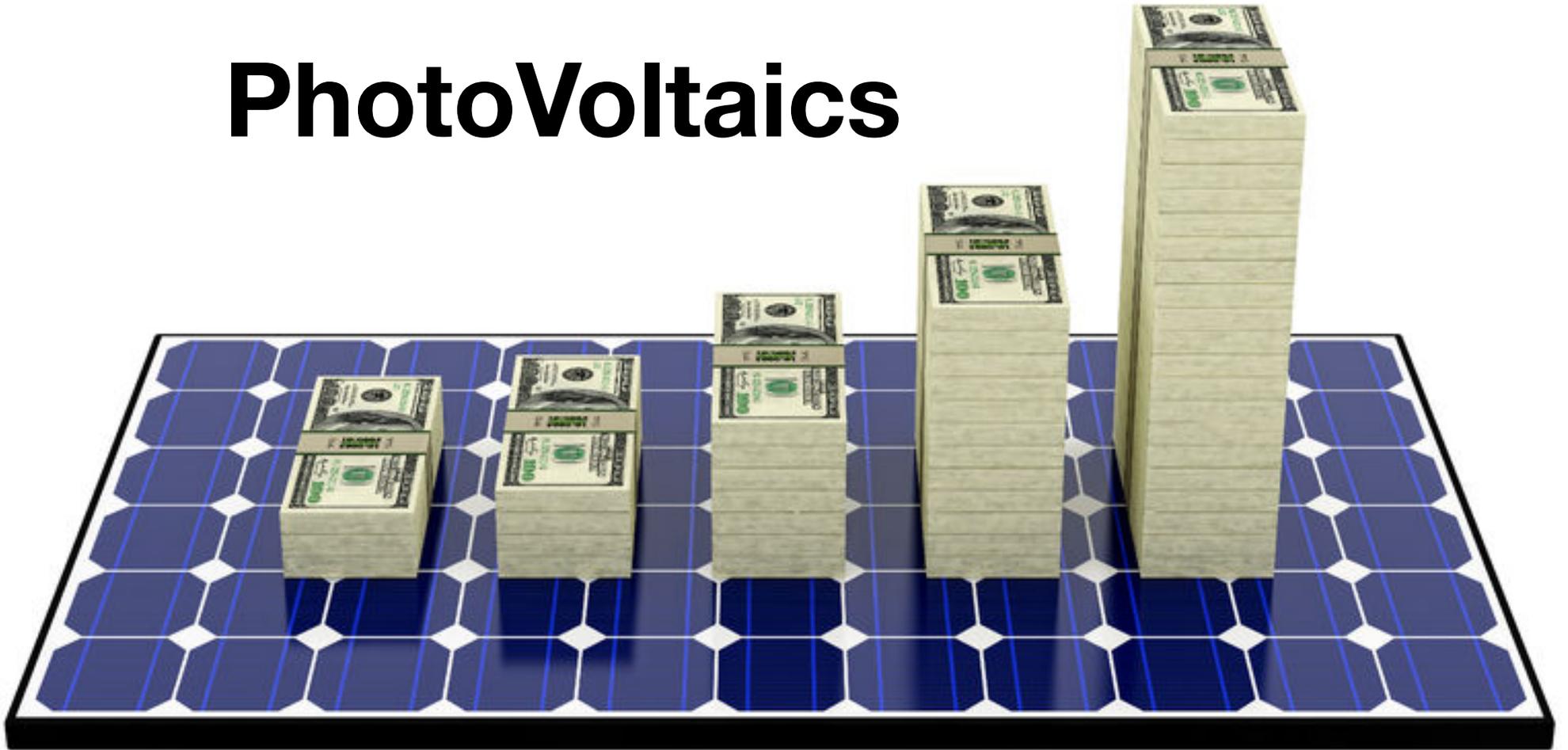


PhotoVoltaics



Objectives

- **Energy Requirements vs Energy Available**
- **How sunlight is converted to electricity**
- **Costs and Benefits of Solar PV**
- **Basic Equipment Overview**

ENERGY (kWh)

VS

POWER (kW)



Energy

- 1 Gallon of Gasoline = 34kWh
- Average home consumes ~1500kWh/mo (\$150 @ \$0.10/kWh)
- A 8kW PV system will produce ~1500kWh/mo
- 8kW system occupies ~500 square feet

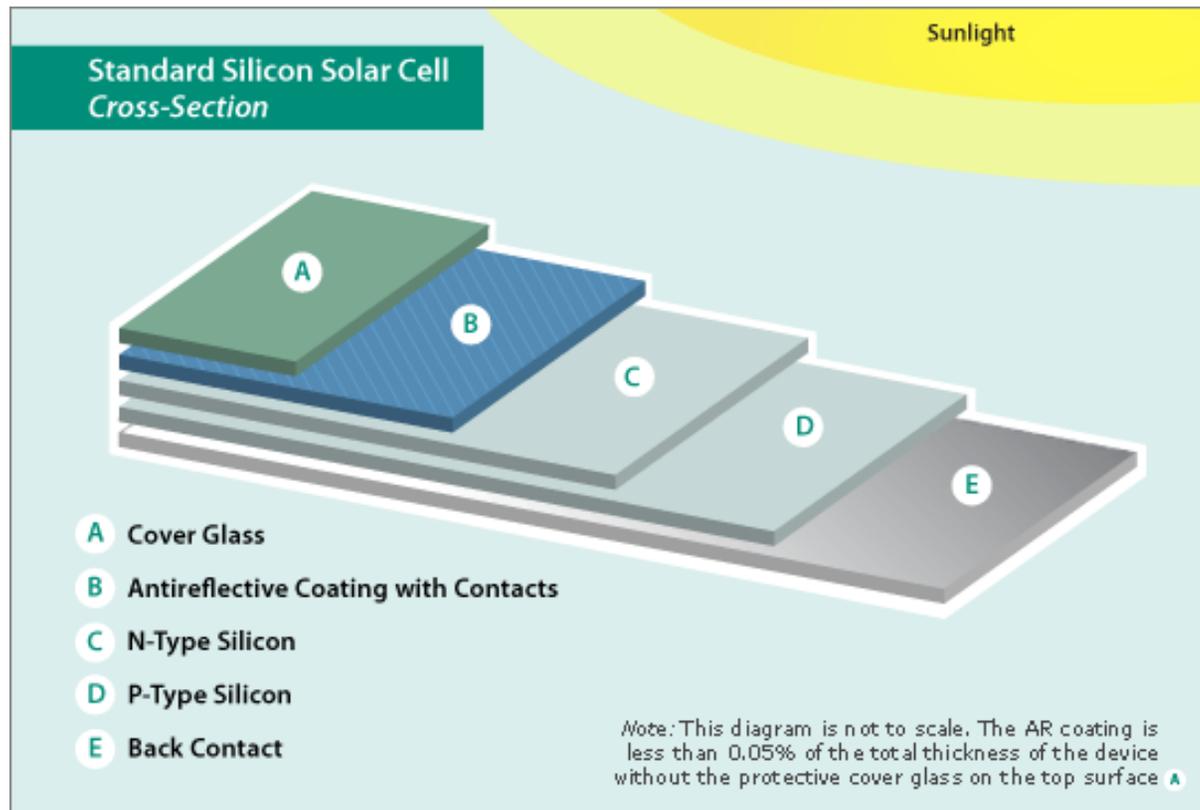
Power

- HVAC ~4kW
- Dryer ~3kW
- Microwave ~1.2kW
- 46" Television 200W
- Output of 12k BTU heater ~3.5kW

Solar Resources

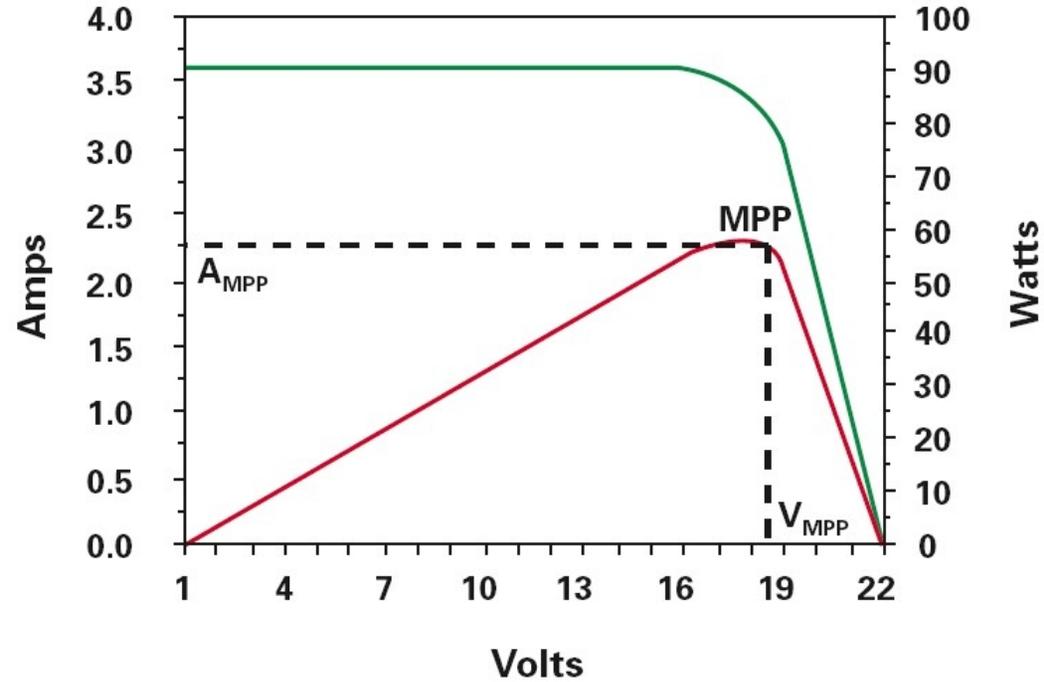
- Andrews County is 1500 sq miles
- 1 sq Mile receives ~2.5GW of solar power
- Andrews County receives ~3.7TW of solar power
- Annually Andrews County receives 8000 TWh
- US annual electric consumption: 4000TWh

PV = Simplicity

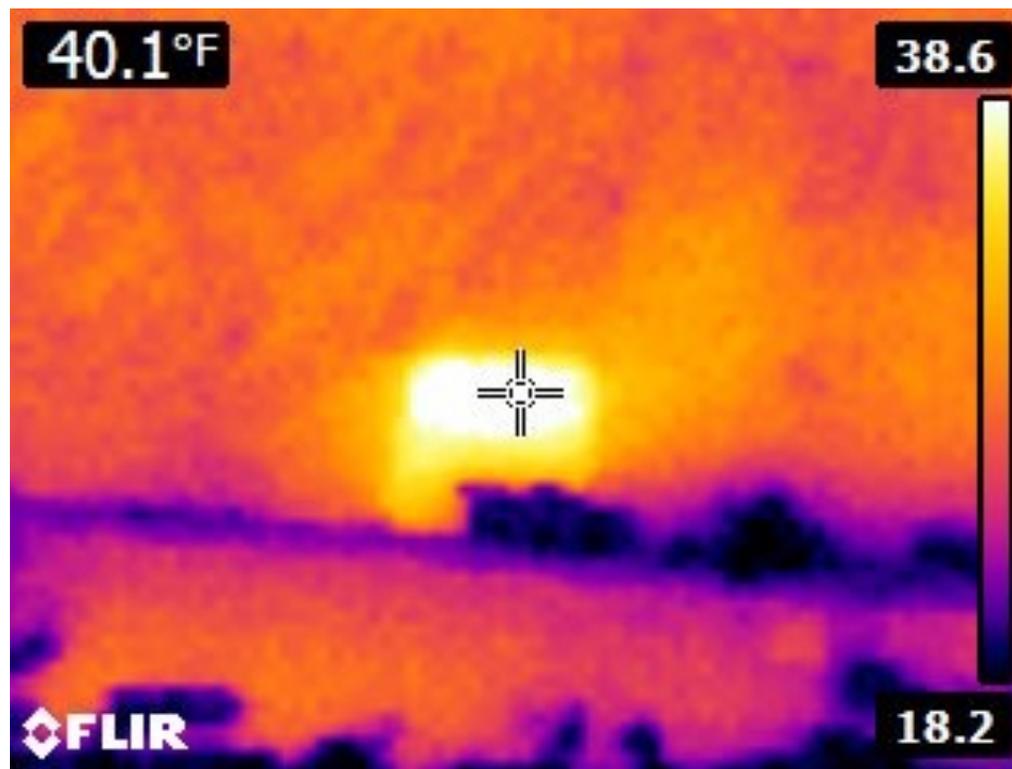


Maximum Power Point

PV Panel IV Curve

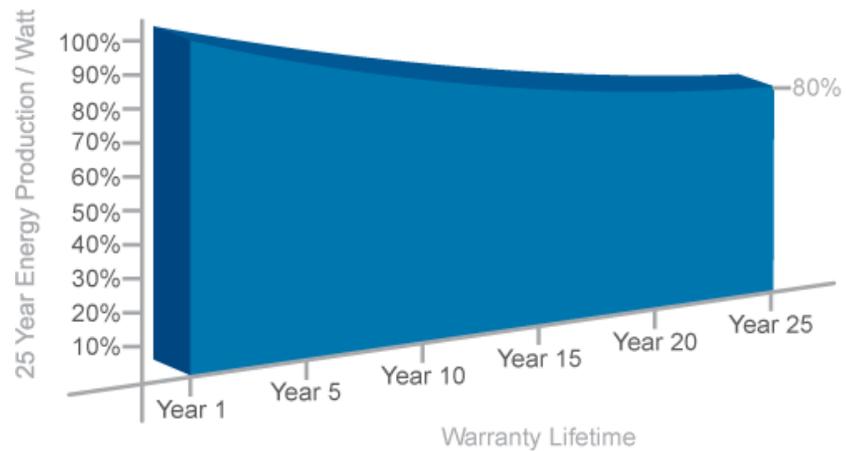
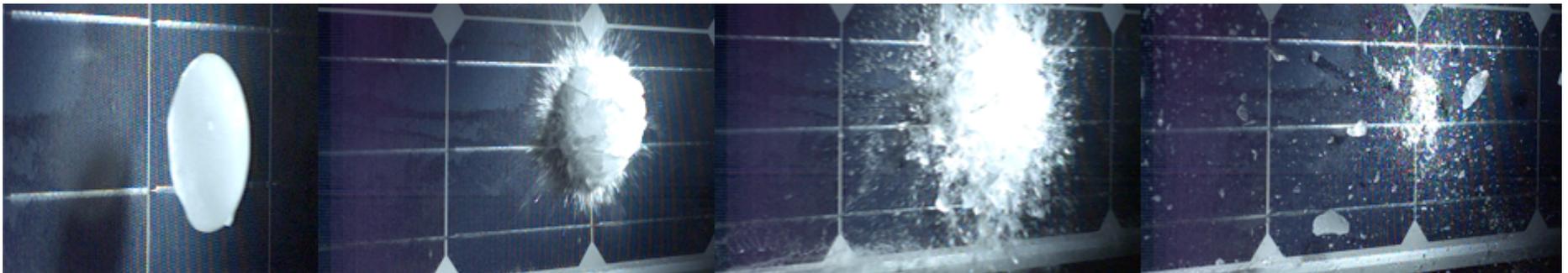


'Christmas Light Effect'





Durability and Long Life

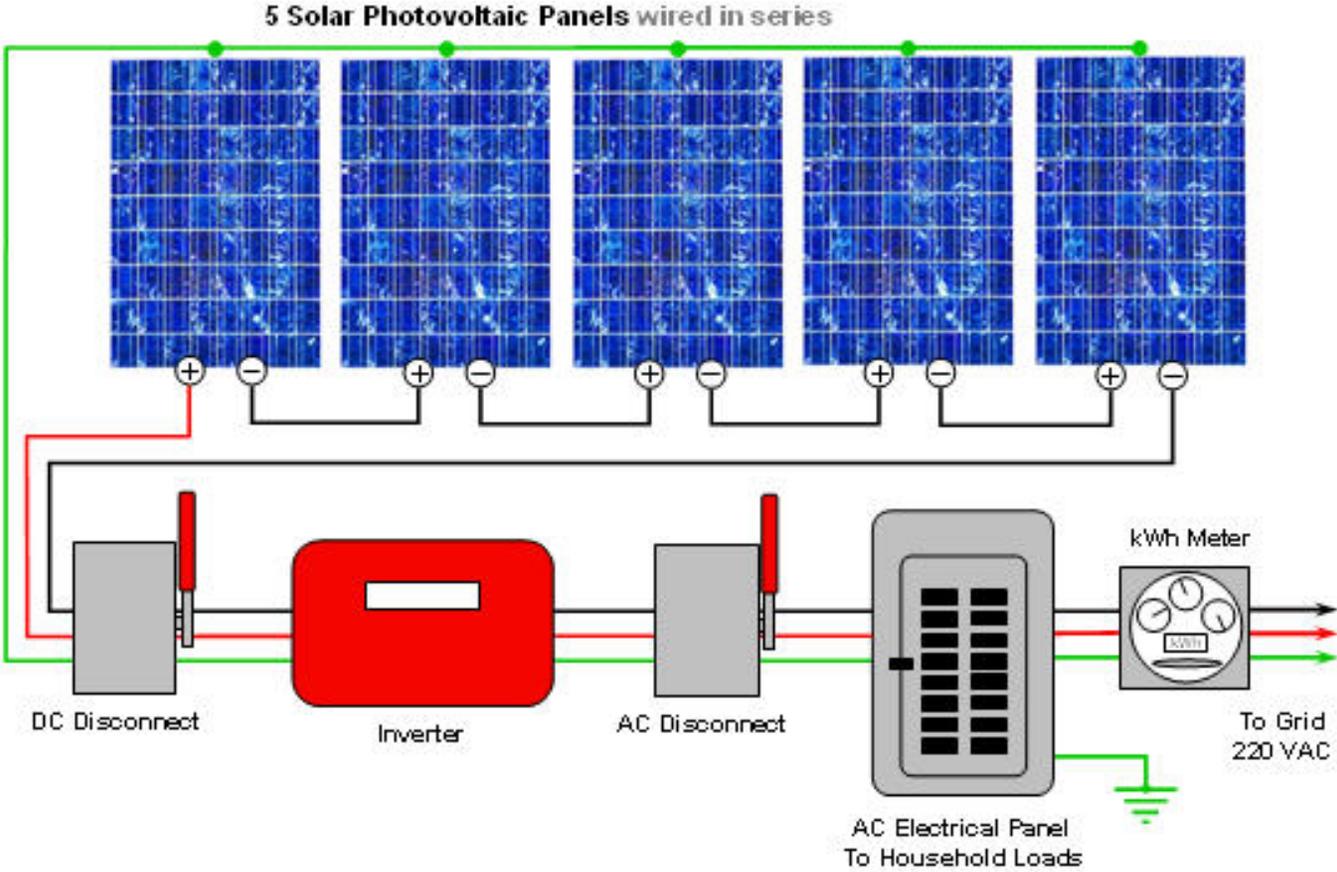


- 25 year warranty
- <0.5% degradation per year
- 1" Hail at 50 mph
- 140 mph winds

\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$

- Assume \$4/w cost; \$0.10/kWh savings
- Example 8kW system
- Upfront Cost: \$32,000 minus 30% ITC = \$22,400
- Expected annual production: 17MWh
- Expected Lifetime Production (25 years): >400MWh
- Value of Lifetime Production = >\$40,000

Basic Equipment overview



Types of PV systems

- **Grid-Tie**
- **Hybrid**
- **Off-Grid**

Grid-Tie

- **Very Efficient (>95%)**
- **Will not function during grid failure (anti-islanding)***
- **~40% less expensive than a hybrid system**

Types of Grid-Tie

String Inverter \$\$\$

- Least Expensive
- High Voltage for long runs
- 'Christmas Light' Effect

DC Optimizer \$\$\$\$

- ~15% more efficient
- 'Safe Shutdown'
- Storage Ready*

Micro Inverter \$\$\$\$\$

- ~15% more efficient
- 'Safe Shutdown'
- No Central Inverter
- No Single Point Failure

Hybrid & Off-Grid Systems

- Capable of Operating during a grid failure
- Typically ~40% more expensive than Grid-Tie
- Requires Batteries
- Requires Charge Controller or Grid-Tie Inverter
- <90% efficient

Production / Exports / Imports

$$\text{Use} = \text{Production} - \text{Exports} + \text{Imports}$$

$$\text{Savings} = \text{Use} + \text{Exports}$$

$$\text{Arbitrage} = \text{Cost of Import} - \text{Exports}$$

Storage and Back-up with Grid-Tie Systems

- **AC Coupled**
- **DC Coupled**
- **Opportunity Power**

AC Coupled

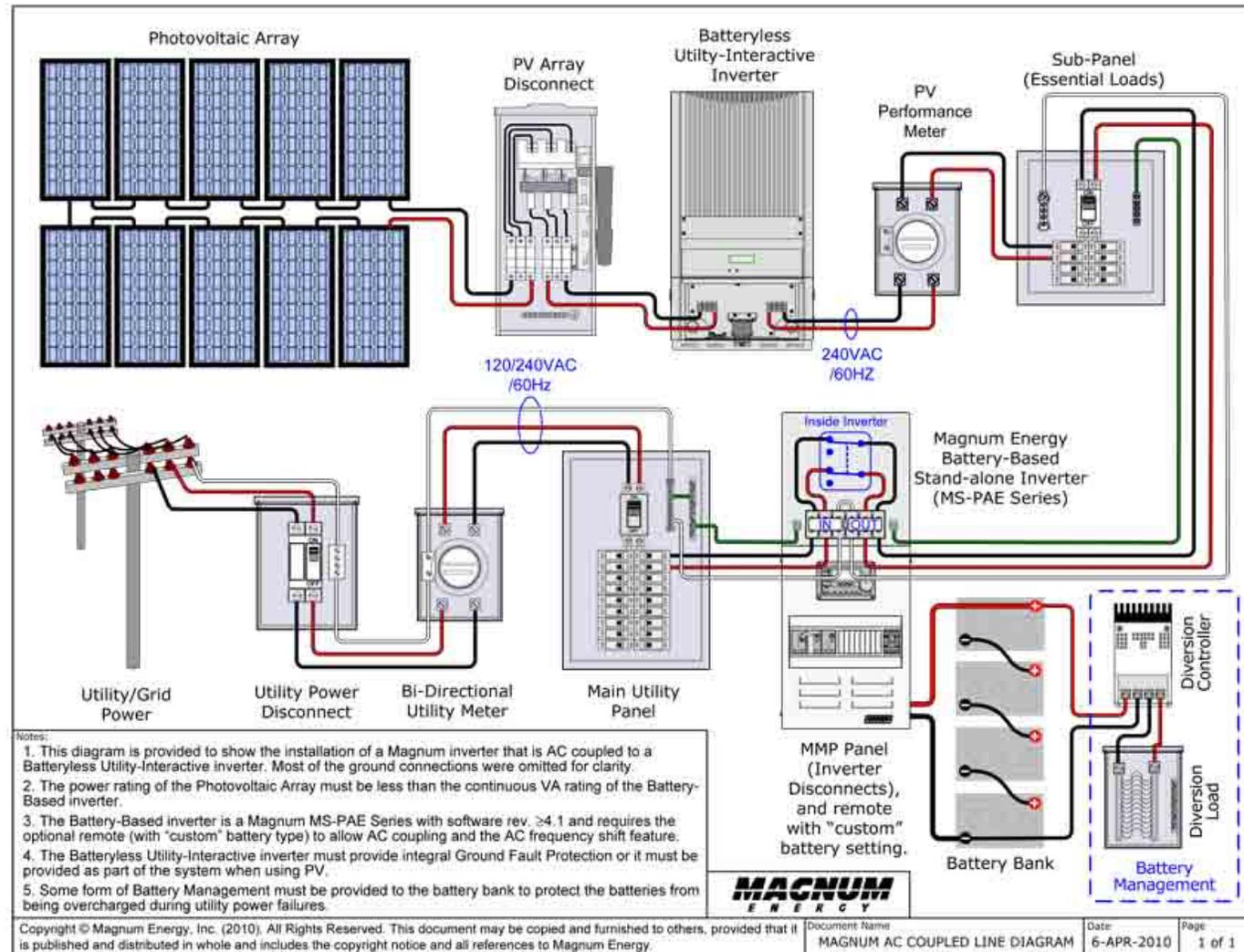
Requires AC-Couple inverter

50% larger than grid-tie*

Possible Resonance issues

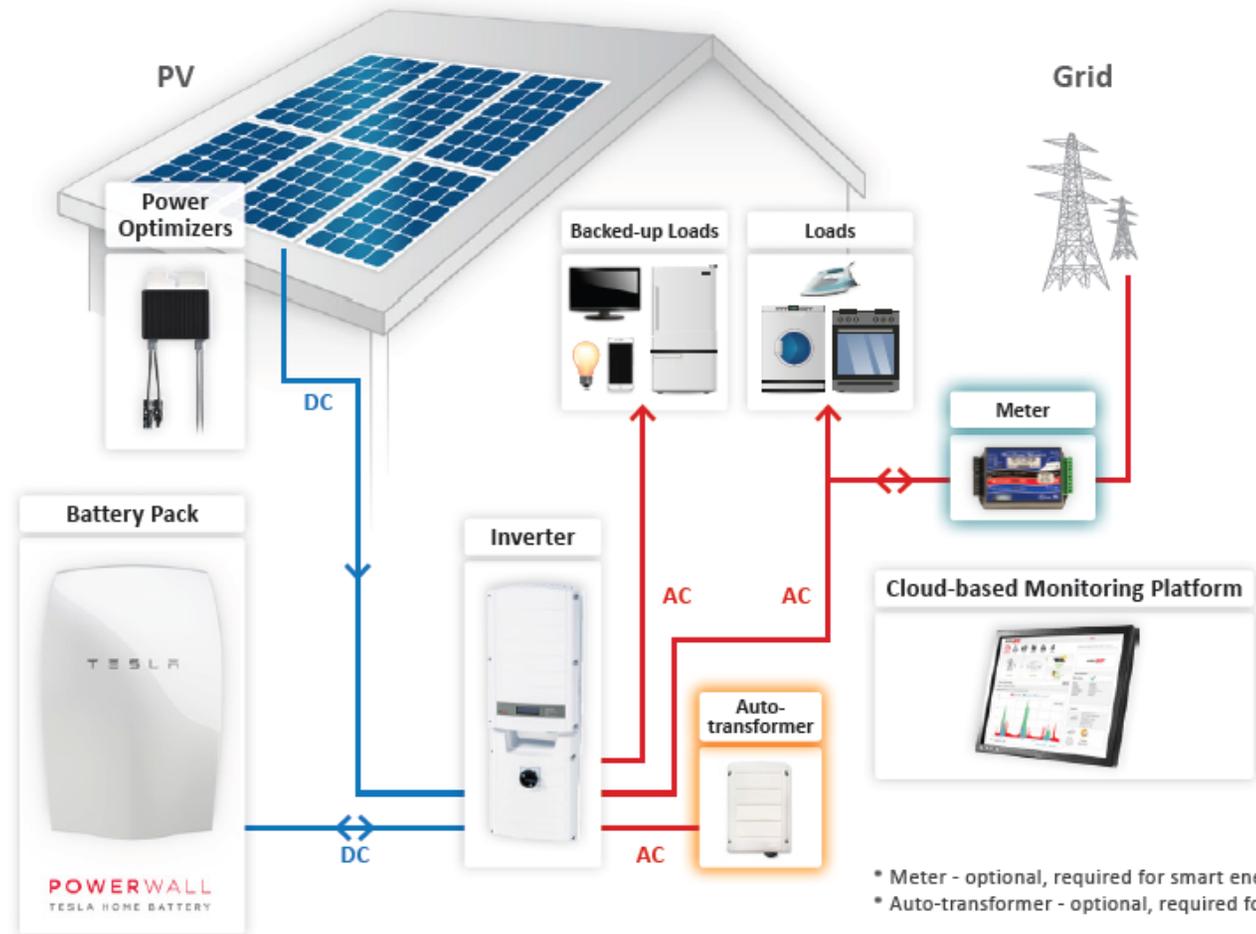
Automatic Backup*

Payback with Arbitrage*



DC Coupled

- New Tech
- High Efficiency
- No additional inverter required
- Limited Compatibility



Opportunity Power

Only Available from SMA

Limited Power <2kW

No Batteries

Least Expensive Option

Only Available during Day

Manual

