Basic technical information on solar PV
Agenda

1. Solar Thermal Systems
Types of Solar Energy Systems

Passive

Solar Thermal

Photovoltaic

Slide credit: International Renewable Energy Council (IREC) and International Code Council (ICC)
Solar Thermal Systems
(....just FYI!)
Solar Photovoltaics vs. Solar Water Heating

- **Solar Photovoltaic (PV) Systems**
  - use light from the sun to produce electricity for your home.

- **Solar Water Heating Systems**
  - use the sun’s heat to provide hot water for your home.
How Does Solar Water Heating Work?

Active Systems

– Use a pump and a heat exchange fluid
– Fluid may be either glycol or water
How Does Solar Water Heating Work?

Passive Systems
– Require no pumps
– Simple design
– Solar storage is on the roof

Photo credit: NREL
Flat Plate Collectors

- Most common solar water heating collector
- Heat is transferred to water or to a heat exchange fluid flowing through the collector
- Long track record of reliability

Courtesy of Sunearth inc.
Other Collector Types

Evacuated Tube Collectors

Unglazed Collectors
(Generally for Pool Heating)
Solar Storage Tanks

- All solar water heating systems have a storage component
- Solar storage is separate from your existing tank or tankless water heater

Roof mounted storage

Solar storage tank next to existing water heater
How Does Solar PV Work?
Solar Photovoltaic Technology Basics

U.S. DEPARTMENT OF ENERGY

Energy Efficiency & Renewable Energy

Powered by SunShot
U.S. Department of Energy
How does solar work?

Sunlight

Front electrode (−)

Antireflection coating

Back electrode (+)

Current
What’s a watt?

**Watt (W)** = unit of instantaneous power

**Kilowatt (kW)** = a measure of 1,000 W
What’s a kilowatt hour?

**Kilowatt-hour (kWh)** = unit of energy equal to 1,000 W x 1 hour

It is the use of power over time
Energy vs. Power

- **kW**: unit of power
  - Power is the rate at which electricity is generated or used

- **kWh**: unit of energy
  - Energy is a measure of how much electricity over a specific period of time
Voltage (V) = unit of electromotive charge

Current (amps) = the strength of an electric current
Direct Current vs. Alternating Current

Direct Current (DC) = Produced by solar panels

Alternating Current (AC) = ‘usable’ energy in your home or business
What are the Main Components of a PV System?
Main components of solar PV

1. Solar PV Panels
2. Inverter
3. Service Panel
4. Smart Meter
5. Utility Grid
Main components of solar PV

From a solar cell to a PV System

- Solar Cell
- Solar Module
- Solar Array
- Solar Panel

PV-System

Powered by SunShot
U.S. Department of Energy
Solar PV cell technology

Crystalline silicon

Thin film
Main components of solar PV

Photo credit: International Energy Agency
Main components of solar PV
Main components of solar PV

Multiple PV cells make up a **PV module OR panel**

The visible assembly of multiple modules and support structure is the **array**
Inverters change **DC** electricity from panels to **AC** electricity for use in your building.

- String Inverters
- Micro Inverters
String Inverters

One individual inverter per array
String Inverters

One individual inverter **per array**

**Benefits**
- Longer track record
- Established reliability
- High efficiency
- Lower cost*

**Disadvantages**
- Shading can affect power output dramatically
- Does not allow for easy system size increases
One individual inverter per module
Micro Inverters

One individual inverter per module

Benefits

- Makes the array more tolerant to shading
- Allows flexibility in design and for future additions
- Built-in rapid shut-down compliance

Disadvantages

- Shorter track record
DC Power Optimizers

Attaches to or is integrated in the junction box of a PV module
Which inverter is best?

String vs. Micro vs. String + DC Power Optimizer
What are the Solar PV Mounting Options?
Mounting System Options

- Flush mounted
- Tilted rack mounted
- Pole mounted
- Ballasted

Photo credit: NREL
Flush mounted PV systems

Photo credit: EERE

Powered by SunShot
U.S. Department of Energy
Tilted Rack mounting systems
Ballasted PV mounting systems

Photo credit: EERE
Ballasted PV mounting systems

STRING INVERTERS

Photo credit: EERE
Ground & pole mounting

Photo credit: NREL
Peel-and-stick modules

Photo credit: Miasole
Peel-and-stick modules

Photo credit: Miasole
Quiz & Discussion
Question 1

Which unit do utilities use to measure electric service?

a) Kilowatt-hour (kWh)
b) Voltage (V)
c) British thermal unit (BTU)
d) Horsepower (hp)
Which unit do utilities use to measure electric service?

a) Kilowatt-hour (kWh)
b) Voltage (V)
c) British thermal unit (BTU)
d) Horsepower (hp)
What is the dominant semiconducting material used in the production of solar cells?

a) Amorphous silicon  
b) Crystalline silicon  
c) Cadmium telluride  
d) Halide perovskite
What is the dominant semiconducting material used in the production of solar cells?

a) Amorphous silicon
b) **Crystalline silicon**
c) Cadmium telluride
d) Halide perovskite
Question 3

What are the primary features of a micro inverter?

a) Converts DC electricity to AC
b) Provides rapid shut-down capability
c) Allows flexibility in design of the array
d) All of the above
What are the primary features of a micro inverter?

a) Converts DC electricity to AC
b) Provides rapid shut-down capability
c) Allows flexibility in design of the array
d) All of the above
Which of the following is not a roof mounted PV system?

a) Tilted rack PV system
b) Pole mounted PV system
c) Ballasted PV system
d) Integrated PV system
Which of the following is not a roof mounted PV system?

a) Tilted rack PV system
b) Pole mounted PV system
 c) Ballasted PV system
d) Integrated PV system