If we do not change our direction,
we are likely to end up where we are headed.

Chinese Proverb

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SES 194

Energy in Everyday Life

Solar Heating

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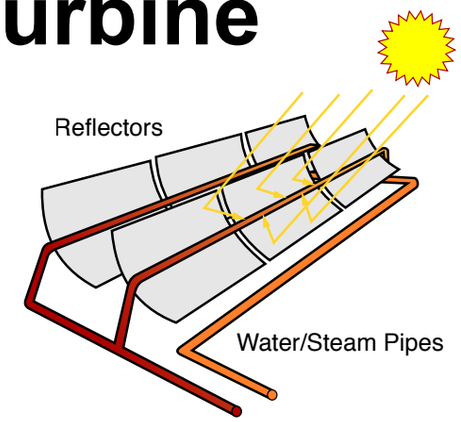
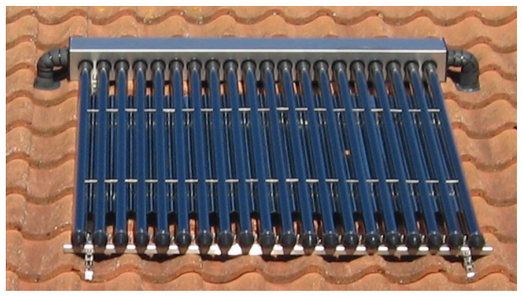
Solar energy is light (photon energy) from the sun harnessed using a range of evolving technologies such as:

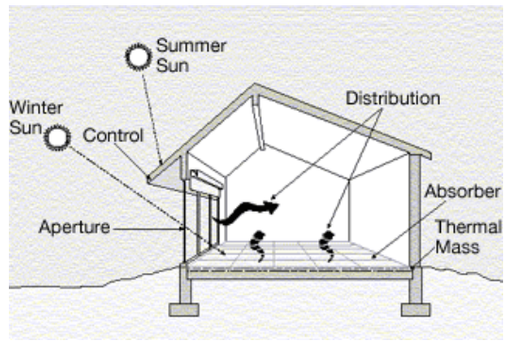
solar photovoltaics - direct conversion to electricity

solar thermal electricity - boil water to drive steam turbine



solar heating - hot water generation





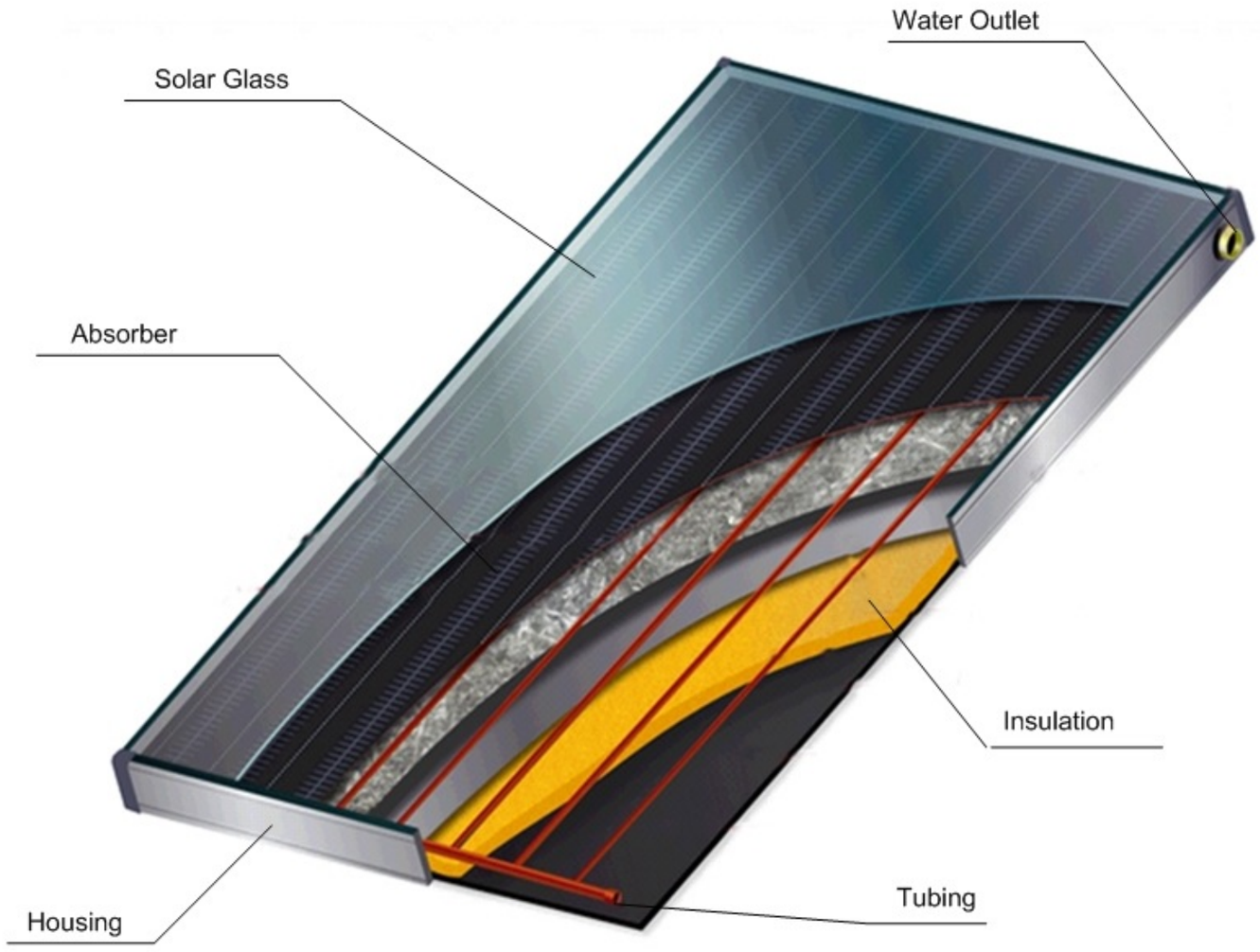
solar architecture - block summer sun, allow winter sun

A common type of solar panel used for home water heating of a dark surface behind glass.

The maximum temperature of the water for such devices is ~190 °F; none reach this maximum but still hot enough for showers, washing, etc.

The trick is to channel as much of the solar energy into the water while minimizing paths for thermal energy losses.

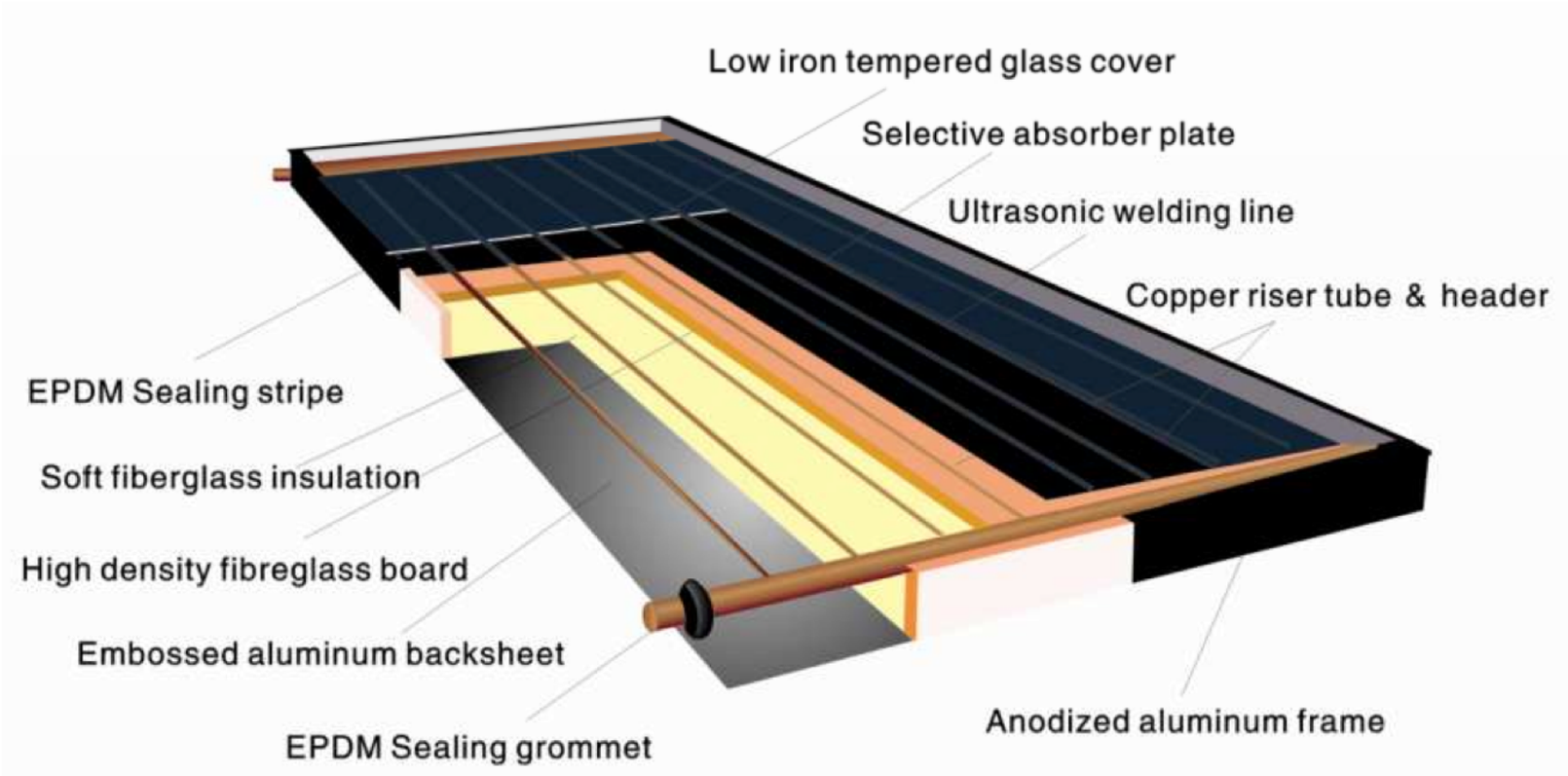
Double-pane glass cuts energy losses from heat conduction in half while also buffering radiative losses - the inner pane heats up by absorbing radiation from the collector.



If the space between the glass plates is thin, convection of air between the panes is minimized making air a good insulator.

Insulation behind the absorber minimizes thermal energy losses out the back of the device.

Solar energy has few options but to go into the circulating water.



Bottom line is an efficiency of ~50% at converting incident solar energy into heated water.

A typical home uses ~100 gallons ~ 500 liters ~ 500 kg of hot water per day. To heat water from ~60 °F to ~120 °F requires an energy ~4000 J/kg-K × 500 kg × 35 K ~ 65 MJ.

For average insolation of 200 W/m^2 at 50% efficiency, this requires ~8 m^2 of collection area, about 10-feet by 10-feet, costing ~$8000.

In some parts of the world, the use of solar water heaters is mandatory. For instance, 95% of homes in Cyprus use them.

Careful architectural design can boost the importance of sunlight in maintaining the temperature in a house. Three key design elements: collection, insulation, and storage.

For example, a window collects solar energy, insulation keeps it in, a thermal mass stabilizes against fluctuations, and an overhang minimizes overheating during the summer.