**Introduction to PV system**

A PV system contains many different components besides the PV modules. For successfully planning a PV system it is crucial to understand the function of the different components and to know their major specifications. Further, it is important to know the effect on the location of the (expected) performance of a PV system.

**Types of PV systems**

PV systems can be very simple, consisting of just a PV module and load, as in the direct powering of a water pump motor, which only needs to operate when the sun shines. However, when for example a whole house should be powered, the system must be operational day and night. It also may have to feed both AC and DC loads, have reserve power and may even include a back-up generator. Depending on the system configuration, we can distinguish three main types of PV systems: stand-alone, grid-connected, and hybrid. The basic PV system principles and elements remain the same. Systems are adapted to meet particular requirements by varying the type and quantity of the basic elements. A modular system design allows easy expansion, when power demands change.

**Stand-alone systems**

Stand-alone systems rely on solar power only. These systems can consist of the PV modules and a load only or they can include batteries for energy storage. When using batteries charge regulators are included, which switch off the PV modules when batteries are fully charged, and may switch off the load to prevent the batteries from being discharged below a certain limit. The batteries must have enough capacity to store the energy produced during the day to be used at night

and during periods of poor weather.

**Grid-connected systems**

Grid-connected PV systems have become increasingly popular for building integrated applications. They are connected to the grid via inverters, which convert the DC power into AC electricity. In small systems as they are installed in residential homes, the inverter is connected to the distribution board, from where the PV-generated power is transferred into the electricity grid or to AC appliances in the house. These systems do not require batteries, since they are connected to the grid, which acts as a buffer into that an oversupply of PV electricity is transported while the grid also supplies the house with electricity in times of insufficient PV power generation.

Large PV fields act as power stations from that all the generated PV electricity is directly transported to the electricity grid. They can reach peak powers of up to

several hundreds of MW

MW system installed in Germany.

**Hybrid systems**

Hybrid systems consist of combination of PV modules and a complementary method of electricity generation such as a diesel, gas or wind generator. A schematic of a hybrid system. In order to optimise the different methods of electricity generation, hybrid systems typically require more sophisticated controls than stand-alone or grid-connected PV systems. For example, in the case of an PV/diesel system, the diesel engine must be started when the battery reaches

a given discharge level and stopped again when battery reaches an adequate state of charge. The back-up generator can be used to recharge batteries only or to supply the load as well.