Benha University

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Benha University
Faculty of Engineering at Shoubra
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Undergraduate Course

Solar Cells Fundamental

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Lecture (8)

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PV Solar Site

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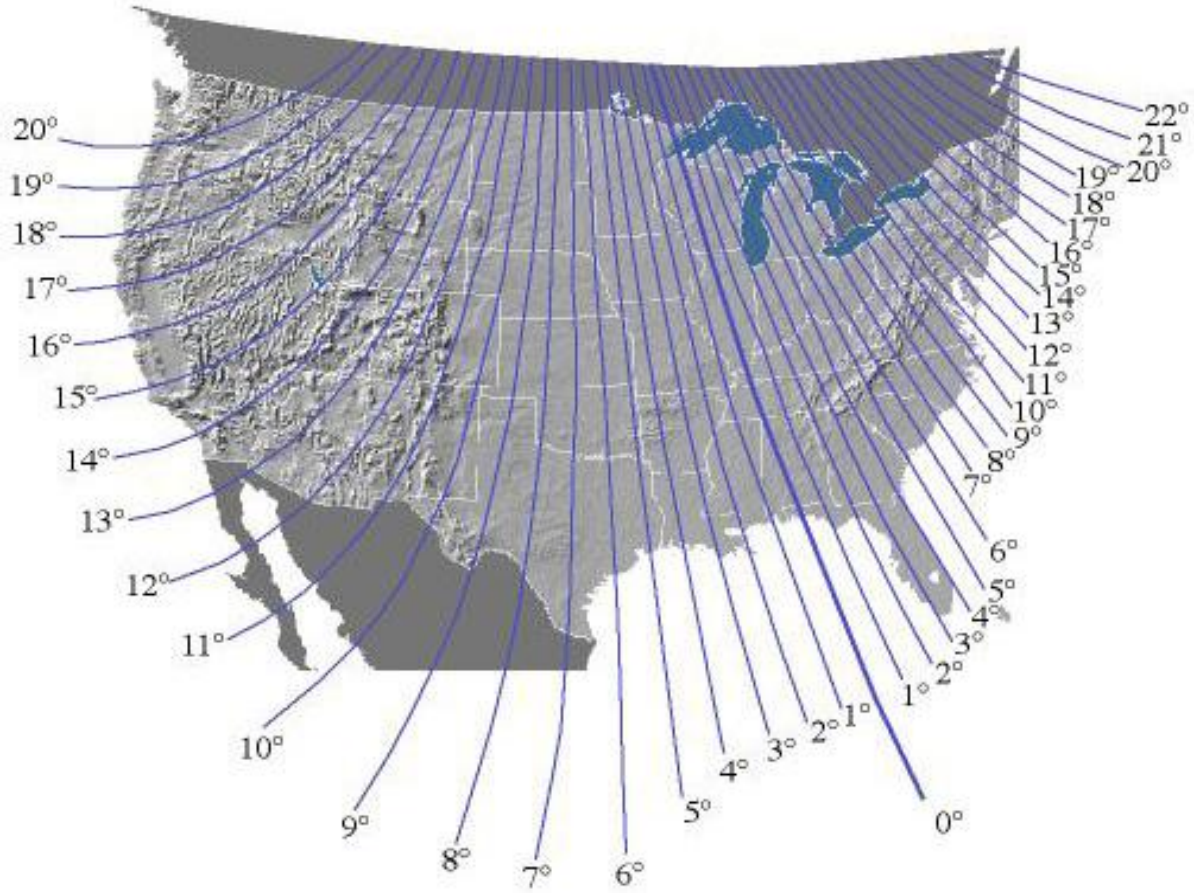
Site Selection – Panel Direction

- Face true south.
- Correct for magnetic declination



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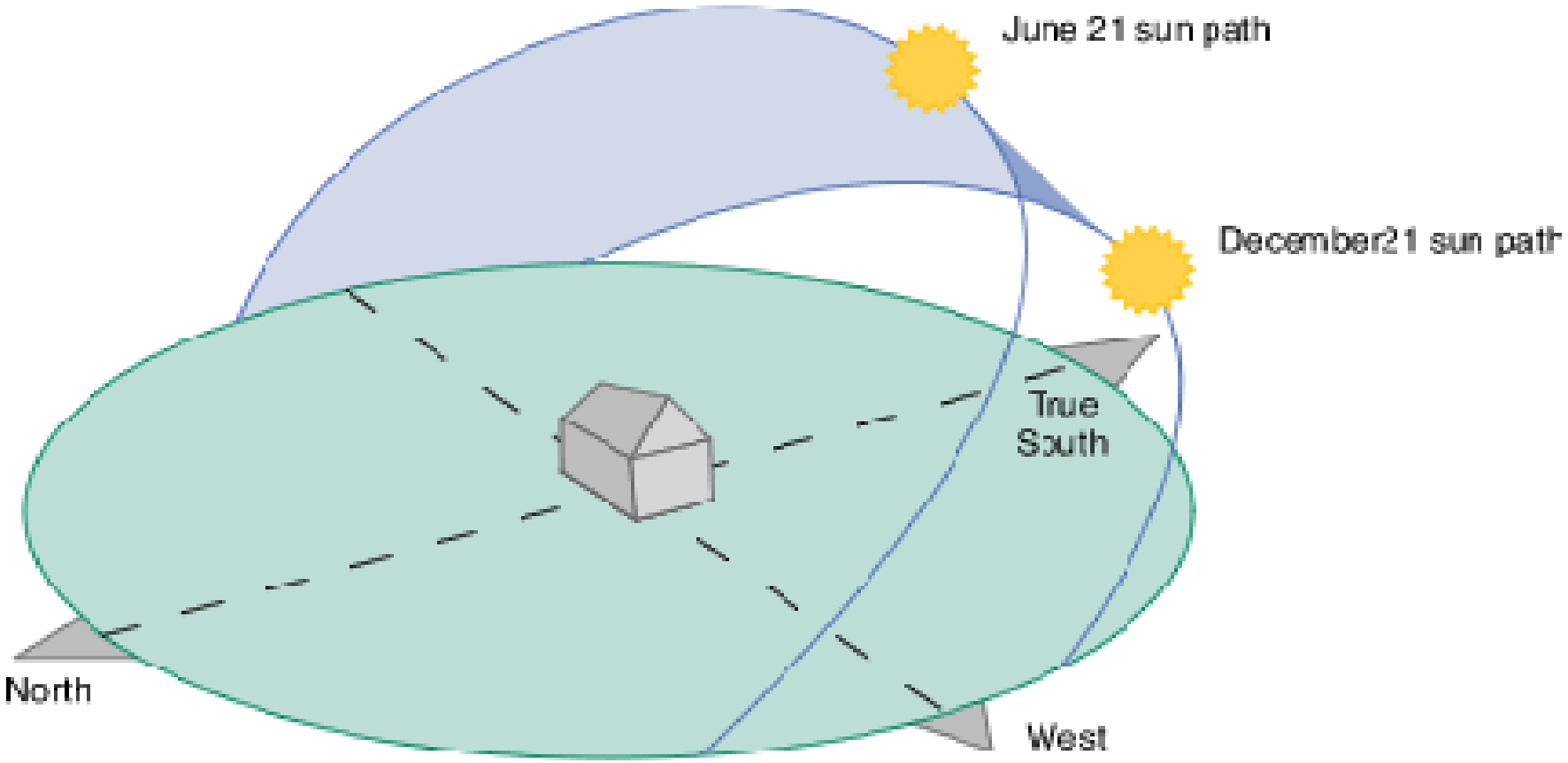
Altitude and Azimuth



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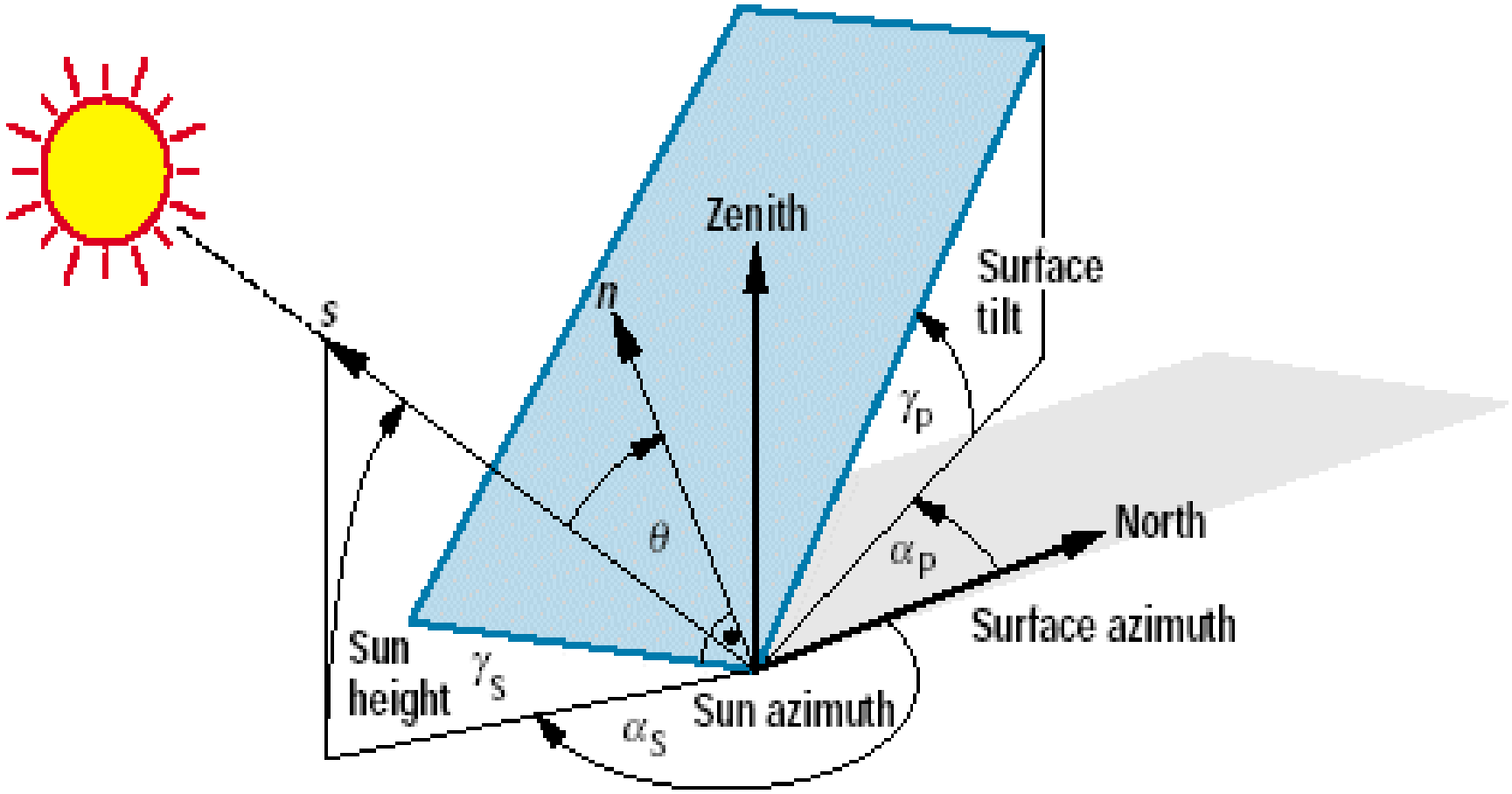

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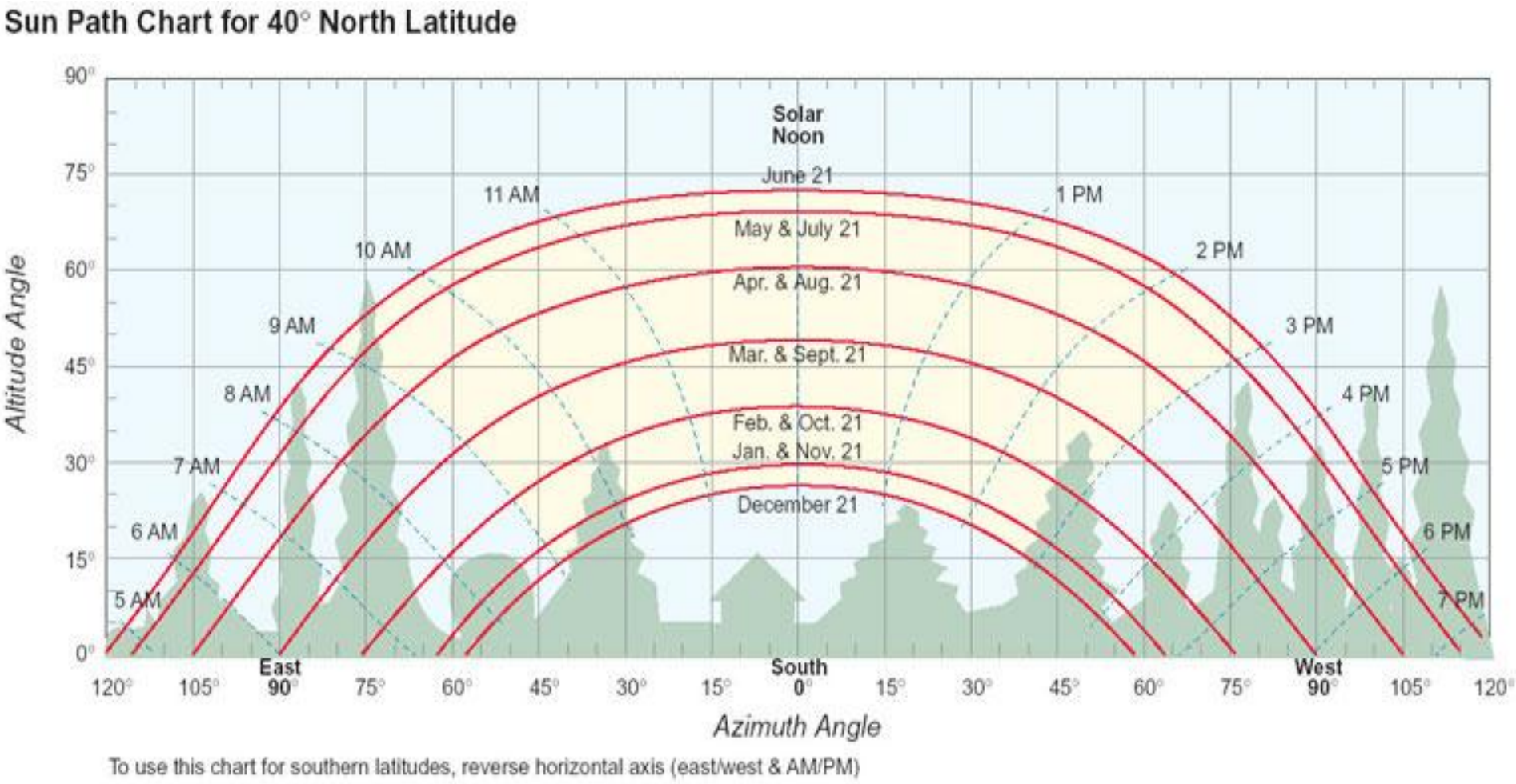
Sun Chart for 40 degrees N Latitude



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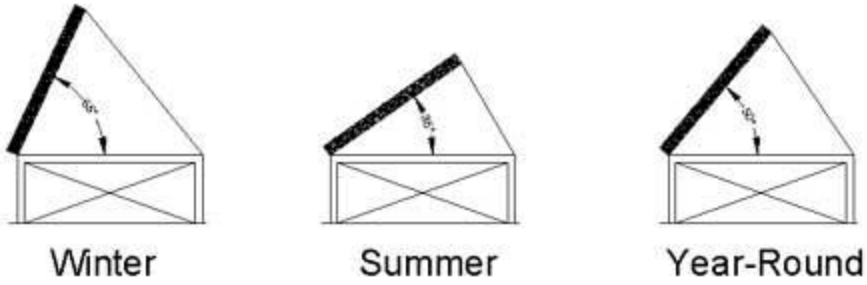
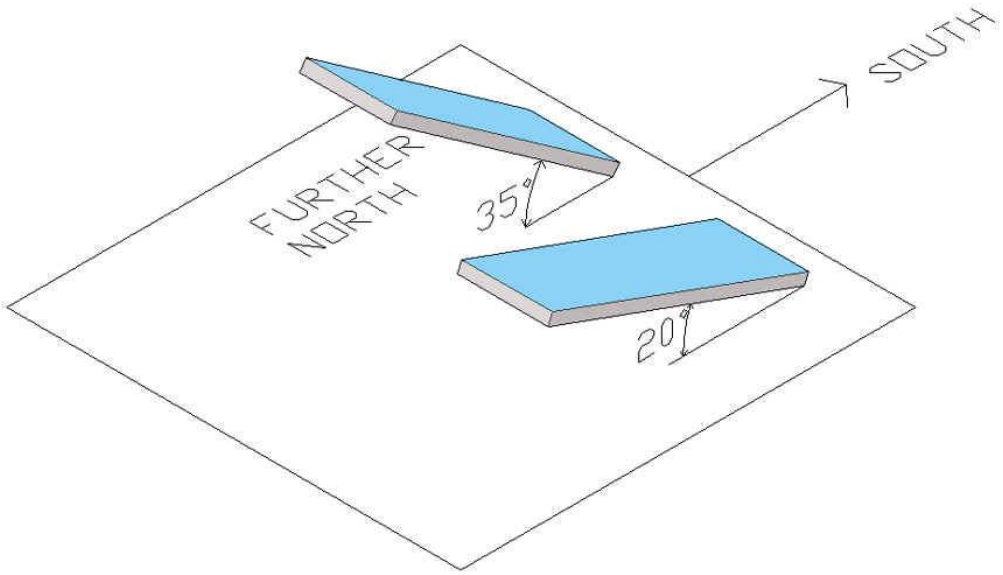
Solar Pathfinder

- An essential tool in finding a good site for solar energy is the Solar Pathfinder.
- Provides daily, monthly, and yearly solar hours estimates.

Site Selection – Tilt Angle

Max performance is achieved when panels are perpendicular to the sun's rays





Year round tilt = latitude

Winter + 15 lat.

Summer – 15 lat.

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Solar Access

- Optimum Solar Window 9 am – 3 pm.
- Array should have NO SHADING in this window (or longer if possible)

Site Assessment

- A site assessment is the first step to determining how a solar system will work.
- The site assessment will provide this evaluation:

1. Optimal Location.
2. Mounting Options.
3. Energy Usage.
4. Expected Energy Output and Estimated System Cost.
5. Financial Incentives.
6. Return on Investment

General Considerations

- **Weather characteristics**
  - Wind intensity.
  - Estimated snowfall
- **Site characteristics**
  - Corrosive salt water
  - Animal interference
- **Human factors**
  - Vandalism
  - Theft protection
  - Aesthetics

- **Loads and time of use.**
- **Distance from power conditioning equipment.**
- **Accessibility for maintenance.**
- **Zoning codes.**

Solar Cell Conversion Efficiency η

- The conversion efficiency of a typical solar cell is the ratio of the maximum output generated power to the input or incident power.
- Certain output parameters greatly influences how efficient a solar cell is and are defined as follows:

1) Short circuit current $I_{SC.}$
2) Open Circuit Voltage V_{oc}
3) Maximum Power P_{MP}
4) Fill Factor FF

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PV System monitoring

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PV system monitoring

- Monitoring and control of photovoltaic systems is essential for reliable functioning and maximum yield of any solar electric system.
- The simplest monitoring of an inverter can be performed by reading values on display.
- Values like PV array power, AC grid power, PV array current are usually available.
- For sophisticated monitoring and control purposes environmental data like module temperature, ambient temperature, solar radiation, wind speed can also be data logged, stored and analyzed later.

1. **Local Monitoring**

- Most simple way to perform local monitoring is display available on inverter or on inverter control unit.
- Other possibilities of local monitoring includes monitoring by local PC via RS232 connection and/or remote display located in living room for example (connection between inverter and display is usually wireless).
- The following parameters can usually be monitored, datalogged and stored in inverter's memory or external data logger for particular time.

Parameters	#	Unit
Array voltage	V_{DC}	V
Grid voltage	V_{AC}	V
Array current	I_{DC}	A
Grid current	I_{AC}	A
Array power	P_{DC}	W
Grid power	P_{AC}	W

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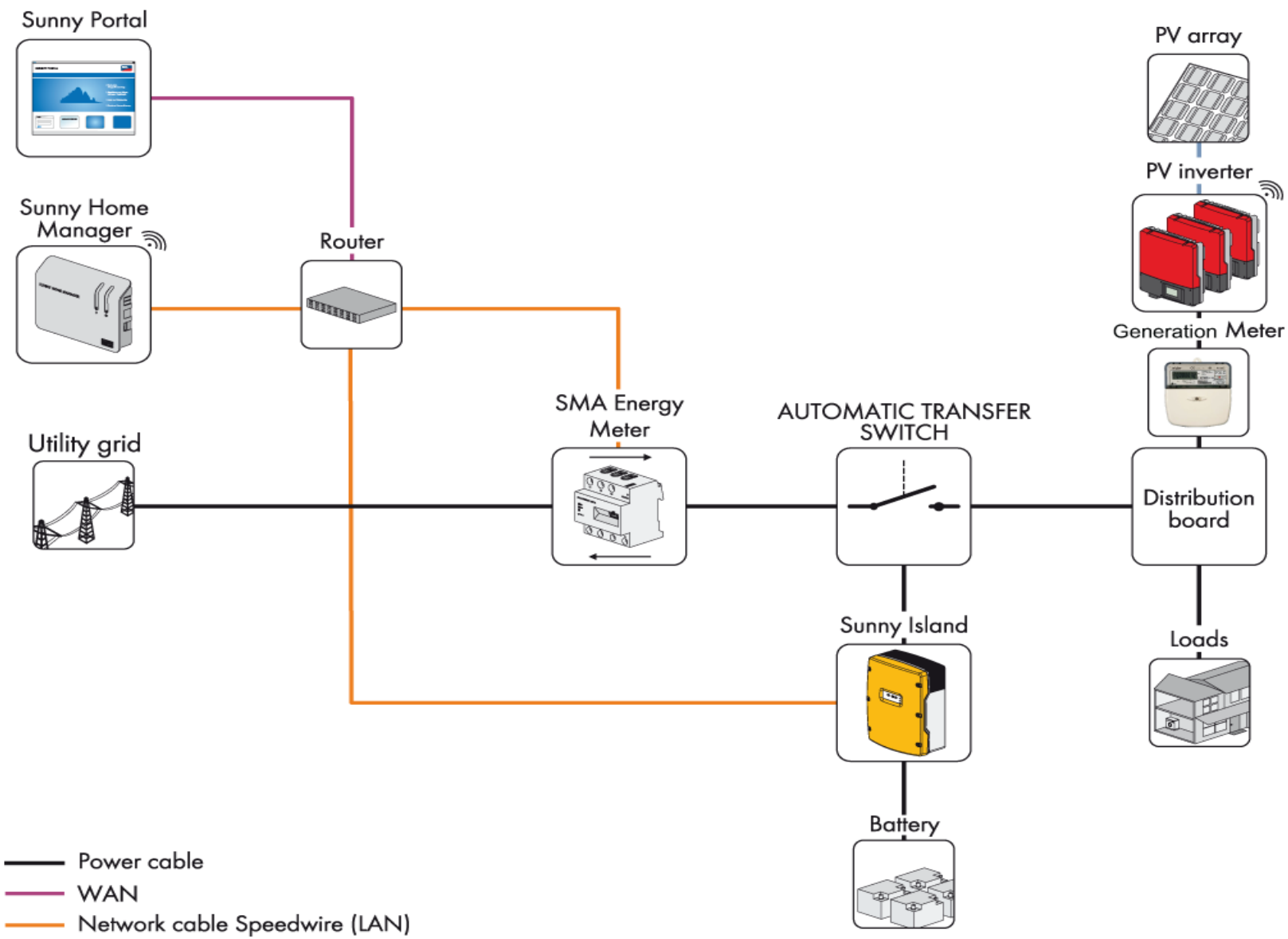
2. **Remote monitoring**

- Remote control and communication between inverters can be realized with wireless connection (Bluetooth or Wi-Fi), trough RS485 interface or via grid (powerline connection).
- Distances up to 1200 m represents no problem, several tenth inverters can be connected in chain and monitored at the same time.
- For remote monitoring different ways of communication can be used: Ethernet, Internet, dial up access.
- System can send alerts and status messages to the control center or user.
- Alerts and system messages can be send by SMS service, fax machine.



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Types of Monitoring

- Since the profitability of photovoltaic installations depends mainly on them being operational, it is essential to ensure that they are permanently functional.

- The best way of ensuring this is to acquire a monitoring system for the installation. This system should notify all faults immediately and be capable of detecting drifts in output.

- **Several types of monitoring are available for installations:**

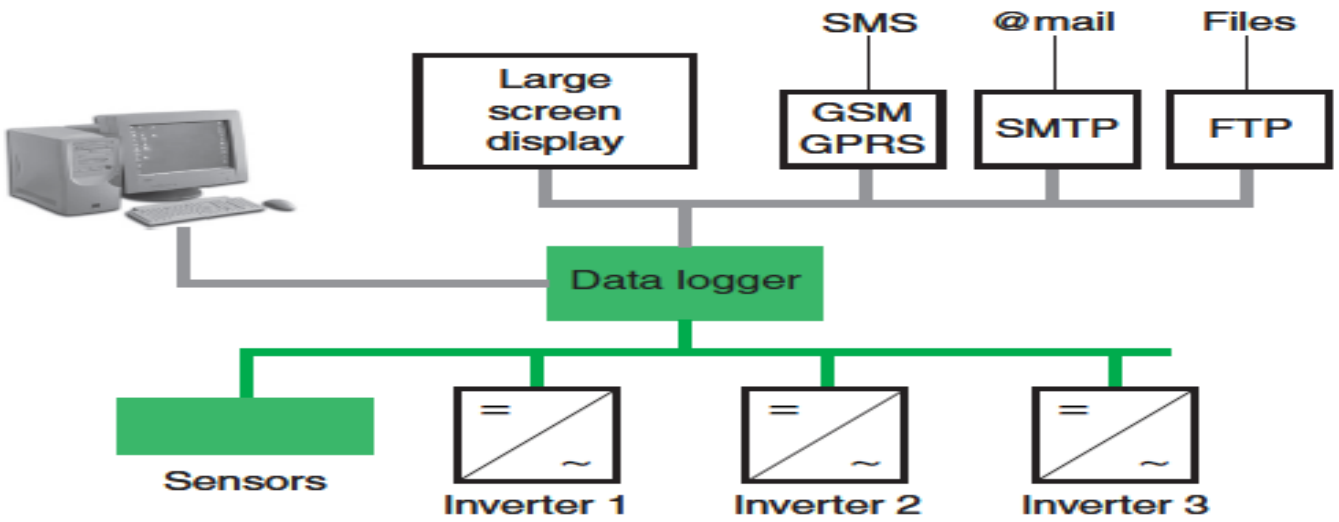
1. Systems which communicate with the inverters and are able to monitor all electrical values relating to output from the installation as well as the condition of the inverters.
2. Systems without communication protocols for the inverters but fitted with measurement inputs capable of monitoring photovoltaic output.
3. systems supplementing information from the inverters with measurements which are external to the installation such as solar radiation and temperature.

Monitoring systems

- These systems may be autonomous or include remote monitoring.

1. **Autonomous monitoring systems:**

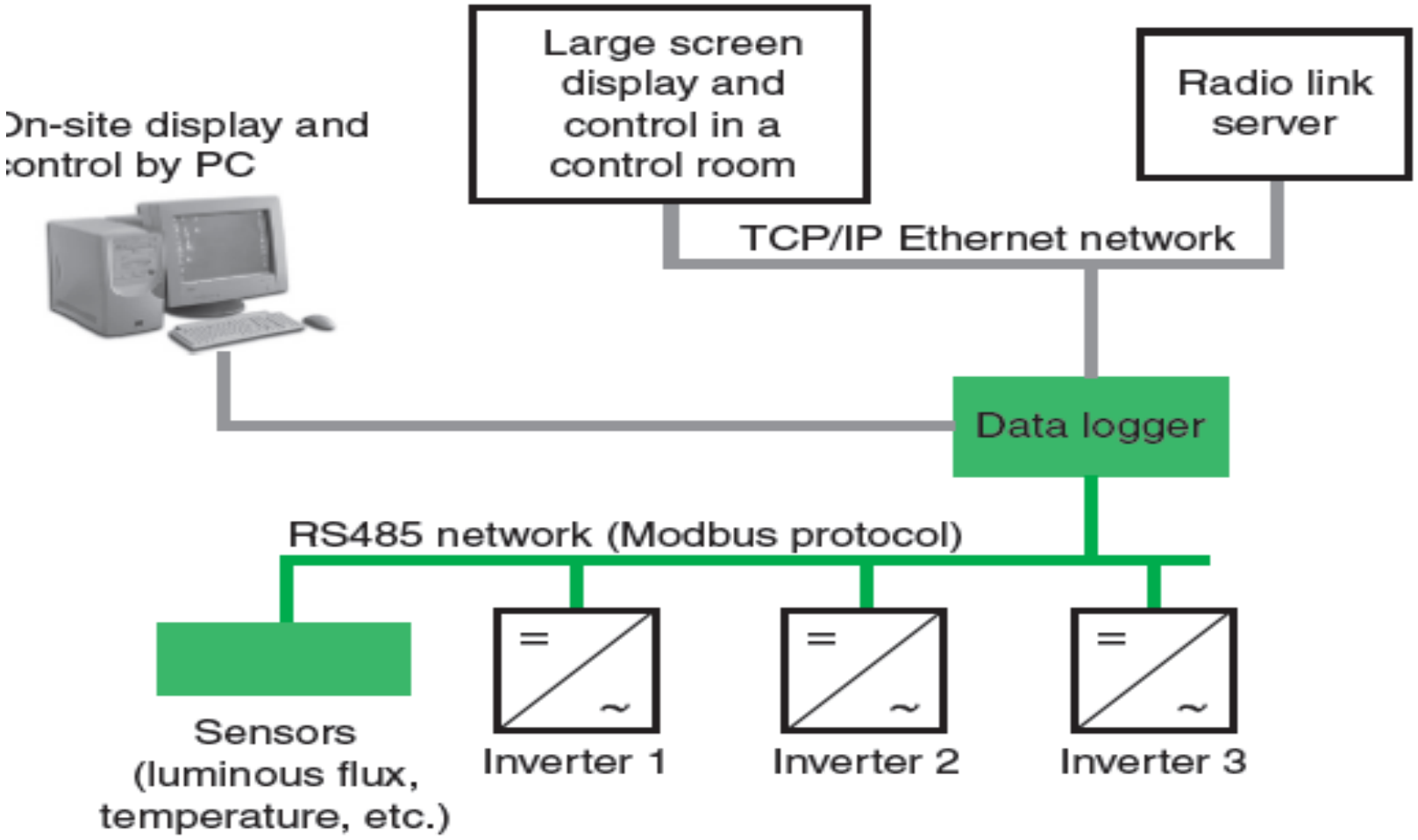
Once data is collected locally, the system sends alerts directly to the maintenance operators as soon as they are generated.



2. **With remote monitoring:**

- Once the data is collected locally, the system sends output data and alerts as soon as they are generated to a remote monitoring system capable of managing stand-by periods for maintenance work.

- This enables the installation to be monitored closely, which is essential for multi-site installations or where operators of photovoltaic installations are not necessarily the site occupants.



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