Creighton Farm Feasibility Study

UC Davis
ABT 212 - Path to Zero Net Energy
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Introduction

Our client, Seth Dawson, is the owner of a 236-acre plot of land in Warren, Maine, as shown in Figure #. Our client is currently considering converting the land into a sustainable event space equipped with an RV park, campsite facilities, and tiny houses. This feasibility study will look into the energy demand of those facilities and give an estimate on the quantity of solar panels required to meet the energy demand.

Figure #. Aerial shot of Creighton Farm, a 236 Acre plot of land in Warren Maine

RV (Recreational Vehicle) Park

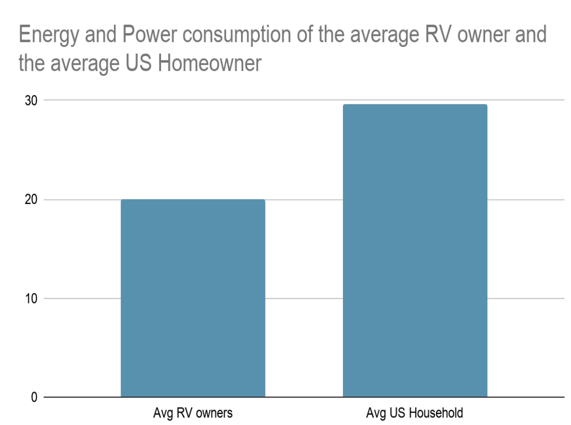
Determining the Electrical Load of An RV

According to Morten Storgaard from Go Downsize, the average use for a typical RVer is around 20 kWh/day. This translates to a power rating of around 830 kW. The table below shows the average daily consumption of an RV in two different parts of the US in the state of Philadelphia and in Southern California.

Table #. Average daily consumption of RVs on the east and the west coasts.

Description	**Average Daily Energy Load (kWh/day)**
Average	**20**
Philadelphia	12.5
Southern California	20.8
With Air Conditioner on all day	40-45
Without Air Conditioner on all day	10

The average energy use without an air conditioner, on the other hand, has an average consumption of 10 kWh/day. However, according to Gadekar, an RV enthusiast, “A newcomer with [a] lot of heat usage, Ac can end up with 40-45kwh per day usage.”



In 2019, the EIA reported that “the average annual electricity consumption for a U.S. residential utility customer was 10,649 kilowatthours (kWh), an average of about 877 kWh per month”. This means that the average US homeowner consumes around 29.58 kWh/day with a power rating of 1232 kWatts. Data shows that the average RV consumer uses less daily electricity compared to the average US homeowner.

RVs consume a lot of electricity. Especially during the summer, RV Campers blast their air conditioner on. According to a study of sustainability in RV Parks, “a mid-Atlantic park described a midsummer scenario with 40-45 big rigs running double ACs, many with screen doors open due to RV neighborliness.” In addition, RV campsites usually charge overnight and don’t meter RV electricity consumption, which doesn’t promote electricity conservation.

Electrical Systems in an RV

An RV typically has two Electrical systems: 12V DC system and 120V AC System

1. 12 Volt DC automotive system battery: overhead lights, furnace, fan, stereo
2. 12 Volt DC coach system battery: lighting, fridge, water pump
3. 120 Volt AC coach system: microwave, refrigerator, roof air conditioner

When the RV is connected to the 120v AC source from the grid (Shore Power), the electricity is used to power 120v appliances as well as charge the 12 volt DC batteries. Driving the vehicle also charges the 12 volt battery. The 120v AC power is used to supply for appliances that use 120 volts ie. refrigerators, rooftop air conditioner, microwaves, etc. The 12 volt DC batteries power 12 volt appliances like lighting, fan, stereo, etc.

Shore Power

Shore power is defined as the power you obtain when you plug your RV into an AC electrical grid. A home typically runs on a 15 to 20 amp electrical outlet. RVs on the other hand need 30 to 50 amp set-ups which is usually supplied by RV campsites.
Most RV campsites supply two types of RV charging station set ups:

1. 30A/120 volts AC that draws up to 3.6 kWatts
2. 50A/120 volts AC that draws up to 12 kwatts.

Campground

Determining the Electrical Load of a CampGround

We conducted energy demand estimations for campsite facilities under the following assumptions

- 10 campsites, which would each have a maximum of 10 campers at one time (based on client choice)
- 5 showers (based on NPS campsite design recommendations, 1 shower per 20-25 people)
- 3 washing machines and 3 dryers (client choice)

We did not take into account the energy demand of outdoor lighting or toilets, since their energy usage is likely negligible.

Facility	Number of Units	Assumptions	Annual Energy Demand
Showerheads* (Energy saving model, 2.2 gal / min)	5	(50 individuals x 5 minute shower x 270 days / year)*	19,299 kWh
Laundry washer (4 ft^3 Energy Star commercial model, IMEF = 2.55 ft^3 / kWh / cycle)	3	(50 individuals x 1 cycle / 7 days x 270 days / year x 1.6 kWh / cycle)	3,086 kWh
Laundry dryer (8 ft^3 Energy Star residential model, Estimated 608 kWh / year for 283 cycles = 2.15 kWh / cycle)	3	(50 individuals x 1 cycle / 7 days x 270 days / year x 2.15 kWh / cycle)	4,146 kWh
Total Energy Consumption for Campsite Facilities = **26,531 kWh / year**			

*Calculated using the Energy Cost Calculator for Faucets and Showerheads (Energy.gov), input: 2.2 gpm flow rate, 250 minutes per day of operation, 270 days per year of operation

While beyond the scope of this report, potential methods for decreasing energy use from heating water include solar water heaters and instantaneous water heaters. More information on those can be found on the US Department of Energy website, Energy.gov.

Recommended Best Campsite Practices

Two potentially valuable sources of information on sustainable campsite design and practices are the National Park Service Campground Design Guide and the European Commission Best Environmental Practice in the Tourism Sector 9: Campsites. In particular, the NPS Guide is useful for ensuring accessibility and overall layout recommendations, while the European Commission document has specific recommendations for energy efficiency, water conservation, and preserving biodiversity, as well as relevant examples. We recommend that our client further consult these guides as they get farther into the campsite design process.

Tiny Houses

Determining the Electricity Load of Tiny Houses

To estimate the electricity load of tiny houses, we used data obtained from the Electric Power Research Institute (EPRI) for a manufactured home with electric heating (Electric). Although most tiny house owners use propane for their heating needs, our client wanted a fully electric set-up to avoid constantly obtaining and distributing propane tanks among the four planned tiny houses (ElectricChoice.com). Out of the available data in the EPRI load shape library, we set our location to Concord, New Hampshire as this was determined to be the closest location to Creighton Farm in Warren, Maine. One thing to note is that the EPRI data is only available for the 2001 calendar year. After choosing the data set most relevant to our situation, as shown in Figure #, we manually input each data point for the average electricity load into an Excel spreadsheet. Then, we imported the data to MATLAB and used the "trapz" function to integrate under the curve to get the total daily electricity load. The "trapz" function computes the approximate value of the integral using the trapezoidal method. This yielded a result of 60.70 $kWh \cdot day^{-1}$, which is equal to 22,156 $kWh \cdot year^{-1}$.

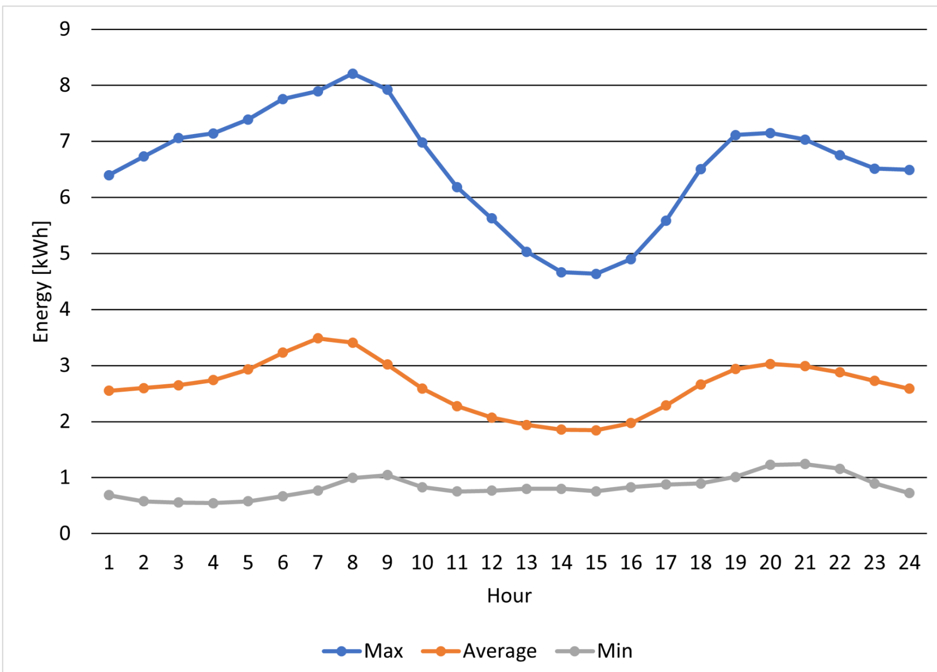


Figure #. Electricity load profile for a manufactured home with electric heating in Concord, New Hampshire in 2001 (Electric).

While our data is representative of a 2001 manufactured home, we are more interested in a modern-day tiny house, so we had to scale it to our situation. This means we had to scale our data based on the year because while electrical devices have become more efficient over the years, we are adding more and more electrical devices to our homes. We also had to scale our data based on the square footage because smaller spaces require less total energy to heat and cool. Since we could not find a relationship for how electricity usage scales for these parameters, we assumed they scaled proportionally. To account for the differences in years, we used data from the Residential Energy Consumption Survey (RECS) from the EIA. We used the data set for the New England region from 2001 (U.S. 2001), which is the year of our original data, and from 2015 (U.S. 2015), which is the most recent available data set. The RECS data showed the electricity consumption per household was 7,151 $kWh \cdot household^{-1}$ in 2001 and 7,503 $kWh \cdot household^{-1}$ in 2015. This yielded a 4.9% increase in total electricity consumption per household over those 14 years. For the square footage data, we used the upper range of how large these two residential buildings can be, as we wanted to provide our client with a conservative estimate of the total annual electricity load. A single-wide manufactured home can be as large as 18 ft wide by 80 ft long, or 1,440 ft^2 total (MHVillage). A tiny house has no formal definition but can usually be as large as 400 ft^2 (HomeAdvisor). This yielded a 72% decrease in total interior area going from a single-wide manufactured home to a tiny house. Combining all the numbers together yielded a total annual electricity load of 6,457 $kWh \cdot year^{-1}$ for our tiny house, which utilizes electric heating. The typical household in Maine uses 6,612 $kWh \cdot year^{-1}$, but Maine residents are greatly reliant on natural gas to keep their electricity usage one of the lowest in the nation (ElectricChoice.com). This shows the electricity consumption estimates for our fully electric tiny house are valid as they are roughly in line with the typical household in Maine.

Tiny House Best Practices

One thing to consider before building the tiny houses is using propane tanks for the heating needs of tiny houses to significantly reduce the total annual electricity load, as shown in Figure #. This also reduces the required size of the solar panel system. We used the same methodology used to determine the electricity load of the tiny house with electric heating to determine the electricity load of a tiny house with fossil fuel heating. The total annual electricity load of a manufactured house with fossil fuel heating was calculated to be 31.39 $kWh \cdot day^{-1}$ or 11,457 $kWh \cdot year^{-1}$. Scaling this value for a tiny house with fossil fuel heating yielded a total annual electricity load of 3,339 $kWh \cdot year^{-1}$. This showed a 48% decrease in total annual electricity consumption going from electric heating to fossil fuel heating.

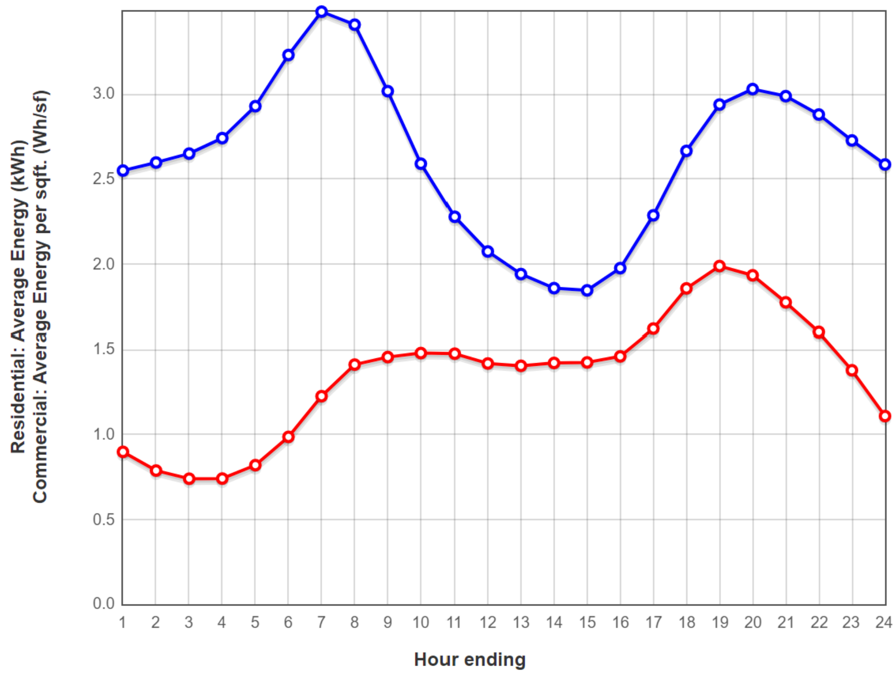


Figure #. Average electricity load profile for a manufactured home with electric heating (top) and fossil fuel heating (bottom) in Concord, New Hampshire in 2001 (Electric).

Other design tips to consider include using light colors, strategically placed mirrors, and plenty of windows to increase the visual size of the tiny house and make the interior space feel more expansive (Woolbert). Incorporating reflective materials, such as lacquered or glossy finishes, can create the same maximizing effect that light colors or mirrors do (Mendelsohn). A wall-mounted desk can double as shelving units when not in use (Mendelsohn), and fold-down desks and tables can become flush with the wall when not in use (Woolbert). Hanging cooking utensils from the bottom of shelves can help to fully maximize the usage of the shelving units (Extra). Lastly, installing drawers under seating areas, under stairs, and in the walls can maximize the amount of usable storage spaces (Extra).

Regarding the legality of tiny houses in Maine, the Bureau of Motor Vehicles will no longer issue titles or identification numbers for tiny houses on wheels because they no longer comply with the definition of a camp trailer or a trailer (Bayly). However, Maine does allow the construction of tiny houses on permanent foundations. To meet this requirement, tiny houses must be smaller than 400 ft^2 and must remain in the same location for more than 120 days out of the year. As part of this requirement, sleeping lofts with access via ladders are permitted as well as skylights in the loft areas for use as emergency exits (Langdon).

The only grant or incentive designed specifically for tiny houses I could find was from Operation Tiny Home. Operation Tiny Home previously provided down payment assistance grants to be used to buy tiny houses. However, these grants were only available to specific “community heroes” or to people struggling with hardship due to a list of things. The list of community heroes included military service members or veterans, law enforcement, firefighters, emergency medical personnel, and pre-K to 12th-grade teachers. The list of hardships included the COVID-19 pandemic, illness, aging out of foster care, disability, hurricanes, wildfires, and any other natural disasters. At the time of writing this report, grant applications were no longer being accepted (Operation).

Discussions

Load Calculations

Table #. Average energy consumption for each proposed facility on Creighton Farm.

# Units	Description	Average Energy Consumption per Unit (kWh / day)	Total Average Energy Consumption (kWh / day)
6	RV charging site	20	120
5	Showers	14.3	71.5
3	Laundry washer	3.8	11.4
3	Laundry dryer	5.1	15.4
4	Tiny house	18	72
Estimated Total Average Energy Consumption = **290.3 kWh / day**			

Summing up the estimated load required for the RV Park, Campsite facilities and Tiny houses, we get an estimated total average energy consumption of 290.3 kWh/day.

Solar Power Calculations

Below are the simulation results obtained from HomerPro Solar Modelling software.
We made some assumptions to our model which include renewable energy fraction, panel installation cost for ground mounted solar, operating costs, and incentives. Note that the operating cost per year includes the estimated electricity costs for 25 years as well as expected panel maintenance. There is still electricity cost because our design was not 100% solar. Plugging those assumptions onto HOMER PRO, we obtained the solar panel capacity, initial capital costs, total cost for 25 years, and the electricity rate as a result of the solar installation.

Optimizing Renewable Fraction Scenarios

HOMER Pro

Grid only
25 yr Cost:
$213,793
15.8 ¢/kWh

	Assumptions, Total Daily Load = 290 kWh, Lifetime = 25 years			
Assumptions	**Renewable Fraction**	**30%**	**66.7%**	**90%**
Assumptions	Panel Installation Costs ($ / W)	3.00	3.00	3.00
Assumptions	Operating Cost ($ / year) Maintenance + electricity	13,571	14,616	27,310
Assumptions	Incentives	0%	0%	0%
Results	Solar Panel Capacity (kW)	27.3	100	383
Results	**Initial Capital Cost ($)**	**81,866**	**300,078**	**1,150,000**
Results	Total Costs 25 years ($)	255,345	486,937	1,500,000
Results	**Electricity Rate (¢ / kWh)**	**18.1**	**20.9**	**22.7**

Takeaway: Without incentives, the more solar you use, the higher the cost

Simulating for different renewable fractions, we found that the more solar implemented, the higher the cost of electricity. The HOMER PRO simulation highlights that the grid will be a better cost effective option to meet our load. However, the downside is that in 2019, 20% of Maine's electricity is generated by non-renewable energy sources including coal and petroleum that release toxic emissions. Utilizing grid electricity still contributes towards these toxic emissions. Solar on the other hand, is very low in carbon emissions.

Optimizing Incentive Scenarios

HOMER Pro

Grid only
25 yr costs: $213,793
COE: 15.8 ¢/kWh

	Assumptions, Total Daily Load = 290 kWh, Lifetime = 25 years				
Assumptions	Renewable Fraction	30%	30%	30%	30%
Assumptions	Panel installation costs ($ / W)	3.00	3.00	3.00	3.00
Assumptions	Operating Cost ($ / year) Maintenance + Electricity	13,571	13,571	13,571	13,571
Assumptions	**Incentives**	**Solar ITC* 26% (2021 - 2022)**	**Solar ITC* 22% (2023)**	**0% (2024 or later)**	**Net Energy Billing + 22% Tax Incentive**
Results	Solar Panel Capacity (kW)	27.3	27.3	27.3	27.3
Results	**Initial Capital Cost ($)**	**81,866**	**81,866**	**81,866**	**81,866**
Results	Total costs 25 years ($)	234,066	237,340	255,345	189,876
Results	**COE (¢ / kWh)**	**16.6**	**16.8**	**18.1**	**13.4**

* Solar ITC = Solar Investment Tax Credit

In the simulation above we took into consideration the Solar Investment Tax Credit from the federal government and the Net Energy Billing Program from the government of Maine. Note that the federal ITC incentive will no longer be available for 2024. Although this is the case, the price of solar panel installation is expected to go down.

Using the simulation above we are able to find a design where the cost of electricity is lower than the grid. The Net Energy Billing Program and the 22% Tax incentive brought down the cost of electricity to 13.4 cents/kWh. The costs are more likely to go down after taking into account other incentives. There are various other incentives that can apply to Creighton Farm.

Next Steps

1. Contact Maine solar project sponsors
2. Contact loan and grants representatives to ensure funding
3. Contact Planning Board of Warren, Maine (permits)
4. Contact Central Maine Power (Net Energy Billing)

Contact Information

#	Purpose	Contact Person	Information
1	Campground permits	Melody Town of Warren, Maine	207-273-2421
2	Maine Energy incentives	Matthew Rolnick Staff Analyst Maine Public Utilities Commission	Matthew.Rolnick@Maine.gov Phone: (207) 287-1390
2	Rural Energy For America Program	Loans: Tommy Higgins, Acting State Director for Maine Grants: Brian Wilson, USDA Rural Development Energy Coordinator	Higgins: Voice: (207) 990-9160 Fax: (855) 589-1060 Wilson: Tel: (207) 990-9125 brian.wilson@usda.gov
3	Solar Power Vendors	See list attached	https://apps.web.maine.gov/online/aeviewer/ME/9/list.html

Conclusions

A campground and event space powered by solar energy generated on the property is possible; however, due to the high cost of solar equipment installation, this report concludes that the client should look into the variety of resources available to offset the cost.

Appendix

RV PARKS

RV Load Audit

Other methods to calculate the Energy demand in an RV is by doing an energy audit on the RV. The procedure would be similar to doing a home/building energy audit.

To determine the load of an individual RV, use the following steps for an energy audit:

1. Take note of the Power (Watts) of appliances around the RV
2. Multiply the power(Watts) with time(hours) the appliance is used daily to get the Energy (kWh)
3. Sum up all the energy for the appliances.
4. Obtain the Energy load per day

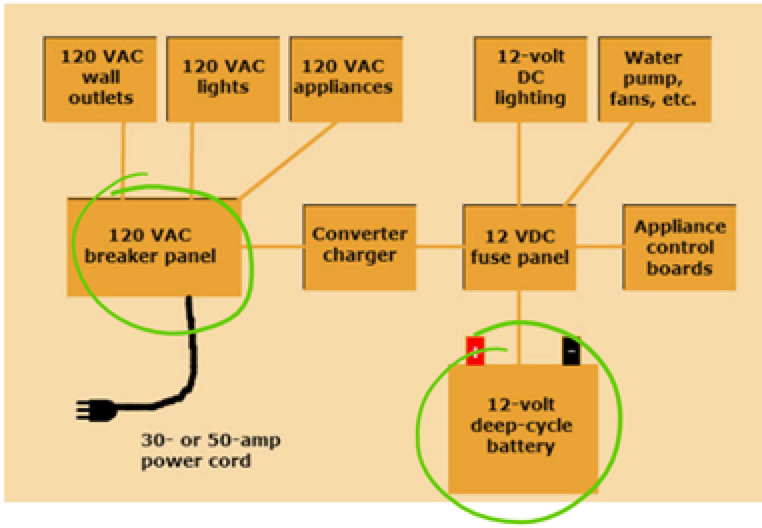
$$Energy = Power \times \Delta T$$

For reference, a list of typical RV appliances is attached

Appliance	Load Range (Watts)	Average Load (Watts)	Amps
Air Conditioner (each)	1400-2000	1700	14.1
Battery Charger	Up to 2,000	1000	8.3
DC Convertor	300-1200	750	6.2
Refrigerator	600-1000	800	6.6
Microwave Oven	1000-1500	1250	10.4
Electric Frying Pan/Wok	1000-1500	1250	10.4
Electric Stove Element	530-1500	675	5.6
Electric Water Heater (6 gallon)	1000-1500	1250	10.4
Electric Iron	500-1200	850	7.1
Hair Dryer	500-1500	1000	8.3
Electric Coffee Pot	550-750	650	5.4
Television (CRT)	200-600	400	3.3
Radio	50-200	125	1.0
Electric Drill	250-750	500	4.2
Electric Broom	200-500	350	2.9
Electric Blanket	50-200	125	1.0
Portable Heater (Ceramic)	1500-750	1500	12.5
Toaster	1200	1200	10.0
Food Processor	720	720	6.0
Hand Vacuum	240	240	2.0
Crock Pot	230	230	1.9
Satellite Dish and Receiver	200	200	1.7
Heating Pad	60	60	0.5

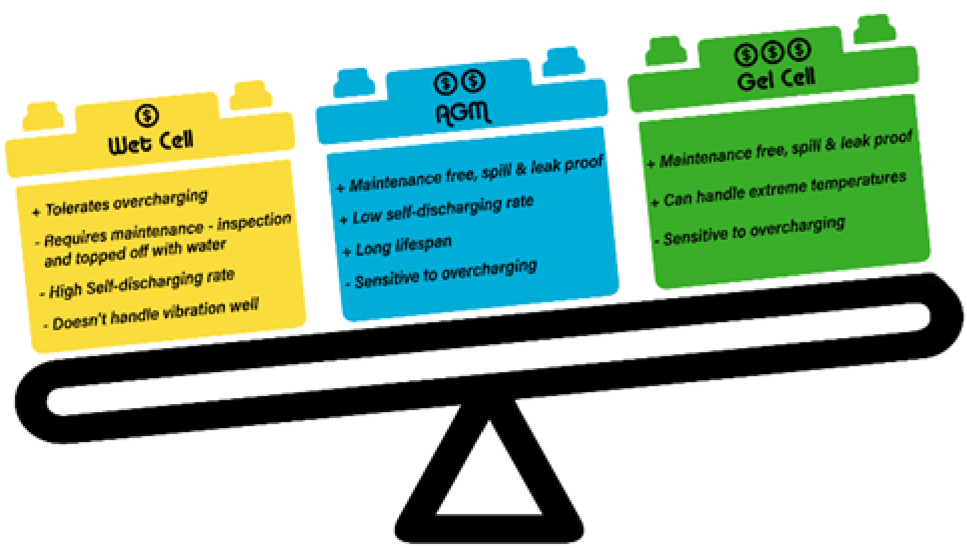
Appliance/Tool	Running Watts	Starting Watts
Aquarium	200	250
Blender	300	800
Ceiling Fan	100	300
Central AC 10.000 BTU	1500	2400
Central AC 24.000 BTU	3800	5000
Central AC 40.000 BTU	6000	7500
Clothes Dryer - Electric	5000	7000
Clothes Dryer - Gas	700	1800
Coffee Maker	1000	0
Curling Iron	1500	0
Deep Freezer	500	1500
Dishwasher	1300	1800
Electric Can Opener	170	220
Electric Grill 1.6 kW	1600	0
Electric Stove 2kW	2000	0
Electric Water Heater 4 kW	4000	0
Food Processor	400	0
Furnace Fan 1/3 HP	700	1400
Furnace Fan 1/2 HP	800	2350
Garage Door Opener 1/2 HP	900	2400
Hair Dryer 1.5 kW	1500	0
Heat Pump	4700	5500
Humidifier 13 gal.	175	0
Iron (Clothes)	1500	0
Iron (Waffles)	1200	0
Light Bulb 60 W	60	0
Light Bulb 75 W	75	0
Light LED Bulb 10 W	10	0
Microwave Oven 600 W	600	0
Microwave Oven 1000 W	1000	0
Refrigerator/Freezer	700	2200
RV Air Conditioner 7.000 BTU	900	1600
RV Air Conditioner 10.000 BTU	1200	2000
RV Air Conditioner 13.500 BTU	1600	2500
RV Air Conditioner 15.000 BTU	1700	2700
Security System	500	0
Space Heater 2 kW	2000	0
Sump Pump 1/3 HP	800	1300
Sump Pump 1/2 HP	1050	2200
Television 27"	500	0
Toaster	900	0
Toaster Oven	1200	0
Vacuum Cleaner 7 Amps	850	1300
Vacuum Cleaner 12 Amps	1440	2500
VCR	100	0
Washing Machine	1200	2300
Well Pump 1/2 HP	1000	2100
Window AC 5.000 BTU	600	900
Window AC 10.000 BTU	1200	1800
Window AC 12.000 BTU	1500	2300
Window AC 15.000 BTU	1900	2900

How Electricity is Connected in an RV



When the RV is connected to the 120v AC source from the grid (Shore Power), the electricity is used to power 120v appliances as well as charge the 12 volt DC batteries. Driving the vehicle also charges the 12 volt battery. The 120v AC power is used to supply for appliances that use 120 volts ie. refrigerators, rooftop air conditioner, microwaves, etc. The 12 volt DC batteries power 12 volt appliances like lighting, fan, stereo, etc.

Types of Batteries



Different Types of RV Batteries

Three of the most popular rechargeable batteries used in an RV based on their design are Lead-Acid Flooded wet cell, Valve-regulated lead acid (AGM) and lithium ion batteries (RV Chronicles)

1. **Lead Acid: Flooded Wet Cell Batteries**

   Lead Acid batteries are the most common and cheapest battery options for
   Lead acid batteries are good at tolerating overcharging. However, they are pretty heavy and they release gas emissions. They frequently need maintenance by adding water, and may require topping changes every six months. They also have a tendency to leak and don't handle vibrations very well.

   Some examples of AGM Deep Cycle Batteries:
   UB121000 Universal Power Group 12V 100Ah AGM Deep Cycle Battery $180
   UPG 85980 12 V 35A $100

   Lead Acid: Absorbed Glass Mat (AGM) Batteries

   Compared to the Flooded lead acid battery, the AGM charges faster, has a better cycle life and vibration resistance. They also don't require a lot of maintenance. However, they are more expensive. They are also more sensitive to overcharging. A frequently overcharged AGM battery cell will emit toxic gas and cause the batteries to fail.

2. Gel Cell Batteries

   Gel Cell Batteries are similar to AGM Batteries. They require low maintenance, no leaks or fumes and are resistant to vibrations. The drawback to this type of battery is that they are pretty expensive, have a slow charging rate and also sensitive to overcharging and failure.

3. Lithium Ion Batteries

   Lithium Ion batteries are lighter than both AGM or Flooded wet-cells. They can hold more power for your RV compared to the other type of batteries, so you'll need less batteries compared to lead-acid types. It has a longer lifespan, higher efficiency, and lower maintenance compared to the AGM. However, they are expensive ($200 - $2999) and they are sensitive to overcharging.

4. Others: Nickel-Cadmium (NiCd), Nickel-Metal Hydride (MiNH), etc.

Shore Power

Shore power is defined as the power you obtain when you plug your RV into an AC electrical grid. A home typically runs on a 15 to 20 amp electrical outlet. RVs on the other hand need 30 to 50 amp set-ups which is usually supplied by RV campsites.

Most RV campsites supply two types of RV charging station set ups:
1. 30A/120 volts AC that draws up to 3.6 kWatts
2. 50A/120 volts AC that draws up to 12 kwatts.

The 50 Amps set up generates 3.33x the power of 30 Amps set up. With a current of 50A, that should generate only 1.67x more power compared to the 30 Amp set up. However, the 50 Amp set up generates 3.33x more power because 50 amp setups actually provide 100 amps. Their plugs have two 50 amp hot wires built into it.
For RV Park setups please refer to NEC Article 551.

To supply this much power to an RV, a 30 to 50-amp outlet has to be designed. There are step by step guidelines to hook up your own 30 to 50 amp outlets however a local electrician would be more reliable to install the ports.
Reference 1. Installing 50 Amp Service on the References Folder will provide a step by step instruction to DIY set up your 50 Amp service.

PORTABLE RV CHARGING STATION

Portable Solar Panel

Portable solar panels can be moved around for optimal sunlight. Extension cords allow for placement of the panels in an area with direct sunlight whilst placing the RV in a nearby shade. Portable panels cost nothing to operate and don’t produce noise.Portable solar panels can be attached to RVs to charge their batteries. Most solar panels for RVs are typically 100-400 Watts, a full system might be 800 Watts.
Feasibility Portable RV Charging Station

Backup batteries / Power Packs

Backup batteries can be charged by the grid and be readily supplied to RV campers during their time of need. Powerpacks or RV battery power banks can also be used to provide power to RV campers. However, depending on the budget, batteries can be expensive.

Here is an example of a Powerpack:
The Xantrex Powerpack-1500 Watts.
cost = around $500.
Supplies 120 VAC that can power appliances in the RV while the camper's RV battery is charging with solar or charging with a grid on another area in the campsite.
The downside is that they are pretty expensive.

Alternative: Propane Generators
Portable generators can be used to power up an RV and charge its batteries. Generators typically use propane/natural gas to generate electricity. They are portable and easy to install. However, they are very noisy, consume fossil fuels, and release emissions that are dangerous to the environment. They are also not fuel efficient

RELEVANT RV PARK GUIDELINES

RV Parking Pads

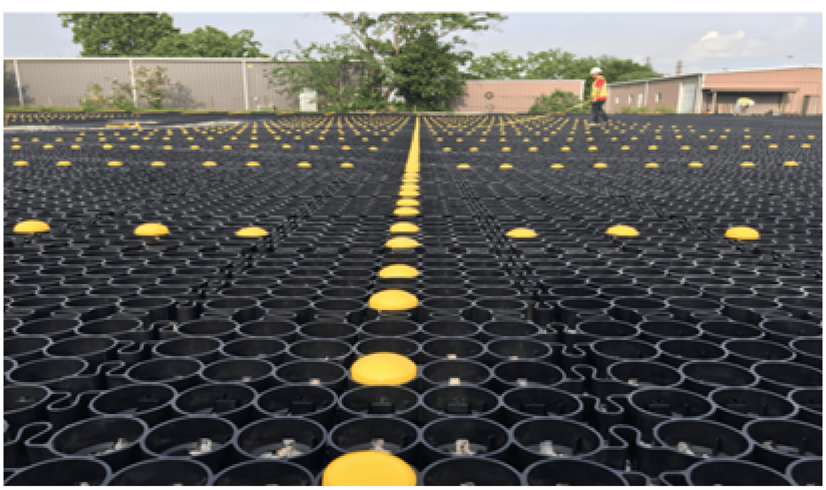


Figure 4. Permeable RV Pavement

Permeable pavers, honeycomb-grid styled RV pads can be used as a more sustainable alternative compared to concrete or asphalt. They are more sustainable than concrete in many ways. Many of them are produced by 100% post-consumer recycled plastic. They are also 100% permeable meaning water can be absorbed back to the soil without pooling. In addition, they provide good support for vehicles and are also low in cost and maintenance. The system can be easily rolled, shipped and stored. They cost $5-$7 per square foot.

Other options:

- Concrete
- Asphalt
- Gravel
- Leveling blocks ($30 - $50)
- RV Vapor Barriers (0.50 to 0.75 per sqft)
- Plastic cutting mat
- Tire covers

Setting up an RV Campsite

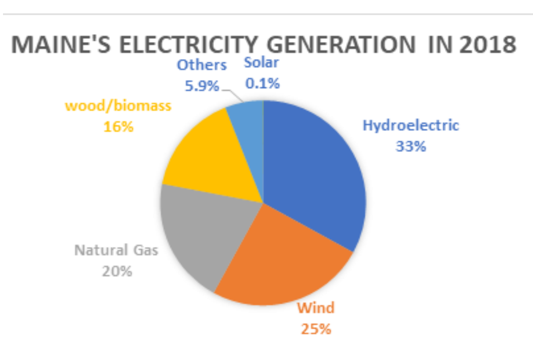
Refer to SunPark Campsite-Basic of Design.pdf

GRID AND SOLAR

Solar in Maine

The average peak sunlight hours in Warren Maine is around 3-3.5 hours/day.

Maine's Renewable Energy Goal and Incentives



The local government of Maine has goals to move towards renewable energy. By 2050, Maine aims to have 100 percent of the state's electricity come from renewable sources.

In 2018, a study found that 75% of Maine's electricity net generation came from renewable energy sources. However, only 0.1% of Maine's total energy generation is from solar power.

Therefore the government is moving towards expanding solar energy generation today. Net Energy Billing (NEB), a Net Metering program that supports Solar energy projects, is currently implemented in Maine. The state plans to further promote solar energy projects by having a goal of 375 MW of distributed generation Photovoltaic projects by 2024. The state promises to incentives commercial renewable energy projects.

NET ENERGY BILLING FROM MAINE

As of June 2021, NEB rate incentive is the only incentive in Maine that the Maine Public Utilities Commision is aware of.

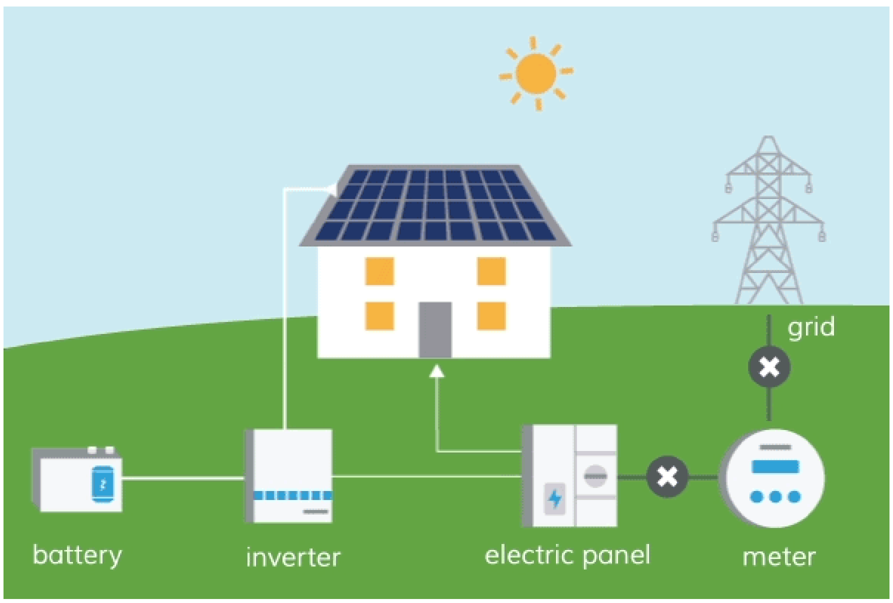
A Table on Maine's two Net Metering Project Incentives:

NEB kWh Credit Program **(Available to all electric utility customers)**	**NEB Tariff Rate Program** **(Available to non-residential customers)**
Provides kWh credits on participating customers' electricity bills	Provides dollar credits on participating customers' electricity bills. Rates are determined annually by the PUC. For current rates used to determine the monthly credit, please see the Net Energy Tariff Rates below.
Projects must be renewable generators less than 5 MW in size	Projects must be renewable generators less than 5 MW in size
Customers may choose to have their own project, such as by installing solar panels on their rooftop, or to participate in a larger project on a "shared" basis with other customers. Shared projects are sometimes referred to as "community" projects.	Customers may choose to have their own project or to share in a project with other commercial or industrial customers.
Entities that market projects to residential or small commercial customers must be registered with the PUC. See the list of Registered Project Sponsors, Marketers, etc.	Entities marketing projects to small commercial customer must be registered with the PUC. See the list of Registered Project Sponsors, Marketers, etc.
Entities marketing projects to residential and small commercial customers must provide those customers with an NEB Disclosure Form (kWh Credit) that includes information on the costs and benefits of the project to the customer.	Entities marketing projects to small commercial customers must provide those customers with an NEB Disclosure Form (Tariff Credit) that includes information on the costs and benefits of the project.
Unused credits expire after 12 months	Unused credits expire after 12 months

This is a table with the tariff rates or how much the utility company will pay us per kWh

Period	Customer Class	Central Maine Power Company	Versant Power – Bangor Hydro District	Versant Power – Maine Public District
Calendar Year 2021 (November 24, 2020 Order in Docket No. 2019-00197)	Small Commercial	$0.125561 per kWh	$0.142576 per kWh	$0.128556 per kWh
	Medium Commercial or Industrial	$0.122824 per kWh	$0.143020 per kWh	$0.124588 per kWh
	Large Commercial or Industrial	$0.119265 per kWh	$0.130800 per kWh	$0.148079 per kWh

Grid Connections



This diagram shows how the grid is connected to batteries and the load

https://www.energysage.com/solar/solar-energy-storage/how-do-solar-batteries-work/

Inverters turn AC power to DC power. The grid supplies AC power that needs to be converted to DC to be used for appliances at home. Solar panels provide DC power that needs to be converted to AC to deliver power to the grid.

NPS Campground Design Guide and EC Best Practices

Relevant takeaways from these resources include:

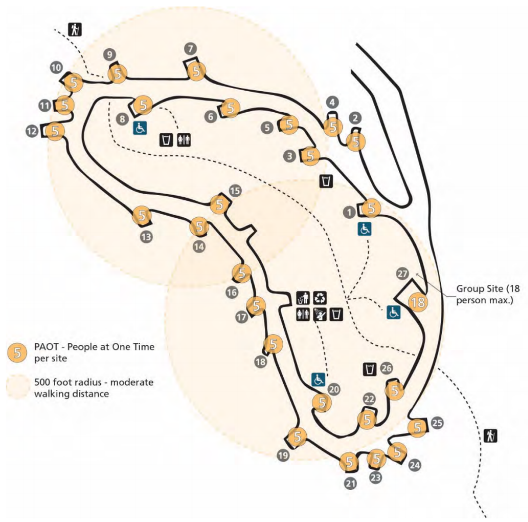


Figure 3.64 A campground with 26 campsites plus one group site of 18 PAOT equates to approximately 148 people per day (26 x 5 PAOT + 18 = 148 PAOT). Notice the accessible sites are distributed throughout the campground and exceed the minimum number required under [ABAAS F244.2.](#) *CAMPING UNITS WITH MOBILITY FEATURES.* 500-foot radius bubbles ensure recommended moderate walking distance to comfort stations from most of the campsites.

National Park Service Campground Design Guide*

- The National Parks often utilize a loop layout, which has proven to be very efficient
  - This type of design also helps ensure that each campsite is located within reasonable walking distance of various facilities
- Native plants can be used to provide privacy between campsites and around cabins
- Unisex bathrooms and showers
  - More accessible to families and those with disabilities, more convenient since they can be utilized by everyone (which is even more important given the small number of facilities available)
- Provide dishwashing stations outside bathrooms and/or showers

*This guide is currently a draft, which can be downloaded from <https://parkplanning.nps.gov/document.cfm?parkID=415&projectID=97629&documentID=106910>. A final draft is set to be published by the NPS in the following months.

European Commission Best Environmental Practice in the Tourism Sector 9: Campsites
<https://ec.europa.eu/environment/emas/takeagreenstep/pdf/BEMP-9-FINAL.pdf>

- Sensors and timers can be used to reduce energy consumption due to lighting
- Green roofs (roofs covered in vegetation and a growing medium) can provide temperature insulation for buildings, support the local ecosystem, and can be aesthetically pleasing
- Harvested rainwater and greywater can be used for flushing toilets or irrigation, reducing water consumption
- Include the campsite's sustainable practices in marketing as a draw for environmentally conscious consumers

Solar and Project Incentives

REAP: Rural Energy for America Program

Purpose: "The program provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses for renewable energy systems or to make energy efficiency improvements." (USDA)

Eligibility:

- "Businesses must be located in rural areas with populations of 50,000 residents or less."
- https://eligibility.sc.egov.usda.gov/eligibility/welcomeAction.do?pageAction=rbs
  - According to the USDA eligibility website, 336 Cushing Rd, Warren, Maine, is located in an eligible area

Apply:

- Forms can be found on the USDA.Gov Website: https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency
  - Prior to filling out forms, contact the representatives below for more information and to save time
- Loans: Contact Tommy Higgins, Acting State Director for Maine

Voice: (207) 990-9160
Fax: (855) 589-1060

- Grants: Contact Brian Wilson, USDA Rural Development Energy Coordinator

Tel: (207) 990-9125
brian.wilson@usda.gov

Renewable Energy Investment Exemption -

- Purpose:“This program exempts renewable energy equipment, such as solar panels, from property tax beginning April 1, 2020. Taxpayers must apply for the credit by April 1 of the first year the exemption is requested.” (Maine Revenue Services)
- Apply: Application can be found on the Maine.gov website under Property Tax Exemptions.

ITC Federal Solar Tax Credit
(26% 2021-2022, 22% 2023, 0% 2024 and later)
Refer to *Homeowner’s Guide to Federal Tax Credit for Solar Photovoltaics.pd*f in the Reference folder.

Other Solar Incentives in Maine:
https://www.energysage.com/local-data/solar-rebates-incentives/me/

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