On-Site Commercial Solar PV Decision Guide

For the Healthcare Sector

4 August 2015

Acknowledgments

This report was prepared by Navigant Consulting, Inc. under the guidance of Andrew Mitchell, Amy Jiron, and Kristen Taddonio of the U.S. Department of Energy's Better Buildings Alliance program. We would also like to thank the following contributors and reviewers:

- Erin Richmond, JDM Associates
- John Jameson, ICF International
- Rick Avery, Healthcare REIT
- Tommy Sunderland, Borrego Solar
- Kyle Kearney, Borrego Solar
- Sarah Horn, Borrego Solar
- Jim Johnson, Madera Community Hospital
- Thomas McNamara, NSLIJHS Southside Hospital
- Kevin Feyen, Gundersen Health System
- Tom Thompson, Gundersen Health System

Disclaimer

This report should be viewed as a general guide to best practices for end users in the healthcare sector who are considering the installation of a solar photovoltaic array. A qualified professional engineer or solar installer should always be contracted to oversee a photovoltaic project.

Table of Contents

Introduction

The Better Buildings Alliance works to develop and deploy innovative, cost-effective, energy-saving solutions in U.S. commercial buildings. According to the Department of Energy, hospitals and other healthcare facilities consumed more than 8% of the total energy used in U.S. commercial buildings in 2012 and spend more than $8 billion on energy every year. A hospital with 1 million square feet uses 2.5 times as much energy as a similarly-sized office building, making healthcare the second most energy-intensive building sector.[1] Additionally, according to the Healthier Hospitals Initiative, healthcare energy costs rose 56% between 2003 and 2008.[2] As large energy consumers, healthcare providers are becoming increasingly aware of energy saving opportunities.

Healthcare survey responses collected by Pepper Hamilton in 2011 indicated that 58% of respondents considered energy management a top priority, and 67% intended to make a facility improvement in energy management in the next year.[3] Reasons included:

- Concern for the environment,
- Expectations to be a community leader,
- Cost savings,
- Expectation of future increased energy costs, and
- Desire to enhance the reliability of the energy supply to healthcare facilities.

Hospitals and care systems are increasingly looking for ways to improve efficiency and reduce overall costs–while improving patient experience. As part of this, more hospitals are pursuing LEED certifications[4] and seeking other means to achieve energy and sustainability goals. This guide focuses on solar PV as a means for healthcare facilities to reduce electricity consumption and operating costs as well as showcase a commitment to public health.

In September 2014, the Better Buildings Alliance Renewable Integration Project Team published the On-Site Commercial Solar PV Decision Guide for commercial buildings. Building on this work, the On-Site Commercial Solar PV Decision Guide for the Healthcare Sector is intended to serve as an additional, targeted resource to address specific solar PV barriers and help drive solutions for hospitals and other healthcare facilities, including long-term care providers, laboratories, retirement communities, and outpatient facilities. This guide will not duplicate the information presented in the On-Site Commercial Solar PV Decision Guide, and so these guides should be approached as a complementary set of resources.

Benefits and Barriers of Solar PV for Healthcare

Benefits of Solar PV for Healthcare

As hospitals and other healthcare facilities looks for ways to reduce energy consumption and/or increase

[1] Whitson, 2012. The food service industry is the most energy-intensive (U.S. DOE EERE, 2012).
[2] "Leaner Energy." Healthier Hospitals, January 25, 2012. (healthierhospitals.org/hhi-challenges/leaner-energy)
[3] Fader et al., 2011.
[4] More information on LEED certification available at: www.usgbc.org/leed

environmental sustainability, decision-makers should consider the various, significant benefits of solar PV.

- Installing solar PV reduces electricity consumption and helps decrease the peak demand of a facility, which means the organization has lower operating costs and hence more resources for patient care.

Though renewable energy projects may have longer payback periods than some other sustainability measures and other healthcare-related capital investments, a solar PV project typically has a very **favorable return on investment (ROI)** over its 25+ year operating life. This is especially important since hospitals are using increasingly sophisticated clinical equipment and therefore have higher energy demands.

- As an energy-intensive industry, healthcare is more vulnerable to rising fossil fuel prices and price volatility than other commercial sectors. Solar energy can help protect against rising costs and volatility by decreasing utility bills and locking in electricity generation at a fixed price.
- Healthcare facilities may be considered especially compatible with solar PV because of the public health benefits of renewable energy. Solar technology provides electricity without any direct emissions, and helps reduce harmful air pollution and greenhouse gas emissions by displacing electricity generated from coal, natural gas, and oil power plants.
- Hospitals also have the option to increase energy resilience using renewable energy including solar PV. Recent natural disasters have highlighted the need for critical infrastructure improvements and the failure of typical diesel backup generators. One solution to serious power outages is reliable distributed generation, such as combined heat and power systems (CHP) and solar PV systems with battery storage. Though this application of on-site solar PV is not the focus of this guide, healthcare facilities should explore these options to increase emergency preparedness.[5]

Barriers to Solar PV in Healthcare

Although interest in saving energy is high in the healthcare sector and many organizations already target sustainability in healthcare,[6] leaders of the Better Buildings Alliance healthcare sector team and solar installers report a number of challenges faced by solar PV projects. These challenges, or barriers to solar PV, include the following:

- Hospital roofs are crowded with other equipment and there is very limited space for a solar PV array.
- Staff have limited availability to focus on energy, and many hospitals do not have a dedicated energy manager.
- Large healthcare systems are often made up of many small, autonomous organizations which complicate ownership considerations for solar PV installations and other capital projects.
- Nonprofit healthcare organizations and Real Estate Investment Trusts (REITs) cannot take direct advantage of tax benefits for solar PV projects and nonprofits may be intimidated or confused by third party financing, leading to difficulty deciding upon the project transaction structure.
- Management sees solar PV as a large investment that may not be financially viable for the organization, especially compared to new and advanced healthcare technology–the organization's core focus.

---

[5] More information on renewable emergency services for critical infrastructure may be found in the 2013 Clean Energy States Alliance report, "Using State RPSs to Promote Resilient Power at Critical Infrastructure Facilities." (www.cesa.org/assets/2013-Files/RPS/Using-State-RPSs-to-Promote-Resilient-Power-May-2013.pdf).

[6] A list of sustainability-focused organizations and publications may be found in "Resources for Healthcare" at the end of this guide.

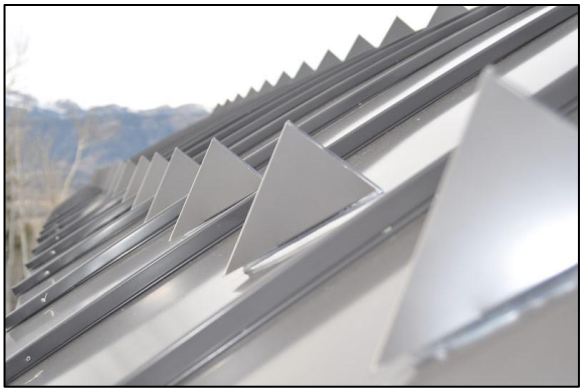
Technical Considerations for Healthcare

Installation Type

The largest technical barrier for solar PV on hospitals is the insufficient roof space due to medical equipment. Many hospital roofs are dominated by specialized medical equipment that require easy access. One solution to the roof space barrier is to design a carport-mounted solar PV array for the parking lot or parking garage. Due to the extra materials for the carport structure, these solar PV systems come with a higher price tag than roof-mounted systems. However, carports arrays also add benefits like shading cars from the sun (a valuable amenity in hot climates), sheltering cars from rain and snow, providing a convenient location for electric-vehicle charging stations, and providing a more visible commitment to clean energy than a rooftop array.

In snowy climates, hospital management may have concerns with carport structures or parking canopies shedding snow into the visitor parking lot. But in most regular storms, the snow melts before it accumulates too significantly (the array heats up as soon as the sun comes out). However, if there is a storm overnight and snow remains on the carports the following day, several preventative actions can be taken:

- The carport can be manually cleared with a roof rake by maintenance staff.
- Management can have snow rails or guards installed on the carport, retaining and breaking up the snow so there are no large pieces sliding off the structure.



Snow guards on a roof in Jackson, WY.
Photo Credit: Wikipedia Commons.

A large commercial carport-mounted PV array.
Photo Credit: National Renewable Energy Laboratory.

Alternatively, if the hospital is situated on a large property with unused grounds or owns an empty adjacent plot of land, a ground-mounted array is also a favorable option. This puts underutilized land to use and will likely also host a larger array than the rooftop type, meeting more of the building's electricity requirements. Ground-mounted arrays are also typically less expensive than roof or carport systems.

Location

It is important to note that healthcare facilities other than hospitals will often be better hosts for a solar PV array. Medical office buildings, laboratories, material management centers, outpatient facilities, and other care centers often have less rooftop equipment than a hospital or none at all aside from typical building HVAC systems, providing more space for the solar installation. Additionally, many of the alternate buildings have a smaller energy footprint than a hospital, so solar production will meet a higher percentage of the on-site electricity consumption. These facilities should not be ignored when a healthcare organization is assessing the feasibility of a solar installation.

New Construction

Building management should also keep in mind that new construction may be the best option for solar PV on hospitals because new buildings can be designed to better accommodate the PV system by positioning medical equipment to the north (accommodating south-facing or west-facing PV panels). Typical project siting considerations are further described in the 2014 Onsite Commercial Solar PV Decision Guide and a 2011 DOE fact sheet for hospitals.

The architectural community has undertaken a **"2030 Challenge"** which calls for the design of **new buildings that use no carbon-emitting energy by 2030**.[7] To accomplish this, today's target is for all new buildings, developments and major renovations to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 70% below the regional (or country) average/median for that building type. Energy-efficient design strategies and on-site renewable energy are prioritized, with a 20% cap for purchasing off-site renewable energy and/or renewable energy credits.

Gunderson Health System

Location: La Crosse, Wisconsin

Size: 56 kilowatts

Energy Production: 75,000 kWh/year

Solar Installer: Full Spectrum Solar

Financing: Cash purchase and state grant

A new hospital for Gunderson Health System was designed with a "green" underground parking ramp. The ramp has solar PV panels installed flat on the roof, as well as 100% recycled glass flooring, environmentally-friendly paint, and other measures. The solar array was the first in a portfolio of local renewable generation – including wind energy, solar thermal, geothermal, and biogas – that enabled the entire health system to achieve 100% energy independence in late 2014.

Photo credit: Gundersen Health System
www.gundersenenvision.org

Organizations planning to build new hospital buildings are recommended to take an integrated design approach to achieve a higher level of performance. For new and existing healthcare facilities, pursuing energy efficiency opportunities prior to installing solar enables the solar PV array to meet a larger percentage of the facility's needs.

[7] More information available at: www.architecture2030.org/2030_challenge/the_2030_challenge.

Operations & Maintenance

Hospitals and medical laboratories are facilities with extensive equipment needs. Additionally, healthcare facilities are highly regulated and undergo continuous maintenance, inspection, and certification. Fortunately, solar PV equipment requires little, straightforward operations and maintenance (further described in the Onsite Commercial Solar PV Decision Guide).

The National Renewable Energy Laboratory estimates average fixed operations and maintenance costs to be just $20 per kilowatt per year (lower fixed costs than comparable distributed generation including small wind, biomass combined heat and power, and fuel cells).[8,9]

Financing Solar PV for Healthcare

The Onsite Commercial Solar PV Decision Guide discusses general financing considerations for solar PV installations, including the Federal Investment Tax Credit (ITC) and depreciation benefits, types of state and local incentives, and some information on owning the system versus using a third party ownership model. Readers should refer back to that guide for additional information on this topic.

Third Party Ownership

Third party ownership structures typically involve a power purchase agreement (PPA) for the electricity generated by the solar PV array. The third party owns, installs, and operates the array, and in turn, the medical facility purchases the power generated at an agreed upon price.

For **nonprofit healthcare organizations** that cannot take advantage of tax benefits, **a PPA is likely the most advantageous financing strategy** because the third party will be able to access the tax incentives and reflect this in the electricity price (resulting in indirect tax benefits for the nonprofit healthcare organization).

Additionally, there is no direct commitment of capital by the healthcare organization and industry advisors consider a PPA to be low-risk.[10,11] The PPA model is also an energy hedge against utility rate volatility, because the agreement locks in an electricity price for an extended period of time (typically 20 or more years).

Madera Community Hospital

Location: Madera, California

Size: 1,140 kilowatts

Energy Production: 2,183,220 kWh/year

Hospital Energy Offset: 40%

Solar Installer: Borrego Solar

Expected Monthly Savings: 12-15%

Madera Community Hospital is a nonprofit organization that decided to go solar as a way to cut electricity costs. An energy service company working on the hospital's energy portfolio issued a request for proposals for a solar PV system that would provide electricity at or below the utility electric rate. A 20-year PPA agreement with Borrego Solar achieved this goal, with zero capital investment by the hospital and immediate savings of 12-15% on monthly bills. Borrego Solar is also responsible for operations & maintenance of the large ground-mounted array.

Photo credit: Borrego Solar

[8] Comparison of O&M costs of distributed generation technologies: www.nrel.gov/analysis/tech_cost_om_dg.html.
[9] SENTECH, Inc., 2010.
[10] Fader et al., 2011.
[11] Sustainability Roadmap for Hospitals: www.sustainabilityroadmap.org/strategies/financialfunding.shtml.

To begin developing a project under a PPA structure, a healthcare organization may issue a request for contractors to bid on the solar installation and stipulate a particular electricity price ($/kWh). The solar provider will design a system to meet these requirements; for example, a fixed-tilt ground-mounted PV array has a lower upfront cost than a tracking ground-mounted array, but the higher energy production of the tracking array may lower the long-term PPA price more significantly and turn out to be the best option for the customer. One example is the Madera Community Hospital (right), which successfully engaged a solar provider with a PPA rate lower than its local electric utility rate.

Direct Ownership

On the other hand, lifetime dollar savings are often higher with direct ownership. Direct ownership of the project may be the better choice if a healthcare organization has sufficient internal funds for the upfront system cost. Many hospitals have investment funds, from endowment, cash reserves, or retained earnings. The most common sources of capital for hospital project finance (in 2001-2002) were municipal bonds, for-profit debt/equity, bank loans, leasing, and philanthropy. These options can be considered when evaluating the purchase of a PV system. An in-depth guide to energy investments with these types of funds is presented in the Hospital Facility Investment Guide by BetterBricks, a Northwest energy efficiency initiative.[12] Using funds for a solar PV array can yield a higher return on investment than many other investment options.

Other Financing Considerations

When pursuing the direct ownership option, the healthcare organization should seek local and state grants to cover a portion of the solar array's costs. For example, in 2011 the Southside Hospital of the North Shore LIJ Health System was awarded a grant for its rooftop solar PV array (right). Currently, the New York State Energy Research and Development Authority (NYSERDA) NY-Sun Incentive Program offers financial incentives for solar PV systems, and further offers low-interest rate financing options for small businesses and nonprofits. Participation Loans of up to $100,000 at below-the-market interest rates and On-Bill Recovery loans of up to $50,000 at 2.5% interest are available with repayment periods of up to 10 years.[13] State funding is also available for other on-site renewable technology at hospitals; for example,

North Shore LIJ Health System – Southside Hospital

Location: Bay Shore, New York

Size: 50 kilowatts

Energy Production: 55,000 kWh/year

Expected Payback: 2 years

The Southside Hospital installed its 50 kilowatt rooftop solar array in December 2011, as part of a Hospital Administration and Engineering Department effort to curtail energy usage. The project was financed in-house by the organization and was supported by an American Recovery and Reinvestment Act (ARRA)/NYSERDA grant which reimbursed a significant portion of the cost.

Photo credit: NSLIJHS Southside Hospital

[12] Full investment guide at: www.betterbricks.com/graphics/assets/documents/FinanceGuideFinal.pdf.
[13] Program details at: ny-sun.ny.gov.

Gaylord Hospital in Connecticut was awarded a $323,000 grant from the Connecticut Clean Energy Fund for a $550,000 solar thermal hot water project in 2011.[14]

Additionally, as the PV system owner, the organization can benefit from Solar Renewable Energy Certificate (SCREC) revenue if located in a state with an active market. These states are New Jersey, Massachusetts, Pennsylvania, Maryland, District of Columbia, Delaware, and Ohio. An SREC represents the renewable aspect of the solar electricity and its value is determined by the market.

Project Planning and Execution

Planning for Solar PV in Healthcare

During project development, the solar PV project should be approved by both the healthcare organization's Chief Financial Officer and the Facilities Manager and/or Director of Engineering (or equivalent). After this, the project will likely proceed up through an executive board or other committees to the Board of Directors. This poses a small timing challenge, as a Board will typically meet only once per quarter. Larger healthcare organizations should be prepared for a slower, more incremental approval process. Having an internal champion, such as the Director of Engineering or a Sustainability Manager, helps ensure the project will make it through the longer process.

The American Society for Healthcare Engineering (ASHE) recommends integrating sustainability efforts into the organizational structure of the healthcare organization, forming permanent groups and committees such as an environmental leadership council with the Board of Trustees, directors, and vice presidents, and an overall sustainability coordinator that works with green subcommittees and departmental sustainability coordinators.[15] This would encourage multiple internal champions for solar PV and other projects.

Projects are generally more successful if ownership is invested and there is top-down motivation from management. For new buildings, the healthcare organization should maintain a vision of on-site renewable energy generation from the beginning of the project. And once existing healthcare systems adopt sustainability policies, changes must be promoted and advocated throughout the organization. Education for the hospital community is an important part of the process. Physicians, nurses, administrative staff, and facilities staff can all be part of the task force supporting sustainability measures and solar energy.

A solar PV project may be one part of a larger energy improvement portfolio at the hospital or healthcare facility. For these large-scale efforts encompassing multiple energy projects, hospitals (and many other organizations in commercial sectors) often work with an Energy Service Company (ESCO). The U.S. Department of Energy maintains a Qualified List of ESCOs, comprised of firms that have been approved by a qualification review board.[16] An ESCO is an energy project developer, typically with experience in integrating multiple efficiency measures. The ESCO may be the primary interface with the solar developer and help shepherd the project through the necessary approvals.

---

[14] mcdmag.com/2011/08/connecticut-clean-energy-fund-awards-solar-energy-grant-to-gaylord-hospital.
[15] ASHE & HRET, 2014.
[16] The DOE Qualified List of Energy Service Companies: energy.gov/sites/prod/files/2015/01/f19/doe_ql.pdf.

Executing the Project

When it comes to installing solar PV, there is one primary difference between hospitals and other types of commercial buildings: the interconnection of the PV system to the hospital building will almost certainly occur late at night. This is because hospitals typically have a consistent 24-hour load profile, with no convenient time to disrupt power for interconnection to the electricity grid. However, hospitals are already well-equipped for power outages with backup generators and there should be no risk to critical operations. Many solar installers have experience working with hospital facilities for the midnight to 2:00 AM interconnection. Medical laboratory buildings may choose to go this route as well, since many labs are also active on a 24/7 schedule.

When the installation is complete, the healthcare organization should make sure its facilities staff receive adequate training; for example, monitoring the condition of solar equipment and cleaning panels (if the organization owns the solar array directly). To reach staff outside of dedicated facilities personnel, the healthcare organization may include progress reports on the solar array's construction and an announcement of its completion in the in-house newsletter.[17]

Following project execution and internal outreach and education, the healthcare organization may be interested in external promotion for the solar project. One avenue could be participation in award and recognition programs through the various healthcare sustainability organizations listed in the next section. Additionally, educational posters, photographs, and a display screen showing construction footage and real-time electricity production can be attractive features in the main lobby to interest staff, patients, and visitors.

The 1.14 MW Madera Community Hospital ground-mounted array *Photo credit: Borrego Solar*

[17] Communication Quick Sheet: www.betterbricks.com/graphics/assets/documents/BB_CommQuickSheet.pdf.

Resources for Healthcare

There are many other resources that provide support for energy management and renewable energy implementation in the healthcare sector. A selection of these are provided below.

- **The American Hospital Association (AHA):** A national organization that represents and serves hospitals, healthcare networks, and their patients and communities. Through the three membership groups listed below, AHA sponsors the Sustainability Roadmap for Hospitals. The Sustainability Roadmap for Hospitals provides tools and resources for individual healthcare organizations to map a path to reduce impact on the environment. www.aha.org, www.sustainabilityroadmap.org/topics/energy.shtml.
- **The Association for the Healthcare Environment (AHE):** A personal membership group of AHA that supports professional development, industry information, and advocacy for the physical healthcare environment. www.ahe.org.
- **The American Society for Healthcare Engineering (ASHE):** A personal membership group of AHA representing the work of professionals responsible for care of the patient environment. ASHE created the Energy to Care program, a free energy benchmarking and awards program for healthcare facility management professionals. www.ashe.org, www.energytocare.com.

  Sample resource: "The Dawning of Power Purchase Agreements." ENERGY STAR. Inside ASHE, January-February, 2008. (www.ashe.org/resources/inside_ASHE/pdfs/2008/16_1_c.pdf)

  Sample resource: "Evaluate opportunities to use alternative and renewable energy sources." Webpage. Sustainability Roadmap for Hospitals. (www.sustainabilityroadmap.org/pims/260)
- **The Association for Healthcare Resource & Materials Management (AHRMM):** A personal membership group of AHA, and the leading national association for executives in the healthcare resource and supply chain profession. www.ahrmm.org.
- **Practice Greenhealth:** A nonprofit membership organization committed to environmental solutions for the healthcare sector, supporting better, safer, greener workplaces and communities. The Greenhealth Energy Alliance offers energy solutions to facility members such as the Healthcare Clean Energy Exchange. A pilot program called the Healthcare Renewable Energy Initiative in New Jersey and Massachusetts works with Citi Bank to finance and implement renewable energy.[18] practicegreenhealth.org/topics/energy-water-climate, practicegreenhealth.org/initiatives/greenhealth-energy-partners.

  Sample resource: The official membership magazine of Practice Greenhealth, greenhealthmagazine.org.
- **Healthcare Without Harm:** An international coalition of hospitals and healthcare systems, medical professionals, community groups, and environmental organizations promoting ecologically sound and healthy alternatives to polluting health care practices. The coalition helped develop and launch the Green Guide for Health Care (GGHC) self-certification green building rating system, a ten-year program which ended in 2011 but created many tools and resources that are still in use. noharm-uscanada.org/issues/us-canada/building-and-energy-resources.

  Sample resource: *Green Guide for Healthcare*, a best practices guide for sustainable construction and operations for the healthcare industry. (www.gghc.org)

[18] Healthcare Renewable Energy Initiative: icg.citi.com/icg/global_markets/product_solutions/healthcare_renewable/healthcare_how.jsp.

- **The Center for Health Design:** An international community focusing on improving the quality of healthcare facilities with the design of healthcare environments. www.healthdesign.org.
- **Healthier Hospitals Initiative (HHI):** A national campaign to improve environmental health and sustainability in the healthcare sector, created by Healthcare Without Harm, the Center for Health Design, and Practice Green Health. The initiative aims to enroll at least 2,000 hospitals in the U.S. over the next three years, to implement sustainable operations and measure the impact on improved patient, worker, and community health and reduced costs. www.healthierhospitals.org.

  Sample resource: "Leaner Energy." Webpage. Healthier Hospitals. (www.healthierhospitals.org/hhi-challenges/leaner-energy)
- **Healthcare Energy Impact Calculator:** A tool to estimate premature deaths, chronic bronchitis, asthma attacks, emergency room visits, and more, by energy use (kilowatt-hour per year). Based on a U.S. EPA analysis of the health impacts of power plant emissions. www.eichealth.org.
- **RES-Hospitals:** A European project from 2011-2013 that encouraged hospitals to be more strategic and sustainable about energy reduction and production, including renewable energy opportunities. www.res-hospitals.eu.

  Sample resource: *Renewable Energy Guide for European Hospitals*. (www.res-hospitals.eu/renewable-energy-guide-for-european-hospitals)

  Sample resource: *Summary Report of the RES-Hospitals Project.* (www.res-hospitals.eu/LinkClick.aspx?fileticket=5GiYUhTWsLQ%3d&tabid=741)
- **BetterBricks:** An initiative of the Northwest Energy Efficiency Alliance funded by regional utilities, providing tools and services to help improve energy efficiency, contribute to critical hospital services, and improve patient care. The High Performance Hospital Partnership is a collaboration between BetterBricks and Northwest state and regional hospital associations. www.betterbricks/healthcare.com.

  Sample resource: "The Business Imperative for Sustainability: The Seven Critical Success Factors." BetterBricks. (www.betterbricks.com/graphics/assets/documents/BB_Article_BusinessImperative.pdf)
- **Health Facilities Management Magazine:** A publication of the American Hospital Association. The magazine covers health facility design, construction, and operations expert insight and industry changes. www.hfmmagazine.com.
- **The Database of State Incentives for Renewables & Efficiency (DSIRE):** A comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States. DSIRE includes up-to-date, state-by-state policy and incentive information. The database is a useful tool to review current incentives programs for any organization considered solar energy and energy efficiency. www.dsireusa.org.

References

Burpee, Heather, Hatten, Michael, Loveland, Joel, and Stan Price. “High Performance Hospital Partnerships: Reaching the 2030 Challenge and Improving the Health and Healing Environment.” Paper presented at the annual American Society for Healthcare Engineering Conference on Health Facility Planning, Design, and Construction. Phoenix, AZ, March 8-011, 2009.

“Commercial and Industrial CHP Technology Cost and Performance Data Analysis for EIA.” SENTECH, Inc. for the Energy Information Administration, June 2010.

“Environmental Sustainability in Hospitals: The Value of Efficiency.” American Society for Healthcare Engineering and Health Research & Educational Trust, May, 2014. <www.hpoe.org/Reports-HPOE/ashe-sustainability-report-FINAL.pdf>

Fader, Henry C., Machlin, Marc D., Reinstein, Todd B., and Mark A. Solomon. “Renewable Energy for Hospitals and Health Care Provides: Solar, Wind and Cogeneration.” Pepper Hamilton LLP, May 5, 2011. <www.pepperlaw.com/resource/2149/18J1>

“Guide to Optimizing Hospital Facility Investments.” BetterBricks. <www.betterbricks.com/graphics/assets/documents/FinanceGuideFinal.pdf>

“Hospital Energy Alliance 2012 Annual Report.” U.S. DOE Energy Efficiency & Renewable Energy, October, 2012. <apps1.eere.energy.gov/buildings/publications/pdfs/alliances/hea_annual_report_2012.pdf>

“Improving Air Quality with Solar Energy.” U.S. DOE Office of Energy Efficiency and Renewable Energy, *DOE/GO-102008-250*, April 2008. <www.osti.gov/accomplishments/documents/fullText/ACC0433.pdf>

Olinsky-Paul, Todd. “Using State RPSs to Promote Resilient Power at Critical Infrastructure Facilities.” Clean Energy States Alliance, May 2013. <www.cesa.org/assets/2013-Files/RPS/Using-State-RPSs-to-Promote-Resilient-Power-May-2013.pdf>

“Renewables Make a Powerful Case as Hospital Energy Source.” U.S. DOE Energy Efficiency & Renewable Energy, July, 2011. <apps1.eere.energy.gov/buildings/publications/pdfs/alliances/hea_renewables_fs.pdf>

Sheppy, Michael, Pless, Shanti, and Feitau Kung. “Healthcare Energy End-Use Monitoring.” National Renewable Energy Laboratory, August 2014. <www.nrel.gov/docs/fy14osti/61064.pdf>

“The Renewable Energy Guide for European Hospitals.” The Intelligent Energy Europe Programme of the European Union. <www.res-hospitals.eu/renewable-energy-guide-for-european-hospitals>

Whitson, Alan. “Developing a Plan for Reducing Energy Costs in Hospitals.” Healthcare Financial Management Association, August 2012. <hcinstitute.info/download/developing-plan-to-reduce-hospital-energy-costs-hfma.pdf>


Better
Buildings®
U.S. DEPARTMENT OF ENERGY