



Featuring NICC  
Electrical Industrial  
instructor  
Jeff Foster




## **Bumps and Benefits of DIY Solar** **October 15th Lunch-and-lecture**

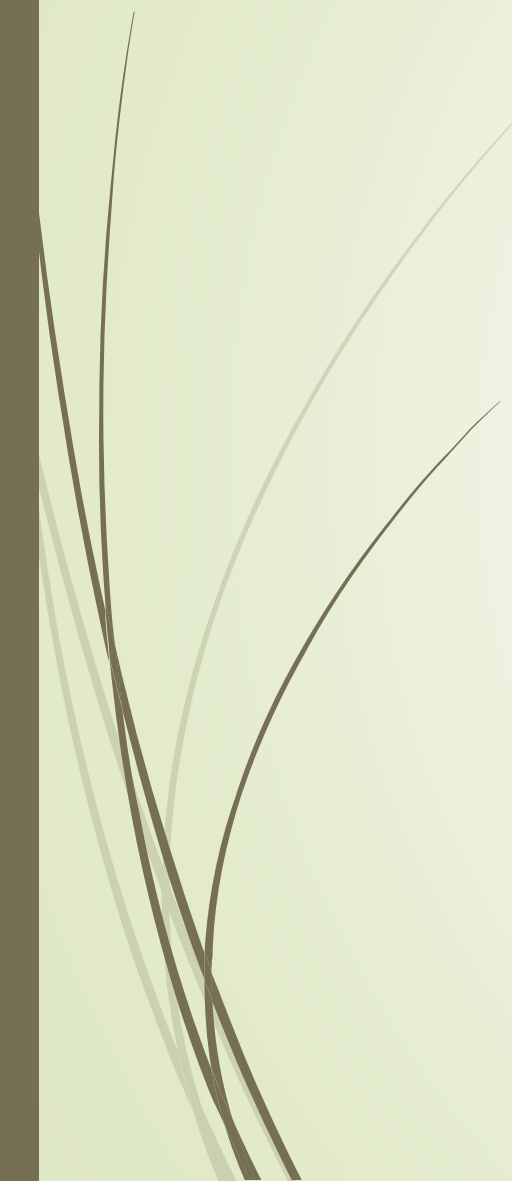
Noon - 1 PM at Northeast Iowa Community College's Wilder Business Center  
Register at [energydistrict.org/breakfast](http://energydistrict.org/breakfast)




Jeff Foster



# First question : How much solar should I get?

- ▶ How much solar do I need?
  - ▶ How much can I afford ?
  - ▶ How much space do I have ?
  - ▶ How much will the utility let me have?
- 



# Step 1: Getting current bill from your utility. 18.114 MWh. Ouch!

Page 2 of 3

109 RURAL AVE, DECORAH, IA, 52101  
Residential Electric Service  
Rate Code: I400  
Meter Number: 065419006

Bill Date (Month/Day/Year)	Electricity (kWh)	Dollars
03/27/19	1287.000000	\$177.55
03/01/19	1732.000000	\$231.89
01/31/19	1684.000000	\$232.24
12/27/18	1314.000000	\$178.60
11/27/18	1158.000000	\$170.26
10/29/18	1267.000000	\$187.91
09/27/18	1221.000000	\$198.80
08/30/18	1659.000000	\$296.44
07/27/18	1552.000000	\$274.57
06/27/18	1317.000000	\$204.41
05/29/18	1417.000000	\$203.84
04/26/18	1229.000000	\$181.82
03/27/18	1277.000000	\$183.93



# Utility resources.

- ▶ <https://www.alliantenergy.com/InnovativeEnergySolutions/SustainableEnergyChoices/CustomInterconnection>



Average price  
for solar installed  
is from 2.60 –  
3.40 per watt.

## Solar Financing

Ready to start rolling back your utility meter?

- By installing solar in 2019, you can still claim the 30% Federal Tax Credit.
- Your immediate reduction in electricity spending is usually enough to cover the solar loan payment!
- Up to 100% financing is available.
- Take up to 10 years to pay off the loan.
- Decorah Bank has financed over 100 solar projects providing more than \$7 million in financing to date!



Ask one of our energy loan specialists for complete details.

Family & Employee-Owned

**Decorah Bank** & TRUST CO.  **Cresco Bank**  
A DIVISION OF DECORAH BANK & TRUST CO.

202 E. Water St., Decorah, IA 52101  
563.382.9661 ♦ DecorahBank.com

126 Second Ave. SE, Cresco, IA 52136  
563.547.2244 ♦ CrescoBank.com

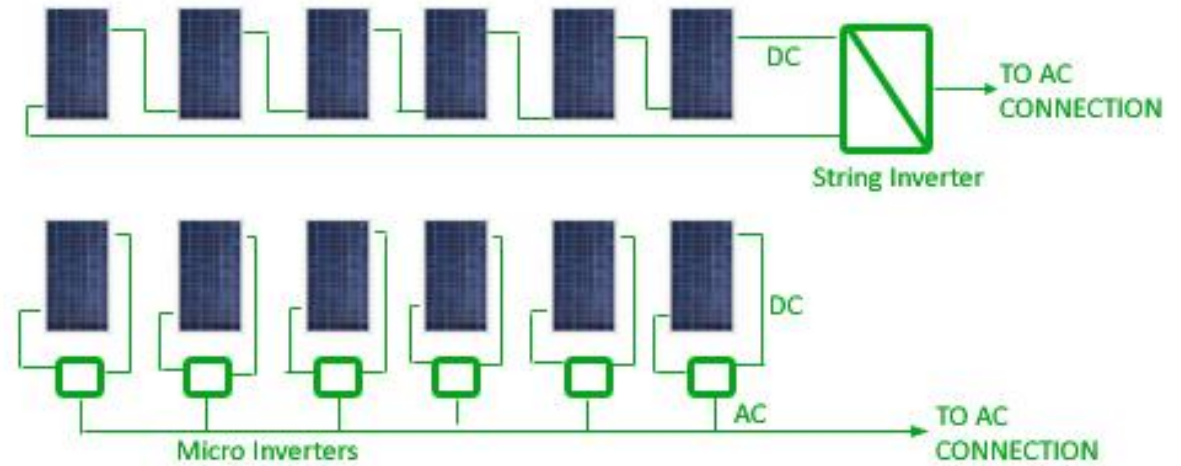


## What type of grid tied system do I want ?

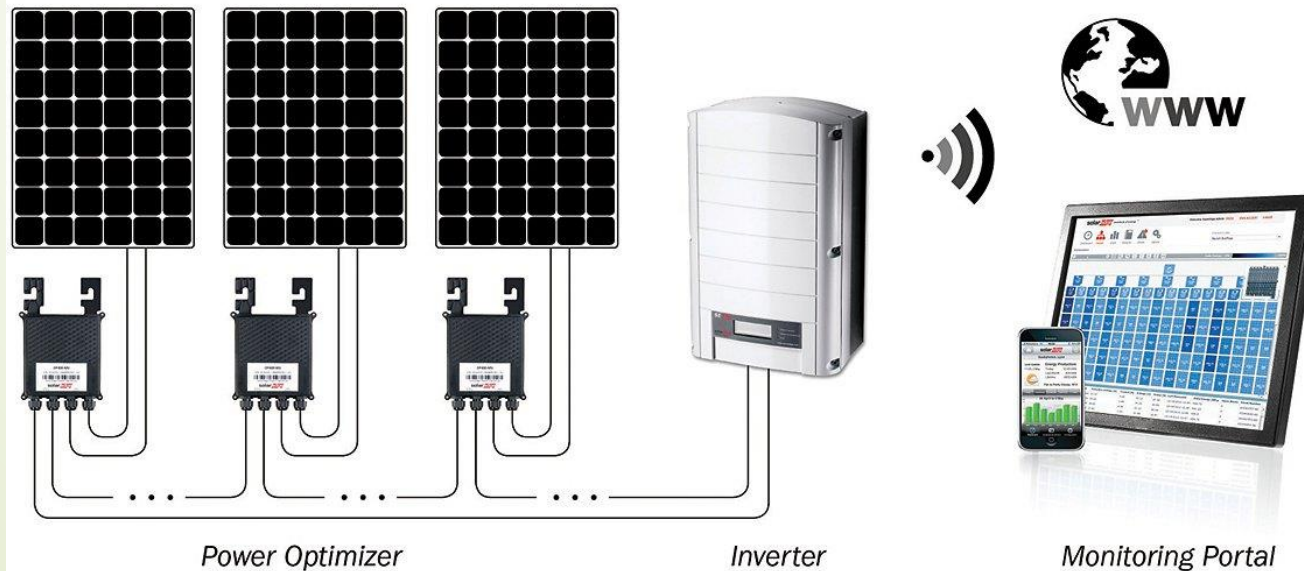
String inverter: more affordable, less efficient, must include rapid shut down.

Microinverter: More expensive, more efficient, better communications.

Power optimizer: Best of both worlds.



SolarEdge System





# Solar edge sizing app.

- <https://www.solaredge.com/us/products/installer-tools/designer#/>



# Beginning an interconnection agreement with your utility.

- ▶ <https://www.alliantenergy.com/InnovativeEnergySolutions/SustainableEnergyChoices/CustomerInterconnection>






# DIY home owner Electrical permit rules.

- ▶ Chapter 103 of the Iowa Code allows for homeowners and farmers to do electrical work on their property without the requirement of an electrical license. They merely apply for the Electrical Permit and schedule an Electrical Inspection as their wiring project proceeds. If they have any questions concerning their particular installation, we urge that they contact the Electrical Inspector Supervisor or view the Interactive Map of County and State Inspectors for assistance.
- ▶ Their exemption includes any accessory buildings on the property that do not exceed 3000 square feet but does not extend to investment property, business property, rental property, vacation homes, etc. A new home must be wired by an electrical contractor.



# Farmer DIY electrical permit rules.

- ▶ The exemption for the farmer is basically the same as that for the homeowner except that it extends to all agricultural properties that he/she may own and is not limited to 3000 square feet. Any new home or any existing residence other than the primary residence must be wired by an electrical contractor.
- 

# Obtaining a home owner electrical permit.

[http://www.dps.state.ia.us/fm/electrician/inspection/inspections\\_index.shtml](http://www.dps.state.ia.us/fm/electrician/inspection/inspections_index.shtml)

The image shows a screenshot of a web browser with two tabs open. The left tab shows a Google search for "dps electrical permit". The search results show "Electrical Permits - Iowa Department of Public Safety" with the URL [www.dps.state.ia.us](http://www.dps.state.ia.us). Below the search results, there are sections for "People also search for" and "People also ask".

The right tab shows the Iowa Department of Public Safety website. The header includes "iowa.gov" and navigation links for "Services", "Agencies", and "Social". The main content area features the Iowa Department of Public Safety logo and the text "State Fire Marshal Division". Below this, there is a navigation menu with links for "DPS", "Divisions", "Online", "Publications", "Contact", and "AMBER". A search bar is visible with the text "Search WWW" and "Search DPS Website".

The website content includes a section for "Electrical Permits" with the subtitle "Electrical Licensing and Inspection Program". Below this, there is a list of criteria for when electrical permits are required:

- 1. The installation is to be legally performed by a State of Iowa licensed journeyman or master electrician or by a licensed apprentice electrician under the direct supervision of a licensed journeyman or master electrician.
- 2. The installation does not involve work within a new or existing switch board or panelboard.

The taskbar at the bottom of the browser shows the time as 8:28 AM on 9/6/2019.

Electrical  
Examining Board

Electrical  
Examinations

Electrical  
Training Programs

Fee Schedules

Forms

Frequently Asked  
Questions

Homeowner/Farmer  
Information

journeyman or master electrician or by a licensed apprentice electrician under the direct supervision of a licensed journeyman or master electrician

2. The installation does not involve work within a new or existing switch board or panelboard.

3. The installation does not involve any electrical line-to-ground circuit of more than 30 amperes.

4. The installation does not involve any electrical line-to-ground circuit of more than 277 volts single phase.

Electrical permit is usually done by an electrical contractor performing the installation. There are some exceptions to [Iowa Chapter 103](#) that allow the [Homeowner/Farmer](#) to perform the electrical installation but the other requirements for electrical permits and inspections still apply.

The application for electrical permit is usually done online at [iowaelectrical.gov](http://iowaelectrical.gov) which uses a secured program to accept payment by credit card. This format is available 24 hours a day and the payment and submittal are instantaneous. For those without internet access or who prefer paper forms the [Manual Permit Application](#) can be filled out and submitted by mail with an accompanying check or money order. Naturally, this option is slowed by using the postal service. Contact your area electrical inspector using the [Inspector Map](#) and they can assist you with the [Manual Permit](#) form.



# Iowa Department of Public Safety State Fire Marshal Division Electrical Bureau Online State Permitting & Inspection System

- Home
- License and Course Search
- Contact Us

## HOME

### Welcome

Welcome to the Iowa Electrical Licensing and Inspection website. From this site you will be able to apply for an electrician license, renew your license, get a duplicate license, create and view your personal license account, purchase an electrical permit, or request inspections by clicking on the appropriate icon to the right.

- For more information on electrician licensing and permitting/inspections please visit the [State Fire Marshal's website](#).
- To find out who does the permitting and inspections in your area visit our [interactive county map](#) and click on the county where you are working.

### Log in or Create an account:



# Permit

The screenshot shows a web browser window with a Gmail inbox. The search bar contains the word "permit". The selected email is titled "Payment Confirmation for DPS Electrical Permits" and is from "DPS Electrical Permits <epaynoreply@usbank.com>". The email content includes a warning not to respond, a thank you message, and payment details for a permit submitted on April 11, 2019. The payment amount is \$55.00, with a convenience fee of \$1.51, for a total of \$56.51. The payer is identified as Jeff Foster, and the merchant is DPS Electrical Permits.

Browser tabs: Northeast Iowa Community Colle x, M Payment Confirmation for DPS El x

Address bar: mail.google.com/mail/u/0/#search/permit/FMfcgXwCgCQMZCKDMrITcgjXIVcvmxJ

Search bar: permit

Subject: Payment Confirmation for DPS Electrical Permits

From: DPS Electrical Permits <epaynoreply@usbank.com>

Date: Thu, Apr 11, 3:26 PM

Body:

\*\*\* PLEASE DO NOT RESPOND TO THIS EMAIL \*\*\*

Thank you for your payment.

This email is to confirm your payment submitted on Apr-11-2019 for DPS Electrical Permits.

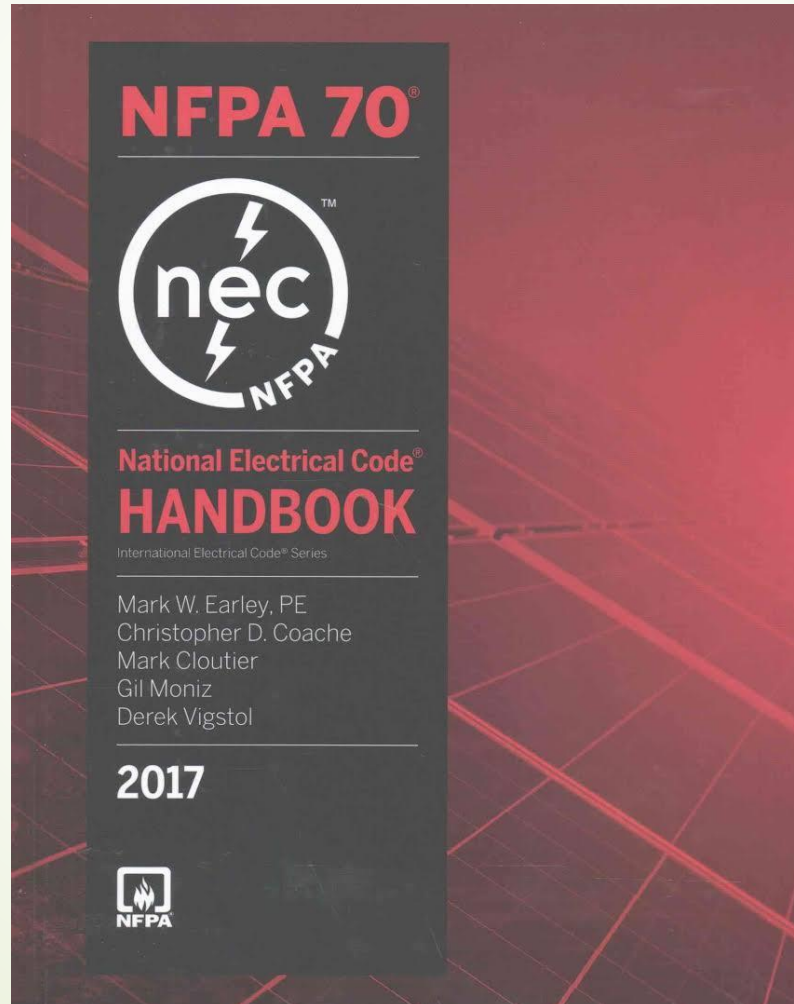
Confirmation Number: IOWDP2006996674  
Payment Amount: \$55.00  
Convenience Fee: \$1.51  
Total Amount: \$56.51  
Scheduled Payment Date: Apr-11-2019  
Amount Due: \$55.00

Payer Name: Jeff Foster  
Credit Card Number: \*1954  
Credit Card Type: MC  
Approval Code: 484621

Merchant: DPS Electrical Permits  
Website: <http://www.dps.state.ia.us/>

Taskbar: Windows logo, Search (Type here to search), Edge, File Explorer, Chrome, System tray (8:23 AM 9/6/2019)

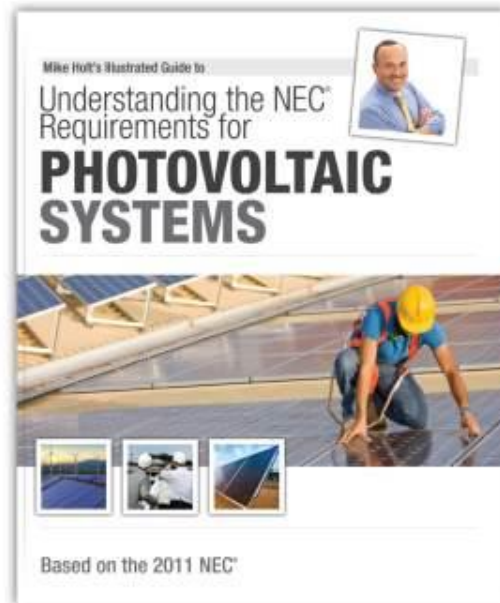
Get to know NEC Book. Article 690 deals with PV systems .



# WELCOME TO

## Mike Holt's Illustrated Guide to Understanding the NEC® Requirements for **PHOTOVOLTAIC SYSTEMS**

part 2 of 2





# The NEC handbook is good for code beginners because the blue print give you explanations for the rules .

Because the smaller cables permitted by 690.31(D) are not normally marked with standard *Code*-recognized markings (e.g., USE-2), the PV module-manufacturer or installer should verify that these cables are listed and labeled for PV use, thereby indicating that they have the necessary sunlight and moisture resistance and are suitable for exposed, outdoor use.

In accordance with 200.6(A), grounded conductors that are smaller than 6 AWG and used in PV source circuits are permitted to be marked at the time of installation with a white marking at all terminations.

**(E) Direct-Current Photovoltaic Source and Output Circuits Inside a Building.** Where dc photovoltaic source or output circuits from a building-integrated or other photovoltaic system are run inside a building or structure, they shall be contained in metal raceways, Type MC metal-clad cable that complies with 250.118(10), or metal enclosures from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. The disconnecting means shall comply with 690.14(A), (B), and (D). The wiring methods shall comply with the additional installation requirements in (1) through (4)

The use of metallic raceways, Type MC metal-clad cable, or metal enclosures inside a building provides additional physical protection for these circuits. Metallic raceways also pro-

within 25 cm (10 in.) of the roof decking or sheathing except where directly below the roof surface covered by PV modules and associated equipment. Circuits shall be run perpendicular to the roof penetration point to supports a minimum of 25 cm (10 in.) below the roof decking.

Informational Note: The 25 cm (10 in.) requirement is to prevent accidental damage from saws used by fire fighters for roof ventilation during a structure fire.

**(2) Flexible Wiring Methods.** Where flexible metal conduit (FMC) smaller than metric designator 21 (trade size ¾) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.

**(3) Marking or Labeling Required.** The following wiring methods and enclosures that contain PV power source conductors shall be marked with the wording "Photovoltaic Power Source" by means of permanently affixed labels or other approved permanent marking:

- (1) Exposed raceways, cable trays, and other wiring methods
- (2) Covers or enclosures of pull boxes and junction boxes
- (3) Conduit bodies in which any of the available conduit

# Where to get solar equipment?

<https://www.altestore.com/store/>

The screenshot shows the altE store website. The header includes the altE logo with the tagline "making renewable do-able", navigation links for SHOP, RESOURCES, COMMUNITY, and BLOG, a search bar, and contact information: "Installers | Free Quote | Login", "877-878-4060", and "My Cart: 0". The main content area features a "GET SPECIAL DISCOUNTS" section with a "Sign-Up for altE Newsletter" button, a "SHOP ALL PRODUCTS" button, and a "FEATURED PRODUCTS" list including Solar Panels, Solar Power Systems, Battery Backup Solar Power Systems, Productos Solares en Puerto Rico, Charge Controllers, Inverters, Deep Cycle Batteries, and MORE PRODUCTS (Cables & Wiring, Enclosures, Electrical & Safety). A central banner promotes "PRE-WIRED SYSTEMS" with benefits: AFFORDABLE, FLEXIBLE, and EXPANDABLE, and a "SHOP NOW" button. Below this is a "FEATURED SOLAR PANELS & SOLAR GEAR" section with a "VIEW ALL +" link. Three featured products are displayed: Xantrex XPower Powerpack 1500 - Portable Backup Powerpack (\$530.55, list price \$599.99), MT Solar 9 Module Top of Pole Mount, 60-Cell Modules, w/Crank (\$2,302.38, list price \$7,949.00), and HT-SAAE 310 Watt Solar Panel, Black (\$172.00, list price \$250.00).

**Nate Dooley**

- **Technical Sales Representative**
- Making Renewable Do-able™
- 330 Codman Hill Road, Boxborough, MA 01719
- [www.altEstore.com](http://www.altEstore.com)
- 
- Tel: +1.877.878.4060 x211 or +1.978.562.5858 x211
- Text: +1.857.270.5029
- Fax: +1.978.263.7081



26	DISCCHKWIRE	Discount for check, cash, wire	1	\$-145.00	EA	\$-145.00
27						
28	WIRE-TRANSFER	Wire Transfer Fee	1	\$0.00	EA	\$0.00
29		<p><i>Bank Wire Instructions</i>  <i>Company Name: Alternative Energy Store, Inc</i></p> <p><i>Address</i>  <i>* Citizens Bank</i>  <i>* Telephone 800-922-9999 or outside of USA,</i>  <i>+1-877-360-2472</i>  <i>* Address:</i>  <i>* 28 State Street</i>  <i>* Boston, MA 02109</i></p> <p><i>* Account #: 1333472134</i>  <i>* Routing # (for domestic wires): 011500120</i>  <i>* SWIFT (IBAN) Code (for international wires):</i>  <i>CTZIUS33</i></p>				
30						
31	SH	SHIPPING & HANDLING	1	\$460.58	EA	\$460.58

**"Good Faith Price Match"**

We are proud to offer you the service and technical expertise you need , and work very hard to earn your business. In addition, if you find that our sales quote does not meet your budgetary needs, we would appreciate an opportunity to re-evaluate it for you. Please include a competitive quote in your reply and we are happy to get back to you within one business day with our response.

NOTE: 1) The prices on this quote are valid for only 7 days. 2) It is the responsibility of the installer and the person requesting this quote to verify that the listed components on this quote will work for the actual installation conditions. Neither altE nor any of its employees has visited the site or personally assessed actual renewable energy system design requirements, and neither altE nor any of its employees is liable or responsible for the listed components, design, installation, energy production, code compliance, and all other matters related to the system.

**Tax Details**  
EXMPT \$0.000

**Taxable**

\$0.00

**Total Tax Exempt Total**

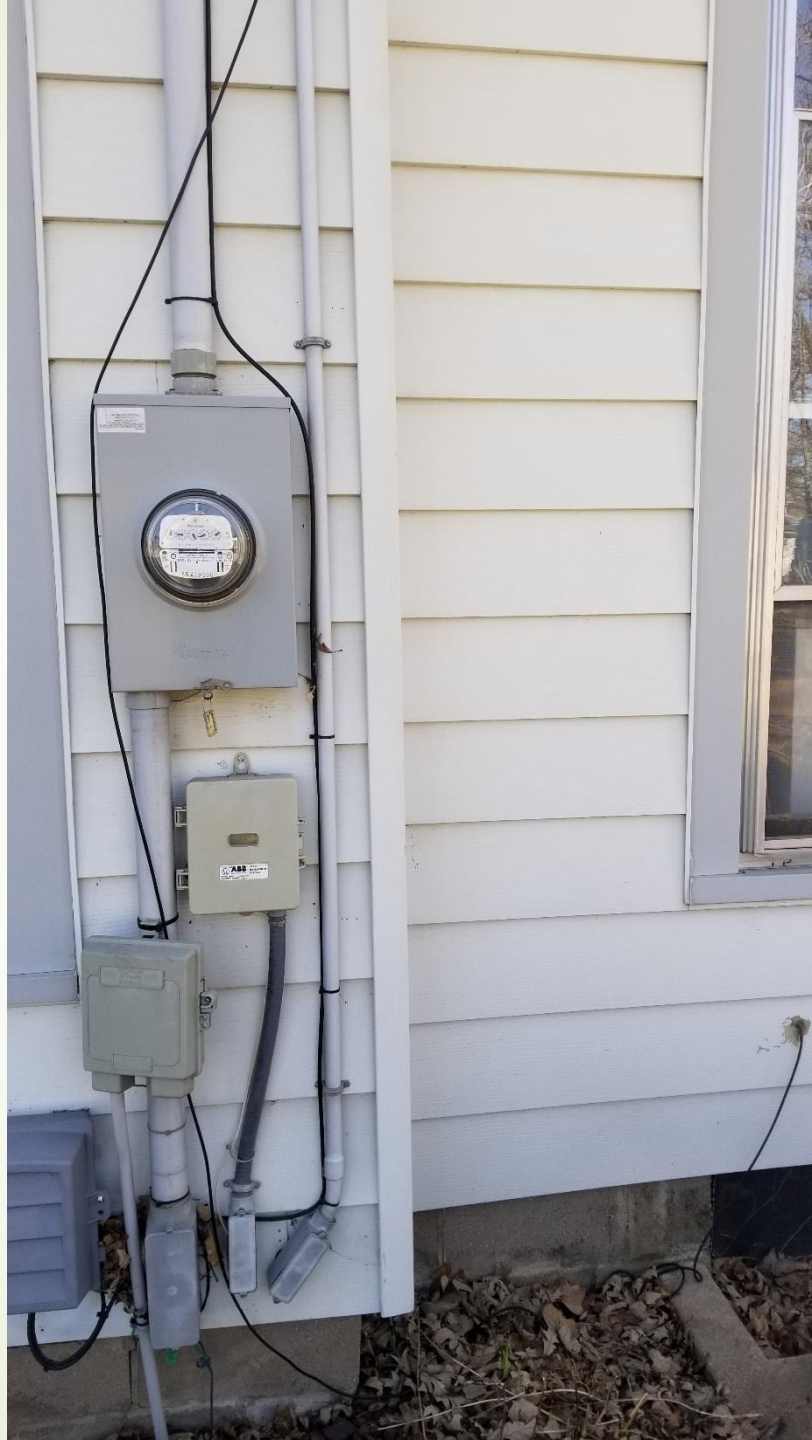
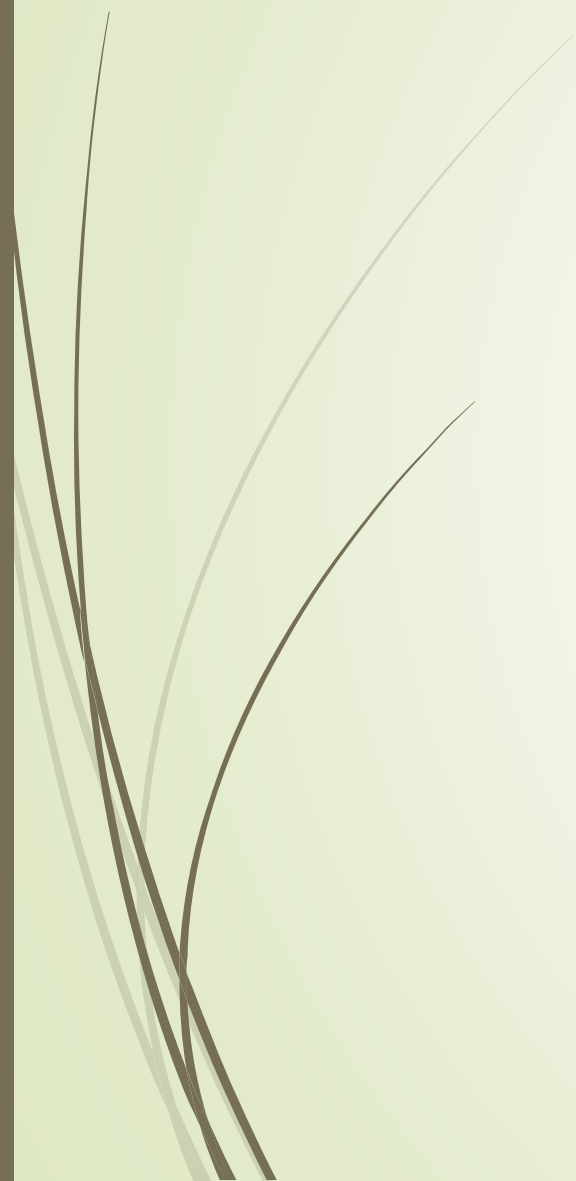
\$0.00

\$7,256.99

\$7,256.99

**Balance**

\$7,256.99





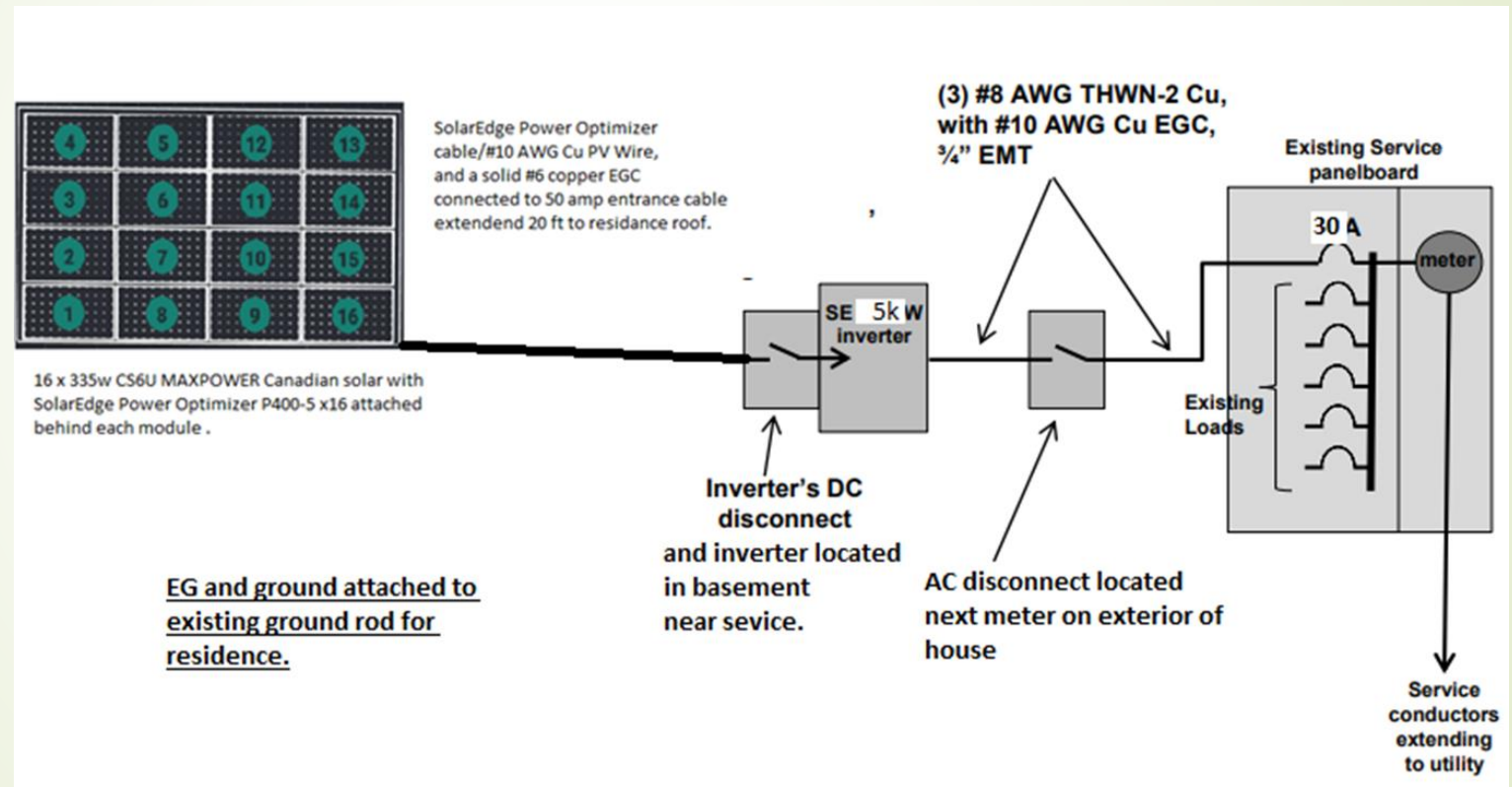
109 rural ave Decorah IA 52101



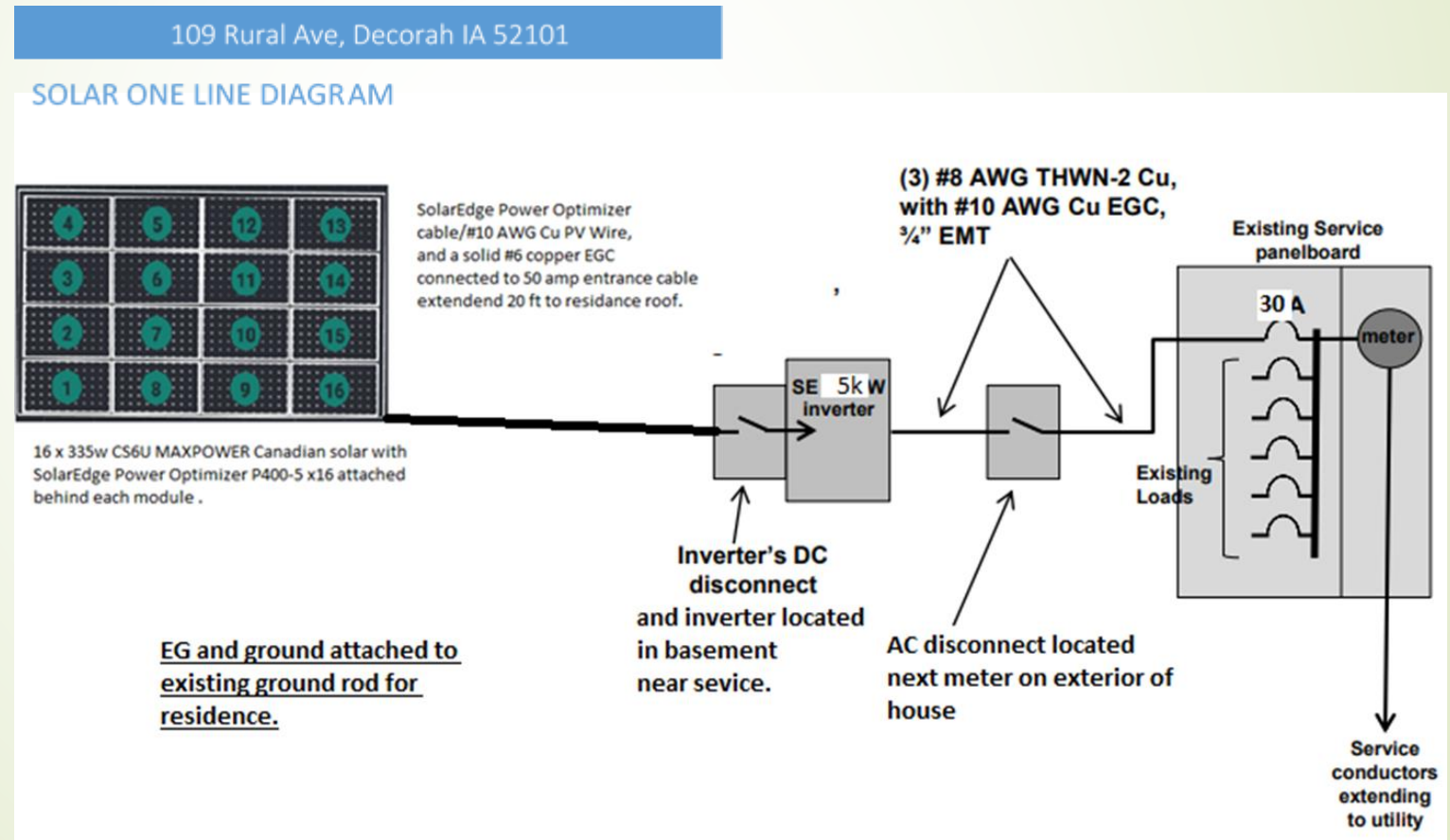
AC disconnect next to meter at rear West side of house.



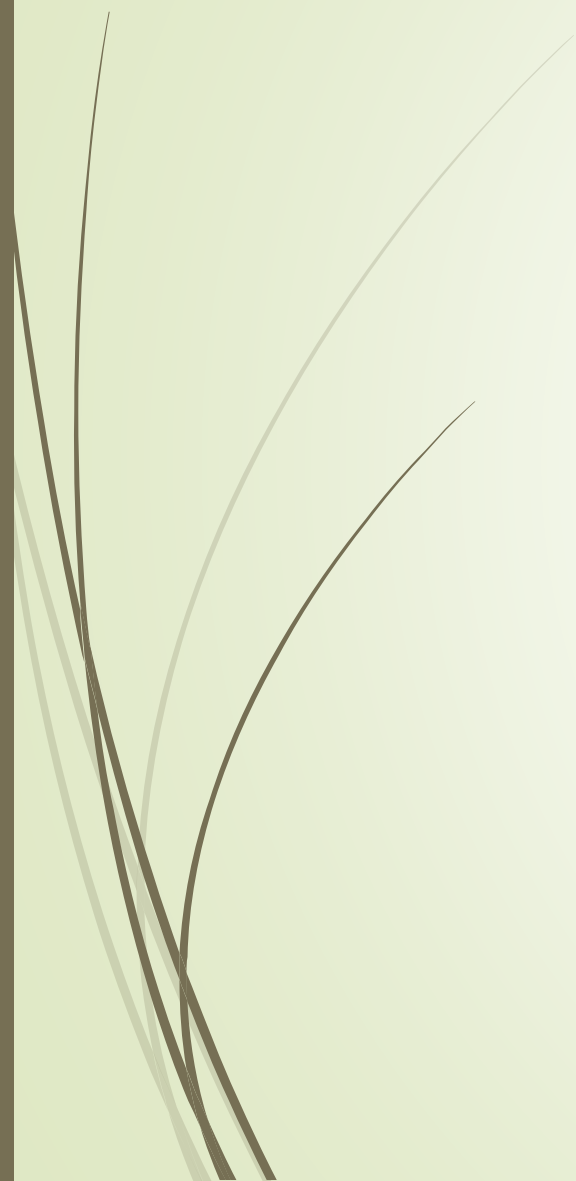
One line diagram Alliant did not accept.



This One line Was accepted.  
This along with pictorial drawing should be sent to the AHJ also.
























Measure at least twice! Precut all 6x6 with shoulders at 24 degree pitch for the beams takes careful measuring and cutting.

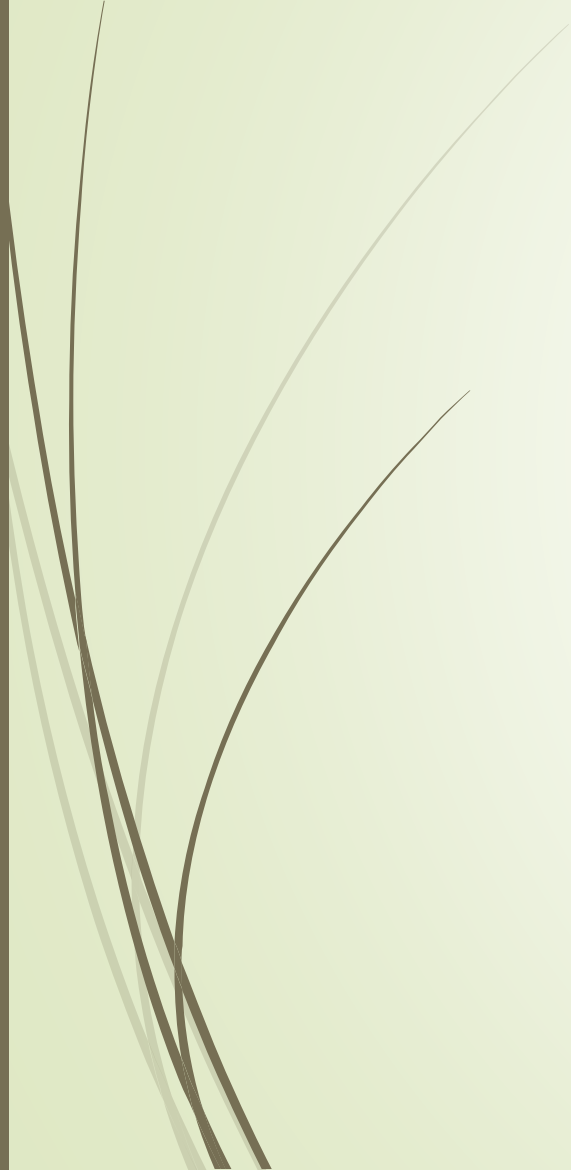


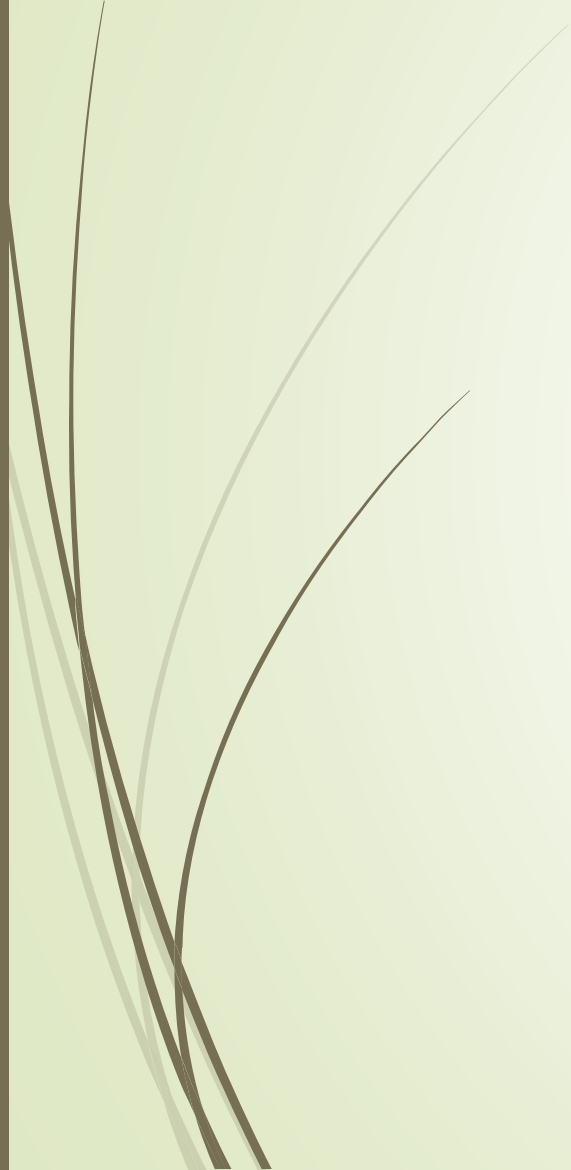




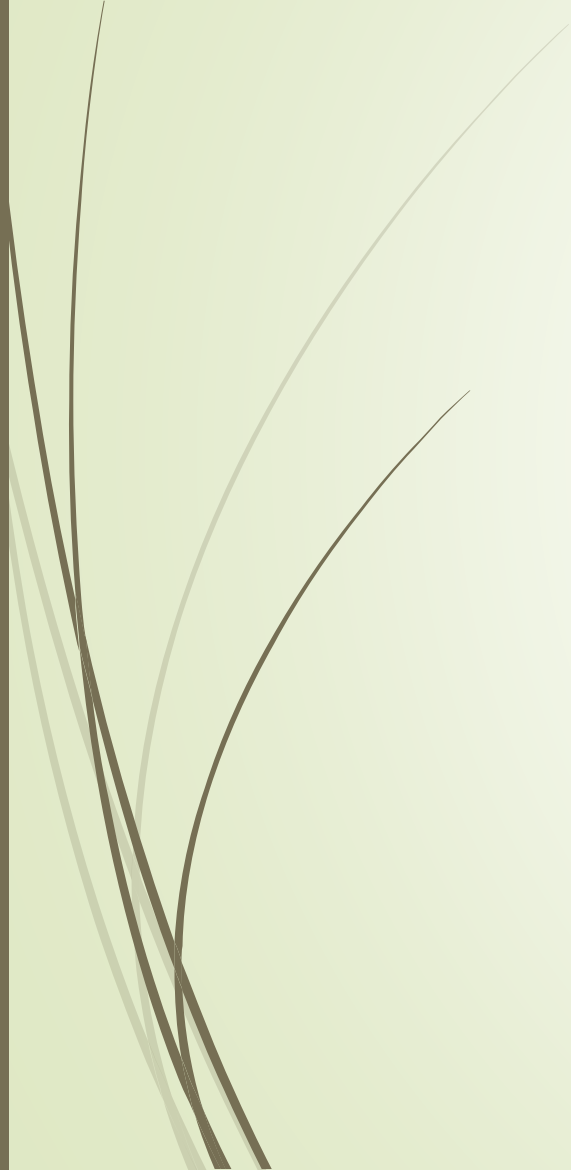






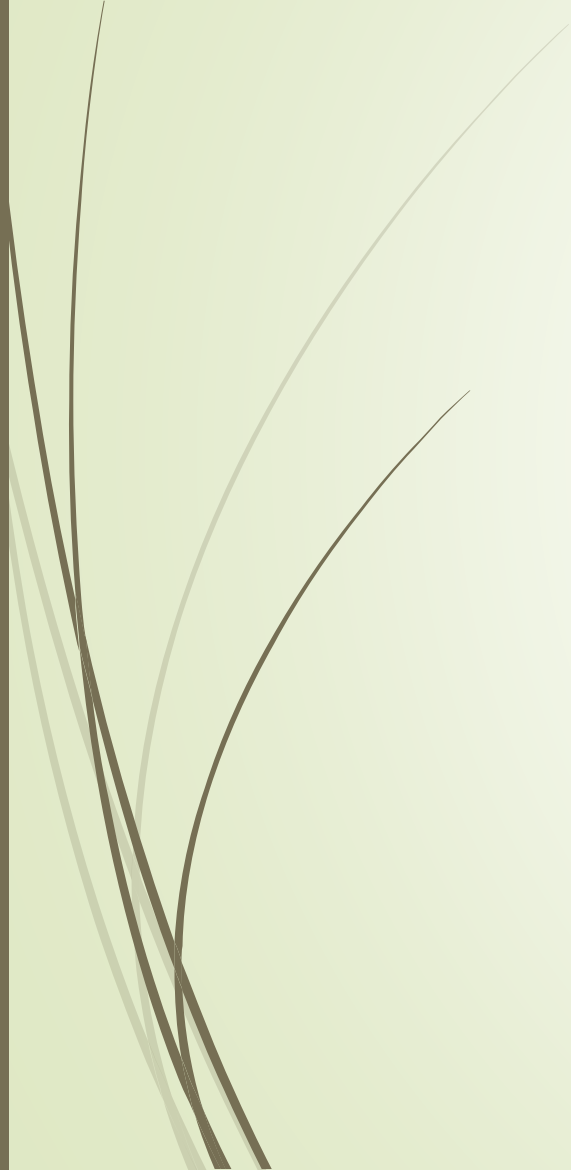
























r-pod  
eco-constructed



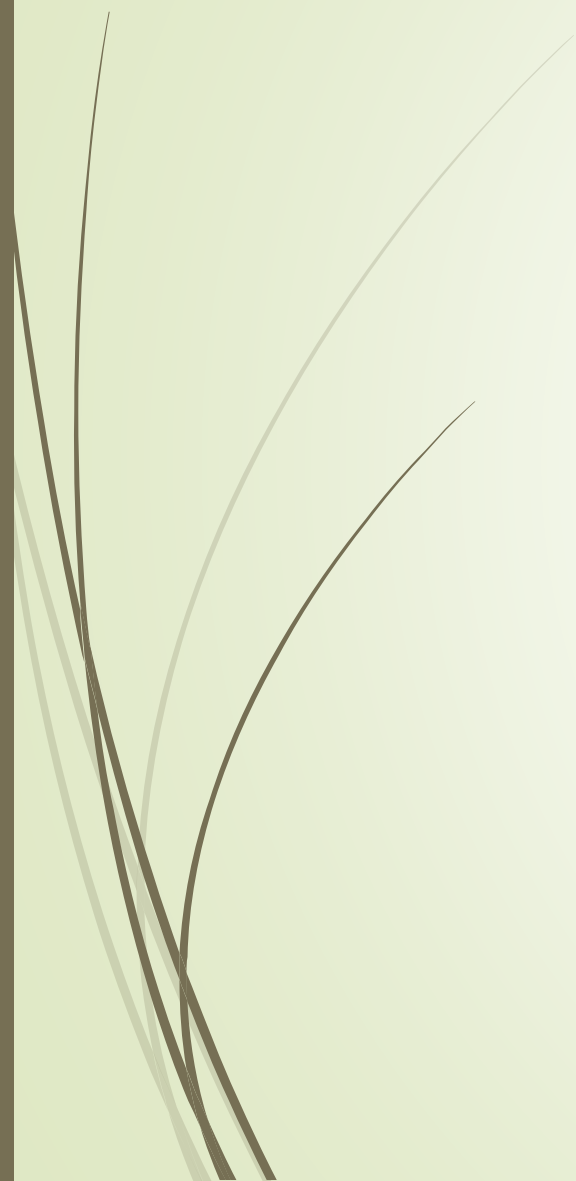




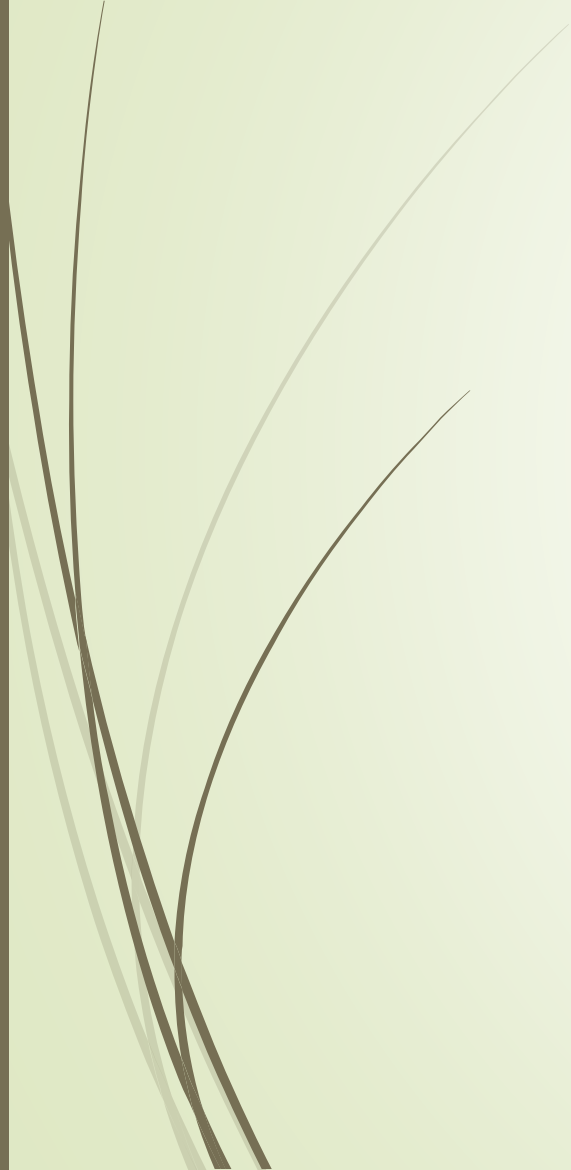




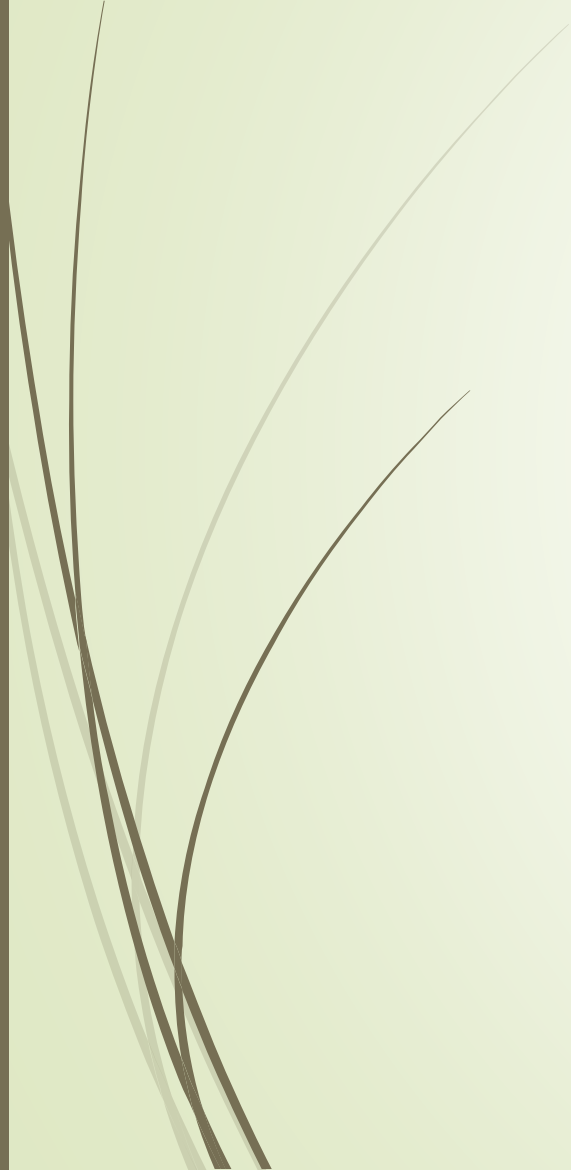












## A little bit about the Mods.

390 WATTS

VOC 48.8 volts dc

ISC 10.14 amps

ENGINEERED, DESIGNED AND QUALITY TESTED BY Q CELLS IN GERMANY

### Q.PEAK DUO L-G5.3 390

#### PERFORMANCE AT STANDARD TEST CONDITIONS\*

Nominal Power* (+5W/-0W)	$P_{MPP}$	[W]	390
Short circuit current*	$I_{SC}$	[A]	10.14
Open circuit voltage*	$V_{OC}$	[V]	48.48
Current at maximum power	$I_{MPP}$	[A]	9.66
Voltage at maximum power	$V_{MPP}$	[V]	40.38
Maximum system voltage	$V_{SYS}$	[V]	1500 (UL)
Weight	M	[kg / lbs]	23.5 / 51.8

\*Measurement tolerances:  $P_{MPP} \pm 3\%$ ;  $I_{SC}$ ,  $V_{OC} \pm 5\%$  at STC: 1000 W/m<sup>2</sup>, 25 ± 2 °C, AM 1.5 according to IEC 60904-3. Data given are rated (nominal) values.



Safety Class II



C Certified US  
UL 1703  
(254241)

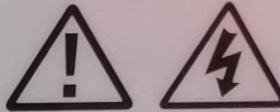


201119165501200433

Hanwha Q CELLS USA Inc.,  
300 Nexus Drive, Dalton GA 30721, USA

# Q CELLS

Assembled in USA



#### DANGER!

##### Risk of electric shock!

DO NOT connect or disconnect plug contacts while system is under load current. Refer to the Installation and Operation Manual before installing, operating or servicing this unit.

#### DANGER!

##### Risque de choc électrique!

NE PAS connecter ou déconnecter les connecteurs lorsque le système est en charge. Consultez le manuel d'installation et d'utilisation avant installation, utilisation et entretien du produit.

**Fire Rating:** Class C / Type 1

**Design load:** 33 lbs/ft<sup>2</sup>

**Fuse Rating:** 20 A

For field connections, use minimum No.12 AWG copper wires insulated for a minimum of 90 °C

EMAIL [service@q-cells.com](mailto:service@q-cells.com)

WEB [www.q-cells.com](http://www.q-cells.com)



First panel takes the longest.

Two self tapping stainless screws tapped on back of solar module to rest on first rail. Two small beam clamps on back would also work.

This allows for easier adjustments to square first module before tightening down end clamps.





First mod needs to be perfectly square or the whole system walks.



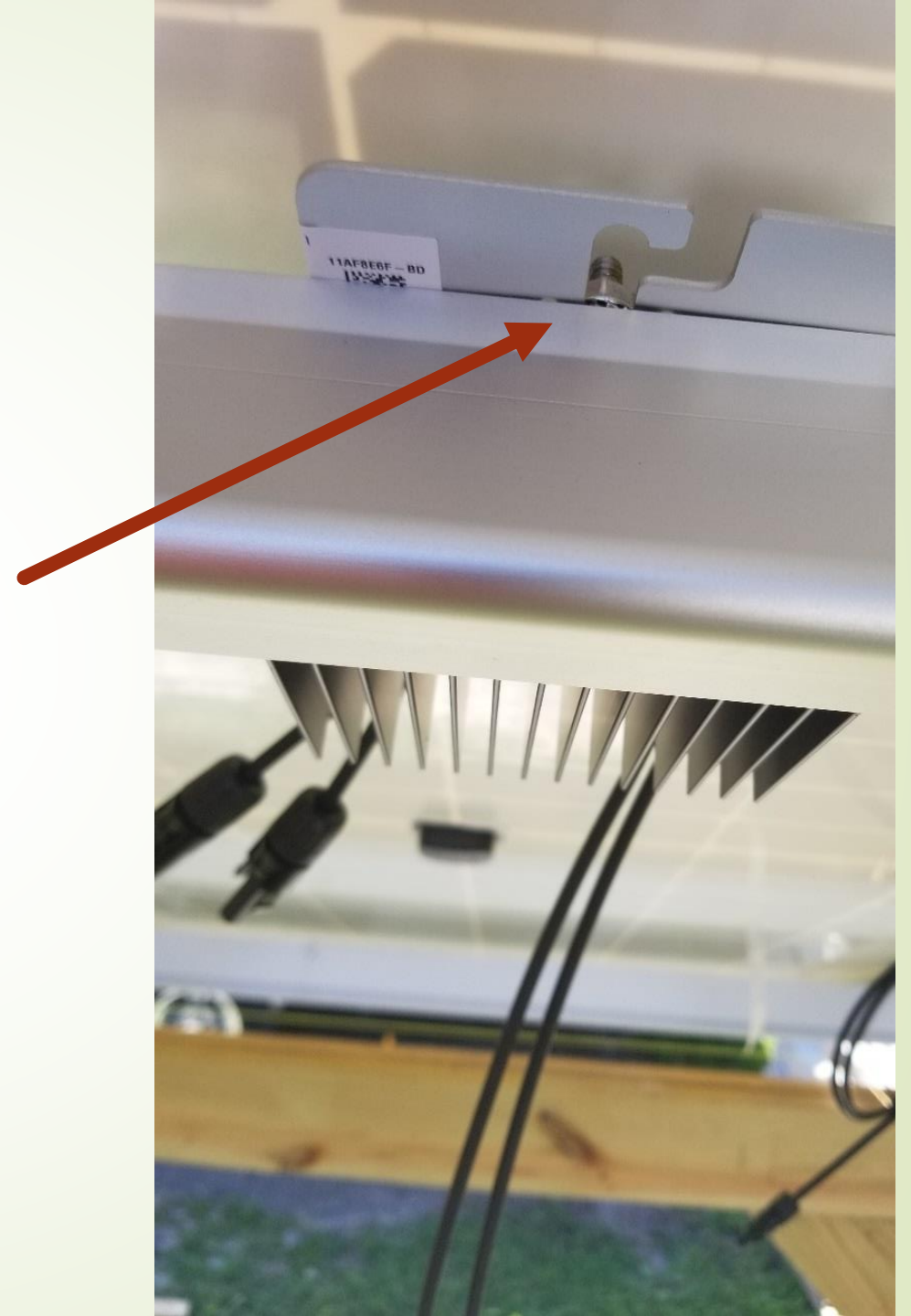






## Grounding

Equipment grounding is vital! Every thing must be grounded. Grounding washer between power optimizer and rail to ensure the anodization is bitten through and an grounding bond is made.





# Solar edge P505 power optimizer





## Optimizer scan sticker

Collect each sticker from each optimizer and place it on paper in order. These will be scanned and entered to an app. With a created mock of my system. I will be able to monitor what each module, optimizer and the inverter is doing and producing from my phone. Also this will alert me of any issues.



Dave is measuring center of where modules will be and mounting the power optimizer that will stay under the module and allow for all module connected in series.











rpod  
eco-constructed

rpod  
eco-constructed

























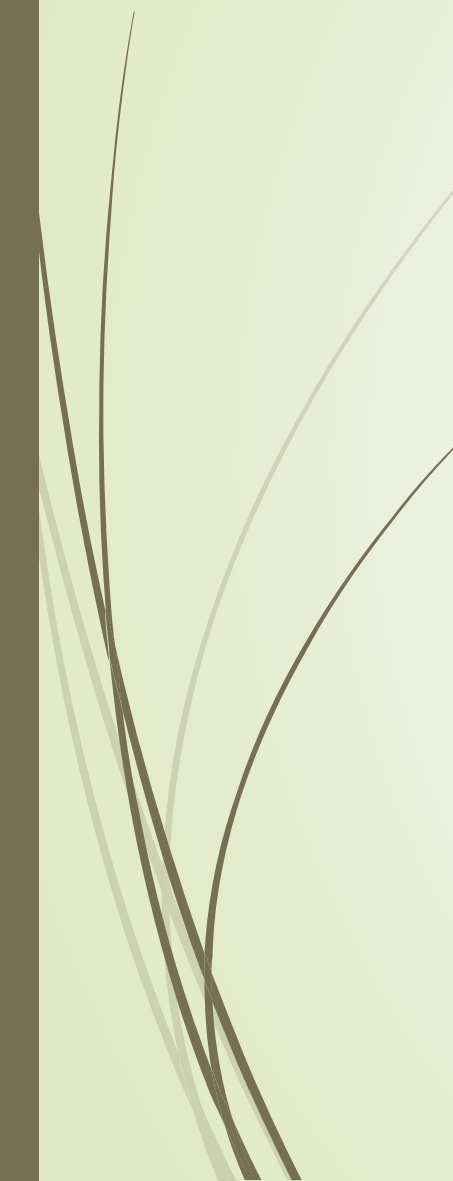




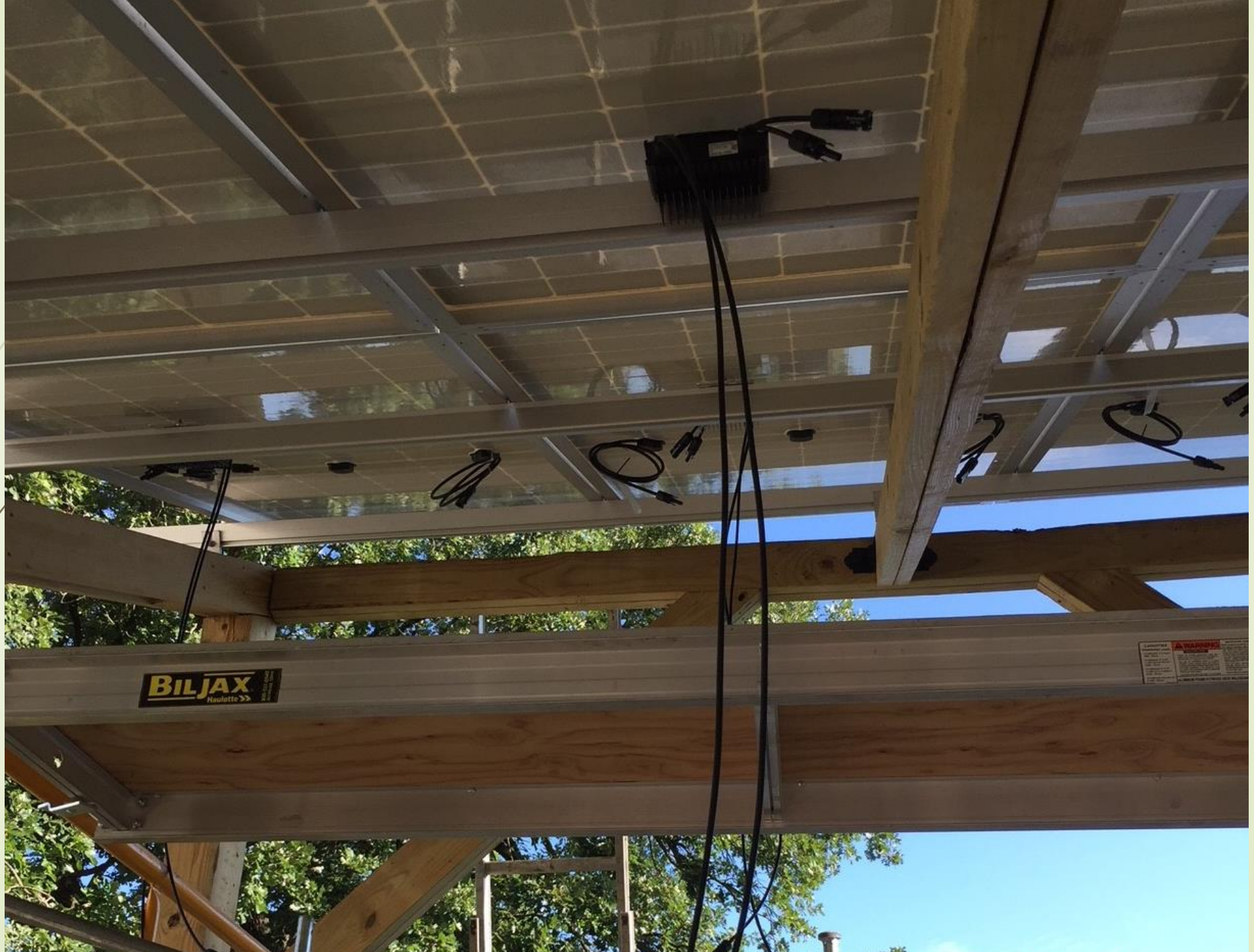












## Wire management

UV resistant is important. Stainless wire clips are available. Zip ties are the right price though.

Nothing must touch or rub!









# Cool morning Modules





Hot noon modules.







## Working properly.

As each module is connected to the optimizer the output for each is pair volt. This is because the system cannot produce the full voltage output unless it senses the utility voltage through the inverter. So if the power is down it will stop producing or exporting electricity at the power optimizer under the module. This is code.

So the fourteen modules all connected to their optimizers and the optimizers are connected in series they will show 14 ish volts. This is not dangerous voltage and proves they are connected correctly.



















Equipment ground.  
Non reversible  
crimps.

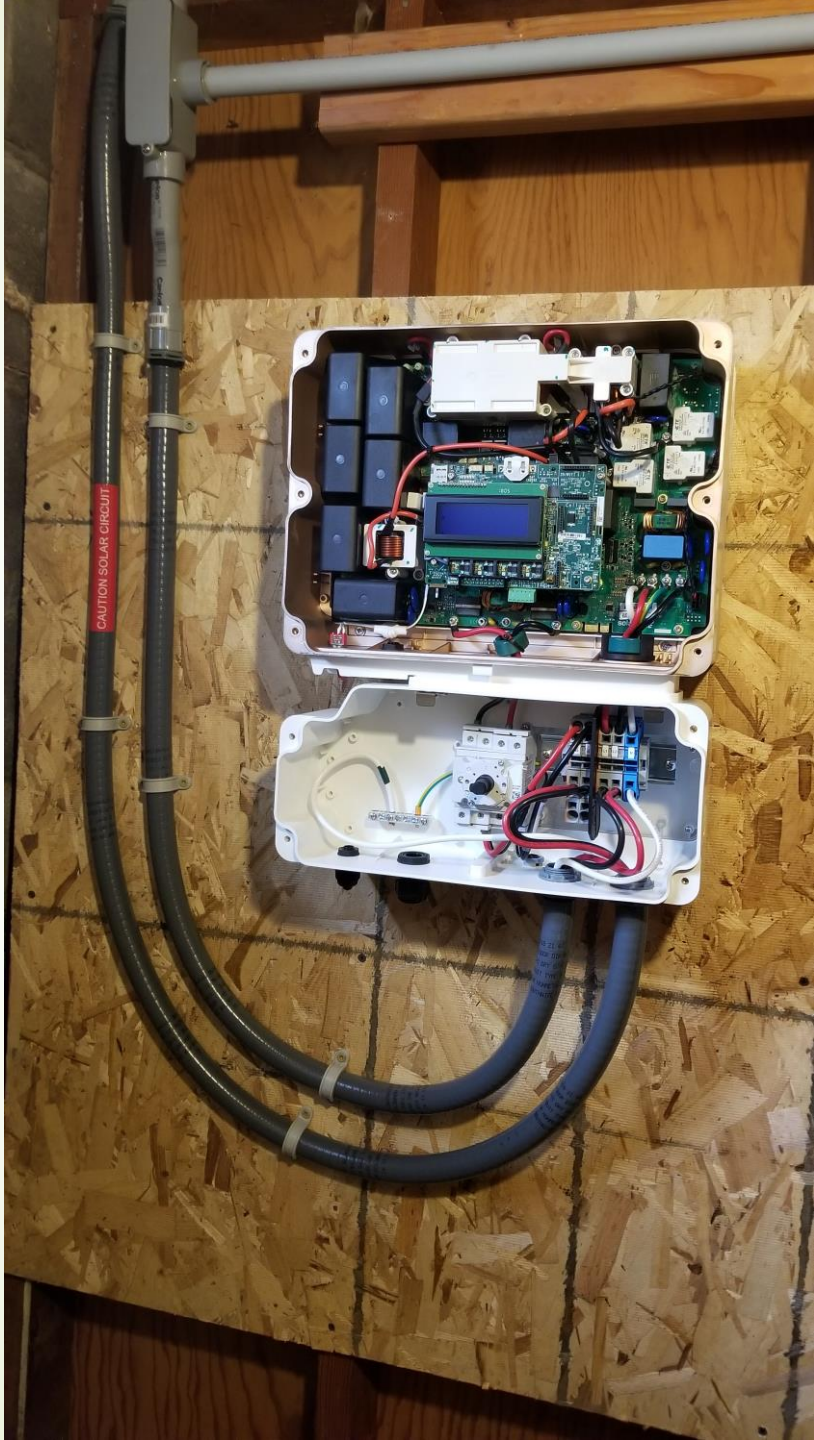
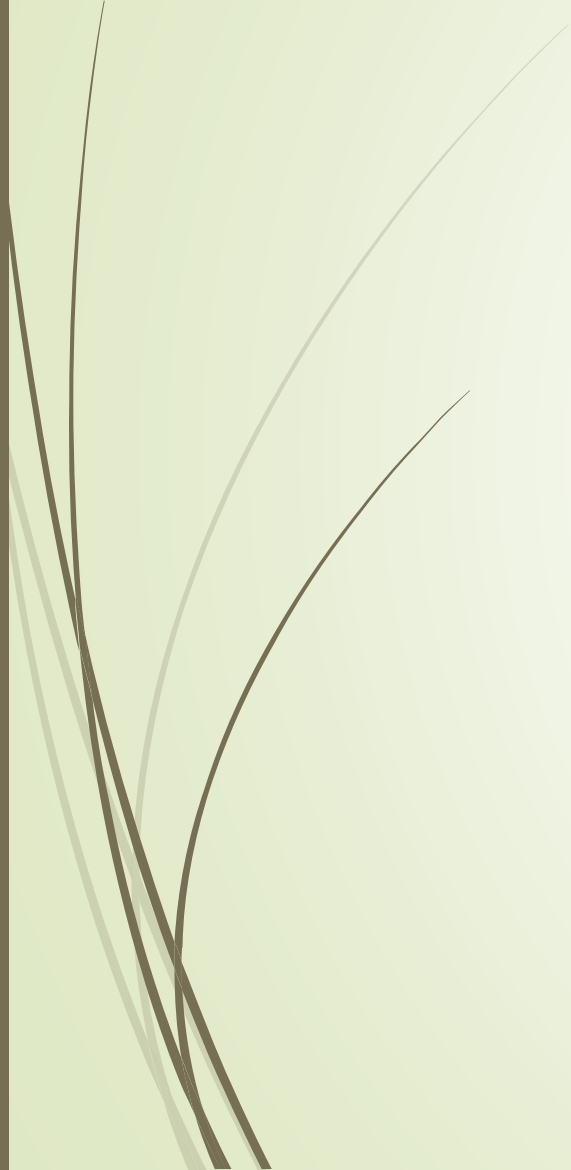






Might be a good time for a rough in inspection? Ask questions, take notes. Set it up on line through the Iowa Department of Public Safety.

The screenshot shows a web browser window displaying the Iowa Department of Public Safety website. The browser's address bar shows the URL [iowaelectrical.gov/index.php/pages/home](http://iowaelectrical.gov/index.php/pages/home). The website header includes the Iowa state logo and navigation links for Services, Agencies, and Social. The main content area features a blue banner with the text "Iowa Department of Public Safety State Fire Marshal Division Electrical Bureau Online State Permitting & Inspection System". Below the banner, there is a navigation menu with "Home", "License and Course Search", and "Contact Us". The main content area is titled "HOME" and "Welcome". It contains a welcome message and two bullet points: "For more information on electrician licensing and permitting/inspections please visit the [State Fire Marshal's website](#)." and "To find out who does the permitting and inspections in your area visit our [interactive county map](#) and click on the county where you are working." On the right side, there are two orange buttons: "Electrical Permitting & Inspections System" and "Electrical Licensing System". The Windows taskbar at the bottom shows the time as 8:33 AM on 9/6/2019.





# AC Disconnect.

- ▶ Must be located within 4 ft of meter.
- ▶ Solar edge is considered to be a rapid shut down system.
- ▶ Rapid shutdown shuts down to safe voltages within 10 ft of modules.









Combiner box.  
One string.





# Polaris lugs \$\$





Polarity is very important!





# Back fed Breaker. 120% rule.

## 705.12(D)(2)(3)(b) Busbars Option 2

The sum of 125 percent of the inverter(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar

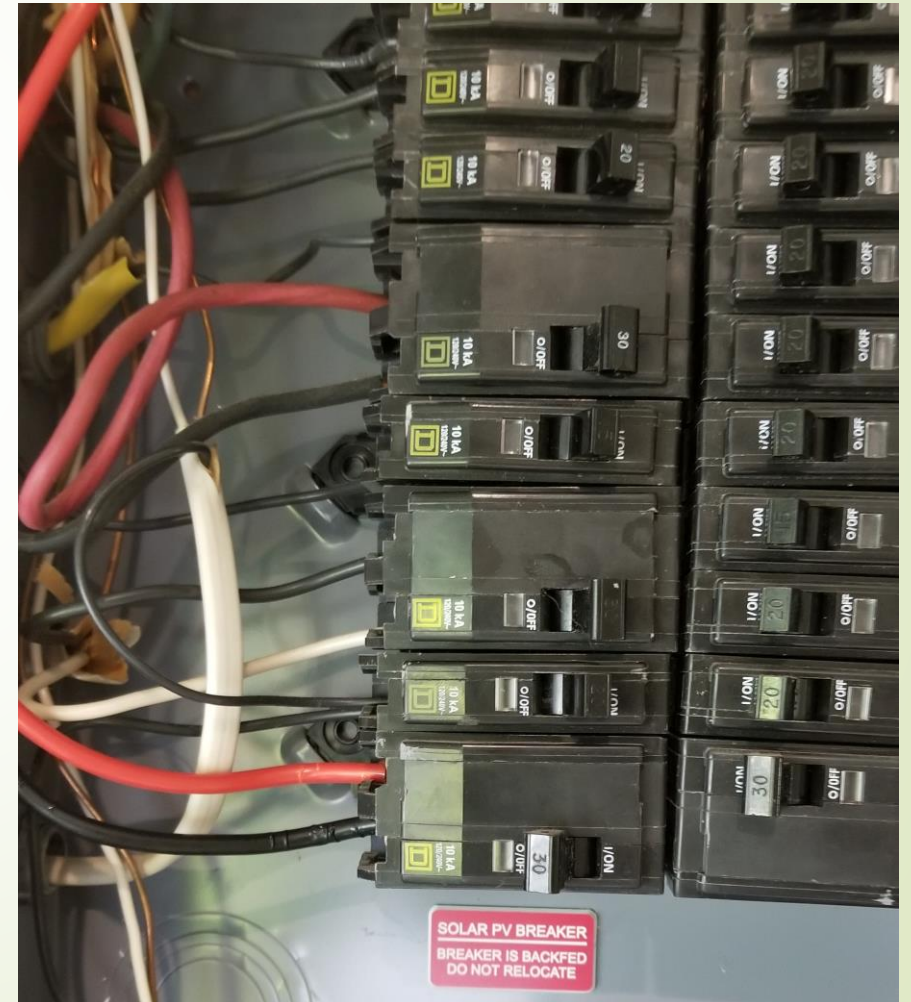
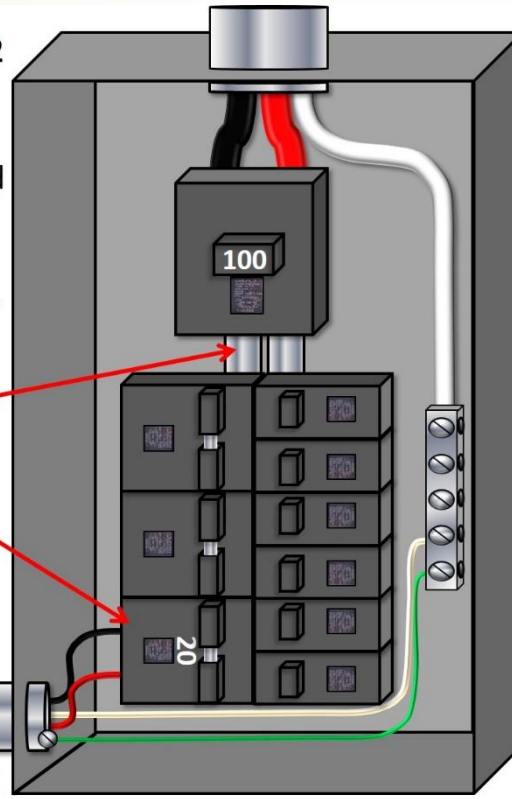
100 amp rated busbar

Backfed PV breaker must be opposite the MCB

Inverter output current 16 amps  
 $16 \times 125\% = 20 \text{ A}$

Inverter output circuit

The warning label shall comply with 110.21(B).



# Solar Labels Poster

[http://wpc.ac62.edgecastcdn.net/00AC62/documents/datasheets/NEC2017\\_Solar\\_Label\\_Poster.pdf](http://wpc.ac62.edgecastcdn.net/00AC62/documents/datasheets/NEC2017_Solar_Label_Poster.pdf)

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# When system is complete the next step for me is to work on Efficiencies

- Replace electric water heater with energy star tankless gas water heater.
- Replace electric clothes drier with energy star gas dryer.
- Make sure all lights are LED.
- Replace old windows.
- Install switches to turn off entire rooms electricity. (electronics constantly use electricity even when not in use)
- One day, small off grid battery base to run freezer.



# Questions?

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