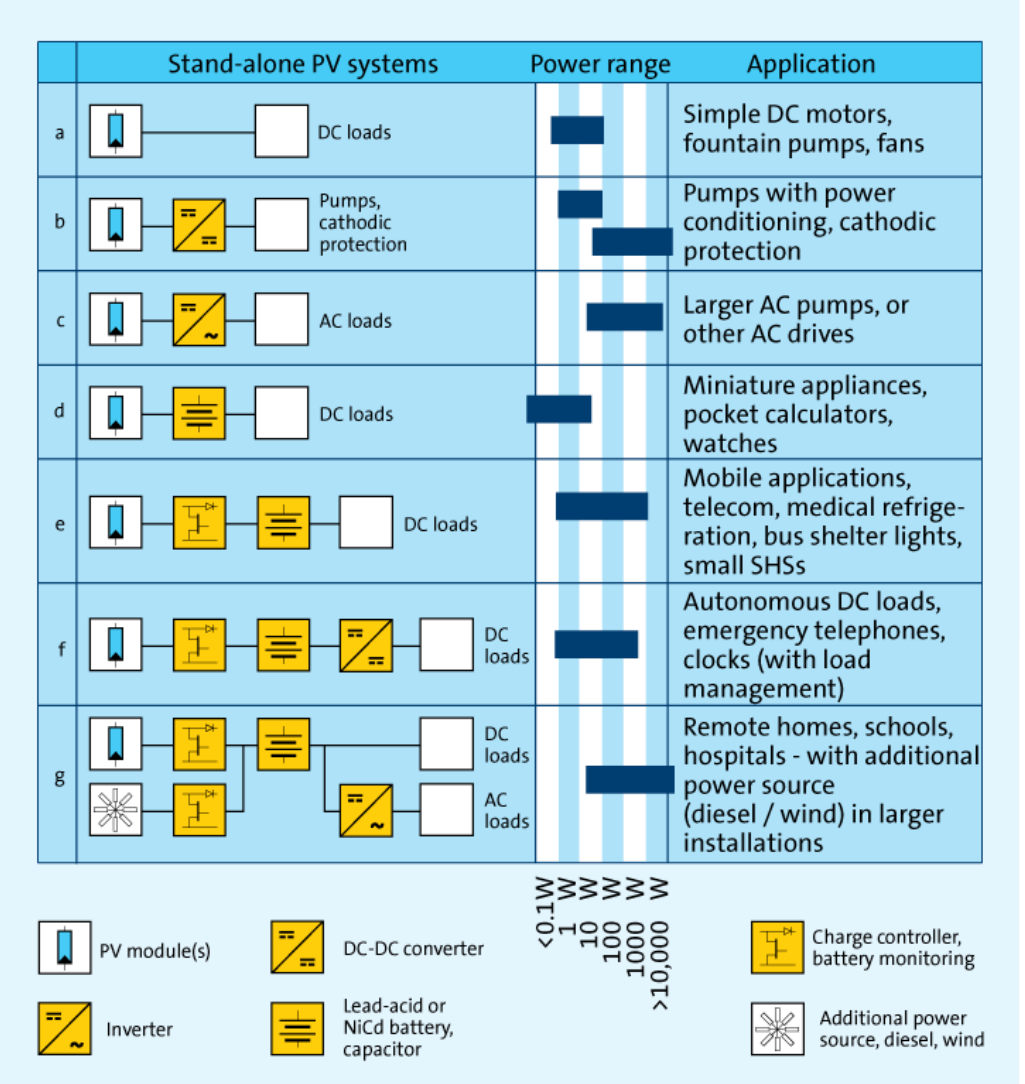
PV & PV-HYBRID SYSTEM CONFIGURATIONS

Range of system configurations



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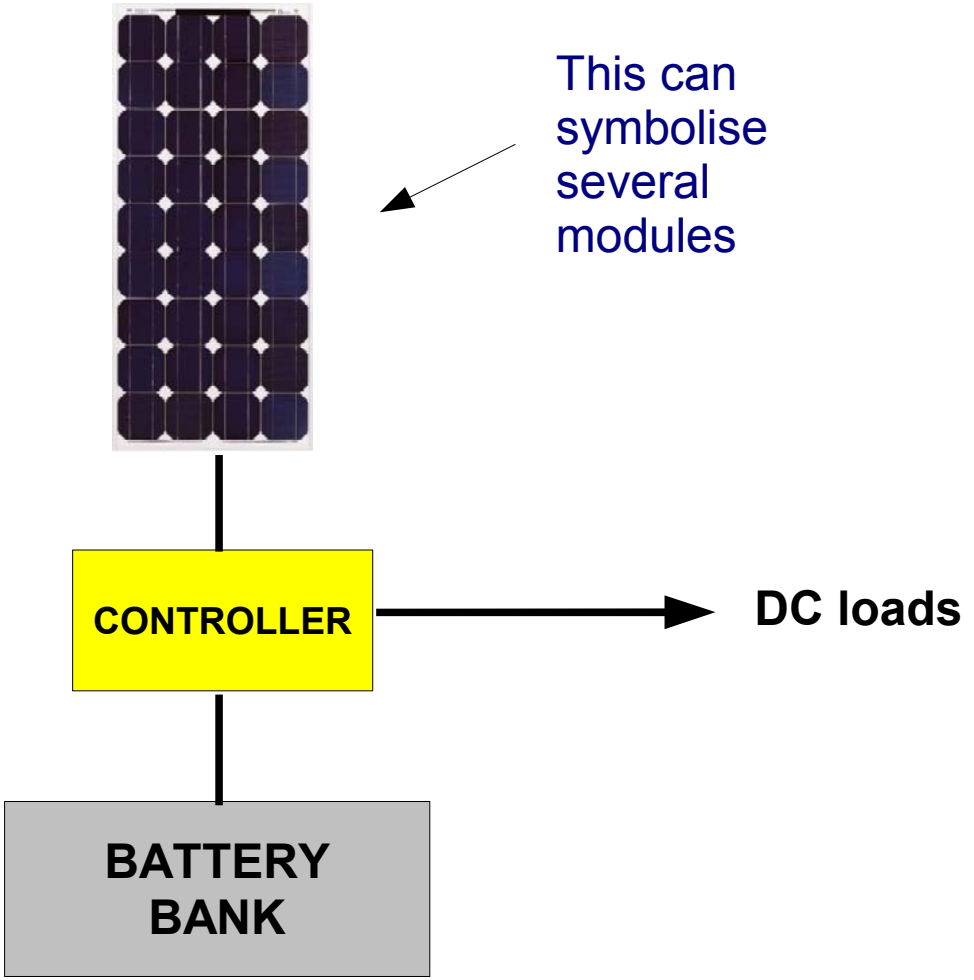
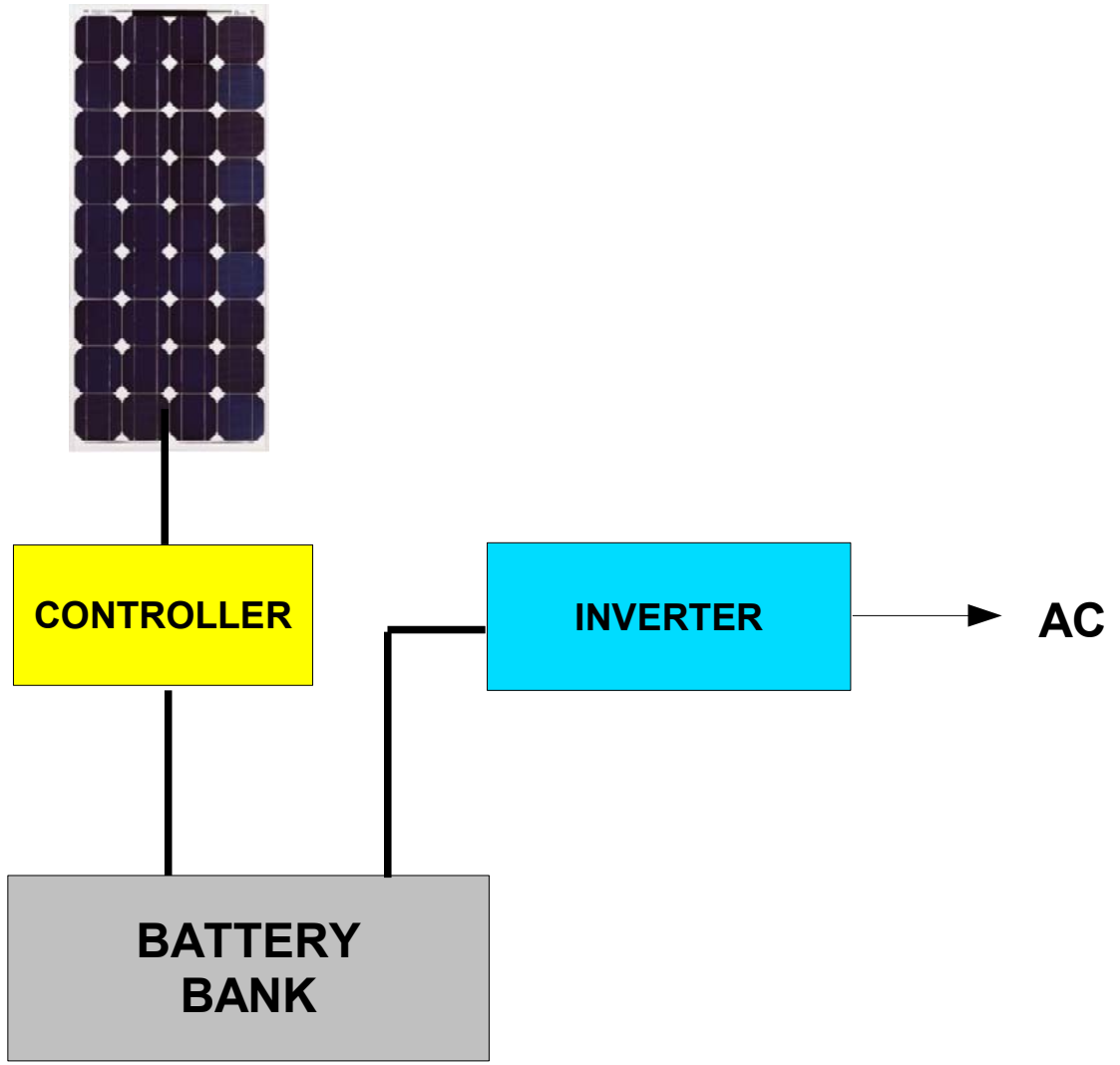
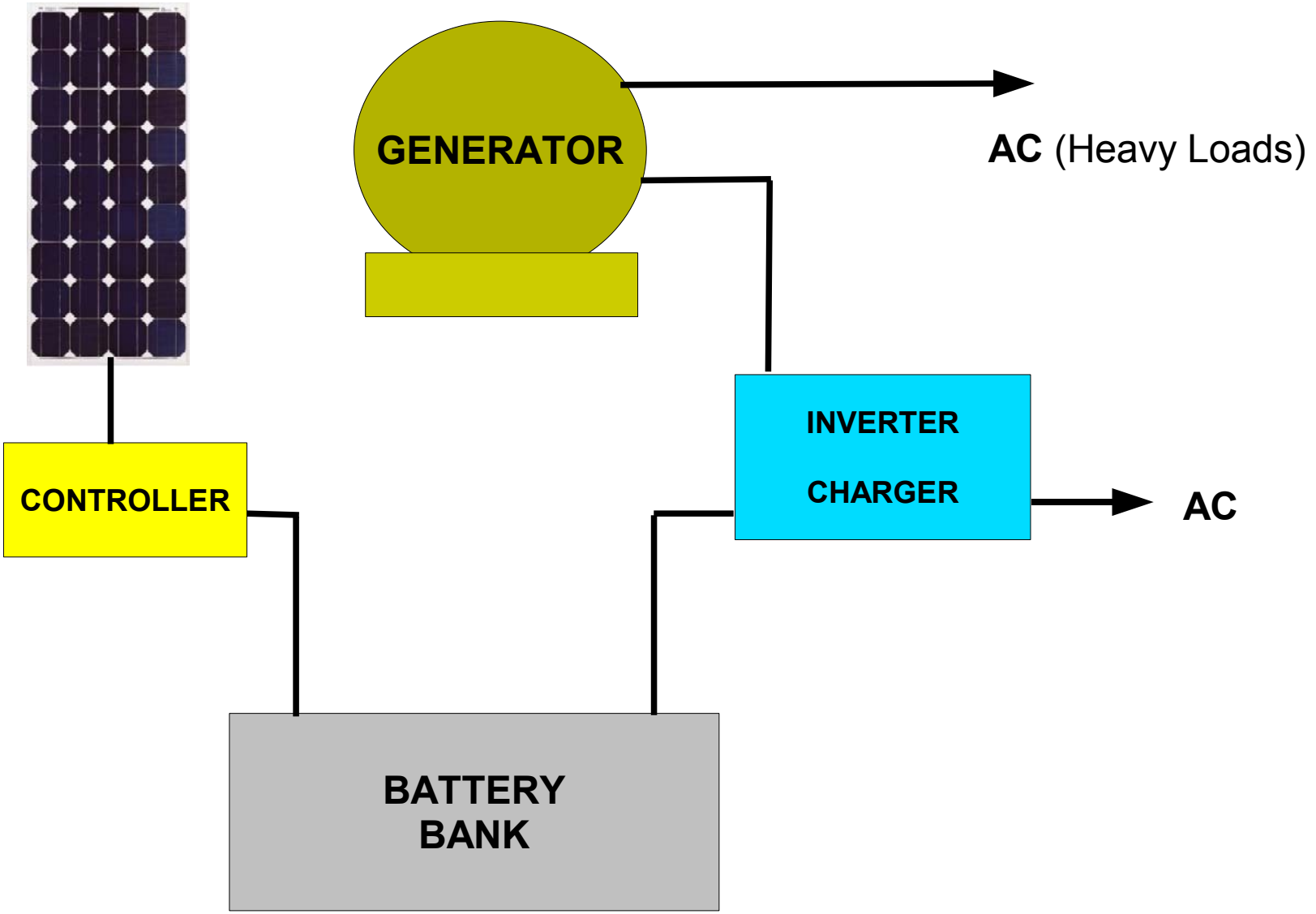
Stand-alone PV - DC only



Stand-alone PV - DC & AC



Stand-alone – PV-diesel-hybrid



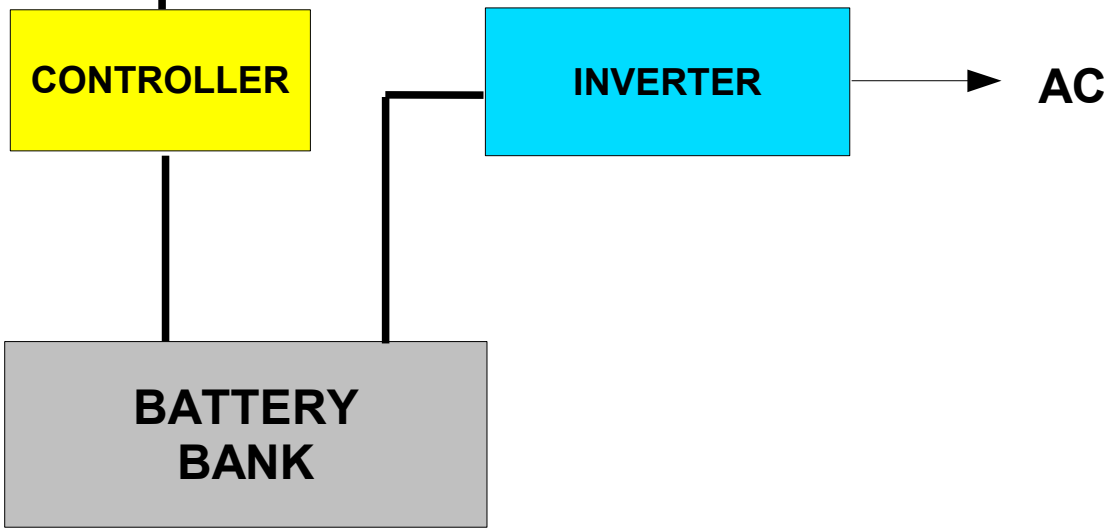
Wind - DC only

CONTROLLER

DC loads

BATTERY BANK

Wind - DC & AC



Wind - DC & AC, with heat dump

HEAT DUMP

CONTROLLER

INVERTER

AC

BATTERY BANK

Stand-alone – PV-wind-hybrid

CONTROLLER

CONTROLLER

INVERTER

AC

BATTERY BANK

Stand-alone – PV-wind-diesel-hybrid

GENERATOR

AC (Heavy Loads)

CONTROLLER

CONTROLLER

INVERTER

CHARGER

AC

BATTERY
BANK

DC coupled mini-grids

AC mini-grids

AC Mini-Grids

The Future of Community-Scale Renewable Energy

Dana Brandt

This 3,600-watt photovoltaic array is part of a groundbreaking "AC mini-grid" system in Bulyansungwe, Uganda.

For decades, nearly all small-scale renewable energy (RE) installations have been DC-coupled systems. These DC-based systems are just like you read about in *Home Power*—where one or more DC sources like photovoltaics (PVs) and/or wind generators are used to charge batteries that, in turn, power DC loads directly, or AC loads via an inverter. Each charging source requires a controller to regulate the power from the RE source to the battery. While DC coupling is still the state of the art in most of the world, a method of AC coupling (connecting several charging sources together on the AC side of the system) has been developed that offers significant benefits for certain applications.

AC coupling uses batteryless inverters networked to one or more centralized battery-based inverters. This configuration allows AC to either go directly to AC loads, bypassing the batteries, or to charge the batteries via the battery-based inverter. Regulation is done on the AC side of the system by limiting the output of the batteryless inverters when the batteries are fully charged.

I had the unique opportunity of working with this new technology for my thesis project while doing graduate studies in renewable energy in Germany. My project was the design and installation of a PV and engine-generator hybrid system with an AC mini-grid. The system powers a rural boarding school complex in the village of Bulyansungwe, Uganda, where there are no utility lines within several miles. The people of Bulyansungwe are primarily subsistence farmers who grow bananas and coffee as cash crops. Bulyansungwe Secondary School is considered the center of the village because there is no conventional village center of houses and shops.

The school complex includes a girls' dorm, boys' dorm, classrooms, a convent, and a social center. The German organization, Together: Assistance for Uganda, has provided funding for its construction and operation. Previously, the only source of electricity was a small, gasoline-powered generator used on special occasions.

Hybrid Systems & Mini-Grids

Hybrid renewable energy systems have proven to be an excellent solution for providing electricity to areas with no utility service. Hybrid systems combine multiple sources to supply steady and reliable energy to consumers. Common system configurations often include one or more renewable

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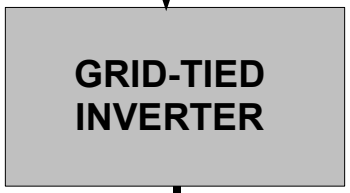
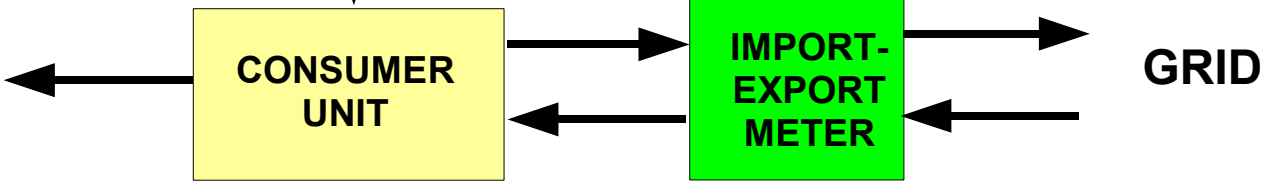
PV grid-tied system



Other meter configurations are possible



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Grid-tied PV with battery back-up

Several configurations possible

EMERGENCY & SMALL LOADS

GRID-TIED INVERTER

BUILDING LOADS

CONSUMER UNIT

IMPORT-EXPORT METER

GRID