

A Solar Program for New School Construction – Avenue to Cost Effectiveness

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Abstract

This paper proposes a solar energy program that incorporates public and private funding to provide a cost effective solar option for local school jurisdictions planning new construction. The proposed program suggests that jurisdictions could create a requirement that each new school meet a certain percentage of the building's energy needs through on-site renewable energy. As designed, the program would create both an initial reliable market for solar energy systems and a seamless avenue to a large market in new school construction when the cost of solar meets a simple life cycle cost-effectiveness test.

Discussion

Schools have long been one of the foci of nationwide solar programs because they are both a center of the local community and a platform to educate future energy consumers. It is fitting that schools be utilized as a conduit to help develop an early reliable market for solar energy systems and provide students with an education about the technology.

New school construction is increasing nationwide. It is estimated that 2400 new schools will be needed by 2003, growing to 6000 by 2007. While these schools are built to provide educational service for 40 years or more, insufficient effort is spent on improving the energy consumption profile of the buildings. Traditional building designs, prompted by procurement systems that award contracts to architects and designers based on low bid, dominate new school construction. What is needed is life cycle cost basis designs that calculate the energy consumption and operational costs as a present value of the cost of construction. Instead of buildings that are built for the lowest initial cost (without regard to the annual energy operational costs), bids for building designs should be awarded on the basis of initial cost plus lifetime energy costs. This type of award will encourage greater expenditures at the time of construction that pay back the initial higher cost through lower annual energy costs.

This concept could and should be incorporated into the award of the architect and design services. Architect and design firms would win new school design bids not simply on the lowest cost for their service (which means the firms pull an old design off their shelf), but based on the lowest life cycle cost design. Firms could spend greater time (and money) in designing a better school building, provided their advanced design more than paid back the extra effort (and cost) through annual energy savings. Inserting the life cycle and performance based design concept into the first step of building a new school, will be the most important method to truly implement lowest life cycle cost school construction.

Assuming this concept is adopted, what is the role solar energy can play? Even after life cycle costing methods are employed, solar, in many cases, will not meet the cost effectiveness test. In most areas of the country, there will remain a cost of solar above its value of annual energy output and

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savings. This root cost issue of solar energy cannot be resolved directly through life cycle cost based designs. Solar will likely require additional funding to make it cost effective in this formula.

However, we know that the price of solar energy systems, particularly photovoltaics (PV) declines with increased module production and deployment. Provided usage and sales of PV continue to grow, costs will continue to decline. It then becomes predictable that at some future point, PV will be cost effective on a life cycle basis. In anticipation of that day, it is appropriate to put in place a program that promotes the usage of PV on schools, but uses the fundamentals of life cycle cost valuation. Not only will such a program anticipate a future day when PV is cost effective, but it can help usher the arrival of that day.

The program can be designed and implemented today by providing a target percentage of building energy consumption that will be met with on site solar. The target could be thermal or photovoltaic or a combination of both. For purposes of this paper, the target focus will be electrical energy from PV that will offset purchases of grid or utility energy.

In the early years of this conceptual program, the cost of solar will be high and the PV system's lifetime energy output will only partially repay the initial capital cost of the system. In later years the cost effectiveness "gap" will be reduced and eventually eliminated. If, however, we are to implement a program today and desire to dovetail PV into a cost effective formula, there becomes a need for funding to reduce system cost to pass the life cycle cost test. This funding element becomes a critical component of the schools solar program.

Such a program, with funding, would allow many new schools to install solar systems. From the perspective of the local school jurisdiction, this program makes solar appear cost effective on a life cycle cost basis. Because funding is coming from a source other than the local jurisdiction (as discussed below), the school system pays only the cost effective portion of the cost of the system. This should leave the local school jurisdiction with a simple choice: either buy electricity from the local utility monthly, or get it from a roof mounted solar system at the same price. The school system would be presented today with the futuristic hope of many – a cost effective solar option.

Program funding for the non-cost effective component could come from a combination of state and private funds. State funds (or earmarked system benefit funds) used for such a solar program would be both highly leveraged and highly visible. If the states included a private cost share opportunity or requirement for the use of any state funds, the net result could be to leverage up to four dollars for every dollar of state funding. This is based on a rough assumption that, in many areas of the country, a PV system today is about twice as expensive as the grid electricity available to a school. This means half of the system cost would be cost effective and incorporated into the school construction budget, but half would need to be funded by the proposed state and private partnership. If the state was matching private funds on a 1:1 basis, every dollar the state provided would buy four dollars of installed PV.

Requiring each new school to meet a percentage of their energy consumption with on-site solar would necessitate school architects and designers consider these systems when designing the construction project. The steps a school designer would undertake would include orienting the school for a solar energy system; identifying the cost of a system to meet a targeted percentage (e.g. 5 to 20 percent) of the school's energy needs; and finally determining the lifetime value of the energy from

those solar systems. This value would be compared to the cost of buying the same lifetime amount of energy from the grid or utility. If the cost of solar was less, the school would install the system, but would save money over buying a lifetime of grid electricity. More likely, the cost of the system will be greater than the energy output. In this case, the school would apply for a grant from the state-private partnership fund to reduce their cost to the point of cost effectiveness. If the school received the grant, again the school would install the system as part of the new construction. If grant funds were not available, the school would not be required to install any solar energy. In all cases under this program, the effective cost to the school is either zero or the school sees a savings.

Green pricing programs would be the best source for a private funding match. It is by this time fairly well established that consumers are willing to pay a premium for renewable energy. While many consumers can now express this willingness through purchase of green power from a competitive supplier, there are many that still do not have that choice, either because their state has not yet initiated competition or the suppliers in their area do not have a green offering. A school based solar program could offer these consumers the opportunity to promote renewable energy and at the same time, do so in a locally beneficial manner. If consumers are willing to pay a premium for renewable energy generation far from their homes, they are more likely to pay a premium if that power helps to offset their local school's energy purchase while providing an educational opportunity for the local children..

While in the early years of a program like this, there will probably be only a small percentage of new schools that will receive grants to install systems, as the cost of solar declines, a greater percentage will be able to do so. Assuming the cost of solar continues to decline, the amount of state and private funding needed to meet the target levels of on site renewable energy production will continue to decline. Eventually, when solar becomes cost effective, all new schools will be installing PV systems without the need for additional funding. The program funding requirements will disappear as the market takes over, thus completing the transition to a cost effective marketplace.

The advantages of this type of program are several fold. Perhaps the biggest advantage is to create a seamless path for future cost effective solar. Ordinarily a product has to have a cost advantage of 50 percent over an established market before consumers (in this case new school designers) will move to the new product. For PV this would mean that its cost effectiveness would not only have to meet the cost of grid electricity, but would need to be half as expensive. For PV this day is far in the future. However, this school's program, by requiring new buildings to meet a certain percentage of their energy needs through on-site renewable energy (an interesting holistic energy concept in itself), will create a transitional market that will fully blossom when PV exactly meets the grid price. It will eliminate the need for PV to be less than grid electricity before it can become established in the electricity market.

Before that day arrives, school architects and designers will have become well versed in the use of solar, its cost, value and operation. This educational barrier, that would otherwise be faced only after PV systems were cost effective, will have been removed years in advance. In addition to providing this training, every school that has undergone a proposed design for solar, even if there is no grant funding to actually help install a system, will be a future platform for a retrofit of a system when they become cost effective. Undoubtedly and unfortunately, many schools are being designed

and built today in a manner that will make the retrofit of a PV system nearly impossible. Lost opportunities for future cost effective PV system installation can be eliminated under this program.

Implementation of this program will provide the solar energy industry with the kind of reliable transition market that it needs to reduce cost. Because the program would remain in place until solar reached cost effectiveness (and could even remain in place after that), the solar industry could count on and estimate an annual market volume for their product. However, the program would prevent industry profit taking in cases of short supply because it incorporates a direct price reduction incentive to the industry. The lower the cost of a system on a life cycle basis, the greater amount of PV to be installed under this program. Conversely, if the cost of PV installations rise, there will simply be fewer schools installing systems.

The market on new schools is substantial. The estimated 6000 new schools needed will create an average market of about 850 new schools each year. If the target PV system size on each new school is 20 kilowatts, based on the need to meet 5 to 20 percent (the higher end is for highly energy efficient schools) of the school's energy needs, the annual market for PV on new schools is over 17 Megawatts. If roughly half of the system's cost at \$8 per watt is cost effective, the cost effective market value is \$68 million (total sales is \$136 million). To make these systems available for schools at the cost effective price, grant funding of \$68 million is needed. If half of this is state or public and half private funding, then the total state component is \$34 million. Since the program is proportional with respect to funding, if total state funding was only 20 percent of this amount or \$6.8 million annually (a small number for the combined efforts of all the 50 states), then the US would see 170 new schools with 20 kilowatt systems on each.

A 20 kilowatt system on a new school would add \$160,000 (0.8 to 2.3 percent) to the total median school construction cost of \$7 to 18 million. By properly designing the school building, the costs to incorporate a PV system should decline with designer's increasing experience. Systems integrated into school construction and design will reduce PV balance of system costs and offset costs for other building materials. Eventually, architects and designers will identify the most cost effective designs for solar energy and become an important ally in promoting PV.

Program implementation issues

The first step to instituting this program is commitment from a state to implement a requirement to use solar on new schools. This must be followed by the creation of a funding source, either by earmarking systems benefits funds, clean air act set asides, or some other state funding mechanisms. If private funding will be used as a match, a state will need an organization that aggregates the various private contributions, both businesses and individual. Many businesses are showing a willingness to participate in the promotion of renewable energy and the combination of a local green pricing effort together with a school program will enhance this willingness.

To make the program truly cost effective for the local jurisdiction undertaking a construction project, financing should be incorporated into the life cycle cost analysis. Instead of simply determining the annual energy output from the system then adding over the life of the system to determine the total value, the annual output will have to cover the financing costs as well. This may not be an idle exercise as many school jurisdictions will be strapped for capital as they undertake new construction and will not have the initial outlay for a solar system. A third party could finance

the system (and energy efficiency improvements) and have the school make annual payments for the energy output, much as they would have done had the school simply purchased utility energy instead. An advantage of the third party financing is that a third party can use the accelerated depreciation and tax credits available to a commercial enterprise. The third party can also guarantee that the monthly financing cost is less than or equal to what the school would have paid for electrical energy which puts the burden on them to maintain optimal output from the system.

These are the three necessary elements to implement the program. By adding some training for school architects and designers, the new school solar program is ready to be deployed.

Sample Program Design for State of Anywhere

The following values assume that a state implemented this program with a design to use PV on every new school constructed in the state.

TABLE 1		At program inception	with 20% reduction in cost of PV	with 40% reduction in cost of PV
School annual energy consumption (kWh)		800,000	800,000	800,000
Annual output from 20 kWp PV system (kWh)		40,000	40,000	40,000
Percentage of school energy from PV		5	5	5
Life cycle cost analysis				
Cost of PV system (\$8/wattp)		\$160,000	\$128,000	\$96,000
Life of system (years)		30	30	30
Grid electricity price (\$/kWh)		0.075	0.075	0.075
Lifetime value of PV system energy		\$90,000	\$90,000	\$90,000
Non - cost effective portion of PV system		\$70,000	\$38,000	\$6,000
Number of schools constructed annually		40	40	40
Total non-cost effective costs		\$2,800,000	\$1,520,000	\$240,000
Annual PROGRAM COST – State share	50%	\$1,400,000	\$760,000	\$120,000
Private fund share	50%	\$1,400,000	\$760,000	\$120,000
Including a Federal cost share component				
State share	33%	\$924,000	\$501,600	\$79,200
Private fund share	33%	\$924,000	\$501,600	\$79,200
Federal share	33%	\$924,000	\$501,600	\$79,200

Assumptions: 2000 kWh annually from a 1 kWp PV system. Cost of PV system includes lifetime O&M. This model assumes neither financing costs nor inflation in the price of electricity. Financing costs would reduce the value of PV electricity but this would be partially offset by inflating the cost of grid electricity.

This program could be modified to accommodate a fixed annual state budget allocation by initially reducing the number of schools that could participate but growing participation as the cost of PV declined. Such a program (using the assumptions from Table 1) would be designed as follows:

TABLE 2		At program inception	with 20% reduction in cost of PV	with 40% reduction in cost of PV
School annual energy consumption (kWh)		800,000	800,000	800,000
Annual output from 20 kWpPV system (kWh)		40,000	40,000	40,000
Percentage of school energy from PV		5	5	5
Life cycle cost analysis				
Cost of PV system (\$8/wattp)		\$160,000	\$128,000	\$96,000
Life of system (years)		30	30	30
Grid electricity price (\$/kWh)		0.075	0.075	0.075
Lifetime value of PV system energy		\$90,000	\$90,000	\$90,000
Non - cost effective portion of PV system		\$70,000	\$38,000	\$6,000
Number of schools constructed annually		40	40	40
Number of schools receiving a PV system		14	26	160*
Total non-cost effective costs		\$980,000	\$988,000	\$960,000
Annual PROGRAM COST – State share	50%	\$490,000	\$494,000	\$480,000
Private fund share	50%	\$490,000	\$494,000	\$480,000
Including a Federal cost share component				
State share	33%	\$323,400	\$326,040	\$316,800
Private fund share	33%	\$323,400	\$326,040	\$316,800
Federal share	33%	\$323,400	\$326,040	\$316,800

Assumptions: The State in this example dedicates approximately \$500,000 per year to the solar schools program either as a budgetary allotment or by earmarking part of an existing system benefits fund for solar schools.

*Provided the budget stays fixed in the later years of such a program, this State will be able to undertake retrofits of the schools that were unable to participate because of a lack of funding in the early years. This is a good example of the need to have every school designed for solar even if the funding is initially unavailable for a cost effective system.