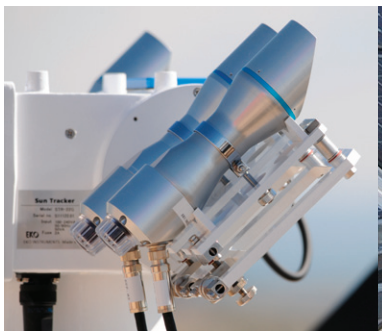
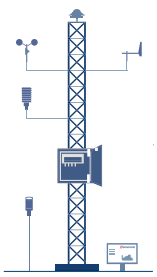
Ammonit Solar Measurement Systems



Solar Resource Assessment



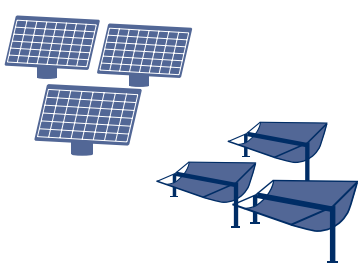
In order to assure well-founded decisions in designing profitable solar power plants, the solar irradiance should be measured in the assessment phase. Irradiation is a crucial parameter for site selection and plant design and economics of plant. There are many different ways and technologies to measure the irradiance phenomena that influences the power generation of a future solar power plant. Ammonit's solutions are designed to meet the latest standards with regard to accuracy and affordability of the measurement.

Accurate measurement under toughest conditions.

Parameters influencing the solar energy production

Insolation
Insolation is the most influential parameter to forecast the power output of a future solar plant. Depending on the planned solar power plant certain measurements are essential, e.g., GHI, DHI, DNI.

Wind speed and direction
The measurement of wind speed and wind direction delivers important data about wind force to construct robust module carriers. The cooling effect of the wind on the modules can be estimated as well.



Temperature
Temperature has a significant influence on the efficiency of solar panels. Thus it is essential to measure the temperature. In order to measure the temperature of the solar module, surface temperature sensors are used.

Precipitation and soiling
The measurement of precipitation and soiling can give important information about losses, whiles high insolation. Additionally, data about the stability of the ground the solar power plant is built on is collected.

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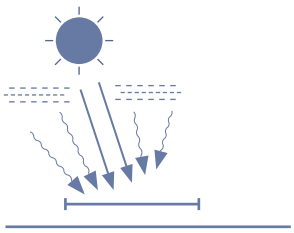
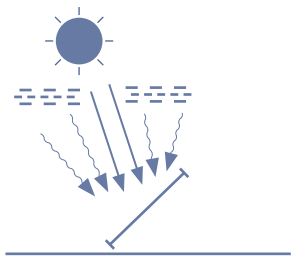
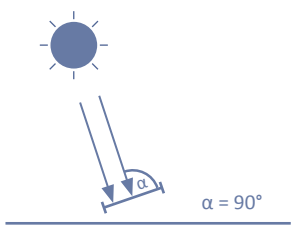
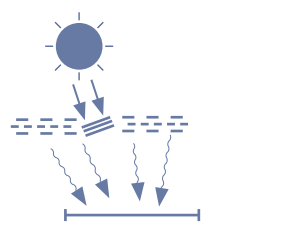
Solar Measurements

For solar applications certain measurements are crucial for site assessment. The insolation combines Direct Normal Irradiation (DNI) and Diffuse Horizontal Irradiance (DHI). Both are linked according to the formula for Global Horiontal Irradiation (GHI): **GHI = DHI + DNI · cos (θ)**, where θ is the solar zenith angle. Normally, on a sunny day the insolation is 100% GHI, 20% DNI and 80% DNI·cos(θ).

Find here a short description of the most important measurements and which sensor type can deliver the values.

Irradiation	Description	Irradiation Measurement Device
GHI Global Horizontal Irradiation 	The total amount of radiation received from above by a horizontal surface. This value includes both Direct Normal Irradiance (DNI) and Diffuse Horizontal Irradiance (DHI). **Application:** • Fixed PV installation • Comparisons with solar data bases to perform MCP (Measure Correlate Predict) evaluations	• Pyranometer (horizontal) to measure Global Horizontal Irradiation (GHI) • Solar reference cell 
GTI Global Tilted Irradiation 	The total amount of direct and diffuse radiation received from above by a tilted surface. GTI is an approximate value for the energy yield calculation of fixed installed tilted PV panels. **Application:** • Fixed PV installation	• Pyranometer (tilted as solar panel) for irradiation on the solar panel surface • Solar reference cell 
DNI Direct Normal Irradiation 	Direct Normal Irradiance is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky. **Application:** • Concentrated Solar Power (CSP) • Concentrated PV Power (CPV) • Fixed PV installation	• Pyrheliometer installed on sun tracker 
DHI Diffuse Horizontal Irradiation 	Diffuse Horizontal Irradiance is the amount of radiation received per unit area by a surface (not subject to any shade or shadow) that does not arrive on a direct path from the sun, but has been scattered by molecules and particles in the atmosphere and comes equally from all directions. **Application:** • Fixed PV installation • Redundancy calculations of GHI → GHI = DHI + DNI • cos(θ)	• Pyranometer with shadow ball or shadow ring installed on sun tracker 

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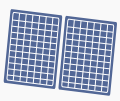
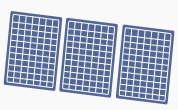
Applications and required measurement components

Depending on the future solar power plant, different measurements are necessary.

	Required measurements	System components
Small PV power plant	GHI and GTI 	• Data Logger • Steel cabinet with solar power supply and communication system • Pyranometer for global horizontal irradiation GHI Optional • Pyranometer tilted as solar panel for global tilted irradiation GTI • 2 solar cells: one horizontal, one tilted
Medium PV power plant	GHI, DHI and calculated DNI (DNI not measured; calculated by using DHI and GHI → GHI = DHI + DNI • cos(θ) 	• Data Logger • Steel cabinet with solar power supply and communication • Pyranometer for global horizontal irradiation GHI • Delta-T SPN1 Pyranometer (solid-state) for GHI, DHI and DNI (calculated) Optional • 2 solar cells: one horizontal, one tilted • Pyranometer tilted as solar panel (optional)
Large PV power plant	GHI and DNI 	• Data Logger • Steel cabinet with solar power supply and communication system • Sun Tracker • Pyranometer for global horizontal irradiation GHI • Pyrheliometer installed on tracker to measure direct normal irradiance. DNI Optional • 2 solar cells: one horizontal, one tilted • Pyranometer tilted as solar panel for global tilted irradiation GTI • Delta-T SPN1 Pyranometer for GHI and DNI
CSP	GHI and DNI 	• Data Logger • Steel cabinet with solar power supply and communication • Sun Tracker • Pyranometer for global irradiation GHI • Pyrheliometer installed on tracker to measure direct normal irradiance DNI Optional: • Pyranometer (including shadow ball) for diffuse horizontal irradiation DHI

All systems can be equipped with:

- Temperature and humidity sensor
- Anemometer
- Wind vane
- Precipitation sensor
- Barometric pressure sensor
- Soiling detector

Thanks to EKO Instruments (www.eko-eu.com)
for providing the photos of the front page.

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