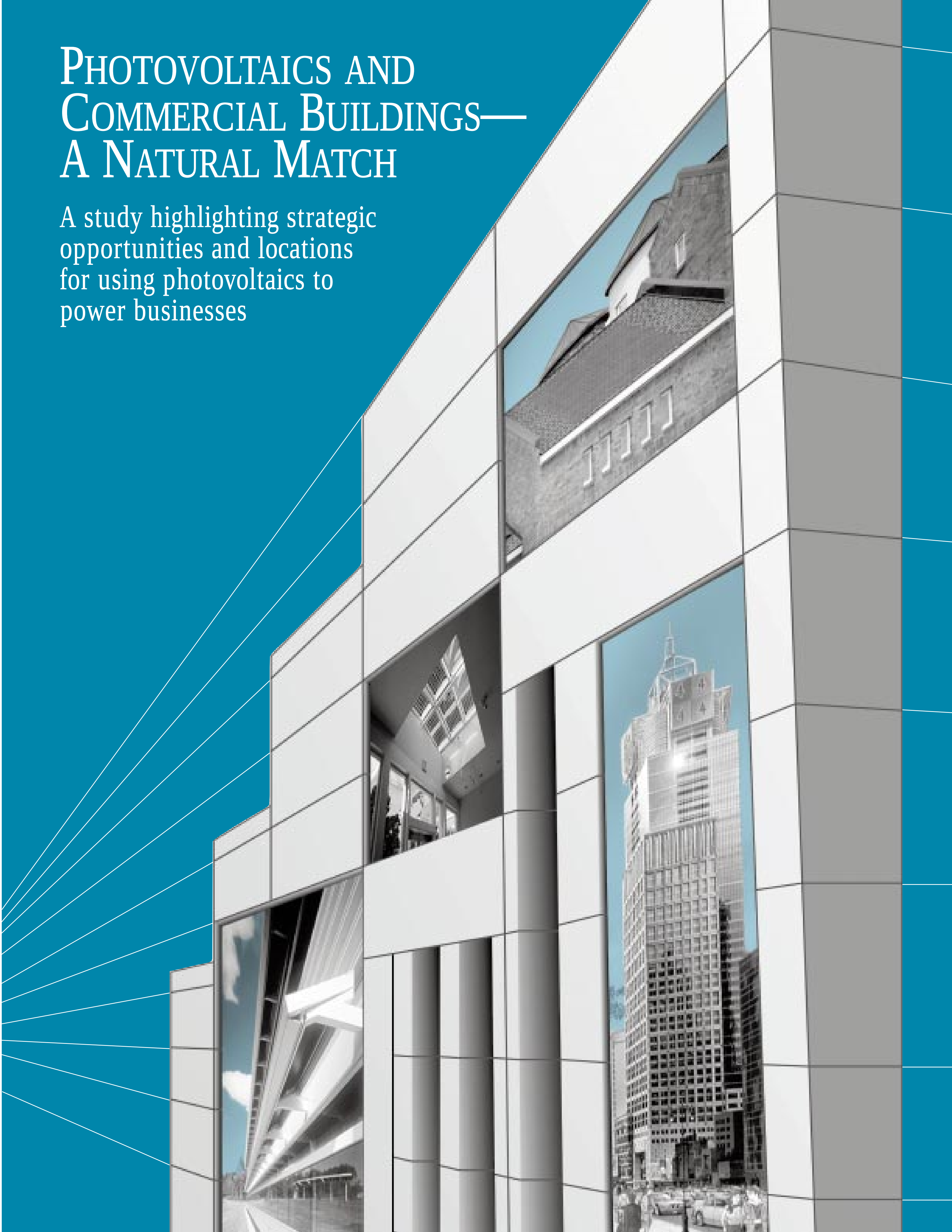
Photovoltaics and Commercial Buildings—A Natural Match

A study highlighting strategic opportunities and locations for using photovoltaics to power businesses



Should PV Be in Your Business Plan?

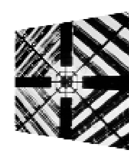
Most people know that solar energy is *environmentally* attractive—and that photovoltaic or PV systems have made great *technical* strides over the past 10 years.

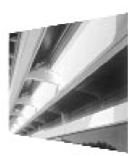
But PV systems can be *economically* attractive as well, especially for *commercial* users. Costs are coming down and the efficiency of converting sunlight into electricity is going up—enough so that PV energy costs in certain regions of the United States are now comparable, or nearly so, to energy supplied from the utility power grid.

The geographic region is important not only because it relates to the amount of sunshine, but also because the cost of grid-supplied electricity varies considerably from region to region. For example, the average cost of electricity for commercial users in Hawaii is more than three times the cost in Idaho. Another variable on a state-by-state basis is whether tax incentives exist that are favorable to renewable energy sources such as PV. So, where users reside affects their power costs, which, in turn, affects whether other power options such as PV might be economical.

Business owners and commercial users are uniquely positioned to capitalize on other important factors:

- PV's electrical output matches well with patterns of energy use in commercial buildings, promoting effective management of electricity demand.
- PV applications are now being integrated directly into building roofs, envelopes, and surrounding spaces—and these technologies are evolving rapidly.
- The commercial-building sector is adding 50 square kilometers of roof space each year—an area suitable for a potential 3000–5000 megawatts of PV power.
- Net metering is not an issue—commercial buildings generally have large minimum loads, and PV systems can be sized to avoid supplying power to the grid.
- Business-owned PV systems convey tax advantages, such as accelerated depreciation and a federal income tax credit.





The 1-2-3 Approach

In our technical report, *Valuation of Demand-Side Commercial PV Systems in the United States*, we sought to measure the cost of electricity for commercial users. Specifically, we examined the cost of PV-produced electricity versus that supplied by the power grid, using a realistic and comprehensive methodology. In brief, this is how it works:

Step 1. The primary index of economics used is the break-even turnkey cost (BTC), expressed in dollars per kilowatt of alternating current at summer operating conditions. Under our assumptions, PV systems priced below the BTC for a given location are economically viable—meaning that *the higher the BTC, the better the fit for PV power*.

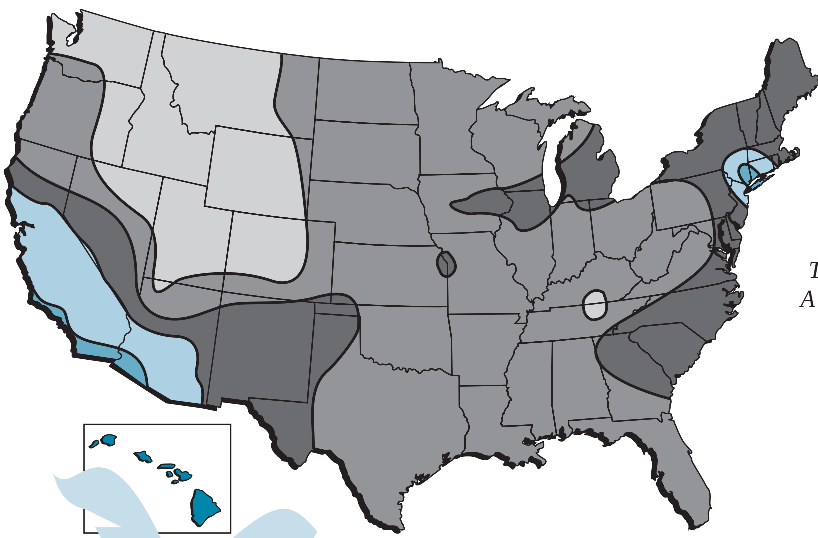
Step 2. The BTC of a PV system is derived from a set of financial parameters and the financial value it brings to its owner. Most of the financial parameters, such as the long-term loan rate and the construction period, are fixed across every location. Other values vary according to geographic locale or political subdivision. The solar resource, including the amount of energy produced by the PV system and its effective capacity (or ability to reduce local demand), is one variable; another is the financial value of energy and capacity as measured by local energy and demand retail rates.

Step 3. To determine the value of energy and capacity, we contacted 143 major electric utilities, accounting for more than 80% of the U.S. installed electric generating capacity. This information was gridded and contoured across a map of the United States so that any point of interest could be assigned a value. The BTC for a given location was determined through a standard life-cycle discounted cash flow analysis (see table on back page).

Where the Cost Is Right

It's in Hawaii. And, with BTCs in the $5,000 per kilowatt range, the cost is close to break-even in the southwestern United States—mainly California and Arizona—and metropolitan areas of the northeastern Atlantic seaboard. Both regions feature high utility rates and high PV effective capacities. Regions with the lowest BTCs are the Pacific Northwest and the Appalachians (both have very low rates and low PV effective capacities) and the northern Rockies. In the central/south region, relatively low utility rates tend to offset much of the observed high effective capacities, while in Florida, both low rates and modest effective capacities tend to offset high energy production. The map shown below demonstrates these results for the "maximum-power PV array configuration," an option using a two-axis tracking system that always keeps the PV panels oriented toward the sun.

Similar to our previous study highlighting the best residential PV markets, Hawaii leads the pack for commercial PV viability. There, the BTC for the best-performing PV array configuration averaged $11,000 per kilowatt, thanks to a combination of fairly large effective capacities, high retail rates, and very substantial local tax incentives.



BTC from Coast to Coast

Buying PV at today's price of about $6 per watt makes this power source economical in places where the BTC is $6,000 per kilowatt or higher. The commercial PV viability winner is Hawaii—with California, Arizona, and New York City following closely behind.

Break-Even Turnkey Cost (BTC) per Kilowatt

These figures are based on a two-axis tracking PV system. A fixed-tilt PV system reduces the BTC by roughly $1000/kW at the high end and $500/kW at the low end.

- <$2,000
- $2,000–$3,000
- $3,000–$4,000
- $4,000–$5,000
- $5,000–$6,000
- $6,000–$15,000

Spotlighting Hawaii's Mauna Lani Bay Hotel

This sprawling hotel had acres of roof space, making it the perfect host for a photovoltaic system. In one intelligent stroke, the hotel's owners are displaying their environmental stripes and saving a substantial sum of money in the bargain. Working with PowerLight Corporation, they installed a PowerGuard® system of insulating PV roofing tiles (see inset photo) that covers 10,000 square feet and generates 75 net kilowatts of electricity. The hotel will be spared hundreds of thousands of dollars in utility bills—while the atmosphere is spared tons of greenhouse gases. When hotel owners saw that this project would produce an internal rate of return over 20%, they arranged project financing through PowerLight.

The Mauna Lani is an example of building-integrated photovoltaics (BIPV) at its finest. BIPV applications, which can be strikingly beautiful, are common in European countries, where the cost of electricity is higher than in the United States. Now, with niche markets such as Hawaii to pave the way, the time is right to use BIPV in advantageous commercial locations throughout the country.

Replacement Value and BIPV

In addition to the maximum-power option, we also drew maps for PV arrays on sloped-rooftop, horizontal (flat-roof), and vertical (wall) structures. Low BTCs resulted for the vertical options, with a maximum of only $2,000 per kilowatt for both south- and west-facing arrays. But this result is not nearly as disappointing as it appears. The *replacement value* of fixed PV arrays—especially vertical ones—makes all the difference, because it's added to their energy/demand value. On top of this, the PV system does double duty as a window and an energy source. And windows and curtain walls are very attractive PV installation options.

Consider the case of thin-film PV windows yielding 50 watts per square meter. Based on our study, these windows have a BTC of $100/m^2. But if these windows replace non-PV components costing $150/m^2, the actual break-even system cost is $250/m^2. This result equates to a BTC for the thin-film window of $5,000 per kilowatt, which is close to being competitive.

Even more compelling is that these types of PV applications—those that are integrated into the building's structure—offer a range of dynamic opportunities for designing energy systems for buildings. And while it's clear that building-integrated photovoltaics (BIPV) will be the trend of the future, the technologies are being used right now. Successful examples of BIPV are shown on these pages. PV manufacturers showcase these technologies on their own buildings, with dramatic results. A major new skyscraper in New York City's Times Square sports PV panels on the facades of the building to replace curtain glass.

PV atrium systems, with their semi-transparent glazing, are not only beautiful, they are also perhaps the highest-value application for BIPV. These existing technologies show payback periods of fewer than 10 years in some regions.

PV power is now built into roofing shingles and tiles that are both functional and easy to install. PV awnings and carports capture the sun's energy while providing shade from its heat. PV greenhouse windows power businesses while sheltering plants. All this adds up to one solid fact: PV and commercial buildings are a natural match.

Input to Life-Cycle Analysis

Tax Environment	
Federal incremental tax	33%
State incremental tax rate	Variable
Equipment depreciation	5 years
Federal investment tax credit	10%
State tax credit	Variable
System Financing and Construction	
Invested equity	15%
Long-term loan rate	9%
Loan term	20 years
Construction period	0.1 year
Construction loan rate	9%
Economic Environment	
Energy escalation rate	4%
Inflation rate	3%
Discount rate	9%
Operational Environment	
System useful life	30 years
O&M costs	1.7%
Energy production	Variable
Energy value	Variable
Effective capacity	Variable
Capacity value	Variable

***Table Notes. Energy Production**—localized PV output for selected array configurations simulated from gridded U.S. hourly irradiance data using the PVFORM 4.0 program. **Effective Capacity**—previous studies established the U.S. geographical distribution of PV effective load-carrying capacity, based on 8 years of utility data; this study assumes the capacity credit a PV system provides a given customer is commensurate with the effective capacity it provides to the considered regional grid. **Local Tax Incentives**—using the Database of State Incentives for Renewable Energy maintained by the North Carolina Solar Center, we considered state tax credits, low-interest loans, accelerated depreciation, deductions, and grants.*

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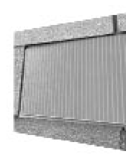

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