A New Type of Hybrid Groundwater Energy System

by
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NGWA Groundwater Week
December 5, 2017
Nashville, Tennessee

This case-history is about:

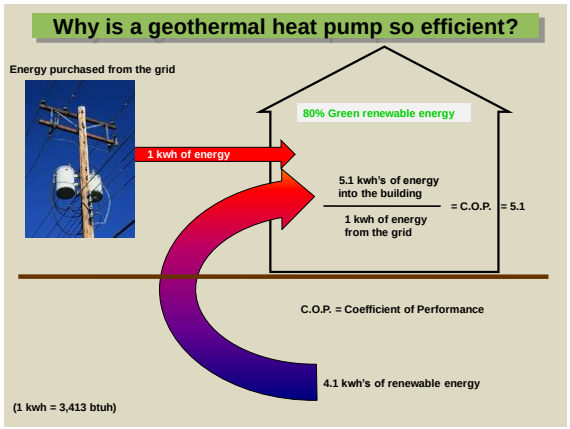
- My 10,000 square foot office building
- Located in State College, PA (5,600 hdd's)
- Constructed in 1986 with 6 HVAC zones
- Original open-loop units replaced in 2013
- Five 48,000 btuh ClimateMaster TE units
- T-8 and LED lighting upgrade in 2013
- 27 kw PV Solar system installed in 2016

5,600 heating degree-days

10,000 square feet on two floors, with 6 zones

Alternative Energy = Going Green

- Wind turbines generate electric power
- Photovoltaic solar panels generate electric power
- Geothermal heat pumps move heat energy and operate on electric power
- The heat in the groundwater or the loop water is the alternative energy



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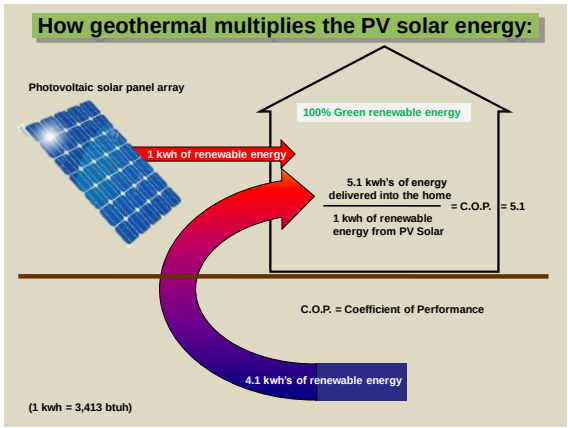
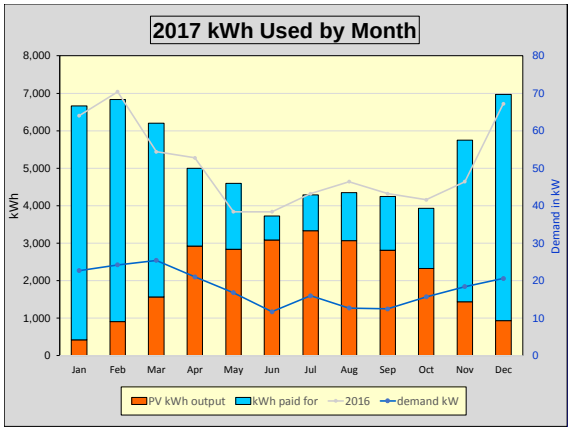
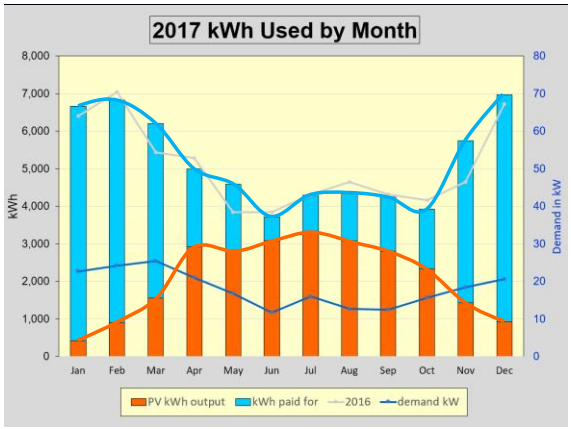
- The heat in the groundwater or the loop water is the alternative energy
- My hybrid system uses PV solar electricity to operate my geothermal heat pumps


How geothermal multiplies the PV solar energy:
Photovoltaic solar panel array
100% Green renewable energy
1 kwh of renewable energy
5.1 kwh's of energy delivered into the home
1 kwh of renewable energy from PV Solar
= C.O.P.
= 5.1
C.O.P. = Coefficient of Performance
4.1 kwh's of renewable energy
(1 kwh = 3,413 btuh)


2017 kWh Used by Month
kWh
Demand in kW
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
PV kWh output
kWh paid for
2016
demand kW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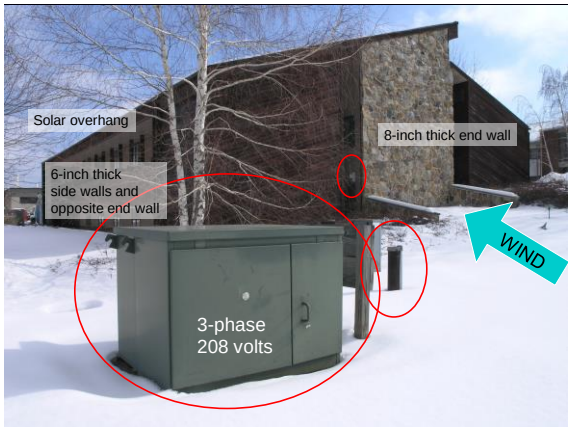
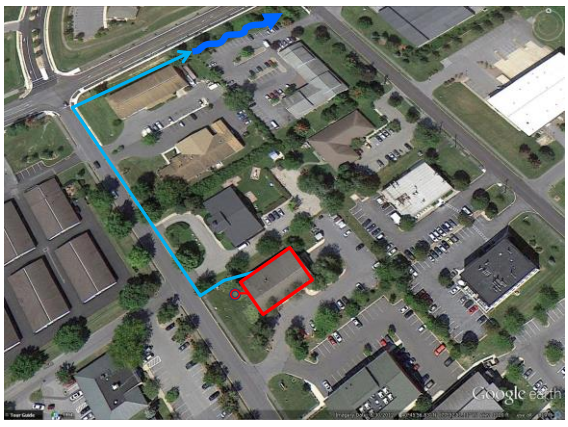
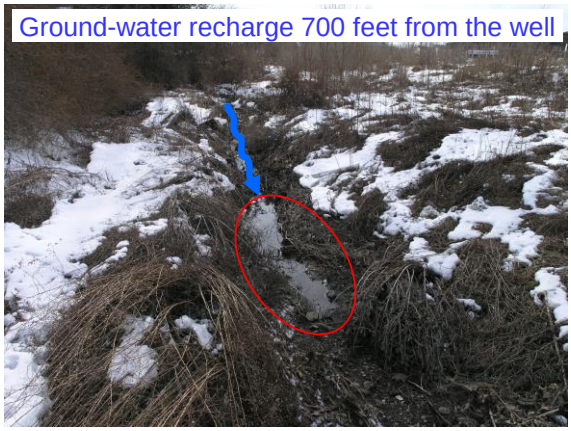

Solar overhang
8-inch thick end wall
6-inch thick side walls and opposite end wall
WIND
3-phase 208 volts


Google earth

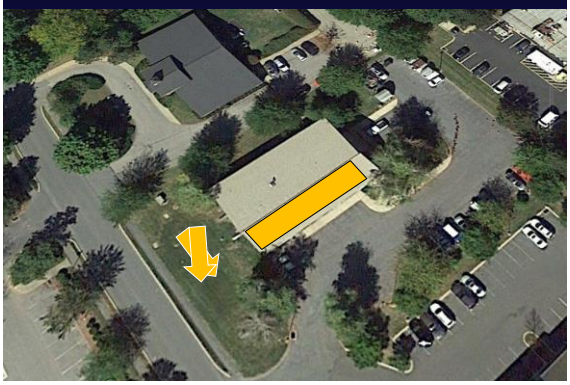

Ground-water recharge 700 feet from the well

Parking lot has LED lighting at 5,000 °K

$0.685 per sq. ft. per year! (2008)

$0.56 per sq. ft. per year! (2015 = 60,800 kwh)

27 KW PV solar system location on building



Each panel is supported by a rail system

Early morning sun in February

27 KW PV solar system components

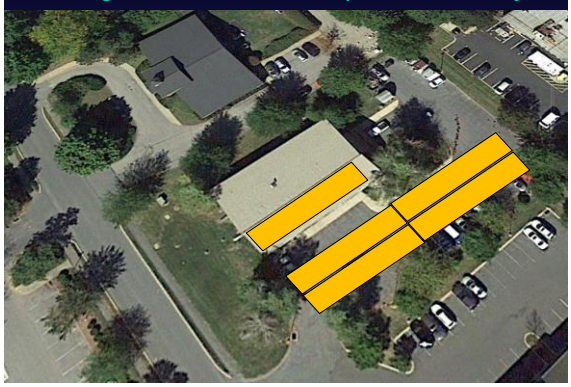
DC strings are between 650 v and 900 v DC

AC is 480 v, 3-phase wye, transformed to 208 v, 3-phase, with 1 phase to neutral = 120 v

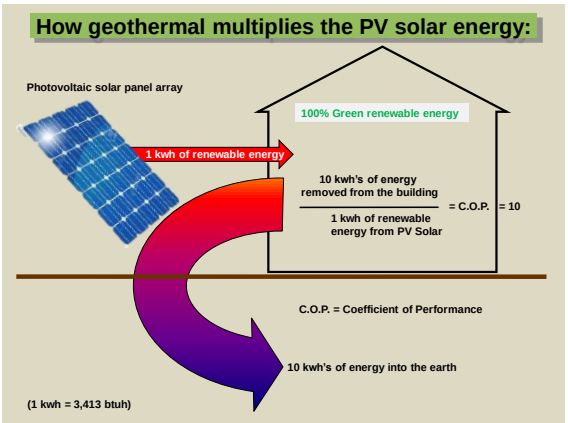
Snow cover severely limits panel output

Snow pack slides down to the snow fence

A heating COP of 5.1 x PV output = 5 PV arrays



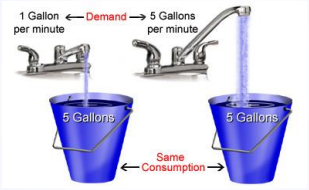
How geothermal multiplies the PV solar energy:



A cooling COP of 10 x PV output = 10 PV arrays

What is Electric Demand?

Demand is the RATE of using electricity, not the QUANTITY consumed



One gallon per minute for *five* minutes vs. *Five* gallons per minute for *one* minute

Different RATE, equal QUANTITY

26

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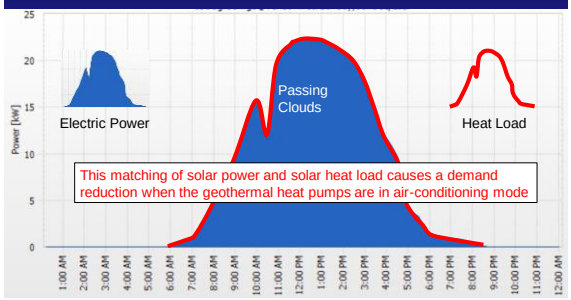
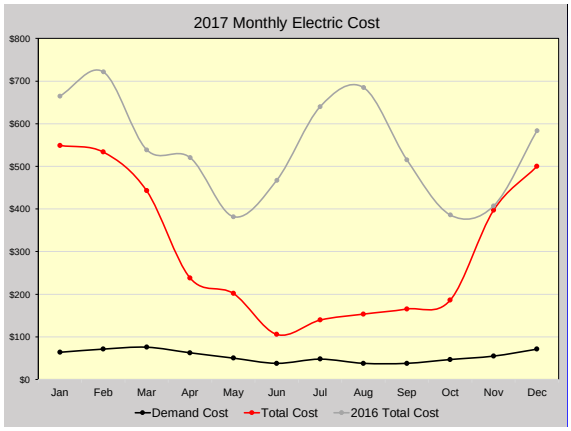
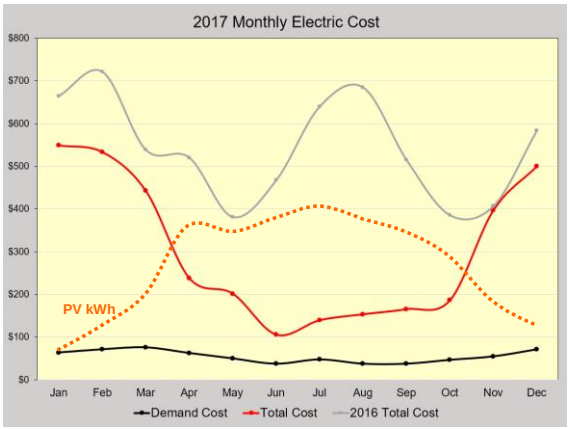
PV solar electric power output vs. solar heat load on my building

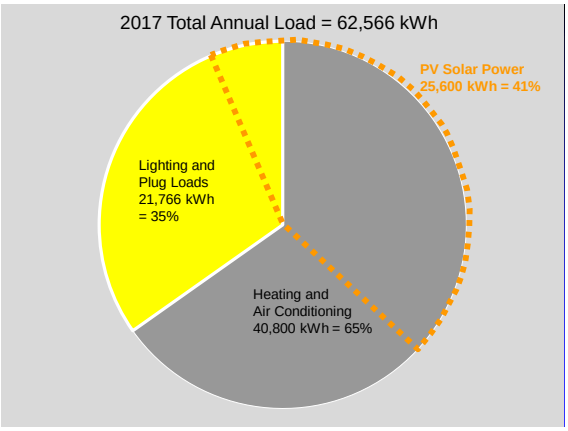


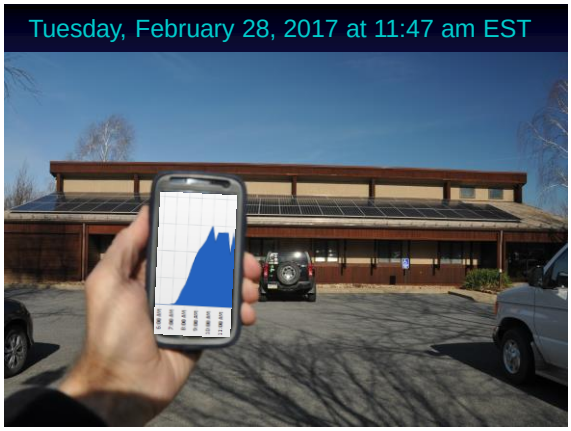
PV Solar electrical output variables:

- Climate: fog, dirt, clouds
- Season: snow cover, sun angle
- Location: latitude, elevation, shade
- Orientation: azimuth, inclination
- Panels: efficiency, temperature, string layout
- System: Inverter & transformer efficiency
- Grid: PV system requires power on grid









Why Geo + PV Solar is a great hybrid:

- COP multiplies the PV's kWh output
- EER multiplies the PV's kWh output
- PV's peak output = cooling load peak
- Matching peaks lower the kW demand
- Savings = kWh + demand reduction

The reasons I added PV Solar:

- Federal Tax Credit is 30%
- Accelerated and bonus depreciation
- Solar Renewable Energy Credit income
- kWh cost per year reduced by 45%, $2,901
- Building value increase
- My geothermal system multipliers
- My pride in "Going Green"