AMERICAN RIVER COLLEGE

PV Markets and Applications

Lesson Plan

- NABCEP Learning Objectives:
  PV Markets and Applications
- Financial Analysis discussion

Next class:

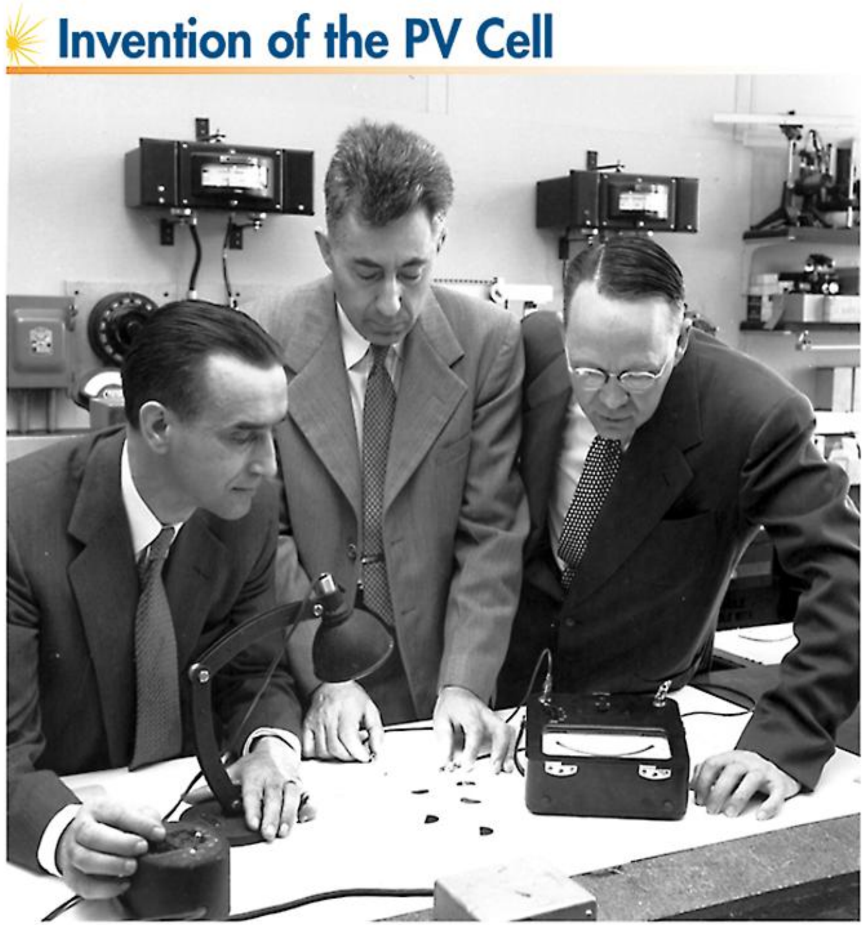
- NABCEP Exam Practice #3

NABCEP Learning Objectives

Category	Course Time By %	Exam Items	Level of Testing
1. PV Markets & Applications	5%	3	Comprehension
2. Safety Basics	5%	3	Comprehension Application
3. Electricity Basics	10%	6	Comprehension Problem Solving
4. Solar Energy Fundamentals	10%	6	Comprehension Application Problem Solving
5. PV Module Fundamentals	10%	6	Comprehension Application Problem Solving
6. System Components	15%	9	Comprehension Application Problem Solving
7. PV System Sizing Principles	10%	6	Application Problem Solving Design
8. PV System Electrical Design	15%	9	Application Problem Solving Design
9. PV System Mechanical Design	10%	6	Application Problem Solving Design
10. Performance Analysis, Maintenance and Troubleshooting	10%	6	Analysis Problem Solving
Totals	100%	60	

1.	**PV Markets and Applications** *Suggested Percentage Time Allotment: 5% or less*	**Learning Priority**
1.1	Identify key contributions to the development of PV technology.	Useful
1.2	Identify common types of PV system applications for both stand-alone and utility interactive systems with and without energy storage.	Important
1.3	Associate key features and benefits of specific types of PV systems, including residential, commercial, BIPV, concentrating PV, and utility-scale.	Useful
1.4	List the advantages and disadvantages of PV systems compared to alternative electricity generation sources.	Useful
1.5	Describe the features and benefits of PV systems that operate independently of the electric utility grid.	Useful
1.6	Describe the features and benefits of PV systems that are interconnected to and operate in parallel with the electric utility grid.	Useful
1.7	Describe the roles of various segments of the PV industry and how they interact with one other.	Useful
1.8	Understand market indicators, value propositions, and opportunities for both grid-tied and stand-alone PV system applications.	Useful
1.9	Discuss the importance of conservation and energy efficiency as they relate to PV system applications.	Useful

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

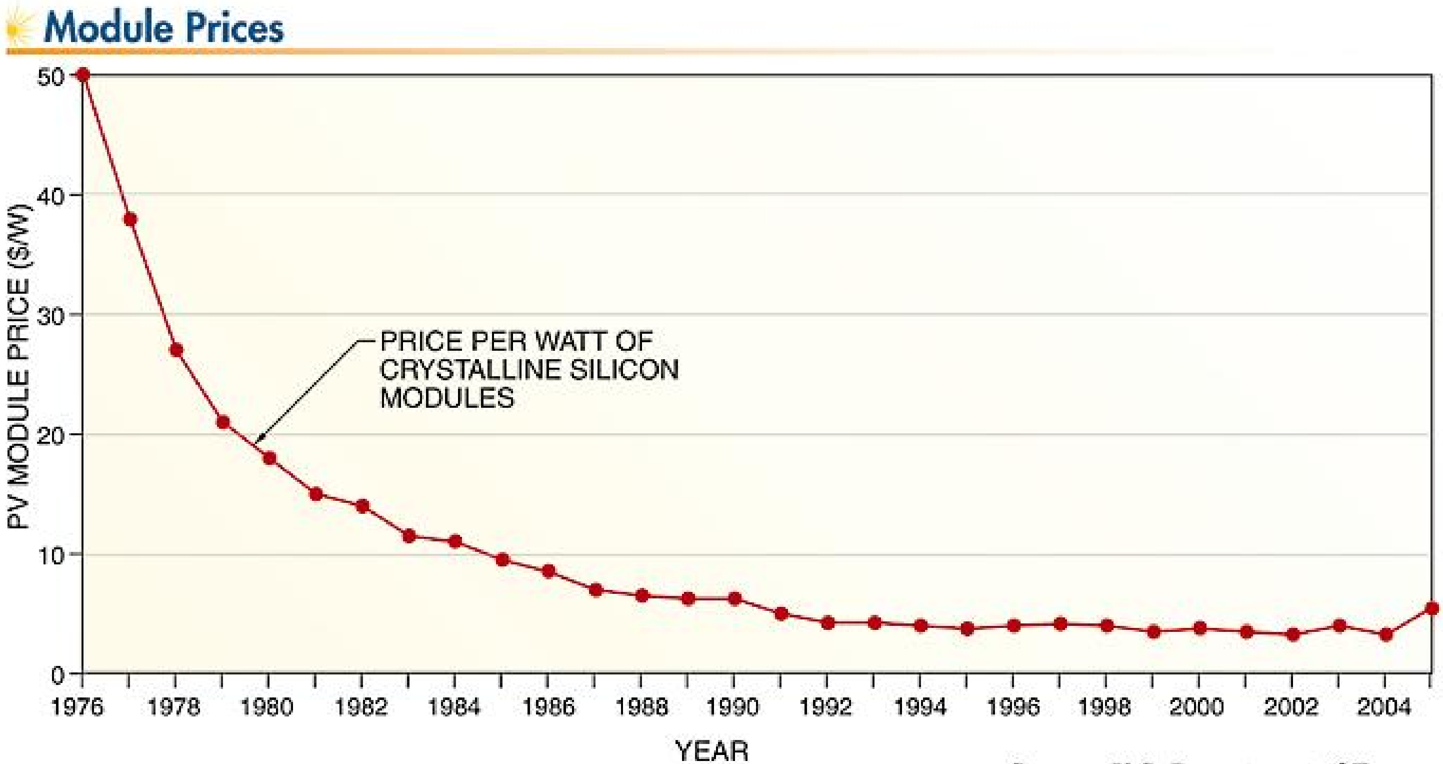


Lucent Technologies Inc./Bell Labs

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

Early PV Applications

Lucent Technologies Inc./Bell Labs



Source: U.S. Department of Energy

- Decades of development and manufacturing improvements have decreased the price per watt for PV systems.

Space PV Applications

DOE/NREL, NASA/Smithsonian Institution/ Lockheed Corp.

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

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

Remote Applications

DOE/NREL, Dave Parsons

OFF-GRID RESIDENCES

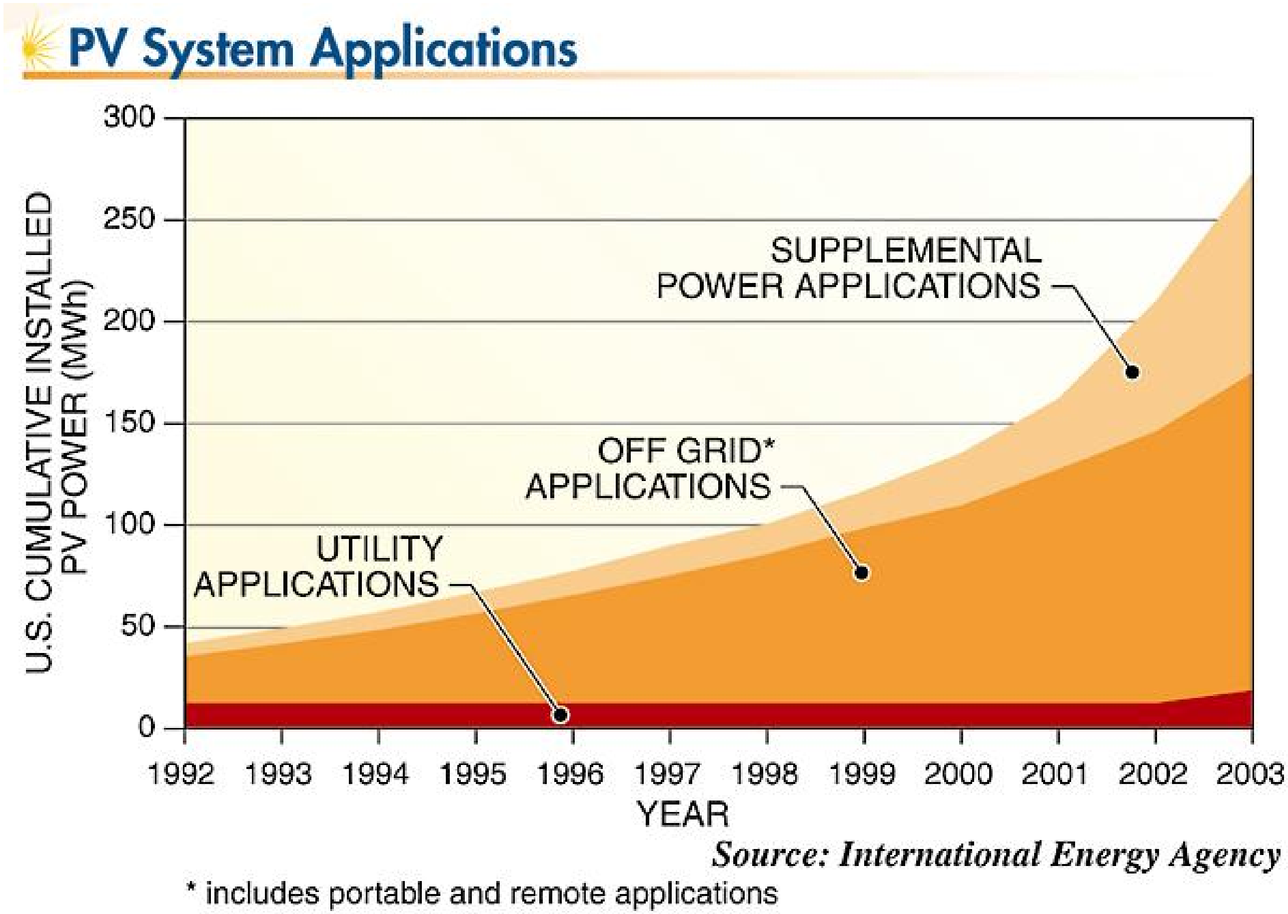
DOE/NREL, Minnesota Department of Commerce

REMOTE MONITORING

DOE/NREL, Jerry Anderson, Northwest Rural Public Power District

WATER PUMPING

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



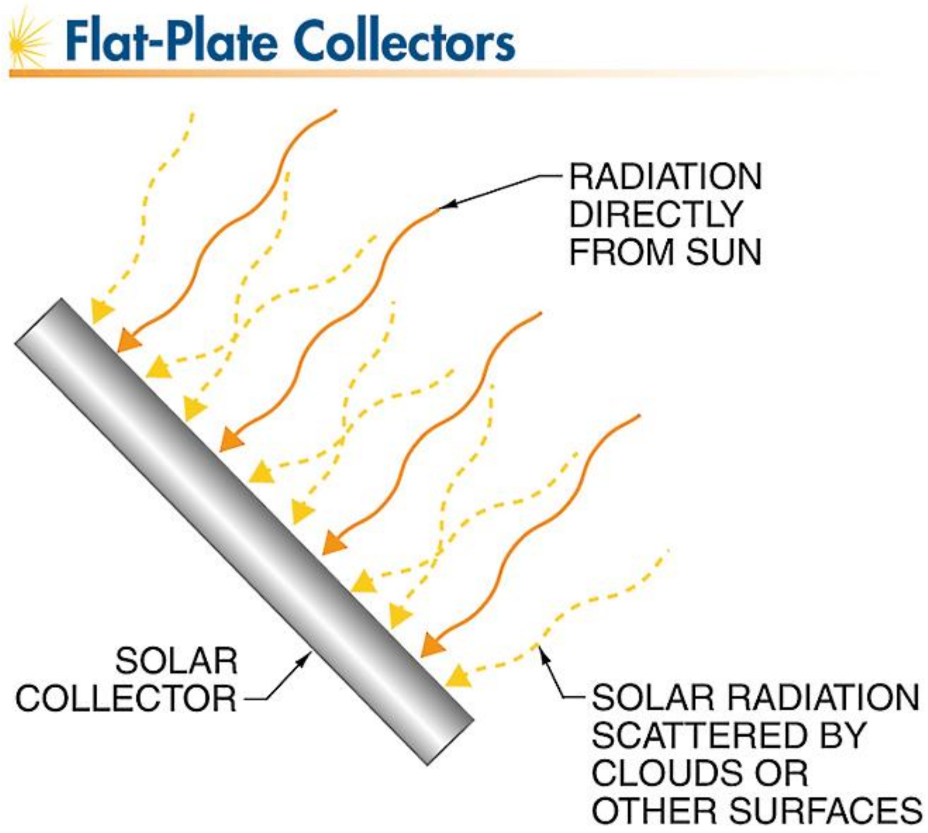
- Supplemental power systems, most often for single-family homes, are the fastest-growing type of PV system installation.

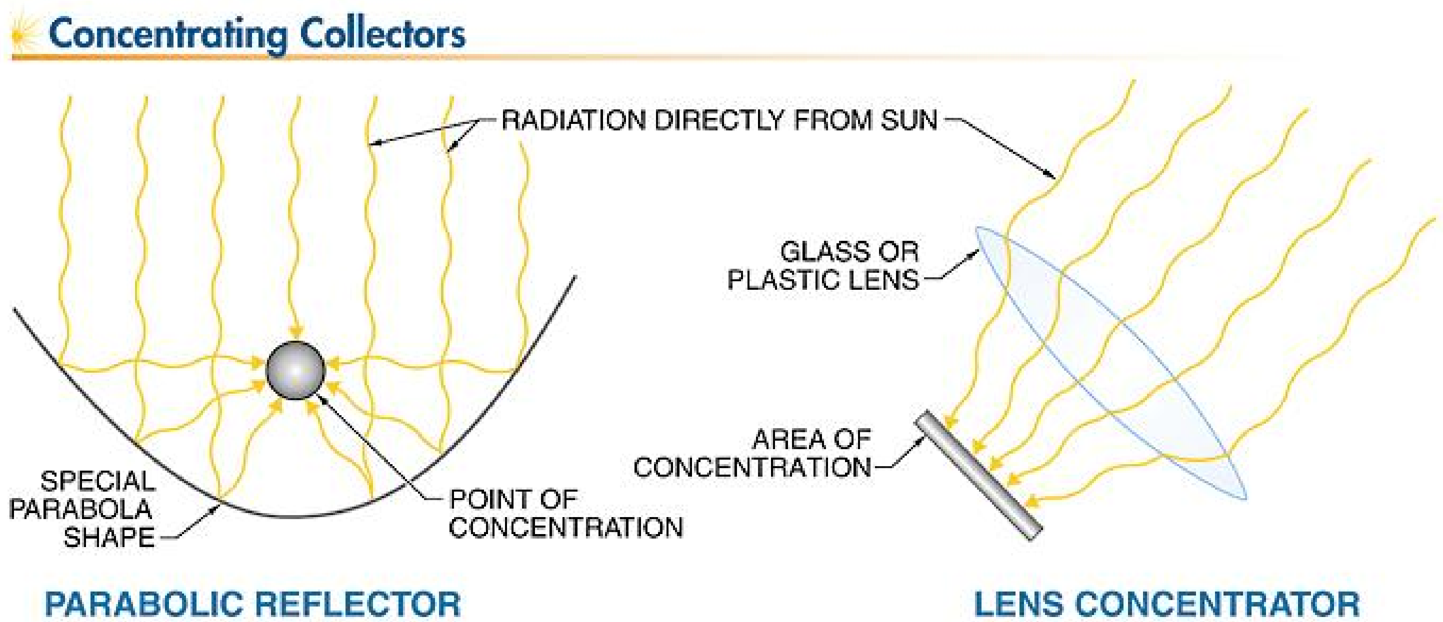
Utility-Scale Applications

DOE/NREL, Warren Gretz

- PV technology can be used for large-scale power production, but this application is not yet common.

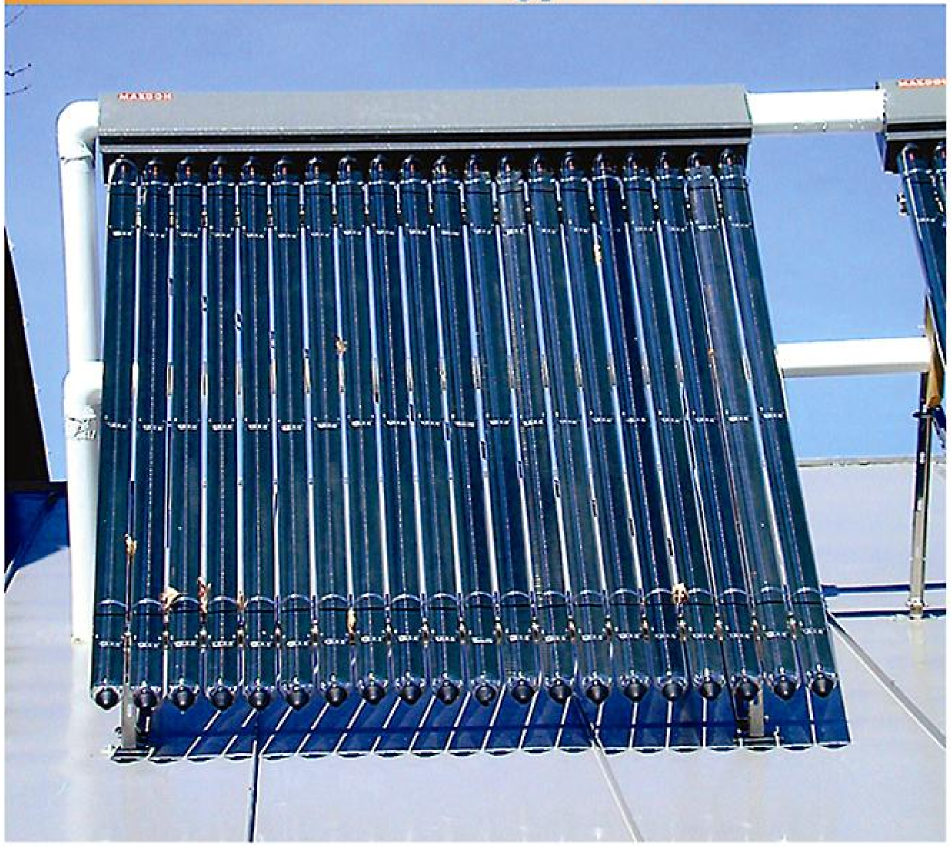
- A flat-plate collector can utilize any solar radiation, direct or reflected, that strikes its surface.





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

Solar Thermal Energy Collectors



DOE/NREL, Alan Ford

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

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

Concentrating Solar Power

DOE/NREL, Dave Parsons

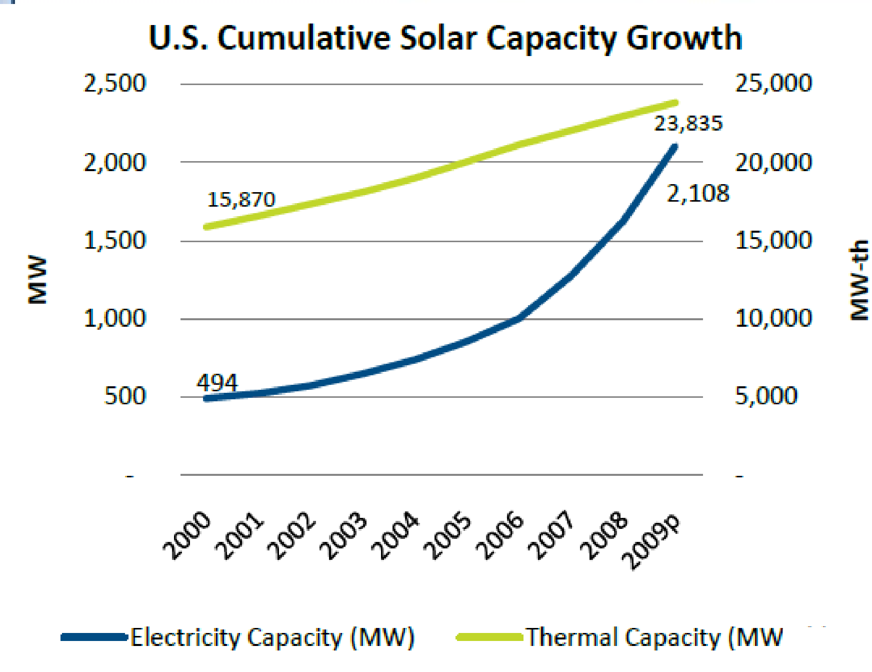
TROUGH COLLECTOR

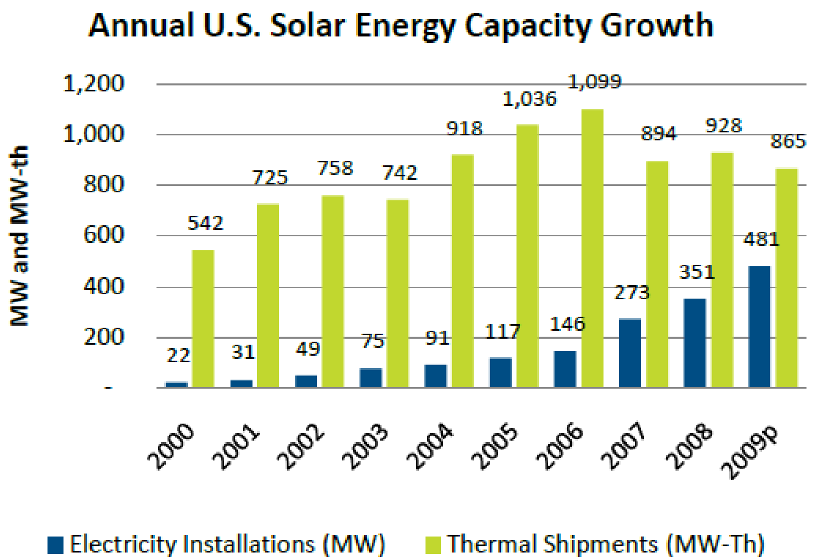
DOE/NREL, Warren Gretz

DISH COLLECTOR

DOE/NREL, Sandia National Laboratories

POWER TOWER


U.S. Cumulative Solar Capacity Growth
MW
MW-th
2,500
2,000
1,500
1,000
500
-
25,000
20,000
15,000
10,000
5,000
-
15,870
23,835
2,108
494
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009p
Electricity Capacity (MW)
Thermal Capacity (MW


Annual U.S. Solar Energy Capacity Growth
MW and MW-th
1,200
1,000
800
600
400
200
-
542
725
758
742
918
1,036
1,099
894
928
865
22
31
49
75
91
117
146
273
351
481
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009p
Electricity Installations (MW)
Thermal Shipments (MW-Th)

Utility-Scale Solar Projects in the United States
Operational, Under Construction, and Under Development
Updated February 8, 2011

Utility-Scale Projects in Operation (Page 2)

Concentrating Solar Power Total (MW)	508
Photovoltaics Total (MW)	277
Total Projects in Operation (MW)	785

Utility-Scale Projects Under Construction (Page 3)

Concentrating Solar Power Total (MW)	399
Photovoltaics Total (MW)	259
Total Under Construction (MW)	658

Utility-Scale Projects Under Development (Pages 4 - 6)

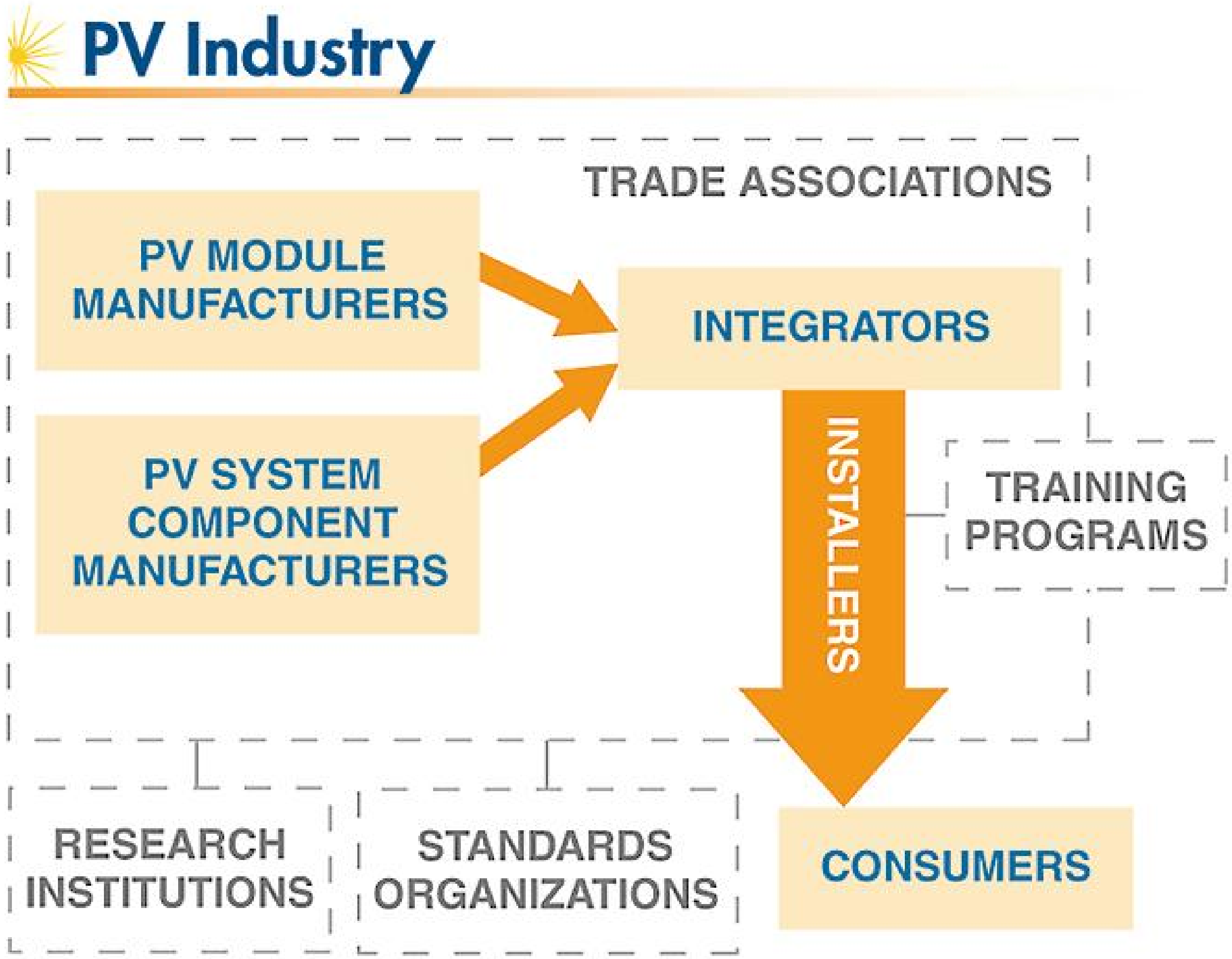
Concentrating Solar Power Total (MW)	9,146
Photovoltaics Total (MW)	15,689
Total Under Development (MW)	24,835

Utility-Scale Projects in Operation, Under Construction, and Under Development

Concentrating Solar Power Total (MW)	10,053
Photovoltaics Total (MW)	16,225
Total Projects in Operation, Under Construction, and Under Development (MW)	26,278

Developer	Project Name	Electricity Purchaser	Location	Technology	Land Type	Online Date	Capacity (MW)
Concentrating Solar Power (including Concentrating Photovoltaic)							
Abengoa Solar	Cameo Coal-Fired Hybrid Demonstration Project	Xcel Energy	Grand Junction, Colo.	Trough[1]	Private	2010	1
Acciona	Nevada Solar One	NV Energy	Boulder City, Nev.	Trough	Private	2007	64
Ausra	Kimberlina	California's wholesale market	Bakersfield, Calif.	Linear Fresnel	Private	2009	5
eSolar	Sierra SunTower	Southern California Edison	Antelope Valley, Calif.	Tower	Private	2009	5
Florida Power & Light Co.	Martin Next Generation Solar Energy Center	Florida Power & Light Co.	Martin County, Fla.	Trough[1]	Private	2010	75
Luz	Solar Energy Generating Systems (SEGS) I	Southern California Edison	Daggett, Calif.	Trough	Private	1985	14
Luz	Solar Energy Generating Systems (SEGS) II	Southern California Edison	Daggett, Calif.	Trough	Private	1986	30
Luz	Solar Energy Generating Systems (SEGS) III	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1987	30
Luz	Solar Energy Generating Systems (SEGS) IV	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1987	30
Luz	Solar Energy Generating Systems (SEGS) V	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1988	30
Luz	Solar Energy Generating Systems (SEGS) VI	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1989	30
Luz	Solar Energy Generating Systems (SEGS) VII	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1989	30
Luz	Solar Energy Generating Systems (SEGS) VIII	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1990	80
Luz	Solar Energy Generating Systems (SEGS) IX	Southern California Edison	Kramer Junction, Calif.	Trough	Private	1991	80
Solargenix	Saguaro Solar Power Plant	Arizona Public Service	Red Rock, Ariz.	Trough	Private	2005	1
Sopogy	Holaniku at Keahole Point	HELCO	Kona, Hawaii	Trough	Private	2009	2
Tessera Solar	Maricopa Solar Power Plant	Salt River Project	Phoenix, Ariz.	Dish-engine	Private	2010	2
				Concentrating Solar Power Total (MW)			508

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



- What do we mean by PV financial analysis?
- Why do we care?
- How do we measure?

- Important terms
  - PNL NOPAT
  - GM% OPEx
  - ROI PAYBACK
  - Lifecycle Cost Analysis IRR
  - Time Value of Money Discount rate
  - NPV

PNL NOPAT = Profit & Loss, Net Operating Profit After Tax

GM% = Gross Margin Percentage

OPEx = Operating Expenses

ROI = Return on Investment

PAYBACK = Payback period required for avoided costs of alternate energy system to match the cost of chosen system

Lifecycle Cost Analysis = Total cost of all expenses incurred over the life of a system

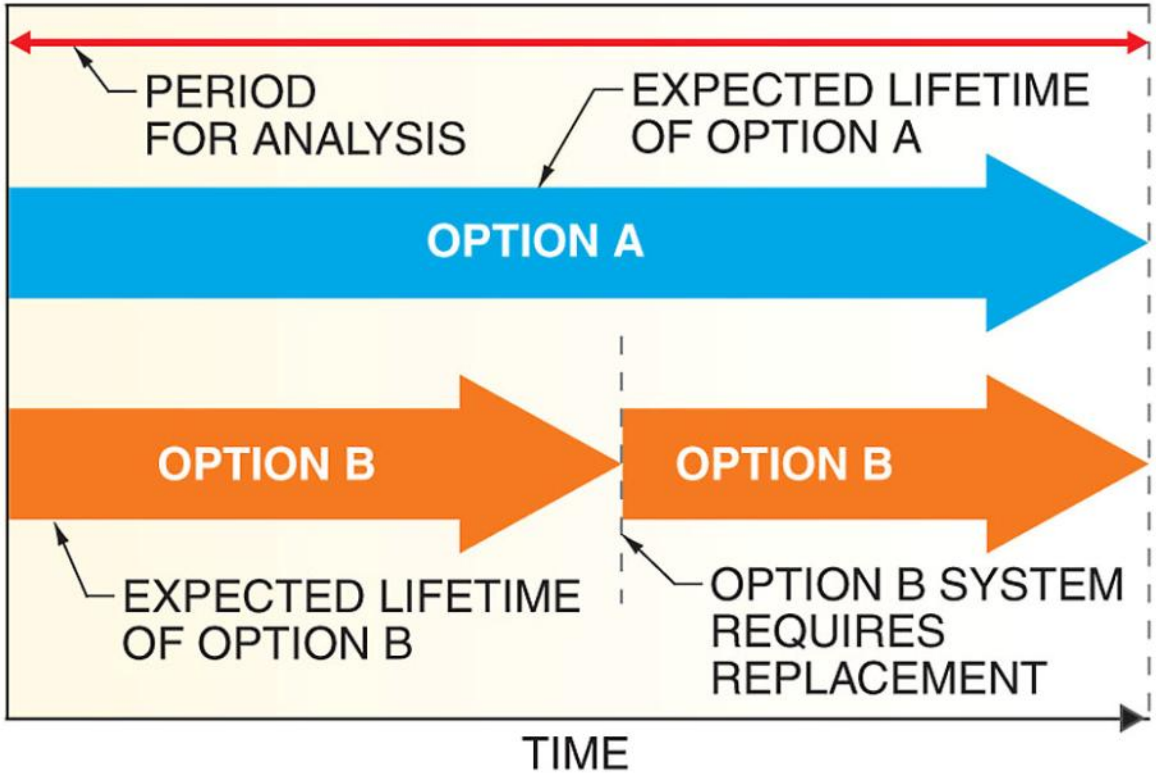
IRR = Internal Rate of Return

Time Value of Money = Value of money figuring in a given amount of
interest earned over a given amount of time

Discount rate = Rate at which future value of money is reduced to its present value

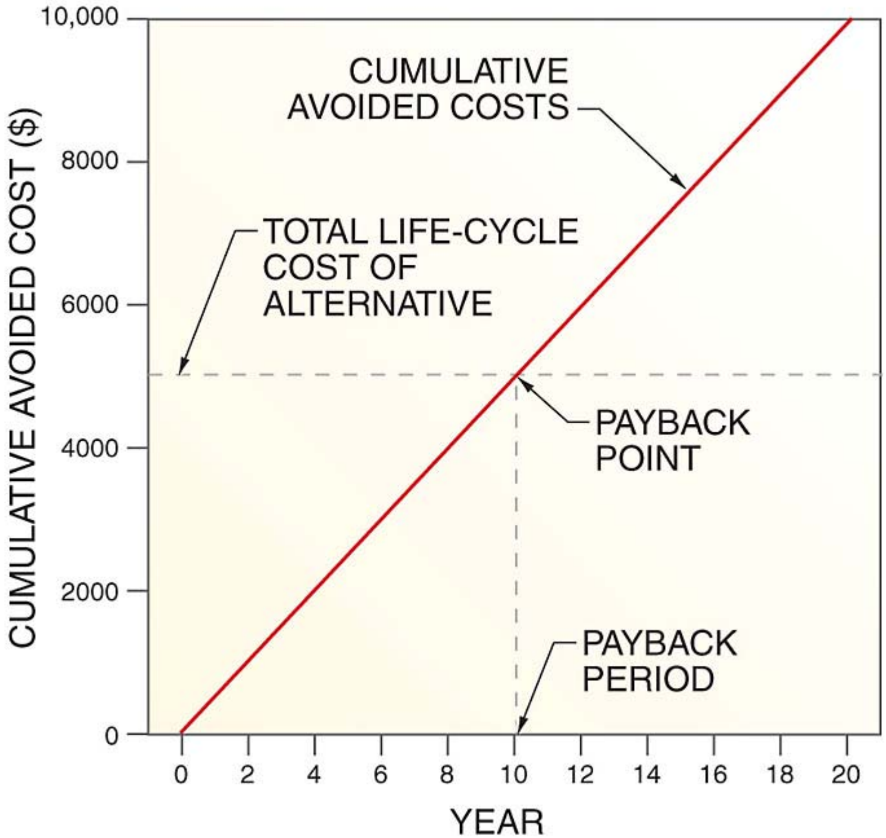
NPV = Net Present Value

Analysis Time Period



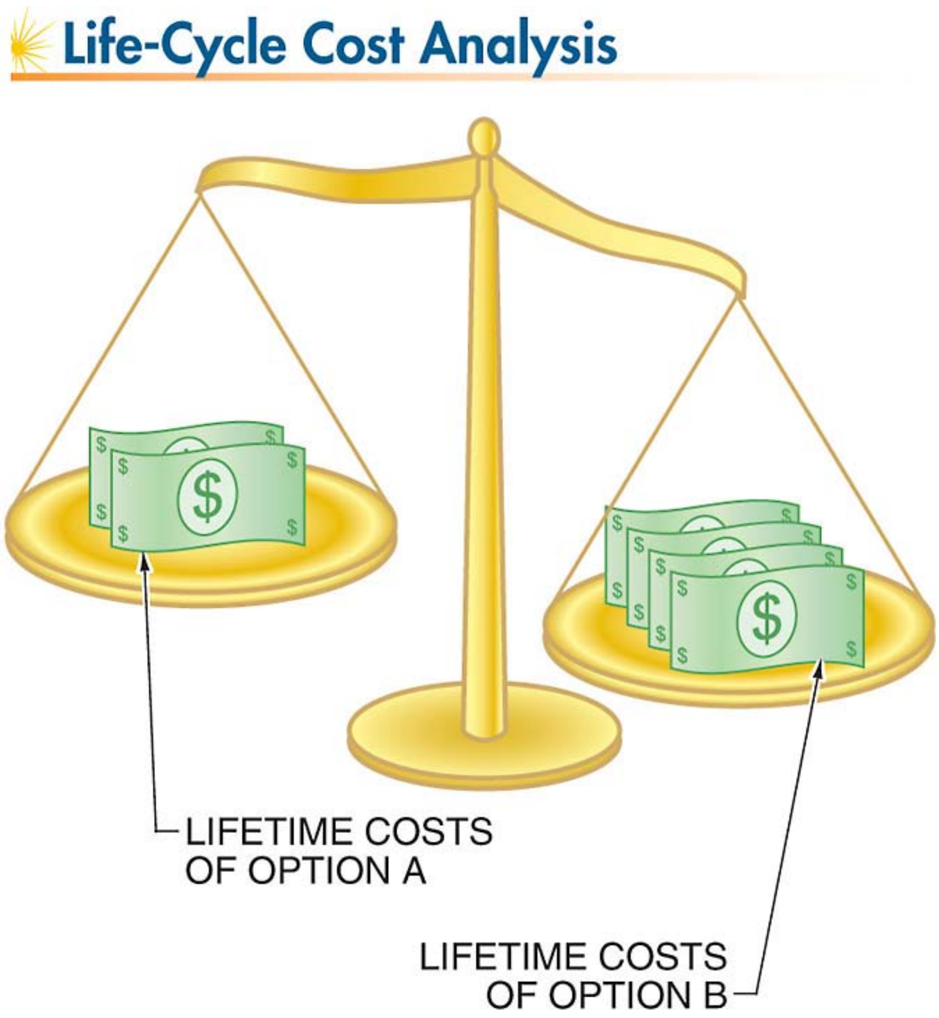
- Each system option must meet the same requirements, including the length of time used to calculate life-cycle cost.

Payback Point

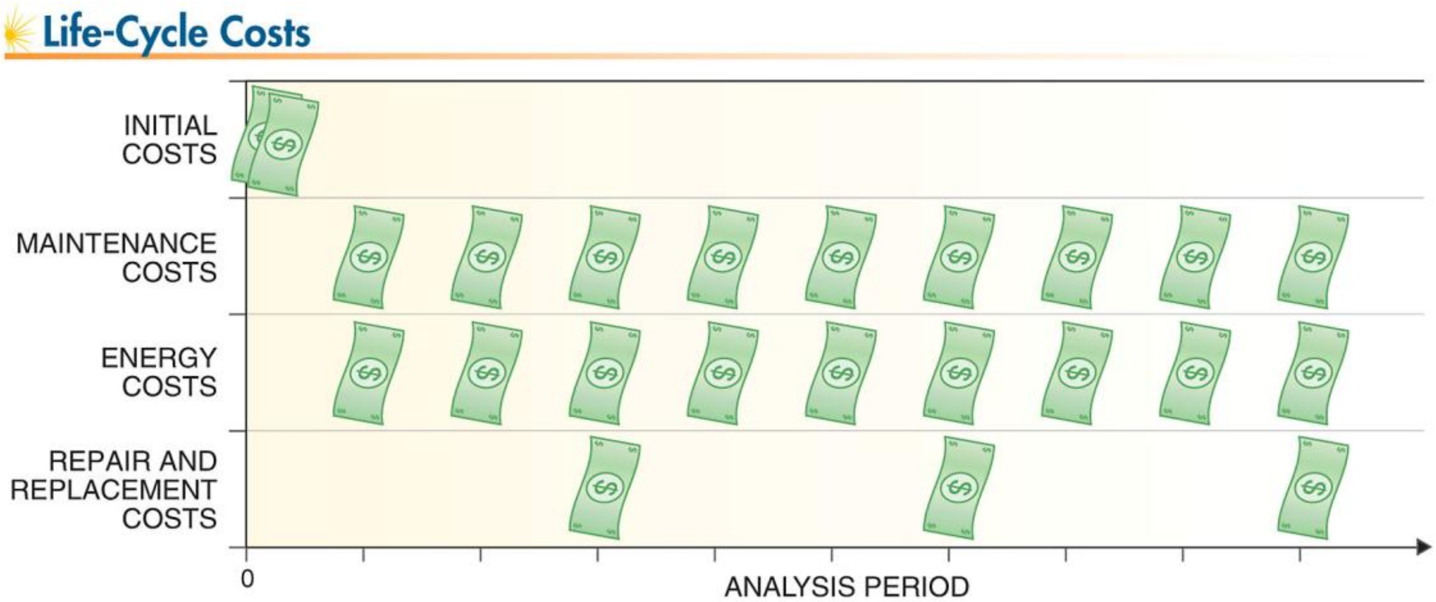


- The payback point occurs when the cumulative avoided cost of one system matches the total life-cycle cost of another system.

- A life-cycle cost analysis compares the life-cycle costs of various electricity-supply options.

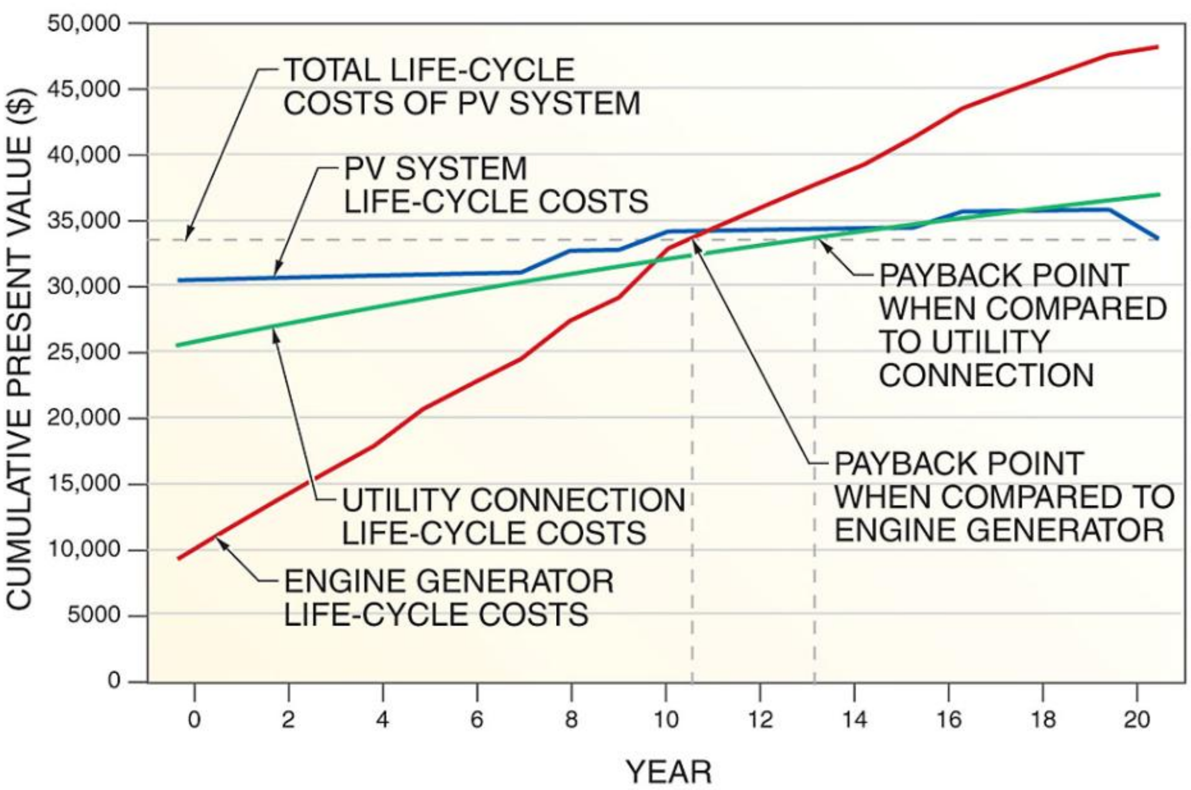


- The various types of life-cycle costs occur at different points in the life cycle of a system.

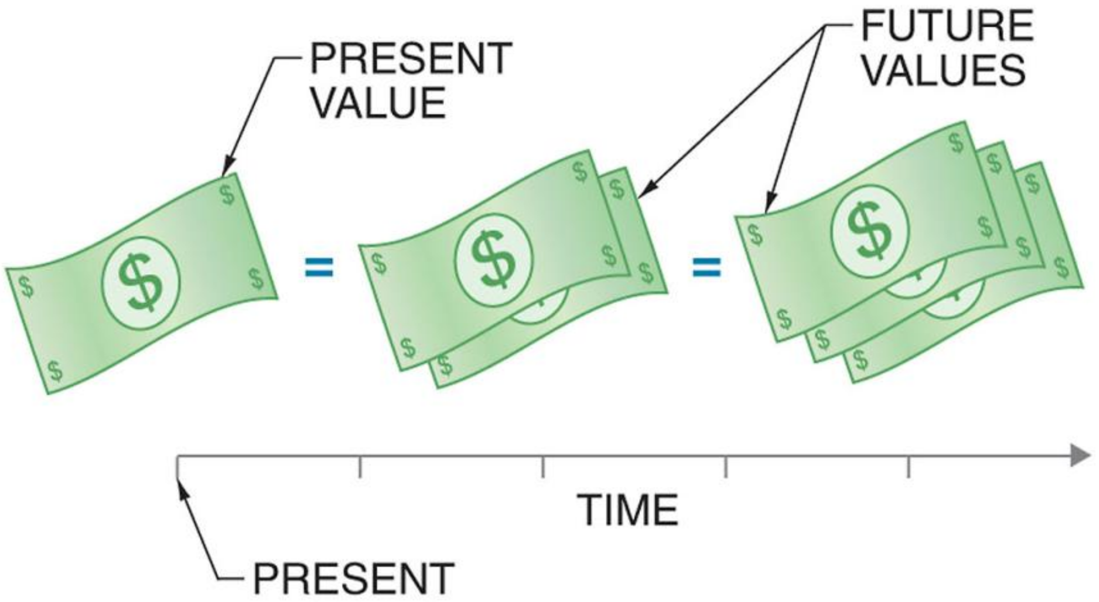


- The payback point can be determined by comparing the actual life-cycle costs of the various system options.

Actual-Cost Payback Analysis



Value of Money



- A certain amount of present money is equal to a greater face-value amount of future money. The difference in face value depends on the difference in time.

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- Manage CEC-approved equipment into each solar estimate
- Customize proposals to print or email
- Utilize one central location to manage customers from lead to installation

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* State/Province: Choose one...
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* Phone:
* Organization:

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