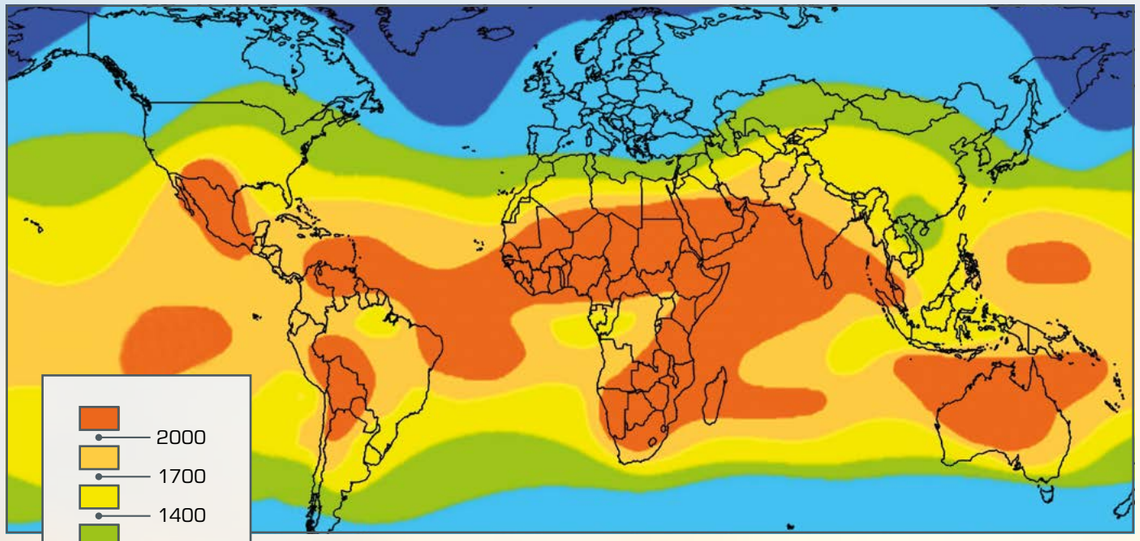
Basic Knowledge
Solar Energy

Energy galore

The amount of solar energy that falls on the Earth's land areas over one year is almost 2000 times greater than the entire world's energy demand. Given the global climate problem, using this potential in the best possible way seems self-evident.

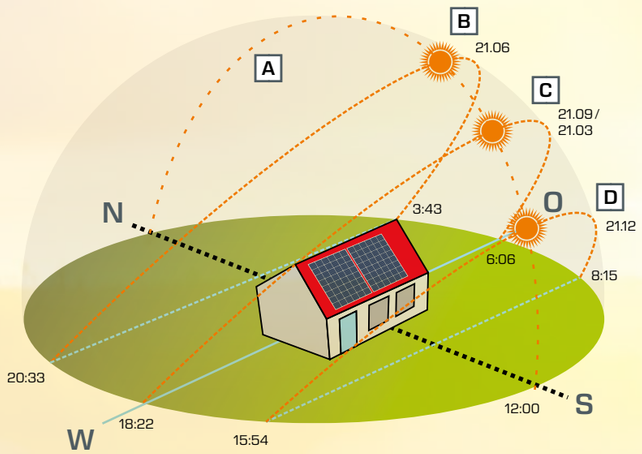


The amount of energy received locally can be stated in kWh/m² and is heavily dependent on the geographical latitude of the location and on meteorological factors. As the map shows, a quantity of energy of more than 2000 kWh/m² can fall on the earth's surface during a typical year in the Sahara region, for example.

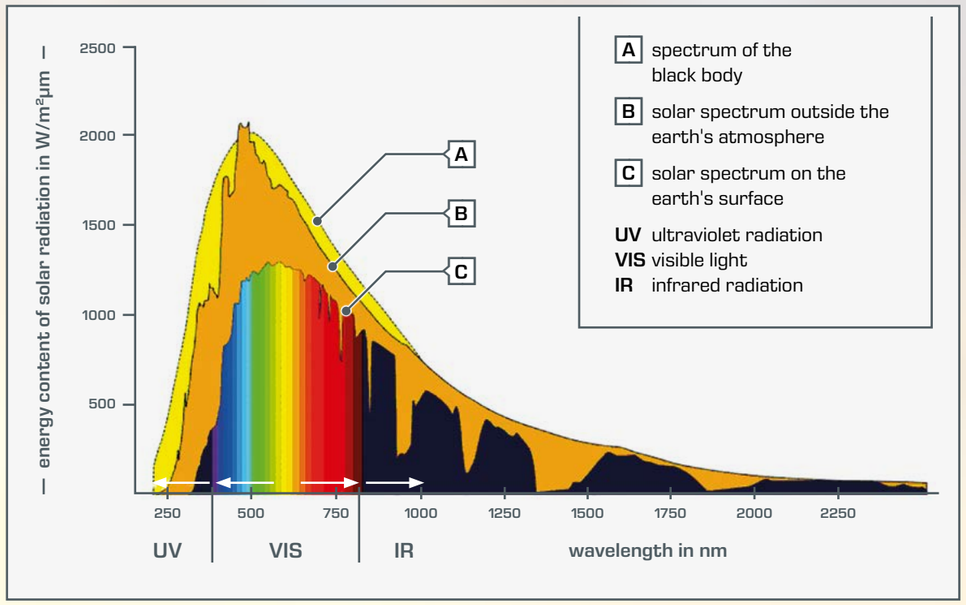
(Figure from C. J. Winter, "The energy of the future is solar energy")

The orientation of the module surfaces to the compass direction and their inclination play a significant role in optimising the yield of a solar installation. The illustration shows the path of the sun visible on the Earth at different seasons of the year. The times given for sunrise and sunset are for Berlin:

- **A** zenith
- **B** summer solstice
- **C** beginning of spring/autumn
- **D** winter solstice



In order to optimise the use of solar radiation, it is first necessary to understand its properties. The spectral composition of sunlight is of particular interest in this regard. Through spectroscopic studies, it is possible to determine the energy content of sunlight at different wavelengths. If one is then able to better adapt the spectral properties of the receiver or absorber to the solar spectrum, then a key condition for improving the energy balance is met.



The spectrum of sunlight

Fusion processes inside the sun lead to temperatures of up to $15 \cdot 10^6$ K. However, the spectrum of emitted sunlight is based on processes in the outer layers of the sun. The spectral composition can be theoretically described by a so-called black body with a surface temperature of 5777 K. On its way to the earth's surface, solar radiation is weakened in the atmosphere by scattering and absorption.

Subject Areas
Solar Energy

Putting solar energy to good use

In principle, two different areas can be distinguished in solar energy usage: photovoltaics and solar thermal energy.

In photovoltaics, electrical energy is generated directly whereas heat is generated first in the case of solar thermal energy. This heat can either be used directly or converted to electrical energy in large-scale solar power plants by means of heat engines.

Both types of usage compete with each other in the range of a few megawatts of electric power. It is possible to build large photovoltaic installations consisting of several thousand solar modules. However, it is equally conceivable to provide the same power with a thermal parabolic trough power plant. Which technology is chosen is largely dependent on the planned site and its integration into the supply grid.

The advantage of smaller solar installations is the ability to provide electricity and/or heat close to the consumer and according to demand. In order to tap the full potential of solar energy as a sustainable energy supply, it is essential that we understand and develop modern concepts of use.

Subject Areas	2E0 Products
Photovoltaics	
Application engineering 1 – **correct use of photovoltaic solar modules**	**ET 250** Solar Module Measurements **ET 250.01** Photovoltaic in Grid-connected Operation **ET 250.02** Stand Alone Operation of Photovoltaic Modules
Fundamentals of photovoltaics – **technological fundamentals of solar cells**	**ET 252** Solar Cell Measurements
Application engineering 2 – **investigation and simulation of systems**	**ET 255** Using Photovoltaics: Grid connected or Stand-alone
Solar Thermal Energy	
Fundamentals of solar thermal energy – **parameters affecting solar thermal heat**	**ET 202** Principles of Solar Thermal Energy **WL 377** Convection and Radiation
Application engineering 1 – **use of modern flat collectors**	**HL 313** Domestic Water Heating with Flat Collector
Application engineering 2 – **combined use of renewable heat sources**	**HL 320** Solar Thermal Energy and Heat Pump Modular System