SOLAR OPPORTUNITIES

Roof mounted solar panels on Bldg L,
Verde Valley Campus

There is a growing national commitment to the utilization of sustainable energy sources. Solar, wind, and bio-mass systems are increasingly available. Arizona has one of the highest quantities of solar radiation in the United States. Yavapai College has solar installations on the Verde Valley and Chino Valley campuses. The main building on the Chino campus is LEED silver certified, has rainwater catchment tanks and a ground-loop thermal system.

Overview:
The average retail cost per kWh for the state of Arizona in 2007 was $.089.
(EIA Electric Power Monthly).

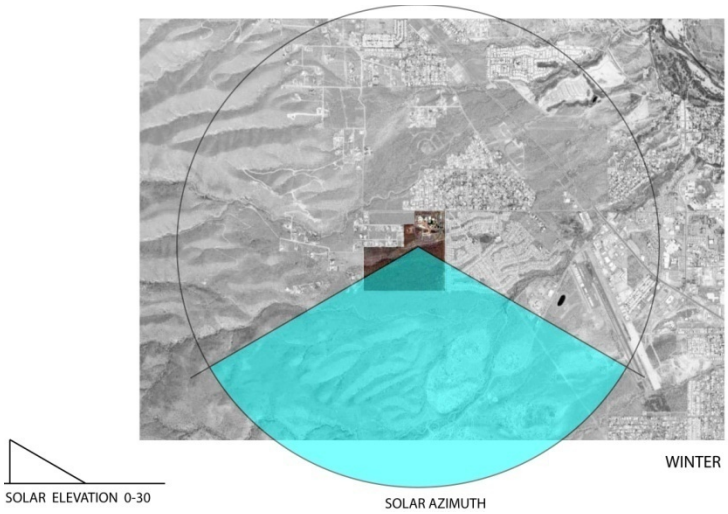
1. One developed Acre can produce approx 100 KW of **peak** solar power.

2. Cost/Developed Acre
   - A fixed photo-voltaic field and support infrastructure $1,000,000
   - A dual-axis tracking system and support infrastructure $1,200,000
     (It tracks the sun and increases the efficiency)

3. Panels must be arranged to minimize shading. .

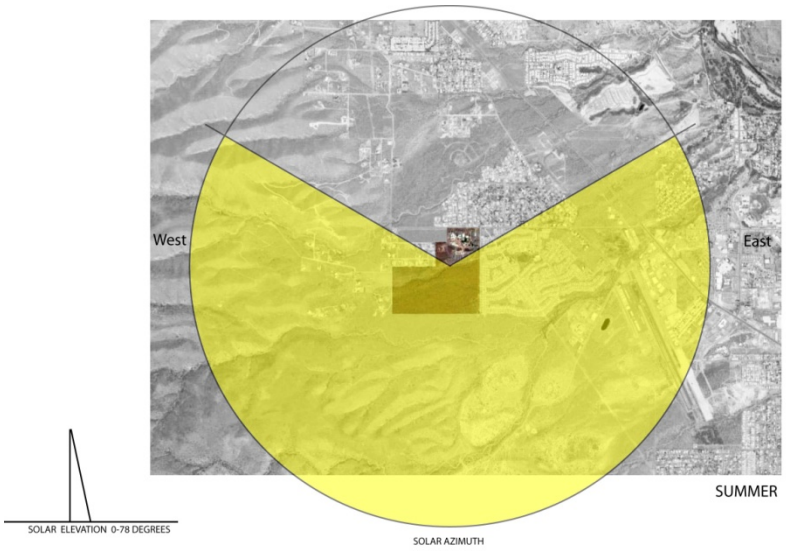
4. A 300 KW fixed photovoltaic system on 3 acres of campus land would cost approximately $3,000,000 . It would generate approximately 486,000 kWh/Year. The distance of installation sites from existing infrastructure impacts costs.

SUNLIGHT



With 300 days of the year in sunshine it is important to design for the sun. In winter the sun is low on the horizon and overall daylight is limited to 8 hours.

In spring and fall we have 12 hours of sunshine. The sun at solar noon is 56 degrees above the horizon. Unlike much of the rest of the country we don't want the sun to penetrate our building envelopes.



By June 21st we are experiencing 14 hours of sunshine with early morning and late evening sun at the horizon line entering windows on the north side of the building.

LOCATION AFFECTS SOLAR COLLECTION

Physical location of the campus on the globe (GPS/satellite) changes the positioning of the panel collection angle with the sun and the horizon.

Station Identification	
City:	Prescott
State:	Arizona
Latitude:	34.65° N
Longitude:	112.43° W
Elevation:	1531 m

(PV Watts:http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/Arizona/)

The following chart illustrates the available average # of collection hours/month:

Month	**Solar Radiation (kWh/m^2/day)**
Jan 1	5.28
Feb 2	5.71
Mar 3	6.15
Apr 4	6.78
May 5	7.06
June 6	7.07
July 7	6.33
Aug 8	6.51
Sept 9	6.59
Oct 10	6.52
Nov 11	5.58
Dec 12	4.99
Year	6.22

- The Prescott Station averages 6.22 kWh/m2/day in solar radiation
- May and June are the highest months @ 7.06 and December is the lowest @ 4.99

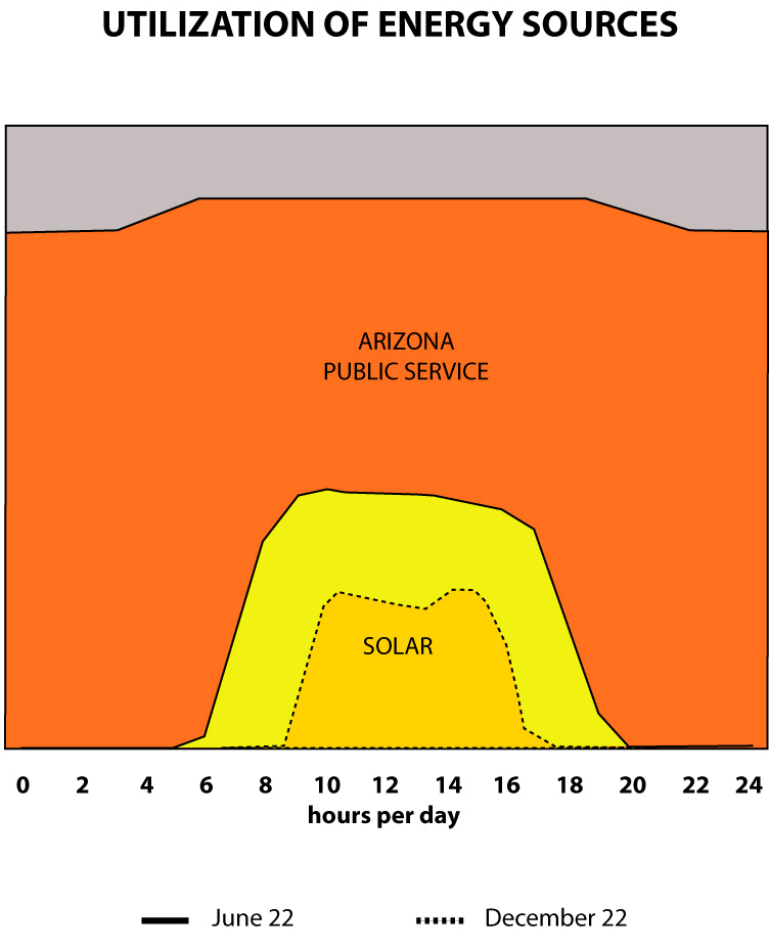
(PV Watts:http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/Arizona/)

SOLAR COLLECTION HOURS PER DAY

Solar systems do not generate electricity all day long. They are only efficiently gathering sunlight for 6-7 hours/day. The sun is not strong in the first hours of morning or the mid-late afternoon. Hours 10 – 2 provide the most efficient collection opportunities. Mid-day, 12:00 noon, is the peak.

The ability of a solar system to produce power is affected by

- hours of sunlight
- time of year,
- climate (number of non-producing cloudy days)



This chart illustrates the of electrical demand during a 24-hr cycle. Solar collection provides approximately 1/3 of total kWh (kilowatt hours). The balance is provided by APS through a tie to the APS electrical grid. Winter collection hours are diminished and represented within the dotted center area.

MAXIMIZING COLLECTION

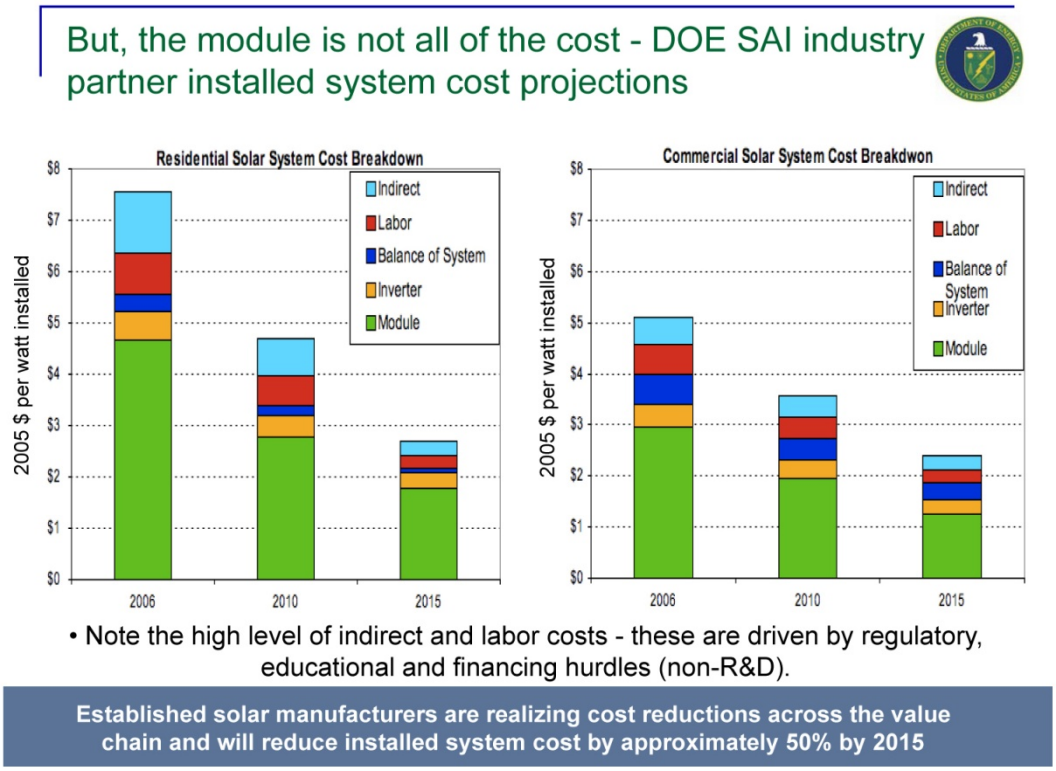
A solar photo-voltaic (PV) system, without storage capability, effectively provides approximately 27% of the campus electrical needs. The balance comes from power provided by the public utility. Maximum collection occurs during peak daylight hours. No solar energy is available during evening hours (4 p.m. – 8 a.m. annual average). The cost of storage including maintenance and disposal is prohibitive.

Solar collection systems are not 'free'. The cost of infrastructure plus debt service must be incorporated into the total life cycle cost. It is important to keep in mind that the College operates 7 days/week from 6 a.m. – 10:30 p.m. (NOTE: With the implementation of the central plant and control systems, during the night hours between 10:30 p.m . and 7 a.m., systems can be put in unoccupied mode to save energy.)

Grid-tied systems only pay back energy at wholesale rates. The user is buying from APS at retail but is reimbursed at wholesale. Systems designed to generate more than peak demand are not cost effective.

INSTALLATION AND MAINTENANCE COSTS

The solar field installation consists of multiple cost components including the design, project management, electrical, civil & structural engineering modules (panels), inverter, shed, fence, labor, indirect costs, and the balance of system (site preparation, grading, ditch, electrical line, bi-directional meters at the buildings, and changes in electrical panels. As market demand for solar increases, the cost of materials and installation will decrease. As the market becomes more saturated, the amount of available incentives will decrease. Timing becomes an important consideration.



Federal and State agencies are beginning to mandate utilization of renewable energy sources. Currently, there are a variety of incentives available.

APS offers incentives based on equipment efficiencies but they are limited. With the economic downturn, funds are shrinking. APS has limited financial resources to replace aging infrastructure and develop renewable energy stations.

3RD PARTY POWER PURCHASE AGREEMENTS

The largest savings are available in the form of tax credits. Community colleges cannot access these tax credits directly. For this reason, many institutions of higher education are exploring third-party providers that finance, install, maintain, and operate the field over a period of time (typically 20 years). These contracts are called power purchase agreements (PPA). The PPA stipulates a fixed rate with a negotiated annual escalation factor. Initially, the cost/kWh of a PPA is higher than the public utility rate with the prediction that over the 20 year period, utility rates will continue to rise and far surpass the PPA rate including the annual escalation factor.

FUNDING OPTIONS

The College has been carefully watching the evolution of the solar industry and has evaluated a variety of alternatives including third party purchase agreements, owner funded installation, and the purchase of green power from APS.

The following illustration compares 3 strategies for financing solar infrastructure & collection fields. The 3 approaches are cash, debt/loan, and an operating lease (power purchase agreement).

Ownership Financing Comparison Chart			
	Cash	Debt/Loan	Operating lease
Initial payment	Highest	Low, regular	Medium, regular
Tax consequences (for system owner with tax liability)	None	Write off interest payment, apply ownership depreciation	Write off entire payment, no depreciation
Use of incentives to lower system cost	100% to you	100% to you	100% to system lessor (not you)
Cost of electricity from solar electricity system	Depends on system cost and opportunity cost of cash used, and overall system kWh production Only really known at the end of system life	Same	Same
Monthly payments	None	Known with a fixed rate loan	• Negotiated in lease- static monthly payment • Known pre-payment option or penalties
Balloon payments	None	Negotiable	Negotiable
Final purchase payment	None	• Possible ability to pre-pay • Final debt payment per schedule	• Usually no ability to pre-pay • Option to buy or return the system • Price defined as "fair market value" by Internal Revenue Service No such thing as "buy it for a dollar"
Capital appreciation	• 100% value goes to owner • Value is captured on building sale	• 100% value goes to owner • Value is captured on building sale	None until system is purchased at end of lease Likely negated by higher overall financing cost
System maintenance and inverter replacement	100% system owner (may contract out)	100% system owner (may contract out)	System owner will contract out and include cost in monthly lease payment
Clean power attributes (SRECs)	100% system owner	100% system owner	Negotiable but usually owned by the system owner The customer does not own the "green" value of the kWh until the system is purchased

The Customer's Guide to Solar Power Purchase Agreements; The Rahus Institute October 2008

APS GREEN OPTIONS

A fourth alternative is the purchase of green power from APS. The benefit of this approach is the cost of construction, operation and maintenance is shared over a large customer base. Arizona Public Service provides two choices: a mix of renewables including solar, wind, and bio-mass or pure solar. The cost of the renewable mix is $.01/kWh above the existing rate.

This is the least expensive way to support renewable energy. It does not tie up land. It does not commit the College to a 20 year payment plan with today's technology and higher cost in a rapidly changing market where technology is evolving, efficiencies are increasing, and costs are dropping. Timing is everything. It does allow the College to support the demand for renewable sources and bide our time as solar technology, installation, operation, and maintenance becomes more cost effective.

CONSERVATION

The greatest savings can be obtained by conservation, utilization of control systems, efficient equipment, occupancy sensors, efficient lighting, and building scheduling. We already have the tools we need to create a culture of conservation college-wide. It is a matter of leadership and commitment.

RECOMMENDATIONS

Buy green power from APS to support renewable energy development
Pursue incentives & federal funding opportunities
Continue to monitor solar market and financing capacity
Phase development in 100 kW arrays