Benjamin Project.

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

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EXECUTIVE SUMMARY

Background

On May 9, 2018, the California Energy Commission (CEC) adopted the *2019 Building Energy Efficiency Standards* (2019 Energy Code), which include new solar photovoltaic (PV) system requirements for all newly constructed low-rise residential, including multifamily buildings. These requirements, along with the rest of the 2019 Energy Code, went into effect January 1, 2020.

The regulations also establish the opportunity, in Section 10-109(k), to submit an application for the CEC to determine if public agency rules cause the CEC's cost effectiveness conclusions to not hold for particular buildings. The regulations require that an applicant provide information regarding the differences between the public agency rules and the cost-effectiveness determinations that the CEC made in adopting the photovoltaic (PV) requirements, including supplementary information requested by the CEC to enable a full review of the application.

After receiving an application and determining that it is complete, the executive director must make the application package available to interested parties and provide no more than 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 CEC to consider.

The documents that C Note Limited Partnership, property developer, submitted with their application for the Benjamin Project are listed in Table 1. On June 7, 2022, the C Note LP application was docketed to the California Energy Commission (CEC). The Notice of the application was docketed on June 22, 2023, and the comments were due on July 10, 2023. Comments were received from the California Solar and Storage Association. C Note LP subsequently responded to those comments. C Note LP also responded to questions from staff about project costs.

The C Note LP application stated and provided documentation that the City of Lodi does not allow virtual net energy metering, and as a result, construction costs and interconnection fees for the Benjamin Project are substantially higher than they would be otherwise, causing the currently proposed PV system to not be cost-effective. Staff has performed a cost-effectiveness analysis based on the public agency rules adopted by the City of Lodi, and PV system costs estimated in bids from electrical and solar contractors to install the PV system designs that C Note LP developed to comply with City of Lodi PV and electrical system regulations. Staff finds that the PV system required for the specified project's buildings, high installation costs resulting from the inability to use virtual net energy metering and unique electrical system requirements, lower compensation for generation exports under Lodi Energy Utility's tariffs, and high bids from contractors cause the CEC's cost-effectiveness findings for solar PV systems under Section 150.1(c)14 to not hold for the Benjamin Project. Staff recommends that the CEC determine that the 2019 Energy Code solar photovoltaic system requirements are not applicable to the Benjamin Project newly constructed low-rise multifamily buildings.

CHAPTER 1: Background

2019 Energy Code Photovoltaic Requirements

Photovoltaic (PV) system requirements were first adopted in the 2019 Title 24, Part 6 Building Standards for low-rise residential buildings.[1] The Benjamin Project was permitted under the 2019 Energy Code, thus the regulations under the 2019 Energy Code apply. Section 150.1(c)14 of 2019 Title 24, Part 6 prescribes the minimum PV system size (kilowatt [kW]) based on the conditioned floor area and the number of dwelling units in a multifamily building. A cost-effectiveness analysis was performed[2] to establish the required PV size for low-rise residential buildings.

Article 1, Section 10 of Title 24, Part 1 contains the administrative regulations related to energy regulations under Title 24, Part 6. Section 10-109(k), under Article 1, specifies the administrative regulations for the PV requirement under Section 150.1(c)14. It states that the California Energy Commission (CEC) "may, upon written application or its own motion, determine that the photovoltaic requirements in Section 150.1(c)14 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, or interconnection fees, causes the Commission's cost-effectiveness conclusions, made pursuant to Public Resources Code 25402(b)(3), to not hold for particular buildings."

The procedure to apply for a determination is also specified: "Applications shall include full information regarding the differences between public agency rules and Energy Commission cost-effectiveness determinations, including all information requested by the Commission to enable full review of the application. Applications shall also include specific recommended limitations to the scope of the determination that is requested, and specific eligibility criteria to determine what buildings would qualify for the determination." (Section 10-109(k).)

Benjamin Apartments Project Application

On June 7, 2023, C Note Limited Partnership (C Note LP) submitted an application to the CEC requesting a determination, as specified under Section 10-109(k), of whether the solar PV system requirements should apply to the Benjamin Project, a 108-unit low-rise multifamily project located within the City of Lodi (San Joaquin County). This staff report describes the analysis performed to determine whether the PV requirements in the 2019 Energy Code would be cost-effective for the Benjamin Project. The analysis for this staff report was assisted by

1 California Energy Commission. December 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.* Publication Number: CEC-400-2018-020-CMF, https://www.energy.ca.gov/sites/default/files/2021-06/CEC-400-2018-020-CMF_0.pdf

2 Energy and Environmental Economics, Inc. September 2017. *Building Energy Efficiency Measure Proposal to the California Energy Commission for the 2019 Update to the Title 24 Building Energy Efficiency Standards for Rooftop Solar PV Systems.* https://efiling.energy.ca.gov/getdocument.aspx?tn=221366.

NORESCO. The report documents are available on the CEC's docket webpage at Docket number 22-BSTD-04 .

The C Note LP application asserts that the City of Lodi does not allow virtual net energy metering (VNEM), and as a result, construction costs and interconnection fees for the Benjamin Project are substantially higher than they would be otherwise, causing the PV system to not be cost-effective.

Table 1 provides a summary of the documents submitted by C Note LP as part of their application. The rest of this report documents the staff analysis performed using the information provided in the application.

Table 1: C Note LP Application Submission Documents Summary

#	Document Name	Description
1	1_The Benjamin Project_10-109(k) Complete Application[3]	Formal Request for Determination on Solar PV Requirements for the Benjamin Project Buildings to not be cost-effective. This document is the complete application, including project cost analysis and bid details
2	1_The Benjamin Project Formal Request to the CEC for Solar Determination_6-6-23[4]	Summary of the complete application
3	Exhibit A_ Benjamin Solar Project Cost Analysis[5]	PV rooftop cost breakdown and analysis in the Benjamin Project Building A
4	Exhibit B_Summary of the Benjamin Project Solar bids with cost adders[6]	Summary of the Benjamin Project Solar Bids with Cost Adders
5	Exhibit C_ The Benjamin Projects Bids[7]	The Benjamin Project Solar Bids
6	Exhibit D_ The Benjamin Solar Project Cost Spreadsheets[8]	The Benjamin Solar Project Cost Spreadsheet
7	Exhibit E_ The Benjamin Single Unit Cost Spreadsheet[9]	The Benjamin Single Unit (Building A, Unit 213) Cost Spreadsheet

3 C Note Limited Partnership. June 2023. *C Note Limited Partnership's Request for a Multi-residential Solar Photovoltaic Exemption Determination for the Benjamin Project,* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250549&DocumentContentId=85327.

4 Ibid.

5 Ibid.

6 Ibid.

7 Ibid.

8 Ibid.

9 Ibid.

#	Document Name	Description
8	Exhibit F_City of Lodi Resolution — No. 2016-125 Virtual NEM[10]	City of Lodi Resolution — No. 2016-125 Virtual NEM: Lodi City Council determination on not allowing Net Energy Metering Aggregation in the Lodi Electric Utility service territory
9	Exhibit G_City of Lodi_Electrical Service Regs and Solar Guidelines Doc[11]	City of Lodi Electrical Service Regs and Solar Guidelines
10	Exhibit H_The Benjamin Project CF1R Summary[12]	The Benjamin Project CF1R Summary (Buildings A, B, and C)
11	Applicant CBECC-Res model	CBECC-Res 2019.2.1 features two separate models, each dedicated to the North and South wings of Building C. Both models consist of 12 apartment units and includes details such as zoning, PV system sizing, building envelope, and systems.
12	Applicant Floor plan for buildings [13,14]	Floor plan for Benjamin Project Building

Source: NORESCO

10 Ibid.

11 Ibid.

12 Ibid.

13 C Note Limited Partnership. June 2023. *Benjamin Apartment Project Roof Plans,* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250600&DocumentContentId=85383.

14 C Note Limited Partnership. June 2023. *The Benjamin Apartment Plans.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250563&DocumentContentId=85342.

CHAPTER 2:
Staff Analysis

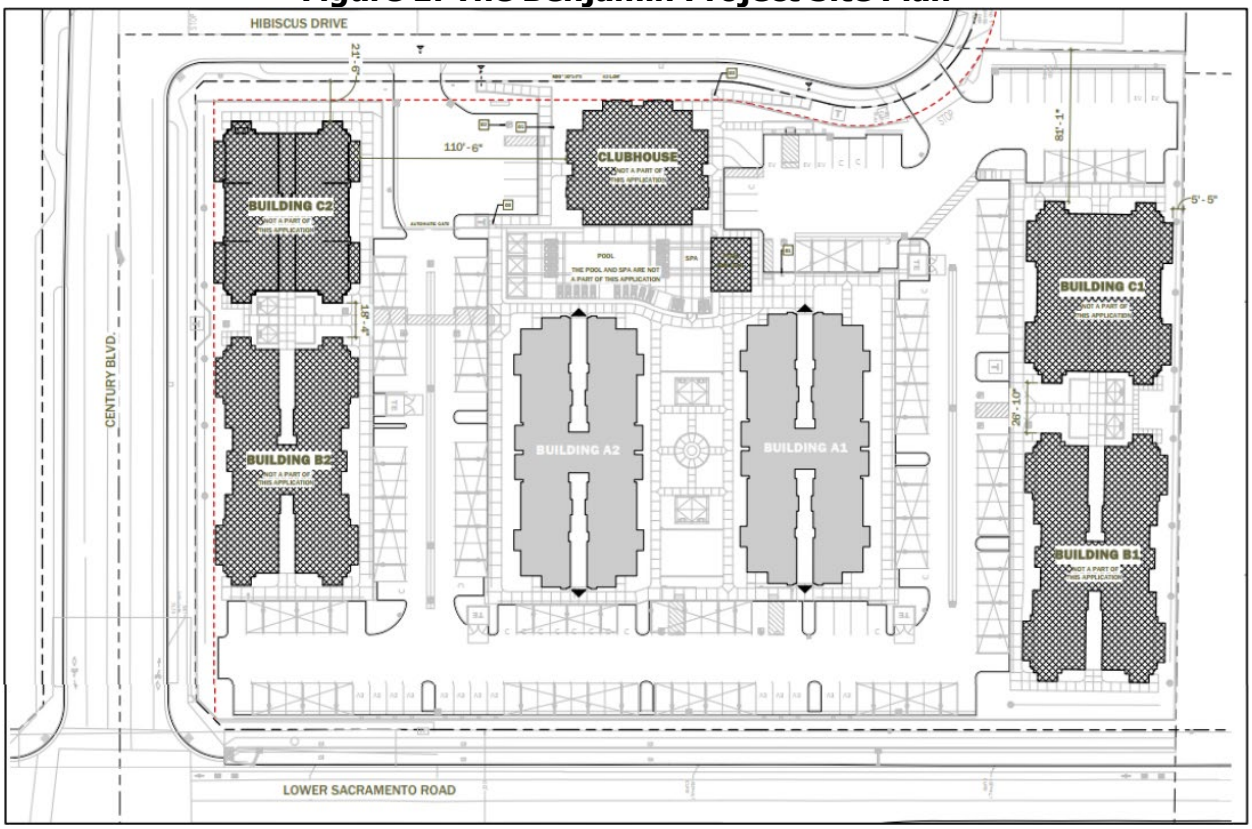
CEC staff performed the following analyses to evaluate the cost-effectiveness of the PV requirements as applicable to the Benjamin Project:

1. Review of submitted bids for installing the PV system: Staff reviewed the contractor bids submitted to C Note LP for installing the PV system on the project buildings. The review and conclusions are discussed in the next section.
2. PV system cost-effectiveness: Staff analyzed whether PV systems as required by the 2019 Energy Code are cost-effective based on the installation cost and utility rates uniquely applicable to buildings in the Benjamin Project.

Review of PV Installation Cost Bids

The Benjamin Project is an apartment complex with a total of six three-story apartment buildings including a clubhouse and pool building. The six apartment buildings are the subject of this application submitted to CEC on June 7, 2023. Figure 1 shows the site plan and Table 2 provides details about each building in the apartment complex. The apartment complex is served by the Lodi Electric Utility (LEU).

Figure 1: The Benjamin Project Site Plan



Source: Applicant provided plans

Table 2: Dwelling Unit Sizes and Building Floor Area Summary

Building	No. of Units	Dwelling Unit Sizes, ft²	Building Floor Area, ft²
A1 & A2	24	975.5	17,172
B1 & B2	18		17,346
C1 & C2	12	1,202	12,408
Total	108		93,852

Source: NORESCO

C Note LP initiated the application process beginning with contacting CEC in November 2022, where construction cost issues and a breakdown of bid costs were provided. C Note LP subsequently provided additional data to the CEC before submitting the formal application in June 2023. C Note LP received several bids and found that the total cost of installing the PV system on the Benjamin Project buildings was much higher than industry estimates from the National Renewable Energy Laboratory (NREL), which were used by staff in the cost effectiveness analysis to establish the PV requirements. C Note LP provided the following reasons for costs being higher:

1. Virtual or aggregate (collective) net metering is prohibited by the City of Lodi. In addition, the City of Lodi's regulations preclude a PV system from back feeding significantly more power through a utility meter than is being consumed by the meter.
2. Without virtual net energy metering, each dwelling unit on the project requires a small, separate PV system on the roof. Alternating Current (AC) wiring is required through the building to a PV room with PV disconnects and meters. The current then must back feed into the subpanel of each unit to meet Lodi regulatory and code requirements.
3. Extensive AC wiring results in additional labor costs and material costs that are not factored into the CEC or NREL single-family home cost analyses. Furthermore, the impact of California labor rates or labor cost increases is not accurately accounted for in the NREL solar cost estimates. Local California prevailing wage rates are not accurately incorporated in the updated 2022 NREL study.
4. Labor costs for a three-story, flat roof, multifamily building are significantly higher than for a single-family home construction analyzed by the CEC.
5. The roofs of the Benjamin Project are a thermoplastic polyolefin (TPO)[15] type roof that requires custom sealing of all mounting feet as well as conduit, and mounting penetrations along with walk pads to protect the roof. This penetration sealing and walk pad work must be done by the roofing subcontractor to maintain the roof warranty. This penetration sealing and walk pad work result in higher mounting costs and racking products are required.
6. The PV sizes that are needed for the individual Benjamin Project dwelling units are much smaller than that analyzed for the single-family home. As the size of the PV system decreases, the cost per watt increases substantially.

15 Thermoplastic polyolefin (TPO) is a single-ply white membrane used in commercial and residential, low-sloped roofing.

The applicant team, upon the CEC's request, broke down the PV installation costs in the same categories as those reported by the NREL.[16] The breakdown was provided for the Chase Construction company and SED Electric company[17] (Chase & SED) bid (ultimately the lowest bidder) and for all three apartment buildings (A, B, and C). The breakdown by the applicant team allowed the CEC staff to compare installation costs estimated by the applicant to those used in the original low-rise residential cost-effectiveness analysis completed for the 2019 Energy Code requirements for rooftop solar PV systems because that analysis also used the NREL approach and data to determine installation costs. The major cost components identified by the applicant that comprise the total installation costs for the PV system and wiring to individual dwelling units were as follows:

1. System hardware
    a. PV modules
    b. Inverter/microinverters
    c. Structural solar balance of system
    d. Building electrical balance of system
    e. Sales tax
2. Installation labor solar electrical permitting, inspection, and interconnection (PII) costs and overhead costs:
    a. Customer acquisition (sales and marketing)
    b. General and administrative overhead
    c. Profit
3. Lifetime incremental maintenance costs (operations and maintenance [O and M] plus microinverter replacement)

A summary of the cost breakdown comparison of the Chase bid to the NREL costs is shown in Table 3.

16 National Renewables Energy Laboratory. September 2022. U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, Q1 2022, https://www.nrel.gov/docs/fy22osti/83586.pdf.

17 Chase Construction company and SED Electric company provided the lowest bid.

Table 3: PV Installation Cost Breakdown Comparison

Cost breakdown	Chase & SED ($/W)- Building A	Chase & SED ($/W)- Building B	Chase & SED ($/W)- Building C	NREL 2022 ($/W)
System hardware	$2.50	$2.39	$2.35	$1.59
Sales taxes	$0.21	$0.20	$0.19	$0.08
Labor	$2.24	$2.04	$1.94	$0.16
PII Costs	$0.90	$0.79	$0.72	$0.21
Overhead + Sales and Marketing	$0.45	$0.44	$0.44	$0.66
O and M plus inverter	$0.78	$0.78	$0.78	$0.78
Profit	$0.59	$0.56	$0.54	$0.34
Total	**$7.66**	**$7.18**	**$6.95**	**$3.82**
PV Size (kW)	42.24	36.08	26.40	7.9

Source: NORESCO

The staff reviewed the breakdown and noted the following items:

1. Costs are higher than NREL's estimate in several cost categories in the design and construction details of the Benjamin Project buildings. The primary reasons are that VNEM is not available and there are unique electrical system requirements due to the City of Lodi regulations. The primary factors driving the higher costs are:
   a. Specialized racking system and associated labor costs dictated by the roof design.
   b. Higher local taxes.
   c. Extra building AC wiring and associated labor costs because the PV system for each dwelling unit must be separately wired to both a central electrical room and then to each dwelling unit.
   d. Extra costs for sealing penetrations around PV rack mounting to ensure that the flat thermoplastic olefin (TPO) membrane roof is leak-proof and for installing service walk pads to provide access around PV panels. Staff reviewed other roof PV attachment methods, including the ballast method, and contacted the applicant for their reasoning regarding why the mechanically attached installation method was chosen instead of the ballast method. The applicant stated that the structural engineer would not guarantee the ballast method because of the additional structural load of the ballast components. The applicant stated that a structural redesign of the building would be required to switch to the ballast method.
2. Sales and marketing costs included customer acquisition costs in both Chase & SED and NREL estimates for PV systems in existing buildings. The need for customer acquisition costs could be negated because the 2019 Energy Code requires builders to install PV systems for their buildings.
3. PII costs, which include Lodi Building Department fees and LEU interconnection fees, were much higher than NREL estimates.

4. Profit was separately calculated for solar, electrical, and roofing subcontractors. In addition to profit, overhead, sales, and marketing were calculated separately to align with the NREL cost categories.
5. Additional overhead and maintenance costs, in particular, the microinverter replacement costs were included without discounting for future years when the replacements would occur.

Comments were received from the California Solar and Storage Association.[18] C Note LP subsequently responded to those comments.[19] C Note LP also responded to questions from staff about project costs.[20] CEC staff communicated with the applicant about the roof penetration and sealing costs, O&M and inverter replacement costs, and overhead and sales and marketing costs. The applicant responded to staff's questions. Upon review of the information provided by the applicant, and after further review of supplementary material presented by the applicant in response to questions about the cost breakdown, staff accepted the bids for further analysis.

Staff synthesized the bid information into a summary comparing each of the bids, shown in Table 4. The rows show the costs submitted by contractors to install the PV system. The "total" rows show the final costs after including the following items to all contractor bids:

1. Roof penetration sealing costs, which were obtained from a specialized roofing subcontractor
2. Building department and interconnection fees
3. O&M and inverter replacement costs (from NREL)[21]

The lowest bid out the five received was from Barrier Solar. A revised bid, specifically for Building C, was solicited by the applicant from Barrier Solar. This revised bid included updated per dwelling unit costs for the inverters and AC wiring. This revised bid resulted in a higher $/W total for Building C, and therefore, the Chase & SED bid of $7.32/W was selected as the lowest priced bid. The Chase & SED bid was used in the cost-effectiveness analysis. The significance of Building C in the cost-effectiveness analysis is explained in the Life-Cycle Cost (LCC) section below.

The federal investment tax credit (ITC) was not included in the applicants total bid costs. Staff applied the 30 percent ITC to the Chase & SED total bid cost to derive the final cost that would be used in the cost-effectiveness analysis. This calculation and the final cost of $5.12/watt (W) are shown in Table 5.

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18 California Solar and Storage Association. July 2023. *Comments – on Benjamin Project.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=251082&DocumentContentId=86025

19 C Note Limited Partnership. July 2023. *Response to California Solar and Storage Association Comments.* file:///C:/Users/benni/Downloads/TN251191_20230726T173204_David%20Chase%20Comments%20-%20C%20Note%20Response%20to%20California%20Solar%20Storage%20Associat-5.pdf

20 C Note Limited Partnership. July 2023. *Benjamin Project's Reasoning for Increased Costs.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=251153&DocumentContentId=86092.

21 Op. cit.

Table 4: Bids Summary

Cost breakdown	Chase & SED	Lenzi	AMPWRX Solar	Cal Solar Inc	Barrier Solar
Solar PV System Cost - as bid	$1,062,818	$1,240,776	$1,249,036	$1,341,721	$1,012,616
Solar PV System Cost - Total	$1,532,654	$1,710,612	$1,718,872	$1,888,794	$1,481,652
System Size (kW DC)	209.44	209.28	209.44	209.72	209.72
Cost per W (DC) – as bid	$5.07	$5.93	$5.96	$6.40	$4.83
Cost per W (DC) - Total	$7.32	$8.17	$8.21	$9.01	$7.06

Source: NORESCO

Table 5: Final Cost per Watt DC of PV System Installation

	$/W
Chase & SED bid	$7.32
Final cost (post-ITC)	$5.12

Source: NORESCO

Life-Cycle Cost Analysis

Approach

The CEC has a standardized approach for evaluating the cost-effectiveness of energy code measures, comparing the life-cycle benefits to the life-cycle costs (LCC). This approach has been documented in the analysis performed to establish the PV requirements in the 2019 Energy Code for low-rise residential buildings, which are applicable to the Benjamin Project apartment buildings. The same approach to LCC analysis was used to evaluate this application.

The LCC approach compares the net present value of energy cost savings (the benefits) to the net present value of the first cost and operations and maintenance costs (the costs) over the 30-year period of analysis, as shown in Equation 1.

Equation 1: Benefit-to-Cost Ratio

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

The PV system is determined to be cost-effective when the present value of benefits is greater than the present value of costs, and the benefit-to-cost-ratio (BCR) is greater than one.

The cost-effectiveness of each apartment was evaluated separately because under the non-VNEM rules of the Lodi Electric Utility, each apartment unit receives its unique energy bill based on its energy consumption and the generation of its PV system. The consumption of the building as a whole is of no consequence to the energy bill of individual apartment units. Of the three apartment buildings in the Benjamin Project, Building C had the largest apartments, with each of the 12 apartments in the three-story building having a floor area of 1,202 ft^2. As seen in Table 3, the cost ($/W) of the PV system was lowest for Building C, primarily because

the larger size of the apartments spread the costs of the PV system over a larger floor area. Staff concluded that if after performing[22] the cost-effectiveness analysis, Building C was shown not to be cost-effective, then smaller apartment units in Buildings A and B would also not be cost-effective. This conclusion was tested by staff by modeling apartment units of various sizes and performing an LCC analysis using Lodi rates and the Chase & SED bid. Staff found that larger apartment units, under Lodi tariff, were more cost-effective than smaller units. Therefore, the analysis focused on Building C apartment units.

Inputs

The LCC analysis required several inputs that are described below:

1. Period of analysis: The period of analysis was set to 30 years, as is the standard practice for all energy code measure evaluations.
2. Lodi utility rates: The latest residential tariffs from the LEU website[23] were used for the analysis. Table 6 shows the charge tiers, and Table 7 shows the important export compensation[24] rates. LEU has posted an example bill calculation showing how the NEM rates are applied.[25] The same approach as the example was used in the analysis. The export compensation rate was lowered to $0.1064/kWh for the 2029-2052 period based on recommendations from LEU.[26] Thus, the export compensation rate was $0.1352/kWh from 2023 to 2028 and $0.1064/kWh from 2029 to 2052.
3. Energy escalation rate: An energy escalation rate of 1.6 percent was used based on recommendations from LEU, as shown in Table 8.
4. Discount rate: A discount rate of 3.0 percent was used, as is the standard practice for energy code measure evaluation.
5. Incremental cost: The incremental cost of the PV system was $5.12/W, as shown in 5.
6. PV system size: The PV system size that would be required by the Energy Code for each apartment in Building C was calculated using 2019 CBECC-Res by isolating apartment units in the model submitted by the applicant.
7. Table 9 shows the PV sizes calculated by the CBECC-Res compliance software for the standard design for each apartment in Building C.
8. Energy models: Upon staff's request, the applicant provided a 2019 CBECC-Res model of Building C, which was used to perform the energy modeling and determine the electricity consumption and savings (kilowatt-hour [kWh]) resulting from installation of the PV system. The electricity import energy is determined by subtracting the electricity

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22 Op. cit.

23 City of Lodi Electric Utility. *Summary of Residential and Small Commercial Electric Rates*. https://www.lodi.gov/DocumentCenter/View/1545/Residential-RatesPDF

24 City of Lodi Electric Utility. *Summary of Solar Generation Credit and Electric Vehicle Charging Rates.* https://www.lodi.gov/DocumentCenter/View/6690/Solar-Generation-and-Electric-Vehicle-Charging-Rates

25 City of Lodi Electric Utility. *Understanding Your Solar Utility Bill.* https://www.lodi.gov/DocumentCenter/View/5955/Understanding-your-Solar-Utility-Bill-EP-Program

26 City of Lodi Electric Utility. July 2023. *Reduced Volumetric Charges Escalation Rate for Lodi.* Letter from Jeff Bekeheimer, Directorhttps://efiling.energy.ca.gov/GetDocument.aspx?tn=251075&DocumentContentId=86015

generated by the PV system from the building energy consumption for each month, and the electricity export energy is determined by subtracting the building energy consumption from the electricity generated by the PV system when the PV generation exceeds the building energy consumption for any month. The monthly import and export energy was extracted from the model to calculate the energy cost savings using the LEU rates.

Table 6: LEU Residential Electric Rate Tiers

Tiers Class (kWh)

Tiers	Winter	Summer
Tier 1	391	481
Tier 2	782	962
Tier 3	> 782	> 782

Source: NORESCO

Table 7: LEU Consumption and Export Compensation Rates

Consumption Tier 1 Import Rate ($/kWh)	Consumption Tier 2 Import Rate ($/kWh)	Consumption Tier 3 Import Rate ($/kWh)	Export Rate (2023-2028) ($/kWh)	Export Rate (2029-2052) ($/kWh)
0.1428	0.1581	0.3366	0.135	0.106

Source: NORESCO

Table 8: LCC Inputs

Assumptions		Source
Energy Escalation Rate	1.60%	Lodi estimated escalation rate
Discount Rate, Real	3.00%	CEC assumption
Life Cycle Period (years)	30	CEC assumption

Source: NORESCO

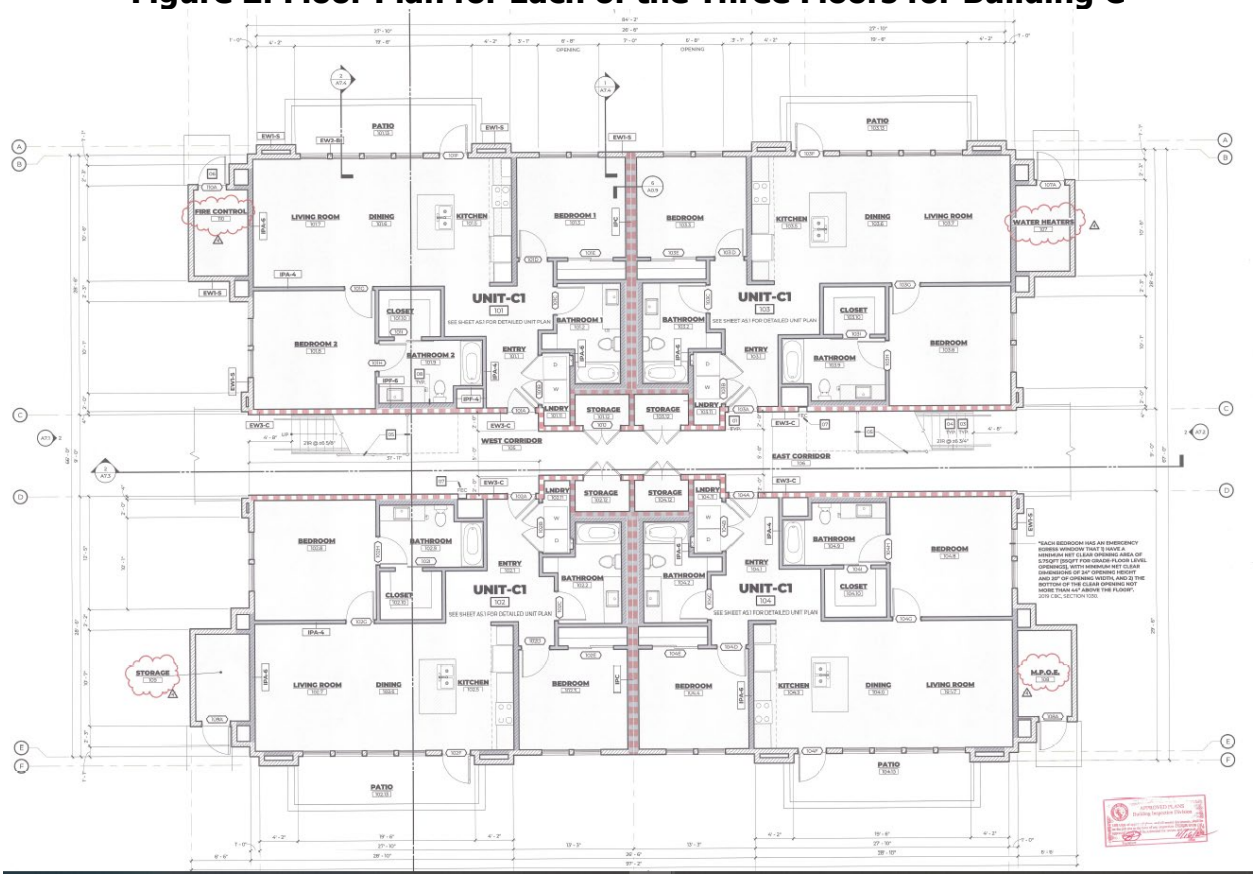
Table 9: Building C Individual Apartment Unit PV Sizes

Unit	F1_NE	F2_NE	F3_NE	F1_SE	F2_SE	F3_SE	F1_NW	F2_NW	F3_NW	F1_SW	F2_SW	F3_SW
PV Size (kW)	2.68	2.86	2.98	2.68	2.86	2.98	2.68	2.86	2.98	2.68	2.86	2.98

Note: F1 = Floor 1, F2 = Floor 2, F3 = Floor 3; NE = Northeast, SE = Southeast, NW= Northwest, SW = Southwest

Source: NORESCO

Figure 2: Floor Plan for Each of the Three Floors for Building C



Source: C Note Limited Partnership

Results

Table 10 through Table 19 show the results of the energy modeling and LCC analysis. The following steps were followed to calculate the BCR for each apartment unit in Building C:

1. The first step was to use the 2019 CBECC-Res Building C model and separate the total building model into models for each dwelling unit. The single Building C model already included individual apartment units. To construct an individual apartment unit model, all other apartment units (including and the associated loads, HVAC and DHW systems, and envelope for the other apartment units) were deleted from the model, leaving only the desired apartment unit in the model. Surfaces separating two apartment units were modeled as adiabatic assuming that the heat transfer across those surfaces would be zero. This step was repeated for all units in the model. A check was performed to ensure model integrity by running the models and eliminating errors, when present. The apartment unit models were then simulated, and the hourly consumption and PV generation output was extracted.
2. The model output was brought into a spreadsheet, where the hourly import kWh (that is, the net energy consumption when energy consumption is equal to, or greater than PV generation) and hourly export kWh (that is, the net PV generation when PV generation is greater than energy consumption) were calculated for each apartment unit. The monthly import and export kWh were then calculated, and the appropriate rate tiers and consumption import rates and export compensation rates were applied.

Table 10, Table 11, and Table 12 show the calculation results for an example apartment unit in Building C — the first-floor apartment in the northeast corner of the building.

3. Table 13 shows the annual energy cost savings for the first year and, Table 14 shows the annual energy cost savings in 2029. The savings in 2029 must be calculated separately from Year 1 because of the difference in export compensation rates.
4. Table 15 shows the energy cost savings for each year over 30 years for the northeast first floor apartment in Building C. The discounted NPV over 30 years for the first-floor northeast apartment unit is $12,821. As outlined in Table 14, the observed trend indicates a decline in energy cost savings in 2029. This decrease can be attributed to the reduction in export compensation rates beginning in 2029. Specifically, the export rates were projected to decrease from $0.1352/kWh to $0.1064/kWh, representing a decrement of 2.9 cents, as stated in Table 7.
5. Table 16 and Table 17 show the incremental cost of the PV system for each apartment unit within Building C. The incremental cost is the system size (as calculated by CBECC-Res) multiplied by $5.12/W.
6. Table 18 and Table 19 summarize the first-year bill savings, 30-year NPV savings, the incremental NPV costs, and the BCR for each apartment unit in Building C. The BCR for all apartment units was found to be less than 1.0, indicating the PV system would not be cost-effective.

Table 10: Net Energy Consumption Results and Net Energy Bill Charge for NE First-Floor Apartment Unit With PV System (Building C)

Month	Total Net kWh	Tier 1 Net kWh	Tier 2 Net kWh	Tier 3 Net kWh	Net Energy Bill Charge ($)
1	703.9	391	313	0	$105.3
2	465.5	391	75	0	$67.6
3	357.4	357	0	0	$51.0
4	299.7	300	0	0	$42.8
5	243.2	243	0	0	$34.7
6	219.7	220	0	0	$31.4
7	317.7	318	0	0	$45.4
8	293.2	293	0	0	$41.9
9	295.5	296	0	0	$42.2
10	272.2	272	0	0	$38.9
11	444.3	391	53	0	$64.3
12	715.3	391	324	0	$107.1
Total	4627.7				$672.5

Source: NORESCO

Table 11: Energy Consumption Results and Energy Bill for NE First-Floor Apartment Unit Without PV System (Building C)

Month	Total kWh	Tier 1 kWh	Tier 2 kWh	Tier 3 kWh	Energy Bill Charges ($)
1	804.9	391	391	23	$125.4
2	598.9	391	208	0	$88.7
3	510.1	391	119	0	$74.7
4	483.6	391	93	0	$70.5
5	441.9	442	0	0	$63.1
6	412.3	412	0	0	$58.9
7	532.1	481	51	0	$76.8
8	500.8	481	20	0	$71.8
9	474.4	474	0	0	$67.7
10	415.0	415	0	0	$59.3
11	556.8	391	166	0	$82.0
12	817.0	391	391	35	$129.4
Total					$968.2

Source: NORESCO

Table 12: Export Credit Results for NE First-Floor Apartment Unit With PV System (Building C)

Month	Export kWh	Export Credit (2023-2028) ($)	Export Credit (2029-2052) ($)
1	-46.7	-$6.3	-$5.0
2	-123.6	-$16.7	-$13.1
3	-212.2	-$28.7	-$22.6
4	-240.9	-$32.6	-$25.6
5	-269.1	-$36.4	-$28.6
6	-300.4	-$40.6	-$32.0
7	-280.2	-$37.9	-$29.8
8	-268.7	-$36.3	-$28.6
9	-234.9	-$31.8	-$25.0
10	-208.7	-$28.2	-$22.2
11	-103.4	-$14.0	-$11.0
12	-55.4	-$7.5	-$5.9
Total($)		-$316.9	-$249.4

Source: NORESCO

Table 13: First-Year Savings Summary for NE First-Floor Apartment Unit (Building C)

CASE	Annual Energy Bill Charges	Cost Savings ($)
With PV	Energy Bill Charges with PV System (Annual $)	$672.5
	Export Credit with PV System (Annual $)	-$316.9
Without PV	Energy Bill Charges without PV System (Annual $)	$968.2
	First-Year Savings (Annual $)	$612.6

Source: NORESCO

Table 14: 2029 Savings Summary for NE First-Floor Apartment Unit (Building C)

CASE	Annual Charges	Cost Savings ($)
With PV	Energy Bills Charges with PV System (Annual $)	$739.7
With PV	Export Credit with PV System (Annual $)	-$249.4
Without PV	Energy Bill Charges without PV System (Annual $)	$1065.0
	First-Year Savings (Annual $)	$574.7

Source: NORESCO

Table 15: 30-Year Incremental Net Present Value Estimated Savings for NE First-Floor Apartment Unit (Building C)

Year	F1_NE Savings ($)
1	$612.6
2	$617.4
3	$622.2
4	$627.1
5	$632.0
6	$637.1
7	$574.7
8	$583.9
9	$593.2
10	$602.7
11	$612.3
12	$622.1
13	$632.1
14	$642.2
15	$652.5
16	$662.9
17	$673.5
18	$684.3
19	$695.3
20	$706.4
21	$717.7
22	$729.2
23	$740.8
24	$752.7
25	$764.7
26	$777.0
27	$789.4
28	$802.0
29	$814.9
30	$827.9
Total NPV ($)	$13,006

Source: NORESCO

Table 16: Incremental Cost of PV System (Apartment Units With Exterior Walls on the East)

Building Type (CZ:12)	F1_NE	F2_NE	F3_NE	F1_SE	F2_SE	F3_SE
PV Size (kWdc)	2.68	2.86	2.98	2.68	2.86	2.98
PV Cost ($)	$13,728	$14,650	$15,265	$13,728	$14,650	$15,265

Source: NORESCO

Table 17: Incremental Cost of PV System (Apartment Units With Exterior Walls on the West)

Building Type (CZ:12)	F1_NW	F2_NW	F3_NW	F1_SW	F2_SW	F3_SW
PV Size (kWdc)	2.68	2.86	2.98	2.68	2.86	2.98
PV Cost ($)	$13,728	$14,650	$15,265	$13,728	$14,650	$15,265

Source: NORESCO

Table 18: Model Results (Apartment Units With Exterior Walls on the East)

	F1_NE	F2_NE	F3_NE	F1_SE	F2_SE	F3_SE
First-Year Bill savings ($)	$612.6	$641.9	$641.9	$611.7	$641.6	$670.8
30-year NPV savings ($)	$13,006	$13,568	$14,153	$12,996	$13,624	$14,185
Incremental Total Cost NPV ($)	$13,728	$14,650	$15,265	$13,728	$14,650	$15,265
Floor Area (ft^2)	1,202	1,202	1,202	1,202	1,202	1,202
Performance Standard Design PV size (kW)	2.68	2.86	2.98	2.68	2.86	2.98
BCR	0.95	0.93	0.93	0.95	0.93	0.93

Source: NORESCO

Table 19: Model Results (Apartment Units With Exterior Walls on the West)

	F1_NW	F2_NW	F3_NW	F1_SW	F2_SW	F3_SW
First-Year Bill savings ($)	$611.7	$641.6	$641.6	$612.6	$641.9	$671.4
30-year NPV savings ($)	$12,996	$13,624	$14,185	$13,006	$13,568	$14,153
Incremental Total Cost NPV ($)	$13,728	$14,650	$15,265	$13,728	$14,650	$15,265
Floor Area (ft^2)	1,202	1,202	1,202	1,202	1,202	1,202
Performance Standard Design PV size (kW)	2.68	2.86	2.98	2.68	2.86	2.98
BCR	0.95	0.93	0.93	0.95	0.93	0.93

Source: NORESCO

CHAPTER 3:
Staff Recommendation

Staff Recommendation

Based on the analysis in this report, staff recommends the CEC determine the CEC's cost-effectiveness conclusion for solar PV systems under Section 150.1(c)14 of the 2019 Energy Code to not hold for the Benjamin Project. This recommended determination is caused by:

- Design of the PV system for the buildings.
- High installation costs resulting from the inability to use virtual net energy metering.
- Unique electrical system requirements.
- Lower compensation for generation exports under Lodi Energy Utility's tariffs.
- High bids received for the project.

In accordance with section 10-109(k), staff therefore recommends that the CEC determine that the solar PV system requirements in the 2019 Energy Code not apply specifically to the Benjamin Project's 108 unit newly constructed low-rise multifamily buildings described in the application referenced above.

REFERENCES

California Energy Commission. December 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.* https://www.energy.ca.gov/sites/default/files/2021-06/CEC-400-2018-020-CMF_0.pdf

California Solar and Storage Association. July 2023. *Comments – on Benjamin Project.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=251082&DocumentContentId=86025

C Note Limited Partnership. June 2023. *C Note Limited Partnership's Request for a Multi-residential Solar Photovoltaic Exemption Determination for The Benjamin Project.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250549&DocumentContentId=85327

C Note Limited Partnership. June 2023. *Benjamin Apartment Project Roof Plans.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250600&DocumentContentId=85383

C Note Limited Partnership. July 2023. *Benjamin Project's Reasoning for Increased Costs.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=251153&DocumentContentId=86092

C Note Limited Partnership. June 2023. *The Benjamin Apartment_Plans.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=250563&DocumentContentId=85342

C Note Limited Partnership. July 2023. *Response to California Solar and Storage Association Comments.* https://efiling.energy.ca.gov/GetDocument.aspx?tn=251191&DocumentContentId=86138

City of Lodi Electric Utility. July 2023. *Reduced Volumetric Charges Escalation Rate for Lodi.* Letter from Jeff Berkeheimer, Director. https://efiling.energy.ca.gov/GetDocument.aspx?tn=251075&DocumentContentId=86015

City of Lodi Electric Utility. July 2023. *Summary of Residential and Small Commercial Electric Rates.* https://www.lodi.gov/DocumentCenter/View/1545/Residential-RatesPDF

City of Lodi Electric Utility. July 2023. *Summary of Solar Generation Credit and Electric Vehicle Charging Rates.* https://www.lodi.gov/DocumentCenter/View/6690/Solar-Generation-and-Electric-Vehicle-Charging-Rates

City of Lodi Electric Utility. December 2023. *Understanding Your Solar Utility Bill.* https://www.lodi.gov/DocumentCenter/View/5955/Understanding-your-Solar-Utility-Bill-EP-Program

Energy and Environmental Economics, Inc. September 2017. *Building Energy Efficiency Measure Proposal to the California Energy Commission for the 2019 Update to the Title*

24 Building Energy Efficiency Standards for Rooftop Solar PV Systems. https://efiling.energy.ca.gov/getdocument.aspx?tn=221366

National Renewables Energy Laboratory. September 2022. *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, Q1 2022.* https://www.nrel.gov/docs/fy22osti/83586.pdf

GLOSSARY

California Energy Commission (CEC) is the state agency leading 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.

California Building Energy Code Compliance (CBECC) is an open-source compliance software that may be used by code agencies, rating authorities, or utility programs in developing 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.

Energy Code, also referred to as the California's Building Energy Efficiency Standards, is adopted by the CEC to reduce wasteful and unnecessary energy consumption in newly constructed buildings, and additions and alterations to existing buildings. 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.

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. This separately provides compensation for both the amount that is consumed and the amount that is generated in excess of the consumption following rules established for the utility.

National Office of Energy Conservation and Renewable Energy Service Company (NORESCO) is an Energy Service Company, with a focus on providing energy efficiency and sustainability solutions. NORESCO provides consultation services to the CEC Building Standards Branch to support Energy Code development, analysis, and implementation.

LEU is the City of Lodi Electric Utility.

Permitting, inspection, and interconnection (PII) requirements help ensure safe PV installation and operation. Each PV installation must be approved both by the building code enforcement agency and by the LSE authorizing interconnection, which will charge fees to conduct the PII approval process.

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.

Virtual net energy metering (VNEM) is a billing method that enables the energy bill credits from a shared renewable energy system to be virtually distributed among multiple utility accounts. This occurs when a single solar PV system serves the needs of multiple users or tenants within a building or property. Virtual energy bill credit approaches may be called different names, but are examples of VNEM systems.