ENER-1005 Renewable Energy Installation and Construction Safety

# B1-1. Introduction to Photovoltaic Systems

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- Photovoltaics
- PV Applications
- PV Industry
- Solar Energy Technologies

This PowerPoint is based on Chapter 1 – *Introduction to Photovoltaic Systems* in the *Photovoltaics Systems* textbook.

A utility-connected PV system is the most common system configuration. Various electrical components control, condition, and distribute the power to on-site loads.

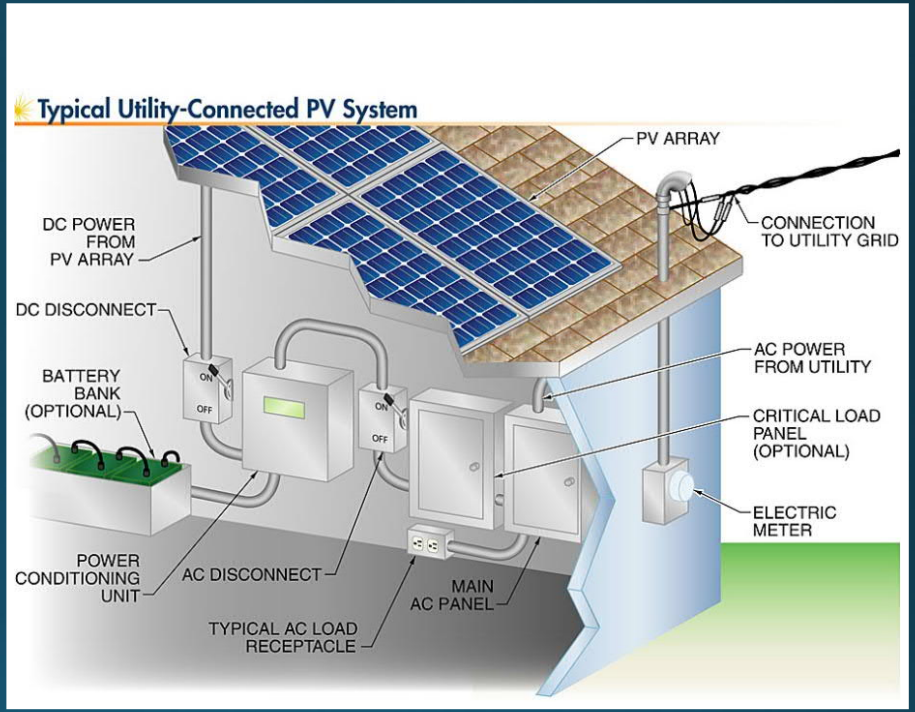


Figure 1-1

An electric utility produces electricity at a power plant and distributes it to consumers through power lines, substations, and transformers.

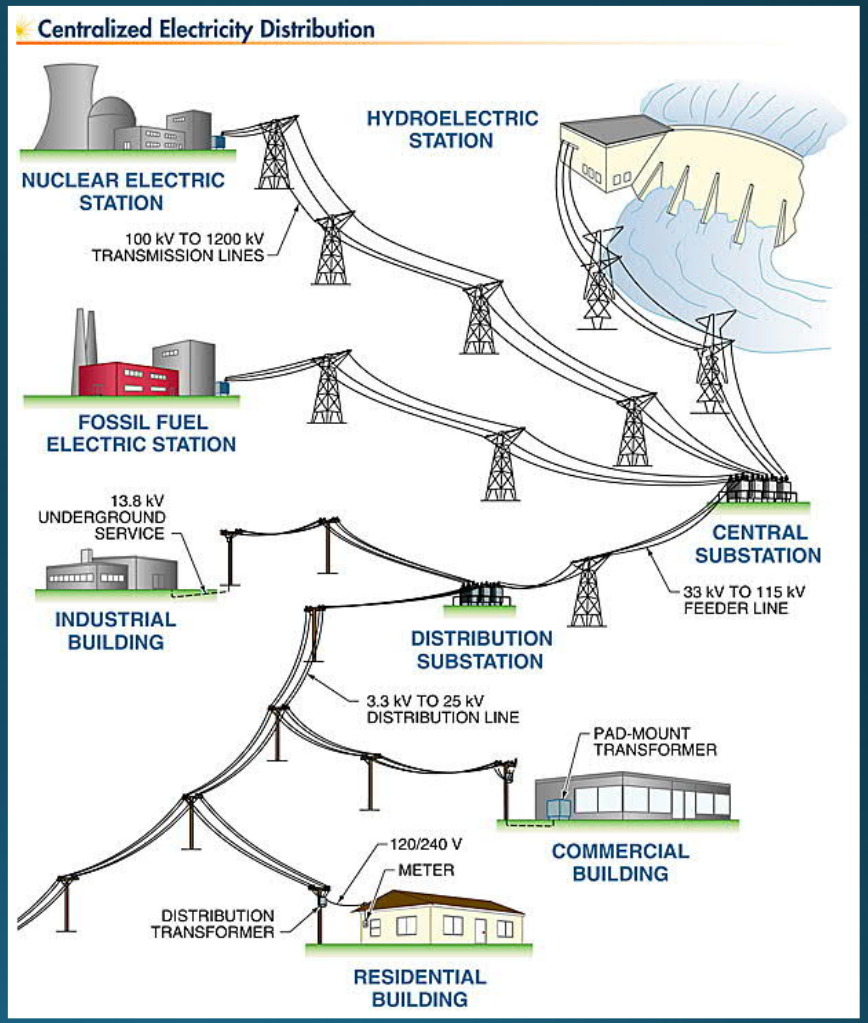


Figure 1-2

Distributed generation systems produce electricity close to where it is used.

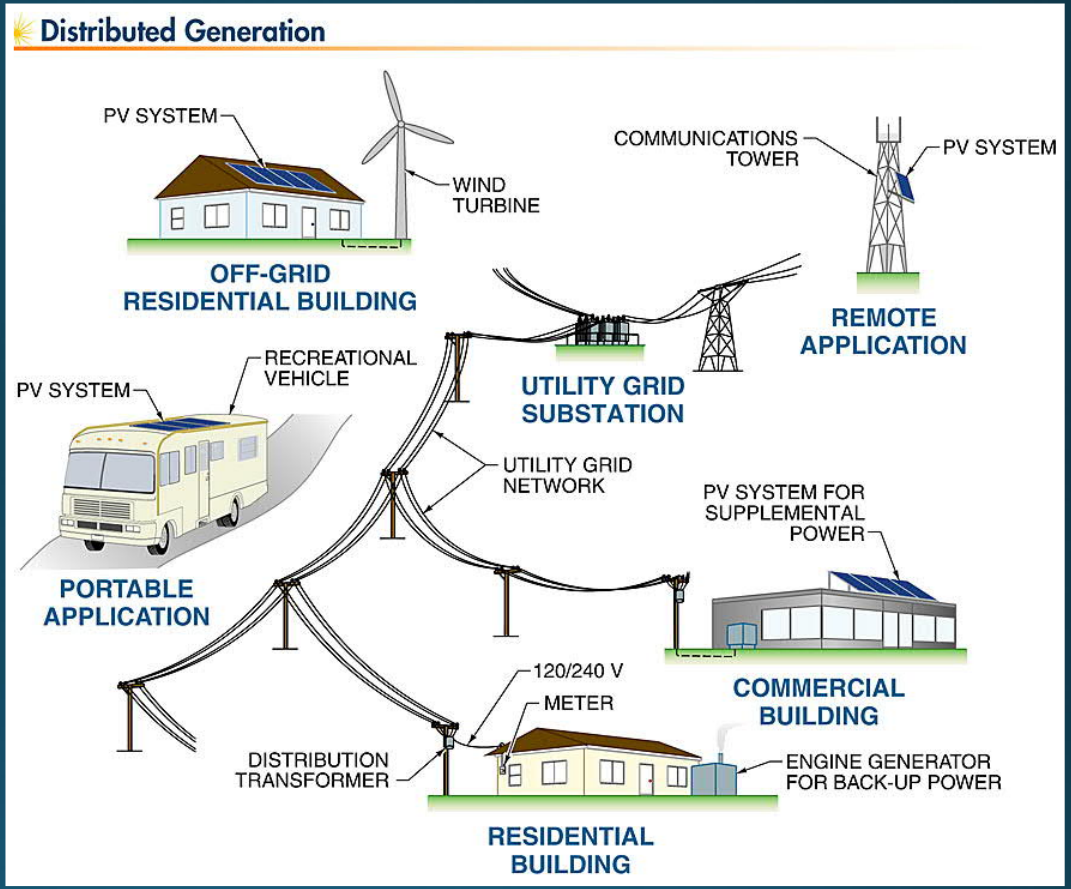


Figure 1-3

Selenium photoconductive cells are commonly used in light-sensing electronics, such as exposure timing circuits in cameras.

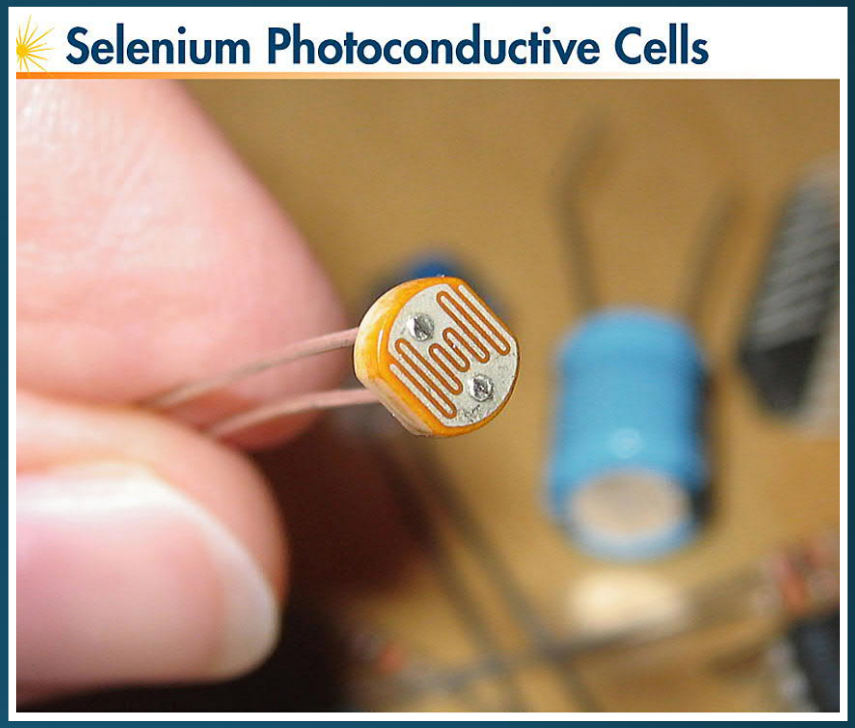


Figure 1-4

The first practical photovoltaic cell was invented at Bell Laboratories in 1954.

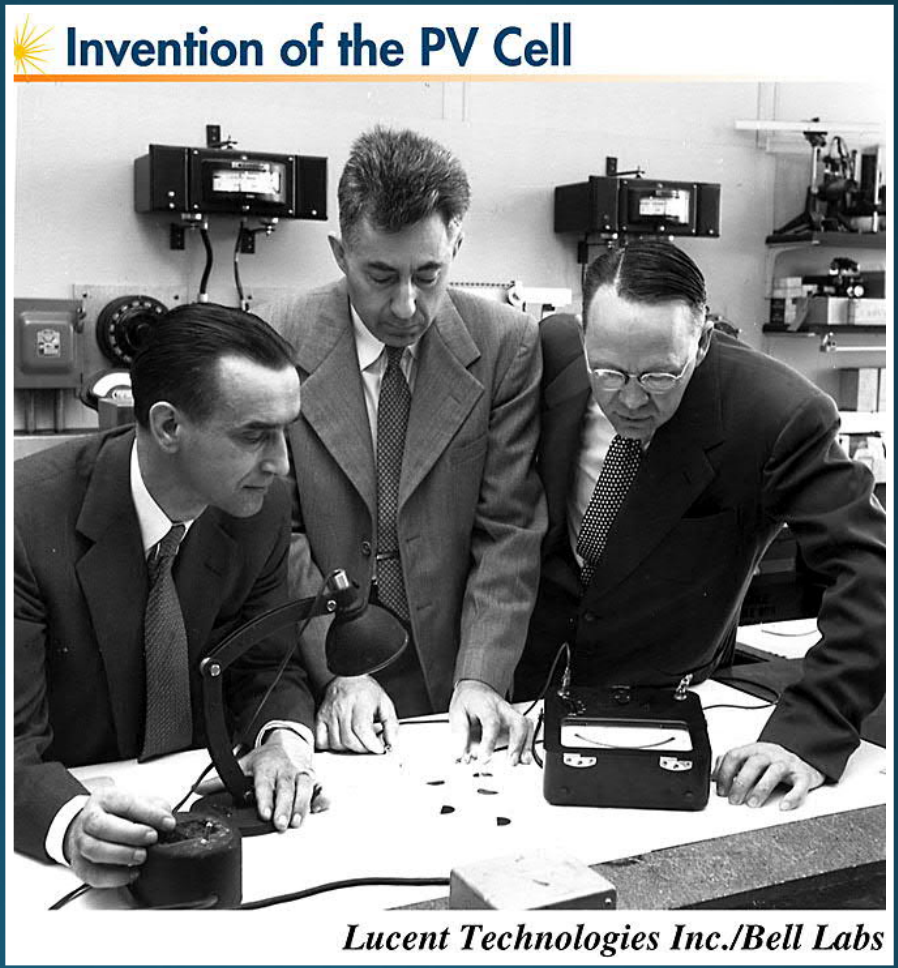


Figure 1-5

Rural communications systems in the 1950s were the first terrestrial applications of PV technology.

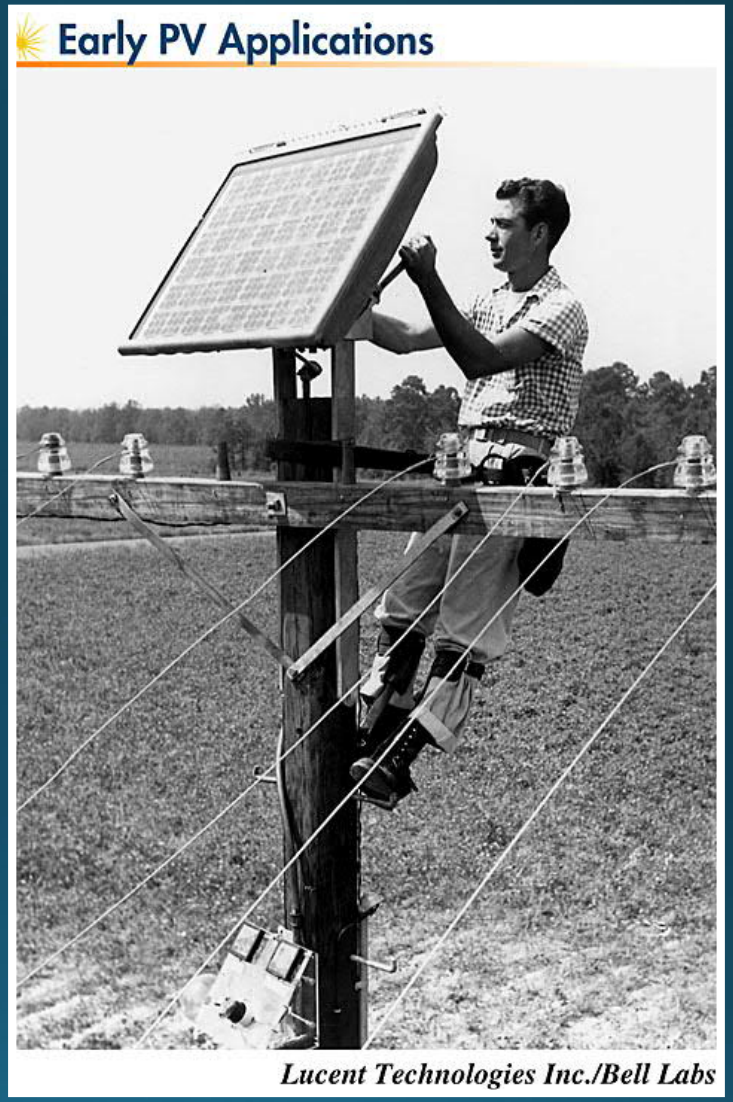


Figure 1-6

# The PV industry has developed significantly over the last few decades.

**PV Industry Development**

| INDUSTRY CHARACTERISTIC | 1990 | 2010 |
|---|---|---|
| Installed capacity | <50 MW/yr worldwide | >10 GW/yr worldwide; >500 MW/yr in US |
| Product listing and certification | Development at initial phase | UL listing standards for most or all of equipment |
| Code compliance | PV introduced in 1984 NEC®, but few systems are permitted and inspected | Established permitting and inspection practices by building officials |
| System Voltage | Residential ≤48 VDC | Residential <600 VDC; commercial <1000 VDC |
| Predominant Markets | Stand-alone | Utility-interactive residential and commercial; utility-scale |
| Number of PV companies | Hundreds | Tens of thousands |
| Maximum system size | 10 kW to 100 kW | 1 MW to 20+ MW |
| Utility interconnection | Few allowed | Permitted in all states and utilities, up to 20 MW |
| Licensing and personal certification | None | State licensing and national certification programs |
| Contractors and installers | Small specialized companies | Large companies, electrical contractors, and project developers |
| Global PV industry revenue | $200 million | $82 billion |

Figure 1-7

# Production and installation of PV systems is growing rapidly.

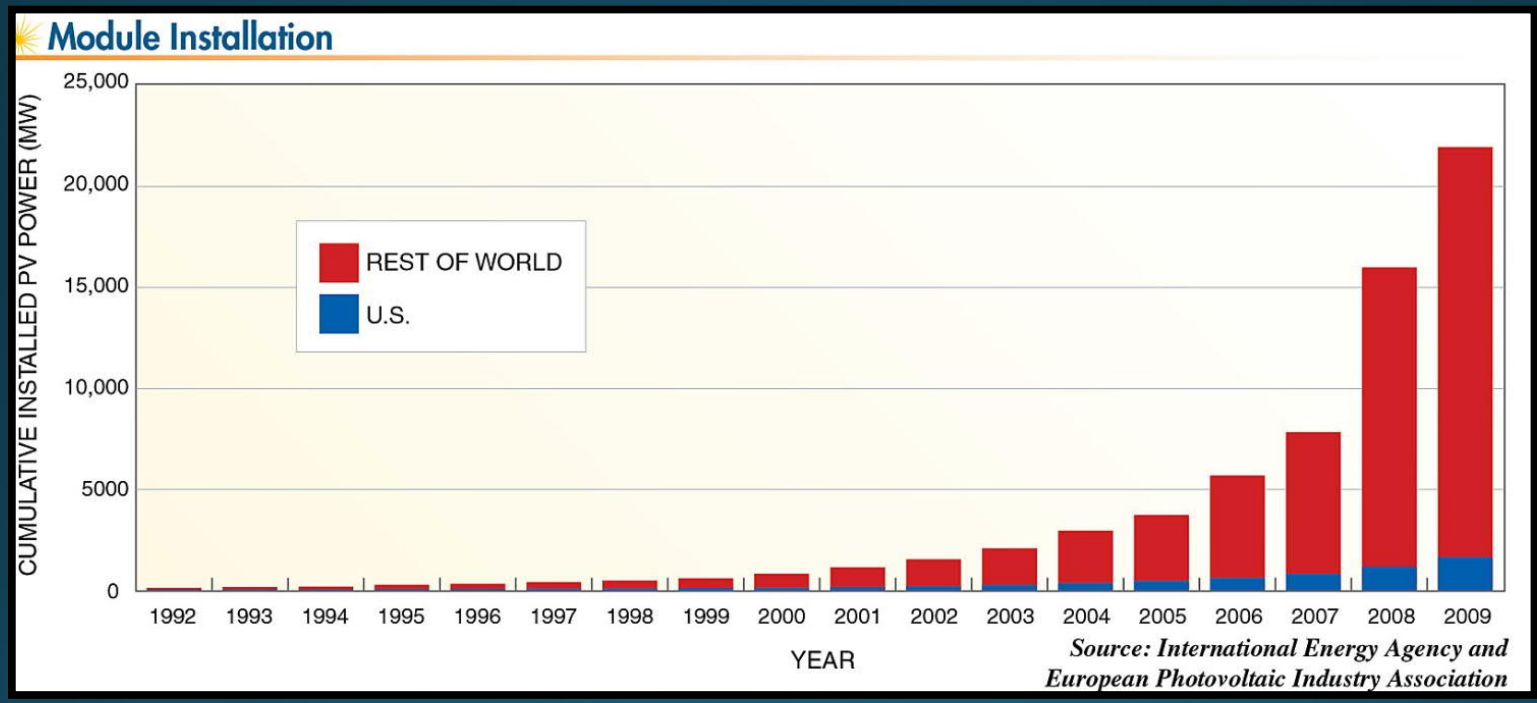


Figure 1-8

Nearly every satellite and spacecraft since 1958 has relied on a PV system for power generation.


Figure 1-9

# Portable PV systems tend to be small and intended for specific loads.

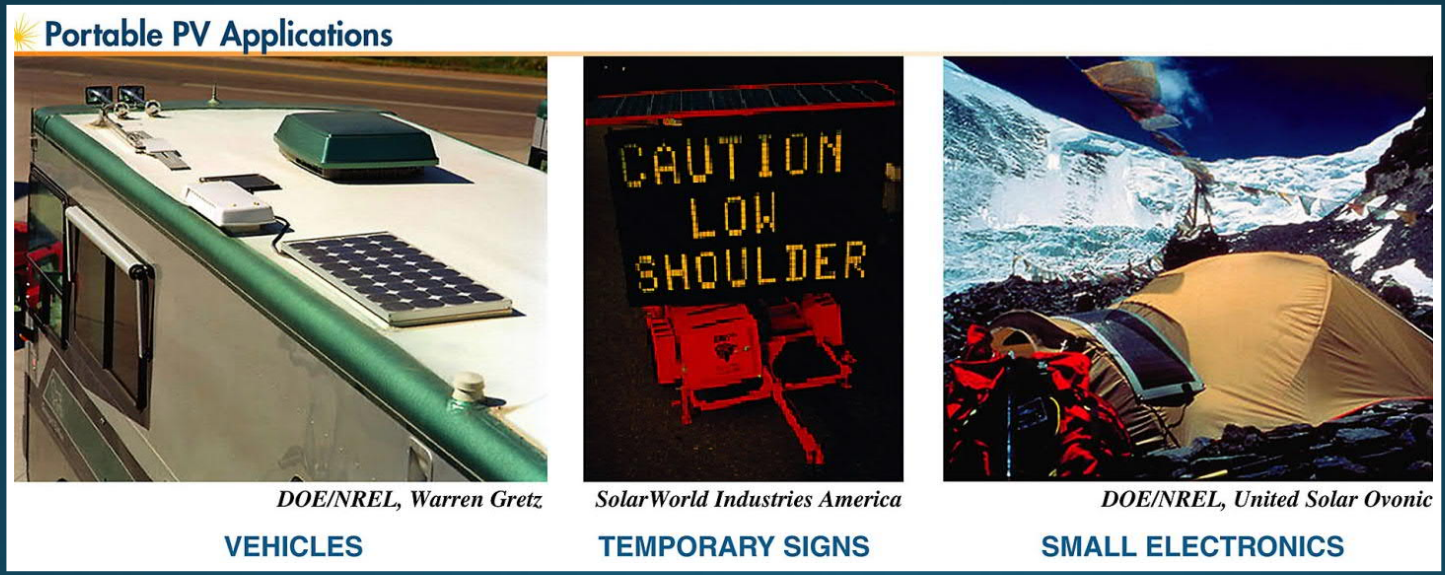


Figure 1-10

Remote areas where conventional utility-supplied power is out of reach are ideal for the application of PV technology.


Figure 1-11

Utility-interactive systems, most often for single-family homes, are the fastest-growing type of PV system installation.

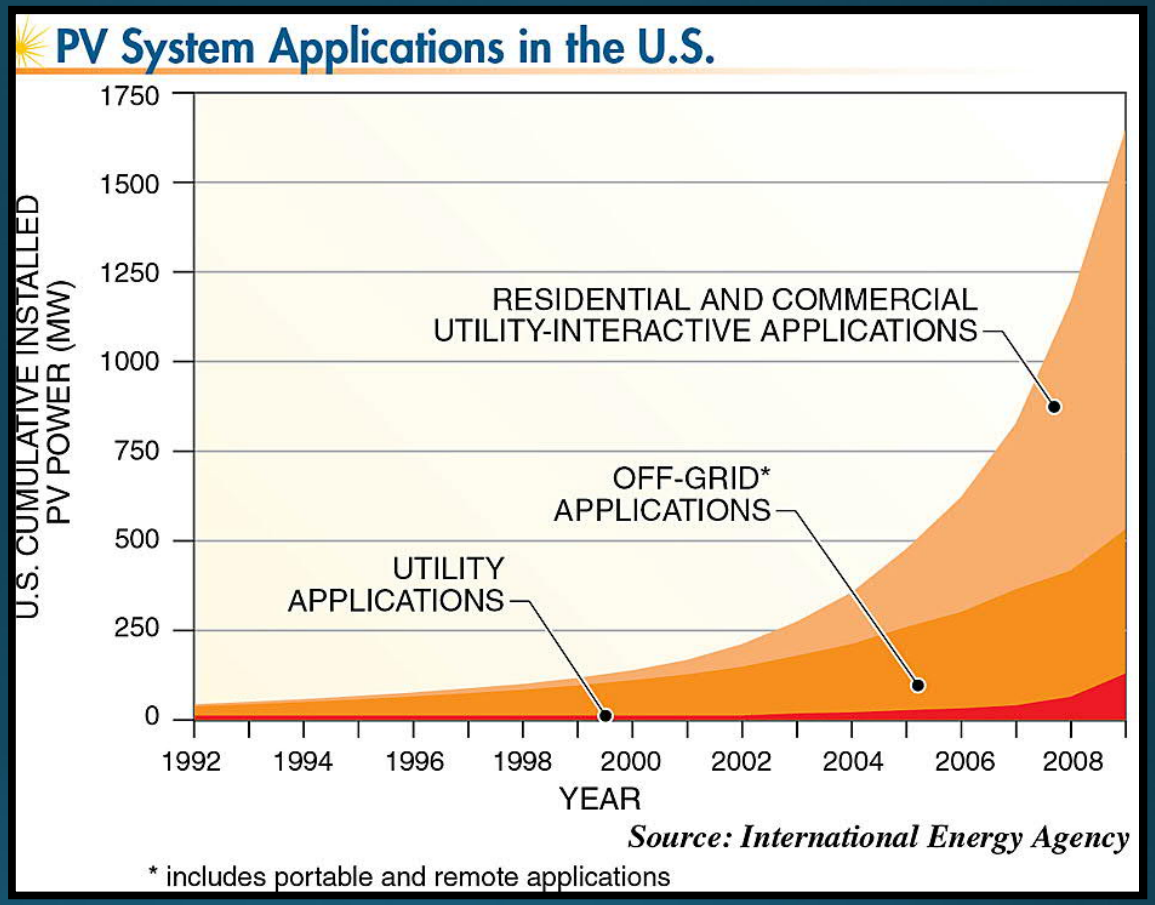


Figure 1-12

PV technology is increasingly used for large-scale power production.

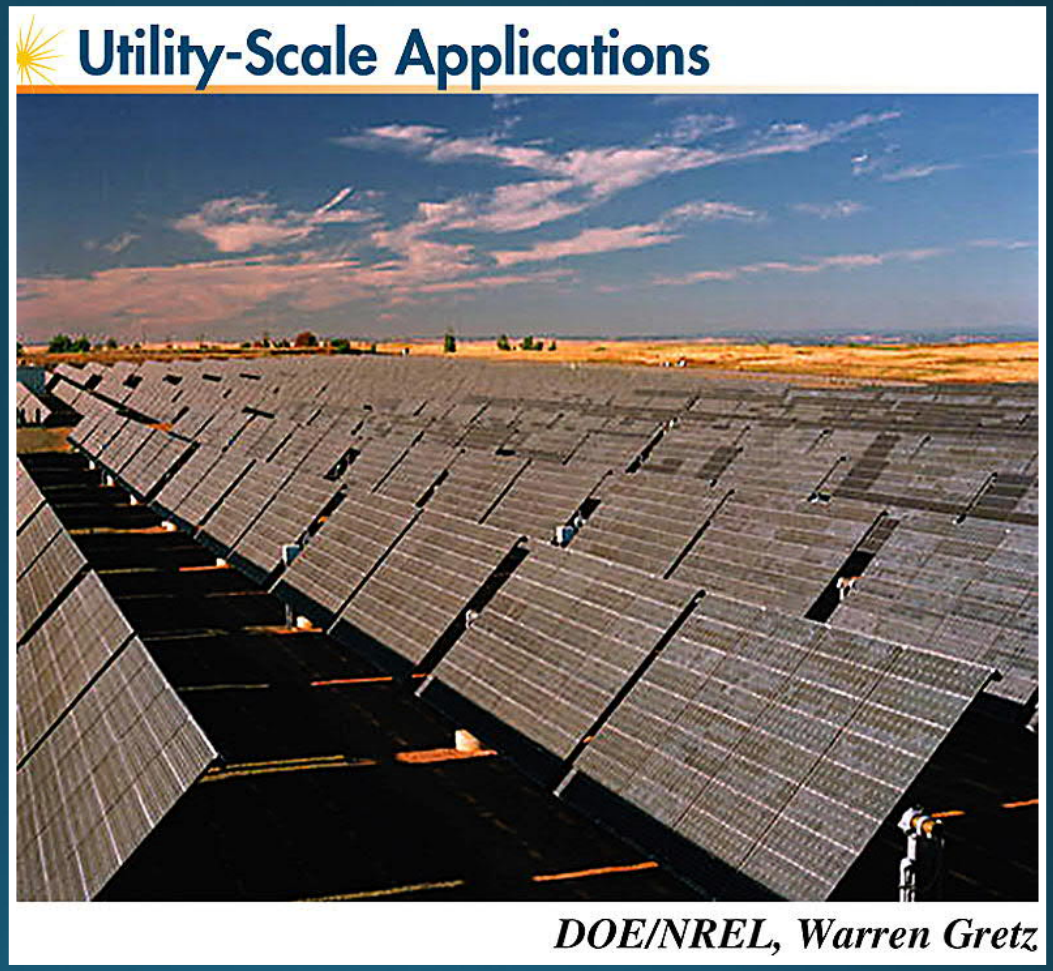


Figure 1-13

The PV industry is composed of several levels of businesses and organizations.

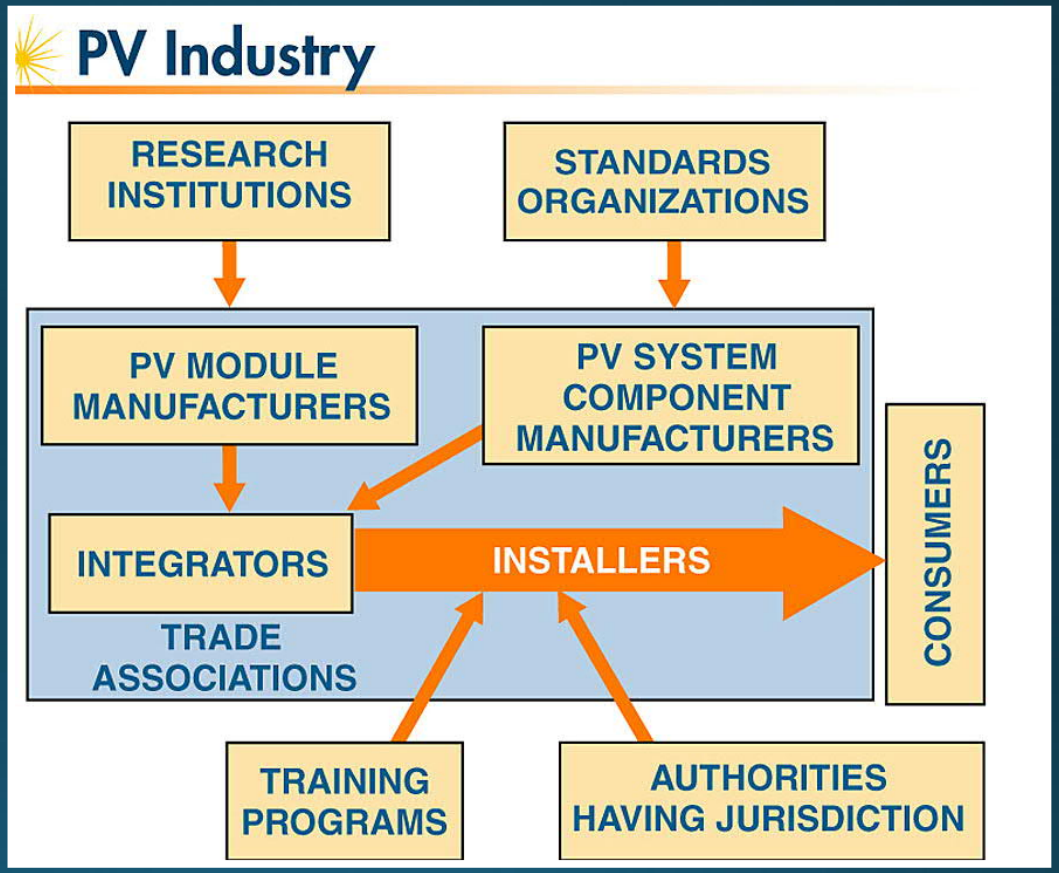


Figure 1-14

Quality PV installation relies on the quality of the selected components, system design, and installation practices.

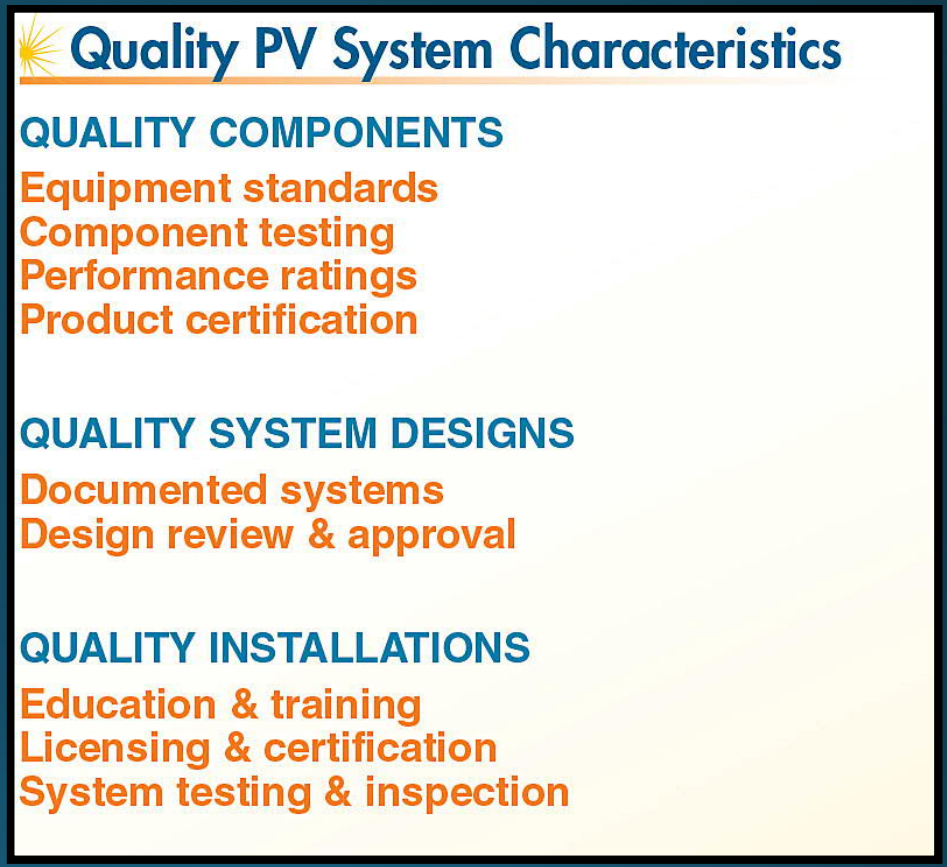


Figure 1-15

The official mark of a listing organization signifies that a product meets the organization's standards for safety and quality.

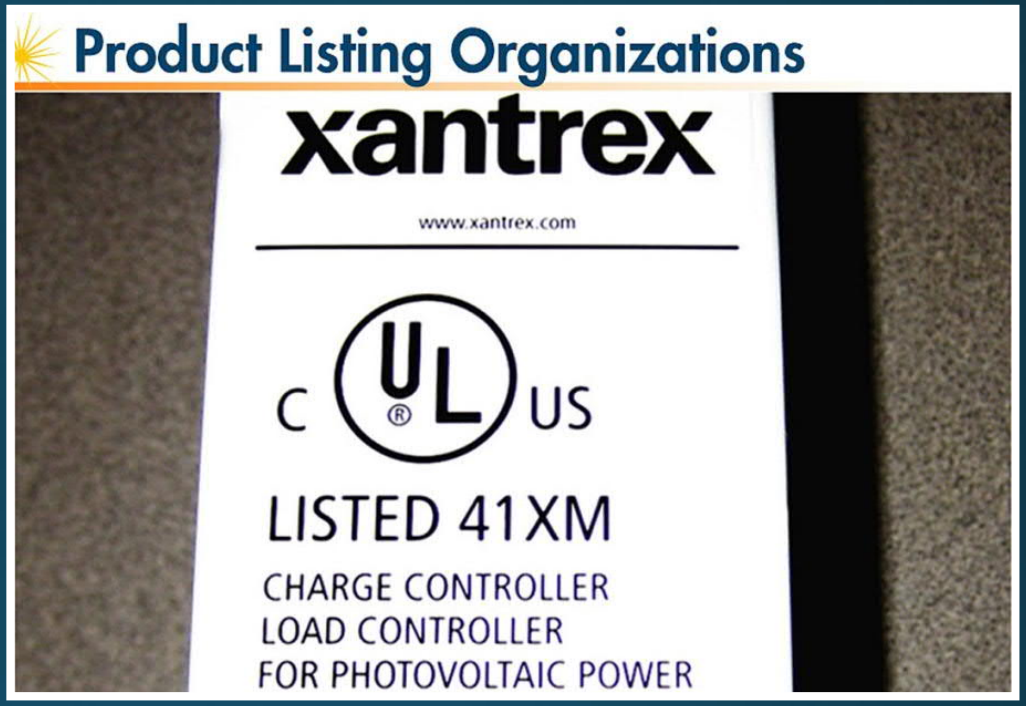


Figure 1-16

Renewable energy is expected to compose an increasingly larger portion of energy production.

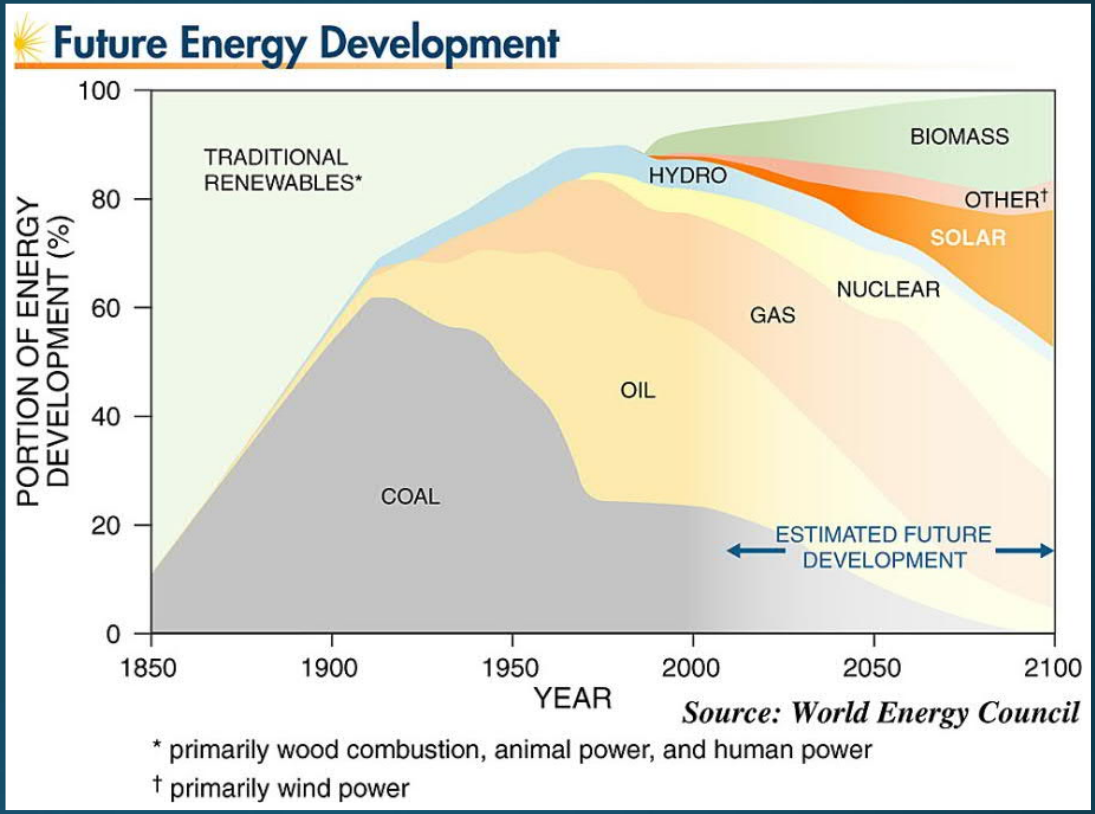


Figure 1-17

# Renewables portfolio standards and goals vary by state.

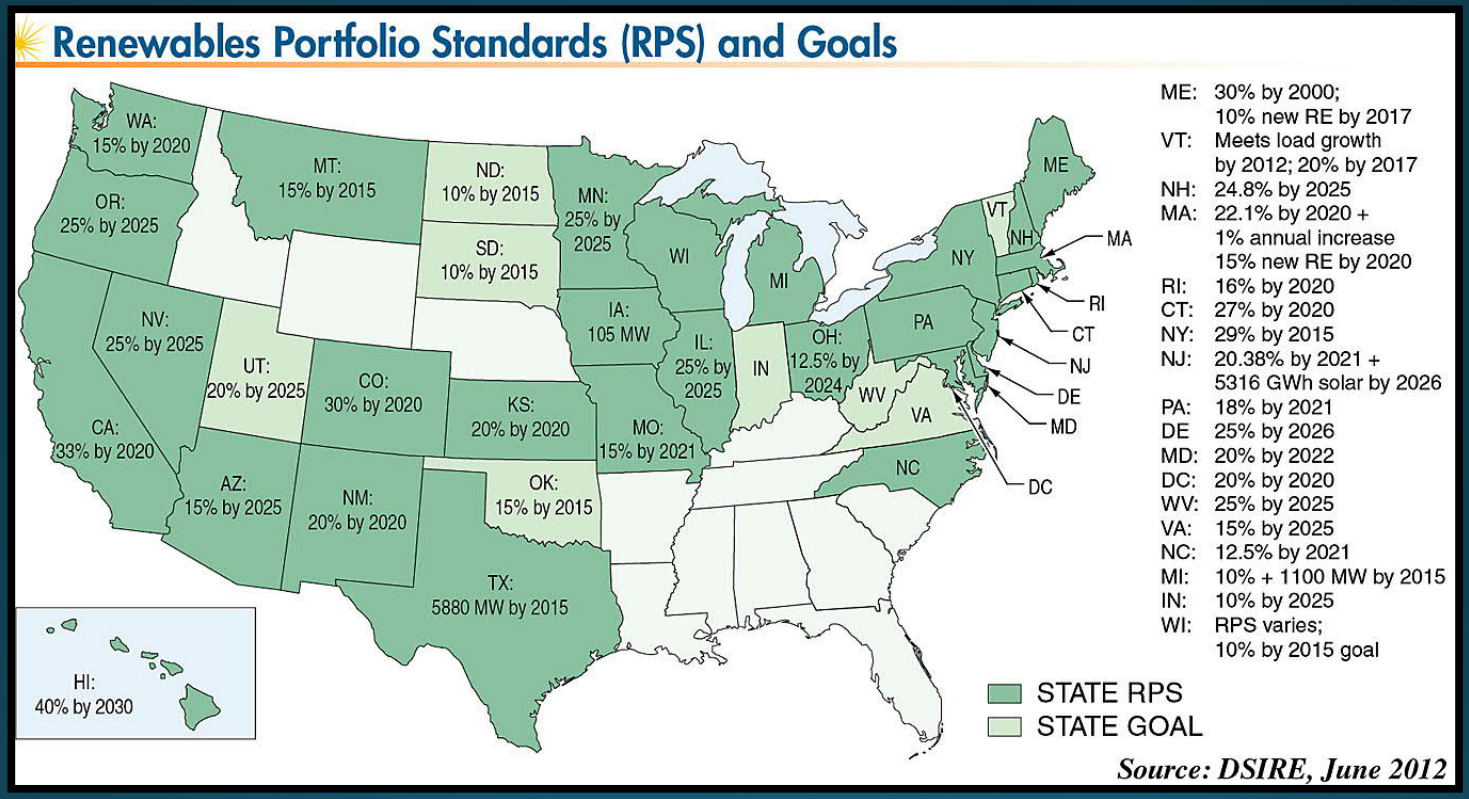


Figure 1-18

A flat-plate collector can utilize any solar radiation, direct or diffuse (reflected), that strikes its surface.

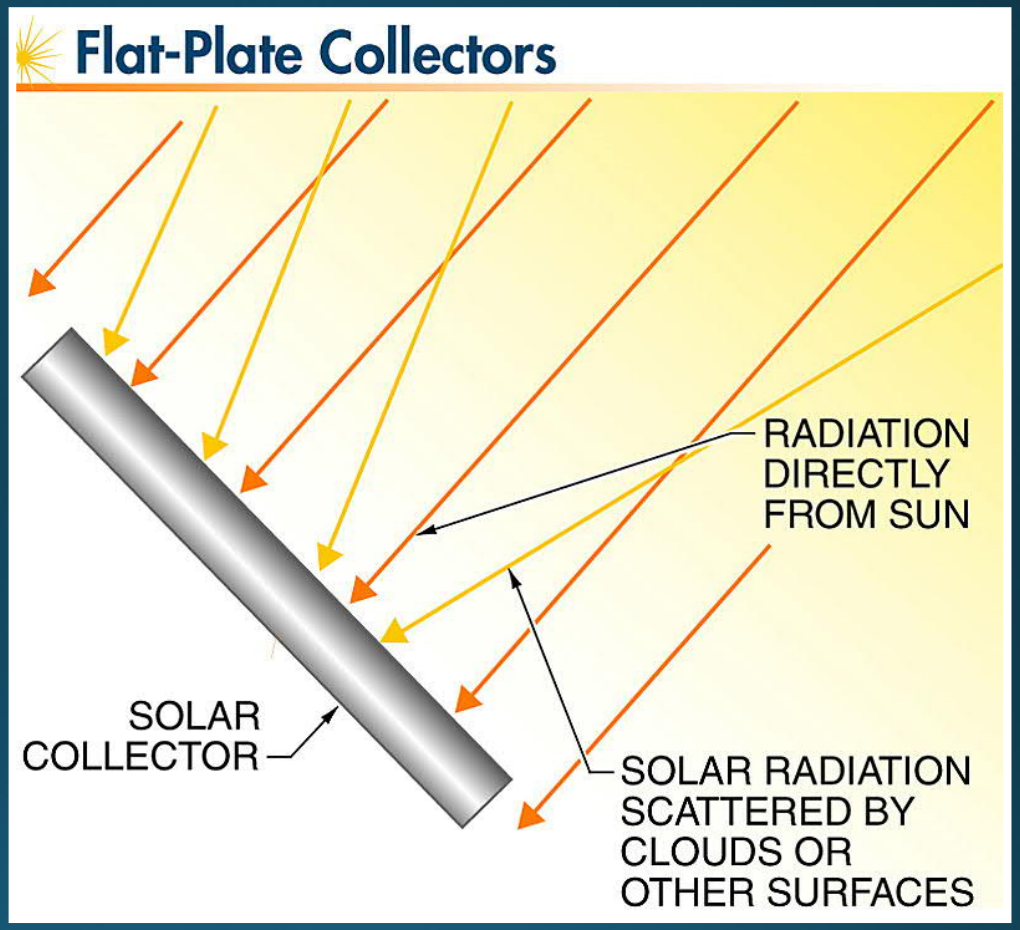


Figure 1-19

Solar architectural design uses building materials or design techniques to provide light and comfortable temperatures inside a building.

This is know as **passive solar design.**


Figure 1-22

# Concentrating collectors focus a large area of direct solar radiation onto a relatively small area.

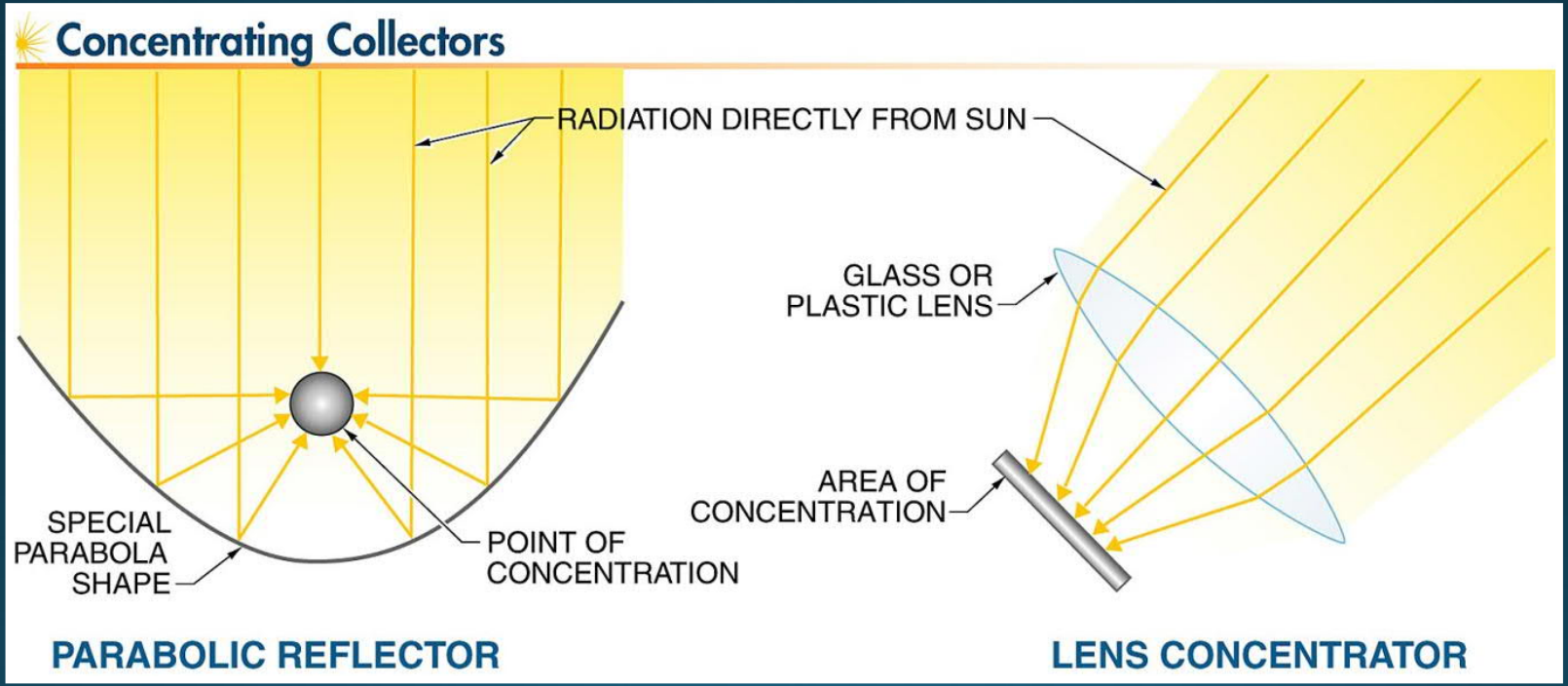


Figure 1-21

Solar thermal energy is a relatively simple way to provide domestic hot water or heating.


Figure 1-23

The intense solar radiation needed to produce electricity from thermal energy requires solar concentrating systems.

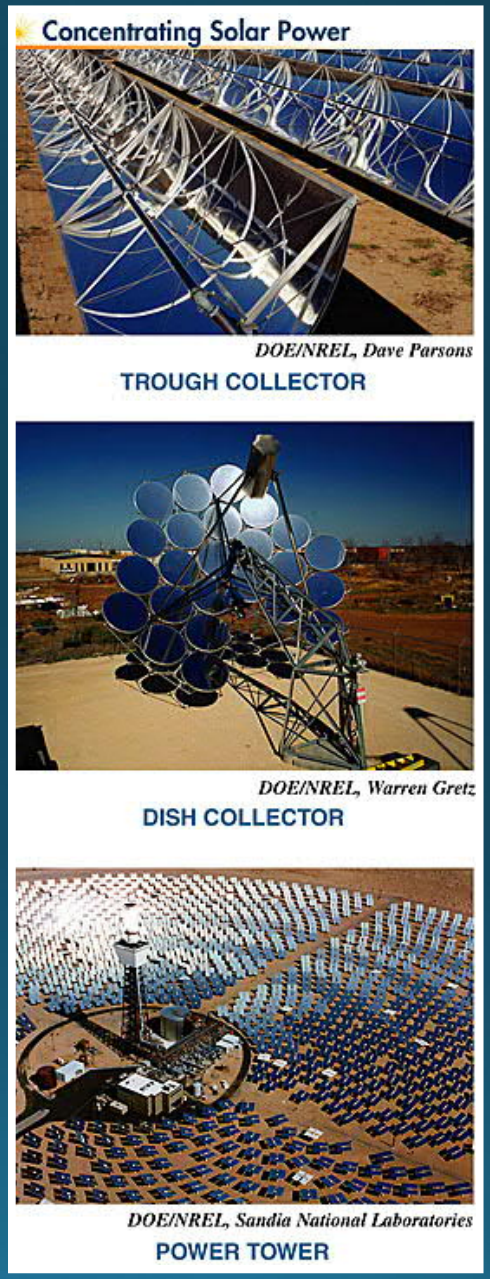


Figure 1-20