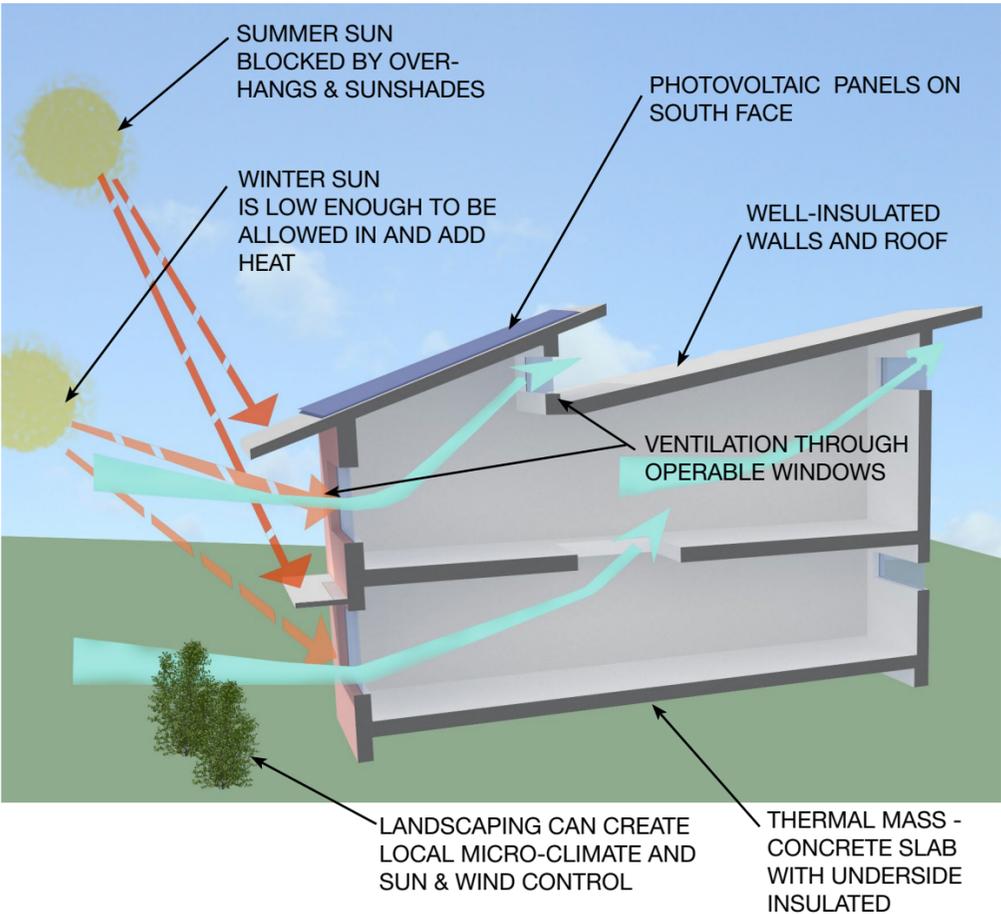


On-Site Renewable Energy: Solar

Passive Design

Passive solar is a design strategy focused on the thoughtful design of windows, walls and floors to collect and distribute solar energy in a building. This simple strategy requires little to no mechanical or electrical systems (and no moving parts). Vernacular architecture is well known for its intuitive use of passive solar design.

Passive solar strategies include orienting the building in response to the sun's path, shading the building, using materials with favorable thermal mass properties for the climate, and designing the interior spaces of the building to assist in effectively heating and cooling the building naturally. Passive solar technologies reduce the building's reliance on mechanical and electrical systems to heat, cool and light the building. It is a foundation on which high performance buildings are conceived.



Active Design

Active solar technology uses equipment to convert solar energy into usable electricity or to heat water for process or domestic use in the building. These technologies are steadily evolving and their efficiency is improving rapidly.

Fall 2014 competitive pricing puts a typical roof-mounted installation at approximately \$3-3.50/ watt (inclusive of material, labor, inverters, mounting and electrical, but exclusive of incentives and rebates). A typical mid-rise office building (approximately 130,000 gsf) can expect to install an array comprising 154 250w panels for approximately \$115,000 (before rebates). Depending on the building's load profile, a system at this scale can be expected to mitigate up to 6-10% of the building's energy demand. Regional variations can greatly affect production and installation costs.



Encore Wire Active Solar System / McKinney, Texas

Design Considerations

Passive design considerations

- Microclimate**
Buildings in humid environments require different passive strategies than buildings in an arid climate.
- Building Orientation**
Position long side of building in a north-south orientation whenever possible.
- Fenestration Orientation**
Size and configure windows to minimize heat loss. Shade windows to further minimize heat gain.
- Thermal Mass**
Design solid walls with thermal properties that follow vernacular rules regarding storage and release of heat.

Active design considerations

- Large unobstructed roofs or ground areas are ideal for photovoltaic panel arrays. Trees, mechanical units and other buildings should not shade the panels at any time.
- Panels typically produce the most energy when tilted at the correct angle equal to the latitude of the sun at that specific location. Designers to determine the optimal solar panel installation angle.
- For buildings with smaller floor plates, consider installing panels on parking structures or covered parking pavilions.
- Install an energy dashboard for tracking and displaying the array's performance. The energy dashboard also educates the building occupants on how their behaviors impact building performance.

Active Solar

Types

Monocrystalline

Efficiency: 15-22%

Monocrystalline is the most efficient type of solar panel available due to the high silicon content; therefore, monocrystalline arrays require fewer panels than other system types. They are also long-lasting and usually come with a 25-year warranty.

Their higher efficiency also drives higher installation cost. Like other systems, they are susceptible to performance degradation if panels are partially covered by shade, dirt, snow, and other hindrances.

Polycrystalline

Efficiency: 13-16%

Polycrystalline panels have a lower silicon content than the mono-panels resulting in a less uniform look than monocrystalline panels.

The process used to make polycrystalline panels is simpler and less expensive. However, the energy efficiency is lower than monocrystalline, resulting in a lower space efficiency.

String ribbon panels are polycrystalline panels manufactured with less silicon. While this lowers installation cost, there is a trade-off with energy efficiency, again resulting in lower space efficiency.

Thin-Film

Efficiency: 7-13%

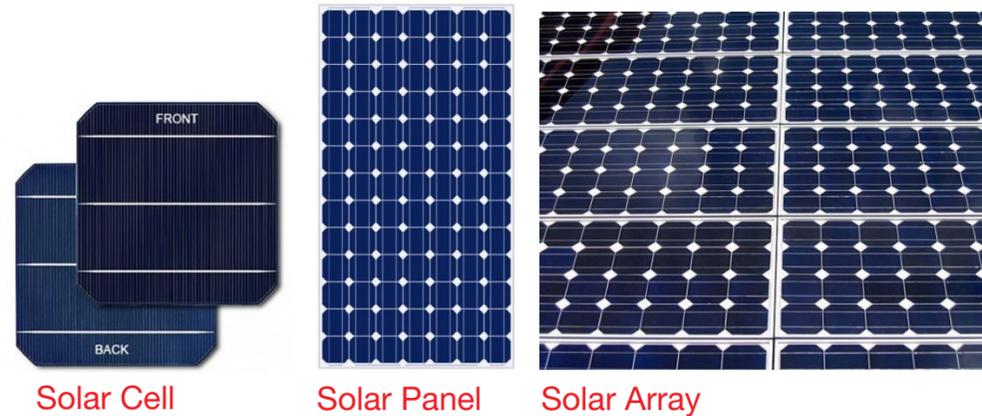
Thin-film solar panels are made from various materials including amorphous silicon, cadmium telluride and copper indium gallium selenide. Simple to manufacture, thin-film panels are very cost effective. They can withstand high heat; however, their low efficiency makes this type of panel not suitable to smaller projects. Thin film is better suited to large solar farm installations.

Building Integrated Photovoltaic (BIPV)

Efficiency: 7-13%

BIPV arrays are integral to the building envelope as solar roofing material, cladding material or glazing material. Although they are more expensive, they can be less efficient. For example, solar collection on vertical surfaces is inherently less efficient than a roof-mounted collection due to the angle of incidence to the sun and the maximum hours of exposure.

Basic Terminology



Solar panels are composed of individual solar cells, while solar arrays are composed of individual solar panels. Solar arrays are commonly installed on building roofs or on covered parking structures. They can be installed directly onto a roof, or installed on a substructure. Panels can also be incorporated into the building facade. Panel efficiency is defined by how well it converts solar energy into usable electricity.

Consultants can help to navigate the many rebates and incentives for installation of a solar array.

Rebates

State and local incentives as well as federal tax credits can reduce the cost of a system by over 50%. It is important to look at the savings associated with these incentives before deciding on the installation of a solar array.

The Business Energy Investment Tax Credit (ITC) allows 30% of the cost of the solar system and installation to be deducted from your federal tax bill. Other incentives may be offered by utility companies. A net-metering program allows customers to get credit for excess power the solar power systems generate.

For information on your state's local incentives, the Database of State Incentives for Renewables & Efficiency provides a comprehensive list of incentives and policies with links to more information to get you started. <http://www.dsireusa.org/>

Case study



Renaissance Riverfront Lofts using Monocrystalline Panels - Denver, Colorado

Page's Renaissance Riverfront Lofts is a 100-unit apartment building for the Colorado Coalition for the Homeless, housing homeless and low-income families.

The building has a \$248,000 roof-mounted photovoltaic array. A \$147,000 green tax incentive, combined with an \$82,000 rebate from Xcel Energy, accounted for nearly all of the construction cost of installation.

Installation labor was donated by Namaste Solar. The system is designed to save \$8,000 in electricity costs annually.

Solar Energy at Page

GSA Office Building Southwest Region

Albuquerque, New Mexico

Solar energy techniques implemented:

- Designed around a central courtyard with full-height glazing on four sides of the courtyard, allowing daylight deep into the building
- Courtyard is shaded by carefully placed series of cable-supported wood slats
- Thick masonry wall with high thermal mass reduces heating and cooling loads in the comparatively high diurnal temperature swings of Albuquerque
- Deep-set openings for windows provide shade
- Wood and metal exterior shading systems surround exterior of building



Architecture of Discovery Green

Houston, Texas

Solar Energy techniques implemented:

- Linear buildings oriented with the long faces on the north and south
- Double-height glass facades on north side to allow for daylighting and minimal heat gain
- Deep porches on south side to shade interior spaces from the south and west direct sun
- 256 solar panels were installed on the roofs, which have recorded over 118,000kWh since their installation in 2008, resulting in over \$25,000 in energy savings. A dashboard may be seen via a link on Discovery Green's website: <http://my.sre3.com/discoverygreen>.

