

# **PHOTOVOLTAICS**



## **PHOTOVOLTAIC RENEWABLE ELECTRIC ENERGY GENERATION**

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**June 23, 2006**

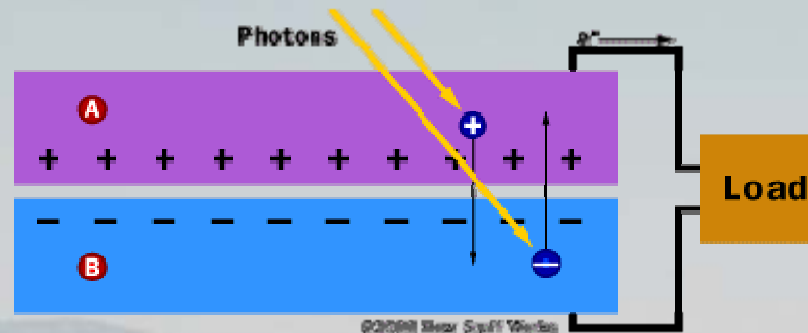
**Save Energy Now Workshop**

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## ■ How Solar Cells Work

- Light photons strike the surface



Electricity is emitted

- Intensity of Light affects energy created

From: [www.howstuffworks.com](http://www.howstuffworks.com)

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## ■ Efficiency/Losses

- 15% of light energy is converted to electricity
- Losses due to
  - Wavelengths too long or short to absorb (70%)
  - Semiconductors: high resistance losses (15%)
    - Most energy lost as heat
    - Must reduce semiconductor cell size

From: [www.howstuffworks.com](http://www.howstuffworks.com)

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## ■ Solar Cell Structure

- Crystals: solid-state semiconductor
- Silicon with some phosphorus or boron
- Produces direct current (DC)
  - Inverter used to obtain AC
- Two types of systems
  - Grid-Tied: interconnection to power grid
  - Stand-Alone: no connection, need batteries

From: [www.conservtech.com](http://www.conservtech.com)

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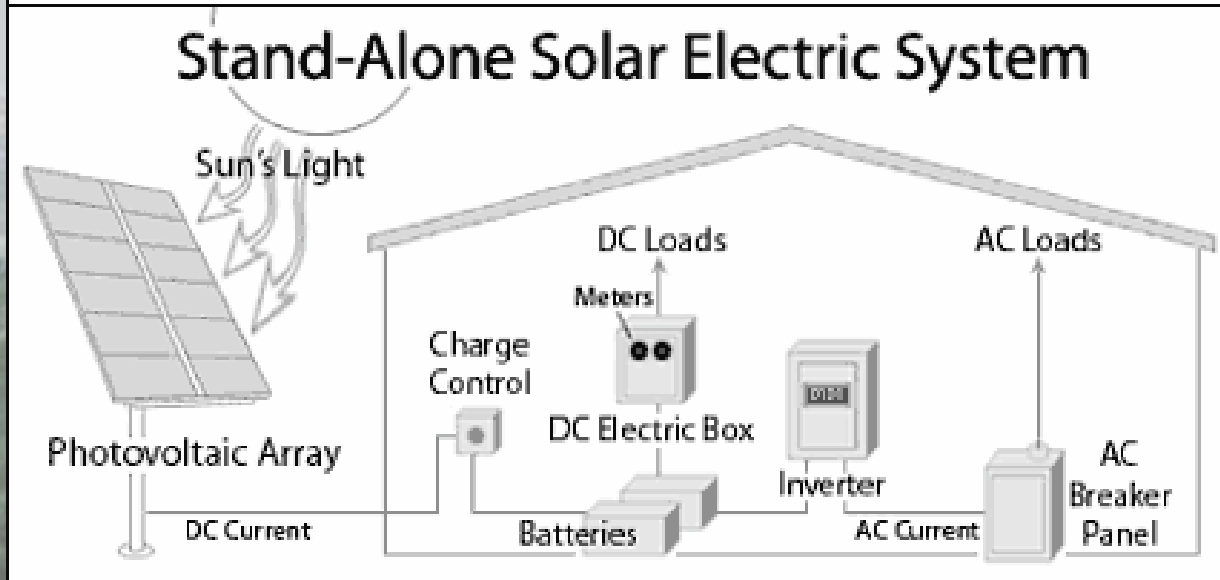
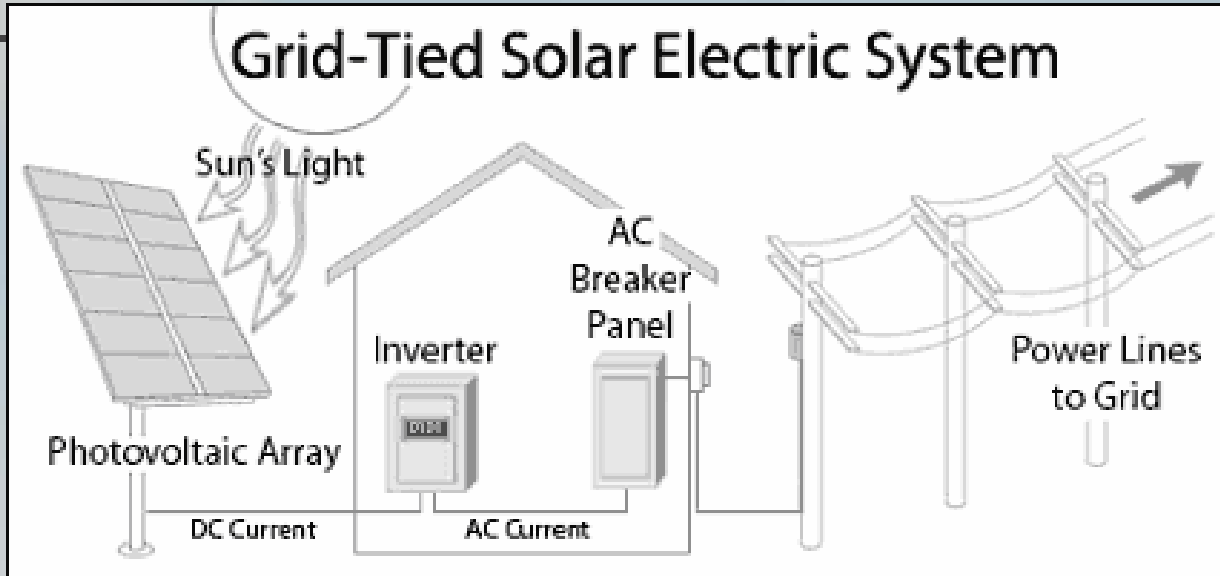
## ■ Inverter

- AC to DC
- Smart features
- Shut off if
  - Low power
  - Grid off
- 90% efficient



from: Andy Walker, FEMP talk

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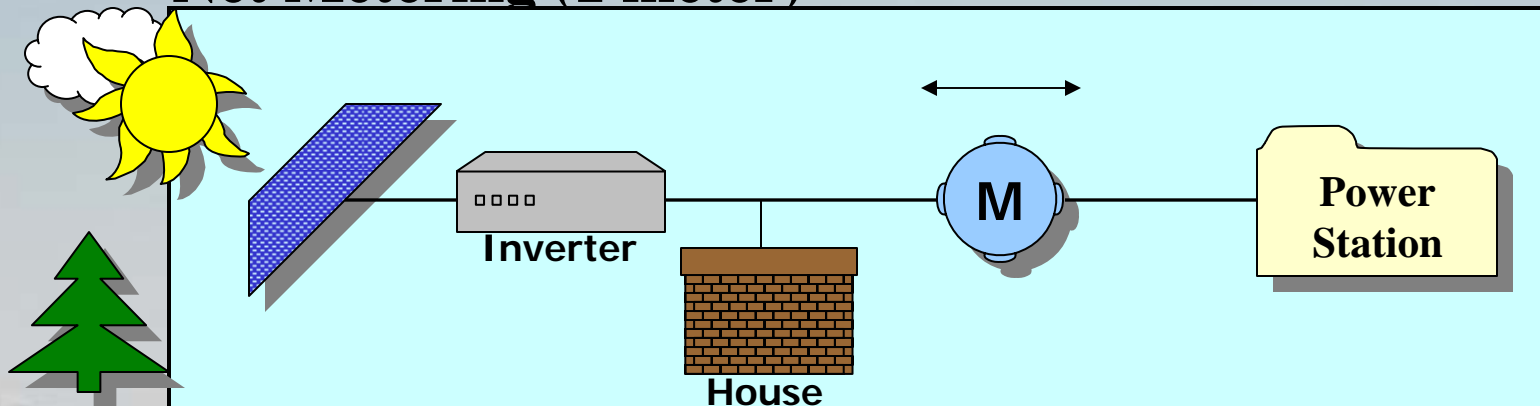


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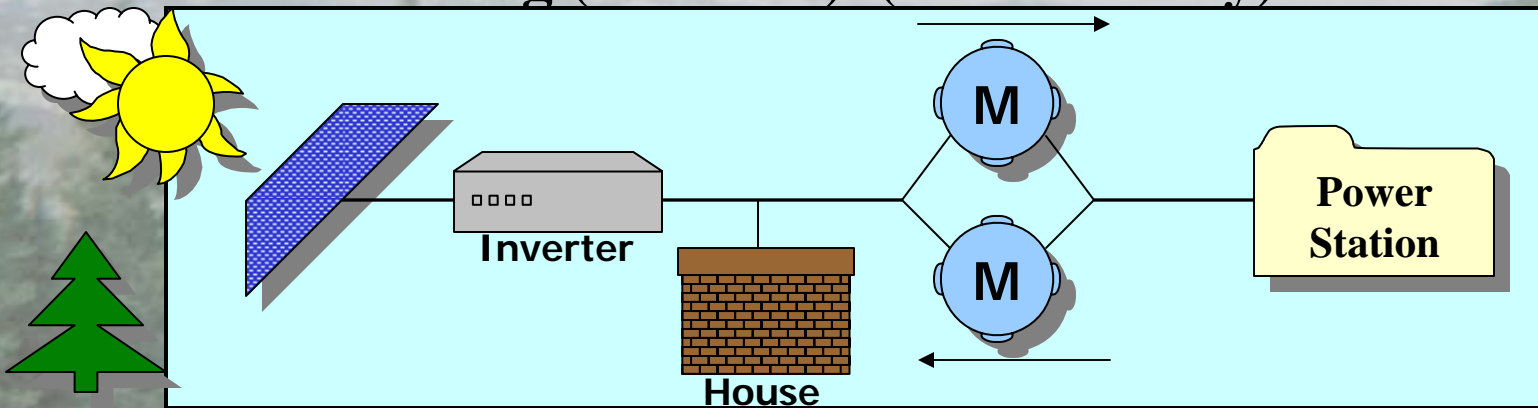


## ■ Metering Systems

### ■ Net Metering (1 meter)



### ■ Dual Metering (2 meters) (REAs mostly)



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## ■ NET METERING

### ■ Monthly Billing

- $\text{\$charge} = \text{connect fee} + \text{NET usage} \times \text{rate}$
- Excess kWh usage will carry over

### ■ Annually

- If there is a carryover annually, customer will be reimbursed.

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## ■ Net Metering Example

- Average customer usage is 500 kWh/month
  - Aug.: PV generates 600 kWh
  - Sept.: PV generates 300 kWh
- Aug. bill: net=600-500 = 100 kWh carryover
  - \$charge= \$15 fee + (net 0) X 0.04 = \$15
- Sept. bill: net= (300+100) -500 = -100 kWh
  - \$charge= \$15 fee + 100 X 0.04 = \$19

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## ■ Quick Review/extras

- **Grid-tied system interconnected to Grid**
- **No battery storage needed (less cost)**
  - **Utility is the backup power supply**
- **Inverter makes AC from DC power**
  - **Effectively sell back to utility**
  - **Smart unit shuts off when PV power is low**
  - **Off when grid is down**
- **Disconnect Breaker panel needed (&fuses)**

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## ■ Example

- PJKK Federal Building, HI
- 2 panels/lamp, maximum 96 W
- 39 W FL lamps  
2,500 lumens
- 90 Ah battery,  
12 hr/night
- \$2,500 per light



from: Andy Walker, FEMP

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## ■ Walmart: McKinney, TX

### Garden Center

14,500 kWh/yr

486 homes for a day

22,100 lb/yr less emissions



### Tire & Lube area

5,710 kWh/yr

190 homes for a day

8,300 lb/yr less greenhouse emissions

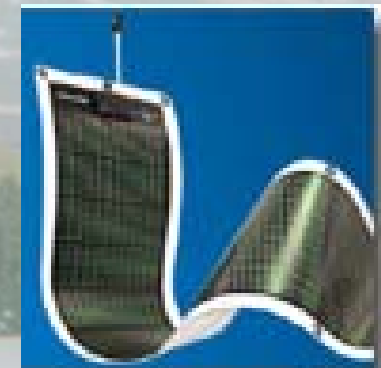
from: <http://walmartstores.com/GlobalWMStoresWeb/navigate.do?catg=445&contId=5640>

Photo by: Douglas A. Hopper

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- **Solar Potential: IAC involvement**
  - **Solar Wall AR: preheat make-up air**
  - **Forklift charging (DC)?**
  - **Warehouse lighting (roof area)?**
  - **Parking lot lights?**
  - **Products available? Deal? \$320 / 20W**
  - **Amendment 37 for CO**
    - **Rebates for 2006 & 2007**



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- **COLORADO AMENDMENT 37**
- **Rebates & Renewable Energy Credits (RECs)**
  - **Up to 10 kW PV system total power rating**
  - **\$2.00/W cash rebate for power rating**
  - **\$2.50/W one-time lifetime RECs**
  - **Total: \$4.50/W up front cash rebate**
    - **\$45,000 on a 10kW system (2006 or 2007)**
  - **Possibly carried by installation contractor**  
**from: [namastesolar.com](http://namastesolar.com)**

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- **PV systems > 10 kW**
  - **Still have \$2.00/W cash rebate up front**
  - **REC's per metering over system life**
  - **Between 10 and 100 kW**
    - **Paid at rate set by utility**
  - **Over 100 kW**
    - **Rate negotiated by bids to utility**
    - **Bid does not have to be accepted.**
  - **Note: 10 kW is easiest to figure payback**

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- PV cost about \$8/W installed
  - \$5.25/W for the panel
- Panels produce 8 to 10 W/ft<sup>2</sup>
- Standard size panel is 2.5ft X 4ft (10ft<sup>2</sup>)
  - One 10 ft<sup>2</sup> panel produces about 100 W
- A 10 kW installation is about 60 panels
  - Area needed is about 1,000 ft<sup>2</sup>
    - Need about 30 ft by 35 ft of roof area

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- **Payback Cost Analysis (less than 5 years)**
  - **CO Cash rebates: \$4.50/W installed power**
  - **Federal Energy Bill: 30% tax credit**
    - **Taken in year of installation (2006 or 2007)**
    - **No cap for commercial (\$2,000 cap residential)**
    - **Rebate revenue is taxed (only partial benefit)**
  - **Depreciation Tax benefits**
    - **Over 5 years; depend on tax rate of business**
  - **Utility bill savings (small part of total)**

from: [namastesolar.com](http://namastesolar.com)

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## ■ SYSTEM PAYBACK ANALYSIS 10kW

- $10,000W \times \$8/W = \$80,000$
- Cash rebate & RECs = **-\$45,000**
- Fed Tax Credits (30%) = **-\$24,000**
- less Tax on rebate(35%) = \$15,750  
net cost after tax&rebates = **\$26,750**
- Depreciable basis  
=  $\$80,000 - (0.5 \times \$24,000) = \$68,000$
- Fed Depreciation Deduction (5 yrs; 35%)  
 $\$68,000 \times 0.35 = \mathbf{-\$23,800}$
- Cost net rebate, taxes, & depreciation  
 $\$26,750 - \mathbf{\$23,980} = \mathbf{\$2,950}$

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## Payback: Annual Utility Cost Savings

- Denver, CO: 14,050 kWh/yr
  - 14,050 kWh/yr X \$0.04/kWh = \$560/yr
- Demand savings
  - 10 kW X 6 months = 60 kW-mo./yr
  - 60 kW-mo./yr X \$13/kW-mo. = \$780/yr
- Total Savings = \$560 + \$780 = \$1,340/yr
- Simple Payback of net Cost :
  - \$2,950 / \$1,340 = 2.2 years
    - recall: depreciation is over a 5 year period.

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## ■ Summary

- Net metering and Interconnection to Grid
- 10 kW system (60 panels, 1,000ft<sup>2</sup>)
- Contractor may carry rebates
- Consider rebates, Taxes, and depreciation
- Simple Payback in under 5 years
- Ongoing energy and cost savings
- 20 to 25 year life expectancy for system

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## ■ Questions?

- PV panel efficiency?
- Why use interconnection?
- How long does the system last?
- What pays for most of the costs?

Discussion...

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THE END