Solar Energy utilization in buildings

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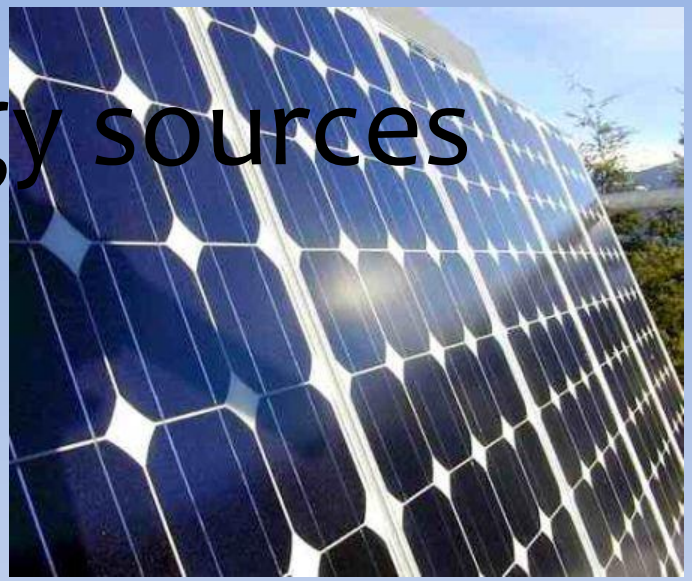
Green building

- Practice of increasing the efficiency with which buildings use resources; energy, water, and materials
- Reducing building impacts on human health and the environment during the building's lifecycle
- Reducing waste, pollution and environmental degradation

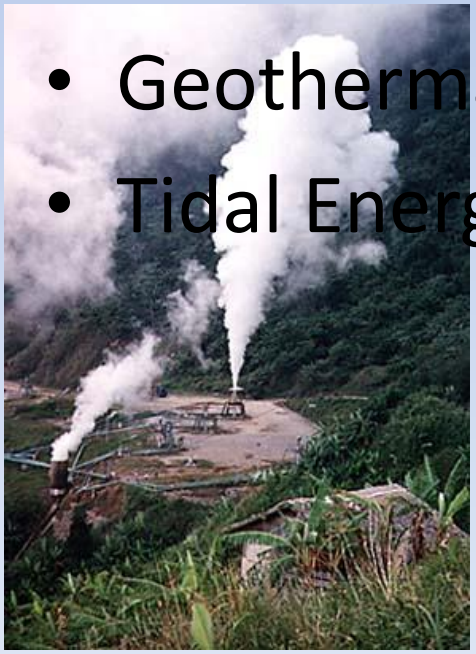
Steps towards Green building

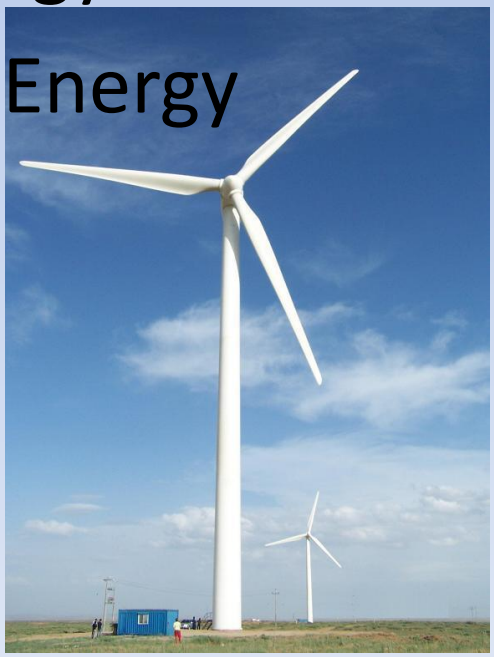
- To minimise building's carbon footprint during design, construction and its maintenance
- To maximise the use of renewable energy sources and recyclable materials

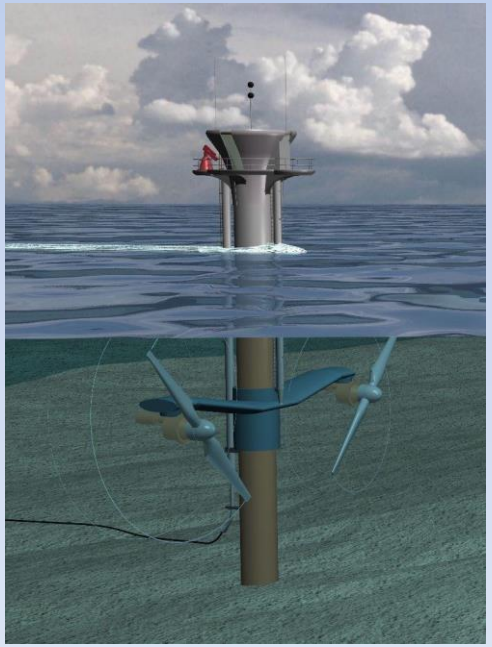
Renewable Energy sources



- Solar Energy
- Wind Energy
- Biomass Energy
- Geothermal Energy
- Tidal Energy







Why Solar?

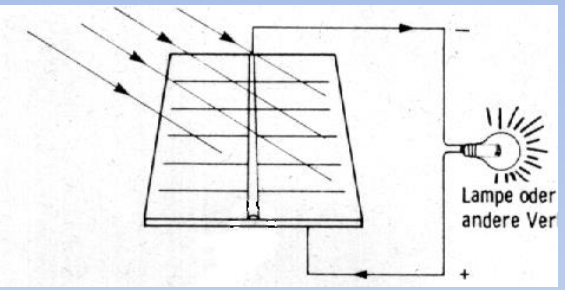
- Abundant source/Renewable
- Reliable
- Homegrown
- Decentralised availability
- Clean/Environmental friendly
- Negligible running cost
- Solar energy reaching every minute can supply world's energy demand for an entire year.

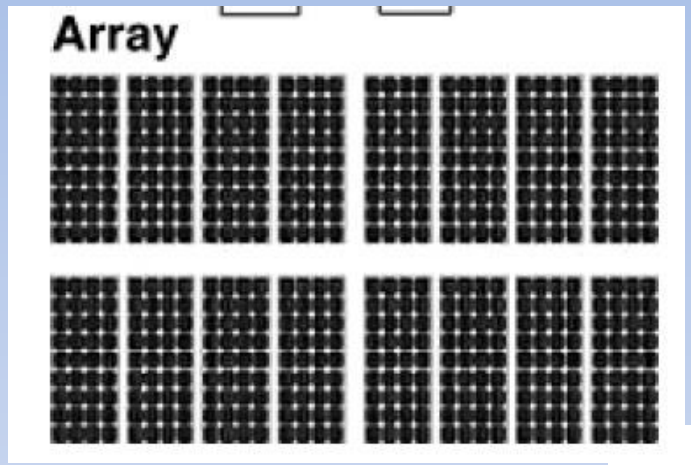
Solar Energy Utilization

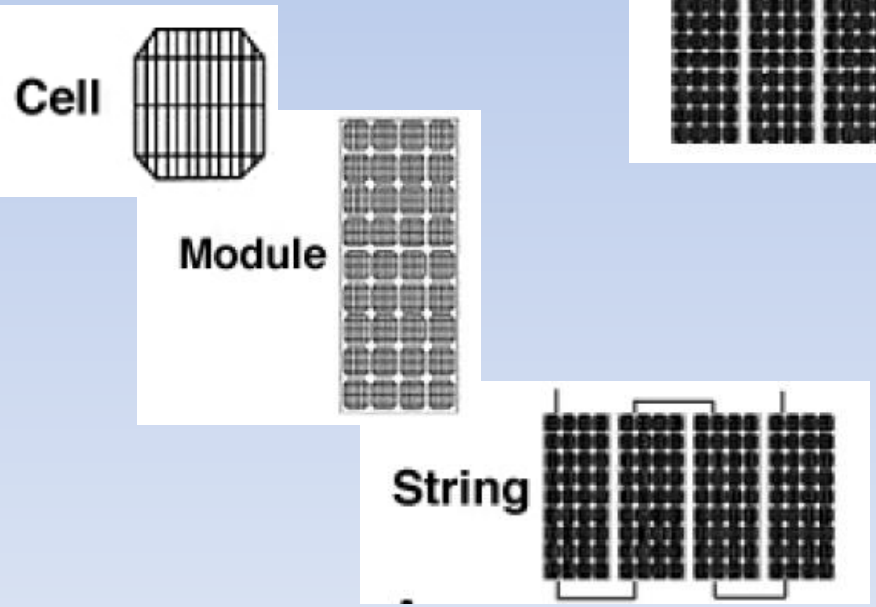
- BIPV- Building Integrated Photovoltaic
- Day lighting
- Solar passive architecture
- Solar water heating systems
- Solar cookers
- Water distillation
- Drying
- Cooling

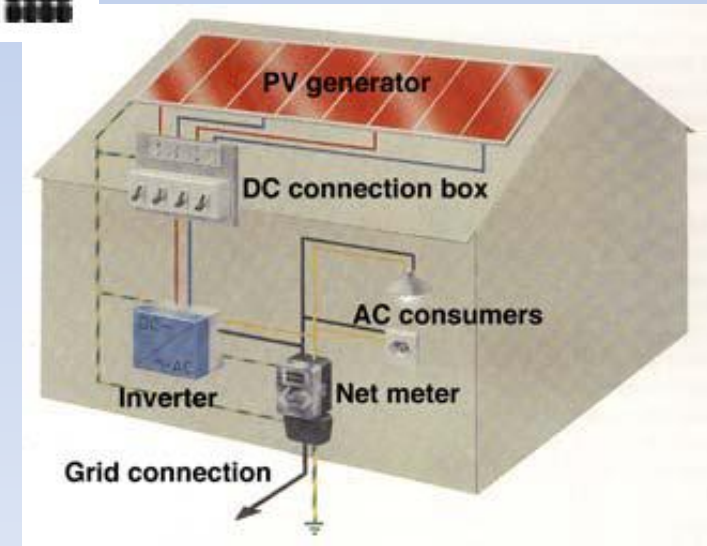
Photovoltaic

Photovoltaic: Electricity produced by solar radiation (photon energy).









Building integrated photovoltaic (BIPV)

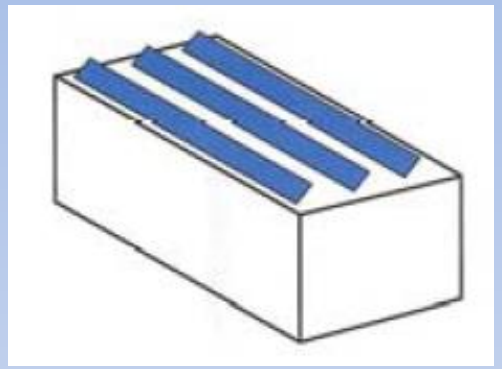
- Refers to photovoltaic integration with building construction
- Solar Photovoltaic could be built into facade or in the roof or used as curtains or integrated into windows
- Energy could be used in building or trasfered to grid

"Solar architecture is not about fashion - it is about survival." - Sir Norman Foster.

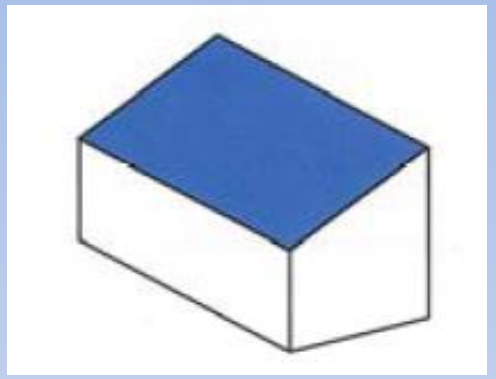
Advantages of BIPV

- Integrates into traditional building materials
- Reduces land requirement and costs
- Generates electricity from sunlight
- Reduces thermal radiations entering building
- Allows natural sunlight to enter in building
- Replaces conventional building materials with no extra space for mounting
- Gives creativity attempt to designers

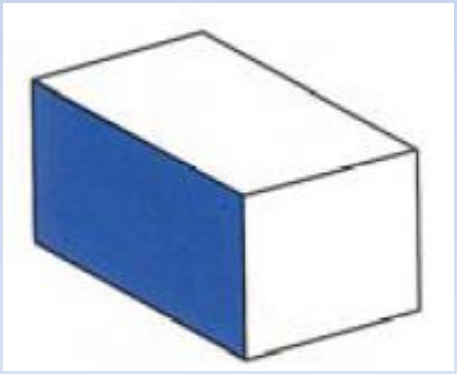
Recognised BIPV systems



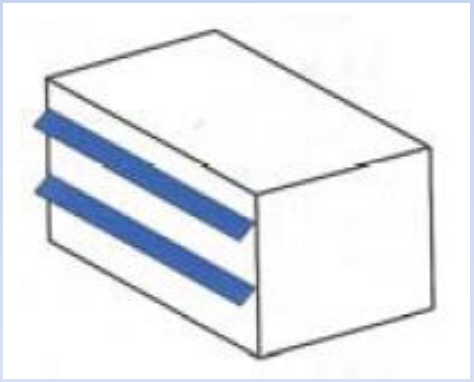
Roof top



Slopped roof



Facade

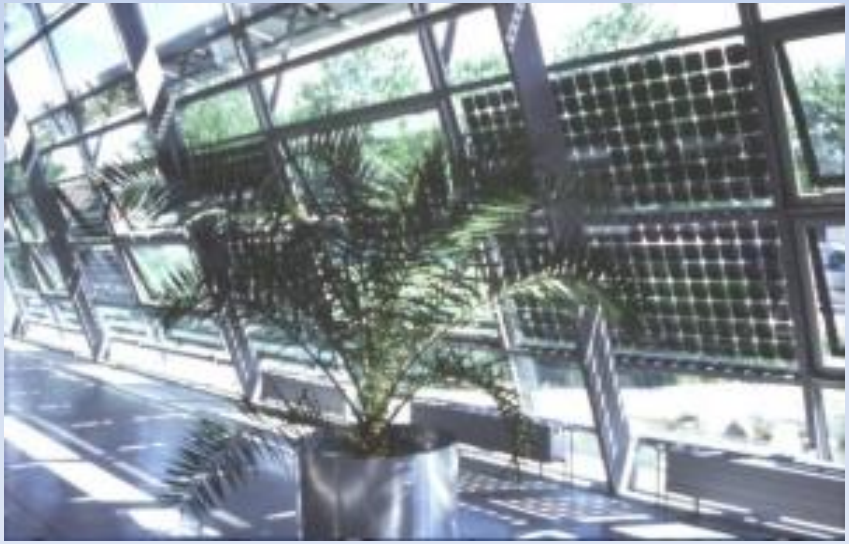


Building element

Roof integrated systems

Building element integrated systems

Vertical awnings with transparent solar cells in "Gemini Haus", Weiz, Austria (Photo: Denis Lenardic)



Solar fabrik, Freiburg atrium with transparent modules and shadowing modules (Photo: Denis Lenardic).

"Shadow-Voltaic" - PV systems also used as shadowing systems,

Movable solar shading device, made of transparent modules (Photo: Denis Lenardic)

Facade integrated systems

Renewed heritage building with transparent solar modules (Source/copyright: Building integrated photovoltaic, CLER, photo Solarte)

Large transparent module - glass/glass laminate (courtesy Ertex Solar GmbH).

Types of Solar cells

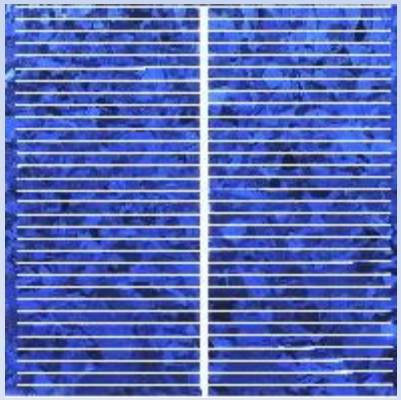
- Crystalline solar cells
  - Monocrystalline
  - Polycrystalline
- Thin film
  - Amorphous silicon cells
  - CIGS(Copper Indium Gallium diselenide) cells
  - Cadmium telluride
  - Dye sensitized solar cells
  - Organic Photovoltaics

Crystalline silicon

- Advantage of high efficiency.
- But restricted BIPV usage because of its high production cost.
- It also has got disadvantages of lower performance in low light level conditions and voltage drop with high temperature.

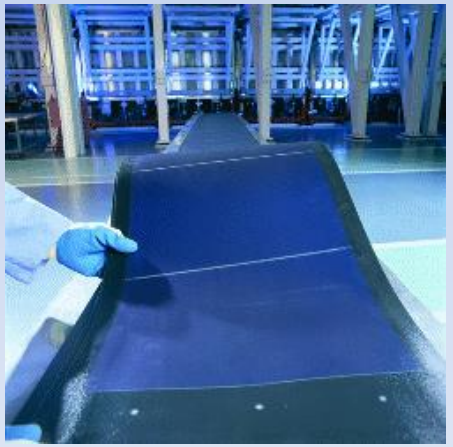
Mono-crystalline

Polycrystalline



Amorphous silicon (a-Si)

- A lot of work is being done to optimize the efficiency of these solar cells.
- The highest commercial products efficiencies are typically in the range of 6%.
- The work is being done on new concept of tandem cell making triple junction amorphous cell and monomorphous solar cells.



CIGS (Copper Indium Gallium diselenide)

- One of the promising thin film candidates for the advancement of solar cell technology
- High attained efficiency and low materials costs.
- However, certain issues have prevented the widespread commercialization and utilization of CIGS for generation of power.

Cadmium telluride

- Cadmium telluride is another heavily investigated thin film technology with high prospects.
- Advantage of high adsorption coefficient and band gap of 1.45eV, which is well suited for the absorption of photons from within the solar spectrum.
- Only few micron thicknesses are enough to absorb more than 90% of light with energy above the band gap.

Dye sensitized solar cells

- Nanocrystalline DSSC based on mechanism of a fast regenerative photo-electrochemical process
- Unlike to Si solar cell technology light absorber is separated from the charge carrier.

Working principle

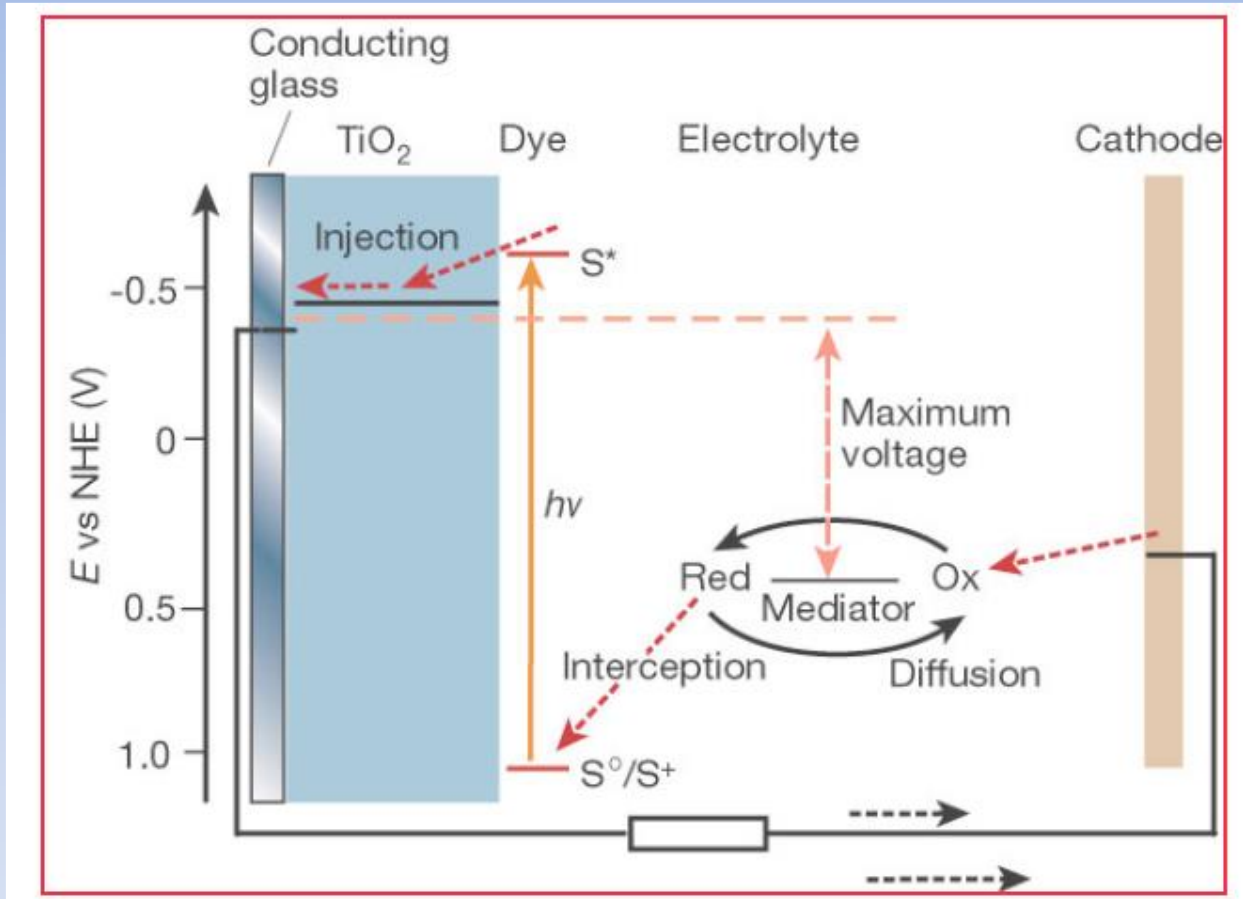
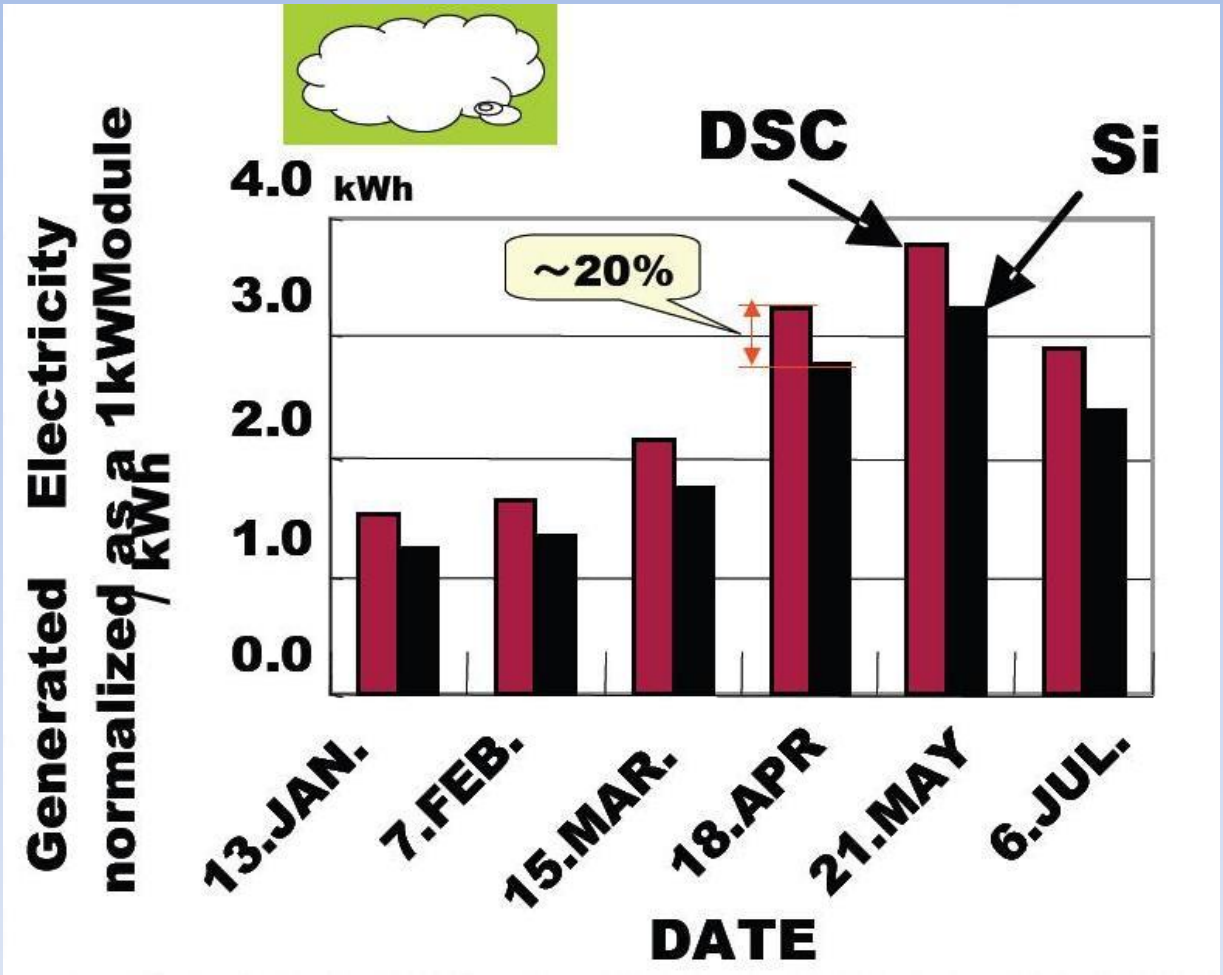


Fig1: Operating principle of the nanocrystalline dye-sensitized solar cell (DSSC).

Advantages

- Low cost material
- Cheap production
- Diffuse light performance
- Bifacial configuration
- High temperature performance
- Use of different colour dyes
- Adjustable transparency level
- Technology works well on all solid and flexible substrates used in solar industry

Comparison of DSC and Si cells in facade application

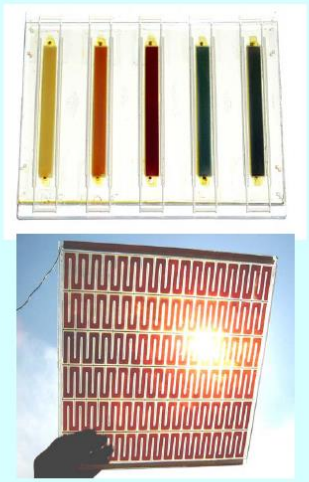


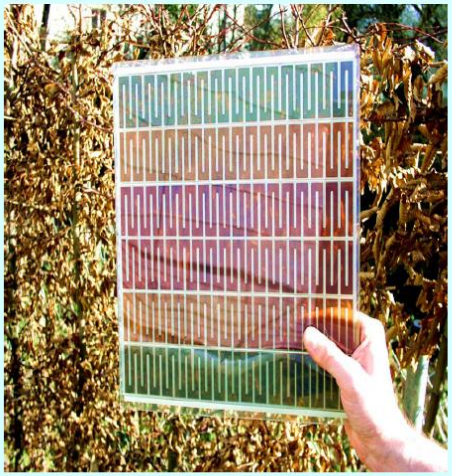
Limitations

- Low efficiency
- Low longevity
- Mechanical stability of flexible cells

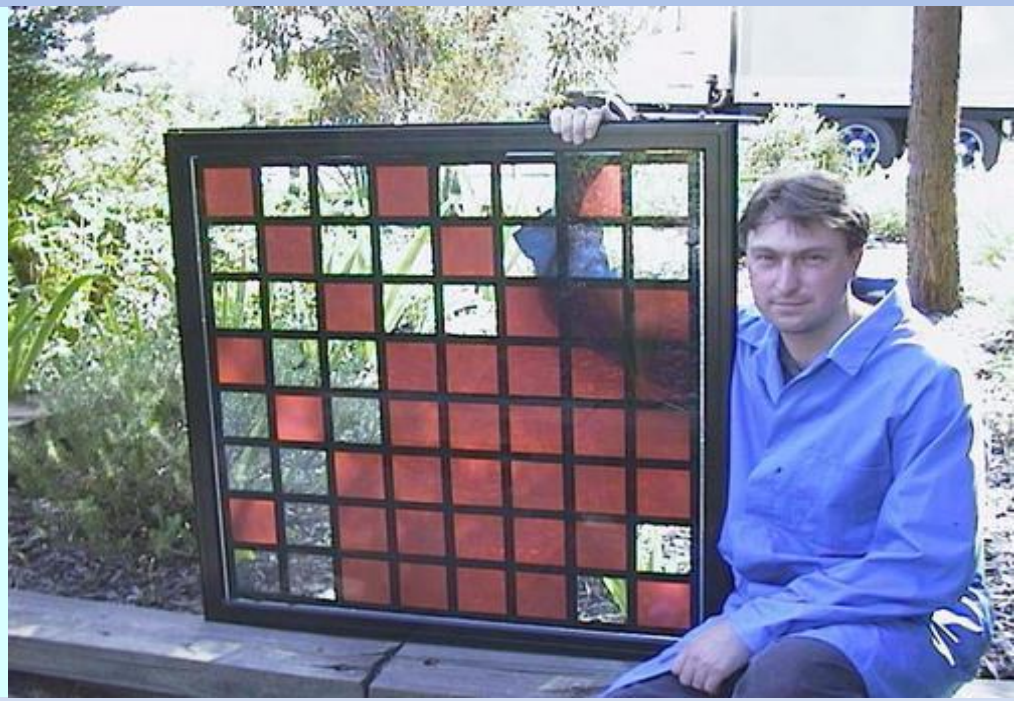
Modules produced using DSC technology

Various colours in a series-connected dye solar cell modules



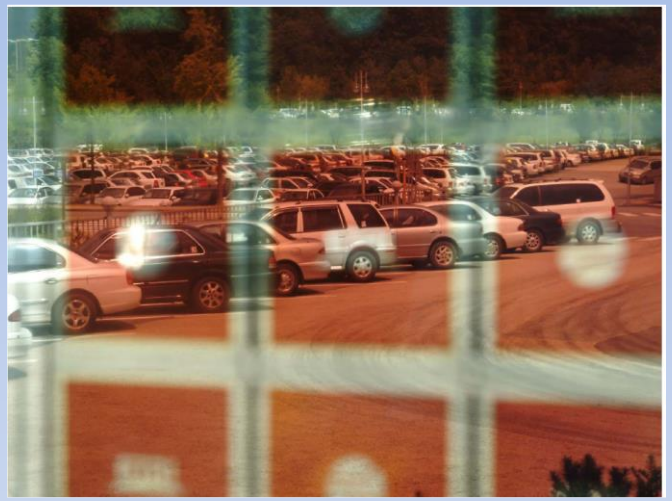


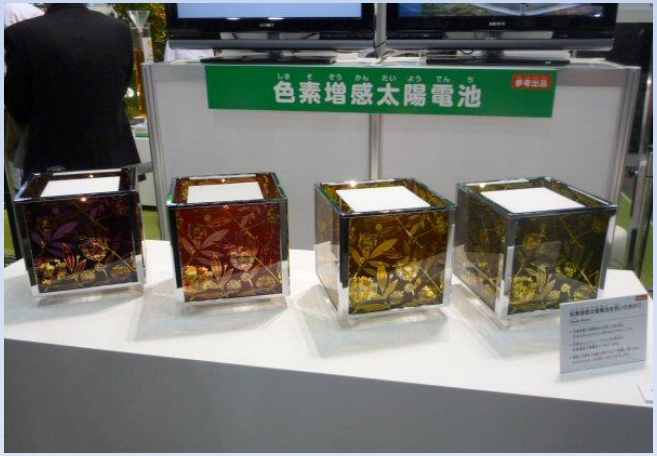
Courtesy Dr. Winfried Hoffman, CEO, RWE, SCHOTT Solar GmbH



Commercial application of DSC technology

10 m² of Dyesol DSC facade panels have been integrated to form a magenta »stripe« across the undulating wall floor-roof of one of the Houses of the Future on display at the Sydney Olympic Park.





Lanterns developed by Sony Corp using DSSC

Thank you

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