

Ottawa PC Users Group

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Energy Freedom & The Internet of Things

An Attack on Fossil Fuels
Reduce the Impact of Climate Change

By

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Pi Desktop



- Overview
 - The Pi Desktop includes an expansion board that can turn a Raspberry Pi into a real desktop PC.
- Features - Intelligent On/Off power switch
 - mSATA SSD socket for up to 1TB on-board storage
 - Integrated RTC (Real Time Clock)
 - Includes case and heat sink
 - Safe power controller
- Use of digital technology to provide energy efficiency.

Climate Change

- Since 1750 – 150 billion tons waste CO₂
- 2016 dumped 9.9 billion of the 150. Profits for billionaires.
- Trump: “Hoax link between CO₂ and Climate Change”.
- Scientific evidence is overwhelming – population major issue
- 400 ppm not seen for 800,000 years
- For 1.5 C rise – 14 months use up CO₂ budget, for 2 C – 10 years
- 2016 records set for sea ice minimum, sea level rise, at +1.1 C,
- Mass Extinctions underway. Every 20 minutes today sees extinction of a plant or animal species.
- Human extinction not impossible, misery and suffering is certain.
- Significant population correction expected. Foresight.
- Live in harmony with all other life forms – stop poisoning, stop killing.
- Diseases from eating, drinking, breathing poisons.

What are you doing?

- What are you doing, your legacy, our legacy? Fighting back is vital to building a better future of our ecosphere.
- Learn, talk, action, influence. Develop your war plan. Attack the Trump anti-science, anti-pollution disaster.
- My war against burning of fossil fuels and climate change mitigation using digital technology.
- Practical application of lifelong learning.

Mitsubishi i-MiEV (2014)



Capital Cost

- Starting at \$28,000
- Ontario Government Rebate \$8,500
- Mitsubishi Rebate \$3,500
- Purchase price = \$16,000
- Add GST, options, delivery etc ~ 20%
- Total about \$20,000

Running cost

- 12 kWh Lithium-ion battery
- Low rate full charge cost \$0.96
- 14 hours on low rate – full charge
- Distance 150 km book – best seen 147 km
- No oil changes, air filters, exhaust pipes
- Cost savings in what is not bought.
- Minnesota \$75 annual fee – lost road tax.

Some Specifications

- 120V/240V charging on passenger side
- DC quick charge on driver's side
- Remote pre-heating/cooling, timed charge
- Regenerative braking
- 8 year battery warranty (very important)

Shift Selector



California EV Incentives

- Exempt from toll fees in High Occupancy Toll (HOT) lanes
- Purchase rebates up to \$2,500
- Sales Tax Exclusion for Manufacturers
- Alternative Fuel & Vehicle Incentives
- Insurance Discount
- Residential Charging Rate Reductions
- Electric Vehicle Supply Equipment Rebate
- Free Parking on city streets
- 50 or more free parking spaces in park-and-ride lots
- Vehicle emissions inspection exemption

EV and Energy Freedom Project

- Digital technology subsystem to manage charge time (energy storage)
 - When ‘free’ solar energy is available
- EV battery can become available to support energy demands in the home.
- Subsystem controlled by a Raspberry Pi

Energy Freedom Project

- R3000 home built in 1985 – 3,500 sq ft
- Many passive heat retention, reduced air leaks
- Cost \$200/year to heat
- Sold and downsized to 1,700 sq ft bungalow
- Some heat retention modifications made
- Now the home for the Energy Freedom Project – Laboratory still being built.

Green House Gas Emissions

- It is recognized that 50% of home energy use for home internal climate (water heating, cooking +)
- Transportation using gasoline engines is more than 10 – 20 times more expensive than an Electric Vehicle.
- It has been reported that 23% of Canadian GHGs are produced by transportation.
- Focus on reduction of home and transportation GHG emissions.

Energy Freedom Project

- A Cleantech Initiative to test new ideas and to explore new solutions by advancing personal Energy Efficiency
- Joining the War against Burning Fossil Fuels
- Canadians must acquire the ability to live sustainably and become a lasting presence on this planet. Learn how and when to use and generate energy.
- Sustainably and smoothly integrate into natural global processes.
- Baseline completion in summer of 2017.

Five Focused Energy Challenges ⁽¹⁾

1. Electricity:

How can we deliver reliable, affordable zero-carbon electricity to the world? Non-fossil fuel generators.

2. Buildings:

How can we eliminate emissions from our homes, offices, hospitals and schools? Go all electric. Generate your own power.

3. Manufacturing:

How can we make everything we use without emitting greenhouse gases? 3D printing, Blockchain, IoT, more.

Five Focused Energy Challenges (2)

4. Transportation:

How can we get around our communities and the world without emitting carbon? Electric cars, trucks, trains, airplanes, ships.

5. Food:

How can we feed the planet without contributing to climate change? Greenhouses (81,000 jobs in Ontario). Plant to Plate distance.

- This project will address electricity, buildings and local transportation. Food and Manufacturing beyond project scope.

Project Mission Statement

To develop fully transparent hardware, software, data analysis and operating procedures to control the home internal climate, energy usage, energy production and family local transportation.

My home becomes a laboratory for a very smart energy efficient, energy producing structure that is part of the Internet of Things.

The energy usage profile will be measured and adjusted for optimum cost efficiency

Benefits: (a) Survival during week long power failures and (b) avoid mismanagement of grid and gasoline cost variations or rationing. There is great concern that heat waves will cause grid “brown outs” or worse.

Project Vision ⁽¹⁾

- **FOSSIL FREE:**
- **ELECTRIFICATION:**
- **PARTS:** Using mainly commercially available parts
- **TRANSPORTATION:** Electric Vehicle.
- **DE-CARBONIZATION:** How close to zero can you get?
- **DISTRIBUTED ENERGY SUPPLIER:** sales to grid
- **BENEFITS:** affordable comfortable accommodation, improved personal cash flows, disconnected from political interference in personal energy supply and pollution reduction.

Project Vision ⁽²⁾

- **COLLABORATIONS:** Employs unusual national and international coalitions with NGOs, industry, government and academia linkages.
- **FUTURE INNOVATIONS:**
- **OPEN SOURCE:** not company Intellectual property
- **EXPERIMENTS:** field trial test platform
- **FIVE 'R's:** Recycle, reduce, repair, repurpose and remaining (using leftovers)
- **ENERGY EFFICIENCY:** technical challenge and lifestyle adjustments
- **CREDIBILITY:** Technical audits, inspections, peer reviews

Electricity Supply vs. Demand

- Power (kW) at all times

$$\text{Supply}(t) = \text{Demand}(t)$$

- Energy (kWh) flows thru a meter

supply side → meter → demand side

“Inside the meter”

Electricity Grid

- What happens on each side of your meter?
- Externally similar to the Internet – a cloud.
- Internally similar to a busy LAN – simpler?
- Most are unfamiliar with inside the meter
 - What is really happening?
 - Where is the energy going? How? When? Why?
 - No detailed records, few controls (switches, thermostats)
- Net metering vs. Micro-FIT (flow in tariff)

23.2 V

voltage

0.20 A

current

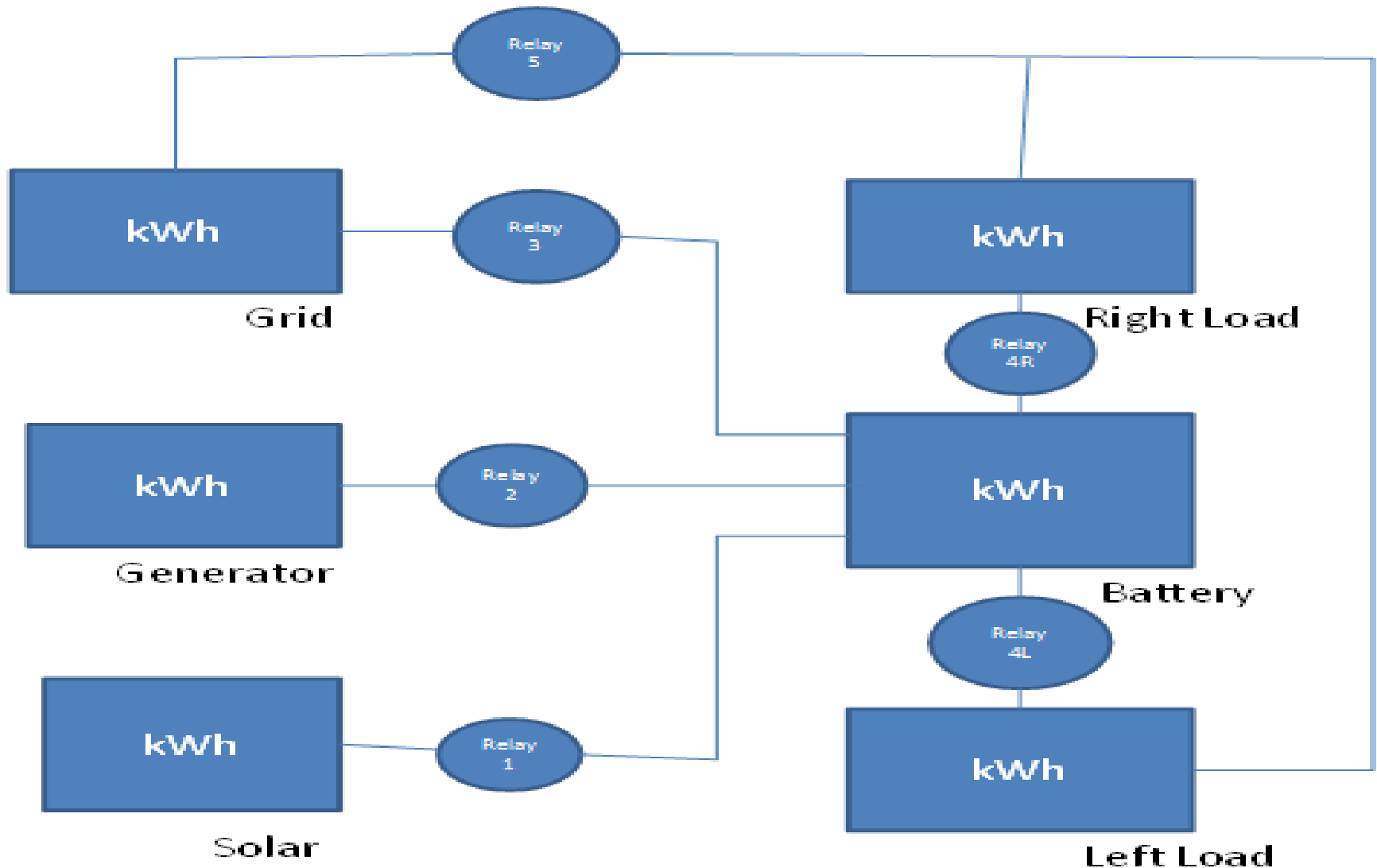
45.8 W

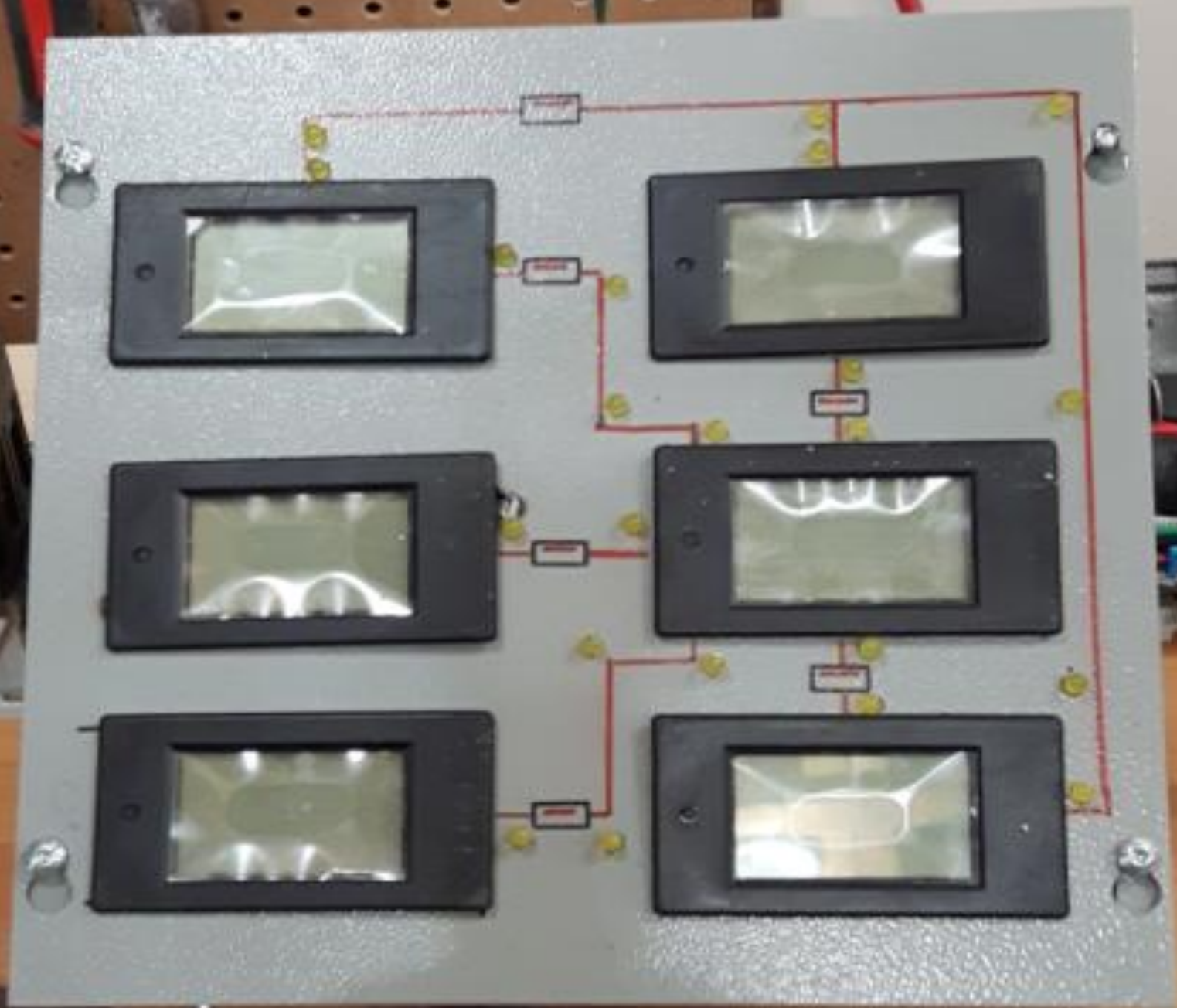
power

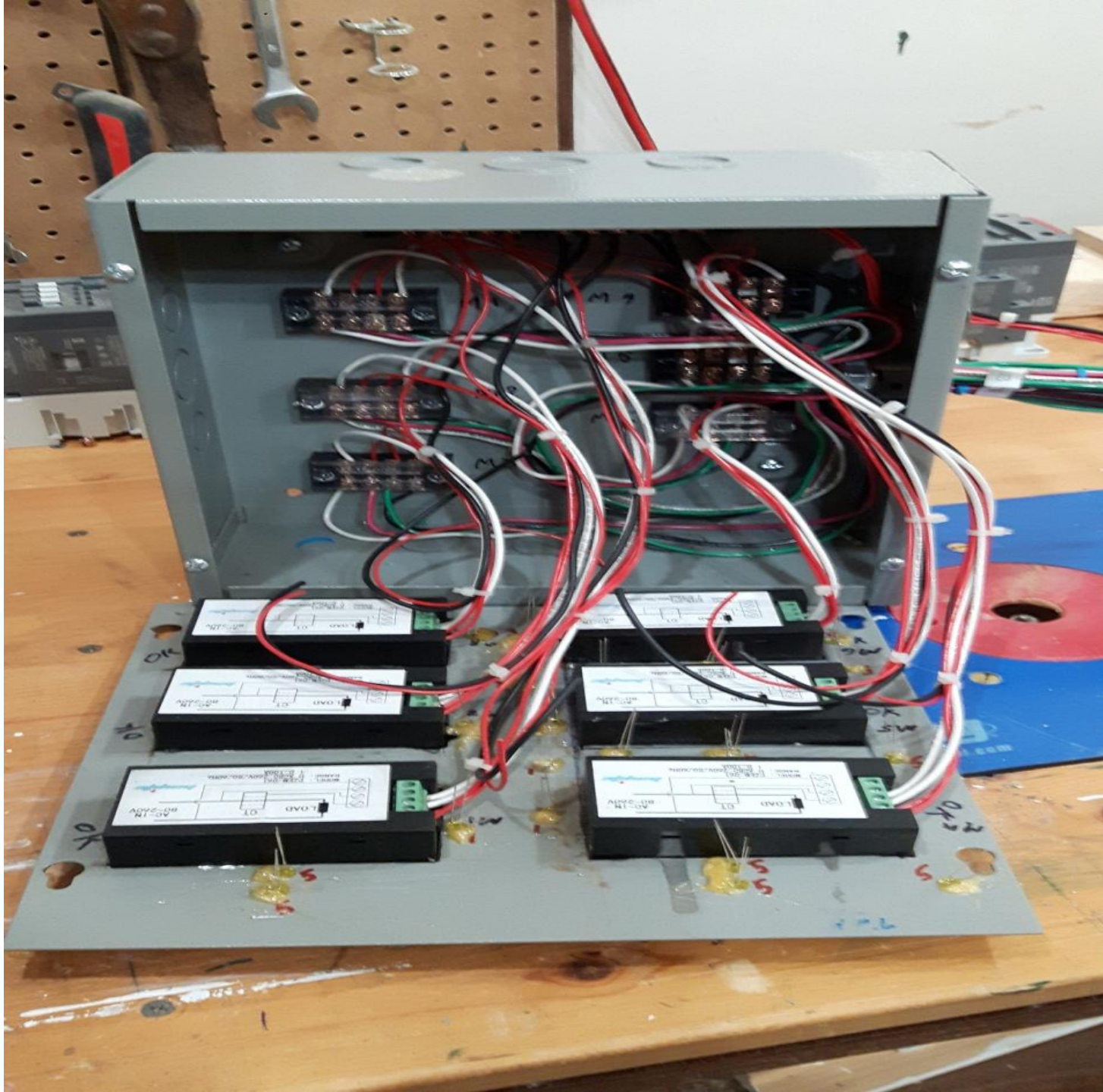
2 Wh

energy

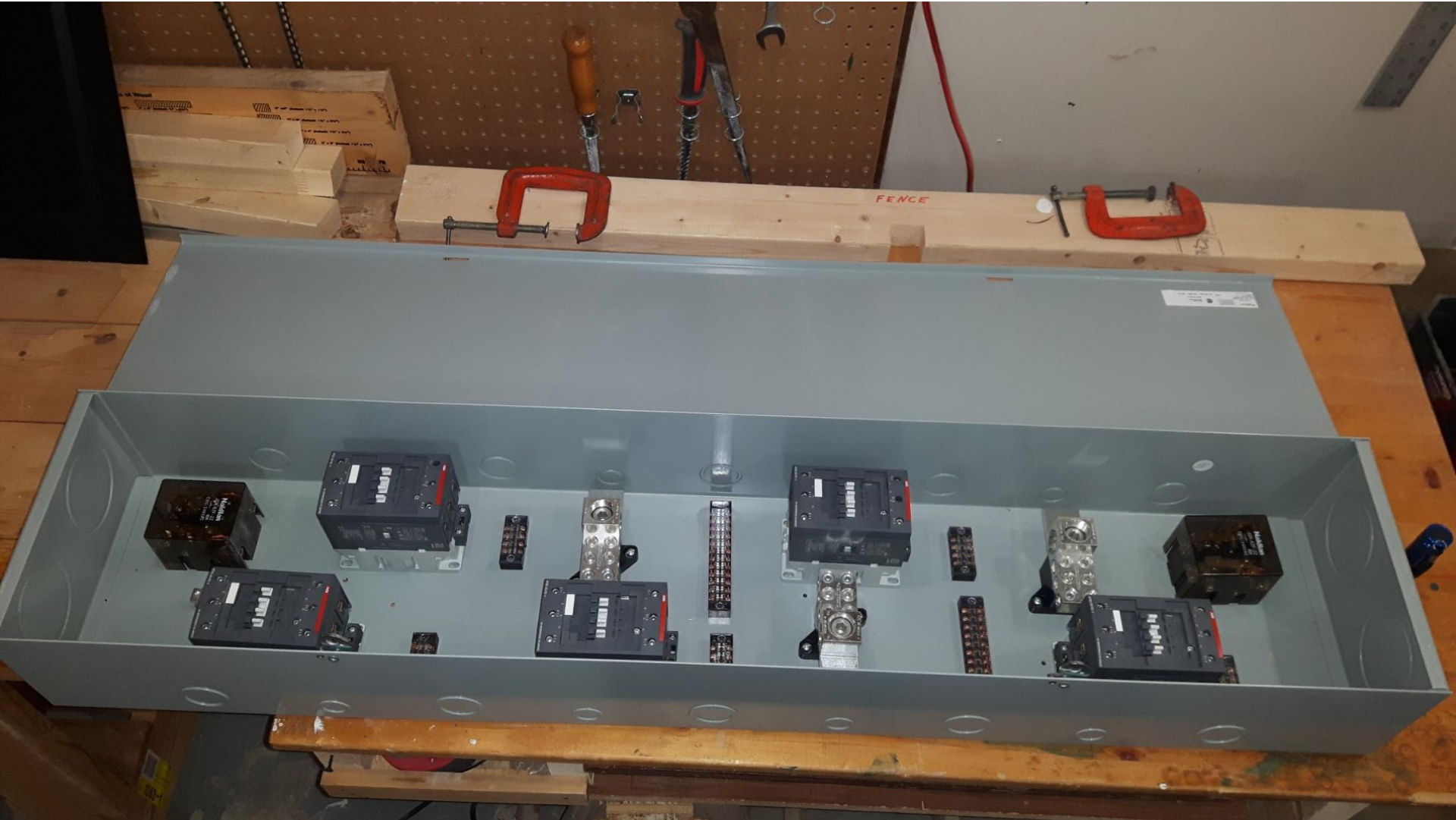
Energy Flow Display Panel







High Voltage Contactors



Command & Control Centre





Tesla Power Wall 2

- One 14 kWh Powerwall battery \$7,800
- Installation and supporting hardware starts at \$1,350
- Total estimate \$9,150
- Installations begin in June 2017 for Canada
first in Canada
- Vital to deliver supply = demand.
- Raspberry Pi controlled subsystem

Battery – Wall mounted



Two Orison Tower Batteries

(2kWh each, LED lights, Bluetooth sound, Pi subsystem)



Canadian Generator

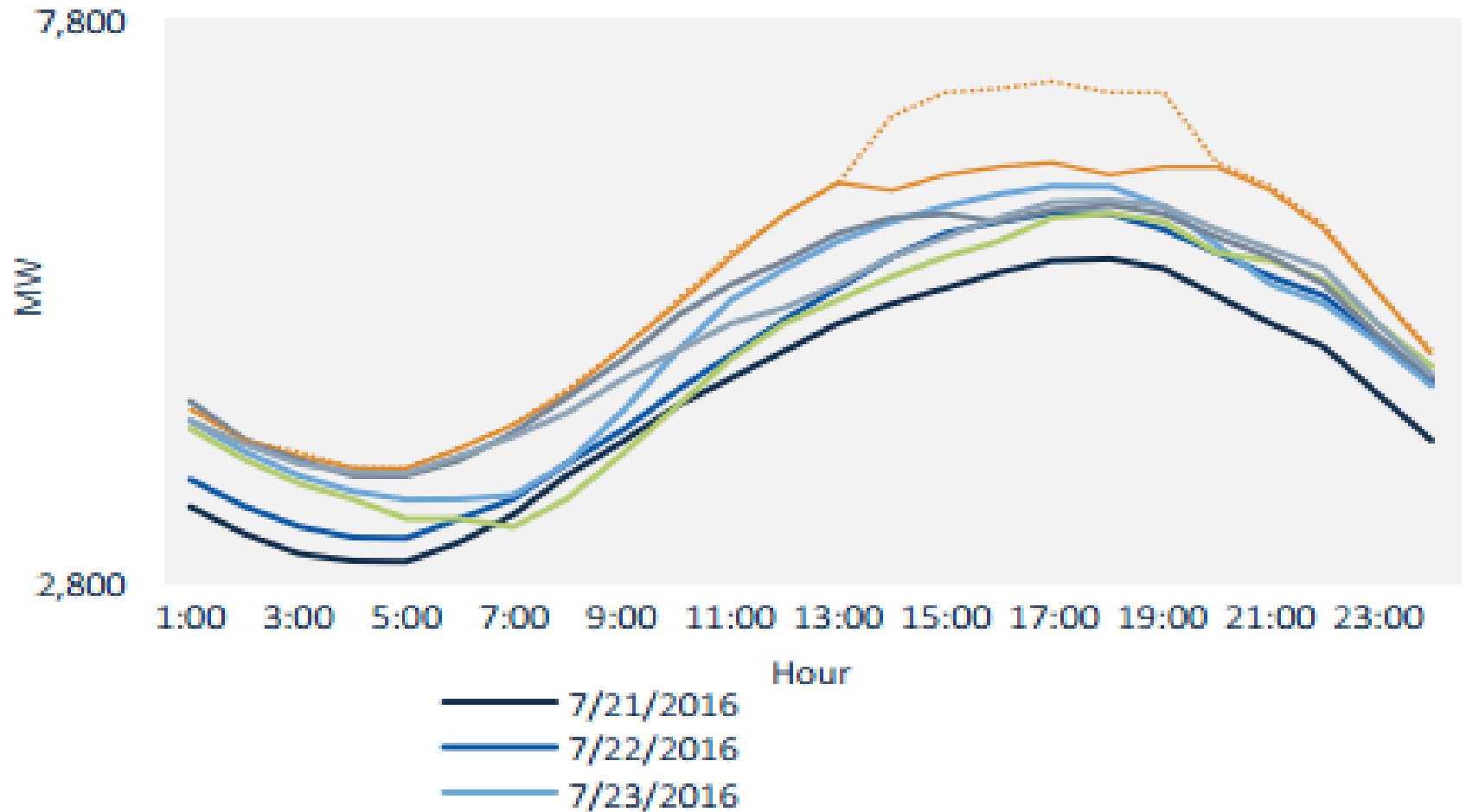
- New energy technology with Patent Pending
- No fossil fuels required. Water.
- Supplier moved to Saudi Arabia
- Working on acquiring a 5 kW unit for the Energy Freedom Project.
- Raspberry Pi controlled subsystem

Ground Source Heat Pump

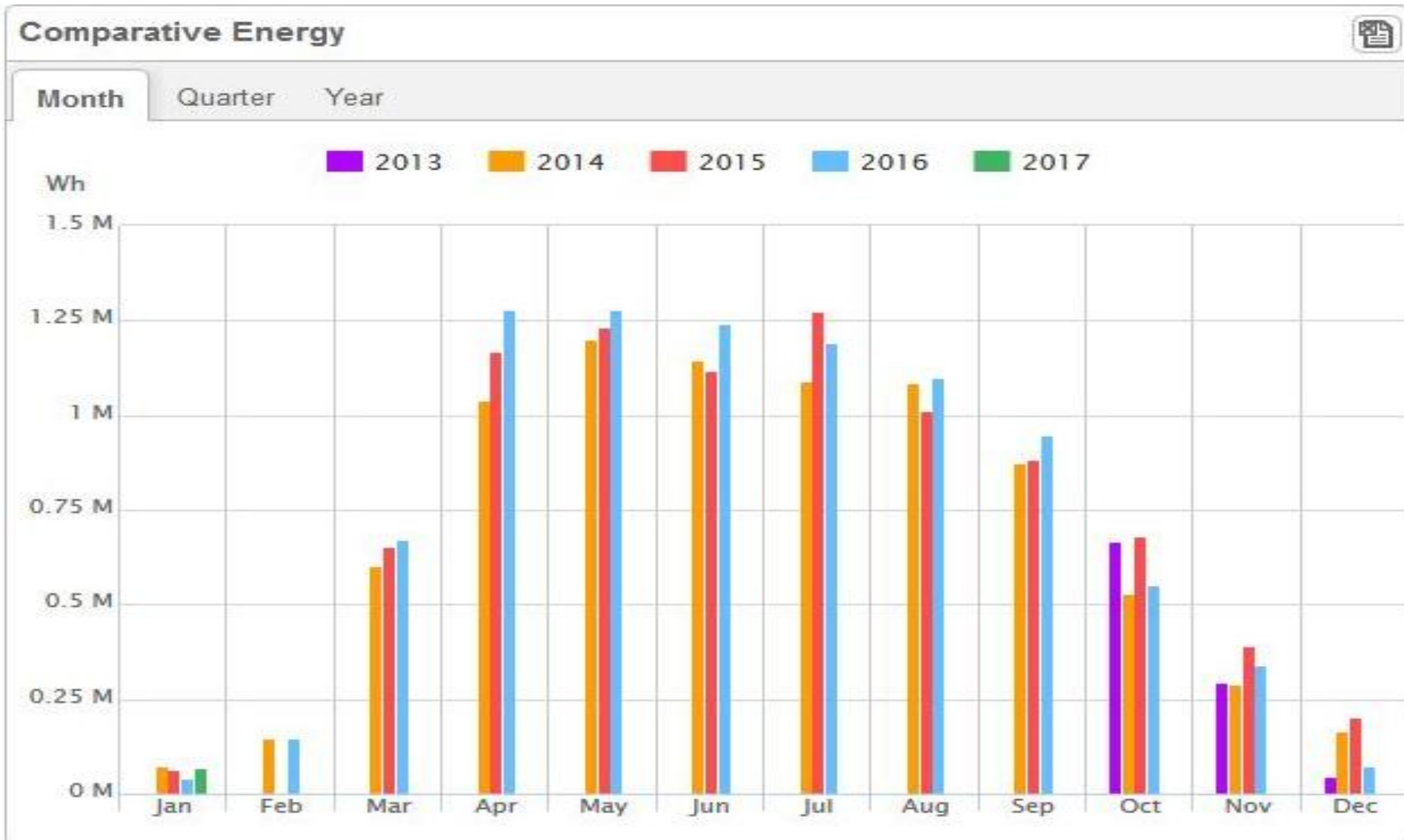
- Unique Canadian designed coil
- One home installation for 20 years
- Expect static COP > 4
- All home heat/cool, 70% water heating
- “block of ice”
- Integrate over full year to get COP >> 4
- Raspberry Pi controlled subsystem

Energy Demand Side Variation

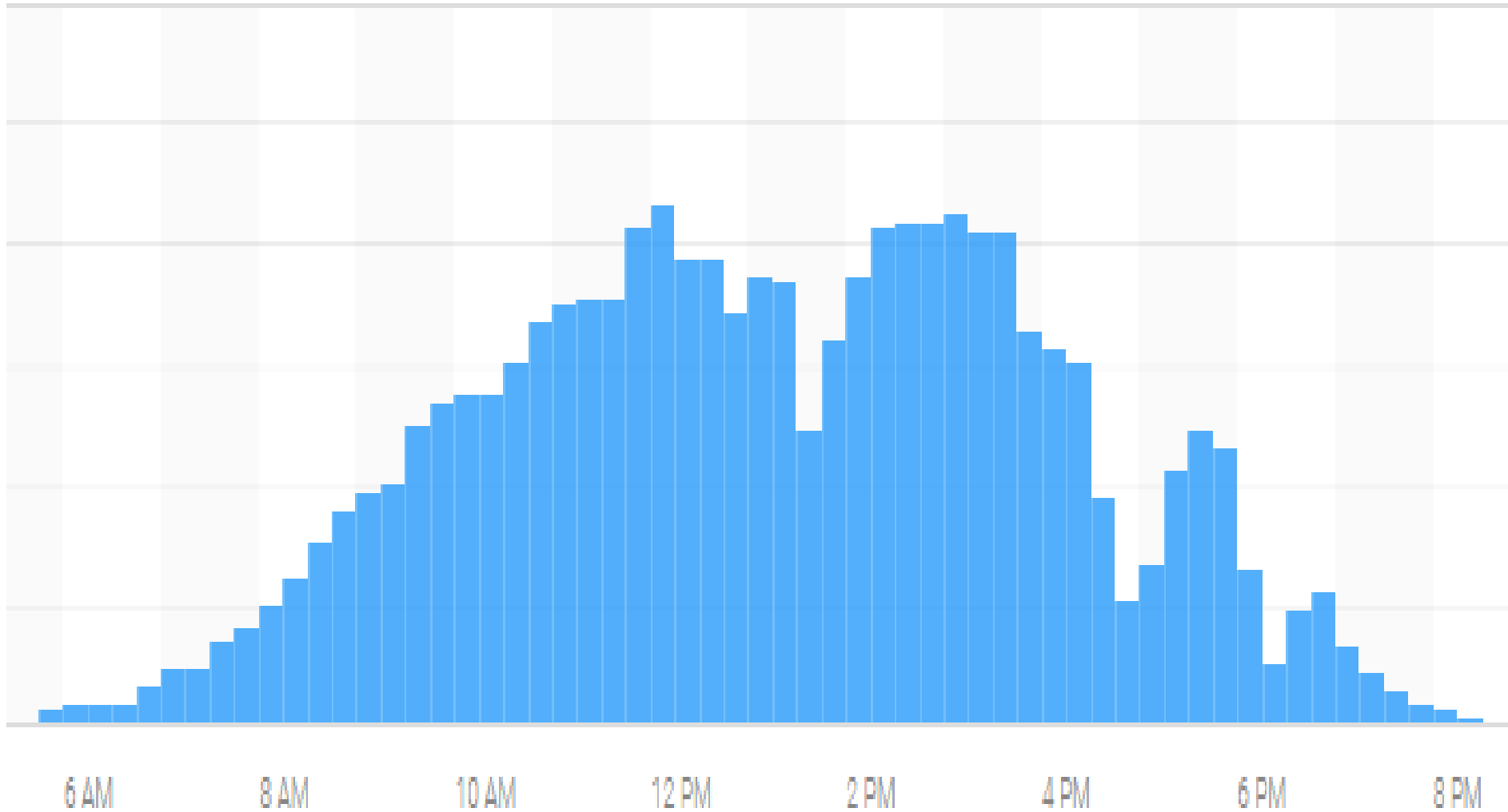
Load in BGE Territory During PJM Declared Heat Days



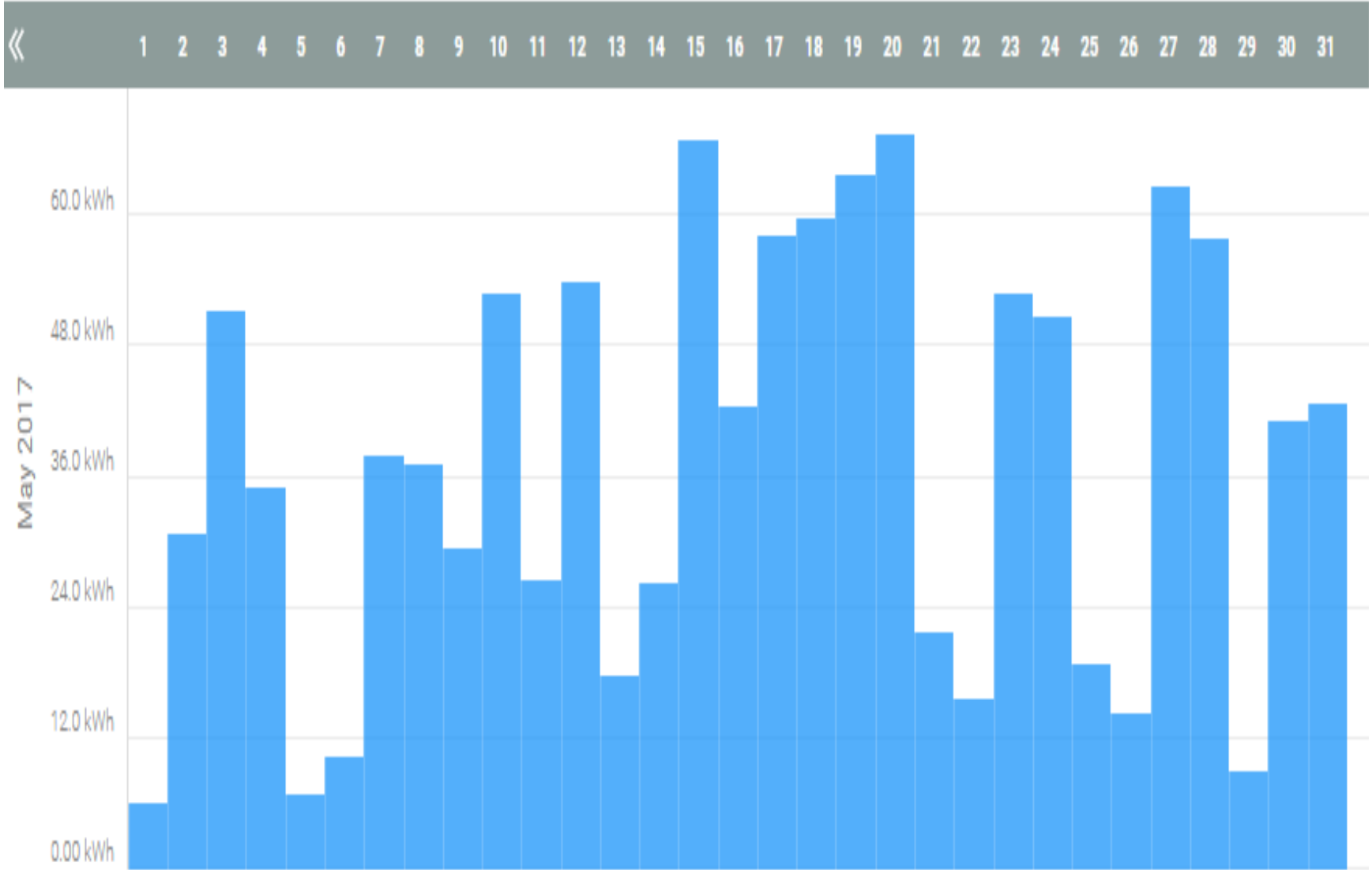
Solar Energy Supply Side



Daily Supply – 28 May 2017



May 2017 Solar Supply



Monthly Energy Production Report for Art Hunter

Enphase Energy maximizes your solar energy production and keeps you informed about your system. Your monthly energy report shows how your system performed and how much you contributed to offsetting the global carbon footprint.

Week	Peak Power	Energy Produced
05/01/2017 - 05/07/2017	9.06 kW	179 kWh
05/08/2017 - 05/14/2017	9.27 kW	245 kWh
05/15/2017 - 05/21/2017	8.44 kW	382 kWh
05/22/2017 - 05/28/2017	8.84 kW	274 kWh
05/29/2017 - 05/31/2017	8.83 kW	93.4 kWh
May 2017 Total:		1.17 MWh
Previous Month Total:		1.10 MWh
Year to Date:		3.17 MWh

For more details on these production results, please visit your [Enphase® system](#).

Your **Carbon Offset** for this month: 1,788 lbs

You have offset the equivalent of: **21 Trees**



DER Major Political Benefits

(Distributed Energy Resources)

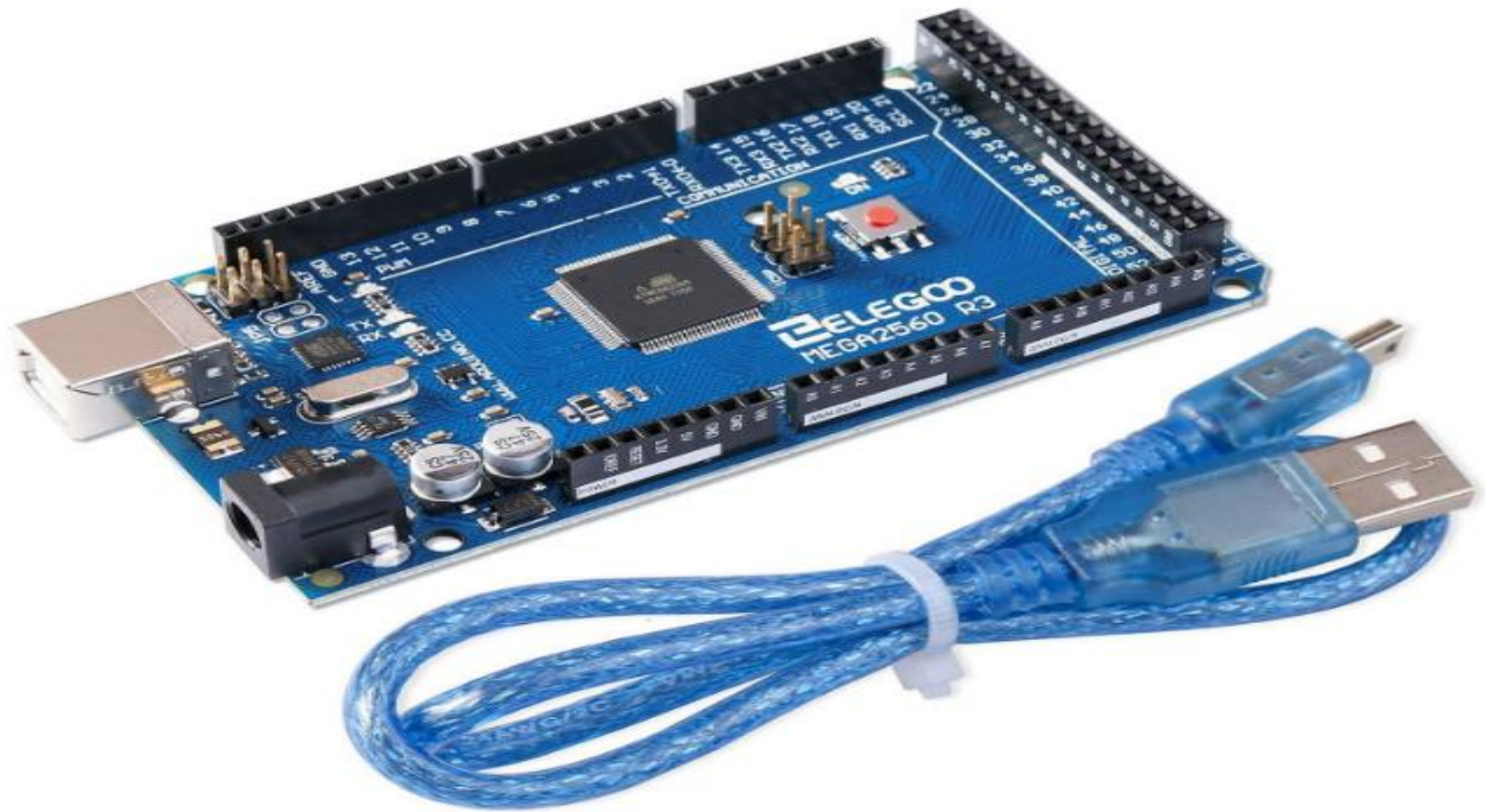
- *Distribution and Transmission*
 - *Hydro One infrastructure (generation and delivery) reduced*
 - *Energy Losses over long distances*
 - *Massive failure vulnerability reduced*
- *Public health benefits*
 - *Reduce air pollution and high voltage lines*
- *Environmental value*
 - *Reduced need for diesel grid 'top up'*

Home Demand

- Mainly unknown in detail but expect
 - Meal time peaks
 - Night minimum
 - Weather dependency
- Could time shift some demands
- Could reduce some demand (area heating)
- Raspberry Pi controlled subsystem

System Control

Arduino Mega 2560



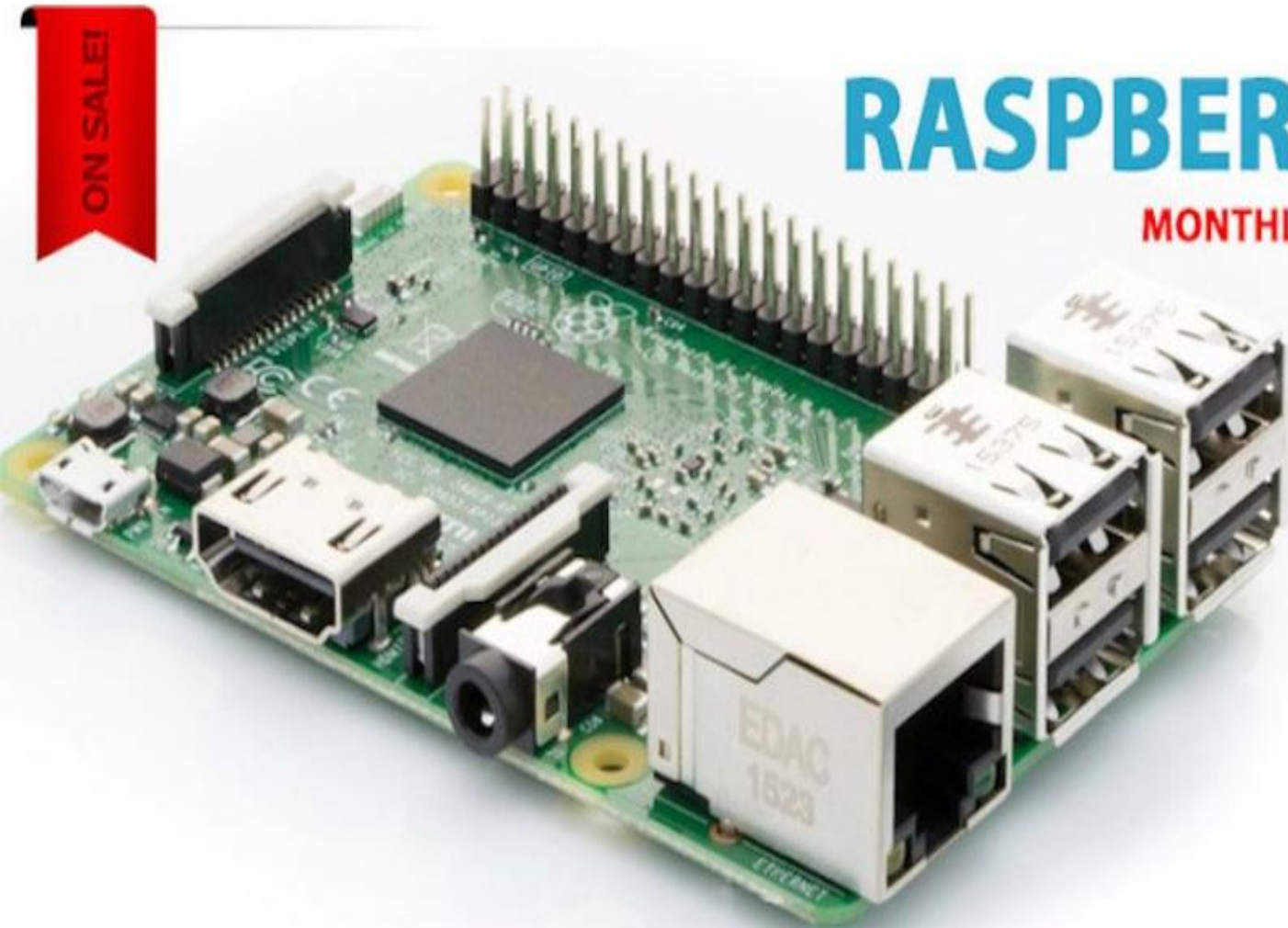
Subsystem Control Raspberry Pi 3B

RASPBERRY PI 3 B

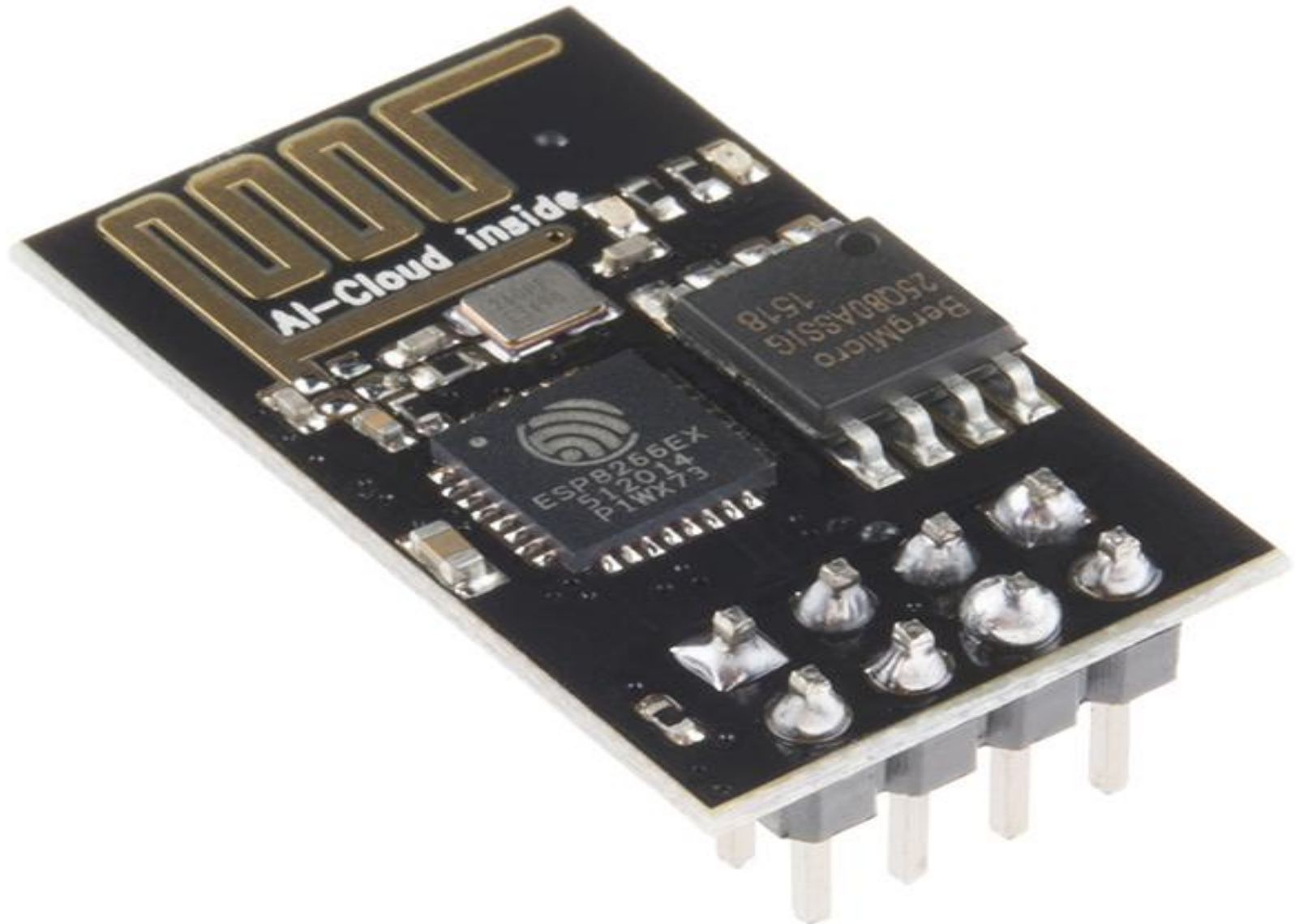
MONTHLY SPECIAL: PI3 ON SALE!

- ✓ QUAD-CORE 64-BIT CPU
- ✓ 1GB RAM
- ✓ BUILT-IN WIFI
- ✓ BUILT-IN BLUETOOTH

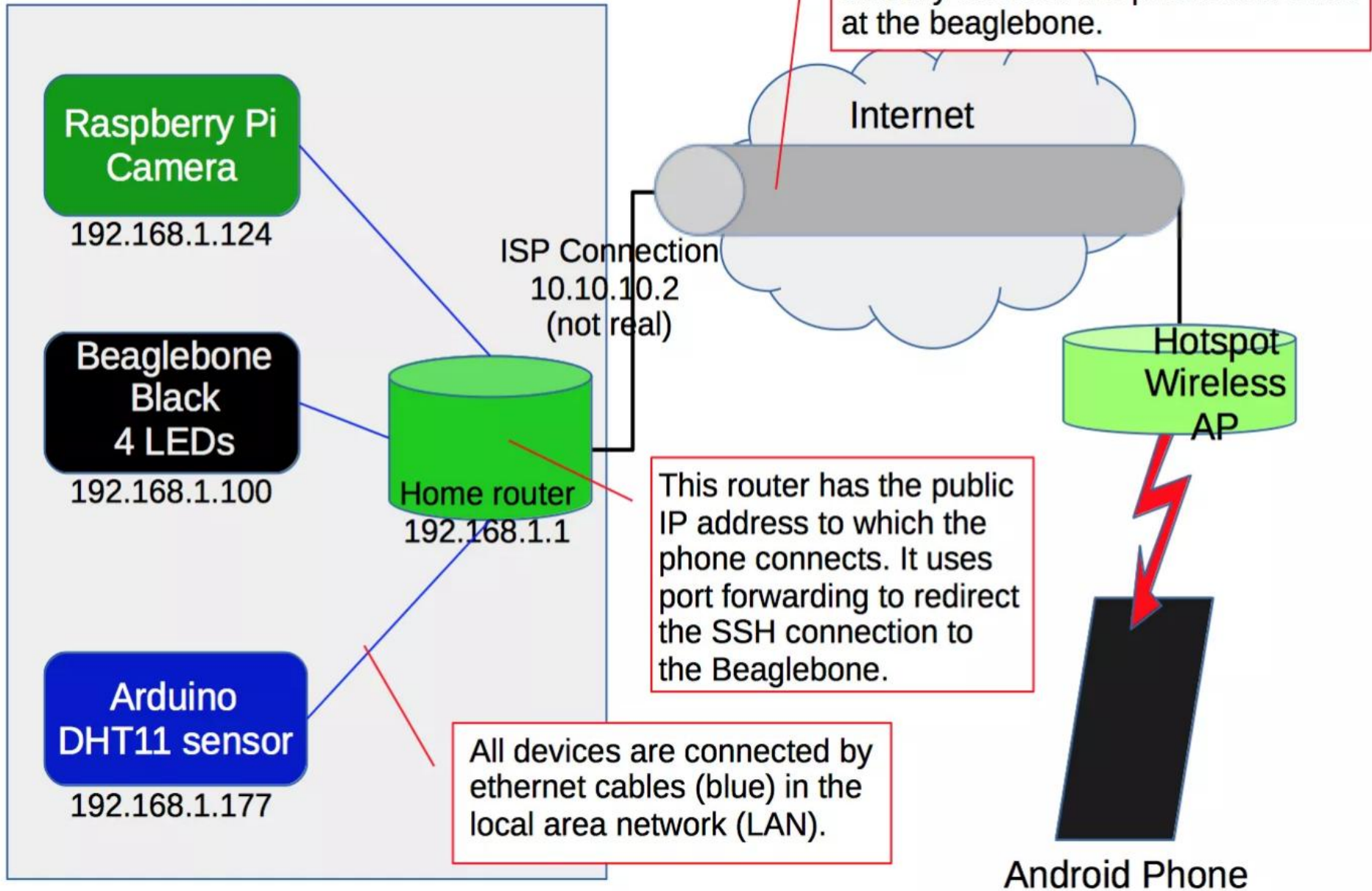
Latest
model!



Wireless ESP8266 Sensor Server



My Home



Energy Freedom Outcomes ⁽¹⁾

Student – Teacher relationship

- COST: Lower living costs without significantly impacting lifestyle or comfort,
- INDEPENDENCE. Efficient, intelligent, reliable, safe and automated electrical power generation, storage and use that is "untethered" from the grid or any fuels infrastructure,
- STABILITY: No further concern about cost variations, outages or rationing from the grid power provider or gasoline suppliers,

Energy Freedom Outcomes (2)

- INCREASED RESILIENCE (resistance and recovery) of the home by:
 - Identifying and prioritizing future upgrades.
 - Engaging with multiple stakeholders, including local, provincial and national government officials, civil society and the private sector, leading to awareness raising and increased coordination on home resilience methodologies.
 - Encouraging learning while developing some recommended best practices for Canada.
- WAR GAINS: Reduced personal carbon footprint in the war on Climate Change,
- SURVIVAL: Adaptability to the health ravages of climate change is increased (e.g. Clean water, food refrigeration, home garden),

Energy Freedom Outcomes ⁽³⁾

- INFLUENCE: Hard evidence (data) supporting conclusions that will be useful knowledge for others interested in off-grid technologies or home energy efficiency,
- FUTURE COLLOBORATIONS: A real occupied suburban home energy management laboratory, suitable for more R&D, is available for qualified researchers for years in the future.
- COMMUNICATE HOW TO: An increase in knowledge in homeowner energy management while eliminating the use of fossil fuels.

Energy Freedom Outcomes (4)

- HOME ASSISTANT: It has been estimated that there will be 30 billion internet (IoT) connected devices by 2020. The Energy Freedom Project will develop a very smart home assistant using some of these devices.
- CASH FLOW: Establishing a “home business” by selling energy to the utility to offset the capital costs (estimated 4 years ROI) and reduced purchases.
- FREEDOM. Delivery of future economic powers to the homeowner permits setting the pace of decarbonization, avoiding utility retail pricing escalation and other energy generation/management investments that would otherwise be left entirely to the utilities to dictate.

Energy Freedom Restated

- Objective: Provide family transportation and an occupied Canadian home with safe, reliable, affordable and secure comfort based on deep decarbonization of the energy sources that are free of existing electrical power grid and fossil fuels infrastructure.
- Challenge: Manage real time balance of supply side energy sources with demand side that are both dynamic and extremely nonlinear, such that there is a return of investment of the development costs.
- Deliver: Knowledge and know-how to influence widespread adaptation of the technology

Questions Please

- Q&A