Current Development in Solar Power Energy Systems and the available local solutions

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الطاقة الشمسية الواقع الحالي عالميا والحلول المتوفرة محليا

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Large Solar Plants Main Types

- Currently there is Two Main types of Electrical Power Solar Plants and each have its sub-categories:
- Solar-Thermal Electricity
- 1- Power Towers.
- 2- Parabolic Dishes and Troughs.
- Direct Conversion into Electricity

Solar-Thermal Electricity: Power Towers

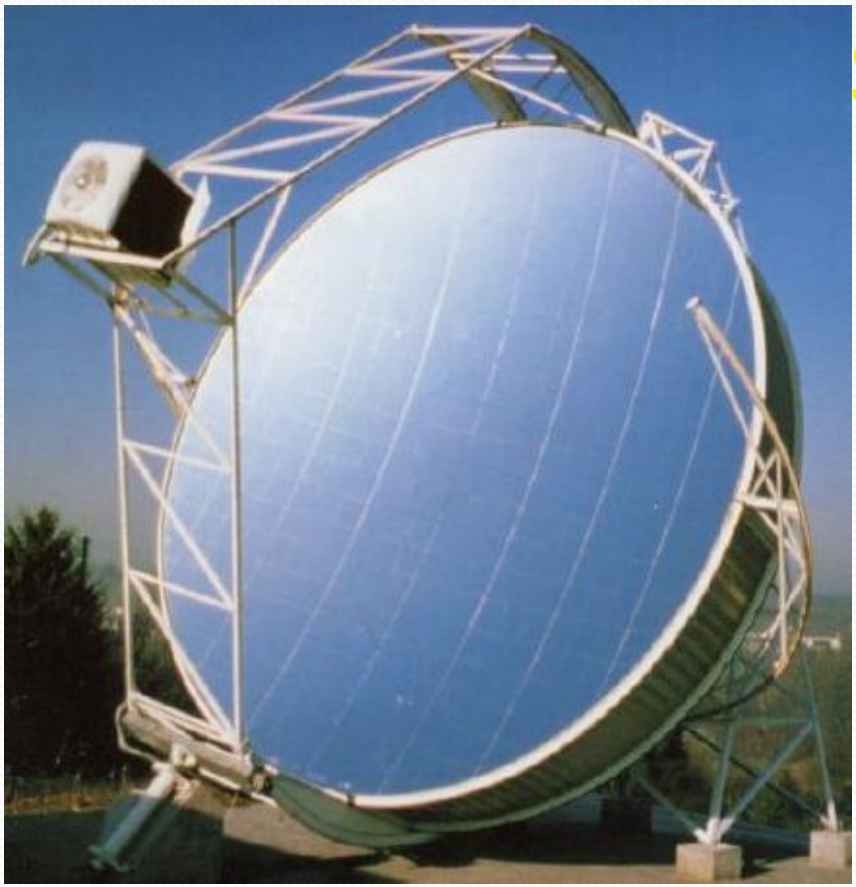
- Power towers (also known as 'central tower' power plants or 'heliostat' power plants) capture and focus the sun's thermal energy with thousands of tracking mirrors (called heliostats) in roughly a two square mile field.
- A tower resides in the center of the heliostat field. The heliostats focus concentrated sunlight on a receiver which sits on top of the tower.
- Within the receiver the concentrated sunlight heats molten salt to over 1,000 °F (538 °C). The heated molten salt then flows into a thermal storage tank where it is stored, maintaining 98% thermal efficiency, and eventually pumped to a steam generator.
- The steam drives a standard turbine to generate electricity. This process, also known as the "Rankine cycle" is similar to a standard coal-fired power plant, except it is fueled by clean and free solar energy.

Power Towers

Power tower in Barstow, California.

Solar-Thermal Electricity: Parabolic Dishes and Troughs

- **Focus sunlight on a smaller receiver for each device; the heated liquid drives a steam engine to generate electricity.**
- **The first of these Solar Electric Generating Stations (SEGS) was installed in CA by an Israeli company, Luz International.**
- **Output was 13.8 MW; cost was $6,000/peak kW and overall efficiency was 25%.**
- **Through federal and state tax credits, Luz was able to build more SEGS, and improved reduced costs to $3,000/peak kW and the cost of electricity from 25 cents to 8 cents per kWh, barely more than the cost of nuclear or coal-fired facilities.**
- **The more recent facilities converted a remarkable 22% of sunlight into electricity.**



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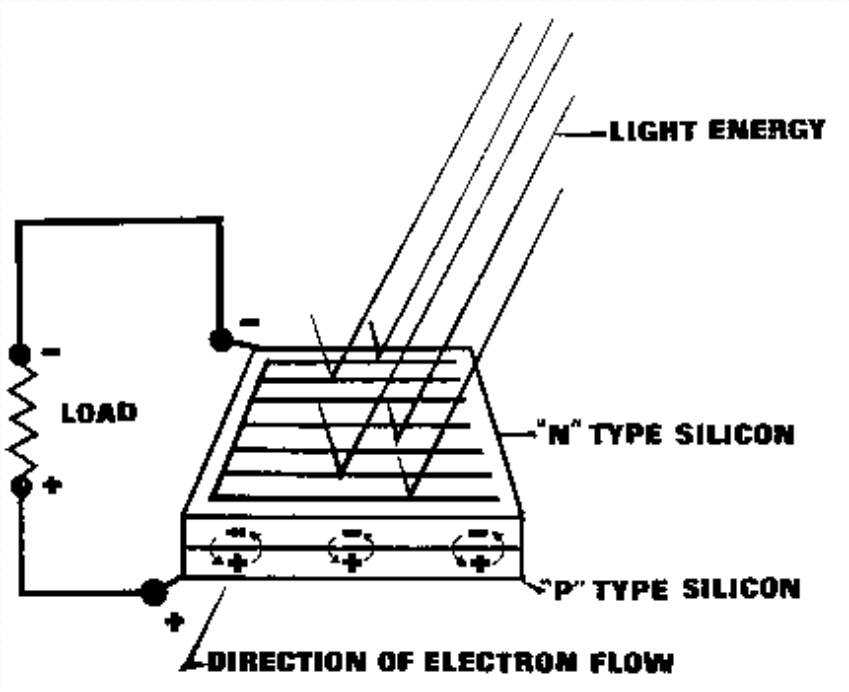
Collectors in southern CA.

Because they work best under direct sunlight, parabolic dishes and troughs must be steered throughout the day in the direction of the sun.

Direct Conversion into Electricity



- **Photovoltaic cells are capable of directly converting sunlight into electricity.**
- **A simple wafer of silicon with wires attached to the layers. Current is produced based on types of silicon (n- and p-types) used for the layers. Each cell=0.5 volts.**
- **Battery needed as storage**
- **No moving parts→do no wear out, but because they are exposed to the weather, their lifespan is about 20 years.**

Solar Panels in Use

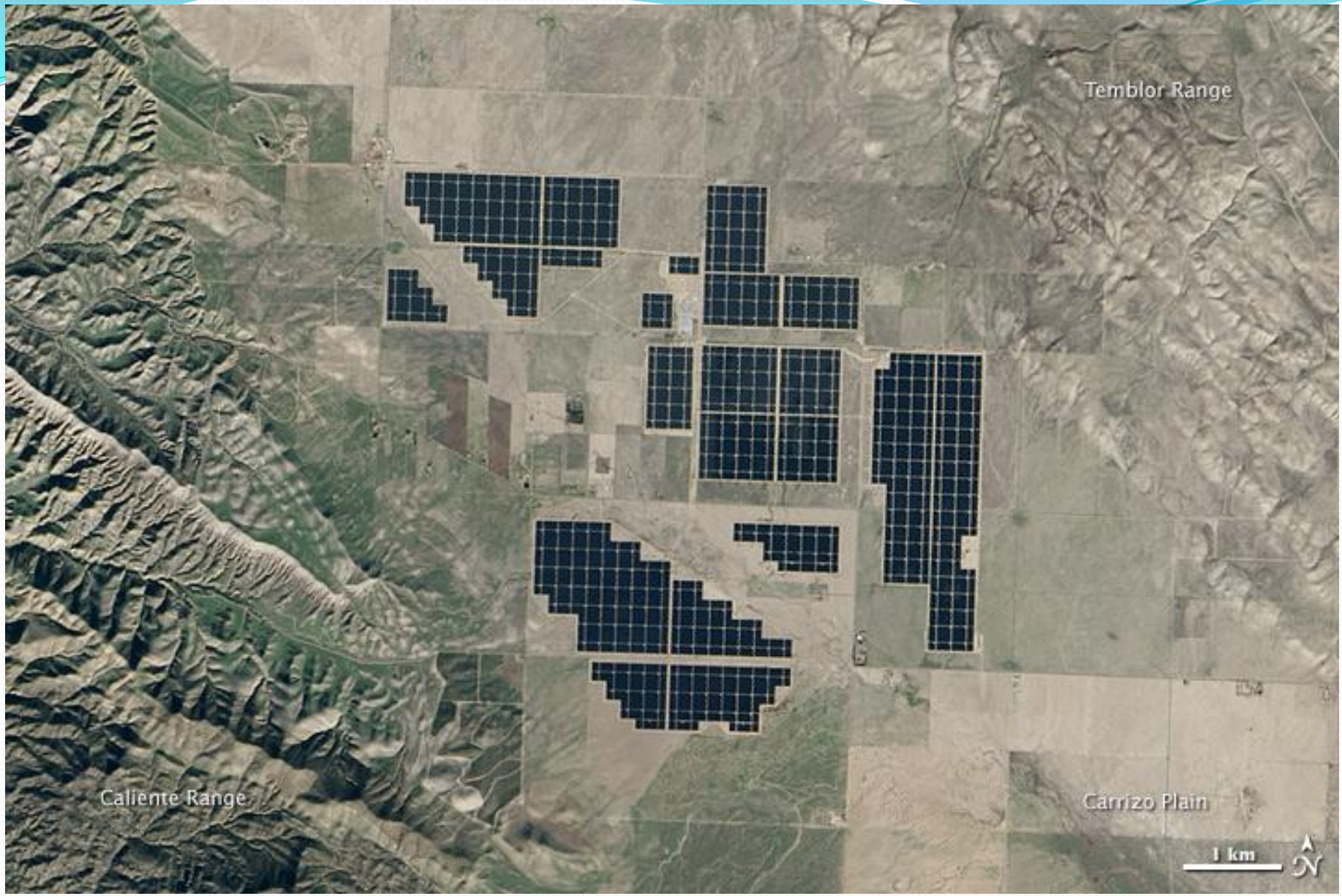
- **Because of their current costs, only rural and other customers far away from power lines use solar panels because it is more cost effective than extending power lines.**
- **Note that utility companies are already purchasing, installing, and maintaining PV-home systems (Idaho Power Co.).**
- **Largest solar plant in US, sponsored by the DOE, served the Sacramento area, producing 2195 MWh of electric energy, making it cost competitive with fossil fuel plants.**

Timeline of the largest PV power stations in the world

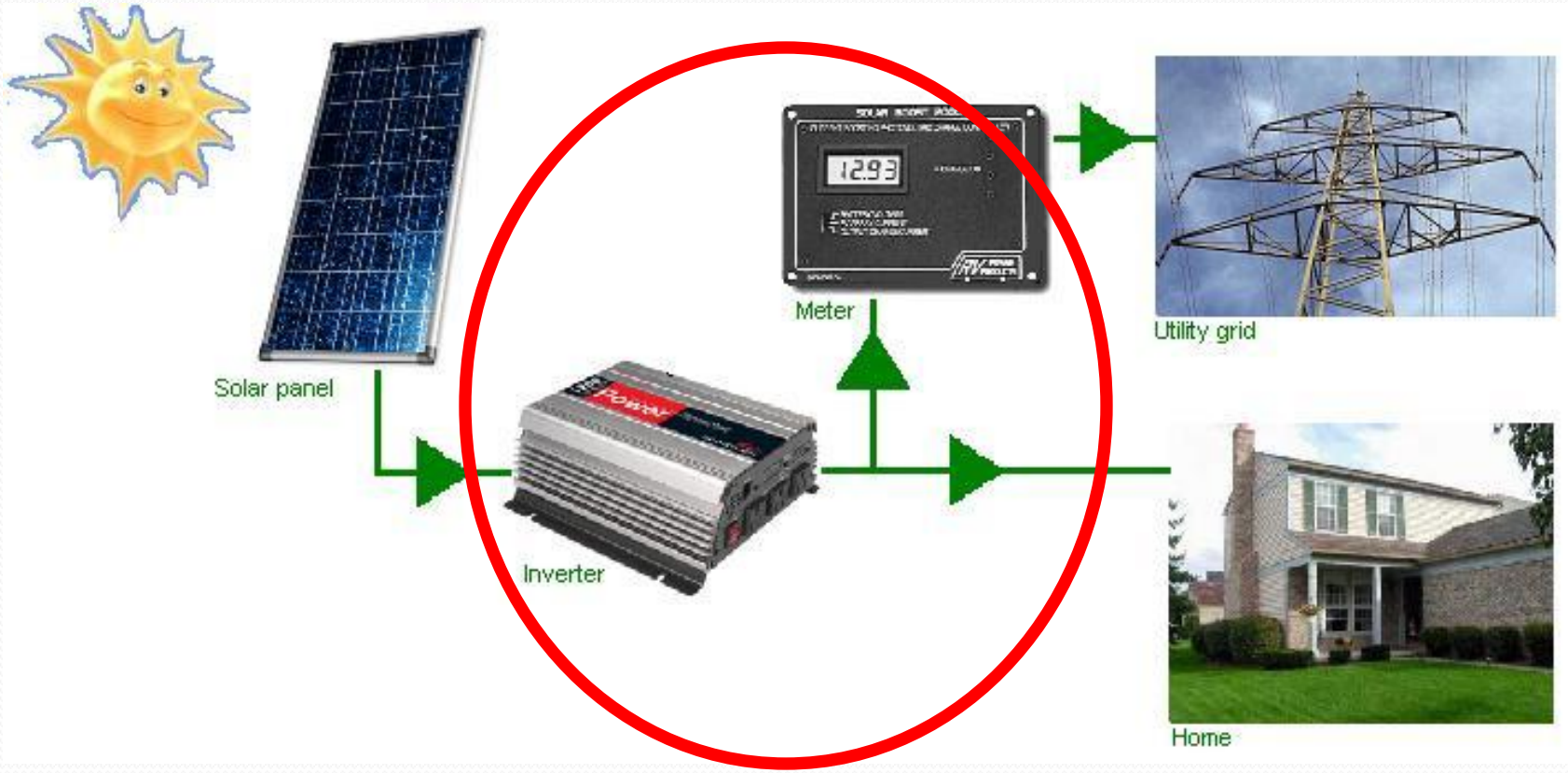
Year[a]	Name of PV power station	Country	Capacity MW
1982	Lugo	USA	1
1985	Carrisa Plain	USA	5.6
2005	Bavaria Solarpark (Mühlhausen)	Germany	6.3
2006	Erlasee Solar Park	Germany	11.4
2008	Olmedilla Photovoltaic Park	Spain	60
2010	Sarnia Photovoltaic Power Plant	Canada	97
2011	Huanghe Hydropower Golmud Solar Park	China	200
2012	Agua Caliente Solar Project	USA	290
2014	Topaz Solar Farm[b]	USA	550
2015	Solar Star[b]	USA	579

Also see list of noteworthy solar parks

(a) year of final commissioning (b) capacity given in MW_{AC} otherwise in MW_{DC}


Temblor Range
Caliente Range
Carrizo Plain
1 km
N

PV Wiring


Solar panel
Meter
Utility grid
Inverter
Home

Wire Components

- Conductor material = copper (most common)
- Insulation material = thermoplastic (most common)

- Wire exposed to sunlight must be classed as sunlight resistant

Cables and Conduit

- ***Cable:*** two or more insulated conductors having an overall covering

- ***Conduit:*** metal or plastic pipe that contains wires

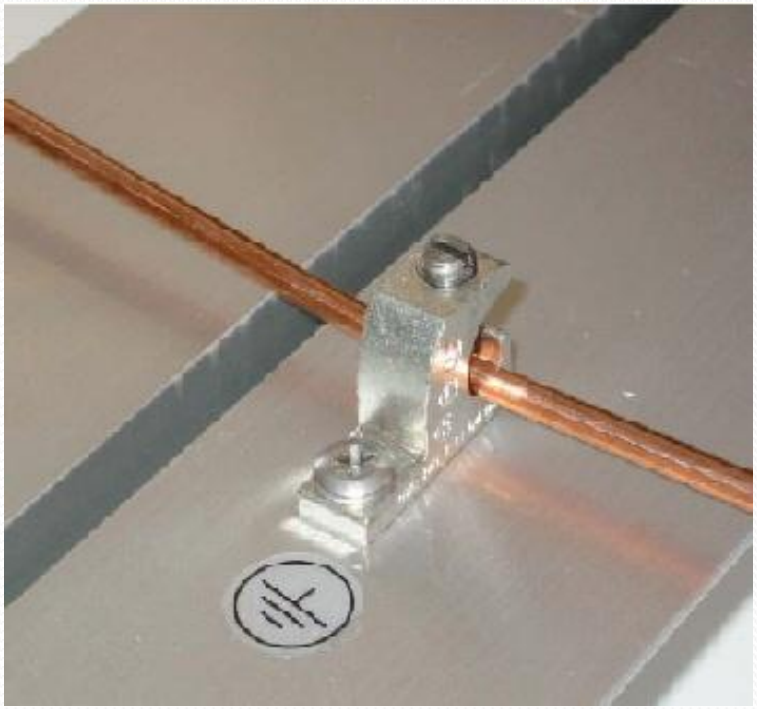
Safety Equipment

- Disconnects

- Overcurrent Protection

Grounding

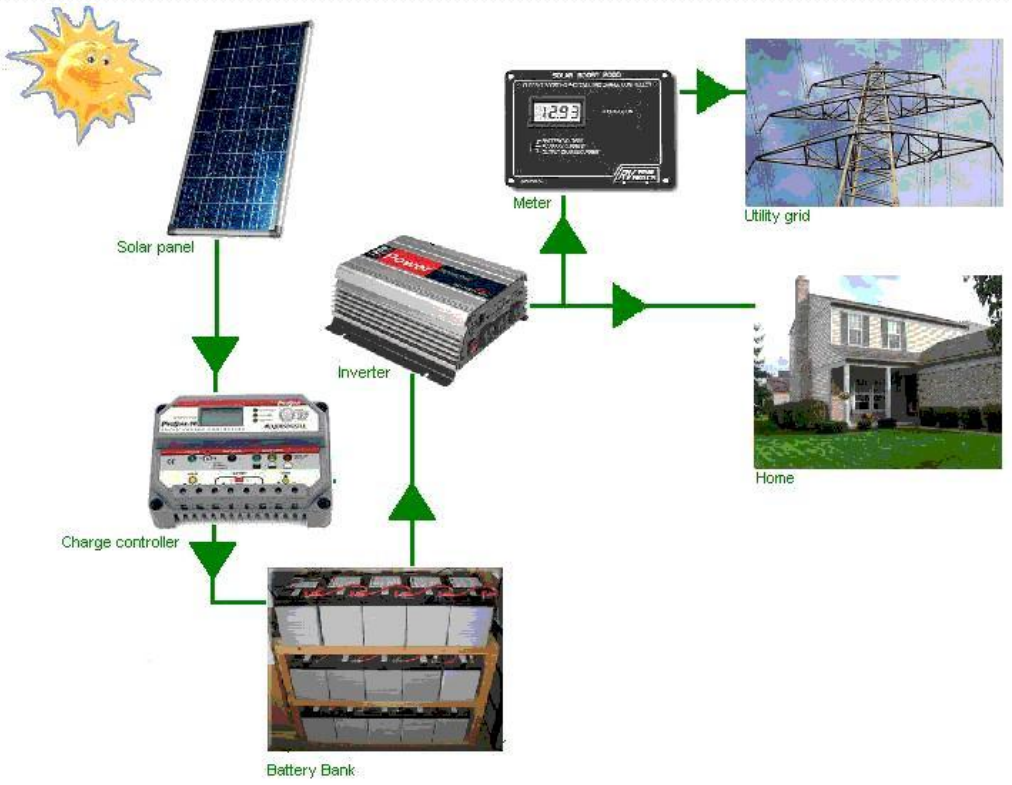
- Provides a current path for surplus electricity to travel too (earth)



Grid-Tied System

(With Batteries)

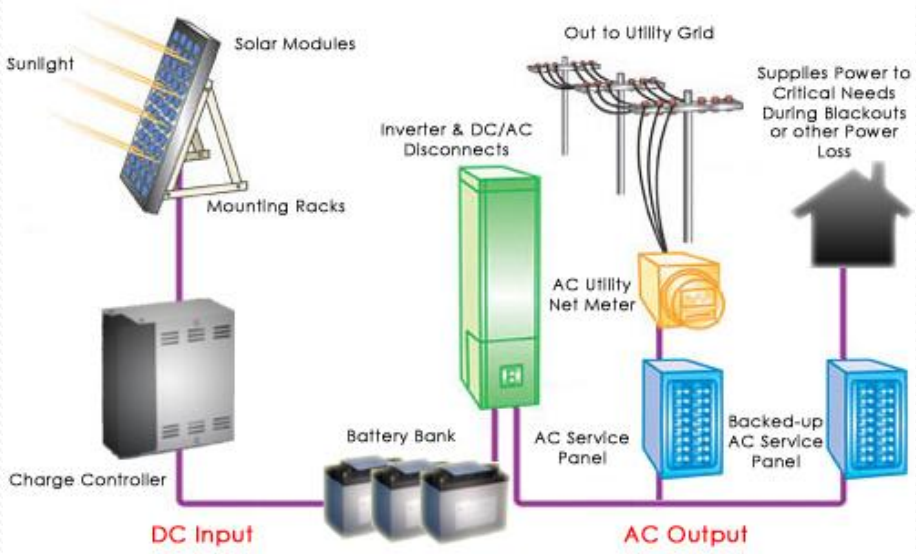
- Complexity
  - High: Due to the addition of batteries
- Grid Interaction
  - Grid still supplements power
  - When grid goes down batteries supply power to loads (aka battery backup)



Controllers & Inverters

Grid-Tied System

- Advantages
  - Low: Easy to install (less components)
  - Grid can supply power
- Disadvantages
  - No power when grid goes down



- Controller basics
- Controller features

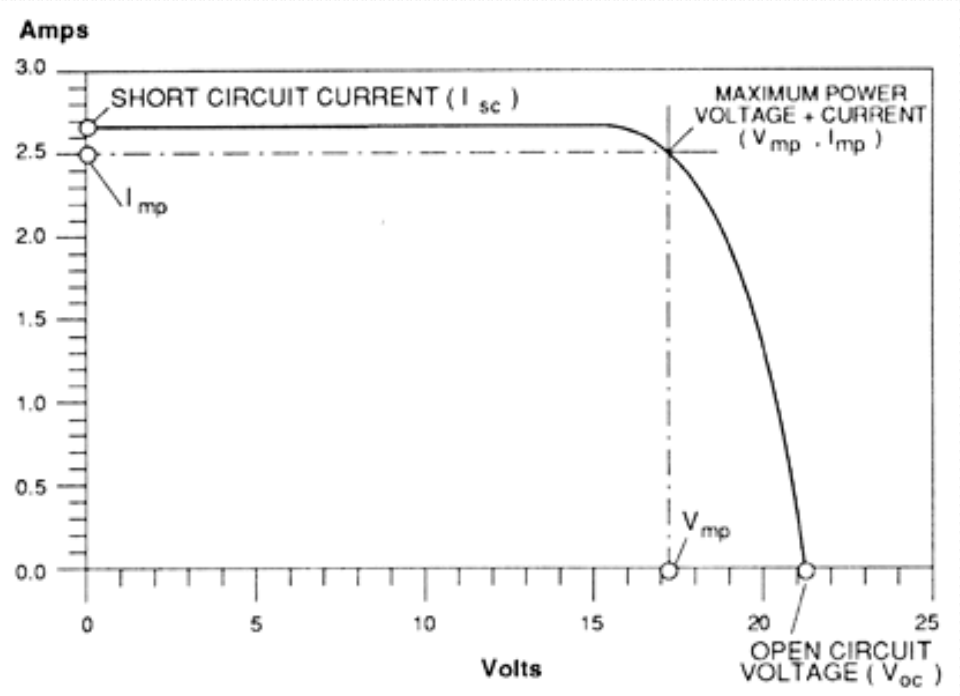
Controller Basics

Function:

- To protect batteries from being overcharged

Features:

- Maximum Power Point Tracking
  - Tracks the peak power point of the array (can improve power production by 20%)!!



Additional Controller Features

- Voltage Stepdown Controller: compensates for differing voltages between array and batteries (ex. 48V array charging 12V battery)
  - By using a higher voltage array, smaller wire can be used from the array to the batteries
- Temperature Compensation: adjusts the charging of batteries according to ambient temperature

Other Controller Considerations

- When specifying a controller you must consider:
  - DC input and output voltage
  - Input and output current
  - Any optional features you need
- Controller redundancy: On a stand-alone system it might be desirable to have more then one controller per array in the event of a failure

Inverter Basics

Function:

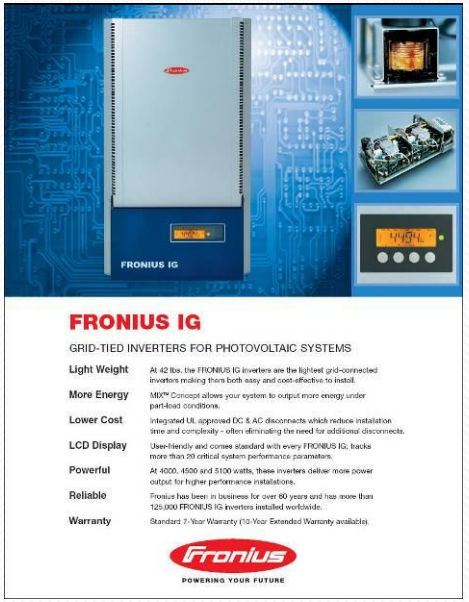
- An electronic device used to convert direct current (DC) electricity into alternating current (AC) electricity

Drawbacks:

- Efficiency penalty
- Complexity (read: a component which can fail)
- Cost!!

Specifying an Inverter

- What type of system are you designing?
  - Stand-alone
  - Stand-alone with back-up source (generator)
  - Grid-Tied (without batteries)
  - Grid-Tied (with battery back-up)
- Specifics:
  - AC Output (watts)
  - Input voltage (based on modules and wiring)
  - Output voltage (120V/240V residential)
  - Input current (based on modules and wiring)
  - Surge Capacity
  - Efficiency
  - Weather protection
  - Metering/programming



Commercial Available options in Iraq

- Currently in Iraq two main solutions available for consumers.
- Water heating systems.
- PV conversion systems for small and domestic consumers.


Solar Charge Controller


220 V
2.5 A , 4.5 A , 6.5 A , 10 A
newmox
Panasonic
Valve Regulated Lead-Acid Battery
Panasonic Corporation
SG 1000H


AC Input
PV Input
AC Output
Overload
Battery
Bypass
ON
OFF
OFF-GRID SOLAR INVERTER


FRAGILE
Panasonic
HANDLE WITH CARE
Panasonic
EXTRA GRADE
CAR BATTERY
145G51H
(N150)
Panasonic Corporation
Made in Thailand


MPP Solar
READY
CHARGE
EQUAL
FAULT
ESC RESET
DATA ENTER
DSPL
INIT
PROG
DATA LOG
MPPT BATTERY CHARGER
SOLAR CHARGE CONTROLLER
PCM8048 MPPT
12~48VDC
80AMP
DIC
Power
IN 24V
24V → 12V
OUT 12V
Car power supply transformer
POWER

Home use solar power systems

- 500 W power system 2 pcs in paraller(around 2.5A):
- 2 solar panel 250 W/30 V.(550$)
- Battery 12 V/100 Ah. 2 pcs in series. (330$).
- Off- grid solar inverter 1 (285$)
- Total cost 1165$

1500 W 6.5 A power system

- Solar Panel 250W/30V. 6 panels 2 in series and 3 groups in parallel 1650$
- Battery 12v/150Ah 4 pcs, 990$,
- Off- grid solar inverter 350$
- DC combiner box.
- Total cost 2990$

2400 W 9 A power system

- Solar Panel 250W/30V. 12 panel 2 in series and 4 groups in parallel 3300$
- Battery 12v/200Ah 4 pcs, 1280$,
- Off- grid solar inverter 520$
- DC combiner box.
- Total cost 5100$

Thank You