Most modeling software's now include energy simulation. The software will not only calculate the total buildings energy use, but will show where the energy is being used. An energy simulation is best used throughout the design process and not just run when the design is complete or in the final stages.

You can also search for the average Energy Use Intensity (EUI) for a specific building type, and that will give you an idea of how much energy the building will use. EUI is measured in btu/sf/year so this will have to be converted into kW in order to determine how much PV is needed.
PM = Energy Start “Portfolio Manager”.
1kBTU = 0.293 kWh

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This rule of thumb includes space around the edges of the solar array.

PV panels are usually 40” wide and 66” tall and produce 330 to 350 watts. That translates to 19 square feet and about 18 watts per square foot.

Another way of looking at it is that 3 panels will produce 1kW.

1kW of PV panel will yield an average of 1200kWh per year in Illinois (according to PVwatts).
You can use the known variables provided by the module manufacturer to determine the approximate size of the photovoltaic array, by knowing the dimensions of the proposed modules and the voltage of the module, simple math will give you the approximate voltage per square foot of roof area which the array will occupy.

Or... for system sizing use the free tools available from NREL and others, like PV watts and The System Advisor Model (SAM)

**Average PV system size**
Residential – 5-10 kW
Small Commercial - 10-20 kW
Medium Commercial - 30-50 kW
Large Commercial - 50 kW +

WE TYPICALLY USE 10KW ARRAYS FOR A HOUSE THAT IS 2500 TO 3000SF. THAT IS ABOUT 2.5 to 3 WATTS OF PV PER SF OF HOUSE. THEREFORE, ONE 330-WATT PV PANEL = 100SF OF HOUSE.
When designing the roof, the PV panels and racking alone will add 2-4 lbs/sqft dead load, while ballasted systems will add 5-9 lb/sqft dead load. Note, in locations with high winds, ballasted systems will need to have more weight added.

Is this dead load or live load? ANSWER: DEAD LOAD.
Lousy Design Decisions
Now let’s talk about a few solar installation failures.

A common mistake is designing the system where a portion of the panels are shaded. This can be from the surrounding landscape or buildings, equipment on the rooftop where the system is installed, or other panels in the system. Keep in mind landscape will grow and if the property owner has permission, trees may need to be trimmed every few years. Also, neighboring new construction should be considered as well.

“After a solar system is installed it is important to properly commission the solar system. This means taking a volt meter through the system to verify you have the correct voltage inputs to the equipment being used.” http://pveducation.com/solar-installation-failures/inverter-commissioning/

For more examples of ‘what not to do’: http://pveducation.com/solar-installation-failures/

OR Aurora Solar: http://blog.aurorasolar.com/shading-losses-for-pv-systems-and-techniques-to-mitigate-them/
Lousy design decisions

Damaged roofing

Potential snow dam

Damaged roof shingle

Poor design/installation
Lousy design decisions

Orientation

North facing system

HOW DO WE KNOW IF THIS SYSTEM IS REALLY FACING NORTH?
These roofs are in a subdivision near my home in Colorado.
ANY REASONS THAT THIS SYSTEM WAS INSTALLED LIKE THIS?
- HIDING THE MICRO INVERTERS?
- MAYBE THEY ARE FACING EAST AND WEST?
- MAYBE THEY JUST DIDN’T KNOW WHAT THEY WERE DOING?
Lousy design decisions

Cables

No bending support

Too loose

Source: First Green

More information on planning cable layouts: http://www.firstgreen.co/2013/05/dc-cable-layout-planning-in-solar-power-projects/
Solar PV and Architectural Integration
There are many ways you can incorporate solar PV into buildings. There are conventional applications like rooftop and carports, but also many ways the solar can be integrated into the building structure with awnings, shade structures, roofs, window glazing and other architectural features.

We will now go through examples of each of these applications.
Here is an example of rooftop solar on a small business. The system is tilted rack mounted.
Here are two examples of flush mounted rooftop solar installations.

The installation on the right could have benefited from moving the panels down the roof where they would be tilted more toward the sun, but it looks like there are plumbing vents in the way. Also, with the palm trees, maybe they are at a very low latitude.
Example of a peel-and-stick roof panel system
Solar panels can also be mounted as shade structures where the solar panels can provide shade instead of standard carports or patio covers.
The support structure for the shading systems can be normal systems as the weight of a standard PV array is between 3 and 5 pounds/ft².
Snow falling into lanes of travel should also be considered where snow loads are expected.
Many Carport PV structures utilize the PV power to facilitate electric vehicle charging stations located beneath the carport array.
In addition to carports, PV can be installed on other shade structures. Here the PV provides shade for outdoor picnic areas.

Why would they go to the effort and expense of putting a roof on this structure, and did not just let the PV panels be the roof?
- The structure was already there, and they just added PV
- This is a rainy environment and they wanted complete protection from the rain
- Other reasons?
Just like any other PV system, it is best to orient the panels south and avoid shading when possible, but because windows are typically vertical they will likely not have the optimal tilt. This will affect the generation output.
Creative use of standard panels

Photo credit: Eileen Blass, USA TODAY

Powered by SunShot
U.S. Department of Energy
Creative use of standard panels
Because they face south it is nice when they provide architectural shade features as well as PV power.
Standard modules can also be used to create sunshades to improve the comfort of the building occupants.
BIPV prices are variable by market and by application, but are typically a higher cost than the traditional PV system. There are additional labor costs for specialized architectural design, engineering design, and installation and maintenance.

They may require additional materials like adhesives and flashing materials, but they will not require the racking and mounting systems.

Like all PV systems, it’s important to clean and maintain BIPV installations.

Today, BIPV only accounts for 1 percent of the total solar installations world wide.
BIPV shingles are typically used in residential applications. PV shingles can be aesthetically pleasing for homeowners than rack mounted systems, and do not require holes to be drilled into the roof. PV shingles have a higher cost than crystalline panels and a lower efficiency.
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BIPV – these solar panels are taking the place of roofing.
Examples of semi-transparent and translucent panels. It’s a BIPV panel (Georgia Tech natatorium). These bi-facial panels are beautiful but the panels cost much more. Performance is similar or better than traditional panels. If you want covered walkways, or parking areas, etc to look pretty.

Semi-transparent and translucent PV modules present the design with a wide range of possibilities to combine the production of the electricity with natural light and interesting light effects.
For more information on the BIPV market, refer to the Inside the BIPV Market white paper.

Visit: [http://www.pointenergyinnovations.com/profiting-from-the-sun/](http://www.pointenergyinnovations.com/profiting-from-the-sun/) to download the white paper. Note: you will need to provide your contact information to have access to copy to download.