GRID NEUTRAL:

Electrical Independence for California Schools and Community Colleges

Advance copy released for the
Green California Schools Summit

December 9, 2008

DGS
Department of General Services

GOVERNOR ARNOLD SCHWARZENEGGER

December 2008

GRID NEUTRAL: Electrical Independence for California Schools and Community Colleges

One of the cornerstones of my administration has been to reduce our state's carbon footprint. By making our schools more environmentally sound, we teach our students the value of preserving our natural resources.

This workbook is a fantastic guide on how to create grid neutral campuses and facilities. Grid neutral is defined as balancing the amount of electricity a facility consumes from an electrical grid with the amount of energy the facility produces. Becoming grid neutral is a sensible strategy for schools to both conserve energy use and explore how to access alternative energy sources for their needs.

I am proud that this workbook will serve as a valuable tool for California's schools, and I am looking forward to seeing grid neutral "green" campuses open their doors for our students.

Sincerely,

Arnold Schwarzenegger

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Why go grid neutral?

Business Case for Grid Neutral

Going grid neutral isn't a challenge—it is an opportunity.

It is an opportunity to lock in electricity costs to provide financial predictability for your district and to lower energy bills. It is an opportunity for cost avoidance for your district. And, if structured properly, it can all be done with no capital costs to your district.

Electricity costs represent the key element of the business case for schools and colleges going grid neutral. Imagine reducing payments to the utility company by 20 to 30 percent and sometimes more. Then imagine what you can do with money not spent on electricity. If a school district pays $6.2 million to its utility company per year, this might be used to hire more new teachers or purchase more than 104,000 textbooks, or buy 6,200 computers. Any one of these expenditures contributes directly to the district's mission of educating our children.

Now imagine achieving these results with no capital costs. The incentives available for solar energy systems dramatically impact the economics. The federal government offers federal energy tax credits for these systems, as well as accelerated depreciation. Utility companies offer additional incentives. There are also emerging markets for renewable energy credits and carbon reduction credits. Collectively, these incentives and revenues reduce the cost of ownership.

Unfortunately, tax credits and accelerated depreciation cannot be claimed by a community college or school district since they are not taxpayers. Conversely, it is just these incentives that can make a project work economically—this is where third party power purchase agreements come in. As the name implies, under these agreements a business installs a solar power system at a school site with no upfront cost to the district. The business—as a taxpayer—can take full advantage of the incentives—reducing the cost of ownership. The district purchases power from the provider at set rates usually at or below market rates—locking in predictable electricity costs. Terms of these agreements vary, but many of these agreements conclude with the district owning the system in 10 to 15 years.

As the cost for natural gas increases, the amount a school pays for electricity will increase, as well. In these times of uncertain energy supply, curbing utility costs will reduce the exposure to this financial risk.

The cost of producing electricity on-site can even be lower with energy efficiency and conservation. If a school district plans to become grid neutral,

> **"With the solar tax incentives available, we have school districts like Milpitas USD and Los Angeles CCD installing solar with no capital costs by utilizing a third party power purchase agreement."**
>
> *—David F. Thorman, AIA*
> *California State Architect*

GRID NEUTRAL:
A site that produces at least as much electricity as it consumes in a year

Solar (photvoltaic) panels are installed on a shade structure above a parking structure, Los Angeles Community College District

Cost Study of Utility at K–12 school in 2006: Elk Grove Unified School District—approximately 62,000 students

In 2007, the Office of Public School Construction approached Elk Grove Unified School District to provide information on their total energy bill for the previous year. It was found that all the campuses consumed 58.2 million kilowatt hours (kWh) of electricity which equated to $6.2 million dollars at their 2006 rate structure.

How could a grid neutral project affect these energy costs?

Using the steps in this grid neutral workbook and proper long term planning, this district could lower their bill with energy conservation policies and energy efficiency measures. Starting with the low cost, no cost items; then adding retrofits to the lighting and heating/air conditioning systems. These changes have been found to have the highest return on investment and could cut costs by up to 30 percent.

Then, this district could install solar (photovoltaic) panels on their campuses by entering into a public/private partnership utilizing a power purchase agreement (PPA). Dependent on the agreement, the district could have fixed electricity costs that are up to 10 less than before. This could reap immediate savings of up to $620,000 per year.

Usually in 15 to 20 years and depending on the purchase option in the PPA, the district would be responsible for the solar systems' production. After paying base utility charges and working toward zero net electricity use in a year, a district could then see up to $6 million dollars freed up for textbooks, teacher salaries, or computers each year.

—Rob Cook,
Executive Officer of the Office of Public School Construction

they must first maximize the buildings' energy efficiency and start conserving energy. This will limit the amount of on-site electricity needed to become grid neutral. There are many financing options available to upgrade existing schools and build new energy efficient campuses, and the return on the investment makes this a good, sound economical decision.

California Global Warming Solutions Act of 2006

Businesses across the globe are moving forward with plans to cut energy costs, even in difficult financial times. Alternative energy is one of America's few growth industries. This is happening because business leaders have accepted the fact that volatile energy costs can cripple their enterprise. Schools and college districts, acting as enterprise businesses, can protect the community's investment at their campus facilities. Grid neutral is a way to take control of the increase that will occur with utility prices over time. Going grid neutral provides schools and community colleges the opportunity to conserve electricity so their utility bills are lower, to fix their electricity prices so they will not escalate over time, and to benefit from the current incentives and technological opportunities now available for alternative energy sources.

Planning and implementing grid neutral schools now will prepare schools and community colleges for compliance with the California Global Warming Solutions Act. It is estimated by the U.S. Green Building Council that 39 percent of all carbon (CO_2) emissions are attributed to buildings; this includes California's aging college and school facilities. The law will require that by the year 2010 school districts must know how much their buildings contribute to carbon emissions and begin efforts to offset their carbon emissions. By 2020, all educational buildings will be required to reduce their CO_2 emissions by 30 percent, based on 1990 levels as established by the California Air Resources Board. In 2050 this will be raised to 80 percent. This is why we need to find out how much energy our buildings use; start work toward more sustainable energy efficient buildings; start producing on-site clean renewable energy. To meet these goals, many school districts have already begun and renewable energy ventures are aligned for success. Now is the time to start planning how to go grid neutral and maintain grid neutrality for the long term.

The Los Angeles Community College District (LACCD) is moving towards a 40-megawatt Renewable Energy Plan, which calls for the installation of photovoltaic (solar) panels, architectural wind and geothermal systems to produce enough electricity on site at each of its nine colleges to meet daytime and evening electricity needs and take the campuses "off the grid." With power purchase agreements, the LACCD will see an immediate 30 percent savings in electricity cost.

District officials expect to have another 30 percent cost savings with the energy conservation measures they are implementing. The power purchase agreements are structured to run for 20 years, at the end of which the LACCD would own all of the renewable generation technology outright.

However, thanks to its most recent bond issue, the LACCD now plans to buy out the energy conservation agreements and power purchase agreements. This will result in an annual savings of approximately $9 million per year. As for AB 32, the Global Warming Solutions Act, it is estimated that this effort would save 31,539 metric tons of carbon emissions per year.

—Larry Eisenberg
LACCD Facilities Planning & Development
http://www.laccdbuildsgreen.org/

A Note from David F. Thorman, AIA, California State Architect

Grid neutral is an idea whose time has come!

California school districts and community college districts are already installing solar collectors with no capital investment and reaping the benefits of clean energy at a lower cost. Banking and energy companies are eager to help make it happen by working with districts through public/private partnerships. The green movement is well underway and the resulting campuses are benefiting students and helping to power the emerging green collar workforce.

So, how can your school site produce as much electricity as it uses in a year?

We set out with subject matter experts to find out. The Division of the State Architect conducted a series of six workshops addressing comprehensive planning, energy efficient design, energy generating technology, innovative funding, energy measurement, and maintenance and operations in September 2008. The conclusions were presented to an audience and webcast viewers in October.

Throughout this collaborative process I recognized that many tough questions needed to be answered. I could sense school officials thinking: how will the state work with me to ensure my school is not only more energy efficient, but actually generates as much energy as we need?

This guidebook will answer your questions:

- What are the key concepts of going grid neutral?
- What type of solar panels or other renewable energy sources at school sites should we install?
- How do you maximize energy efficiency and passive solar technology?
- What are the options for financing?
- What have other school districts and community colleges done?
- What are some useful tips on how to attain higher energy efficiency and on-site energy generation?
- What is the business case for school districts to embark upon this movement?
- What solutions can be provided to school boards and stakeholders to achieve the means, methods and economics of becoming grid neutral?

Grid neutrality translates into cost savings, the reduction of greenhouse gas emissions, and a healthier learning environment for our children and young people. Grid neutral schools can serve as environmental teaching laboratories.

With so much to gain, I strongly believe that all of California's schools should strive for electrical independence. I want to make grid neutrality a reality for all California schools and community colleges!

GRID NEUTRAL: Electrical Independence for California Schools and Community Colleges

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> **We are committed to quickly achieving grid neutrality... This means that through a combination of energy efficiency and self-generation the California schools of the future will produce as much energy as they use.**
>
> —Rosario Marin
> Secretary of the California State and Consumer Services Agency Green Schools Summit 2007

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Executive Order S-20-04, December 2004

Shortly after being elected, California Governor Arnold Schwarzenegger signed Executive Order S-20-04, requiring reduced energy use in State-owned facilities and directing the Division of the State Architect (DSA) to encourage schools being built with State funds to be resource and energy efficient. State Architect David Thorman is now calling out to all California school districts and community college districts to make their schools grid neutral. In September and October of 2008, DSA hosted seven workshops that brought together experts from energy, finance, education, nonprofit and government sectors to brainstorm the key components of a successful grid neutral project. The discussions of their collective experience and knowledge were led by Butte Community College who facilitated each workshop to gather and organize the recommended means, methods and economics of becoming grid neutral that you will find in this guide.

Defining Grid Neutral

Grid Neutral is set apart in the landscape of other green terminology. In fact, it was just recently defined by the Collaborative for High Performance Schools (CHPS) in their new 2009 criteria. Simply put, grid neutral is defined as "a site that produces at least as much electricity as it consumes in a year." Grid neutral is different from zero net energy. Grid neutral focuses on the amount of electricity you consume from the utility grid and the amount you produce on-site. Contrast this with the concept of zero net energy which includes not only electricity, but all energy including fossil fuels. Another concept is going off-the-grid; this requires a district to provide ways to store the energy that they produce.

Grid neutral is different because the campus remains connected to the electrical grid.

Many of the workshop participants questioned why the DSA didn't start with zero net energy. The answer is because when the concepts were clearly defined by CHPS, the DSA decided that grid neutral was an excellent first step in further attaining energy independence such as zero net energy or going off-the-grid. Additionally, grid neutral will substantially contribute to the milestone requirements of the Global Warming Solutions Act by reducing carbon emissions as it has been determined that the energy consumption of buildings make up about 39 percent of the world's carbon emissions. So by focusing on electricity, a school can take a major bite out of its overall energy consumption, since electricity represents about 80 to 90 percent of a campus' annual energy bill. This starts a journey toward electrical independence which can lead to total energy independence.

Key Steps to Achieve Grid Neutral

Both existing and new schools can go grid neutral. There are some variations for getting there; however, many of the key steps are the same once the planning is started.

Step one is the most crucial planning step. For a new school, you need to establish your energy performance goals. For an existing school, you need to measure the current electricity use and then set goals. You will find in more detail how to develop a preliminary plan in the "Comprehensive Planning" section in which this information was discussed by the planners, architects and school districts who participated in that workshop. How to establish the energy use baseline is discussed in detail in the

> **You may still take some energy off of the grid during peak energy use time, or give some energy back to the grid at a nonpeak time, but at the end of the year, you're essentially neutral. You are not taking more from the grid than you're putting back.**
>
> *—David F. Thorman, AIA*
> *California State Architect*

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"Energy Measurement" section where utility providers, architects and school districts already doing this shared their knowledge.

Step two includes the first actions and projects needed to start a grid neutral project. You can start to save energy immediately by establishing conservation policies and put those into practice, and then you can further realize energy savings after planning and implementing appropriate energy efficiency measures through retrofits or modernizations. Continually practicing conservation and maintaining the energy efficiency of the buildings is critical to maximize these energy cost avoidances.

Step three is the undertaking of installing renewable energy sources. The section titled "Energy Generating Technology" gives an overview of the options. The planning team discussed in "Comprehensive Planning" will be your key planners in assisting with technical details; while the funding of these projects is discussed in the "Innovative Funding" section where experts in financing school projects discussed what they have done to successfully fund these energy generating systems.

Step four is the follow-through. The maintenance and operations staff needs to be strengthened to understand the new systems and energy efficiency that the district is implementing at the campuses. The section on "Maintenance and Operations" (M&O) gathered staff from K–12 schools and community colleges that have already started this effort, as well as commissioning agents, energy specialists, utility providers, and folks developing sophisticated energy tracking systems, who all came together to brainstorm the paradigm shift needed to keep all the efforts of going grid neutral a reality over the years to come.

Key Steps to Achieve Grid Neutral

Step 1
a. For a New School: Set energy performance goals.
b. For an Existing school: Measure current electricity use and set performance goals.

Step 2
Implement and maintain appropriate energy efficiency and conservation measures to lower electricity use.

Step 3
Install solar or wind systems to create electricity to meet remaining needs.

Step 4
Monitor electricity consumption and production.

Comprehensive Planning

Collaboration is key for planning grid neutral schools. Districts will assemble the legal, finance, and construction teams required to make the project happen, similar to any new school construction or major modernization. However, when planning a grid neutral school, you will be bringing more people to the table earlier in the process. As you read, you will find comprehensive planning is needed in all of the key steps in achieving grid neutrality.

This section answers the questions:

- Who is the "dream team" for grid neutral schools?
- What is the critical path in planning grid neutral schools?

Assembling the Team for a Grid Neutral School

Assume that your school board has determined to build a new grid neutral school. Who are the members of the "dream team" to plan the construction project? Broadly speaking, they fall into three groups: sponsors, beneficiaries, and implementers.

Sponsors:

Sponsors are the project promoters and supporters—people just like you!

- Project champion
- School board members
- Community stakeholders and media
- Utility companies
- Research/universities
- Government agencies
  - —Federal
  - —State
  - —Local

Beneficiaries:

Beneficiaries are the constituents that receive both direct and indirect financial and environmental benefits from the project.

- Students
- Teachers
- Administrators
- Curriculum planners
- General public (who might also use facilities)
- Taxpayers (who benefit from lower energy bills)

Implementers:

Implementers are the people involved with planning and coordinating the project design and construction. Some implementers are experts in matters that will affect the long-term maintenance of building systems.

- School facility planners
- Green building consultant
- Energy specialist (conservation/ generation)
- Maintenance and operations
- Construction finance/legal counsel (energy)
- Site selection team - environmental consultant - soils and geo-technical engineering
- Design consultants
- Architectural and engineering team (mechanical; structural; civil; electrical)
- Major subcontractors
- Builder
- Construction team
- Energy service company (ESCO)

> **The success of any sustainable project must be a lifelong commitment made by all team members, beginning with the district and community members alike.**
>
> *—George Parker*
> *Director of Facilities*
> *Yuba City USD*

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1. Establish a Baseline
2. Set Performance Goals
3. Develop Electrical Power Master Plan
4. Develop Districtwide Program

- Potential suppliers/energy equipment manufacturers
- Commissioning agent

Although the sponsors, beneficiaries, and implementers have their own responsibilities, they are also need to work together to get the end result. In fact, a number of people on the dream team may work under the same roof. This document does not go into detail on the roles and responsibilities of the dream team members.

In addition to the sponsors, beneficiaries and implementers, there are other roles critical to the planning process for any construction project.

- Custodians
- School site staff (information technology, cafeteria, after-school, administration)
- Local fire marshal or city fire official
- Waste management/recycling expert
- Labor union, workforce development team
- Joint use partners such as local governments and jurisdictions that may share use of facilities
- DSA-certified inspector
- Law enforcement
- Educational organization
- Legislative representatives

Critical Path to Planning a Grid Neutral School

This subsection discusses in more detail how to accomplish step one of the key steps to achieve grid neutral: start by establishing a feasibility committee to evaluate the opportunity to go grid neutral on a districtwide level. This is the time to assemble the appropriate "dream team" for your district and have them walk through the steps on the critical path to becoming grid neutral. Think in terms of long-range planning.

Establish a Baseline

Determine the current electricity use for your district by analyzing annual electricity bills for existing schools.

Set Performance Goals

Set energy performance goals for your district to meet or exceed best practices for the existing schools and any new schools. These goals can be based on the criteria developed by nonprofit organizations such as the Collaborative for High Performance Schools (CHPS) or the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) for schools.

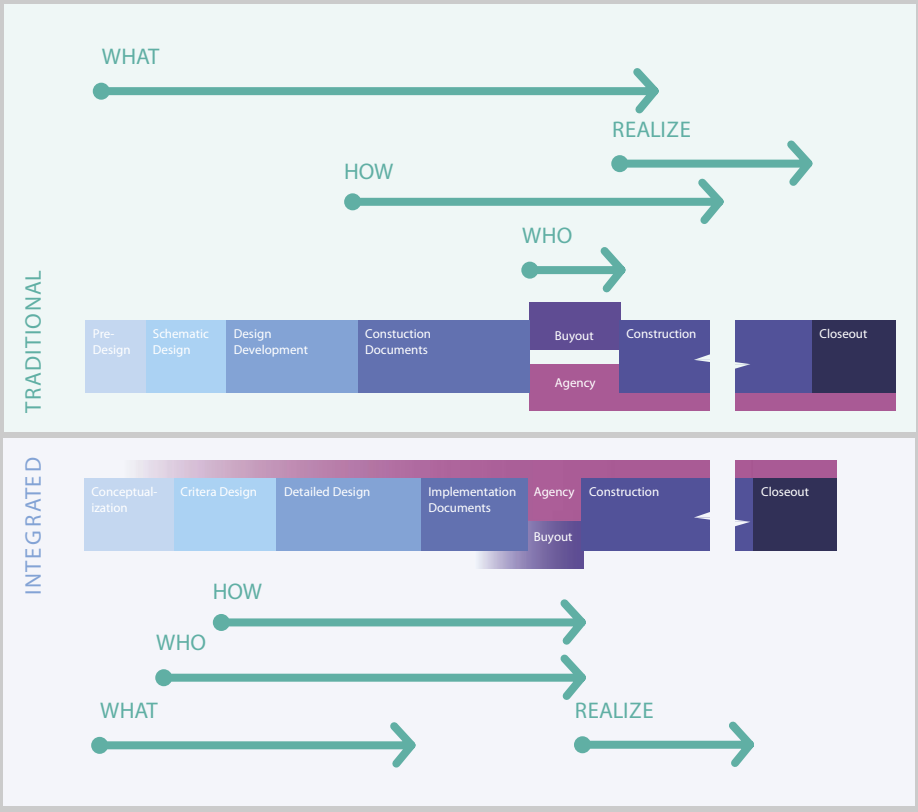
Develop Electrical Power Master Plan

The electrical power master plan is the result of the performance goals from step two. This master plan provides the foundation for future projects within the district.

Develop Districtwide Program

When developing a districtwide program, think ahead to the next 30 to 40 years in terms of the district's energy demand. Work with the key members of the dream team to do a life-cycle cost analysis of the systems needed to meet your performance goals.

See the "Innovative Funding" section of this document for more information on life-cycle cost analysis.



Integrated Product Delivery (IPD): A working definition diagraming the difference between traditional and integrated delivery methods

A project delivery method is the system the district uses to organize and finance the design and construction services for a facility through legal agreements with one or more entities.

Preliminary Plan

The outcome of the districtwide program is a preliminary plan.

The preliminary plan includes:

- Program goals
- Overall strategy for meeting goals
- Financing strategy
- Life cycle cost analysis
- Recommended delivery method (see "Evaluating Project Delivery Methods and Means" in this section)
- Maintenance and operation

Once created, the preliminary plan can serve as a template to help fast-track individual projects that fall under the electrical power master plan.

Evaluating Project Delivery Methods and Means

Unique to a grid neutral project is that you are being asked to deliver a project that meets energy performance goals. This takes energy specialists, photovoltaic manufacturers and equipment fabricators. So what is the best way to approach a grid neutral project and deliver the final constructed building? What are the tools and means that are state-of-the-art today and being used to create a building with less costly change orders?

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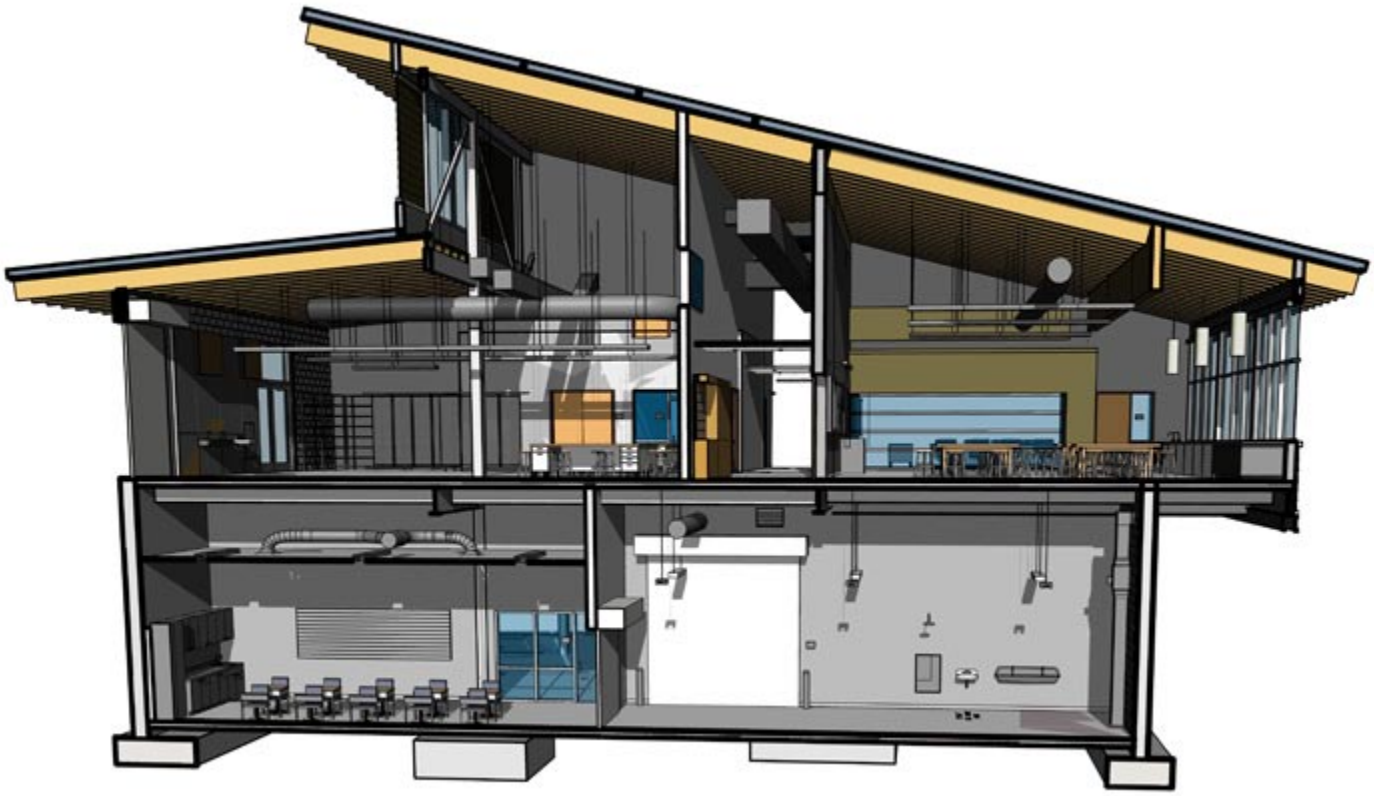
Building Information Model (BIM)–Cross Section of Classroom Building



Traditional Project Delivery Methods

A traditional planning team under the design-bid-build process does not include the builder, the manufacturers of the products, or the fabricators of the systems or equipment until the last phase, which is construction. The builder can provide insight on the constructability of the project. Manufacturers and fabricators provide shop drawings from the drawings (same as blueprints) and specifications; many times they have great ideas that will not be realized because they are involved too late in the process. Design-build does bring the builder in early; however, the fabricators and installers are still not involved until the construction phase. There is lease-lease back, construction management (CM)-at risk, and CM multi-prime as other current delivery methods. Many have inherent problems as the project information ends up being stored in discrete silos making it difficult for team members to collaborate so late in the project phase. Constructors, installers, fabricators, suppliers and designers end up meeting on an "as needed" base in a very linear and segmented process which creates few options for holistic solutions.

Integrated Project Delivery

Integrated project delivery (IPD) is the preferred method to assemble a team of experts similar to the "dream team." Based on the collaboration and involvement of the team members very early in the planning process, IPD allows expertise from the perspective

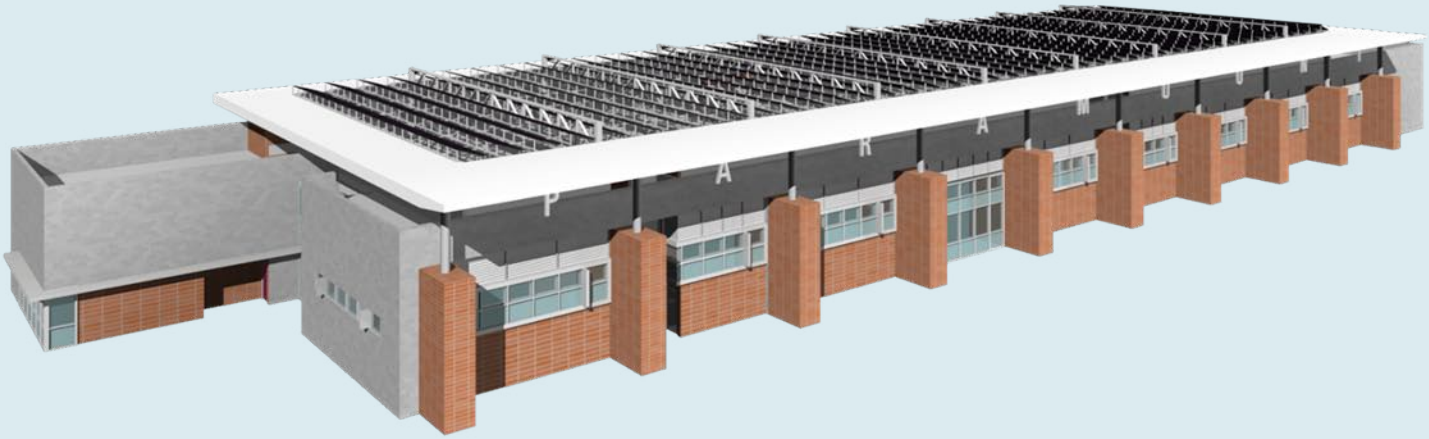
of the builder or PV manufacturer, for example, to provide valuable input that may otherwise be revealed in the construction phase. Resolving design issues between trades is much easier in the planning stages when using computer-aided tools than working with a partially constructed building.

Building Information Modeling (BIM)

One of the computer-aided tools available today is building information modeling (BIM). BIM is the process of generating and managing building data during its life cycle. Depending on the platform, BIM uses three-dimensional, real time, dynamic building modeling software. It helps to increase the productivity in the design phase, assisting in the coordination of all the systems that will be installed in building. BIM also assists with the construction management of a project and provides information on the building geometry, spatial relationships, geographic information, and quantities and properties of the all the building components. BIM is a tool to help enhancing the dream team's efforts and aid in the collaboration of combining designs by the many disciplines involved in the erection, fabrication and materials used on the project.

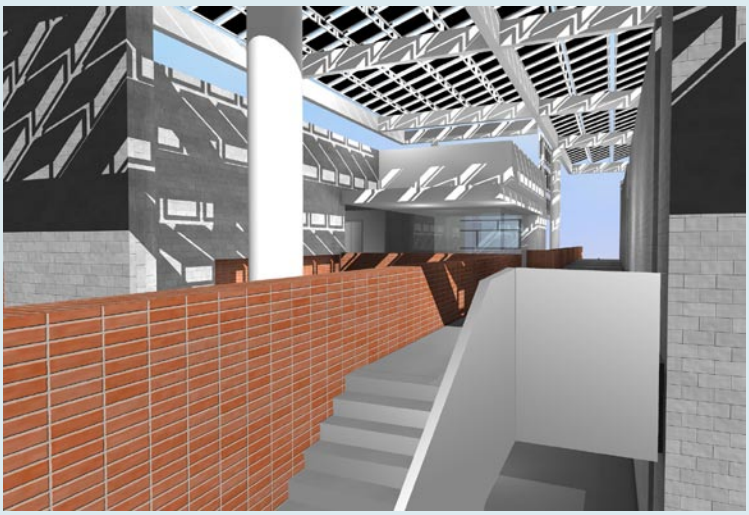
Project Overview:

Moving toward a Grid Neutral campus at Paramount High School



The Paramount High School field house will be a new structure on an existing high school campus with photovoltaic (PV) panels designed for its roof top. Along with energy efficient retrofits on the existing campus and PV panels to be installed on other buildings, this field house/campus project will move the campus one step closer to grid neutrality. The 29,000 square foot field house encompasses locker rooms, weight rooms and indoor classrooms.

Using Integrated Project Delivery (IPD), a comprehensive team comprised of the traditional architect and engineering designers along with energy specialists and PV manufacturers was formed to set energy goals, plan and design the project, and analyze the expected energy demand and projected energy that would be produced. With all the expertise at the planning table, it was determined that the PV panels proposed for this field house would produce over two times the need of that single building and would be available to offset the electrical needs of the other campus buildings. In order to achieve grid neutral, other existing buildings would need to have PV panels installed. The photovoltaic (PV) panels at the field house cover 70 percent of the roof and were anticipated to produce almost 400,000 kilowatts hours per year (kWh/yr); where the expected campus annual demand without the PV panels was projected to be 1.8 million kWh/yr. Life-cycle analysis was also included in the planning of this project.



Additionally, Building Information Modeling (BIM) was used by the comprehensive planning team to construct a computerized three-dimensional model to give depth perception on the building design. To add to the success of this grid neutral project, BIM also provided valuable information concerning cost data, square footage take offs, collision analysis coordinating mechanical and electrical with structural walls, and the dimension of time allowing for construction analysis in real time.

Energy Measurement

Knowing how much energy your district currently uses on a monthly basis is helpful for planning the size of your renewable energy system, setting energy performance goals, and monitoring your performance against those goals. Data is needed at all levels of planning, design and implementation of your energy program.

Energy measurement is primarily step one in how to achieve grid neutrality. However, energy measurement plays a role in step four once systems are in place and the staff is maintaining and monitoring energy use and production.

This section provides an overview of the following key energy measurement topics for going grid neutral:

- How to measure grid neutrality
- Benchmarking your electricity use
- Database and reporting requirements
- Helpful benchmarking and reporting tools

Measuring Grid Neutrality

A grid neutral school produces at least as much electricity as it consumes in a year. How do you measure electricity production and consumption? For purposes of determining grid neutrality, it's simple: both production and consumption are measured by the utility billing meters. So when the total annual kilowatt hours sums to zero, your school is grid neutral.

Benchmarking Your Electricity Use

To determine your district's current electricity consumption, add up the kilowatt hours for each school for an entire year. This is your baseline. After setting the initial baseline, districts should benchmark energy use on a continuing basis in order to monitor operations and performance. Benchmarking helps you to:

- See where you are starting from (the baseline)
- Set your electricity performance goals (your target reduction from the baseline)
- Monitor trends in electricity use to make sure you stay on target

How to Benchmark

Any school district can benchmark their own facilities by collecting monthly energy use values from historical electrical bills.

If bills are not collected or kept handy, you can call your utility representative to get copies. If you have questions on usage or your rate structure, talk with account representatives to clarify the terms and learn how to use the data. Utilities often provide basic courses.

Benchmarking tools range from a simple spreadsheet to a complex software program designed specifically for energy tracking and management. See "Helpful Benchmarking and Reporting Tools" in this section. Another possibility is to hire consultants to help with benchmarking and efficiency goals.

Tracking Photovoltaic (PV) Energy Production

PV energy generation systems come with a production meter that works in parallel with the utility net billing meter. If the PV system produces more than the school uses, then the meter turns backward to credit the district for the excess electricity. Districts should track monthly electrical production from the PV system along with net meter values. Total on-site consumption can then be determined by adding monthly PV production values to the monthly net meter values.

Many utility companies provide educational tips for understanding your utility bills.

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Rule of Thumb: There should be one energy manager per school district.

Recommended but Not Required

You can have a school that measures grid neutral but is otherwise very energy inefficient when it comes to natural gas and other fuels. Consider taking a whole building approach to energy measurement by capturing data on all energy consumption. This ensures your district is not only grid neutral, but is also taking the necessary steps to reduce carbon emissions, which will soon be regulated by the State of California's Global Warming Solutions Act under Assembly Bill 32. When choosing an energy tracking tool, districts should consider those that allow for the calculation of carbon emissions.

Benchmarking and Reporting Requirements

Your district will need to determine your database and reporting requirements so you can monitor energy use and system performance.

Tracking energy use at the district level requires a database of basic energy use values including:

- Name of school (if more than one)
- Meter number (if more than one)
- Monthly billing start date
- Monthly billing end date
- Monthly kWh consumption (prior to on-site generation)
- Monthly kWh generation (from PV or other renewable source)
- Net monthly kWh consumption (kWh consumed minus kWh generated)

Many other site-specific fields might be considered useful for benchmarking on a district-by-district basis (for example, address, square footage, or number of pupils). Site data will be collected by, sent to, or otherwise rolled up into a district database. At the district level, maintenance and operations staff can then monitor each facility's performance and send out people to troubleshoot, as necessary.

Data and Reporting Requirements

Reporting requirements will differ from district to district. Most districts will at least want to have monthly and annual net kWh values. Some may want kWh consumption and production values in addition to net kWh values. When evaluating reporting systems, another key consideration is frequency. At minimum, reporting should be done monthly; however, some districts may want to run reports more frequently.

Helpful Benchmarking and Reporting Tools

There are numerous tools on the market that help you understand your utility bill. At minimum, these tools should automatically capture the data needed for the benchmark reporting tool that the district is using. Additionally, these tools provide the ability to compare data across time.

Portfolio Manager

Portfolio Manager also has an Energy Performance Rating that can answer the question: "How does my school compare to other schools in my peer group?"

Portfolio Manager is available from http://www.energystar.gov.

Outdoor student activities reinforce the power produced by photovoltaics

Target Finder

The sister tool to Portfolio Manager is Target Finder. Target Finder helps users establish an energy performance target for energy efficient design projects and major building renovations. By entering a project's estimated energy consumption, users can generate an energy performance rating based on the same rating system applied to existing buildings. Target Finder can be used in setting your energy efficiency performance goals. You can find more information online at www.energystar.gov.

Monitoring, Management and Reporting Tools

Energy monitoring systems are commercial products that can be used to monitor real-time energy use and performance of large end-uses, such as lighting and HVAC. The cost of purchasing these systems should be considered in relation to the expected savings. Such systems are likely to be more cost effective in larger facilities.

Energy management systems are commercial products designed specifically for the automated control and monitoring of the heating, ventilation and lighting needs of a building or group of buildings.

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CHPS verified: American Canyon High School, Napa Valley USD

Energy Efficient Design

Energy efficiency and conservation are the foundations for energy savings. This is step two, which begins after knowing how much electricity is being used and setting your performance goals. At this point, the school district needs to implement and maintain appropriate energy efficiency measures to lower its electricity use.

This section covers:

- Best practices for energy efficient design.
- Energy efficient design for new schools, including alternatives to typical Heating, Ventilation and Air Conditioning (HVAC) systems.
- Energy efficient renovations for existing schools.

Best Practices for Energy Efficient Design

Whether you are designing a new school or retrofitting an existing one, there are best practices, rating systems, and criteria available to help with making the necessary decisions during the planning of a sustainable and high performing energy efficient facility.

Collaborative for High Performance Schools (CHPS)

CHPS has two certification programs; one which is a third party certification and one allowing for self-certification. CHPS publishes a six volume best practices manual providing a flexible yardstick that precisely defines a high performance school. It provides valuable information on site planning, interior materials and surfaces, lighting, building enclosures and insulation, acoustics, and heat and air conditioning alternatives, commissioning, and more. Information on this rating system is available at www.chps.net.

Leadership in Energy and Environmental Design (LEED) for Schools

LEED is a third-party certification program and a nationally accepted benchmark for the design, construction and operation of green buildings. LEED reference guides are organized into the five environmental categories of sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. There is also an additional

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GEOTHERMAL FACTS

- Keeps space needs to a minimum.
- Requires 225 to 400 square feet of surface area per ton of cooling.
- Requires bore holes to be drilled for pipes. Each bore is normally 5 to 6 inches in diameter and 200 to 300 feet deep.
- Bores are filled and sealed with coolant.

"Daylighting is by far the most effective energy efficiency measure, resulting in 12.7% of savings."

—Steve Oliver's Preso

Educational opportunities for students to build medels, study daylighting, and learn about the built environment

category to facilitate innovative ideas and exemplary sustainable designs. Information on this rating system is available at www.usgbc.org.

Energy Efficient Design for New Schools

Integrated design is critical when coordinating a successful grid neutral school in order to maximize the energy efficiency of the facilities as a whole. It's as if the building and site are a body. You need to ask, what design factors will help the body adapt to changing conditions in the environment? What systems need to be considered and affect the performance of other systems? For instance, how can you automatically control the classroom lights while bringing in natural daylight? Or how can the heat put off by computers and lights be minimized to reduce the heating and air conditioning (HVAC) system's design loads? How can you minimize the electricity drawn by computers, appliances and equipment when they are not being used?

Designing a grid neutral school needs to start with choosing what green features will be included to make the school most energy efficient. CHPS and LEED guidelines provide excellent resources for information on site planning, daylighting (bringing in natural light), building insulation, electrical lighting controls, and other building systems. So you may ask: what measures will provide the highest return on your investment? The workshop participants responded with the top five categories:

Programming

Programming includes the requirements for the site and buildings based on their function. Programming is the written plan document, called the program, by which the building and site design will be developed. The program specifies each necessary space and its size for the new school; establishes the times and days that the spaces will be used; and identifies areas with specialty designs such as commercial kitchens, gymnasiums, and performing arts facilities. Programming is where assembling the dream team for a grid neutral school becomes valuable.

Site

How the buildings are orientated on the site is critical for a successful grid neutral school. Newly designed schools have great opportunities to locate the buildings to maximize daylighting and optimize the sun exposure to the solar panels so that they produce the most electricity. Landscape plans can locate shade trees to provide shade in the summer and allow the warm sunshine through windows during the winters. Other site issues include:

- Combined community use of spaces
- Geothermal pipe locations (an alternative to traditional HVAC systems)
- Passive solar design features
- Building density (land availability can affect how close buildings are located and whether buildings need to be multistory)

Building

Designing the building envelope (walls and windows) with the following features can ensure higher energy efficiency for each building:

- Building insulation
- Weather stripping openings
- Integrating walls into the building with thermal mass—a passive solar technique that uses the temperatures of the each day to heat or cool spaces

- Daylighting—bringing in natural light can reduce electrical lighting need
- Clerestory windows—a daylighting technique of locating windows above space with high ceilings

Tip for daylighting: To alleviate glare, allow the light to hit one surface before entering a space.

Systems

Lighting, heating and air conditioning (HVAC) systems can be targeted as the largest energy users in a new school.

Incorporating automated controls on the energy-efficient lighting and HVAC systems can increase energy efficiency:

- Occupancy sensors can help turn off lights when areas are not in use
- Interlocking controls—closes doors, operable windows, or clerestory windows when HVAC is on
- Daylight harvesting—dimming the light fixtures near windows to maximize the natural light when available

Commissioning the systems with an outside agent that checks that the lights, HVAC and other systems are properly set at their optimum design helps to save a lot of energy. Sometimes fans are running or valves are open when not necessary, so they need to be reset to save electricity. Refer to CHPS' best practices manual for additional detailed information.

Geothermal can also reduce energy loads for heating and air conditioning. Also called ground source heat pumps, the system takes the earth's ground temperatures and pumps that tempered air through a below grade loop (pipe) system and into the building.

Furnishings, Fixtures and Equipment

Although your entire campus will be designed energy efficiently, targeting spaces that consume large amounts of electricity can significantly impact the success of a new grid neutral campus. This would include focusing in on the energy efficiency of the furnishing, fixtures and equipment of spaces like commercial kitchens, welding, woodworking, and auto shops, along with other areas that have combined uses such as multipurpose rooms, gymnasiums, and performing art centers.

The electrical load where equipment is plugged in (plug loads) also plays a large role in energy inefficiencies. Computers and monitors can be equipped with programs to turn them off when not in use and can largely reduce energy losses. Installing Energy Star appliances and equipment is highly recommended. Electrical transformers can be evaluated for opportunities for energy savings. Additionally, making sure that all the photovoltaic (solar) equipment is compatible with the other systems will make a difference, too.

Alternatives to Typical HVAC Systems

Alternative HVAC design options are dependent on the type of climate where the campus is located. Some areas have climates that have nice outdoor air temperatures where natural ventilation can be incorporated, others have cold nights where water towers can store chilled water by night and deliver cooled air during warm afternoons, and still other climates might be best suited for evaporative cooling. Passive solar techniques can even be incorporated into these climate specific design options.

Commissioning ensures that systems are operating according to their design specifications.

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RETROFITTING TIPS:

- Clean air filters
- Tune up HVAC system (retro-commissioning)
- Remove old cathode ray tube(CRT) monitors
- Unplug things that are not being used

SHORT-TERM PROJECTS:

- Efficient lamps and ballasts
- De-lamp (remove bulbs)

- There are loads of ideas for alternative methods of heating and cooling schools and colleges. There are also ways to match the alternatives up with conventional heating and air conditioning to offset the energy used by mechanical means. It is helpful to categorize them into: the systems that provide the air (source), and systems that distribute the air (distribution). Refer to the HVAC chapter in the CHPS best practices manual for more detailed information and alternatives.

Heating/Cooling Source Considerations

- Evaporative cooling cools the air through evaporation. It can be effectively integrated into mechanical systems for pre-cooling, first stage cooling, or in the primary form of cooling.
- Natural ventilation using operable and clerestory windows can create an automatic air movement. Installing automatic closers helps when the HVAC system is on.
- Geothermal systems take the earth's ground temperatures and pump that tempered air through a below-grade loop (pipe) system and into the building.
- Under size the system: design the HVAC system to the most common temperature control needs in a day and not to the peak loads. Rely on ceiling fans and natural ventilation where available.

Heating/Cooling Distribution Considerations

- Displacement ventilation systems bring in cool air close to the floor level at a low velocity and at a temperature below the room temperature. Cooler air then displaces the warmer air in the room.
- Interlocking controls automatically turn off HVAC systems when a door or window opens. These demand control systems need to include an override to allow users to adjust comfort levels.
- Zone control systems are programmed to distribute the air based on where and when it is needed. Establishing and adjusting the system to the different class schedules is important; for example, the administration office is still in use when classes are out, so those rooms don't need air conditioning.
- Dedicated outside air systems introduce outdoor air directly into the zones without mixing with return air and introducing it in a diluted fashion. This allows the delivery of the right amount of air where it is needed.
- Maximize the efficiency of the air distribution by making sure the air is only distributed where it is needed in each room.

Energy Efficient Retrofits for Existing Schools

When retrofitting existing schools, the goal should be the same as for new schools: to design a comfortable building that takes advantage of the existing climate. The following are the top five design measures with the highest return-on-investment. Keep in mind, along with financial gain, return-on-investment also includes reduced absenteeism, increased teacher retention, improved test scores, and higher level of comfort for users.

- Daylighting (no dark classrooms)
- Heat avoidance (protection from the elements)
- Natural ventilation
- High efficiency HVAC
- Appliances, plug loads and special equipment

When retrofitting existing schools, design with the goal of using the natural environment with all systems being supplemental systems. The primary comfort for the building should be driven by daylight and natural ventilation. The following provides considerations for making nonmechanical systems your primary systems.

Passive System as Primary

- Consider climate zone opportunities
- Shade trees to help with heat avoidance
- Daylighting improvements
- Natural ventilation
- Shades and blinds integrated into windows
- High reflective paint (interior and exterior)
- High performance glazing (window glass)

There are several automated controls and strategies that can help assist passive systems.

- Insulation in walls and ceiling
- High reflective roof (cool roof)
- Automatic window ventilation which closes windows when HVAC system switches on and opens them when off to allow for natural ventilation
- Daylight harvesting controls which will dim light system, and compensate for amount of daylight throughout the day
- Lighting, heating and HVAC systems that have automated controls
- Energy efficient electric lighting
- Ceiling fans
- Natural exhaust ventilation (whole house fan)

Energy-Efficient Retrofits Based on Design

The previous section lists the top five, somewhat generic energy efficient retrofits for existing schools. But have you ever wondered how the architectural design of your district's schools impact the potential for energy efficiency? This section presents the major architectural styles applied to schools since World War II and provides retrofit guidelines based on those styles.

Project Overview: Lighting Retrofit

Chico Unified School District

PG&E and staff developed an in-house lighting retrofit project.

1st phase: Removed existing fluorescent lights using CHPS recommendations for lighting levels. This is referred to as "de-lamping." Overlit areas need to be delamped. Installed Super T8 28-watt, high-efficiency fluorescent lamps and high efficiency electronic ballasts, where applicable.

2nd phase: Replaced all outside lighting with Compact Fluorescent Lamps (CFLs).

Savings $150,000/yr

Anticipated Payback Time After PG&E Rebate ..... 1–2 months

Emmisions Reduction ..... 900,000 lbs of CO_2 per year

Pre-War

These are generally multistory buildings with lots of windows and masonry. Most pre-war school stock has been repurposed. The following are retrofits specific to pre-war building types:

- Replace heat and cooling with hydronic and radiant systems.
- Remove suspended ceiling and install high performance window glazing.

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- Install highly efficient multizone heating and cooling.
- Install separate HVAC system for large occupancies.
- Install interior duct work in conditioned space.
- Replace stairwell lighting with lighting that turns on only when people are present.
- Bring daylighting into corridors.

Post-War (1950–1965)

Originally, these buildings were energy efficient but have since been modified. The post-war design presents a high opportunity for energy efficient retrofits such as:

- Restoring daylight using high efficiency windows and skylights.
- Restoring natural exhaust ventilation with mechanical assistance such as automated windows, ceiling fans, and quiet natural exhaust ventilation.
- Avoiding heat and using landscaping to move paving away from classrooms.
- Installing high-efficiency HVAC.

Wing (1960–1970)

These are one-story, back-to-back wings connected by overhangs. The classrooms often already have natural ventilation incorporated into the design. Recommend retrofits similar to the post-war model.

Pods (1970s)

These schools are generally shaped like a box with no natural daylight or ventilation. Total renovation or major modernization is advised.

Post-1970 Schools

Schools built from 1970 to the present are not all one type, and some of the later schools incorporate sustainable, energy efficient design.

Portables

Portables continue to dot the landscape, and the need for them is projected to continue. Consider purchasing a grid neutral, high performance portable rather than trying to retrofit existing portables.

Ground-Mounted PV

Ground-mounted PV's and wind systems must comply with the California Environmental Quality Act (CEQA).

Energy-Generating Technology

Once you understand the facilities' energy consumption and have implemented energy efficient measures to lower the electricity use, the district can also consider energy production through renewable energy systems. Energy-generating technology is step three in achieving grid neutrality.

This section covers:

- Photovoltaic systems (converts sunlight energy to electricity through solar cells)
- Solar-thermal (converts sunlight into heat for heating water)
- Geothermal (pumps ground heat to a building for heating water and air)
- Wind (converts wind energy to electricity)
- Educational Opportunities for Students

Photovoltaic Systems (PV)

Photovoltaic systems can substantially reduce the amount of electricity you need to purchase from your utility

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California is blessed with vast resources…we rededicate ourselves to making California cleaner, greener and more prosperous. The green building approach builds in conservation from the ground up…It's good for business and it's great for the environment.

—Governor Arnold Schwarzenegger

Roof-Mounted PV/Stand-Alone Structures

Diablo Valley College, Pleasant Hill, CA
Solar Panels atop carport structures

Roof-Mounted PV

San Jose High School Academy, San Jose Unified High School District
Roof top mounted Photovoltaic

provider. In addition, the electricity generated by your PV system is clean, renewable and reliable.

Photovoltaic technology converts sunlight directly into electricity through solar cells. An inverter is used to transform the direct current (DC) from the solar system to alternating current (AC) for use in the building.

There are numerous applications for photovoltaic systems at schools, including roof-mounted PV, ground-mounted PV, shade structures with PV, building integrated PV and stand-alone PV applications.

Ground-Mounted PV

Ground-mounted PV applications require open space, which may be more feasible for districts in rural California. Installation options for ground-mounted PV include fixed array, dual-tilt, single axis tracker and dual axis tracker.

Roof-Mounted PV

Roof-mounted PV silicon-based solar panels or newer thin-film PV technologies such as “peel and stick” can be mounted on rooftops. New construction has greater roof-mounted PV opportunities since the design phase can incorporate factors for roof orientation, structural load, and slope of roof. Installation options range from roof-penetrating, nonpenetrating, flat, flush, raised rack, rolled roofing, and PV thin-film that can be adhered to single-ply roofing.

Benefits of Roof-Mounted PV:

- Increases the life span of roof covering.
- Reduces cooling loads.
- Maximizes efficiency of available square footage for PV placement.
- Lessens potential for vandalism.

Stand Alone PV Structure
Solar Scoreboards

- Closer to the utility grid point of connection.
- Lessens distribution loss.
- No underground trenching.

Shade Structure PV

PV applications can also function as shade structures where roof-mounted PV can be attached. This could be a covered lunch area, walkway, supervision area, instructional area, pick-up/drop off area, or a bus shelter.

Building-Integrated Photovoltaic (BIPV)

You can seamlessly integrate energy-generating photovoltaic technology into the design of school buildings.

Applications include:

- Roof-integrated (roof shingles), wall-integrated, overhang-integrated

“PV glass installation creates a visible statement of the sustainable design strategies ... and provides necessary sun shading ...”

—Aaron Jobson, AIA
Quattrocchi Kwok Architects

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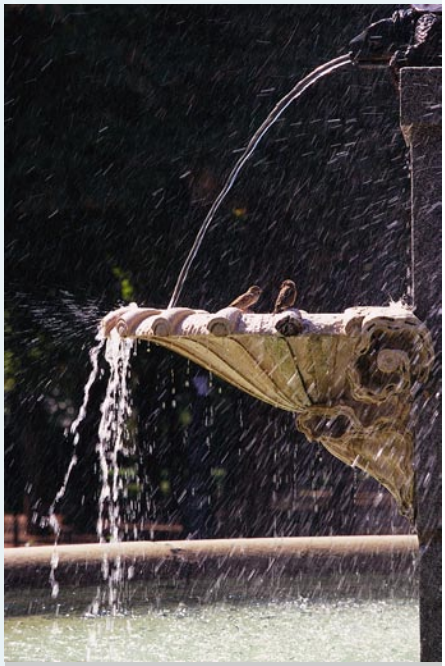


Solar pumps used to power fountains.

- PV glass for windows
- PV glazing used as shading devices
- Shade structures tied into buildings
- Rolled roofing with PV adhered to re-roofing (single-ply, high reflective)

Benefits of BIPV applications include:

- Refined design
- Easier to maintain
- Some savings in construction materials

Disadvantages of BIPV applications:

- Panels fixed in orientation
- High cost of replacement if vandalized

Stand-Alone PV Structures

There are many creative stand alone ways to offset electricity use. Light fixtures, water fountains, scoreboards, even restroom and attic exhaust fans can be equipped with photovoltaic panels and help lower the electricity needs of the campus. This also saves on the conduit and trenching required to bring electricity to the source.

Solar Thermal Converts Sunlight Into Heat

Solar thermal technology converts sunlight into heat for heating water and air. The California Solar Energy Industries Association estimates that solar thermal technology can meet 50 to 75 percent of water heating needs while reducing greenhouse gas emissions.

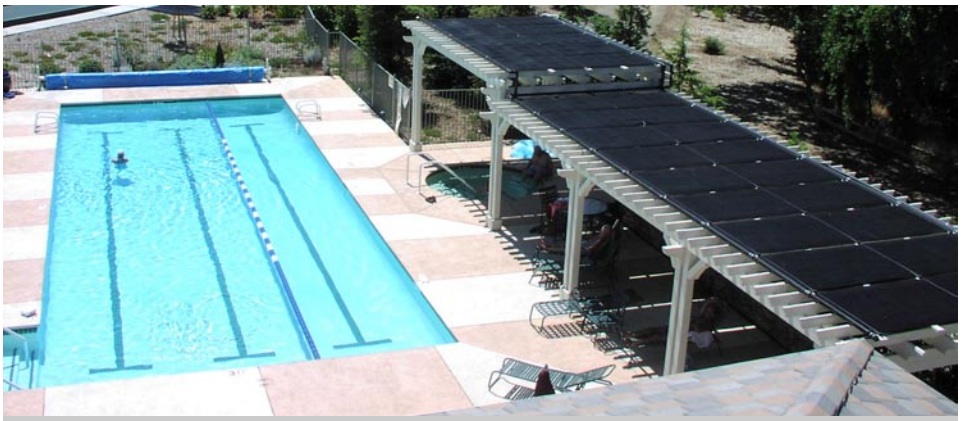
Examples of solar thermal applications include:

- Hot water for schools (lavatories, showers, cafeterias)
- Pools
- Space heating
- Space cooling

Geothermal Heat Pumps Transfer Heat From Ground

Regardless of how efficient conventional heating and cooling systems are, they still use or depend on fossil fuels (e.g., natural gas) which produce greenhouse gas.

Geothermal heat pumps remove the need to burn fossil fuels for heating and cooling. They operate by transferring heat from the earth rather than creating heat. Geothermal heat pumps transport water through a closed-loop system in



Solar Thermal Flat Plate Collectors atop shade structure trellis

the ground Geothermal heat pumps are for radiant heating and cooling, which is more effective than air distributed by mechanical ductwork, and essentially replace cooling towers, chillers, and boilers.

Benefits of Geothermal

- Reduced energy costs - 20 to 60 percent
- Reduced maintenance costs - 20 to 50 percent
- Design flexibility
- Improved comfort—individual room control
- Quiet operation
- No air quality or fire safety issues
- Saves water compared to evaporative cooling
- Low life-cycle costs

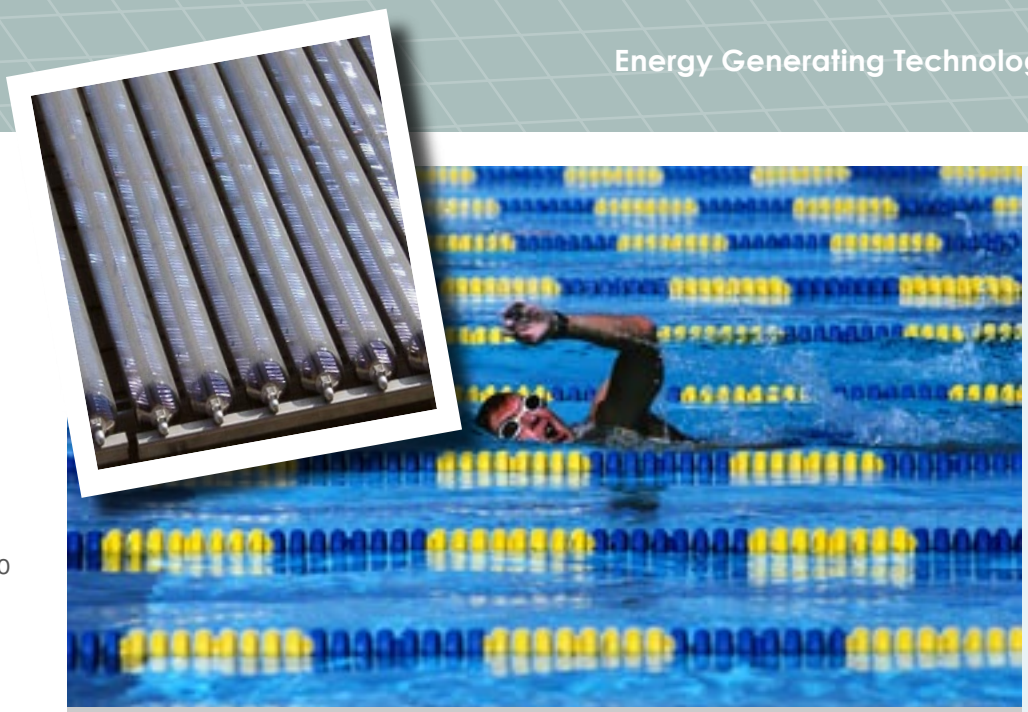
Disadvantages of Geothermal

- Uses electricity
- Costs more on the front-end for drilling a pipe installation; however, new single pipe technology is helping bring down costs

Wind Energy Technology Converts Wind Into Electricity

Wind technology is a clean source of electricity that also assists with reduction of greenhouse gas emissions.

New technologies for wind are currently being developed to incorporate wind into building structures. Climate zones play a large role in whether wind is right for your district's location. Standard three-bladed, small-to-mid-scale wind turbine technologies are commonly used at schools.



Solar thermal evacuated tubes; a second solar heating technology for swimming pools.

For large wind there are three basic project models:

- Behind the meter (a wind turbine sized to less than the school load is used to decrease energy bills)

- A community-scale wind turbine
- Piggybacking (for example, the school or community develops a financial agreement with a large-scale wind farm nearby)

Sculptural structure with solar panels on skin and structure to capture the wind power.

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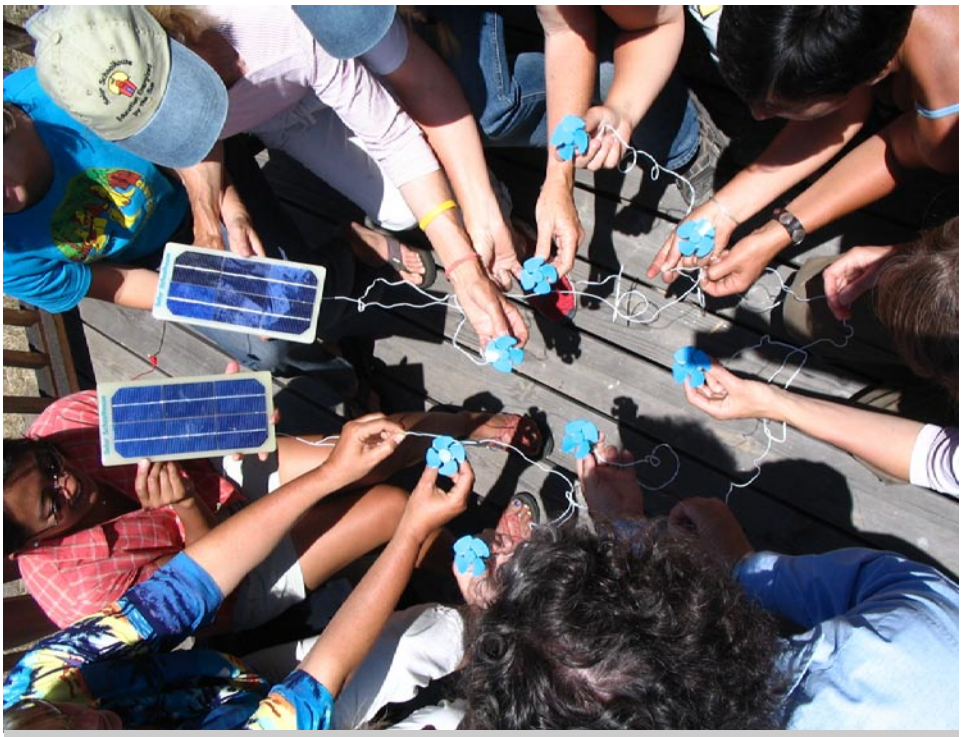

Integrating solar PV into classroom curriculum

Consider adopting existing energy education materials for K–12 schools from the National Energy Education Development (NEED) Project, the National Energy Foundation (NEF) and the Alliance to Save Energy (ASE)

Key Considerations for Energy-Generating Technology

When evaluating renewable energy options, school districts need to consider the performance and reliability of the system, verify the qualifications of the suppliers, ask how they will evaluate the performance of the system and maintain the system.

Educational Opportunities for Students

The potential for incorporating energy-generating technology into education and curriculum is enormous.

The following are just a few suggestions.

- Hands-on experiments and curriculum provide discovery moments by allowing students to see, hear, and experience energy generating technologies.
- Kiosks and reporting tools, complete with renewable energy systems, provide students opportunities to calculate energy production and greenhouse gas emissions, and compare data with other schools.
- Outdoor and weekend activities reinforce math and science components of renewable energy systems.
- Locate signs next to renewable energy systems describing their components and identifying their function.
- Install signs to encourage energy conservation measures, like reducing plug loads.
- Provide energy-awareness training for teachers and students.

Involving M&O staff in the grid neutral project

Maintenance and Operations

Grid neutral projects present a tremendous opportunity for cultural change in school construction projects and how you operate your facilities. Districts need to tap into their in-house maintenance and operations (M&O) staff throughout the process to ensure success. These are the folks who know the nuances of the school's existing site and equipment. They are often the ones tasked with maintaining and operating the new energy systems. Strengthening the M&O staff is primarily a component in step four of the key steps of achieving grid neutrality; however, the M&O staff are key players in planning energy projects, too.

This section discusses:

- How to involve M&O staff throughout the phases of building a grid neutral school
- The types of M&O evaluations that need to happen
- Necessary training and education

Involving M&O Staff in the Grid Neutral Project

M&O staff should be involved in all stages of decision making and development for grid neutral projects. Bringing M&O staff in early will also entail earning their trust. The following lists M&O staff functions in relation to the construction phases for a grid neutral project.

PRE-CONSTRUCTION

- Pursue grid neutral as agents of change to promote grid neutral
- Provide evaluation and assessments (See "Conducting M&O Evaluations" in this section)

PLANNING

- Provide input on existing policies/standards/equipment/systems
- Receive education on new policies/standards

> **Having M&O folks in at the beginning will have a profound impact on the project!**
>
> *—George Parker*
> *Director of Facilities*
> *Yuba City USD*

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Use the following checklist as a starting point for drafting an initial Request for Proposal for the energy generating system. Consider the financial needs of the district in relation to the project.

CHECKLIST FOR AN ENERGY GENERATING SYSTEM

- ☐ Cost and kilowatt hours (savings)
- ☐ Performance
- ☐ Location
- ☐ Reliability
- ☐ Safety
- ☐ Longevity
- ☐ System provider's ability to provide "full service" agreement
- ☐ Low risk of voltage drop
- ☐ Minimum impact from temperature changes
- ☐ Does not degrade quality of grid energy consumption
- ☐ Meets UL 1741 standard for solar inverters
- ☐ Multifunctional (e.g., shade)
- ☐ Self-cleaning
- ☐ Educational component
- ☐ Theft and vandalism resistant
- ☐ Vibration-free for wind

Retro-commissioning ensures that installed systems continue to operate the way they were designed.

PROJECT DESIGN

- Involve in electronic plan review
- Identify issues with maintainability, security and potential vandalism

CONSTRUCTION

- Continually present to observe systems and equipment being installed
- Involve in scheduled construction meetings
- Become familiar with maintenance that will be required of new systems and equipment
- Verify access to equipment and request photos of concealed components as needed
- Identifiy deficiencies/resolutions
- Review substitutions/"as builts"/ change order documents and identifiy issues of M&O concern

CONSTRUCTION: Project Acceptance

- Review commissioning plans and observes while commissioning agents conduct their reviews at the site
- Receive training within six months if there are updates to the system
- Participate in "punch list" of outstanding items needed to be completed
- Receive, review and file warranty documentation, operations and equipment manuals, and scheduled maintenance documents
  - Clarifiy their role under warranty period
  - Receive training for the first warranty year
  - Address warranty issues with installer/manufacturer

POST-CONSTRUCTION: Ongoing Operation

- Identifiy construction defects:
  - Two years after acceptance
  - One year after warranty; request outside resources after project acceptance
- Develop plan to test systems periodically on a fixed schedule
- Develop plan to recommission building
- Plan for long-term and ongoing M&O
- Provide proper maintenance and training.
  - Systems should come with a replacement schedule for roofs, AC and PV
- Measure and monitor system performance
- Understand roles and responsibilities as related to third party Power Purchase Agreements to maintain PV systems
- Obtain all final "as-built" drawings and store in electronic format

M&O Evaluations

M&O evaluations help the district to evaluate the current state of M&O equipment and staff required against what will be required to achieve grid neutral. To do this, districts should evaluate existing energy policies and standards, M&O staffing, facility use, and energy use. Policies and standards evaluation of grid neutral projects will bring change to existing policies and energy standards, since the M&O model has itself changed over time. For example, in post-war construction, schools went from central heating and cooling systems for the entire school to decentralized systems for each classroom. Grid neutral goes back to a more central approach. Evaluations include:

Project Overview:

Butte College Photovoltaic System

Butte Community College, PV Installation

The Butte College Facilities Master Plan Committee released a comprehensive program for a phased approach to going grid neutral by 2015. Phase I included a one-megawatt solar field that generates 1.6 million kilowatt hours annually and provides 25 percent of the college's total energy. Phase II continues efforts to contain and reduce electrical costs by developing financially viable solar projects based on analysis of each electrical meter. The criteria set forth for each potential project was:

- The total maximum annual payment for both the cost of the solar installation and any residual utility cost must not exceed current annual cost of electricity for each meter.
- The annual payment for the solar project must remain fixed with no escalators attached.
- The payment must result in ownership of the system by the District.
- The payment period must not exceed 20 years.
- All meters need to be analyzed.
- The proposals must include a viable financial partner and contractual methodology.
- The contractor and contractual methodology must demonstrate a successful track record.

- Evaluate district's existing performance goals.
- Evaluate existing M&O policy and procedures. For example, if you have a policy of no appliances such as "no refrigerators in classrooms" and if that policy is not enforced, then it's not effective.
- Acknowledge the role of teachers in M&O in respect to the teachers' awareness of energy consumption in their classrooms.
- Evaluate facilities' energy policies.
- Add M&O staff to meetings with the architectural/engineering team.
- Assess existing facilities energy efficiency criteria.
- Assess utility meters and rate structures. For example, some sites have five meters and are paying different rates for each one. Utilities will do rate schedule analysis at no cost.
- Evaluate existing energy systems.
- Locate and update M&O manuals.
- Evaluate M&O staffing needs and assess numbers of in-house staff versus contractors, and assess the ratio of staff assigned to preventative maintenance versus corrective maintenance.

Facility Evaluation

- Evaluate building site

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Infra-red analysis is a tool used to detect air & moisture leaks.

  - Are there opportunities for installing and locating renewable energy systems on-site?
  - What is the existing buildings' orientation for roof-mounted systems? What would be the orientation of new stand-alone or shade structures?
  - Are there any constraints for renewable energy systems associated with the site? For example, do you have land available for a geothermal heat pump system?
- Evaluate building use
  - What is the monthly schedule like for the building? For example, is school in session year-round?
  - What are the hours of operation for the building?
  - Will the building or site be used jointly by other organizations for community functions on weekends (for example, a community pool, or multipurpose room)?
  - Which areas of the building require more electricity (for example, gyms, shops, multipurpose)?
- Evaluate major energy-using equipment
  - What is the condition and lifespan of existing energy using equipment such as HVAC?
  - How efficient is the existing equipment?
  - What is the condition of portables and are they leased or owned?
  - How much electricity is used by staff and where?
  - Is there an opportunity to have some equipment turned off when not being used to reduce plug loads?

Energy Evaluation

- How much electricity are you using? (kWh /sq. foot)
- Where is the electricity being used? (percentage of HVAC, lighting)
- What is the potential for retrofitting or replacing existing equipment?
- What are the commissioning needs? – Retro-commissioning for older schools – Commissioning for new construction
- Evaluate existing energy management systems. Does M&O staff use system capabilities to capture the energy use of facilities?
- Building occupancy profiles—How much energy is being used and when?

Conduct Investment-Grade Energy Audit

This audit can be a comprehensive planning tool that provides information on existing systems and identification of cost-effective energy conservation measures.

Needed Training and Education

Remember that *people* operate buildings; buildings do not operate themselves. Changing the existing culture of energy consumption in the classroom will result in immediate energy savings to schools. There is both an educational (the "why") and training (the "how") component to this cultural shift.

EDUCATION (The "Why")

Districts need to invest in educating M&O staff about the renewable energy systems, and why these systems need

proper maintenance and operation. Some suggestions to make change include:

- Create awareness of the need for energy monitoring and management systems.
- Foster M&O learning communities on green technologies so M&O staff become agents of this change.
- Emphasize the value of integrating M&O staff into other energy conservation efforts at the campus.
- Continually measure and monitor performance of renewable energy systems.
- Assemble a campus guidebook that creates energy advocacy in students, teachers, administrative staff and M&O staff.

TRAINING (The "How")

- Training on how to operate energy management systems
- Add funding for maintenance, training, and support from the vendor in the contract for renewable energy systems.
- Training for any controls (light, PV) in classrooms or buildings to all users
- Function, operation, maintenance training for all staff on campus with in depth training for M&O staff
- Performance measurement
- Provide proper and up-to-date signage to ensure energy conservation in classrooms is understood and practiced.

Teaching solar energy and integrating energy into classroom curriculum

> **"The students in the building are the only sustainable members of the school community to carry energy efficiency into the next century."**
>
> *—Larry Schoff, P.E.*
> *Energy Efficient Solutions*

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Self funded options include public/private partnerships.

Innovative Funding

California's school districts want to be energy efficient and incorporate sources of renewable energy. But the question really comes down to funding. Fortunately, there are many funding opportunities available. This section outlines the considerations for evaluating funding options and provides an overview of the current funding sources.

Determine Who Will Own the System

This means that you provide the up-front installation costs through your district's capital fund, or through another financing option such as a bond, loan, or lease payments. The district is also responsible for all maintenance and operations.

Advantages of Ownership

- Increased building value with the addition of the renewable energy system(s)
- A hedge against escalating energy costs
- Cost of system is known
- Less contractual complexity

The other option is to have the renewable energy project hosted by a third party owner referred to as the "provider." You don't pay for the up-front installation costs nor any associated maintenance and operations costs. Instead, you pay the provider for the electricity the system generates similar to the way you pay the utility bill now. This is typically done through a Power Purchase Agreement, or PPA.

Advantages of Third Party (PPA)

- No capital costs (some administrative costs)
- Predictable electricity rates for term of contract (typically 15 to 20 years)
- Option to purchase system at fair market value after set time period per agreement

A Power Purchase Agreement (PPA) is a long-term contract to buy power from a specific energy provider, usually at equal to or less than market rates. Solar PPA providers install and maintain solar facilities on customer rooftops or properties. As a solar PPA customer, you pay for the solar power—not the solar equipment or installation.

The overriding question school districts must ask when evaluating funding sources is "who will own the renewable energy system?" The first option is simple—you, the district owns it.

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The energy efficiency and/or renewable projects must be part of the stated goal of the General Obligation bond for passage.

Office of Public School Construction and the State Allocation Board

The Office of Public School Construction serves as staff to the State Allocation Board and is responsible for providing State funding to eligible school districts for new construction and modernization of local public school facilities. This includes awarding funding to support the development of high performance "green" schools. For more information, visit the OPSC/SAB web site at http://www.opsc.dgs.ca.gov/AboutUs/aboutOPSC.htm.

- Third Party operates and maintains equipment, and monitors and meters performance.

"Free Money" Programs

Being good stewards of our resources is not only the right thing to do; it also comes with incentives.

Office of Public School Construction (OPSC) and the State Allocation Board (SAB)

In 2007, Assembly Bill 127 set aside $100 million through the High Performance Incentive (HPI) Grant program to promote the use of high performance attributes in new construction and modernization projects for K–12 schools. The plans go through the regular plan check process for schools at the Division of the State Architect with an additional review done by the High Performance Schools Section; they are verified with a final score. Depending on the type of green features incorporated into the design, the grant can increase the OPSC base grant amount by 2 to 10 percent.

OPSC grants require matching funds by the district. Currently, there is approximately $86 million still available of HPI grant monies.

California Energy Commission Bright Schools Program

This program provides technical assistance for identifying energy efficiency opportunities in existing and planned school facilities. This includes up to $20,000 toward investment-grade audits.

Utility Rebates and Incentives

Utility companies offer rebates and incentives for energy-efficient new construction, retrofits and commissioning. The California Solar Initiative rebate pays on either system performance or as a one-time, up-front rebate after installation, depending on the size of the system. Small systems under 50 kilowatts currently can receive the up-front rebate.

Savings-By-Design

This rebate program encourages high performance, nonresidential building design and construction through incentives for the design team and owner for exceeding the State's building energy efficiency standards (Title 24) by at least 10 percent. Savings-By-Design is run by the four major investor-owned utilities (PG&E, Southern California Edison, Southern California Gas, and San Diego Gas & Electric).

Mello-Roos

These land-secured bonds provide a voter-approved source of revenue that leaves the district's general fund intact. Property owners agree to put a lien on the project property and pay off the lien through an annual special tax.

Borrow-to-Buy Programs

This category includes a low-interest loan from the California Energy Commission, tax-exempt financing, and little- or no-interest bonds.

Tax-Exempt Financing

General obligation bonds:

> General obligation bonds provide a voter-approved source of revenue that leaves the district's general fund intact. This mechanism is an alternative for incremental funding and is used to fund big infrastructure projects and not smaller projects like lighting retrofits.

Certificates of participation:

> Certificates are issued to finance construction and acquisition of

Project Overview:

Borrow-to-Buy
Anderson Union High School District Photovoltaic System

CEC Energy Efficiency Loan Program

Utility Rebates – California Self-Generation Incentive Program

In addition to PV, the project also included energy efficient lighting, controls, chiller for administration building and recommissioning. Here is the cost breakdown:

Total Project Cost	$2,017,500
PG&E Rebate	$857,000
CEC Loan	$1,160,000
Cost Savings	$118,333/year
Simple payback after rebate	9.8 years

school facilities and purchases of equipment. They are secured through lease payments made by the district's general fund or through a combination of the general fund and available funds such as Mello-Roos. No voter approval is required.

Tax-exempt lease:

The California School Boards Association offers the Flex Fund, which provides tax-exempt financing for school projects (energy and non-energy).

The California Energy Commission's (CEC) Energy Efficiency Financing Program

The California Energy Commission's (CEC) Energy Efficiency Financing program provides a fixed 3.95 percent low interest loan for feasibility studies and installation of energy-saving measures. The maximum loan amount is $3 million per application.

Charter schools are not eligible for the CEC loan. However, they can take advantage of CEC's Bright Schools program.

Qualified Zone Academy Bonds (QZAB)

These taxable bonds give investors a federal tax credit in lieu of interest payments. QZABs require a private business partnership contribution of at least 10 percent of the bond amount, and are used for rehabilitating facilities and upgrading equipment/technology.

Federal Clean Renewable Energy Bonds

Modeled in part after QZABs, CREBs provide an interest-free loan for renewable energy projects. The federal government provides a tax credit to the bondholder in lieu of the district paying interest.

Self-Funding Options

This category includes self-funded renewable projects through the district's general fund, third-party financing through Power Purchase Agreements (PPAs), and third-party municipal lease financing, typically through an Energy Service Company (ESCO).

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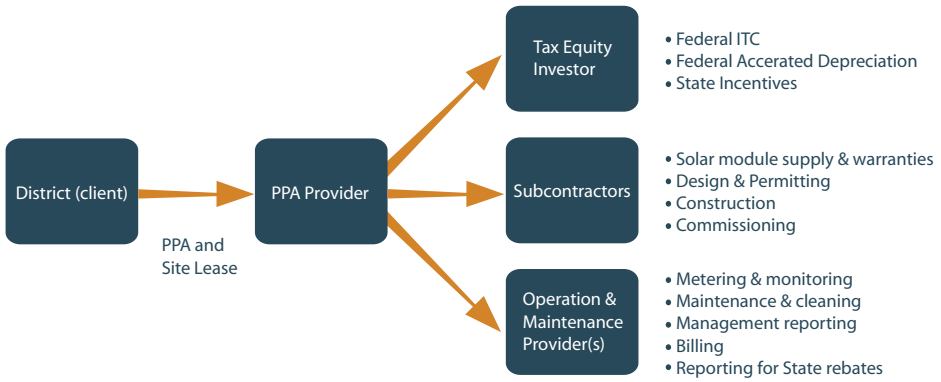
How Power Purchase Agreement (PPA) Works



Third-Party Power Purchase Agreements (PPA)

Power Purchase Agreements enable the third-party owner to leverage federal tax credits and take advantage of depreciation and utility incentives. The 30 percent federal investment tax credit is available to taxable entities.

Federal Tax Incentives

The Emergency Economic Stabilization Act of 2008 extends federal investment and production tax credits for renewable energy.

Accelerated Depreciation

Accelerated depreciation is available on the depreciable basis of the system on the portion of the cost that is not covered by rebates or grants. The five-year accelerated depreciation remains effective beyond 2008.

Third-Party Financing (Energy Service Company)

An Energy Service Company (ESCO) provides services that include energy audit, construction management, project financing, project monitoring and guarantee of energy savings, equipment and M&O. ESCOs are not eligible for tax-exempt financing, so the financing they offer has higher interest because they are a taxable entity. Most ESCOs encourage schools to secure tax-exempt financing for their recommended projects.

Evaluate Return on Investment

While third-party ownership provides an innovative funding solution, it may not necessarily be the best option for your district. Districts should conduct an evaluation (with the help of the "dream team" discussed earlier) to assess the feasibility of the different ownership and funding methods relative to the initial capital outlay required, financial complexity, administrative complexity, and operational savings.

Life-Cycle Cost Analysis

Life-cycle costing is a decision-making tool to calculate and compare different designs to identify which is the best investment. Districts can use this formula to assess the total cost of ownership for a facility over its lifetime. Life-cycle cost analysis is the key to making comparisons between energy generating and efficiency measures, resulting in strategies with the lowest long-term cost of ownership.

Grid Neutral Funding Options

"Free-Money"

OPSC Matching Funds

New Construction Funds

Modernization Funds

High Performance Incentive Grants (K–12)

Utility Incentives (PG&E, SCE, SDG&E)

Savings By Design (new construction)

Commissioning

Retro-Commissioning

Utility Rebates

California Solar Initiative

Energy efficiency rebates

Bright Schools Program: fechnical assistance for energy efficiency project identification

Emerging Renewables Program: rebates for wind and fuel cell renewable energy generating systems

Geothermal Resource Development Account: funding for geothermal development

Flex Your Power: provides information about where to get utility rebates and other funding

Mello-Roos

Individual Grants and Donations

Borrow to Buy

Tax-Exempt Financing

General Obligation Bonds

Certificates of Participation

Tax-Exempt Lease

Qualified Zone Academy Bonds

Federal IRS

Clean renewable energy bonds

CEC: Energy Efficiency Financing Program

Self-Funding Options

District General Fund

Third-Party Power Purchase Agreement (PPA)

Federal Tax Incentives

Accelerated Depreciation

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Conclusion: Grid Neutral and Beyond

The opportunity to go grid neutral is now. This guidebook provides the markers for getting you there. Assemble your dream team and draft a district resolution. Measure your energy use and set performance goals. Make existing facilities more energy efficient and design new facilities using CHPS or LEED criteria. Install renewable energy systems such as solar, geothermal, and wind. Capture additional cost benefits by monitoring and maintaining your energy production. And finally, choose the financing method that makes the most business sense for your district. Remember that there are numerous resources available and many workshop participants who can help you through the process.

So what's the next opportunity after grid neutral? Many workshop participants asked this very question and wondered why the workshops did not focus on zero net energy. The reason being that grid neutral is an excellent starting point for school districts, something achievable and electricity is the largest energy consumer in buildings. However, this does not preclude districts from tackling total energy independence and going beyond grid neutral. Other districts have—your district can seize this opportunity. Grid neutral is a huge step in the right direction… Start planning for a grid neutral campus now!

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I would like to thank all the enthusiastic and knowledgeable people who participated in these workshops and who helped to formulate this information along with Butte Community College as the facilitator and curriculum developer. In the future, I plan to launch a grid neutral course through my Division of the State Architect Academy that works with design professionals and school districts.

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We'd also like to thank workshop participants, Green Technology Magazine, and Pechora Studio for the use of their exquisite photographs and drawings.

General Information

Department of General Services
www.dgs.ca.gov

Green California
www.green.ca.gov

Office of Public School Construction
www.opsc.dgs.ca.gov

California Building Standards Commission
www.bsc.ca.gov

Air Resources Board
www.arb.gov

California Public Utilities Commission
www.CaliforniaEnergy Efficiency.com

United States Department of Energy
www.energy.gov

Energy Measurement

For tracking and benchmarking energy use by Portfolio Manager:
www.energystar.gov

Energy Efficient Design

California Public Utilities Commission

Energy Efficiency Strategic Plan
www.CaliforniaEnergyEfficiency.com

For rating systems for energy efficient design criteria:

Leadership in Energy and Environmental Design (LEED) for Schools
www.usgbc.org

Collaborative for High Performance Schools (CHPS)
www.chps.net

Innovative Funding

For financing opportunities through California Energy Commission
www.energy.ca.gov/efficiency/brightschools/index.html
www.energy.ca.gov/efficiency/financing/index.html

For “The Customer’s Guide to Solar Power Purchase Agreements”: California Solar Initiative
www.gosolarcalifornia.ca.gov

Samples of Power Purchase Agreements used by LACCD and Milpitas USD:
www.laccdbuildsgreen.org/building_green_resources
www.musd.org/cms

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