C2C: Clean Energy *to* Communities
U.S. DEPARTMENT OF ENERGY

Expert Match

C2C Expert Match Technical Assistance New Paltz, New York

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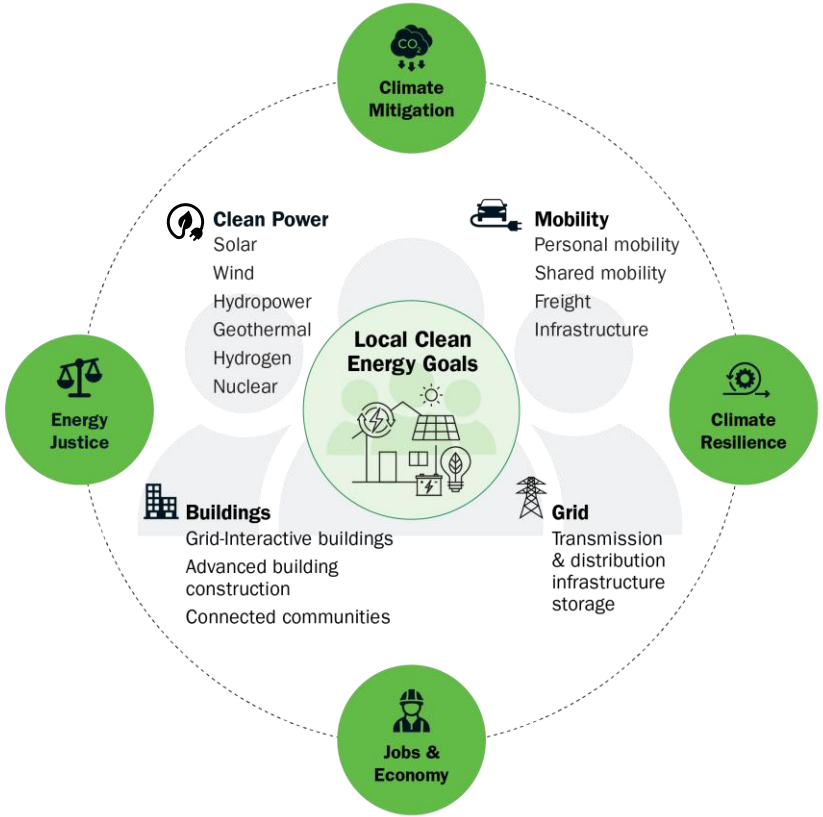
Clean Energy to Communities (C2C)

Clean Energy to Communities (C2C) is an **innovative, technical program** that helps electric utilities, local governments, and community-based organizations meet their **progressive clean energy goals**.



Clean Energy to Communities (C2C)

In-depth Partnership

Multiyear partnership made up of teams (local government, community-based organizations, and electric utilities) that work alongside national lab staff to apply robust modeling and analysis tools and conduct hardware-in-the-loop testing of solutions to evaluate and test potential scenarios and strategies before full technology deployment.

~3 years
~4 communities

For more information, visit:
www.nrel.gov/c2c/indepth

Cohorts

Multi-community engagements to exchange strategies and best practices, learn in a collaborative environment, and workshop strategies to overcome challenges around a common clean energy transition topic. **Applications for next cohort due October 31. Includes building-focused cohort.**

~6 months
~100 communities

For more information, visit:
www.nrel.gov/c2c/cohorts

Expert Match

Short-term, no-cost technical assistance for communities seeking to answer a near-term clean energy question.

Applications accepted on a rolling basis.

~3 months
~200 communities

For more information, visit:
www.nrel.gov/c2c/expertmatch

Request and Technical Assistance

Overview of Technical Assistance

Lawrence Berkeley National Laboratory (LBNL) will provide technical assistance for the techno-economic feasibility analysis of solar photovoltaic (PV) installation scenarios.

Work Area 1: Techno-economic analysis of a solar PV installation at community sites.
The LBNL expert will provide a case study of a techno-economic analysis for a new solar PV installation in the community. This technical assistance (TA) will include a cost-benefit analysis for three electricity load scenarios.

Deliverables: 1) Presentation slides of a techno-economic analysis of a solar PV installation at community sites for three scenarios.

Work Area 1:
Solar Techno-Economic Analysis

Overview of Technical Assistance Request

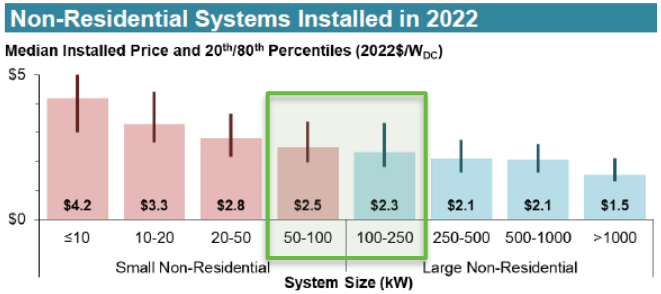
Goal: Technical assistance will provide a techno-economic feasibility analysis for the installation of solar photovoltaic (PV) systems to meet the electricity load of New Paltz's police station under three different scenarios.

PV Techno-Economic Feasibility Analysis Scenarios

1. Scenario meeting the 2023 police station electricity load (includes three Level 2 chargers)
2. Scenario meeting the 2023 police station load plus one additional Level 3 electric vehicle (EV) charger load for electric police vehicles
3. Scenario meeting the 2023 police station load plus one additional Level 3 EV charger load for electric police vehicles plus virtual net energy metering (VNEM) for other buildings

Overview of Key Modeling Assumptions

- PV techno-economic analysis tool: REopt (https://reopt.nrel.gov/tool)
- Solar PV systems
  - Array azimuth (deg): 180°
  - System capital cost ($/kW-DC):
    - $2,500 for 50–100 kW
    - $2,300 for 100–250 kW
  - Operation and maintenance (O&M) cost: $18/kW-DC per year
  - Federal percentage-based incentive (%): 30%
  - Low-Income communities bonus: 10%
  - PV export-to-grid rate: $0.12/kWh
  - Electric storage: None
- Financial
  - Analysis period (years): 25
  - Host discount rate, nominal (%): 6.38%
  - Host effective tax rate (%): 0% for government and nonprofit entities
  - Electricity cost escalation rate, nominal (%): 1.7%
  - O&M cost escalation rate (%): 2.5%



Source: Tracking the Sun: Pricing and Design Trends for Distributed Photovoltaic Systems in the United States 2023 Edition, p. 32.

Scenario #1: PV Feasibility to Meet 2023 Police Station Electricity Load

Police Station Data and Assumptions

- The police station is a 100% electrified building.
- Electricity consumption includes three dual EV chargers (Level 2*) for public use.
  - The number of EVs and charging schedules vary.
- Police station 2023 annual electricity consumption: 191,825 kWh
  - The hourly electricity load profile was extrapolated based on simulated hourly load profile for the prototype small office using the monthly electricity consumption (see table at right).
- Utility rate:
  - New York Power Authority (NYPA) energy rate: $0.12/kWh
  - Central Hudson delivery rate: $0.06/kWh
- Available area for PV installation
  - Rooftop area 8,900 ft^2
- Electric battery storage system is not considered.

Year 2023	Police Station NYPA Electricity Usage Data (kWh)
January	15,160
February	13,360
March	12,760
April	17,240
May	13,920
June	15,760
July	13,120
August	15,985[1]
September	17,520
October	21,400
November	18,480
December	17,120
Total	191,825

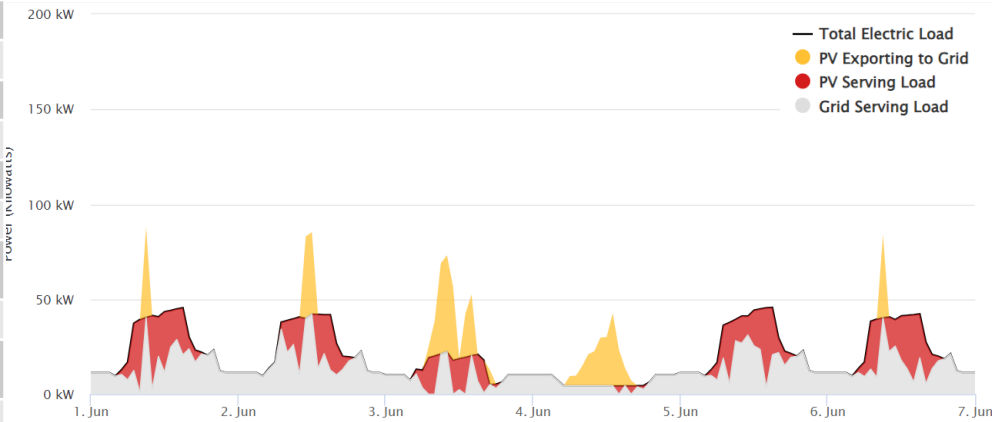
[1]Note that the electricity consumption data for August was recorded at 2,080 kWh, which is unusually low compared to other months. Thus, this value was derived based on the average consumption of other months.

***Level 2 Charger**

Level 2 charger offers AC charging through 240-V (in residential applications) or 208-V (in commercial applications) electrical service and can charge a battery EV to 80 percent from empty in 4–10 hours and a plug-In hybrid EV in 1–2 hours. Typical power output is 7–19 kW.
Source: U.S. Department of Transportation

Scenario #1: Results

Parameter	Alt #1	Alt #2	Alt #3
Array Tilt (deg)	20	30	**40[2]**
Solar PV Installation Size (kW)	89 kW	89 kW	**89 kW[3]**
Array Type	Rooftop, Fixed	Rooftop, Fixed	Rooftop, Fixed
PV Total Electricity Produced (kWh)	107,709 kWh	111,273 kWh	112,293 kWh
PV Serving Load (kWh)	60,684 kWh	38,139 kWh	46,543 kWh
PV Exported to Grid (kWh)	47,025 kWh	73,134 kWh	65,750 kWh
Annual Energy Supplied from Grid (kWh)	131,140 kWh	153,685 kWh	147,831 kWh
Annual Electric Energy Consumption (kWh)	191,824 kWh	191,824 kWh	191,824 kWh
Annual Renewable Electricity (% of Electricity Consumption)	56%	58%	59%
Total Upfront Capital Cost Before Incentives	$222,500	$222,500	$222,500
Net Present Value of the Savings (25 Years)[1]	**$25,268**	**$31,544**	**$33,338**
Internal Rate of Return (%)	8.00%	8.00%	9.00%
Payback Period (yr)	10.73 yr	10.37 yr	10.27 yr
PV Levelized Cost of Energy	$0.123/kWh	$0.119/kWh	$0.118/kWh



Hourly electricity profile from the installation of a PV system with a tilt angle of 40°, for the week of June 1–7, 2023

[1] System capital cost ($/kW-DC): $2,500 for 50–100 kW
[2] A higher tilt angle may lead to increased PV installation costs.
[3] Police station roof area (8,900 ft²) can offer up to 128-kW PV DC system size based on PVWatts.

Scenario #2: PV Feasibility to Meet Level 3 EV Charger for Electric Police Vehicle Plus Scenario #1 Electricity Load

Overview of Level 3 Charger Specifications

- Level 3 charging type: DC fast charging
  - CHAdeMO, CCS (Combined Charging System), Tesla Superchargers
- Voltage: 400–1000 V DC
- Typical power output: 50–350 kW
- Estimated battery (60 kWh) EV charge time from empty to 80%: 20 minutes––1 hour

Source: U.S. Department of Transportation

Level 3 Charger Modeling Assumptions:

- Power output: 250 kW based on Tesla Supercharger
- One EV for police detectives
- 3 charges/day between shifts at 7–8 a.m., 3–4 p.m., and 11 p.m.–12 a.m.
- 20 minutes/charge
- Added electricity consumption from the Level 3 charger: 250 kWh/day
  - 83.3 kWh during 7–8 a.m., 3–4 p.m., and 11 p.m.–12 a.m.
- Available area for PV installation:
  - Rooftop area: 8,900 ft^2
- Electric battery storage system is not considered

Scenario #2: Results

Parameter	Alt #1	Alt #2	Alt #3
Array Tilt (deg)	20	30	**40[2]**
Solar PV Installation Size (kW)	89 kW	89 kW	**89 kW[3]**
Array Type	Rooftop, Fixed	Rooftop, Fixed	Rooftop, Fixed
PV Total Electricity Produced (kWh)	107,709 kWh	111,273 kWh	112,293 kWh
PV Serving Load (kWh)	42,499 kWh	52,047kWh	40,127 kWh
PV Exported to Grid (kWh)	65,209 kWh	59,226 kWh	72,166 kWh
Annual Energy Supplied from Grid (kWh)	240,539 kWh	230,991 kWh	242,755 kWh
Annual Electric Energy Consumption (kWh)	283,038 kWh	283,038 kWh	283,038 kWh
Annual Renewable Electricity (% of Electricity Consumption)	38%	39%	40%
Total Upfront Capital Cost Before Incentives	$222,500	$222,500	$222,500
Net Present Value of the Savings (25 Years)[1]	**$25,287**	**$31,563**	**$33,357**
Internal Rate of Return (%)	8.00%	8.00%	9.00%
Payback Period (yr)	10.73 yr	10.37 yr	10.27 yr
PV Levelized Cost of Energy	$0.123/kWh	$0.119/kWh	$0.118/kWh

[1] System capital cost ($/kW-DC): $2,500 for 50–100 kW
[2] A higher tilt angle may lead to increased PV installation costs.
[3] Police station roof area (8,900 ft²) can offer up to 128 kW PV DC system size based on PVWatts.

- Hourly electricity profile from the installation of a PV system with a tilt angle of 40°, for the week of June 1–7, 2023
- Electricity load spike from Level 3 EV charging of 83.3 kWh between shifts at 7–8 a.m., 3–4 p.m., and 11 p.m.–12 a.m. is not effectively covered by the PV electricity generation.

Scenario #3: PV Feasibility to Meet VNEM Buildings Plus Scenario #2 Electricity Load

VNEM Buildings

- Nine buildings (see table at right)
- Extrapolate hourly electricity load profile using the annual NYPA electricity consumption based on the simulated prototype small office, which considers natural gas heating and hot water system
- Energy rate: $0.12/kWh
- Delivery rate: $0.09/kWh
- Available PV area: 27,700 ft²
  - Rooftop area: 8,900 ft²
  - Parking lot for carport area: 12,000 ft²
  - Land area: 6,800 ft²

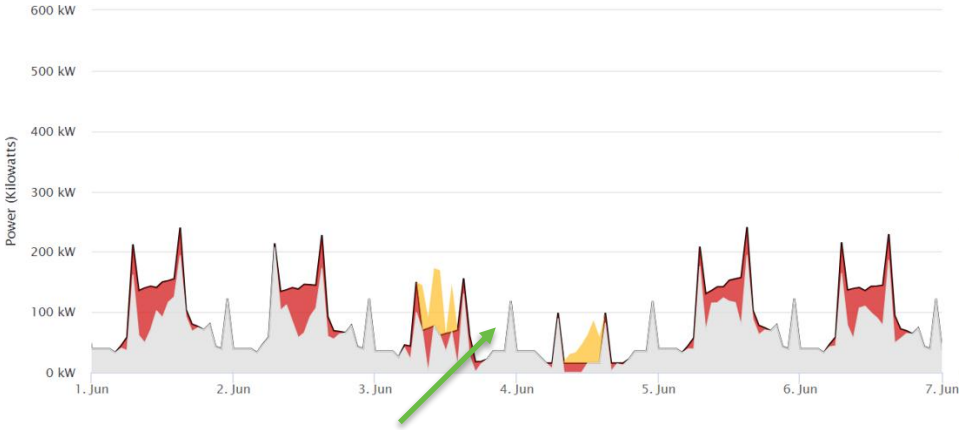
Department		Service Address	Central Hudson Delivery Cost ($)	Central Hudson Delivery (kWh)	NYPA Electricity Cost ($)	NYPA Electricity Usage (kWh)
Justice & Police Dept.		59 N. Putt	$11,336	191,825	$22,651	191,825
VNEM Buildings	Town Hall (2)	1 CLEARWATER RD OFFICES	$8,637	101,280	$11,356	97,920
	Town Hall(1)	1 CLEARWATER RD OFFICES	$9,771	114,080	$14,958	126,334
	Comm Ctr.	1 VETERANS DR COMM BLDG	$5,319	23,649	$2,529	21,876
	Youth	220 MAIN ST FL 1	$3,891	15,856	$0	0
	Recycling/ Reuse	3 CLEARWATER RD	$1,106	10,523	$1,187	10,032
	Pool	4 MULBERRY ST	$4,299	55,446	$6,656	54,756
	Highway	CLEARWATER RD	$5,676	48,296	$5,603	47,201
	Street Lighting	GENERAL TWN CHARGE	$4,243	28,135	$4,001	33,935
	Sewer6 Plant	N OHIOVLE RD	$3,601	27,009	$2,831	24,463
		Total	$57,878	616,099	$71,770	608,342
		Rate ($/kWh)	0.09		0.12	

New Paltz provided the annual VNEM electricity consumption of 436,704 kWh applicable to the scenario.

Scenario #3: Results

Parameter	Alt #1	Alt #2	Alt #3
Array Tilt (deg)	20	30	40[2]
Solar PV Installation Size (kW)	161 kW	**161 kW**	161 kW
Array Type[3]	Rooftop+Parking +Land	Rooftop+Parking +Land	Rooftop+Parking +Land
PV Total Electricity Produced (kWh)	196,479 kWh	201,198 kWh	200,684 kWh
PV Serving Load (kWh)	165,982 kWh	165,502 kWh	162,575 kWh
PV Exported to Grid (kWh)	30,497 kWh	35,696 kWh	38,109 kWh
Annual Energy Supplied from Grid (kWh)	553,760 kWh	554,240 kWh	557,167 kWh
Annual Electric Energy Consumption (kWh)	719,742 kWh	719,742 kWh	719,742 kWh
Annual Renewable Electricity (% of Electricity Consumption)	27%	28%	28%
Total Upfront Capital Cost Before Incentives	$370,142	$370,142	$370,142
Net Present Value of the Savings (25 Years)[1]	**$69,005**	**$77,304**	**$76,387**
Internal Rate of Return (%)	9.00%	9.00%	9.00%
Payback Period (yr)	9.84 yr	9.6 yr	9.62 yr
PV Levelized Cost of Energy	$0.114/kWh	$0.111/kWh	$0.112/kWh

[1] System capital cost ($/kW-DC): $2,300 for 100–250 kW
[2] A higher tilt angle may lead to increased PV installation costs.
[3] The installation costs for PV arrays on rooftops, parking canopies, and land may vary.



- Hourly electricity profile from the installation of a PV system with a tilt angle of 40°, for the week of June 1–7, 2023
- Electricity load spike from Level 3 EV charging of 83.3 kWh between shifts at 7–8 a.m., 3–4 p.m., and 11 p.m.–12 a.m. is not effectively covered by the PV electricity generation
- VNEM energy reflects lower winter electricity consumption, considering natural gas heating and hot water systems in the prototype small-office building specification.

Work Area 1: Summary

- Scenario #1:
  - It would be financially feasible to install 89 kW of rooftop solar PV with a 40° tilt to meet 59% of the police station's total annual electricity consumption.
  - Police station roof area of 8,900 ft^2 can offer up to 128-kW PV DC system size based on PVWatts.
- Scenario #2:
  - Level 3 charger would add electricity demand of 250 kWh/day, and a load spike of 83.3 kWh would be expected at 7–8 a.m., 3–4 p.m., and 11 p.m.–12 a.m. reflecting the shift time.
  - It would be financially feasible to install 89 kW of rooftop solar PV with a 40° tilt to meet 40% of the total annual electricity consumption for the police station and Level 3 charger.
- Scenario #3:
  - It would be financially feasible to Install 161 kW of solar PV on rooftops, parking canopies, and land with a 30° tilt to meet 28% of the total annual electricity consumption for the police station, Level 3 charger, and nine other VNEM buildings.
- A PV panel array with a 40° tilt angle would be more financially feasible for electrified office buildings under New Paltz weather conditions.
- A PV panel array with a 30° tilt angle would be more financially feasible for prototypical office buildings with natural gas heating and hot water systems under New Paltz weather conditions.

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Thank you

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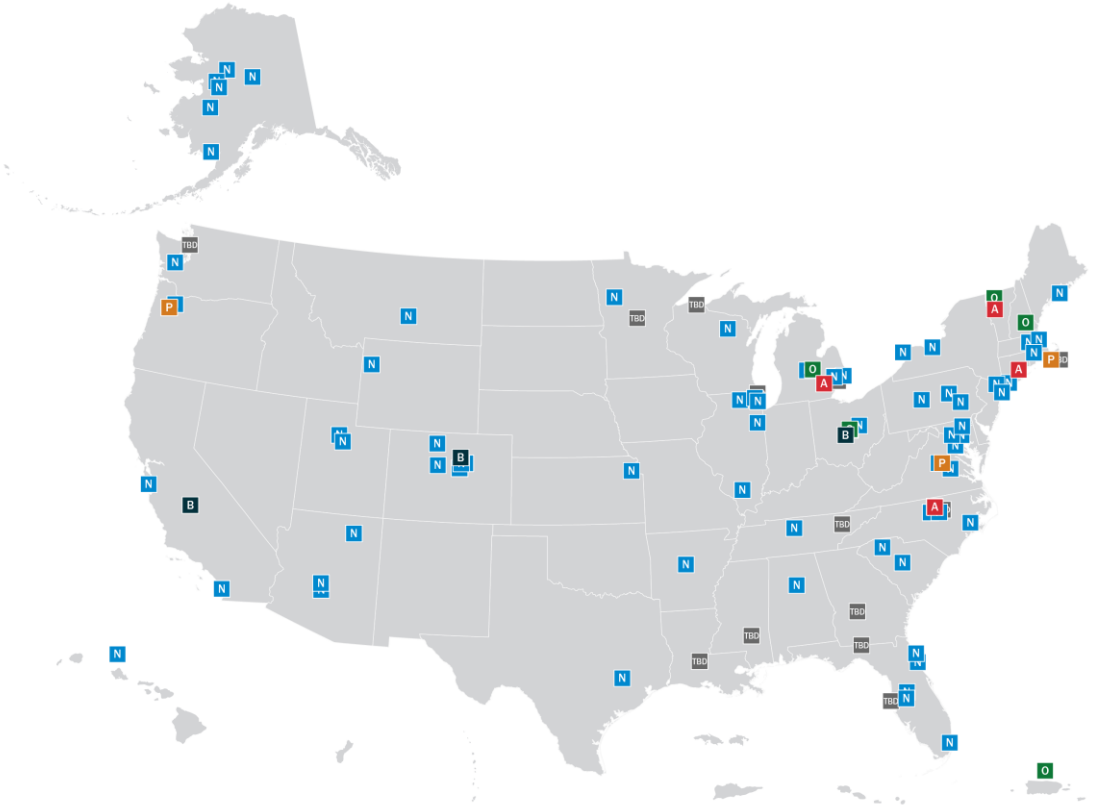

National Lab

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- O — ORNL (Oak Ridge)
- P — PNNL (Pacific Northwest)
- TBD — To be determined