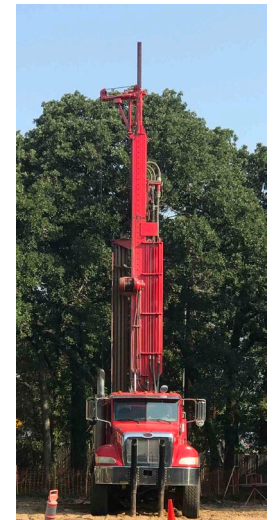
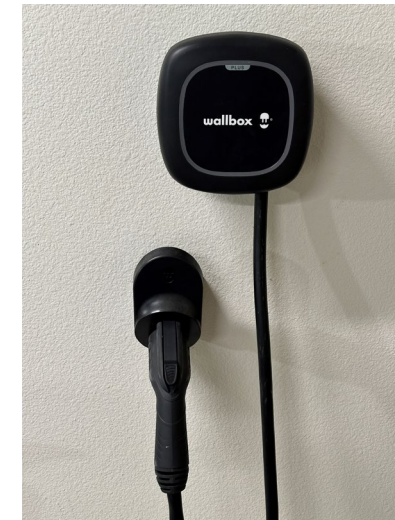
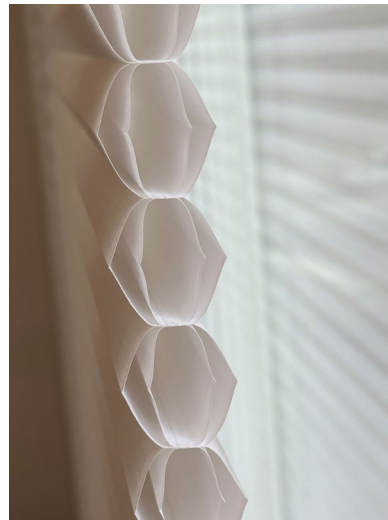
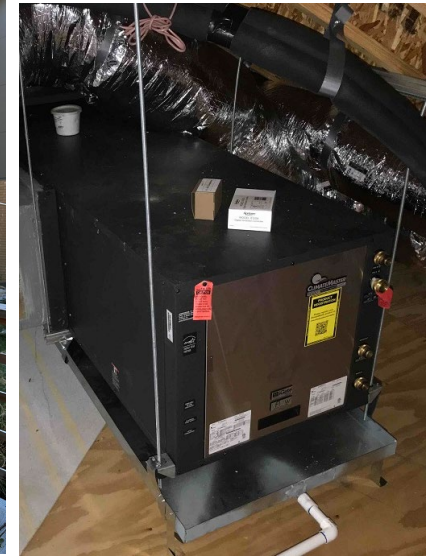


The Byrom Net Zero Energy House



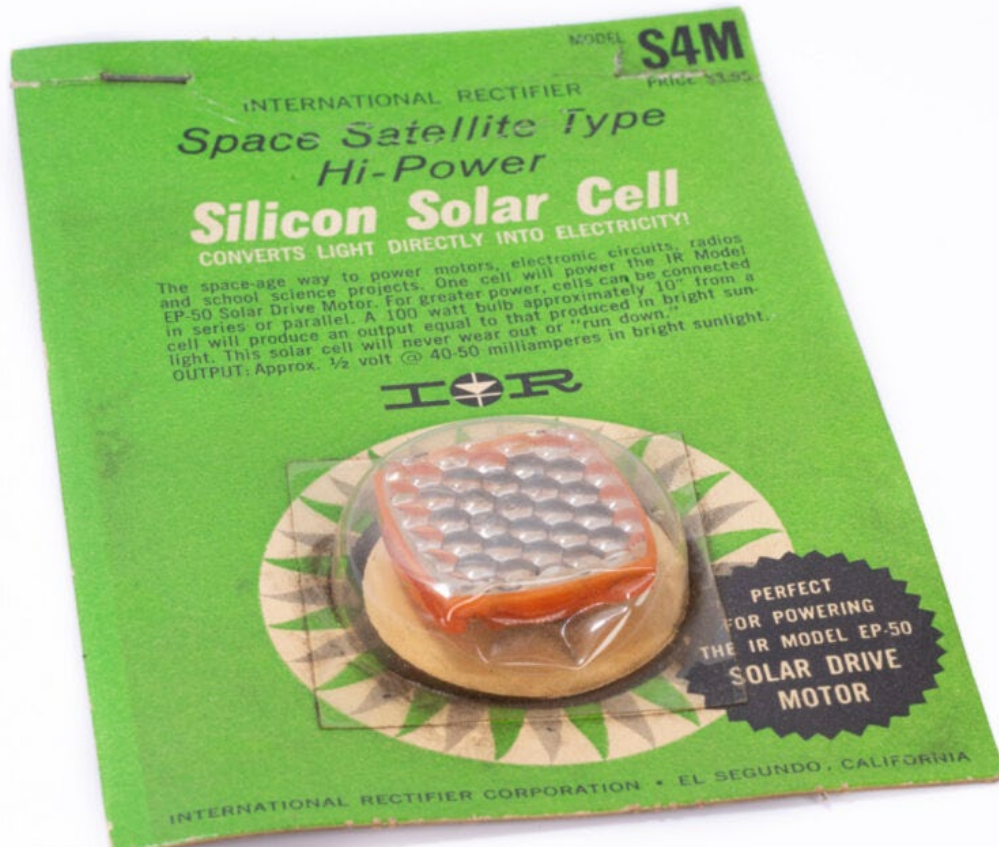
Byrom House Overview

Bill Byrom (Irving TX) --- North Texas Clean Energy Group
solar@byrom.net



Early Solar Cells

My first solar cell was an International Rectifier model S4M, which I used while I was an elementary school student 60 years ago (about 1965). I also owned an EP-50 small DC motor which spun rapidly when powered by the solar cell in direct sunlight. Some of the first solar cells were used to power satellites.



Energy Use Affects the Quality of Life

- Energy is expensive – improving efficiency can help your budget
- Human health and comfort require both heating and cooling of our homes and vehicles in our North Texas climate
- Air pollution due to energy use in our homes and vehicles can lead to discomfort and medical issues such as allergies and cardiovascular disease
- The location of the air pollution can be inside the home, local emissions from a vehicle tailpipe, when refilling a fossil fueled vehicle at a gas station, or outside in the general environment
- Some home HVAC systems and autos can generate noise pollution
- Global warming & other societal issues are directly affected by energy use

Ozone Air Pollution in North Texas

- Dallas Morning News (2025): **Long ozone season starts up in DFW.** Increase in pollutant raises air quality concern for many until November. By MIRIAM FAUZIA, Staff Writer. Ozone season is upon North Texas, meaning air quality will be top of mind for some residents. The season — which marks the window when there's a greater risk of harmful amounts of ground-level ozone — is actually the majority of the year in Dallas-Fort Worth, lasting from March 1 to November 30.
- Ozone is a gas formed in the atmosphere when three atoms of oxygen combine, according to the Texas Commission on Environmental Quality.
- While overall air quality has improved over the past few decades, ozone levels continue to exceed federal standards.

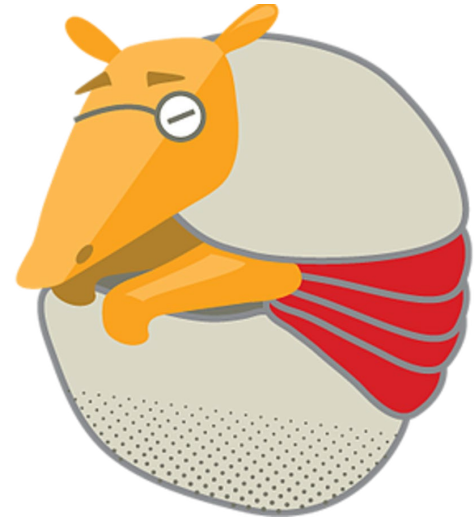
Ozone Action Day **Level Red** DFW Area on Friday Sept 25

Ozone is predicted to be at Level Red in the Dallas-Fort Worth area on Friday, September 25. Here are some examples of things you can do to help improve air quality:

- Drive an **Electric Vehicle**
- Telecommute, carpool, or vanpool
- Bike or walk instead of driving
- Take public transit such as DART, Trinity Metro, or DCTA
- Reduce idling and observe the speed limit

Children, older adults and people with lung disease, such as asthma, emphysema, or chronic bronchitis, should avoid outdoor activity if ozone reaches Level Red. All other people should limit prolonged outdoor exertion if ozone reaches Level Red.

For more information, visit **AirNorthTexas.org**



Building Energy Efficiency

- HVAC heating and cooling of buildings depends on isolating the indoor environment from the outdoor environment
- One important area where energy can be wasted is air leakage around door and window gaskets as well as other locations
- Energy can also leak directly through windows and doors
- Quality insulation of the building envelope is also important, including walls, ceilings, roofs, and flooring
- Many technologies with varying efficiencies are available for heating and cooling the air inside a building – more on this later

Energy Use in a Home

- The greatest use of energy in a house is usually the HVAC and water heating systems
- But appliances also use a significant amount of energy. These include a refrigerator, oven, range top, dishwasher, washing machine, and clothes dryer. Televisions and other electronic devices can also use a significant amount of energy if they are left on for many hours.
- Lighting and fans also consume quite a bit of energy, especially if used for long periods. LED lighting is much better than incandescent.
- Natural gas appliances burn methane and release air pollution and greenhouse gases. Trace gases such as benzene are also released.

Sources Of Energy For Home Use (**grid**/**local**)

- Electric grid supplied renewable energy (solar, wind, hydroelectric)
- Electric grid supplied nuclear energy
- Electric grid supplied fossil fueled energy (methane gas, coal, oil)
- District or co-generation energy (not available in most areas)
- Natural gas via pipes (methane) and oil in some northern states
- Local home solar panels (and batteries)
- Vehicle to house transfer from electric vehicle (coming soon!)
- Heating or electric generator using methane, propane, or gasoline

Renewable vs Non-Renewable Energy Sources

- Renewable energy sources (solar, wind, and hydroelectric) are essentially non-polluting and rely on energy provided in our current era from the sun
- Non-Renewable fossil energy sources (methane, oil, propane) normally require burning of fuels which were created using energy from the sun in previous eras, producing air and often other pollution, including greenhouse gases
- Nuclear energy is technically non-renewable, but does not produce air pollution. But it does produce radioactive waste and thermal (heat) pollution

Renewable Energy Supplied From The Grid

- In most areas of North Texas you can purchase electricity produced by solar farms and/or wind farms
- Solar farms are photovoltaic (PV) solar power plants. Light from the sun directly produces electric power using solar cells mounted on panels. Large solar farms are usually in areas with fewer clouds and moderate to low land cost.
- Wind farms are in areas which tend to receive a lot of wind, often at night. These are often found in areas west and northwest of North Texas, as well as in Oklahoma.
- Hydroelectric power is not prevalent in North Texas.

Home Solar Power Systems

- Solar panels can be mounted on a roof, carport, or a ground mount
- Power is usually generated only when the solar panel receives direct sunlight illumination. Some solar panels are bifacial and can also generate power from the rear of the panel.
- Batteries are often added to the system for use at night.
- The output of a solar panel has a negative temperature coefficient. For example, heating a solar panel by 18 degrees F (10 degrees C) might reduce the power output by 3.4%.
- The output is greatest when sunlight falls normal to the panel surface. So the output varies through the day and during different seasons.

Byrom Net Zero House in Irving TX

- This house was built by owner Bill Byrom between 2020-2023. I bought the 30 year old house on this corner in 1994 and lived in it until I decided to replace it with a new custom energy efficient house without foundation, plumbing, and electrical wiring problems.
- I moved into the new house in April, 2023. The solar power system was activated in September, 2023.
- This is a Zero Energy Building (ZEB). Energy cost is zero (about \$11.33 per month average credit and no monthly energy bill any month since system activation).
- The house is all-electric with no natural gas connection.

Features of this house

- All-electric zero energy building (ZEB)
- Solar power system
 - 14.4 kW DC: 36 X 400 W solar panels (Q.Peak DUO BLK ML-G10)
 - Tigo TS4-A-O optimizers for each solar panel (provides quick disconnect)
 - Sol-Ark 15K system inverter (this is the heart of the solar power system)
 - Fortress Power Vault Max 18.5 kWh LiFePO4 ESS storage battery
- Wallbox Pulsar Plus Level 2 EV charger (mfg in Arlington, TX)
 - Installed to support 40 A (9.6 kW) maximum charge rate at 240 VAC
- Energy efficient double pane windows with insulated motorized window shades for all except two small windows

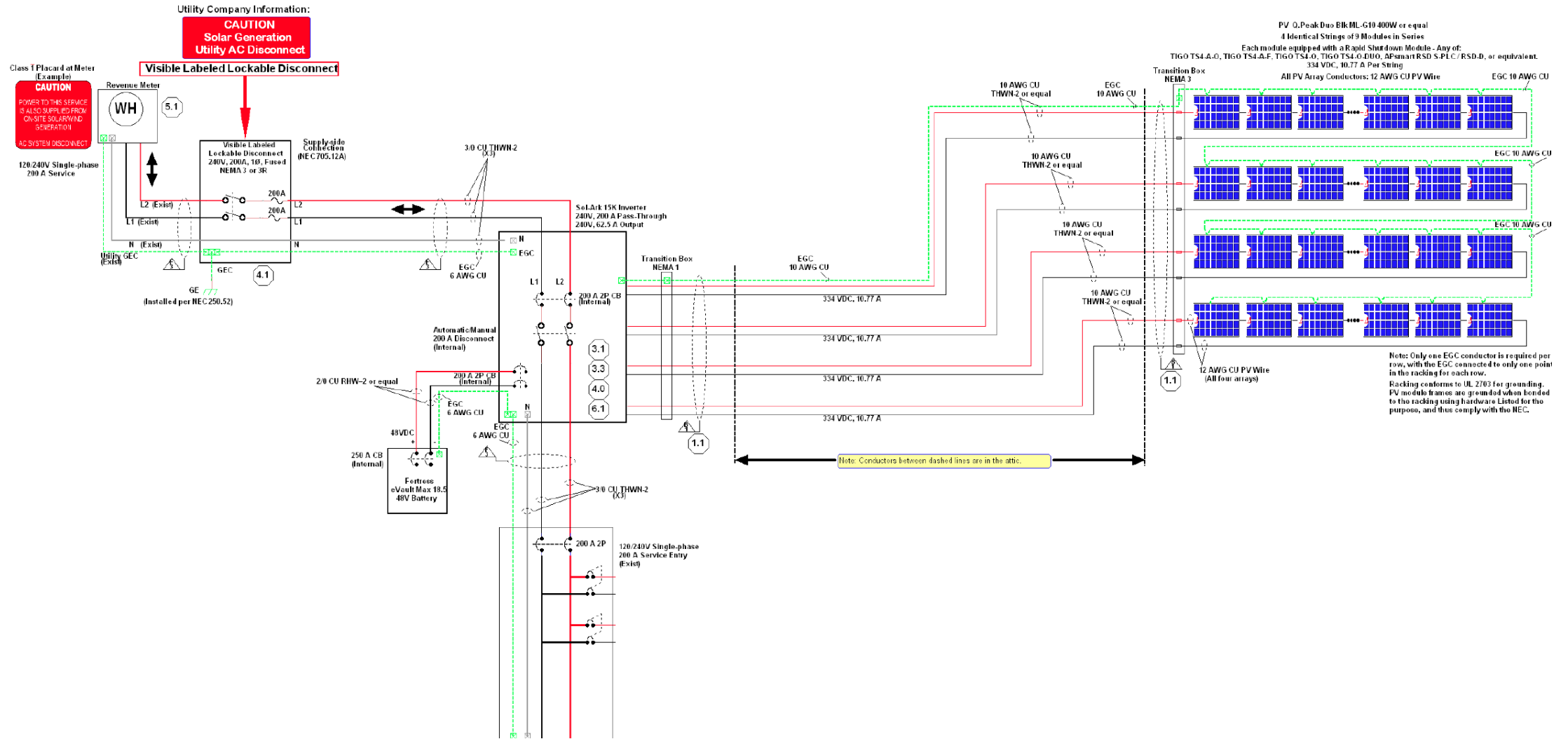
Additional House Features

- Ground source heat pump HVAC and water heating system
 - Six 275 ft deep geothermal boreholes were drilled in the back yard
 - Water circulates in underground tubing through these boreholes
 - A refrigerant-based heat pump in the attic transfers heat between the house and the large underground rock volume beneath the back yard
 - This is the most efficient HVAC system available, with a SEER rating of 56
- Attention during construction to full insulation of all walls and attic areas
- Noise reducing wallboard material on lower level to reduce sound transfer
- Low VOC materials, including natural cork water resistant flooring

More House Features

- Raised seam metal roof (rainfall runoff feeds drip irrigation system)
- Large elevator and circular staircase for second level access
- App-controlled smart house features
 - LED room lighting, vent fans, and room fans with additional LED lights
 - Motorized remotely controllable exterior door locks (3 doors)
 - HVAC system control and monitoring
 - Exterior garage overhead door remotely controlled with cameras
 - ***Sol-Ark*** and ***Tigo*** remote control and monitoring of solar power system

Solar Power System



Operation of the Solar Power System

- PV (photovoltaic) power from the 36 solar panels can be used to advantage in several ways:
 - If the house load (including EV charging) is higher than the PV output, the solar power reduces the import (purchase) of grid energy. Small systems with only a few solar panels can significantly reduce their energy expense. This is true even if the system is not set up to sell energy to the grid.
 - If the PV output exceeds the house load and the system is set up for bidirectional metering, the system can sell power to the grid. Unfortunately, current REP plans typically pay much less for grid export than for import.
 - If the system has a large ESS (Energy Storage System) battery, the house may be able to operate all (or most) of the night using the battery, then recharge the following day. This is called **load shifting** and can reduce your bill.

Zero Energy Building (ZEB) Definition

- A zero energy building (ZEB) produces enough renewable energy to meet its own annual energy consumption requirements, thereby reducing the use of non-renewable energy in the building sector.
- ZEBs use all cost-effective measures to reduce energy usage through energy efficiency and include renewable energy systems that produce enough energy to meet remaining energy needs.
- There are a number of long-term advantages of moving toward ZEBs, including lower environmental impacts, lower operating and maintenance costs, better resiliency to power outages and natural disasters, and improved energy security.
- Reducing building energy consumption in new building construction or renovation can be accomplished through various means, including integrated design, energy efficiency retrofits, reduced plug loads and energy conservation programs. Reduced energy consumption makes it simpler and less expensive to meet the building's energy needs with renewable sources of energy.

Source: “A Common Definition for Zero Energy Buildings” prepared for the US Department of Energy by the National Institute of Building Sciences

Effect of Solar Power System on Electric Bill

My REP (Retail Electric Provider) is Green Mountain Energy (GME). I have a solar buy-back plan. Here are details of my particular multi-year plan:

- Import from grid: \$0.10307/kWh + ~\$0.0558/kWh Oncor delivery charge
- Export to grid: -\$0.05307/kWh per month
- Taxes and fixed service fee

Note that the Oncor delivery charge and taxes can significantly increase the cost of energy imported from the grid (purchased). The effective cost of importing energy is about 3X what I receive by exporting my solar energy to the grid through GME.

In real world conditions, I need to import a little each day to make it easy to run my system during very cold or very hot weather when my ESS battery can't keep the HVAC and other loads running all night.

Byrom House Solar System Results

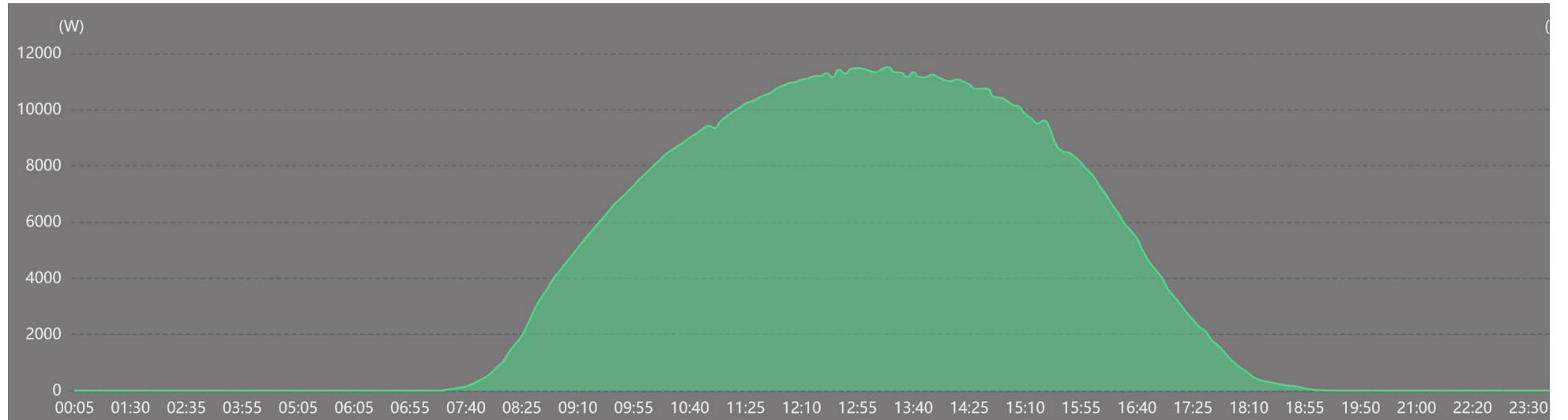
- Conditioned area: 3,143 sq ft all-electric building with natural gas consumption of 0 therms (no gas or propane service to house)
- 2025 house + EV charging electrical load: 11,303 kWh
- 2025 solar power system PV production (AC): 22,800 kWh
- 2025 grid electrical power import (purchase from grid): 2,118 kWh
- 2025 grid electrical power export (sell to grid): 11,861 kWh
- 2025 net export sales to grid (export - import) **surplus**: 9,743 kWh
- 2025 discharge from ESS storage battery (load shifting): 3,612 kWh
- **Total net energy since system was activated in Sept 2023: Under Zero**
(no monthly bill was due and about \$136 accumulated credit per year).

Sun Angle Effect on Solar Power System

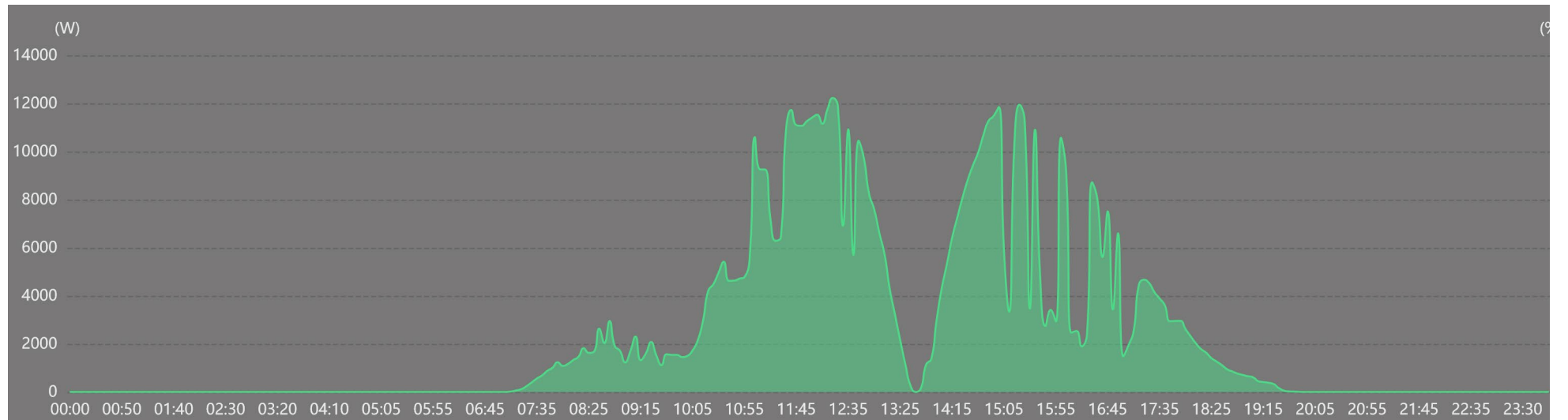
- The Earth's axis is tilted at about 23.5 degrees to our solar orbit, producing differing maximum (local noon) sun angles to the horizon through the year at our latitude of 32.8 degrees north:
 - 57.2 degrees sun height at vernal (March 20) and autumnal (Sept 22) equinox
 - 33.8 degrees sun height at winter (Dec 21) solstice
 - 80.6 degrees sun height at summer (June 20) solstice
- My south-facing roof (containing solar panels) is angled at 30 degrees, producing maximum output at a sun height of $(90-30)=60$ degrees. This is close to optimum for our latitude. The roof faces directly south and the power output follows a modified cosine curve each day.
- The maximum power from the solar panels should be near the equinoxes, when the peak sunlight is directly orthogonal to the panels. Energy production during the summer is increased due to the long days, but the panel output is reduced by 0.34% per degree C. The output in the winter is reduced due to shorter days. Thick clouds reduce the output significantly.

PV Generation on Clear and Cloudy Days

Wed Oct 1, 2024

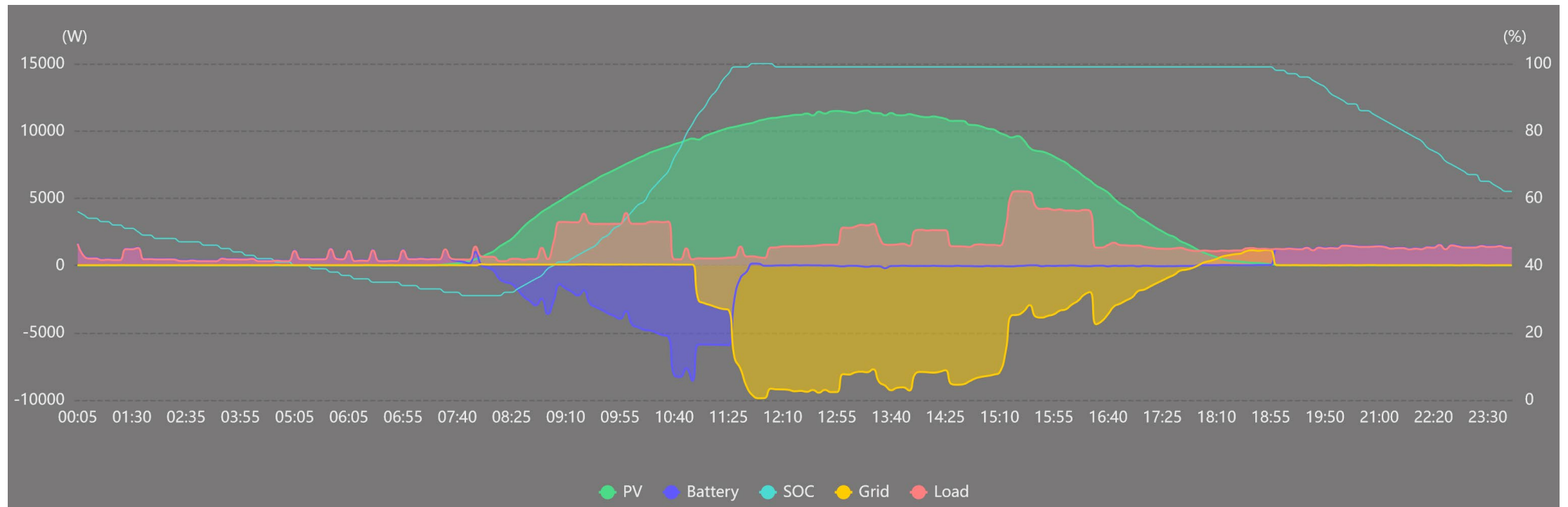


Mon April 8, 2024



Load Shifting Using ESS Battery

My Fortress Power ESS battery can power my house for most or all of the night (depending on temperature and appliance use). The Sol-Ark system inverter is programmed to favor battery use at night. As soon as the sun rises the next morning, the battery is recharged (usually by noon). Energy is exported (sold to the grid) each afternoon and only a small amount of energy is imported (purchased from the grid) before sunup and around sundown.



Comparison with Artemis II Spacecraft

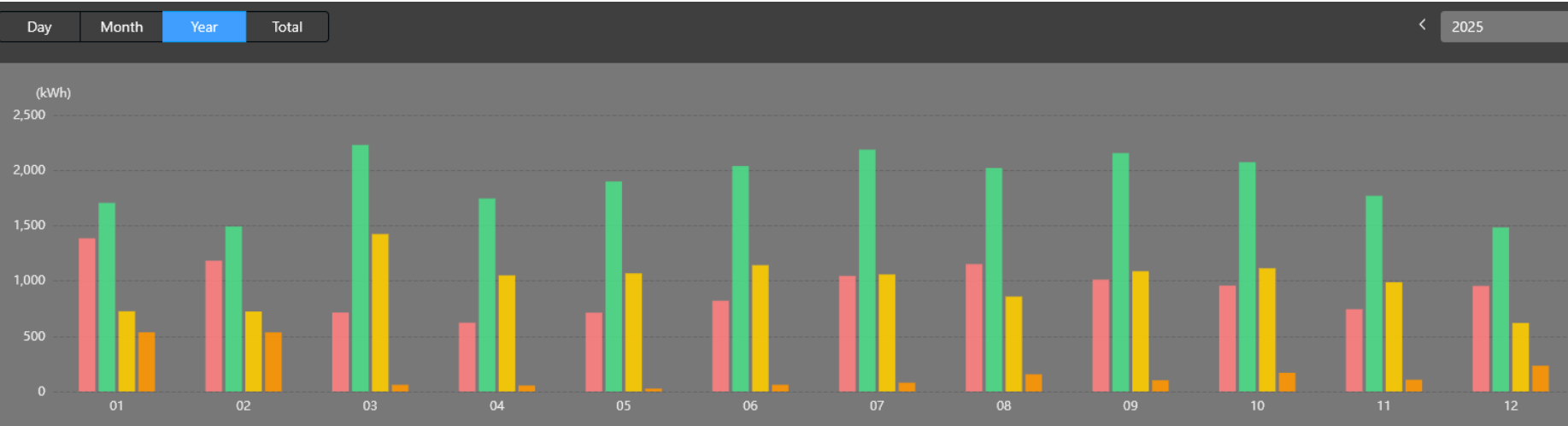
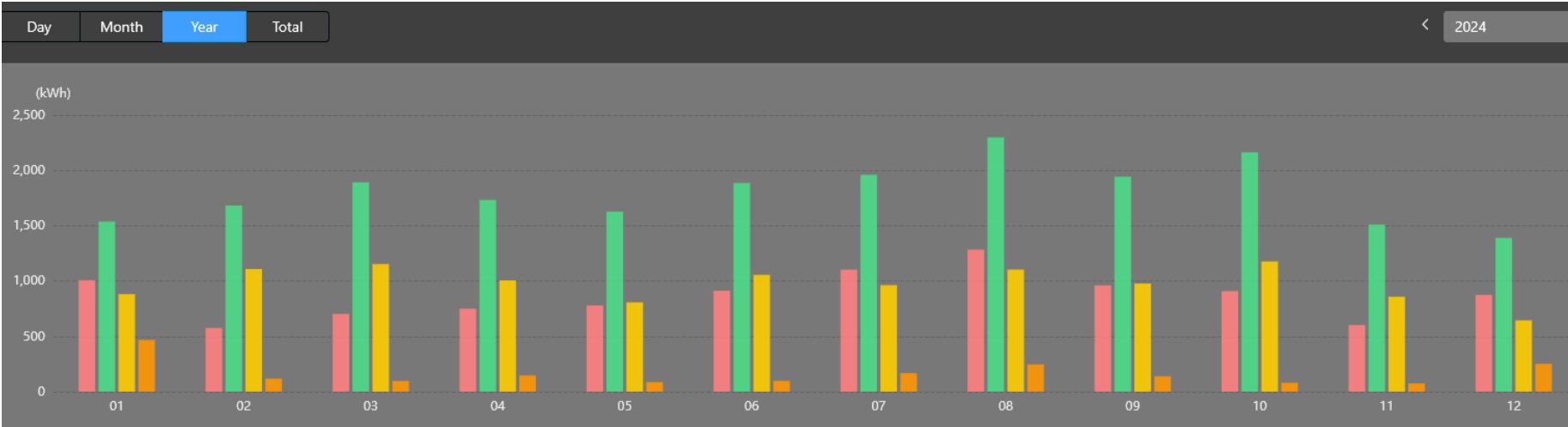
- The European Service Module supplies power to the Orion capsule
- Four movable solar panel wings (each 7 meters long)
- Total mean DC output in daylight: 10.5 kW
- Spacecraft effective daily generation: 180 kWh/day
- Byrom house average daily generation: 62.5 kWh



Solar System History

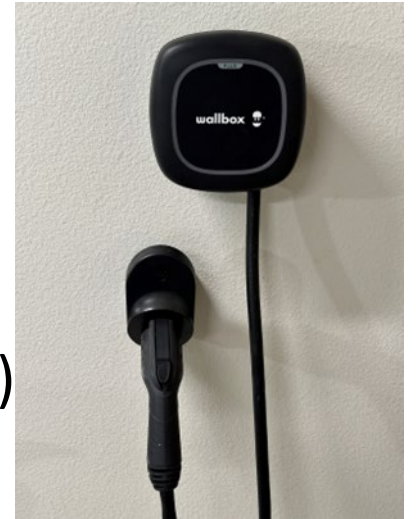
2024/2025

Red: PV generation
Green: PV generation
Yellow: Export to grid
Orange: Import from grid

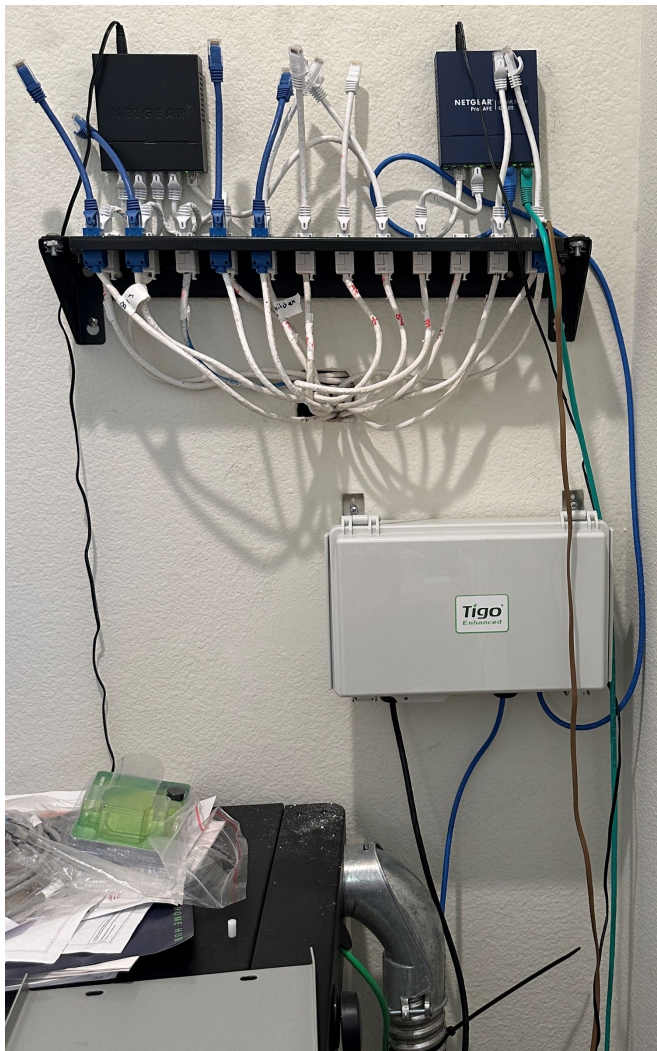


Hyundai IONIQ 5 EV with Wallbox charger

- AWD (dual motor, four wheel drive) full electric SUV
- Original EV battery and power train warranty: 10 years / 100,000 mi
- Battery: 77.4 kWh (about 230 mile range)
- Typical around town mileage: ~ 3 mi/kWh (330 wH/mi)
- Charge rate with Wallbox level 2 charger (set to 40 A max at 240 VAC)
 - @6A (1.44 kW) >> 30 min / 1% charge level
 - @10A (2.4 kW) >> 20 min / 1% charge level
 - @20A (4.8 kW) >> 10 min / 1% charge level
 - @40A (9.6 kW) >> 5 min / 1% charge level
- Charge time from 20% to 80% SOC: ~5 hours @40A
- Vehicle can be charged using 120/240 VAC (level 2) or fast DC charging







Demolition & New House Construction Photos

