

Solar Potential at Treasure Valley Scout Reservation

April 24, 2019

Authors:

James Maxwell
Lillian Neff
Huyen Anh Nguyen

Advisors:

Professor Fred Looft
Electrical and Computer Engineering
fjlooft@wpi.edu

Professor Derren Rosbach
Civil and Environmental Engineering
drosbach@wpi.edu



An Interactive Qualifying Project Report Submitted to the Faculty of
Worcester Polytechnic Institute in partial fulfillment of the
requirements for the Degree of Bachelor Science

This report represents the work of one or more WPI undergraduate students submitted to
the faculty as evidence of completion of a degree requirement. WPI routinely
publishes these reports in its website without editorial or peer review.

EXECUTIVE SUMMARY

Presented below are summaries for each individual building in West Camp. These summaries include recommended actions in alignment with the assumptions made in the full report. Each building summary lists the peak power and peak 1-day energy use before and after these actions, as well as required hardware for the listed off-grid system(s). The prices for the recommended actions (which may be followed regardless of the implementation of a solar energy system) are listed, as are the hardware prices for full building conversion. Due to the large majority of the main report being comprised of raw data and analysis, this summary consists only of the summary sheets below. For additional information on data collection, results, analysis, and recommendations, refer to the full report.

Columbus Lodge

Action (A) refers to using SLA batteries for an off-grid storage system

Action (B) refers to using the Tesla Powerwall for an off-grid storage system

Unspecified actions should be followed regardless

Actions

	Cost
1. Shut off ridge fan breaker	X
2. (A) Remove freezer and refrigerator; replace with ice coolers	X
3. (B) Remove refrigerator, keep freezer	X
4. (B) Use one slushy machine 2 hours/day maximum	X
5. Replace indoor lights with LED lights	\$100
6. Replace outdoor lights with LED lights	\$100
7. (A) Remove outlets (only 12V system implementation, not 120V)	X
8. (B) Keep outlets, building runs on 120V	X
9. Change out all smoke and fire detectors to battery operated, 10 year units	\$100
10. (Optional) Change indoor light switches to 60 minute mechanical timers	\$50
11. (Optional) Change outdoor lights to dusk to dawn sensors	\$50
TOTAL:	\$400

	Before Conversion	After Conversion
Peak Power (kW)	4.4	0.16 (A) 3.7 (B) ¹
kWh (peak, 1-day)	24.6	1.9 (A) 5.7 (B)

TOTAL ENERGY/POWER REDUCTIONS

Peak power reduction	4,240 Watts (A)
	700 Watts (B)
Peak energy reduction (1-day, worst case)	22.7 kWh (A)
	19.0 kWh (B)

Solar System Design for Columbus Lodge

NOTE: Calculations for hardware below were determined based on adherence to the previously listed recommendations and a two-day energy storage requirement for Columbus Lodge of 4.4 kWh (A) or 13.0 kWh (B) (with a 15% factor of safety). Both SLA batteries and the Tesla Powerwall requirements are listed below.

¹ This peak load assumes the surge startup of the slushy machine and freezer, which are optional. The peak load could be as low as in case (A).

ITEM / UNIT (Option)	No. of ITEM	COST (\$)
PV Panels (250W nominal) (A)	2	200
PV Panels (250W nominal) (B)	4	400
Batteries (SLA, 12V, 100Ah, 30% discharge) (A)	13	2,600
Tesla Powerwall (120V, 13.5kWh) (B)	1	9,000
Inverter (500W, 12V) (A)	1	90
Inverter (1.5kW, 120V) (B)	1	229
Charge Controller (30 Amps) (A)	1	80
TOTAL (A): \$2,970 TOTAL (B): \$9,629		

Venture Lodge

Actions

	Cost
1. Replace electric stove with gas stove	\$2,000
2. Replace microwave	\$60
3. Replace AC Unit	\$125
4. Replace Whirlpool fridge with Energy Star Appliance	\$1,150
5. Replace indoor 3ft fluorescent lights with 18W LED	\$720
6. Replace outdoor lights with 10W LED	\$15
7. Change out all smoke and fire detectors to battery operated, 10 year units	\$180
8. <i>(Optional)</i> Change indoor light switches to 60 minute mechanical timers	\$50
9. <i>(Optional)</i> Change outdoor lights to dusk to dawn sensors	\$50
TOTAL:	\$4,350

	Before Conversion	After Conversion
Peak Power (kW)	28.0	8.6
kWh (peak, 1-day)	79.9	19.4

TOTAL ENERGY/POWER REDUCTIONS

Peak power reduction	19,400 Watts
Peak energy reduction (1-day, worst case)	60.5 kWh

Solar System Design for Venture Lodge

NOTE: Calculations for hardware below were determined based on adherence to the previously listed recommendations and a two-day energy storage requirement for West Lodge, 44.6 kWh (with a 15% factor of safety). Due to this, only a Tesla Powerwall solution is recommended and provided.

ITEM / UNIT	No. of ITEM	COST (\$)
PV Panels (250W nominal)	16	1,600
Tesla Powerwall	4	36,000
Inverter (5kW, 120V)	1	339
TOTAL: \$37,939		

West Lodge

Actions

	Cost
1. Replace Freezer	\$200
2. Replace full-size microwave	\$60
3. Replace Coffee Pot	\$20
4. Replace Hot Point refrigerator with Energy Star Appliance	\$1,150
5. Remove Polar refrigerator	X
6. Remove Coffee Machine	X
7. Replace indoor 3ft fluorescent lights with LEDs	\$650
8. Replace indoor incandescent lights with LEDs	\$20
9. Replace outdoor lights with LEDs	\$30
10. Change out all smoke and fire detectors to battery operated, 10 year units	\$100
11. <i>(Optional)</i> Change indoor light switches to 60 minute mechanical timers	\$50
12. <i>(Optional)</i> Change outdoor lights to dusk to dawn sensors	\$50
TOTAL:	\$2,330

	Before Conversion	After Conversion
Peak Power (kW)	21.5	10.4
kWh (peak, 1-day)	70.0	40.2

TOTAL ENERGY/POWER REDUCTIONS

Peak power reduction 11,100 Watts

Peak energy reduction (1-day, worst case) 29.8 kWh

Solar System Design for West Lodge

NOTE: Calculations for hardware below were determined based on adherence to the previously listed recommendations and a two-day energy storage requirement for West Lodge, 92.4 kWh (with a 15% factor of safety). Due to this, only a Tesla Powerwall solution is provided.

ITEM / UNIT	No. of ITEM	COST (\$)
PV Panels (250W nominal)	33	3,400
Tesla Powerwall	7	63,000
Inverter (5kW, 120V)	2	678
TOTAL: \$67,078		