EELE408 Photovoltaics

Lecture 22: Grid Tied Systems

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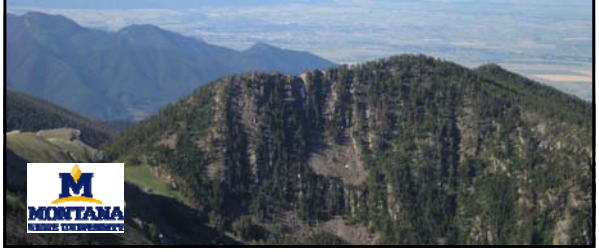
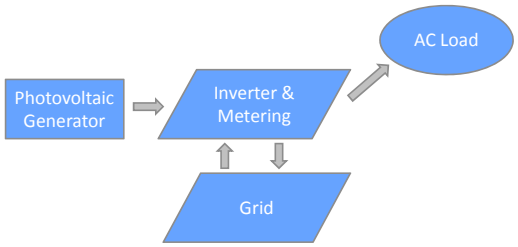
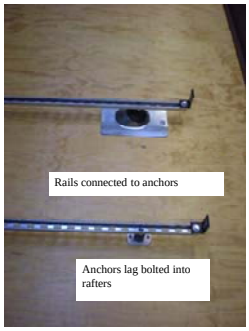


Grid Tied System



Example: Most Home Systems

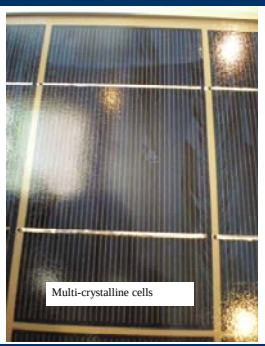
Roof Anchor System

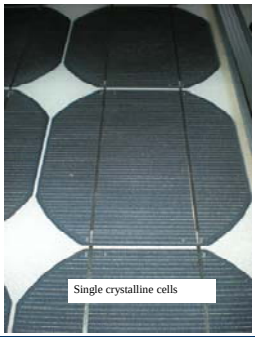


Installed Anchor System

Solar Module

Solar Cells in Modules





MultiCrystalline on Metal Roof

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- Shed roof sloped the wrong direction
- Aluminum frame work to tilt the array

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Rear View of Array System

Aluminum Frame work
Can see the solar cell pattern through the modules

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Bozeman City Hall

Two inverters in this systems

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Photovoltaic & Solar Heating

Hot water tilted for winter optimization

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System Grid Interface

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Exterior Labeled PV Disconnect Required

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Inverter

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Inverter Readout

Has been in operation for 181 days
Producing 840 kW-h per month on average

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Net Metering

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Additional Disconnects

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Wireless Monitoring System

- Newer systems have an add-on where the system parameters can be sent to computer network.

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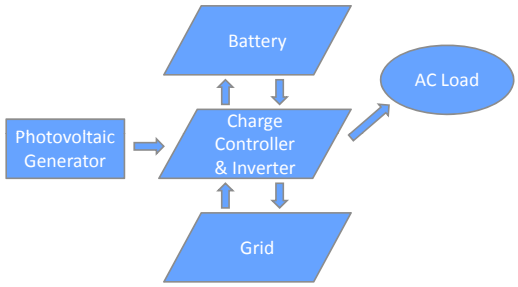
Grid Tied with Battery backup



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Small System with Battery Backup

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48 Volt Battery Backup

23

Inverter and Charge Controller

24

Inverter

25

Read-out

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New solar tracking system on 'M' trail

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Kaiser Shop/Garage #1

- System Specifications
  - Rated Power = 5,040 W
  - 24 panels: Kyrocera 210
  - Inverter: Fronius IG 5.0
    - 5000 W
    - 240V – 21 A
  - Unirac SunFrame
  - Estimated Production
  - **529 kW –hr / month**
  - **$7.14/W**
- Price Estimate
  - Solar Modules (24) $20k
  - Inverter $ 5k
  - Racking $ 3k
  - Wiring $ 1k
  - Installation $ 7k
  - **Total $36k**
  - NW Energy Grant -$6k
  - 30% Federal Tax Credit -$9k
  - State Tax Credit -$0.5
  - **Cost after Incentive $20.5k**

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Kaiser Shop/Garage #2

- System Specifications
  - Rated Power = 6,750 W
  - 30 panels: SunPower 225
  - Inverter: SPR 7000m
    - 7000 W
    - 240V – 29 A
  - Unirac SunFrame
  - Estimated Production
  - **709 kW –hr / month**
  - **$6.81/W**
- Price Estimate
  - Solar Modules (30) $30k
  - Inverter $ 5k
  - Racking $ 3k
  - Wiring $ 1k
  - Installation $ 7k
  - **Total $46k**
  - NW Energy Grant -$6k
  - 30% Federal Tax Credit -$12k
  - State Tax Credit -$0.5
  - **Cost after Incentive $27.5k**

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Kaiser Shop/Garage #3

- System Specifications
  - Rated Power = 10,080 W
  - 48 panels: Kyrocera 210
  - Inverter: Fronius IG 10.0
    - 5000 W
    - 240V – 41.7 A
  - Unirac SunFrame
  - Estimated Production
  - **1058 kW –hr / month**
  - **$6.35/W**
- Price Estimate
  - Solar Modules (48) $40k
  - Inverter $ 8k
  - Racking $ 5k
  - Wiring $ 1k
  - Installation $ 10k
  - **Total $64k**
  - NW Energy Grant -$6k
  - 30% Federal Tax Credit -$17k
  - State Tax Credit -$0.5
  - **Cost after Incentive $40.5k**

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Kaiser Shop/Garage #4

- System Specifications
  - Rated Power = 13,500 W
  - 60 panels: SunPower 225
  - Inverter: SPR 7000m (2)
    - 7000 W
    - 240V – 29 A
  - Unirac SunFrame
  - Estimated Production
  - **1417 kW –hr / month**
  - **$6.37/W**
- Price Estimate
  - Solar Modules (60) $60k
  - Inverter $ 9k
  - Racking $ 5k
  - Wiring $ 2k
  - Installation $ 10k
  - **Total $86k**
  - NW Energy Grant -$6k
  - 30% Federal Tax Credit -$24k
  - State Tax Credit -$0.5
  - **Cost after Incentive $55.5k**

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Stand Offs

Stand offs are screwed into the roof rafters after the roof has been dried in with a membrane

Near the panel closest to the electrical panel a feed through is positioned.

Electrical Feed Through

Flashing is placed around each of the standoffs as the roofing shingles are positioned and nailed.

Standoff Flashing

Once the roof has been shingled (opposite side) the panels are delivered with the balance of the system.

Panel Installation (2 days)

Rail System

Vertical rails are secured on the standoffs.

Horizontal Mounting Rails

Strings are stretched to position the mounting of the horizontal rails.

Straight Rails

The panels are placed on the horizontal rails starting at the top of the array

Panel Placing

The panels are secured with cleats that are screwed into the rails.

Panels Secured

Panel Postioning

Each panel is positioned on the rails adjacent to the previous mounted panel.

Panel Electrical Connections

Each panel is connected electrically to the previous mounted panel in series.

Last Panels

The panels weigh about 80 pounds each. They are usually delivered to the roof with hydraulic heavy equipment.

Electrical Feed Through

The last panel is positioned and connected to the junction box that feeds the electrical wires through the roof.

DC Conduit

Conduit is used to run the electrical wires from the exterior junction box to the electrical panel. This protects the high DC voltage lines from inadvertent damage.

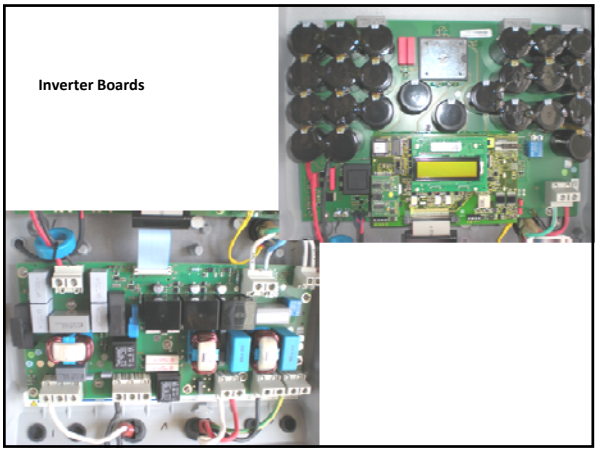
Inverter

The inverter is positioned next the electrical panel. The conduit runs into the inverter.

Inverter without Cover

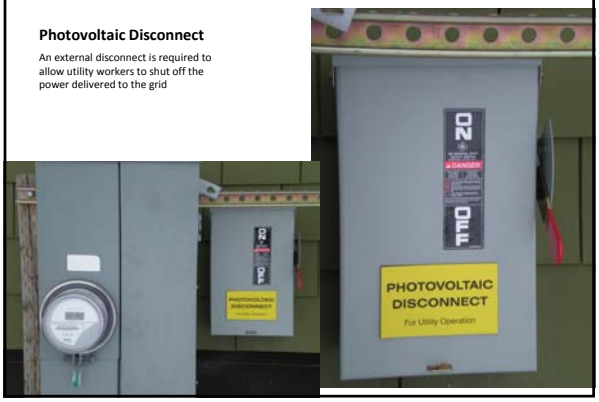
Inverter closeup

Inverter Boards

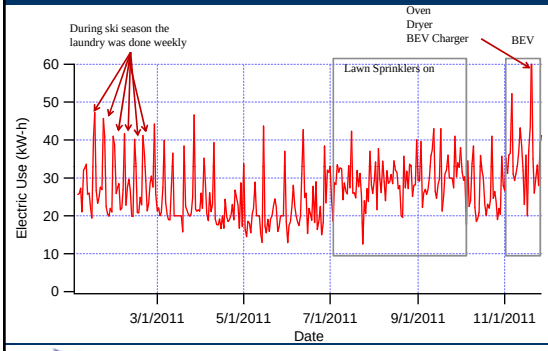


Photovoltaic Disconnect

An external disconnect is required to allow utility workers to shut off the power delivered to the grid



Electric Use



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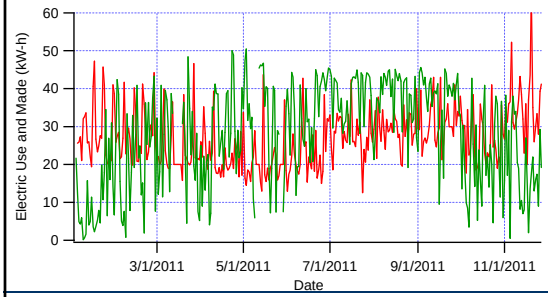
Electric Use and Made



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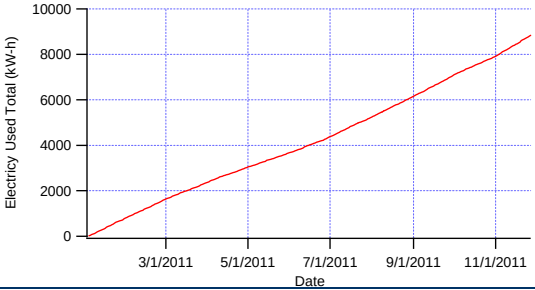
Electric Use Total



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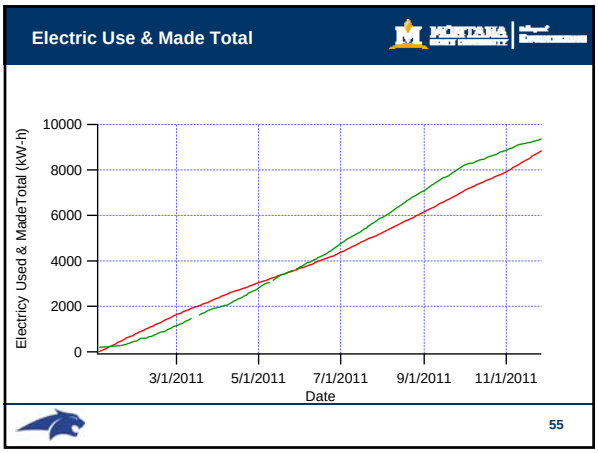
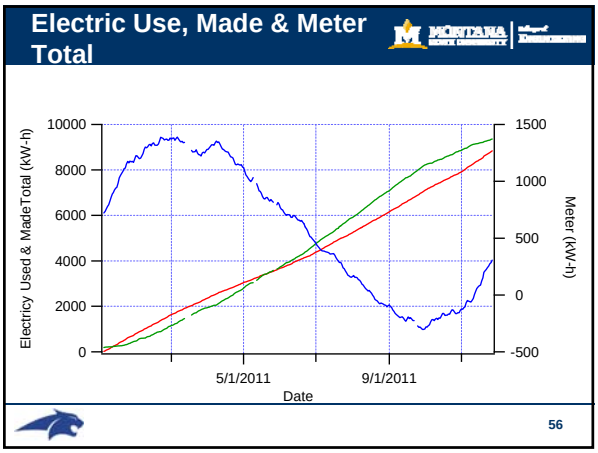

Electric Use & Made Total
Electricy Used & MadeTotal (kW-h)
10000
8000
6000
4000
2000
0
3/1/2011
5/1/2011
7/1/2011
9/1/2011
11/1/2011
Date
55


Electric Use, Made & Meter Total
Electricy Used & MadeTotal (kW-h)
10000
8000
6000
4000
2000
0
1500
1000
500
0
-500
Meter (kW-h)
5/1/2011
9/1/2011
Date
56