Computer science is no more about computers than astronomy is about telescopes, biology is about microscopes or chemistry is about beakers and test tubes. Science is not about tools. It is about how we use them, and what we find out when we do.

Edsjer W. Dijkstra

Arizona State University
SES 194

Energy in Everyday Life

Solar Thermal

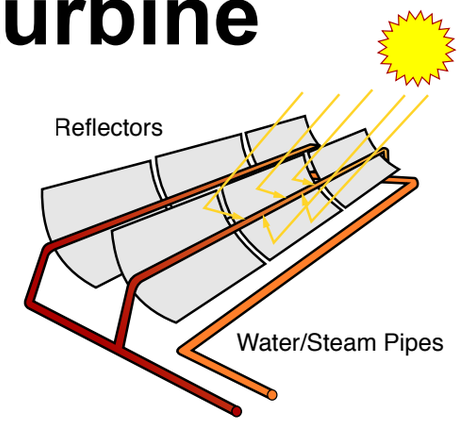
Frank Timmes

ftimmes@asu.edu

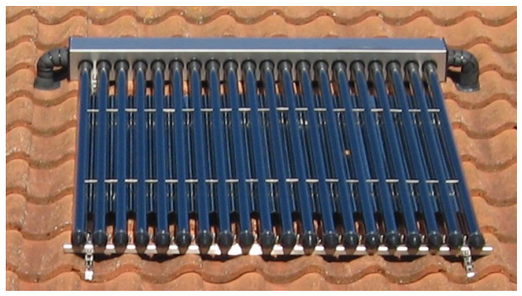
Solar energy is light (photon energy) from the sun harnessed using a range of evolving technologies such as:

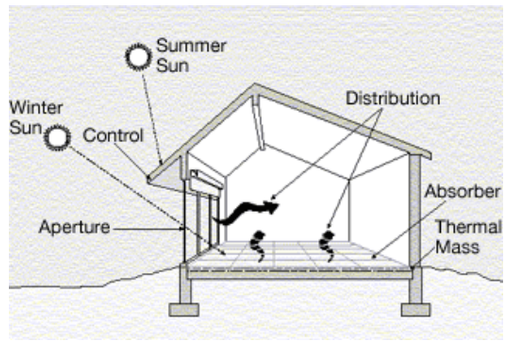
solar photovoltaics - direct conversion to electricity

solar thermal electricity - boil water to drive steam turbine



solar heating - hot water generation





solar architecture - block summer sun, allow winter sun

By concentrating sunlight, one can boil water to make steam to drive a turbine/generator to make electrical power.

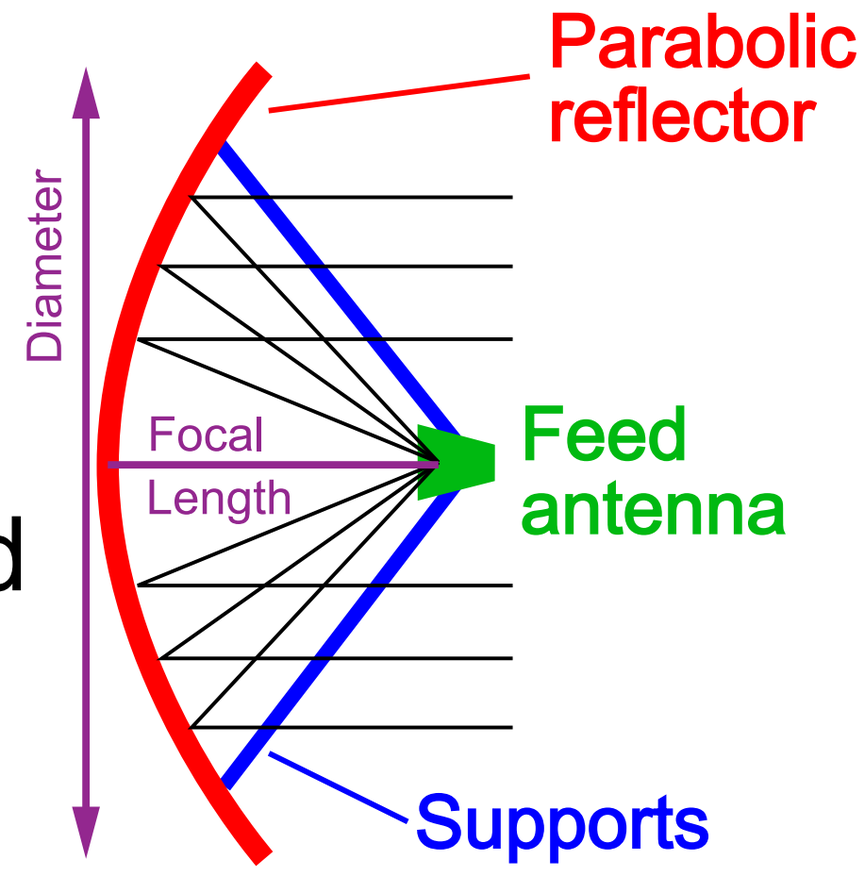
This is called Solar Thermal or Concentrated Solar Power.

One common approach is the parabolic reflector.

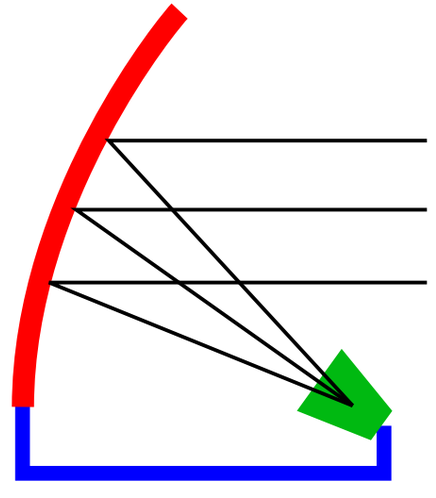
The image of the sun is ~100 times smaller than the focal length.

Concentration factor is ~13,000 x $(D/f)^2$, where D is the diameter and f is the focal length.

Axial or
Front feed



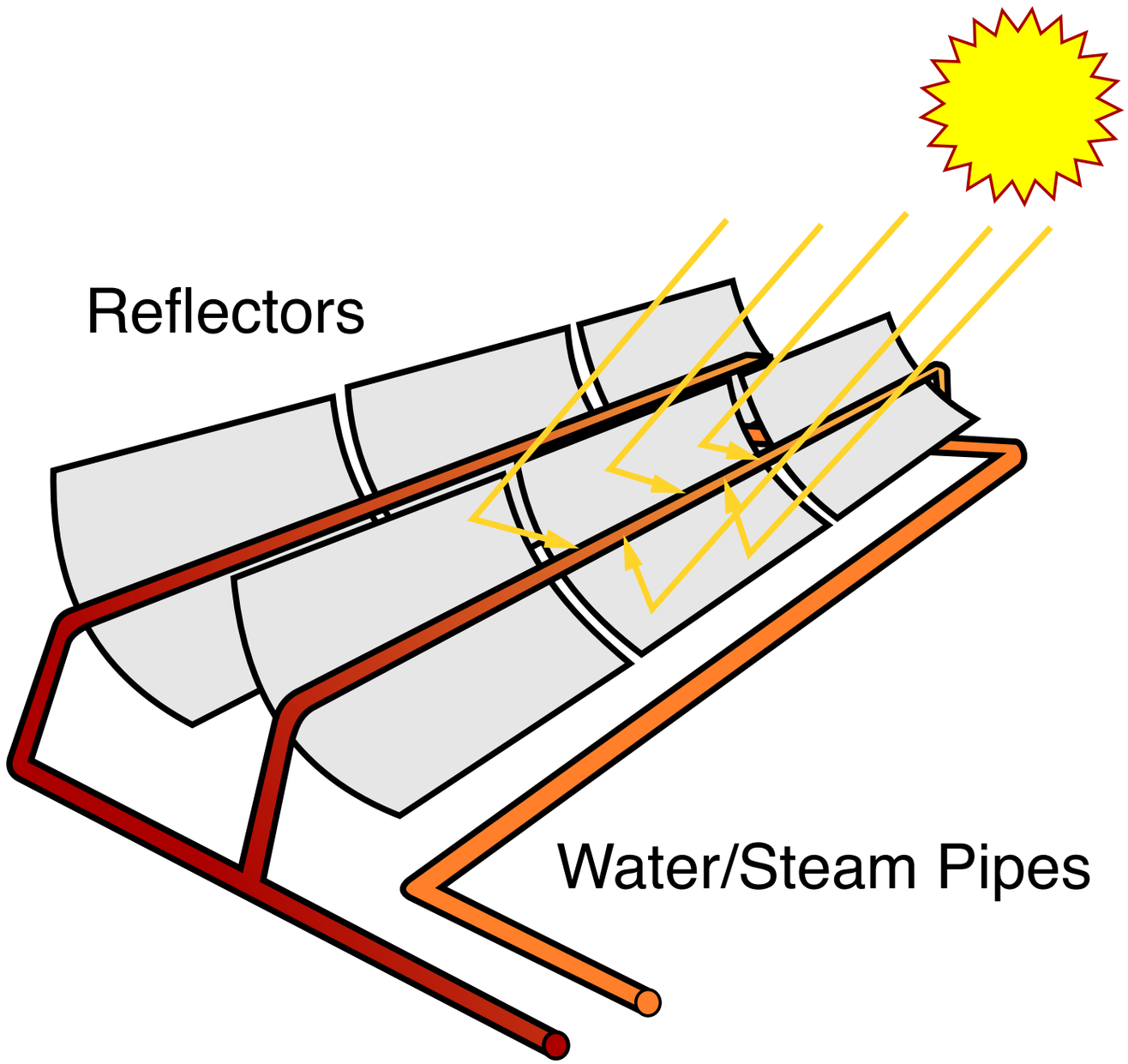
Off-axis or
Offset feed



A parabolic dish must be steered to point at the sun for maximum efficiency. This requires two axes of rotation, which is more costly and complicated. Another issue is routing the water and steam to and from the (moving) focus.

Another common approach is the parabolic trough.

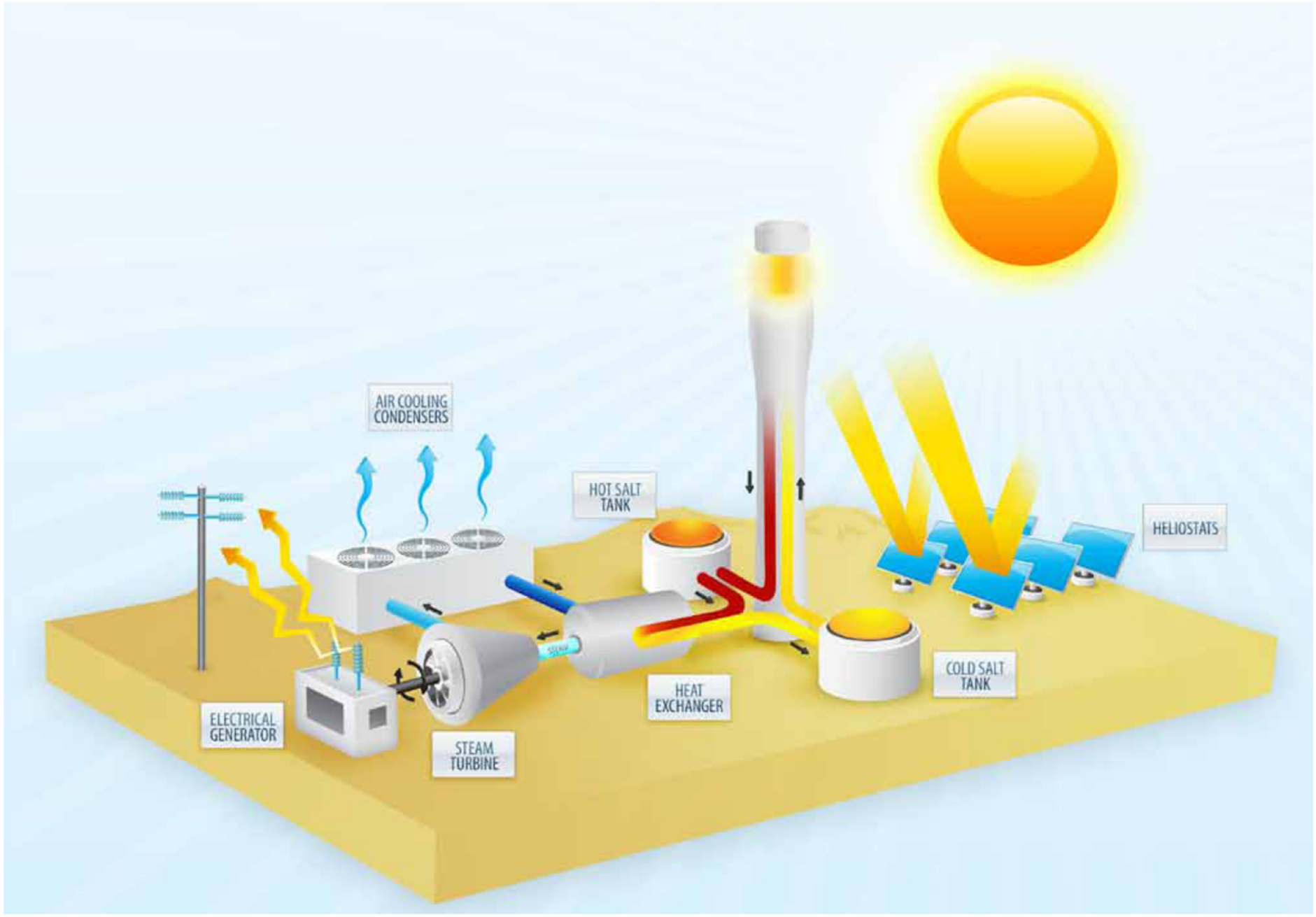
This is simpler since only one axis is needed to steer and the water/steam pipes remain fixed, but the concentration is reduced by ~100 x $(D/f)^2$.



Worlds largest solar thermal plant is in Gila Bend, Arizona. Here synthetic oil is heated to ~750 °F which is then used to generate steam for up to 6 hours after the sun sets.

Another common approach is the power towers.

Here cheap flat, steerable mirrors are used to reflect, not focus, sunlight onto a target, usually molten salt. Concentration factors ~1000 can be easily reached.



Typical efficiencies are ~15% from sunlight to electricity. Examples include the 400 MW plant in near Pimm, NV.