Do It Yourself Solar Photovoltaic (PV) Workshop

Jack Barnett

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Agenda

Tonight:

- Economics and Cost
- Intro to Photovoltaic (PV) Solar Systems
- Paperwork & Permitting
- Roofs and How to Mount
- Sizing and Layout
- Racking Installation

Tomorrow:

- More about paperwork
- Review of racking
- Inverter Installation
- Panel Installation
- Wiring & grounding
- Commissioning
- Maintenance

<u>Homework Assignment:</u> bring a sketch of your roof space including its orientation and measurements (or estimation). Also make note of any obstructions and possible shading concerns.

Most Important Considerations

- Site Quality: Orientation and Shading
  - South(ish) facing roof or nearby area to install a ground-mount
  - No (or little) shading year around;

    Use a Solar Pathfinder to check =>
  - Impacts: lower production = less ROI

- System Sizing: usually limited by one of
  - Physical site issues (roof size), or
  - Available budget (cash to invest)

What Will a Solar PV System Cost?

- <u>Cost:</u> Approximations/Rules of Thumb:
  - PA 2015 costs for an "average" professionally installed 'basic' PV system: ~**$3.70/watt$_{dc}$**
  - Or, with DIY labor: **~$2.00/watt$_{dc}$** for just the 'basic' materials
  - Don't forget permitting and inspection costs
- To be certain, get one or more installation cost estimates from certified solar PV installers. Look for a *North American Board of Certified Energy Professionals (NABCEP)* certification.

How Do You Make Your Money Back?

Three basic ways:

1. Income tax credits
2. Savings from not paying a utility for electricity produced
3. Selling Solar Renewable Energy Certificates (SRECs)

Other grants, financial assistance,
or incentives may also be available
e.g. farms, small businesses loans, etc.

Visit: http://dsireusa.org for a summary of federal & state regulations and incentives across USA

Federal Income Tax Credits

Federal Individual Tax Credit of up to 30% of cost for new residential renewable energy systems

- Does not have to be your ‘main’ home
- Only for actual payments (not DIY labor)
- Extended through 2019, then reduced % for 2 more years

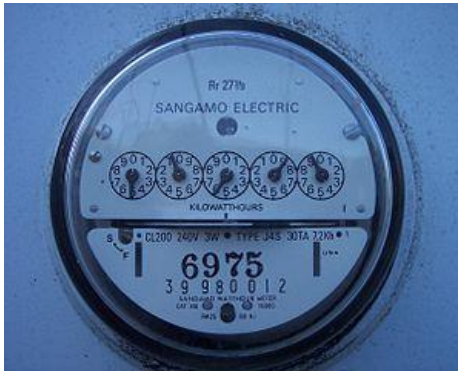
When: filing taxes for the year of the system’s “in-service date”

- Use IRS Form 5695
- Must have taxable income to be offset; or can be carried forward, if needed

Paying the Utility for Less Electricity

PA law requires distribution utilities to provide **Net-metering**

- Meter runs backward! when producing more than you're using
- Utility acts as a 'virtual battery' – providing you with a kWhr of credit for each kWhr of excess production from your system
- Credits are then used when the household's electricity load is greater than production (e.g. when sun is not shining)

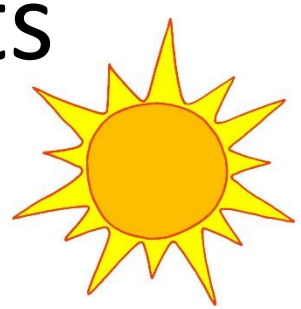


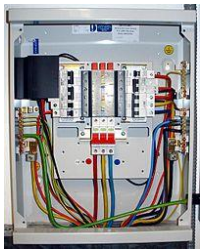
- You must still pay the distribution utility for
  - monthly connection fees,
  - demand charges (commercial tariffs), and
  - for kWhrs used when all credits are consumed
- In PA, if you have remaining kWhr credits in the May billing date, the utility will send you a check
  - BUT using the lower "rate-to-compare" price per kWhr

Basic PV System Components

1. Panels to convert sunlight into DC electricity
2. Inverters to convert DC into AC
   We are using micro-invertors, 1 per panel
3. Racking to hold things in place
4. Wiring to connect everything
5. Grounding/bonding to keep it safe
6. Production meter and/or remote monitoring

This is a Grid-tied and battery-less system, so will not function during utility outages.

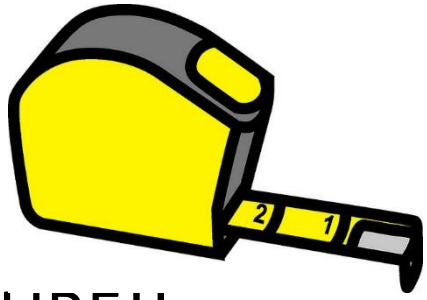




Order of Events

1. Site and Sizing
2. Apply - for permit & interconnection
3. Order Equipment
4. Install
5. Electrical Inspection (required)
6. Final Paperwork submission
7. TURN ON SYSTEM!

1. Site and Sizing



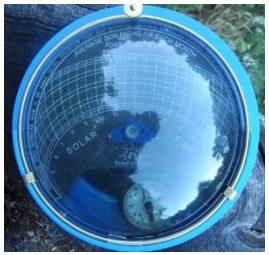
Roof Space:

- Will It Fit? MEASURE MEASURE MEASURE!!
- Panels: ~40” Wide x ~65” Tall – 9, 12, 15 panels?
- Roof Age, Roof Type: Metal or Shingled

No Obstacles: Vent, Chimney, Trees, Satellite dish

South(ish) Orientation without Shading:

- Want Sun All Day!! Best: 6+ hours/day, all year
- Use a Pathfinder



2. Apply

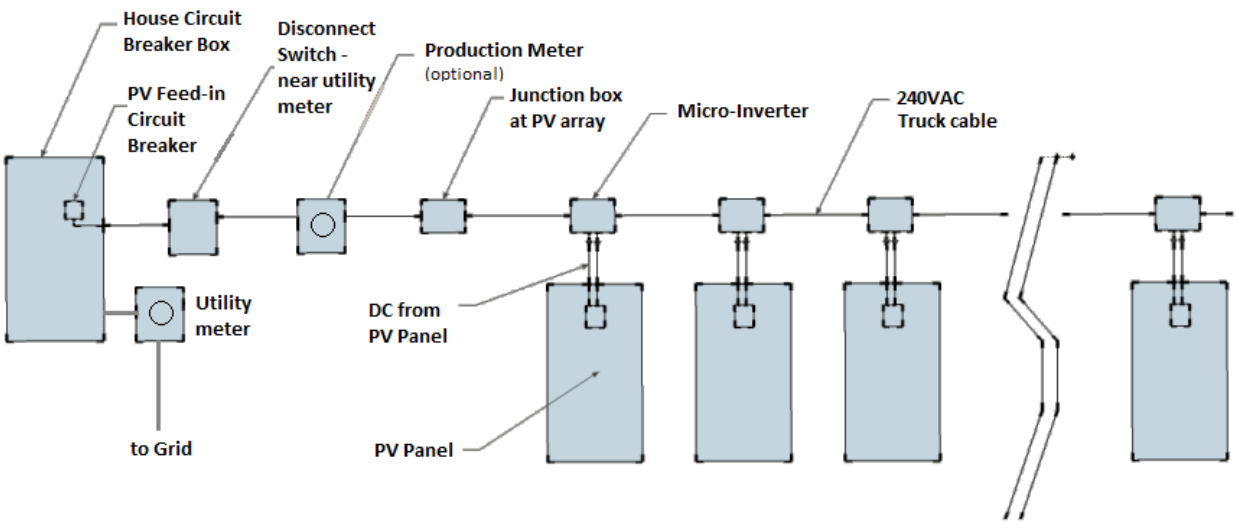
Interconnect Application

A. Utility Interconnection - Part 1

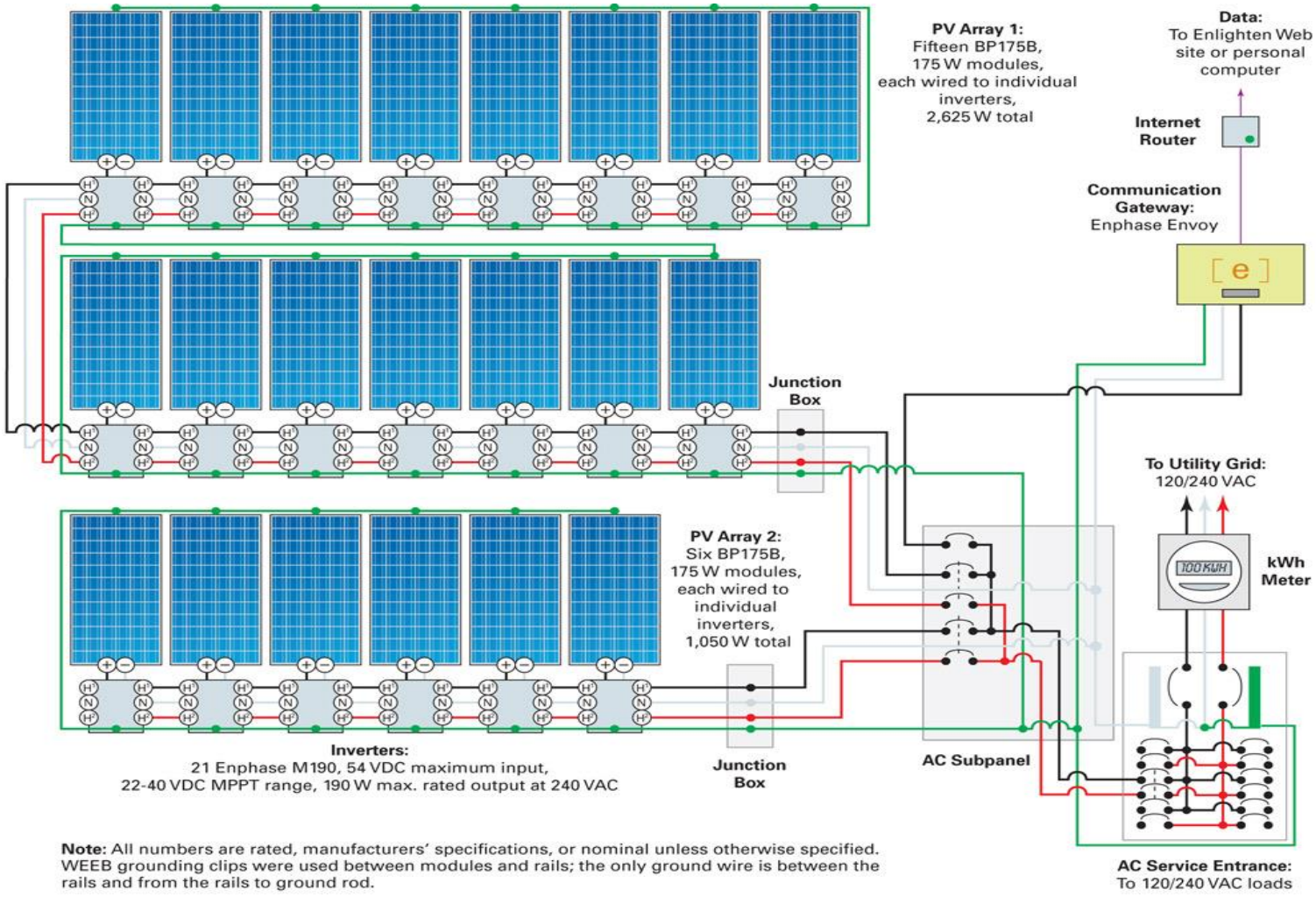
Google: [utility name] interconnection agreement

- Inverter Spec Sheet "DATA SHEET"
- Application
- Fee??
- Site Plan
- 1 Line Electrical Diagram

Enphase Spec Sheet



3-Line Electrical Diagram



Note: All numbers are rated, manufacturers' specifications, or nominal unless otherwise specified. WEEB grounding clips were used between modules and rails; the only ground wire is between the rails and from the rails to ground rod.

2. Apply (continued)

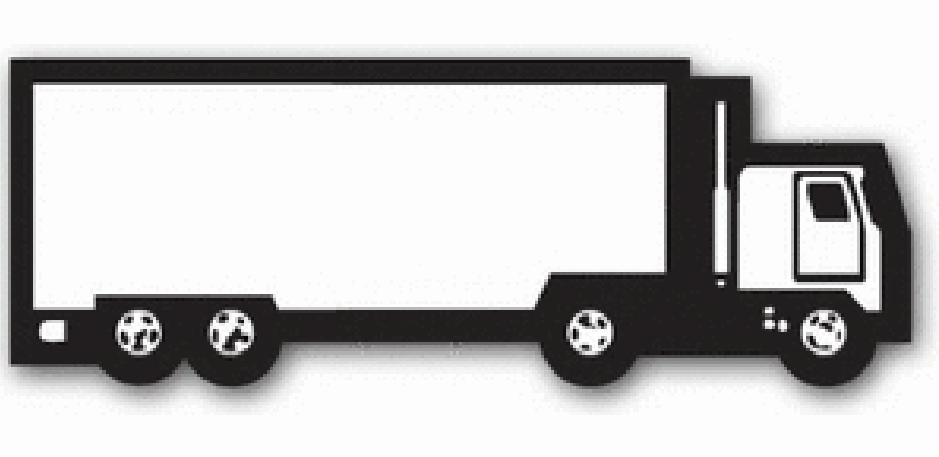
B. Community Permits (if required)
  - Everything from Interconnect
  - Plus data sheet on solar panels, racking, engineering reports
  - Fees vary significantly

3. Order Equipment

Approved! Now What?

Order Equipment

- At least 2 weeks in advance
- Tracker Trailer Lift-gate Deliver Service



4. Install - Prep

Tools Needed:

- Ladders/scaffolding
- Safety Harness & Line
- Chalk Line
- Cordless Drill/Wrench
- Hand Tools
- Ratchet and Sockets
- Pencil, Crayon, Sharpie
- Tape Measure
- Hammer
- Saw
- Caulk Gun
- Volt meter

Misc Equipment:

- Stainless-steel Lag Screws/bolts
- Roofing Caulk/Silicone
- Outdoor Zip-Ties
- Copper #6 wire
- Ground Rod & nut
- Weatherproof Junction Box
- 12/3 Romex wire
- Conduit (if external)
- 20A 240v Circuit Breaker
- Exterior AC disconnect switch
- Meter base (for optional production meter)

4. Install: L-Feet

- Find Array Center, Top and one Side Edge
- Find Rafters 48”-64”
- Layout the Feet
  - Height on Panel - 12”-15” (from top & bottom)
  - Width on Panel – no more than 12”
  - Pre Drill (no larger than lag bore without threads)
- Install with Stainless-steel Lag
  - Silicone (or gaskets provided)

4. Install: Rails

- Rails
  - Align Starting End (either left or right)
  - Let other end run wild (saw off later)
- Splice Bars
- Bonding Lugs
- Bonding Wire

4. Install: Inverters

- Attach Inverter Trunk Cable to backside of Rails
  - Terminate one end
  - Zip-tie so no cables touch roof surface
- Attach Inverters
  - On to upper rail under each panel location
  - Attach copper bonding wire
  - Attach AC Connector to Trunk Cable
  - Zip-tie so no cables touch roof surface

4. Install: Inverters

Day 2: Do It Yourself Solar Photovoltaic (PV) Workshop

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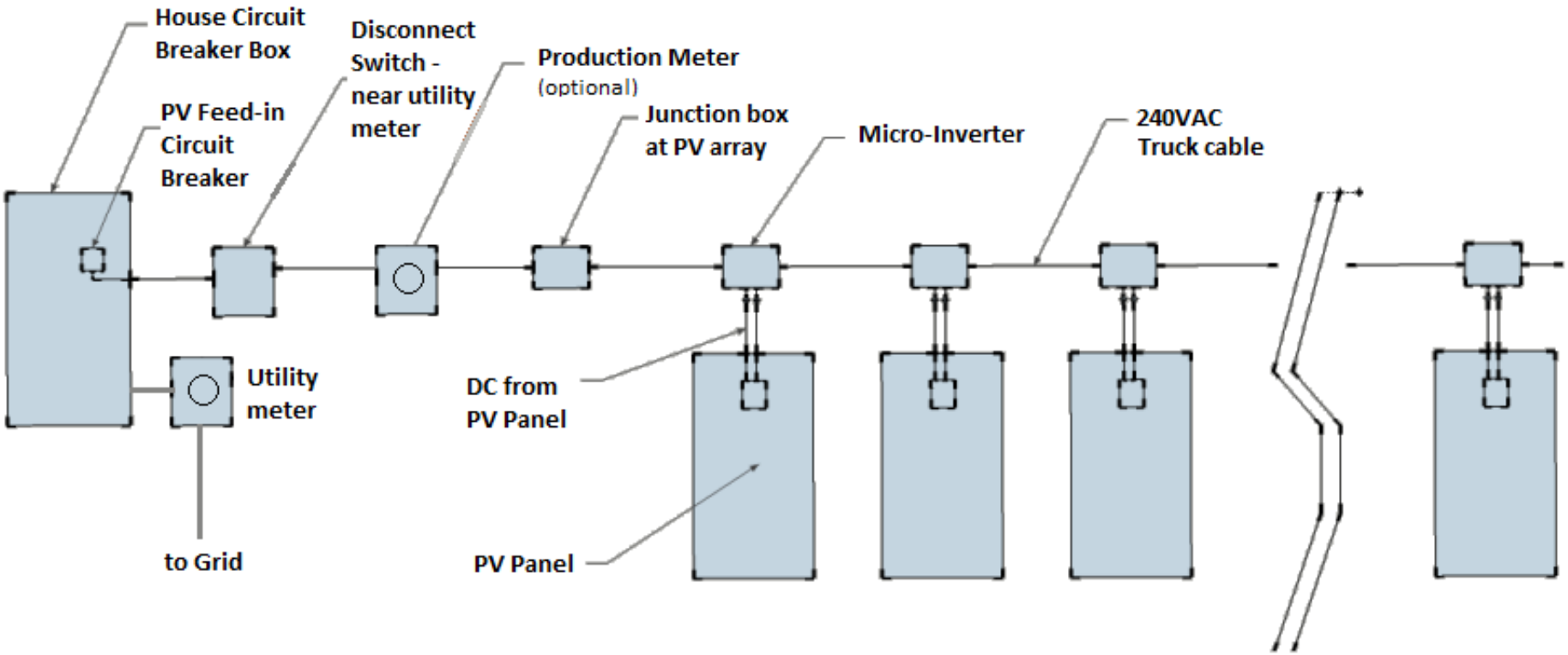
One Line Diagram



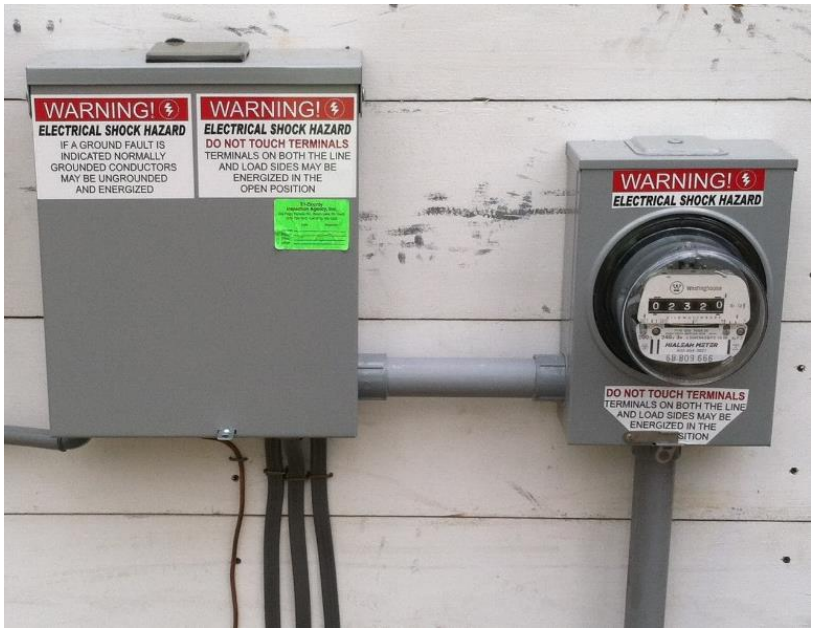
4. Install: Panels

- Connect both DC connectors to Inverter
  - Zip-tie as needed
- End Clips
  - 12”-15” Rule
- Click, Zip, Clips
- Click, Zip, Clips
- Click, Zip, Clips
- End Clips

Here's what's it looks like from below:

4. Install: Wires

- Trunk Cable to WP Junction Box
- 12/3 Romex from WP Box to Sub-panel and/or Production Meter
  - Conduit required if exterior
- Then to Outside Disconnect (near utility meter)
- Disconnect to Breaker
  - Bottom of Panel Box
  - Labeled
- Bonding Wire to
  - Ground Rod and to
  - Existing House Ground



4. Install: Test it

- CHECK VOLTAGES
- TURN ON (briefly)
- COMMISSION – Internet Web Page

5. Electrical Inspection

- Meet With Inspector On-site
- Needs to sign off on
  - Part Two of Utility Interconnection paperwork,
  - And “Cut In Card” (also from Utility website),
  - Plus Community Permit (if applicable)

6. Paperwork – Part 2

- Send Utility: Part 2 of Interconnection and Cut-in Card
- Wait
- WAIT
- WAIT!!!

Turn on System for Real

- SAVE money
- SAVE environment
- SAVE sanity

- Annual Maintenance:
  - Check wiring insulation for wear
  - Clean panels (optional)