

Residential Renewable Energy Assessment



Question

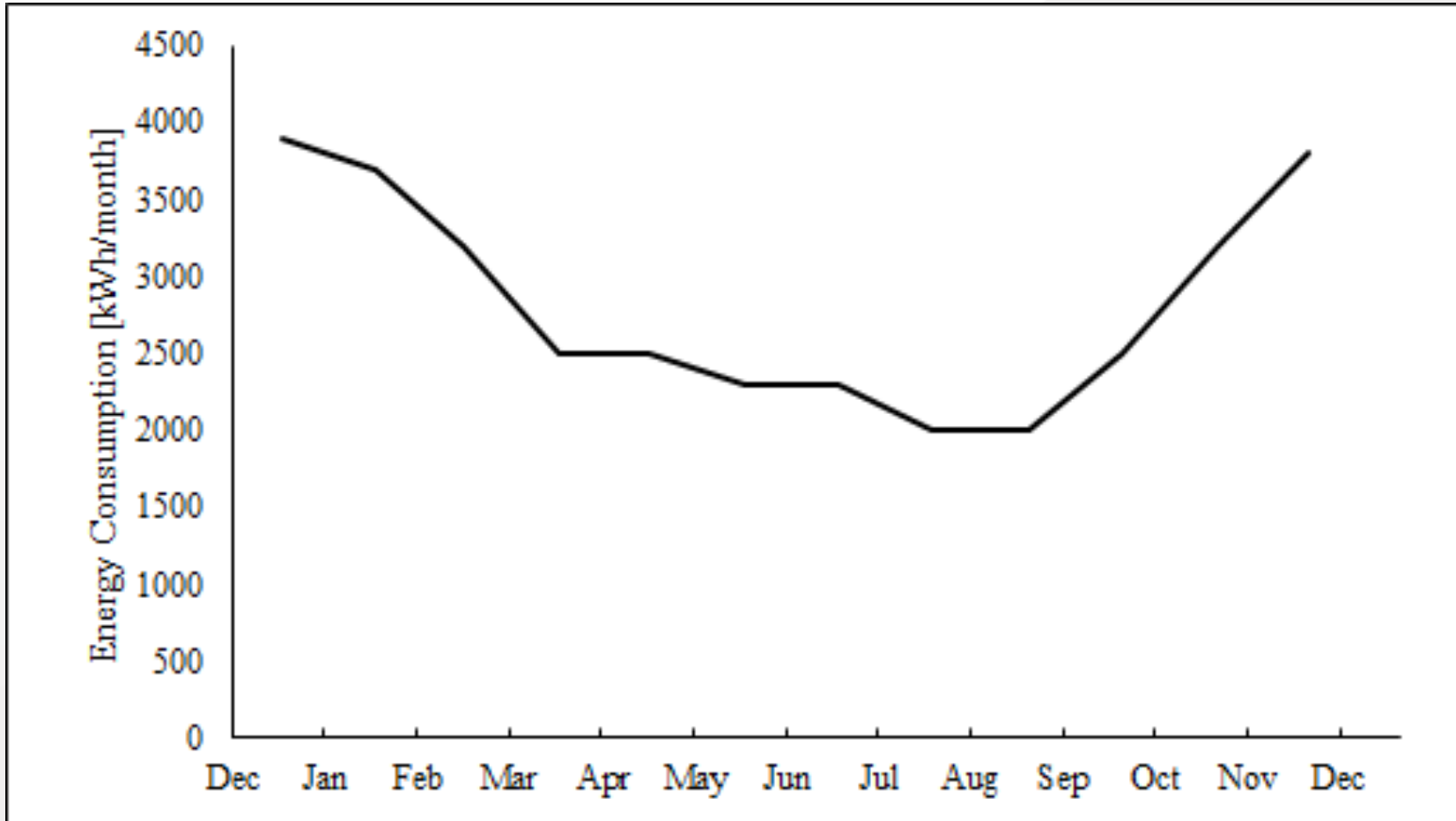
What would it take for Mr. Redfield to generate or save 20% of the electric energy requirements based on 2017's energy consumption?

Assumptions

- Energy saved is counted the same as energy generated
- \$0.14/kWh
 - Summer rate: \$0.18/kWh
 - Winter rate: \$0.14/kWh
 - \$0.14/kWh is conservative



Energy Consumption



2017 Energy Consumption: 33,900 kWh/yr

Savings Goal: 6,780 kWh/yr

Agenda



SOLAR

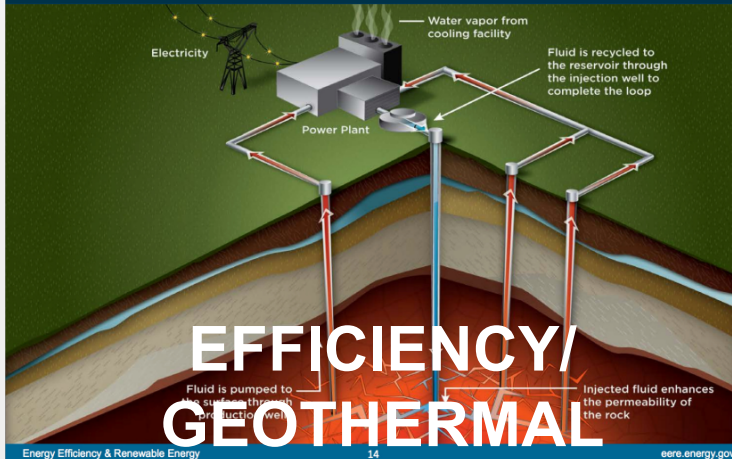


WIND

Enhanced Geothermal Systems
The Future: Creating power from hot, tight rocks

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

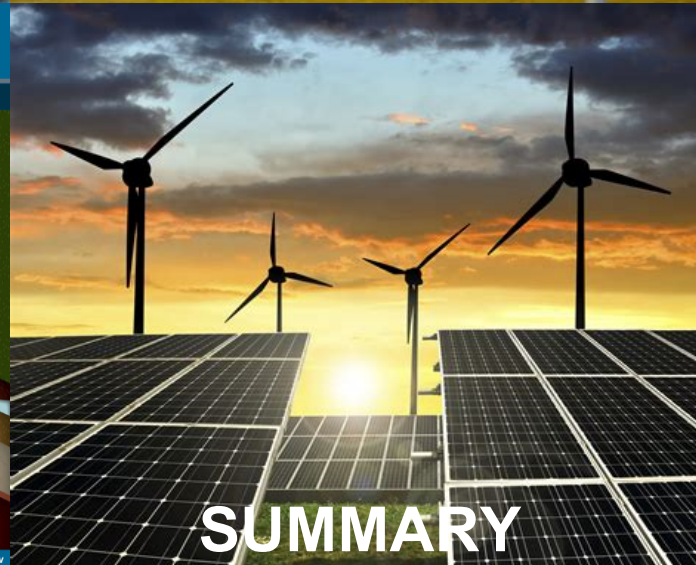
EGS uses advanced technologies to access the heat of the earth and produce electricity.



Energy Efficiency & Renewable Energy

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eere.energy.gov



SUMMARY

Solar

Matt Boelens

Kirk Brink

Melanie Fox

Hendrik Vermeulen

US Solar Radiation

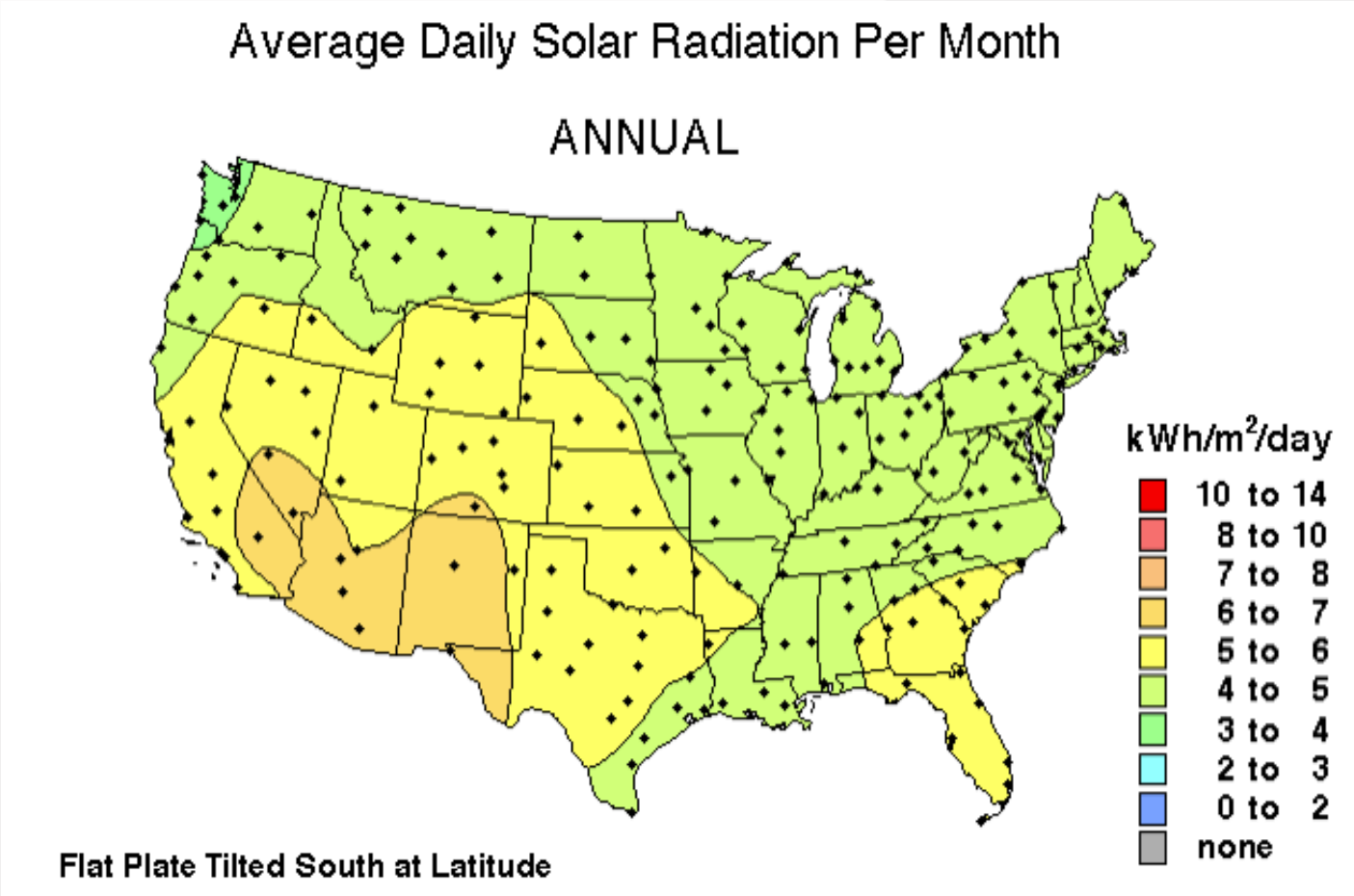


Image Courtesy of NERL Resource Assessment Program

Site Locations



Image Courtesy of Google Earth

Final Site Location



Assumptions

- Use existing electrical infrastructure
 - Conduit
 - Breakers
- No change to taxable property value
- Tree removal by homeowner
- Total cost estimates
 - 30% Rebate on PV cells, inverter

Cost Includes

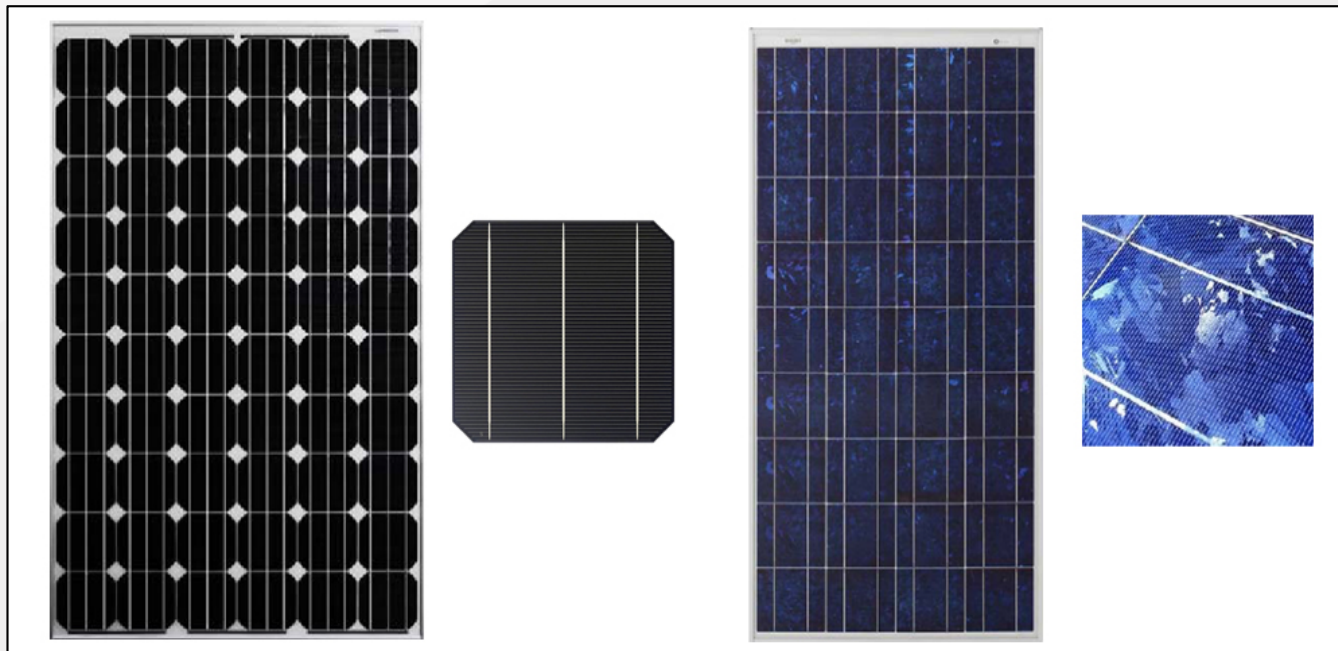
- Panel and Inverter
- Racking
- Labor (10%)
- Shipping (10%)
- 30% Rebate



Courtesy of pngmart.com

Key Variables

- Panel Type
- Quantity

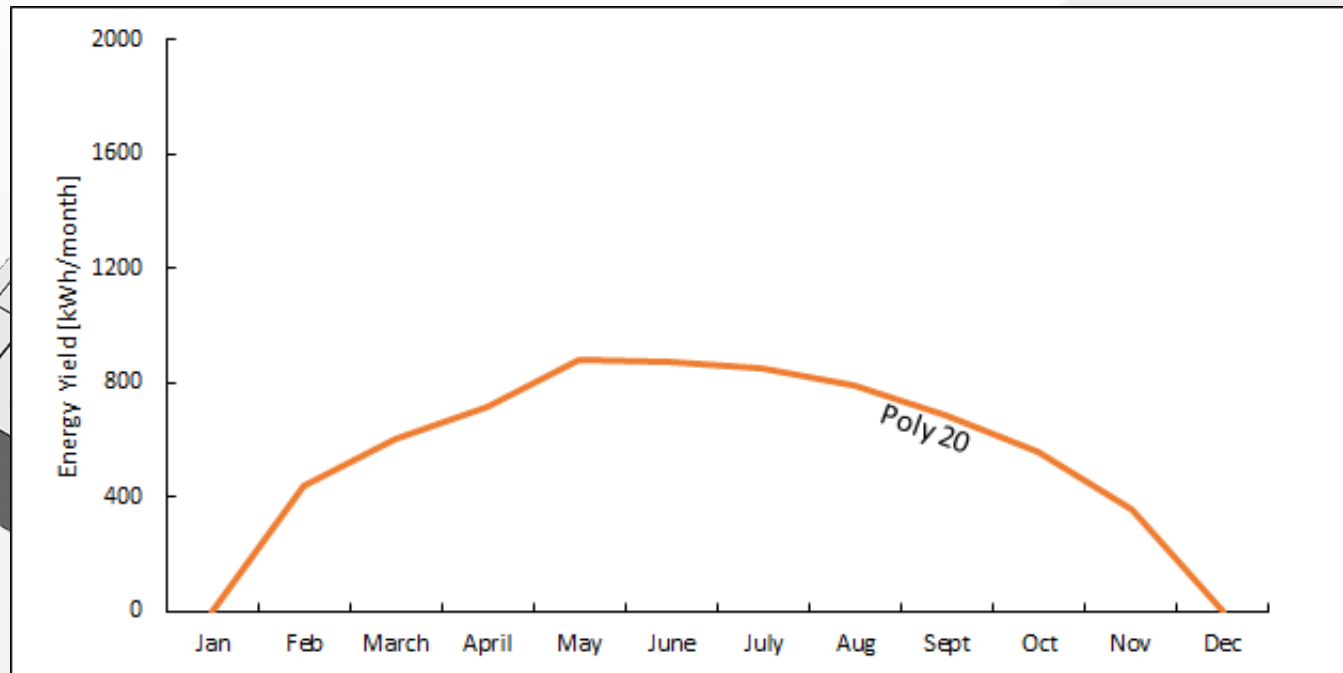


Monocrystalline

Polycrystalline

Courtesy of ALBA Energy

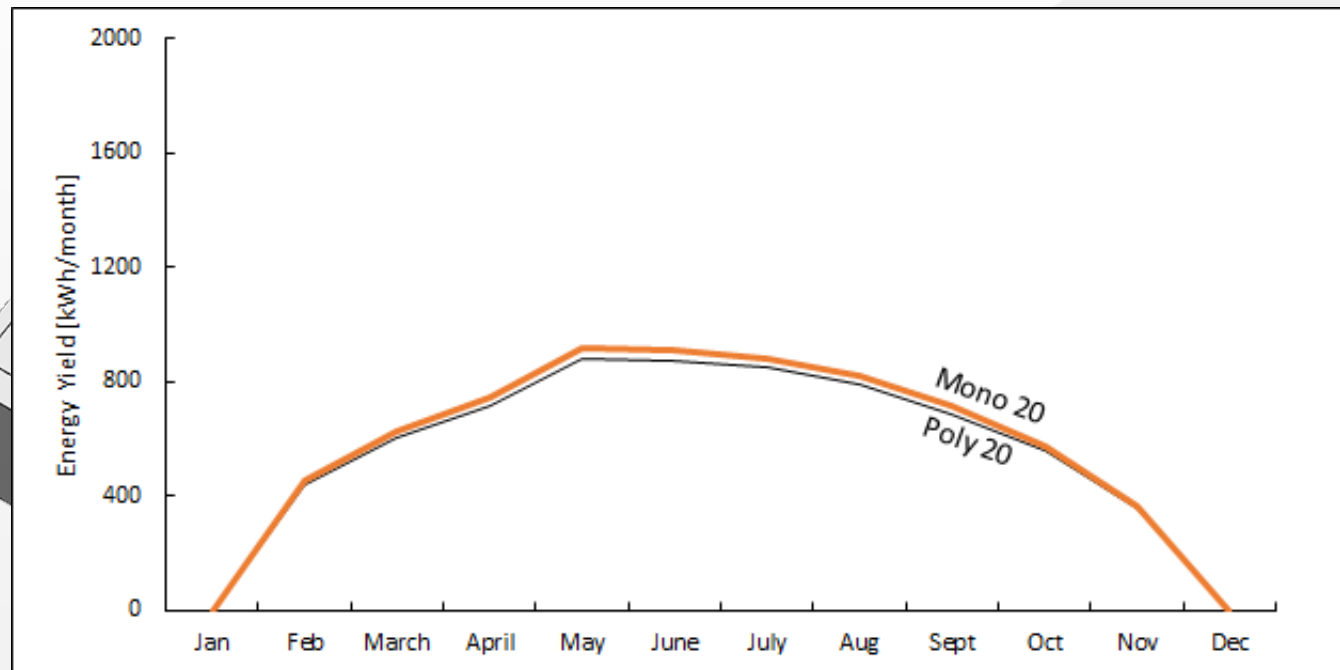
Solar Option A (Poly 20)



n Solar

- Monetary Payback Time: 12 years
- Energy Payback Time: 6 years
- Capital Investment: \$11,500
- % of 2017 Consumption: 19.9%

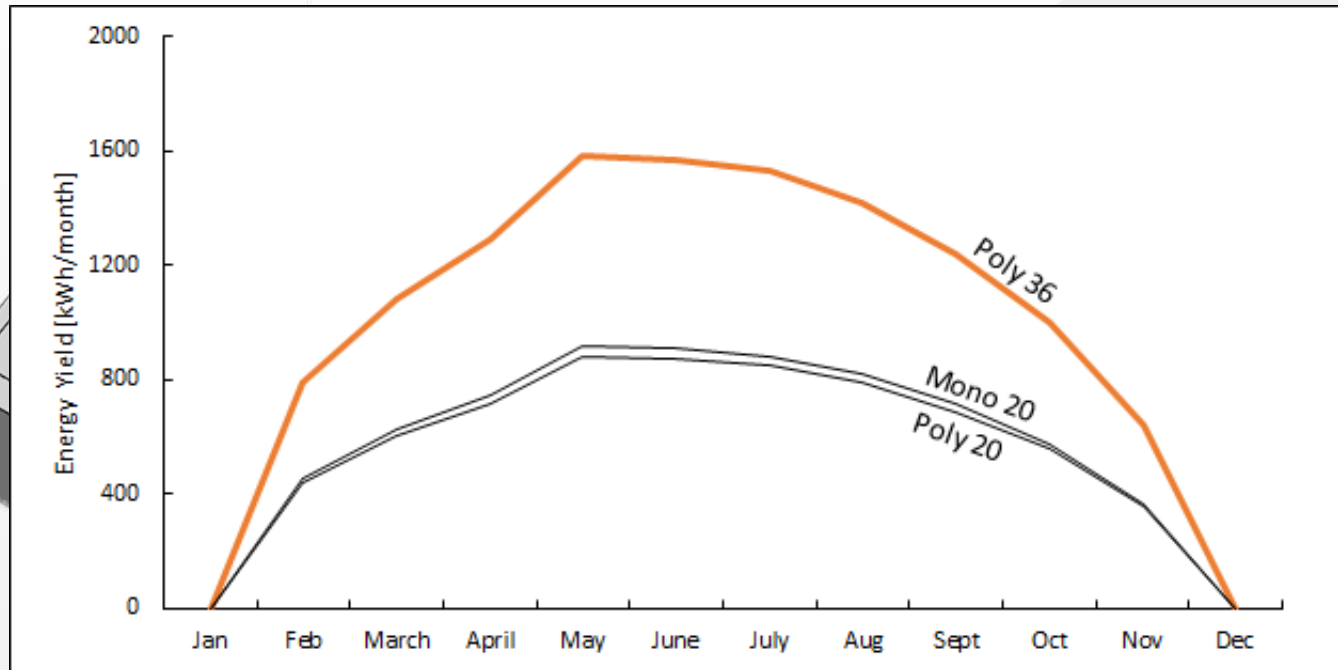
Solar Option B (Mono 20)



an Solar
MS

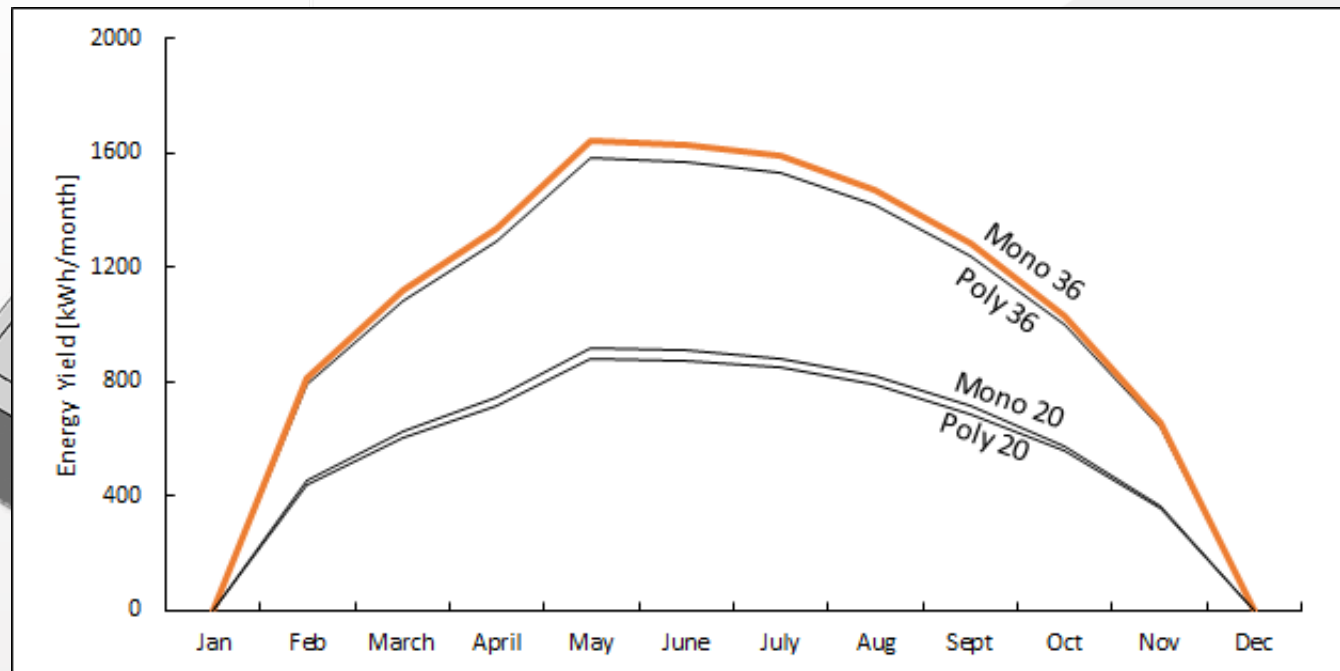
- Monetary Payback Time: 12 years
- Energy Payback Time: 9 years
- Capital Investment: \$11,800
- % of 2017 Consumption: 20.6%

Solar Option C (Poly 36)



- Monetary Payback Time: 10 years
- Energy Payback Time: 6 years
- Capital Investment: \$17,200
- % of 2017 Consumption: 35.8%

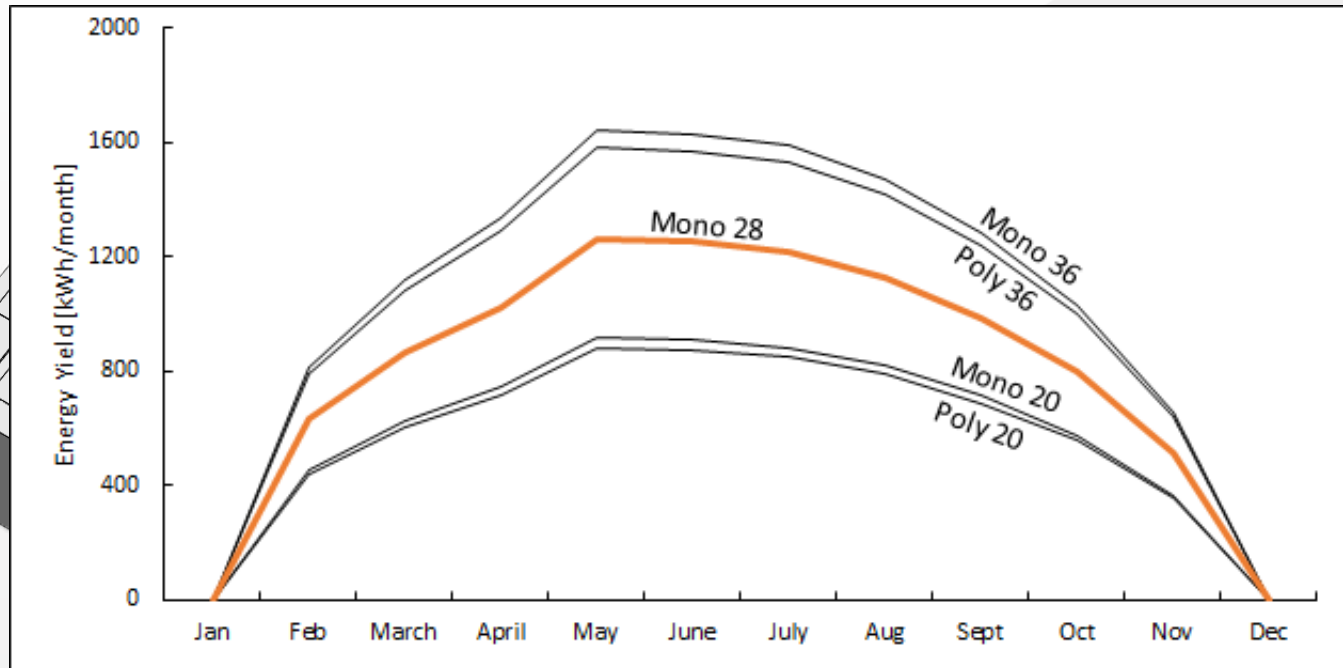
Solar Option D (Mono 36)



n Solar
MS

- Monetary Payback Time: 10 years
- Energy Payback Time: 9 years
- Capital Investment: \$17,700
- % of 2017 Consumption: 37.1%

Solar Option E (Mono 28)



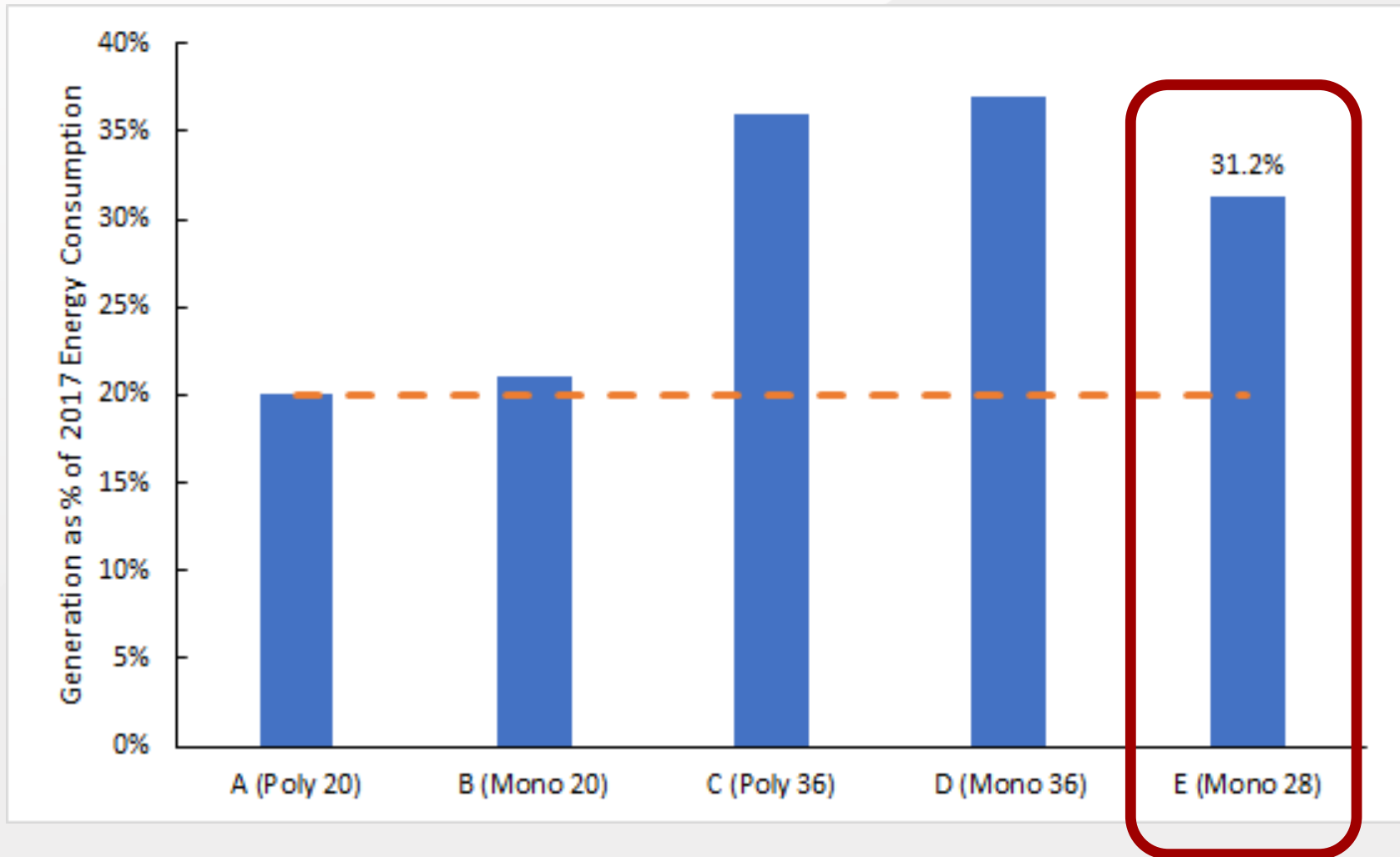
- Monetary Payback Time: 10 years
- Energy Payback Time: 8 years
- Capital Investment: \$14,800
- % of 2017 Consumption: 31.2%

Side By Side Comparison

	A (Poly 20)	B (Mono 20)	C (Poly 36)	D (Mono 36)	E (Mono 28)
Total Cost*	\$11,500	\$11,800	\$17,200	\$17,700	\$14,800
Energy Production (kWh/yr)	6,700	7,000	12,100	12,600	10,600
Energy Production (% Total Use)	19.9%	20.6%	35.8%	37.1%	31.2%
Monetary Payback (Years)*	12.2	12.0	10.2	10.1	10.0
Energy Payback (Years)	6.1	8.9	6.1	8.9	8.2

*Includes: PV cells, inverter, 30% rebate, mounting rails, labor, shipping, wiring

Solar Options





CanadianSolar

CS6K 290 Mono MS

PER MONTH:
\$13

TOTAL PANEL COUNT:
22

TOTAL SYSTEM SIZE KW:
6.38

AVERAGE KWH:
6,870

ACTUAL OFFSET:
20 %

CELL TYPE:
Mono

FRAME/BACKSHEET:
Black/White

INVERTER:
Solar Edge Optimizers



Home Value:
HOME VALUE INCREASE:
\$13,007

INTERNAL RATE OF RETURN:
8.15%



Contract Cost:
CONTRACT COST:
\$22,784

TAX CREDIT:
(\$6,835)

NET PRICE AFTER TAX BENEFIT:
\$15,949



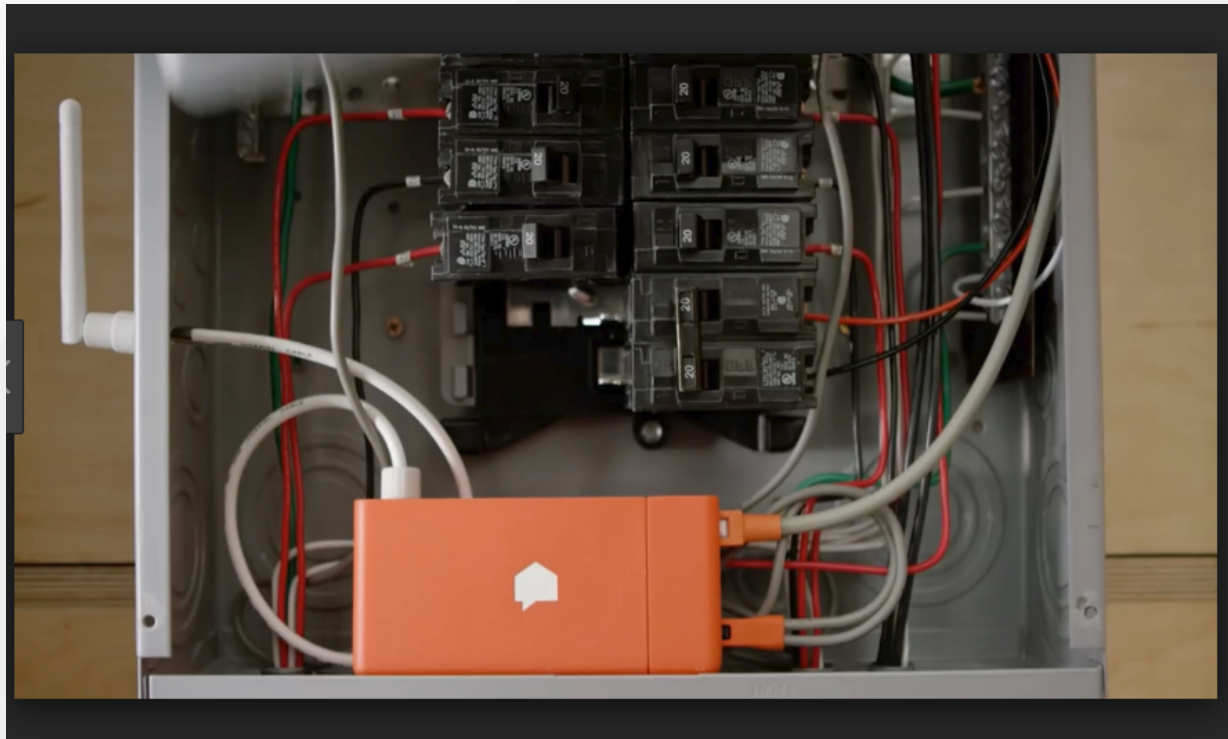
Environmental Impact:
CO2 EMISSIONS AVOIDED OVER 25 YEARS:
137 tons

SYSTEM PRODUCTION ESTIMATE COMPARED TO
COAL BURNED:
64 tons

CARBON SEQUESTERED BY ACRES OF US FORESTS IN
ONE YEAR:
120 acres

Additional Info

- Sense Monitoring System - \$350



Additional Info

- Potential contractors include:
 - West Michigan Solar
 - Solar Winds
 - J & L Roofing

WEST MICHIGAN SOLAR LLC

<https://westmichigansolarllc.com/>



MovingPackets.net

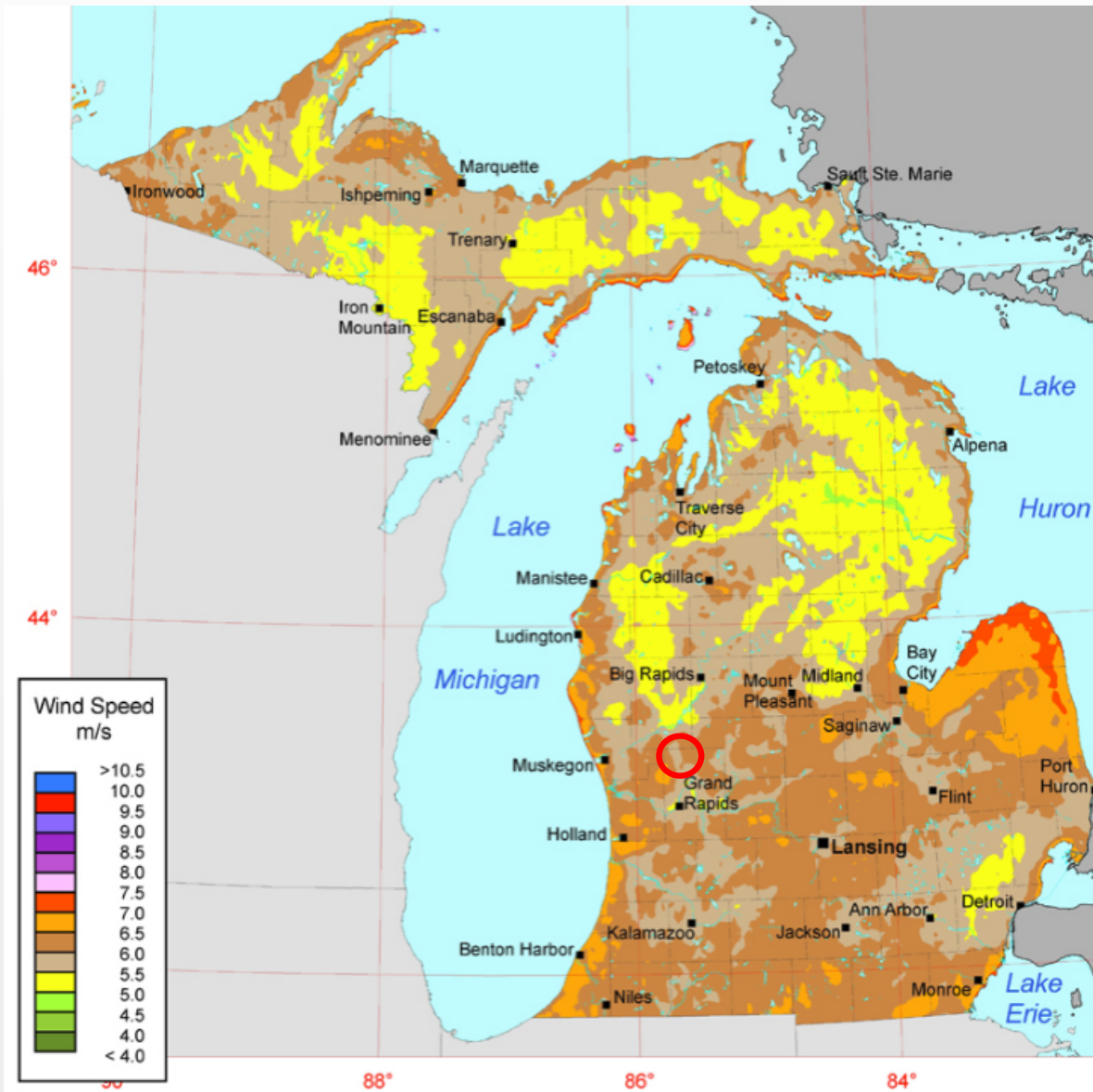


<http://www.jlroofing.com/>

Wind

Richmond Amoh
Edwin Kpodzro
Josh Tempelman
Laura Van Winkle

Wind Estimates for Michigan



Average wind speed for the area is 5.5 m/s (12 mph).

We will be assuming an annual average of 5 m/s with monthly detail.

Assumptions

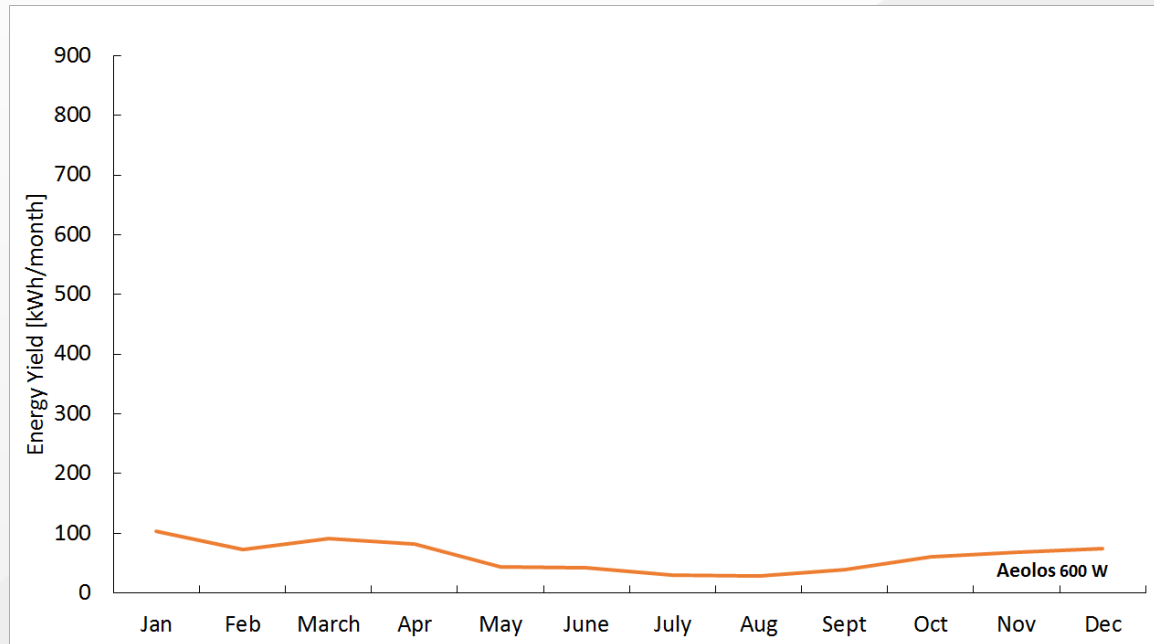
- Cost breakdown estimates emulate a known wind turbine installation.
- Cost of set up is similar for all turbine options

Wind Turbine Cost Breakdown

- Turbine
- Conduit
- Permits
- Fence and Gate
- Weather Monitoring Instruments
- Wire
- Power and Comms Bore

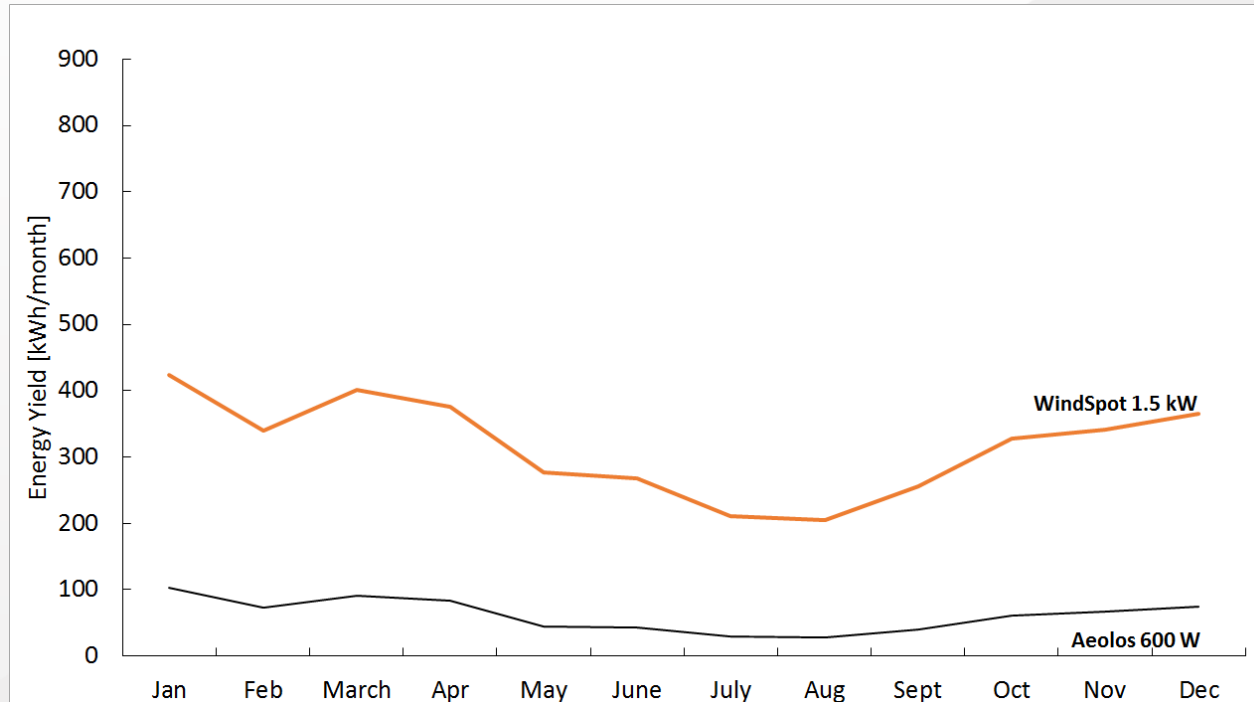


Wind Option A - Aeolos 600W



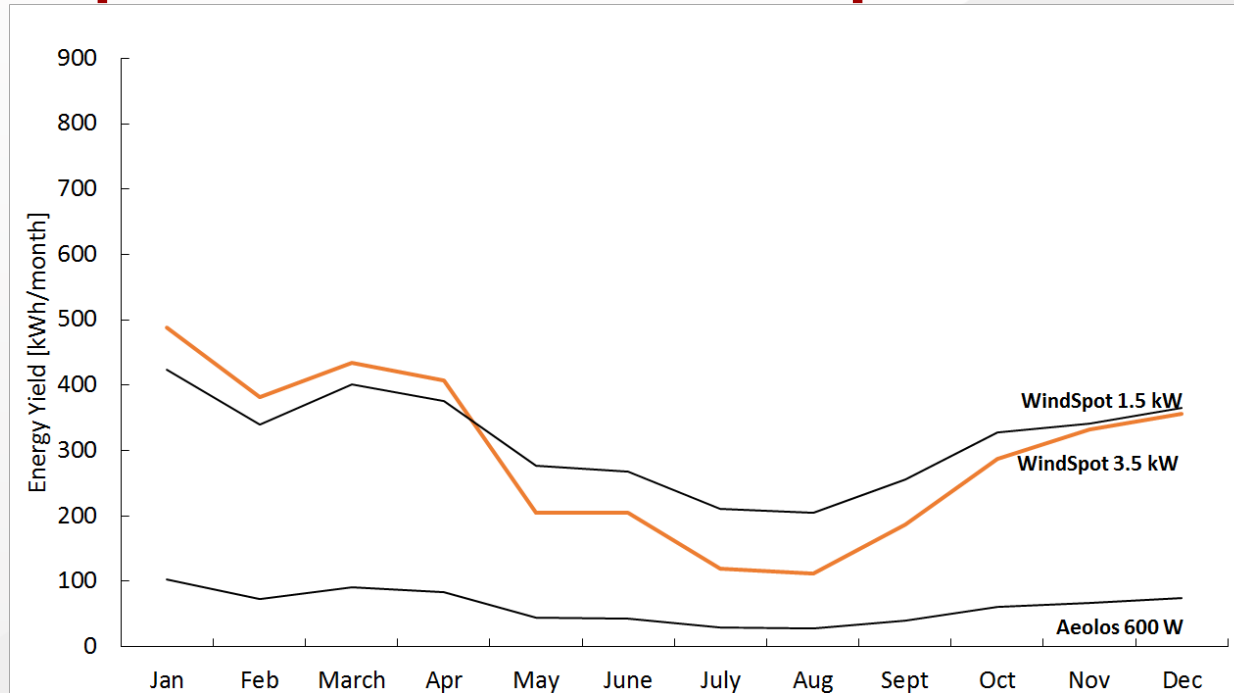
- Rotor Height: 1.8 m (5.9 ft)
- Monetary Payback Time: 364.8 years
- Energy Payback Time: 57.4 years
- Capital Investment: \$38,000
- % of 2017 Consumption: 2.2%

Wind Option B – WindSpot 1.5 kW



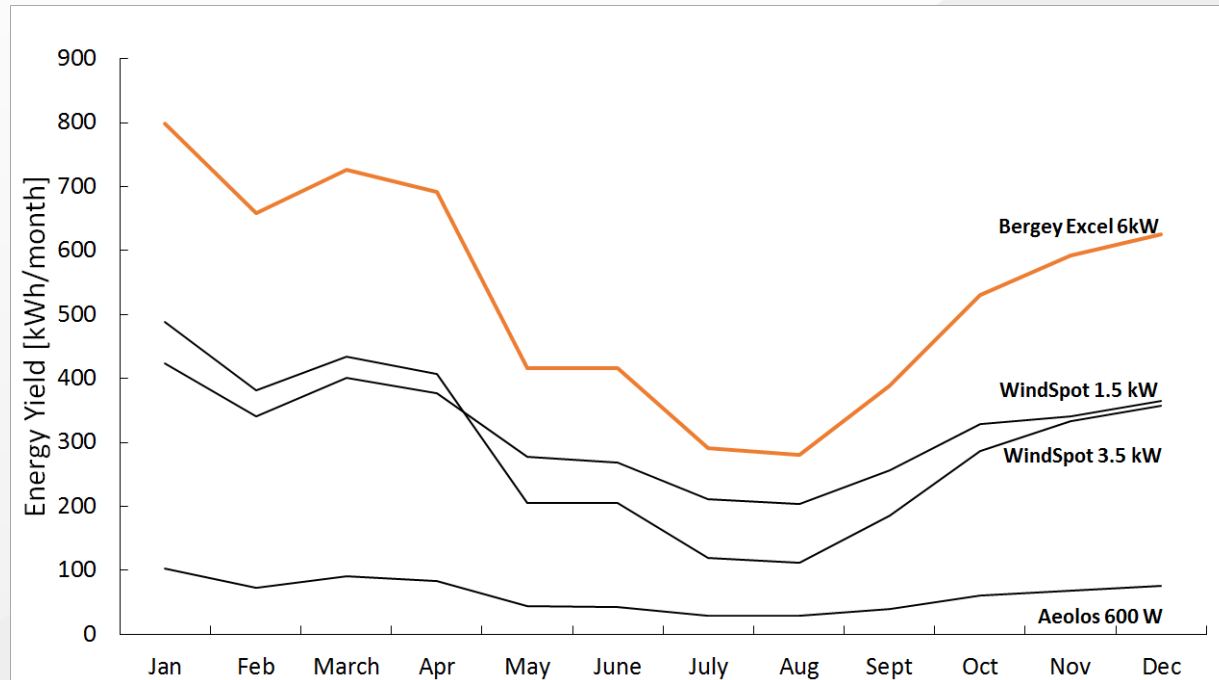
- Rotor Diameter: 4.1 m (13.3 ft)
- Monetary Payback Time: 79 years
- Energy Payback Time: 13 years
- Capital Investment: \$42,000
- % of 2017 Consumption: 11.2%

Wind Option C - WindSpot 3.5kW



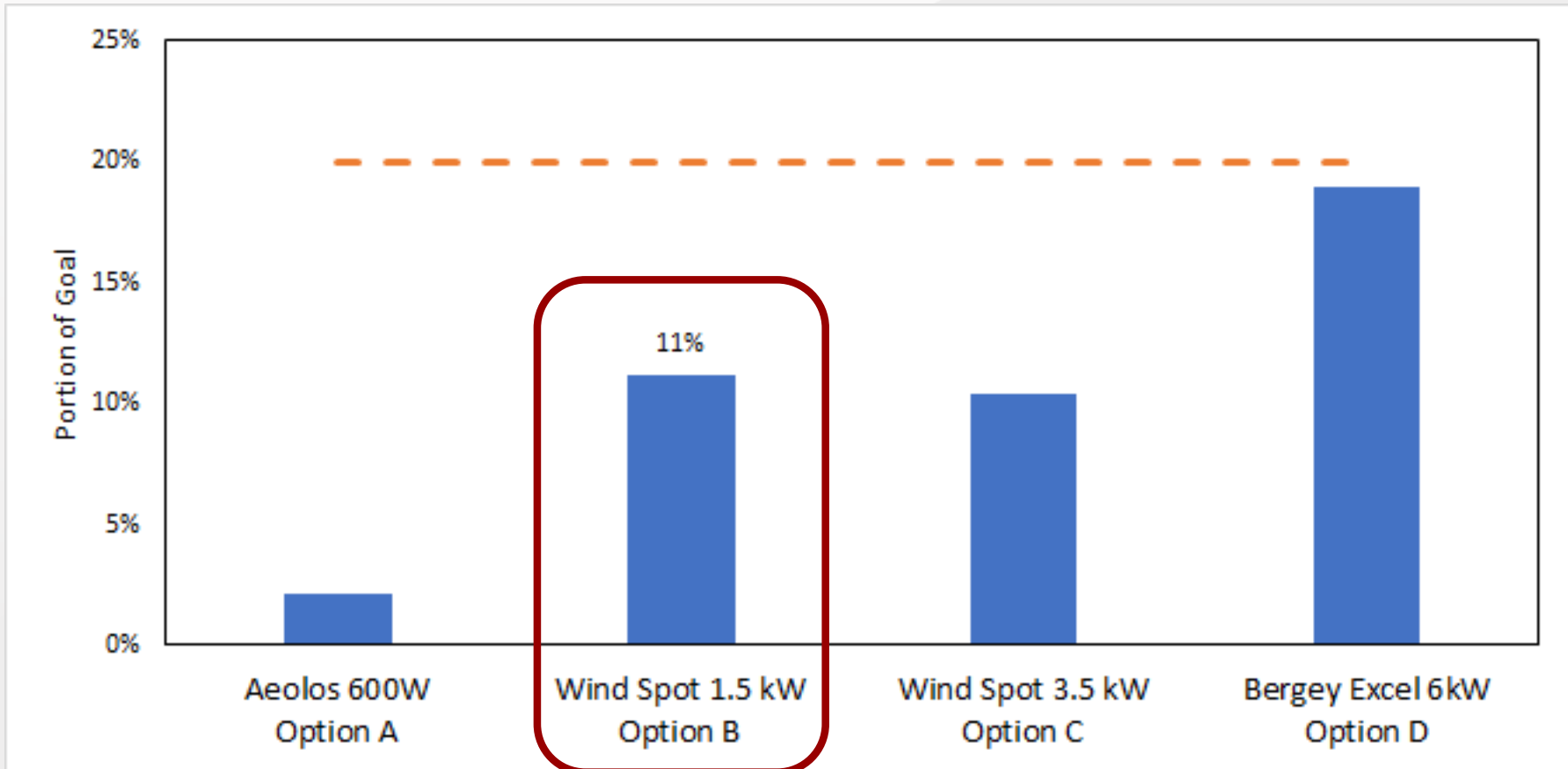
- Rotor Diameter: 4.1 m (13.3 ft)
- Monetary Payback Time: 87 years
- Energy Payback Time: 14 years
- Capital Investment: \$43,000
- % of 2017 Consumption: 10.3%

Wind Option D - Bergey 6kW

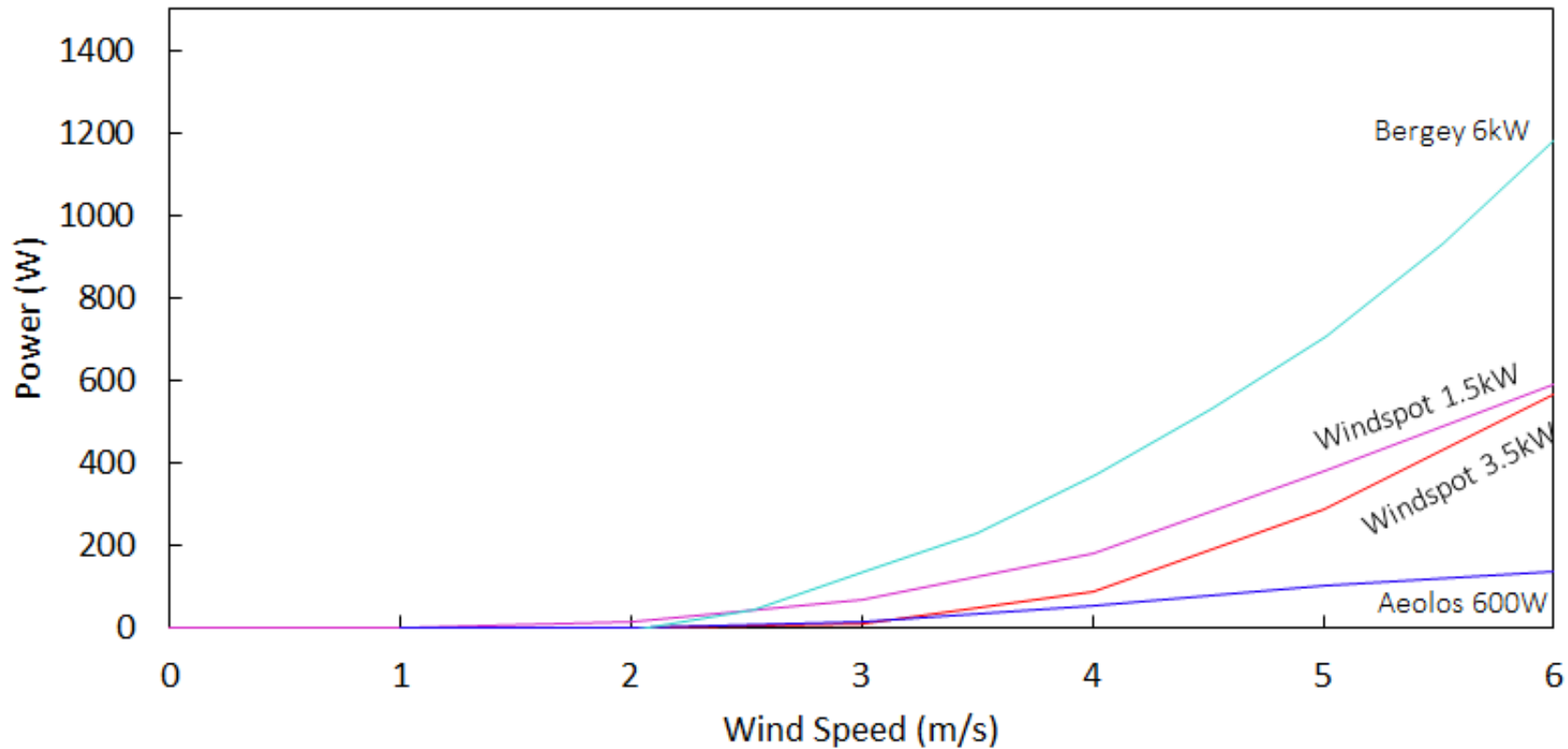


- Rotor Diameter: 6.2 m (20.3 ft)
- Monetary Payback Time: 63 years
- Energy Payback Time: 14 years
- Capital Investment: \$ 57,000
- % of 2017 Consumption: 19%

Wind Options

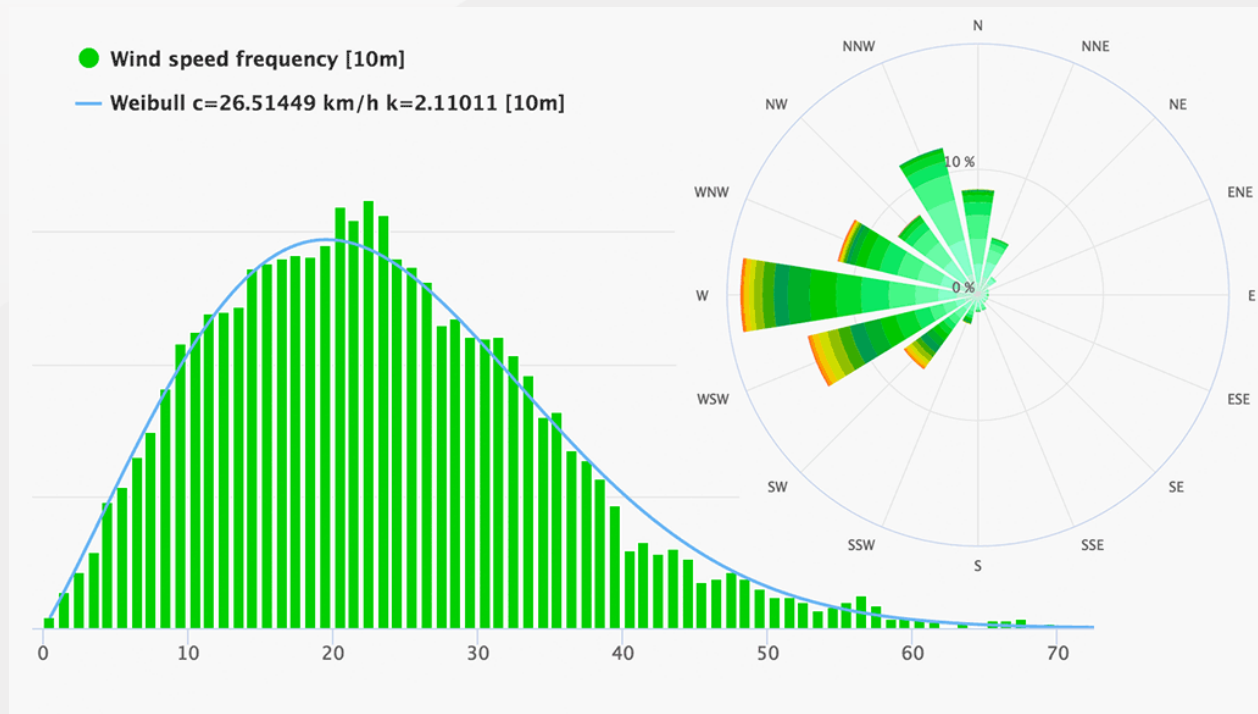


Power Curve Comparison



Wind Study

- Duration of 1 year of continuously logged data
- Should be conducted at location of turbine hub



courtesy of <https://www.meteoblue.com/en/solarplus>

Anemometers

Anemometer Options:

- Solar powered data logger
- AC powered data logger



courtesy of
<http://aprsworld.com/selfcontained/solar/>



courtesy of
<http://aprsworld.com/selfcontained/ac/>

Wind Turbine Recommendation

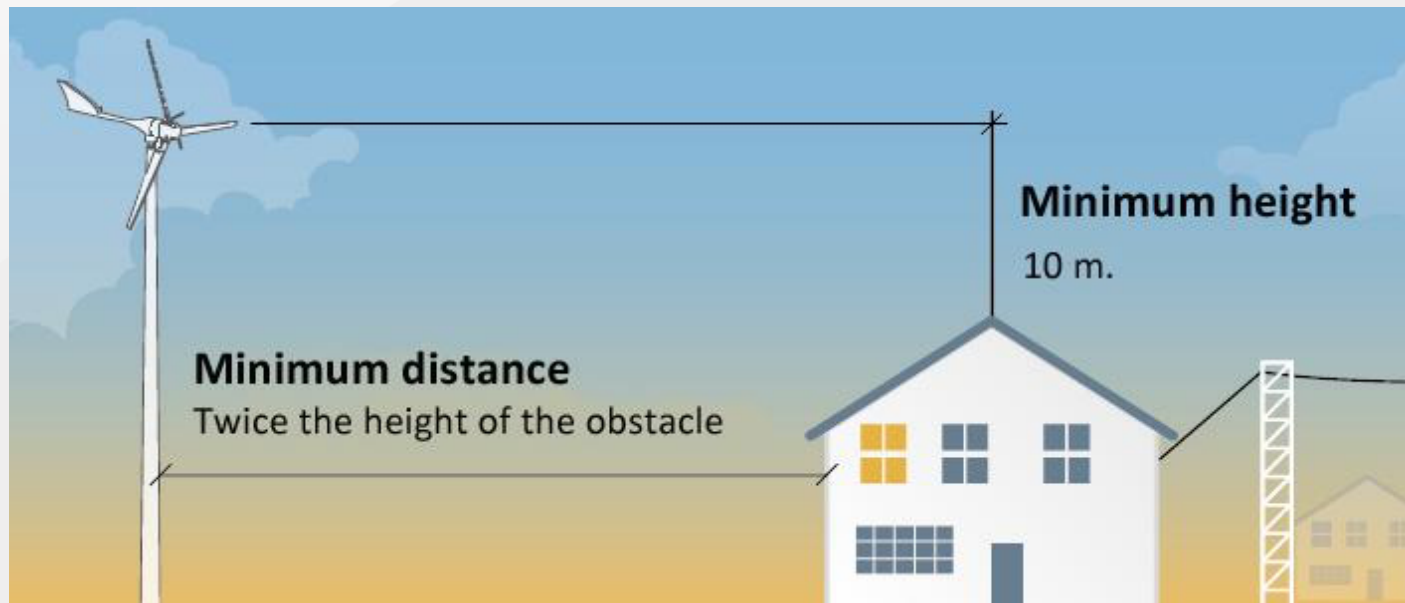
- Windspot 1.5 kW



courtesy of <https://www.alibaba.com/>

Installation Recommendation (Windspot 1.5kW)

- Tower should be 10 meters higher than tallest obstacle
- Turbine should be at a distance twice the height of the obstacle



courtesy of <http://usa.windspot.es/home-wind-turbines/products/106/faq#how-much-space-do-i-need>

Hydro/Efficiency/Geothermal

Abigail Berkompas

Nate DeHaan

Halley Press

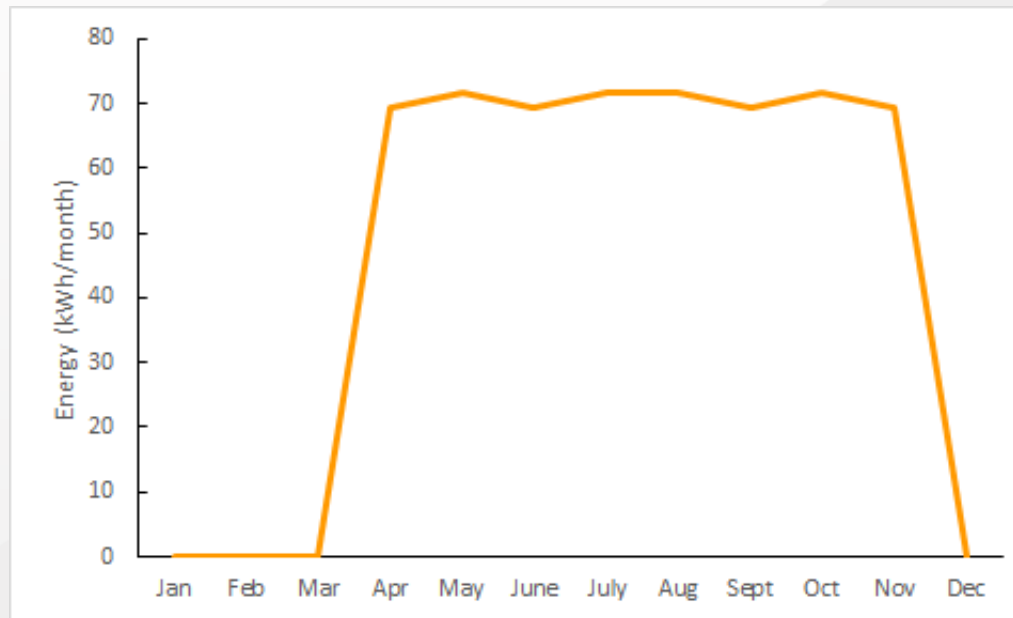
Jake Zandstra

Options

- Hydro
 - Generator on a waterfall
- Efficiency
 - Reseal doors
 - Replace windows
- Geothermal
 - Replace the oldest heat pump

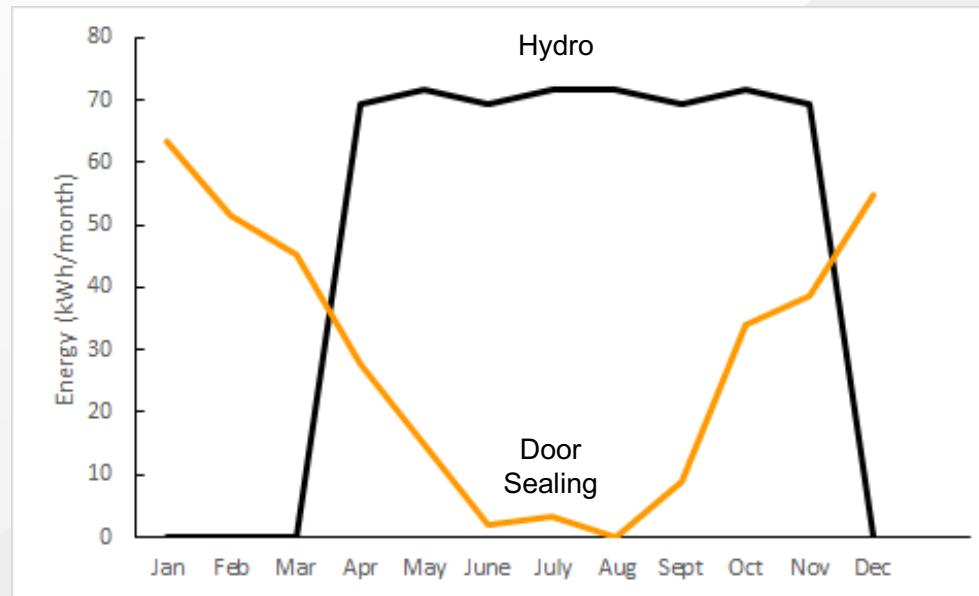


Efficiency Option A – Hydro Generator



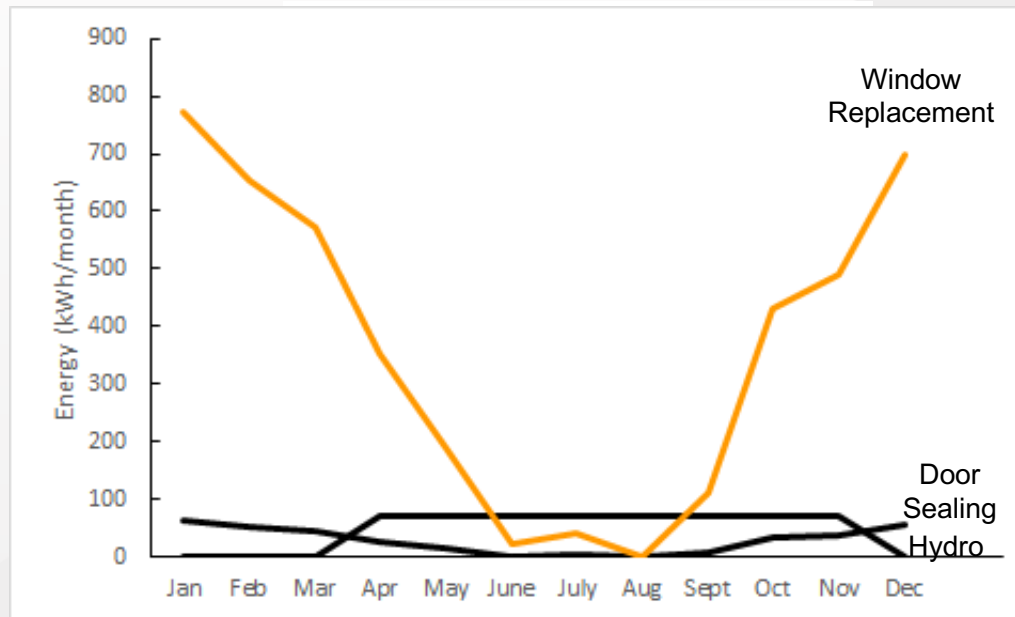
- Monetary Payback Time: 156 years
- Energy Payback Time: 37 years
- Capital Investment: >\$10,000
- % of 2017 Consumption: 1.6%

Efficiency Option B – Sealing of Doors



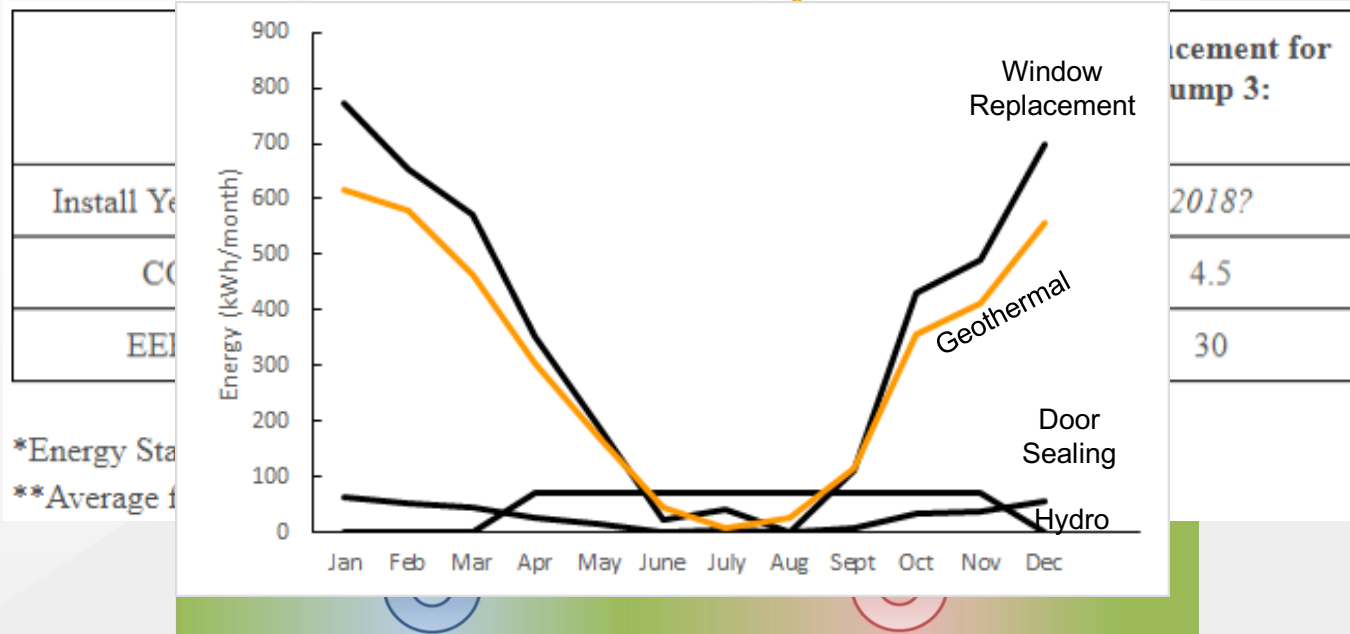
- Monetary Payback Time: 0.51 years
- Energy Payback Time: 0.08 years
- Capital Investment: \$25
- % of 2017 Consumption: 1.02%

Efficiency Option C – Replacement of Windows



- Monetary Payback Time: 63 years
- Energy Payback Time: 8.6 years
- Capital Investment: \$38,000
- % of 2017 Consumption: 10.8%

Efficiency Option D – Geothermal Replacement



Replacement for Pump 3:
2018?
4.5
30

- Monetary Payback Time: 10 years
- Energy Payback Time: 5.5 years
- Capital Investment: \$10,000
- % of 2017 Consumption: 10.7%

Efficiency Options



Additional Info

- Different projects may not have additive savings
- A free professional consultation is available from Consumers Energy
 - Home Energy Analysis- Insulating pipes, installing free LED's, shower heads, thermostats
 - <https://www.homeanalysis-consumersenergy.com/Schedule>

Communications and Infrastructure

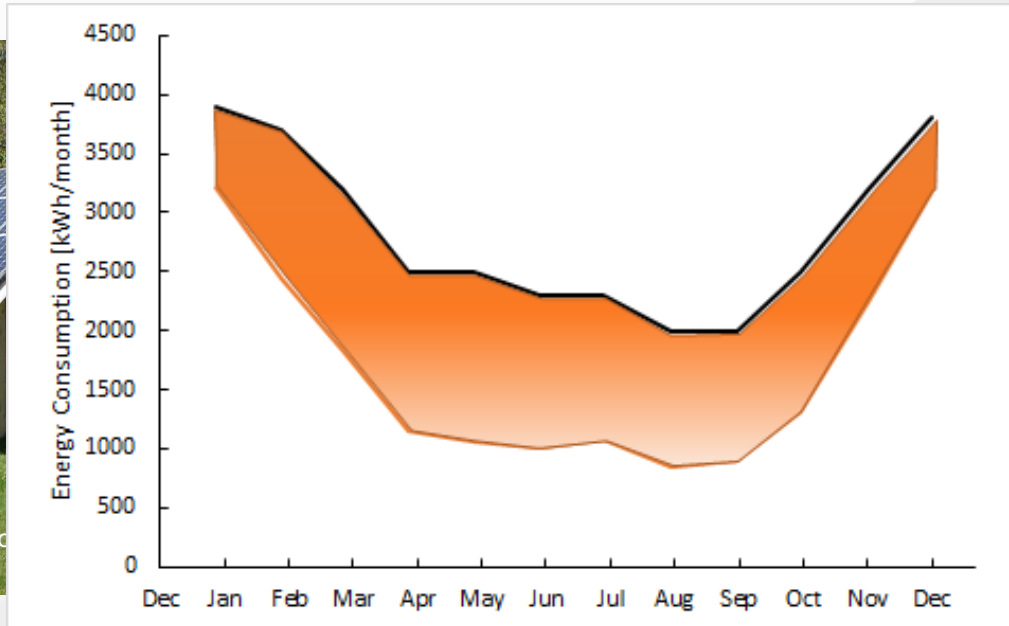
Megan Anders

Jessica Bouma

Elvin Vindel

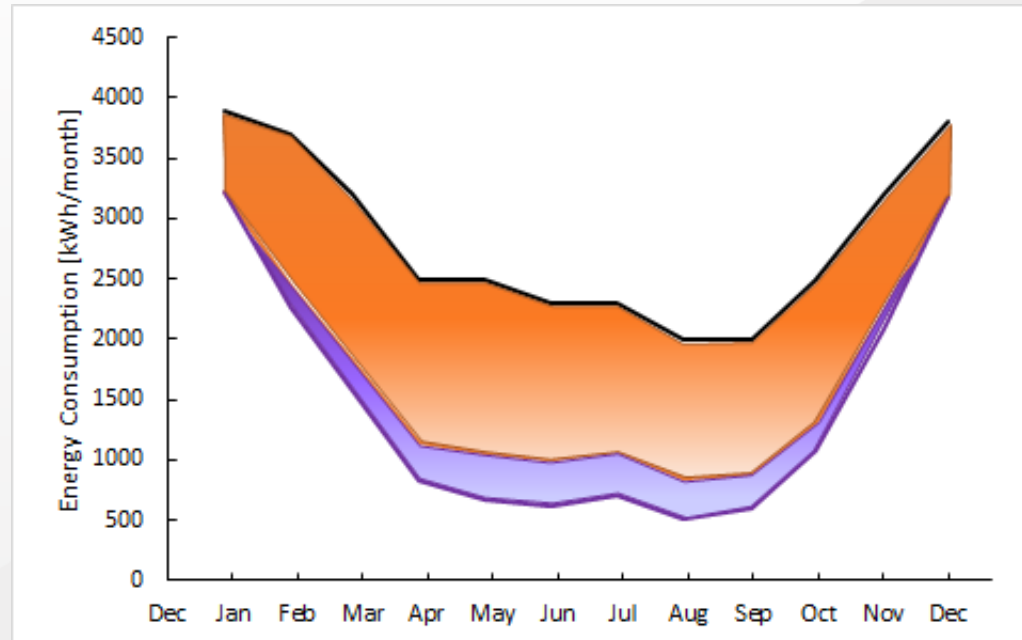
Paul Bootsma

Recommended Work Package



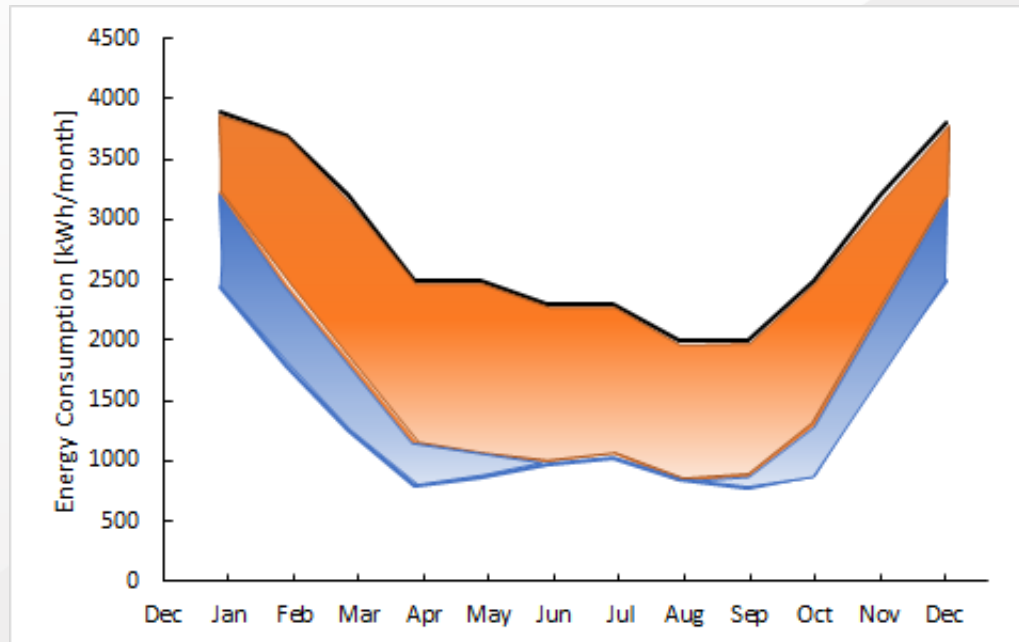
- Monetary Payback Time: 11 years
- Energy Payback Time: 7 years
- Capital Investment: \$25,000
- % of 2017 Consumption: 42.9%

Addition 1: 8 Solar Panels



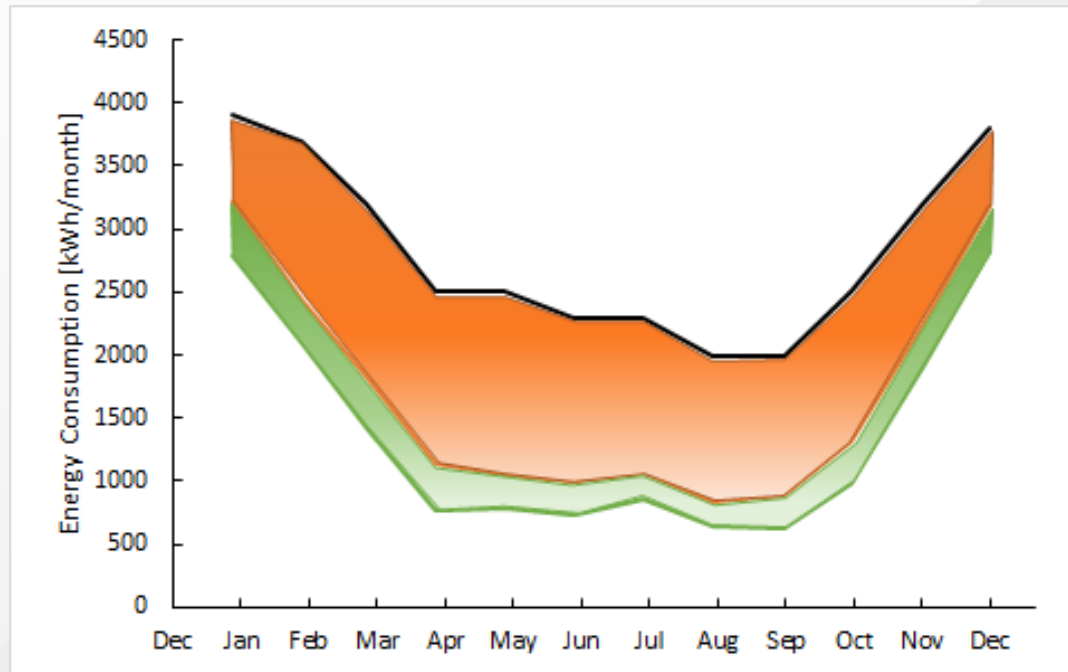
- Monetary Payback Time: -.1 years
- Energy Payback Time: .6 years
- Capital Investment: \$2,900
- % of 2017 Consumption: 5.8%

Addition 2: Window Replacement



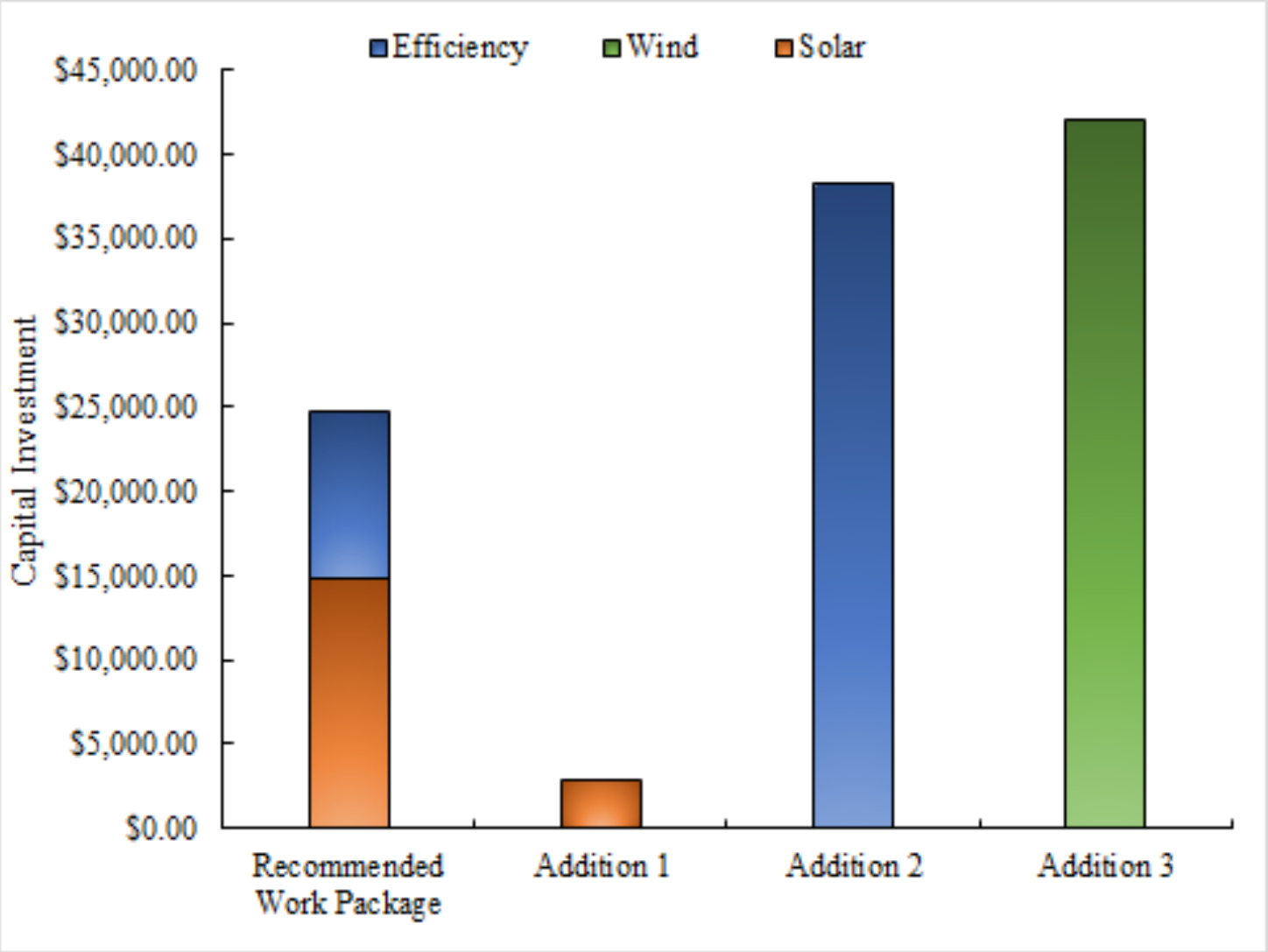
- Monetary Payback Time: 12 years
- Energy Payback Time: .3 years
- Capital Investment: \$39,000
- % of 2017 Consumption: 12.8%

Addition 3: Wind Turbine

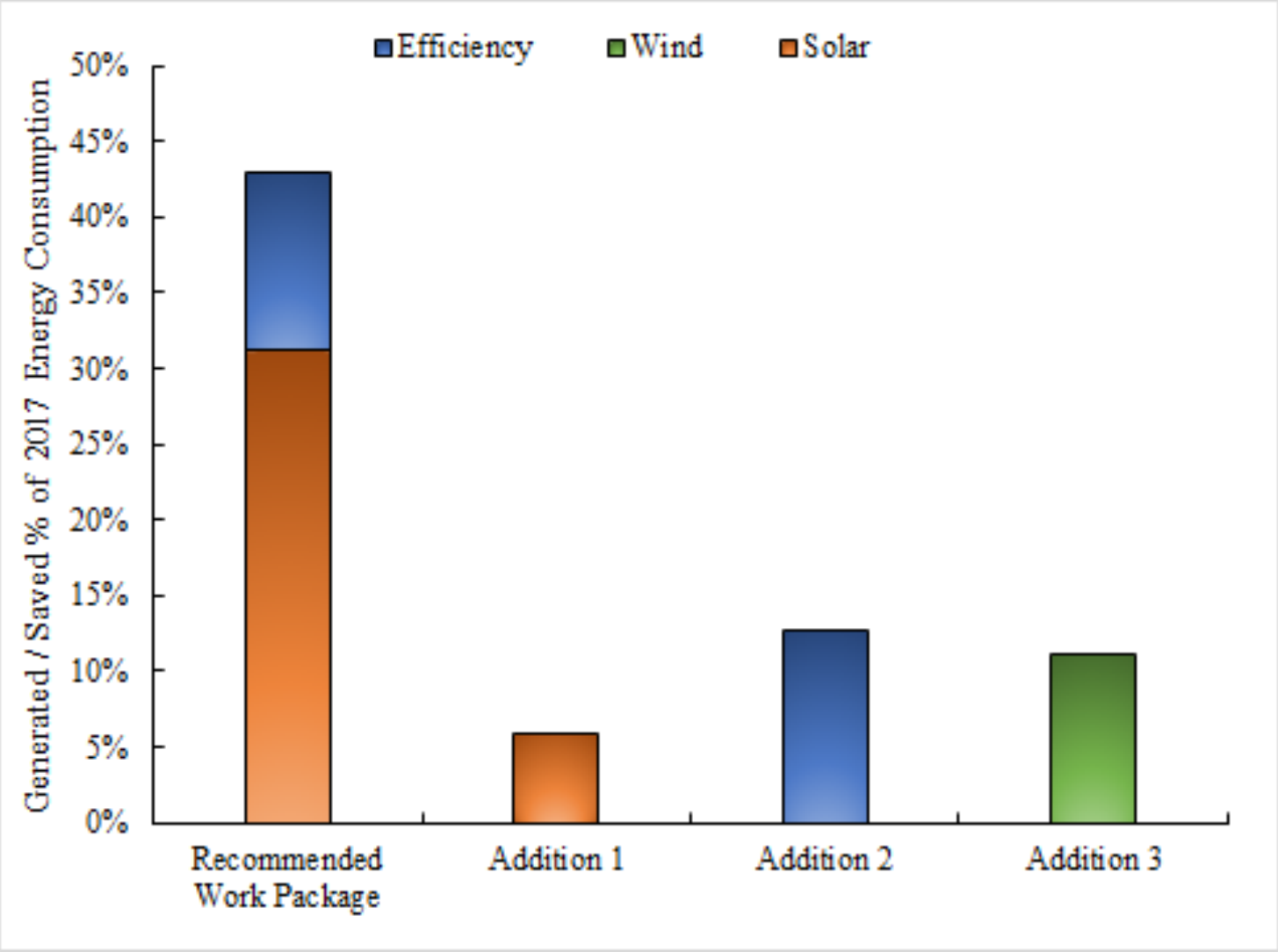


- Monetary Payback Time: 14 years
- Energy Payback Time: 1 year
- Capital Investment: \$42,000
- % of 2017 Consumption: 11.2%

Comparison



Comparison



Connection to Grid



Acknowledgement

- Chuck Holwerda
- Mr. Redfield
- Mrs. Redfield
- Professor Heun

Questions?

