LEMBAGA ILMU PENGETAHUAN INDONESIA
(INDONESIAN INSTITUTE OF SCIENCES)

Design and Implementation of Energy Management System for Hybrid RE Power System

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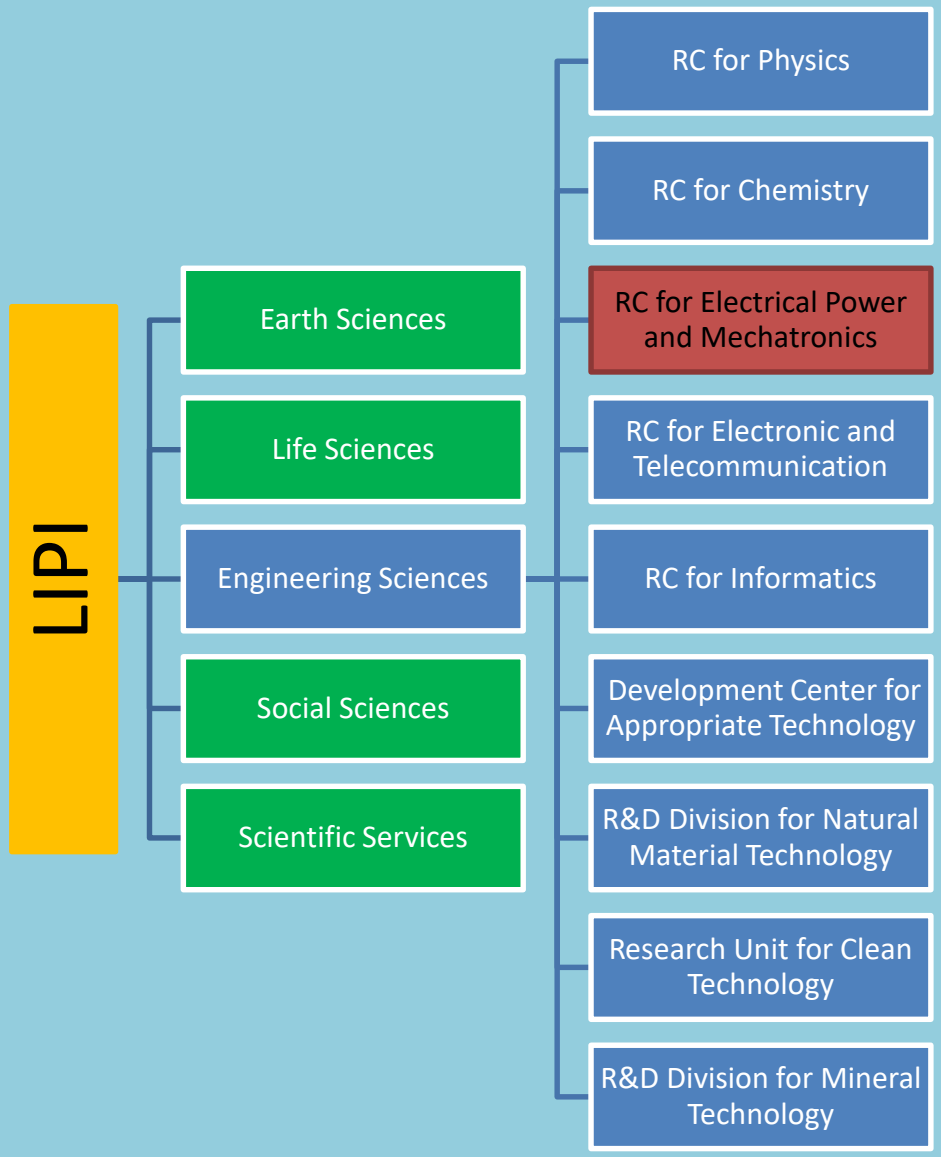
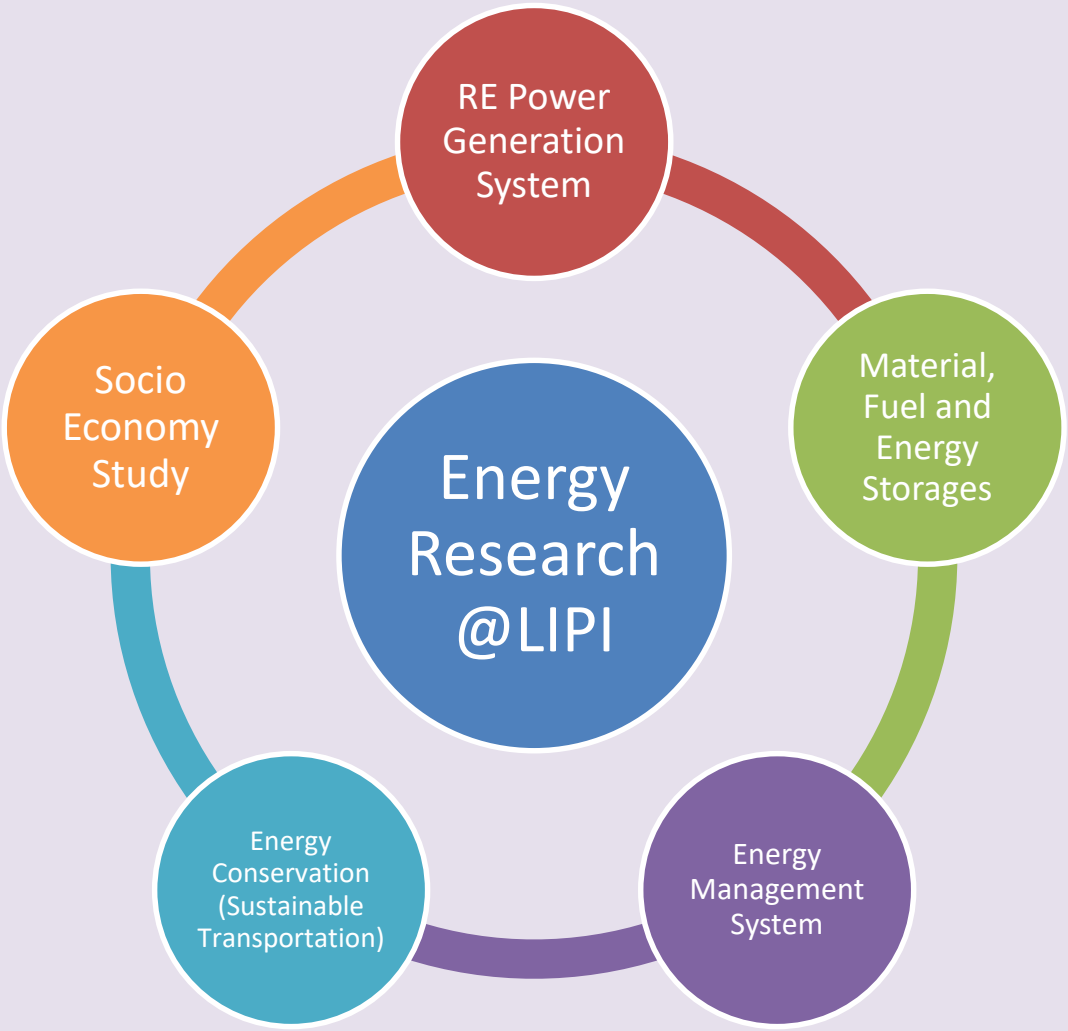
Introduction

LIPI is non-ministerial government research institution responsible to the President under the auspice of the Ministry for Research, Technology, and Higher Education. LIPI's role is to carry out government duties in the field of scientific research.

Researchers : 1588



Energy Research in LIPI



Research Topics

ENGINEERING SCIENCES

Research Centre for Electrical Power and Mechatronics (RCEPM)
- Biogas
- Concentrated Solar Power (CSP)
- Organic Rankine Cycle (ORC)
- Picohydro for Low Head Water
- Hybrid power plant
- Energy Management System

Research Centre for Chemistry (RCC)
- Lignocellulose

Research Centre for Physics (RCP)
- Energy Storage (Li-Battery, FC)

Research Centre for Electronics and Telecommunication (RCET)
- Polymer based Solar Cell

LIFE SCIENCES

Research Centre for Biotechnology (RCB)
- Bioenergy from microalgae (biodiesel, biohydrogen)
- Screening for microorganism for bioenergy

SOCIAL SCIENCES AND HUMANITIES

Research Centre for Economics (RCE)
- Development of alternative energy industry : Biodiesel study case
- Development of alternative energy industry : Bioethanol study case
- Development of alternative energy industry : Geothermal study case
- Community based educational and partnership actions – carbon neutral initiative for community empowerment and climate change mitigation in Indonesia through micro hydro development

SCIENTIFIC SERVICES

Center of Innovation
- Wind Turbine
- NRE asessment
- Energy Management System Assesment

Instrumentation Research Unit
- Control system for power geberation

EARTH SCIENCES

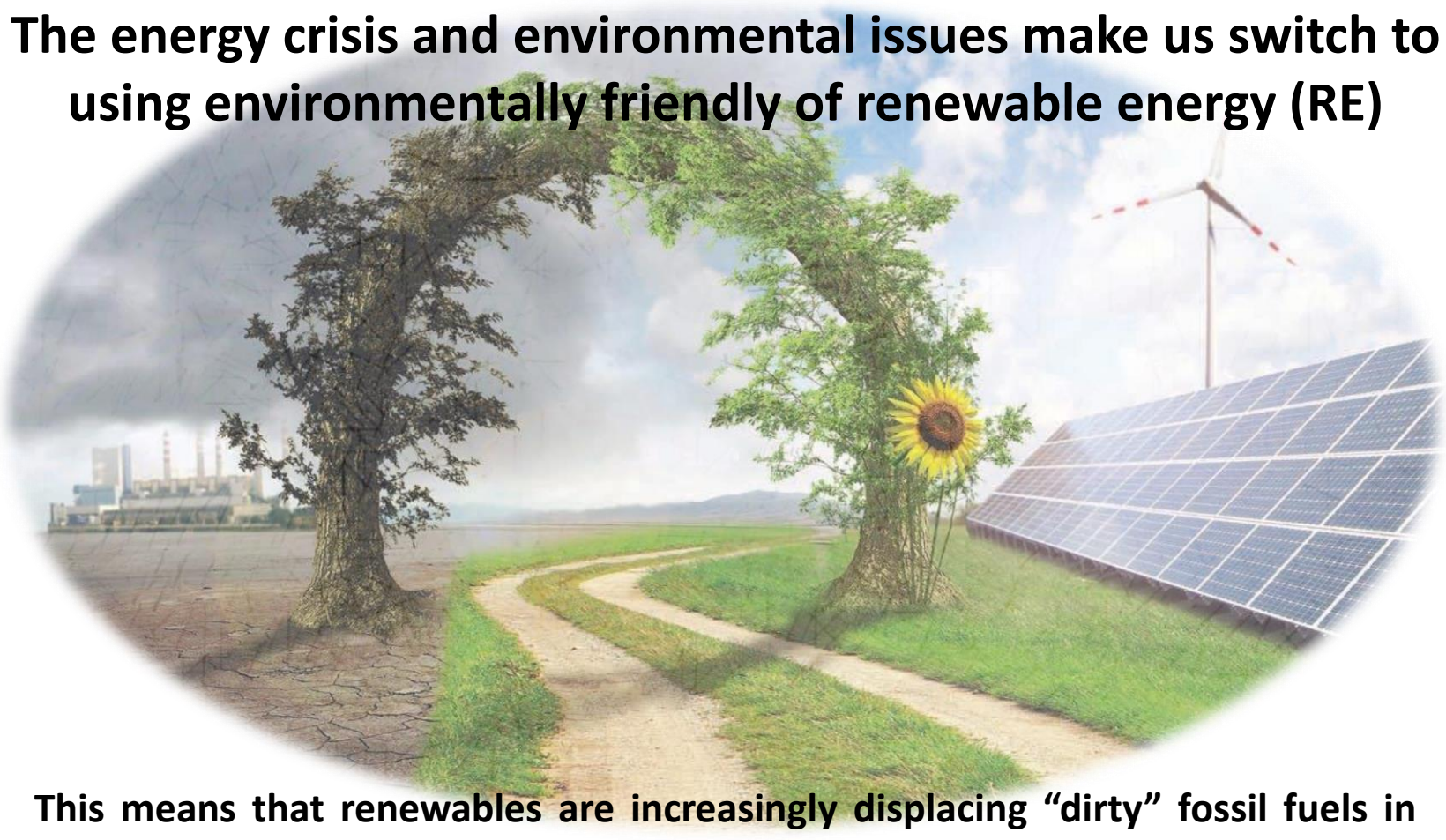
Research Centre for Metallurgy & Material
- Superconductor material
- Laterite Steel
- Super Alloys
- Coatings

VC

- Risk Management
- Model of Technology Adoption

Background

The energy crisis and environmental issues make us switch to using environmentally friendly of renewable energy (RE)



This means that renewables are increasingly displacing “dirty” fossil fuels in the power sector, offering the benefit of lower emissions of carbon and other types of pollution.

Background

Five steps to develop NRE ;

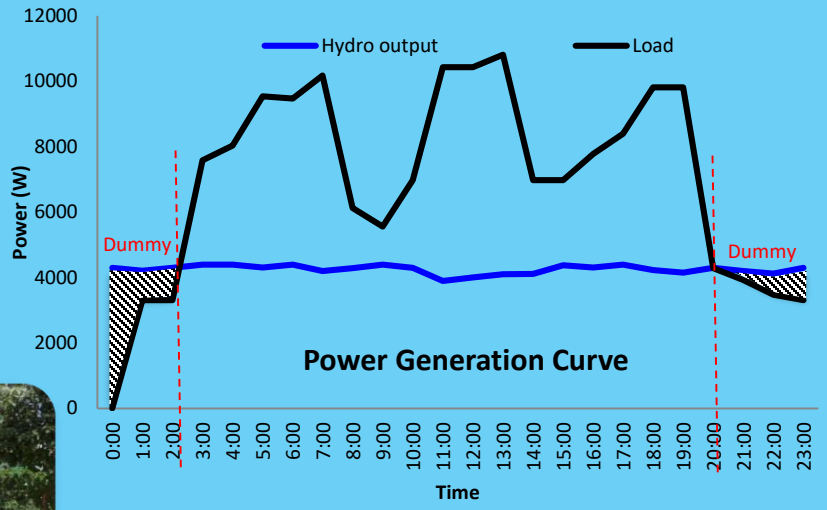
1. Increasing the capacity of power plants in producing energy. In the next several years, the construction of Hydro Power Plants (PLTA) and Geothermal Power Plants (PLTP) will be increased.
2. Increasing the accesses to modern energy in isolated regions, especially rural areas using microhydro, solar power, biomass and biogas.
3. Reducing oil fuel subsidy cost, in which the substitution Diesel Engine Power Plant (PLTD) substitution to NRE power plant will reduce subsidy.
4. Reducing greenhouse gas emission
5. Energy saving at large scale.

Background


- In supporting penetration of RE use in Indonesia, Telimek LIPI has implemented several RE power plants such as hydro, biogas and Solar-photovoltaic.
- One of the pilot project sites is the Baiturrahman boarding school, a rural area on the south side of Bandung, Indonesia.
- Three renewable energy power plants have been built in small capacity to reduce dependence on utility grid.
- The renewable energy power plants installed are 5 kW biogas, 5 kW micro hydro, and 1 kW solar (stand alone).



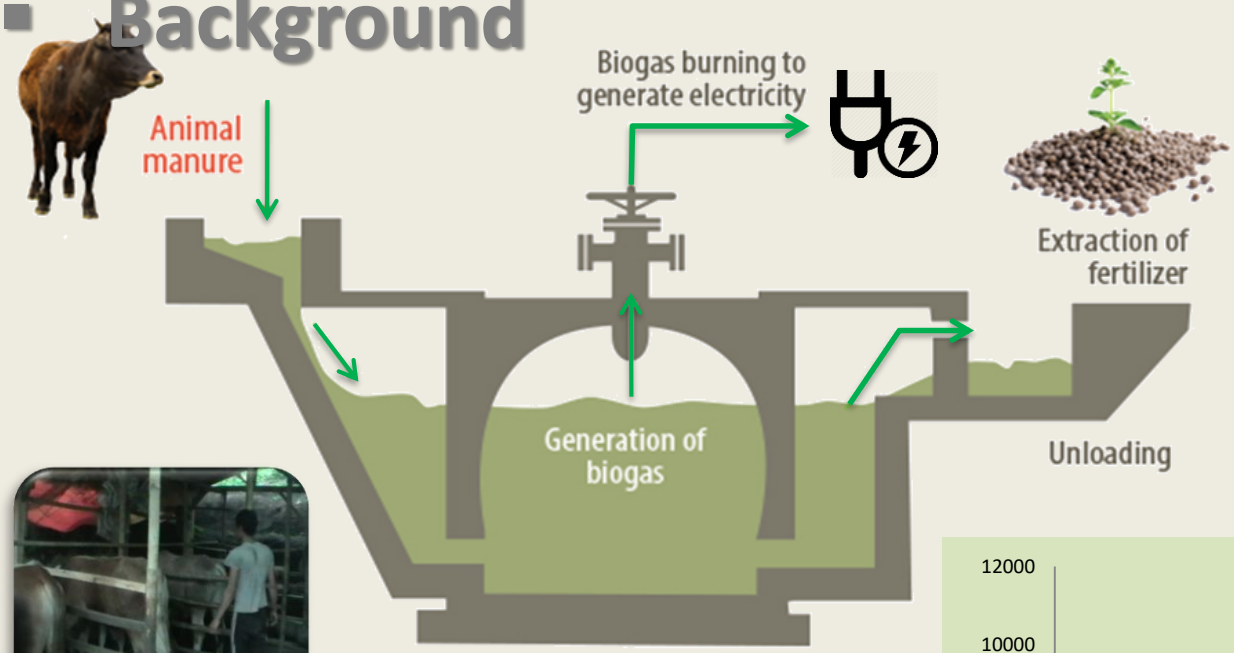
Background



Hydro Power Plant Spesification :

- Propeller turbine that is suitable for use in low head river flows.
- Available head = 1,5 m, flow rate 500 L/s turbine efficiency = 72%.
- Testing Results = 4.2 kW
- Generator Capacity = 5 kW

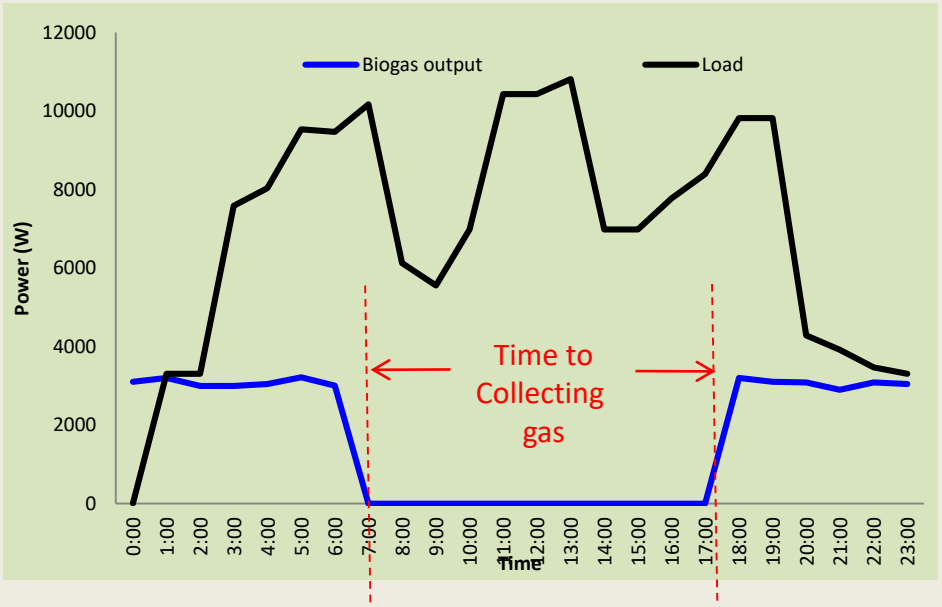
Background



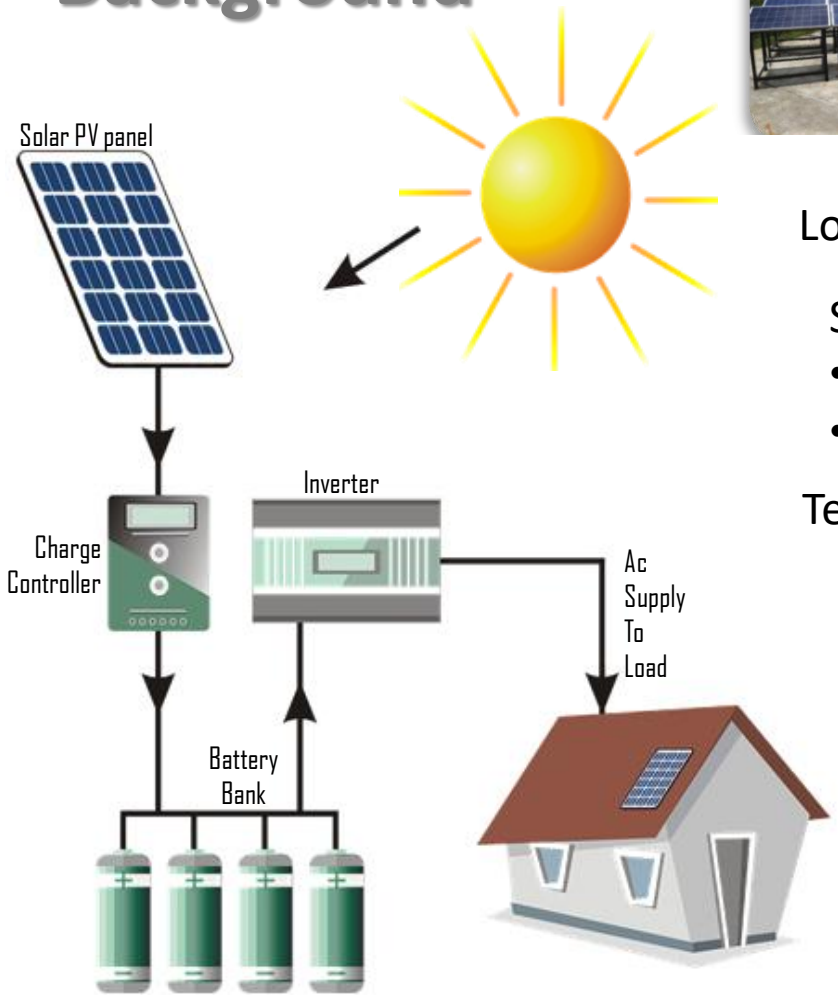
Biogas Power Plant Spesification

- Sources: 28 cows
- Cow waste = ± 0.28 ton/day
- Electricity ≅ 76.5 kWh/day
- Generator Capacity = 5 kW

Testing Results = 40 kWh/day



Background

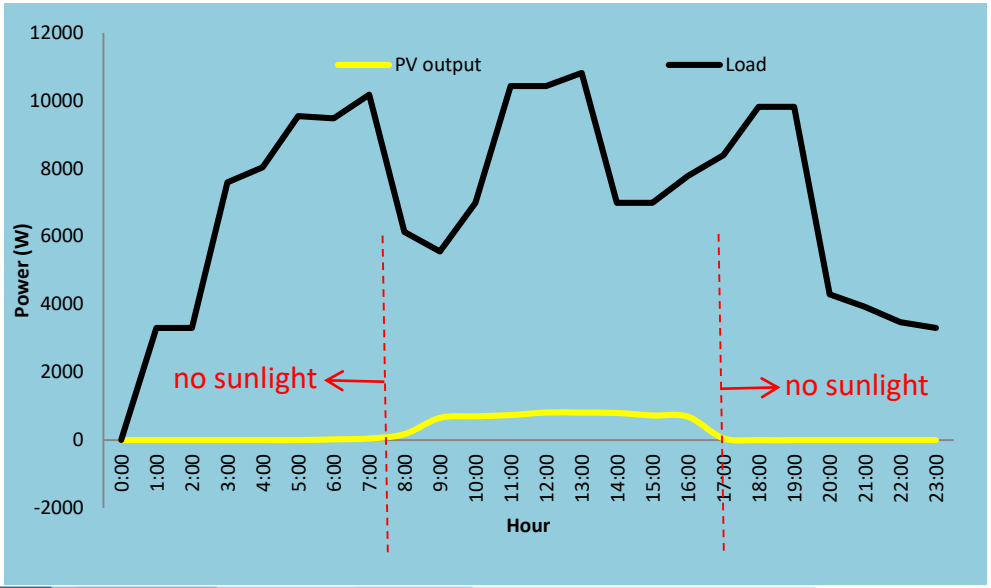


Local average daily irradiation = 4.89kWh/m^2 per day

Solar Power Plant Spesification :

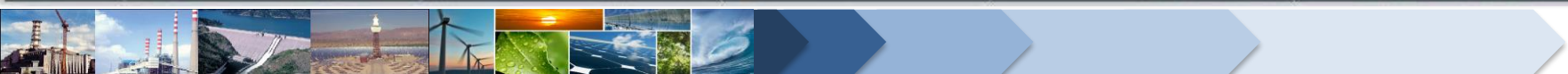
- 10 X 1 panels (@100Wp) = 1kWp
- Panel Efficiency = 14%

Testing results 10 panel ($\pm$ 10m^2) = 6.2 kWh per day

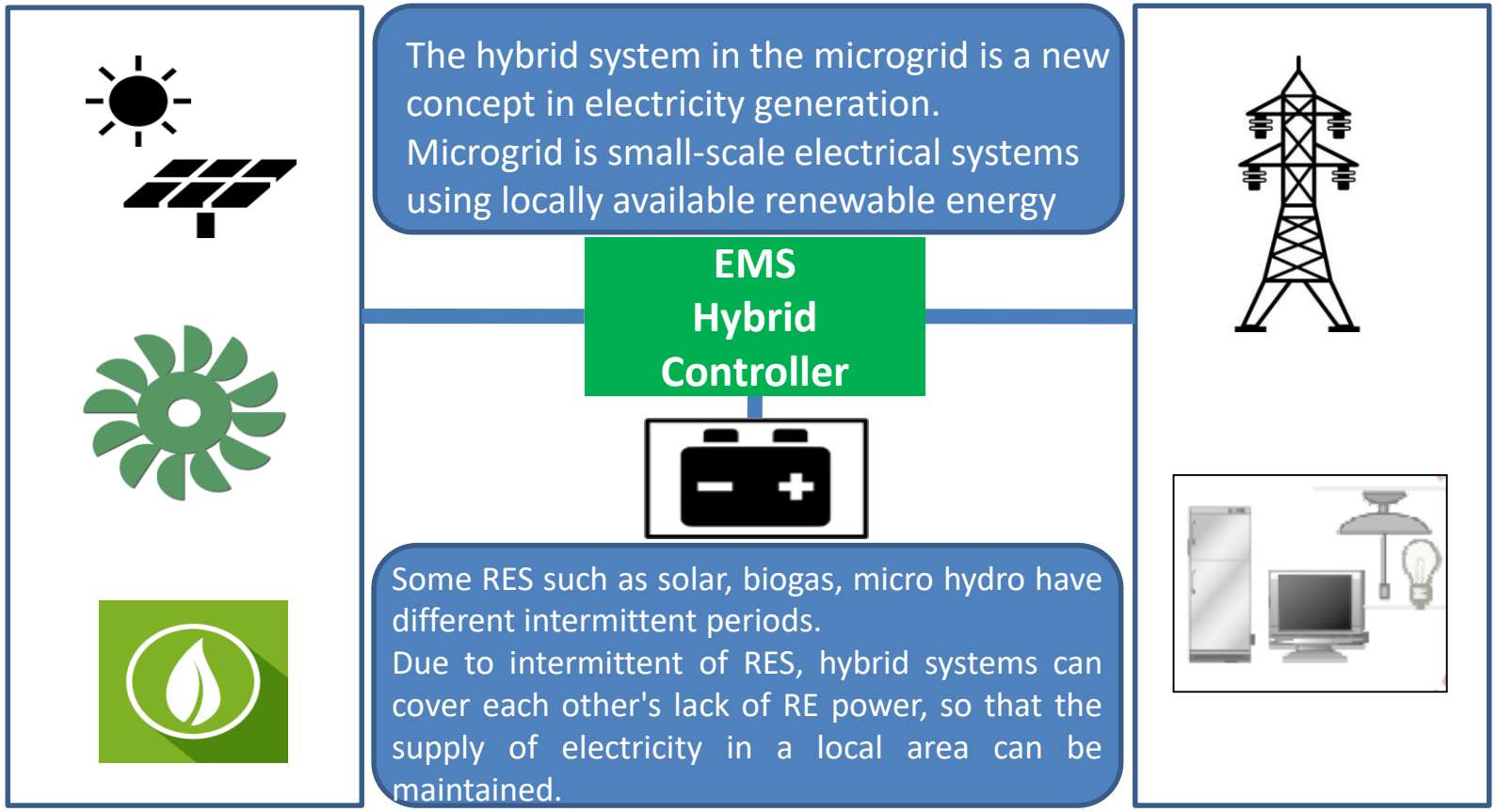


Background

- Now, RE power plants is not only focused on remote areas, but also can be used in urban or rural areas where utility grid are affordable.
- Through micro grid technology, RE power plants can be implemented anywhere as long as their potential available.
- **Energy Management System(EMS)** based on renewable energies can operate stand alone (off-grid) and can also be connected with utility grid (on-grid).

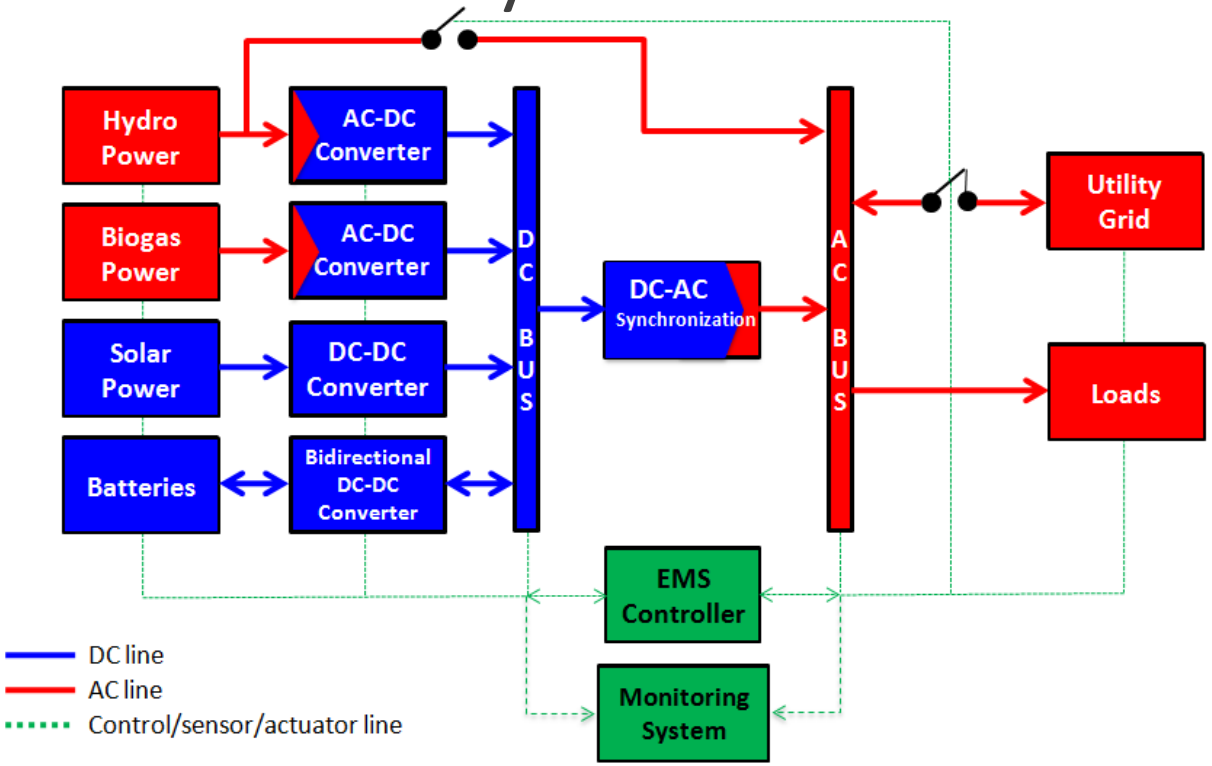


Design of EMS - RE Hybrid Power



Previously all power plants were connected to loads with *standalone* systems using conventional off-grid controls. Furthermore, all of the power plants were integrated into a microgrid that is connected to a utility grid to supply electricity local loads.

Design of EMS - RE Hybrid Power



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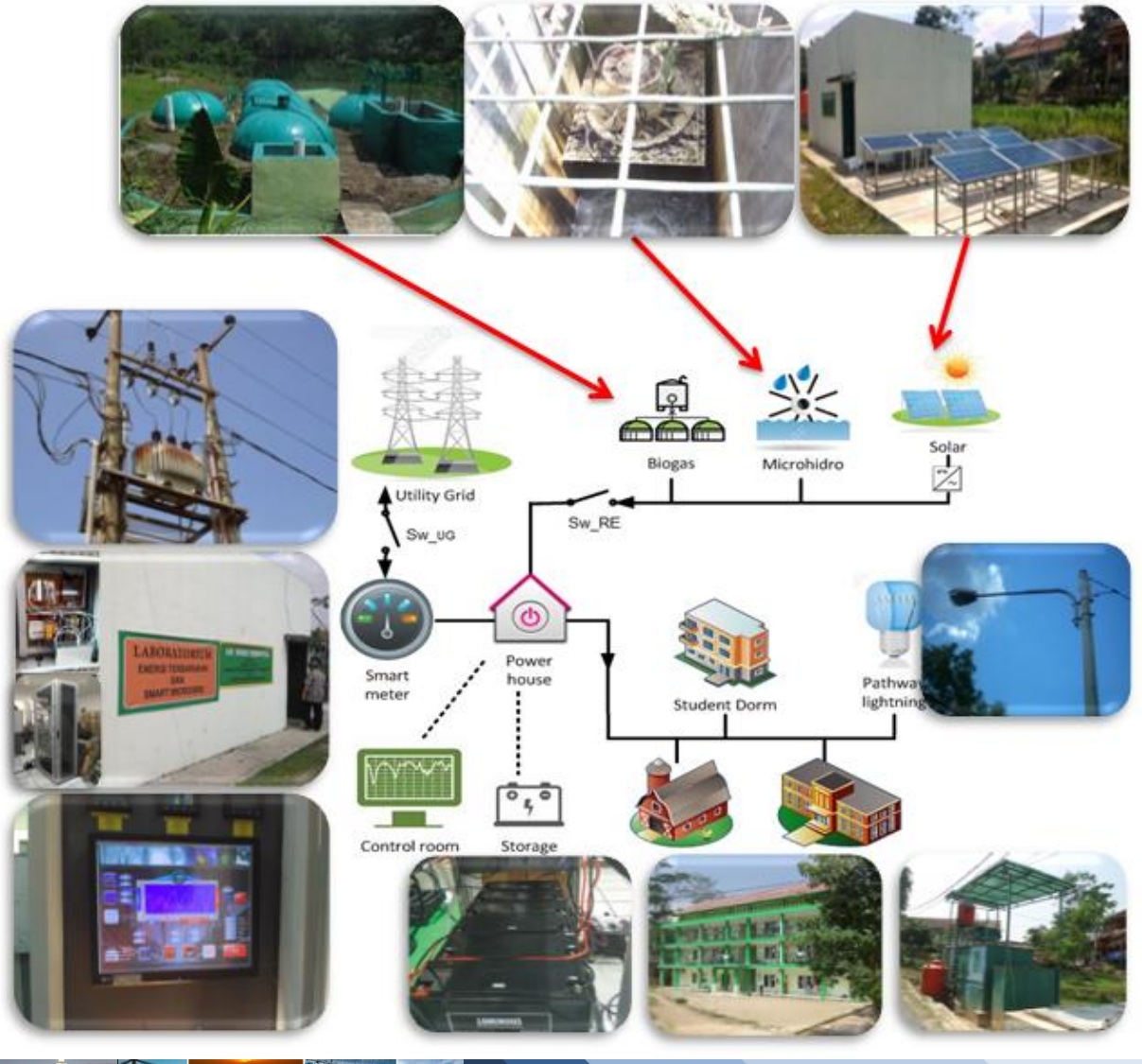
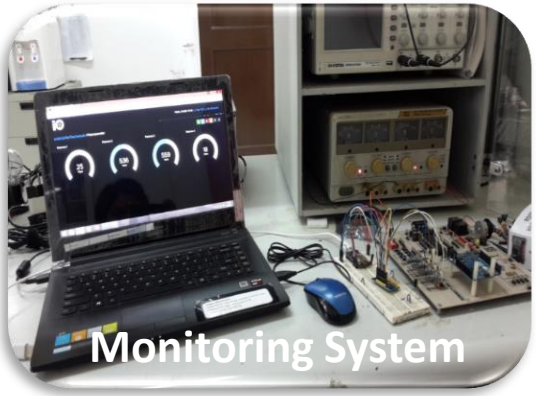
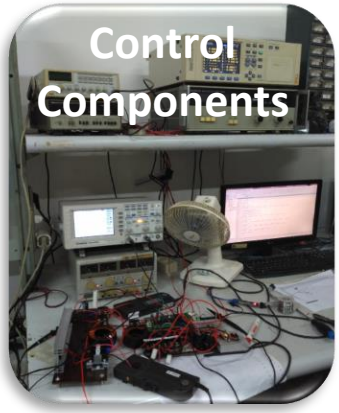
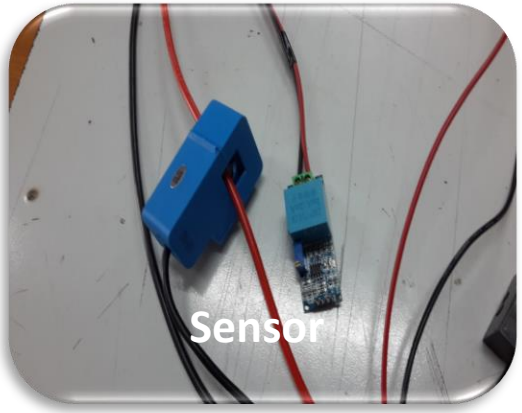


Design of EMS - RE Hybrid Power







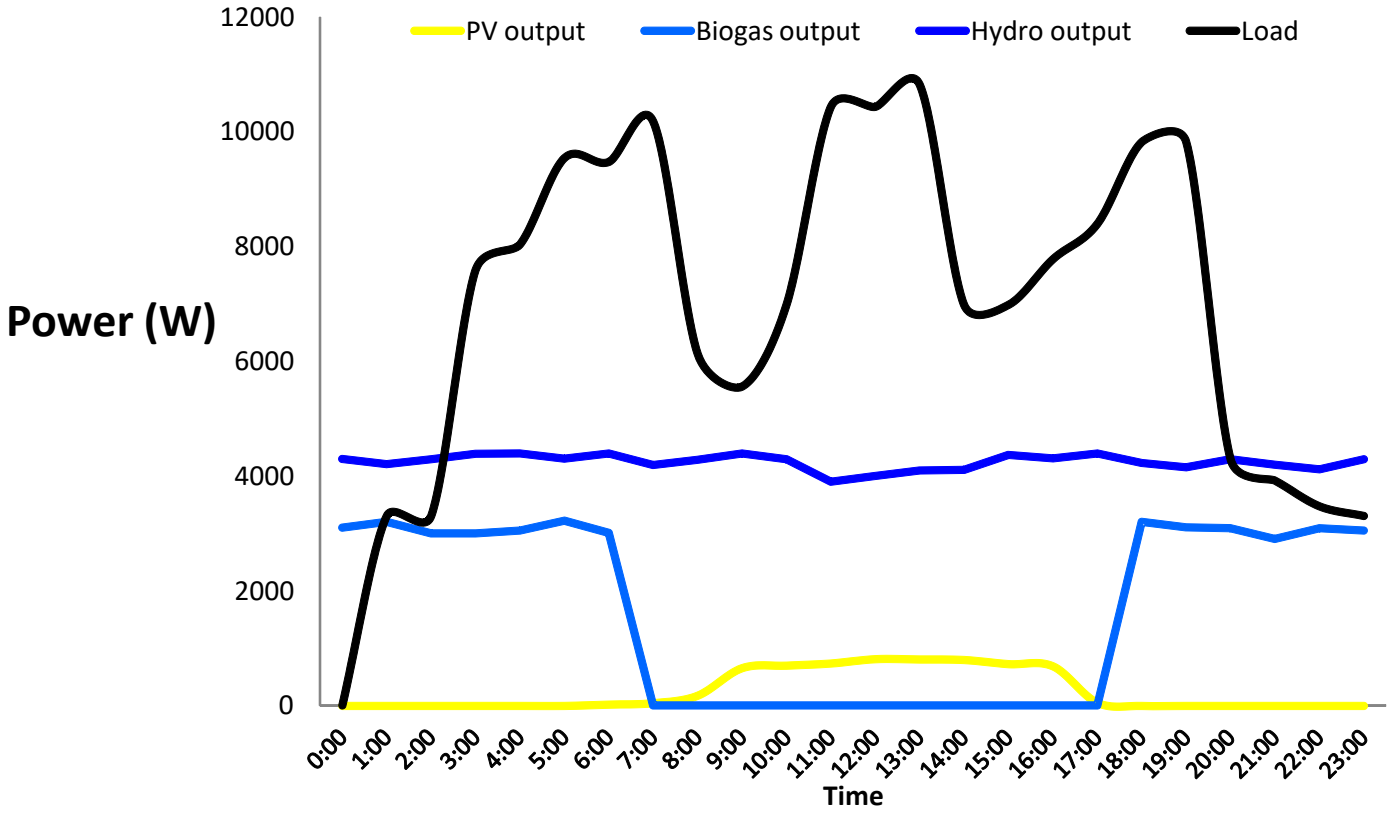
Design of EMS - RE Hybrid Power

Battery

- The storage system uses 6 batteries 12 V, 150 Ah
- All batteries are configured in 2-series 3-paralels to produce a nominal voltage of 24 Vdc, 450 Ah ≅ 10.8 kWh
- Battery recommended in the system to anticipate RE power shortages, because RE power is intermittent

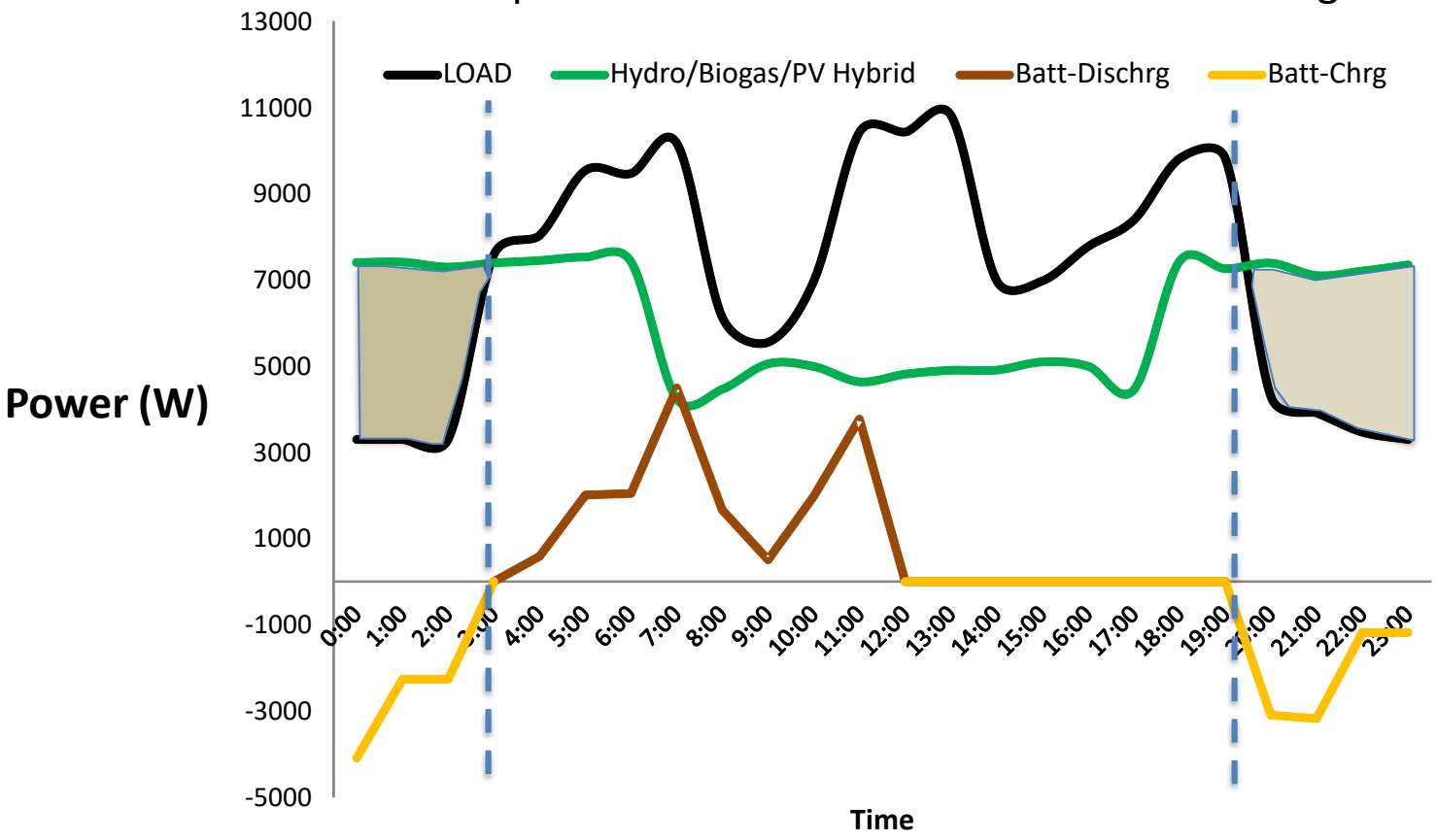
Results

The daily test results from the output of each RE power plant and its comparison with the load



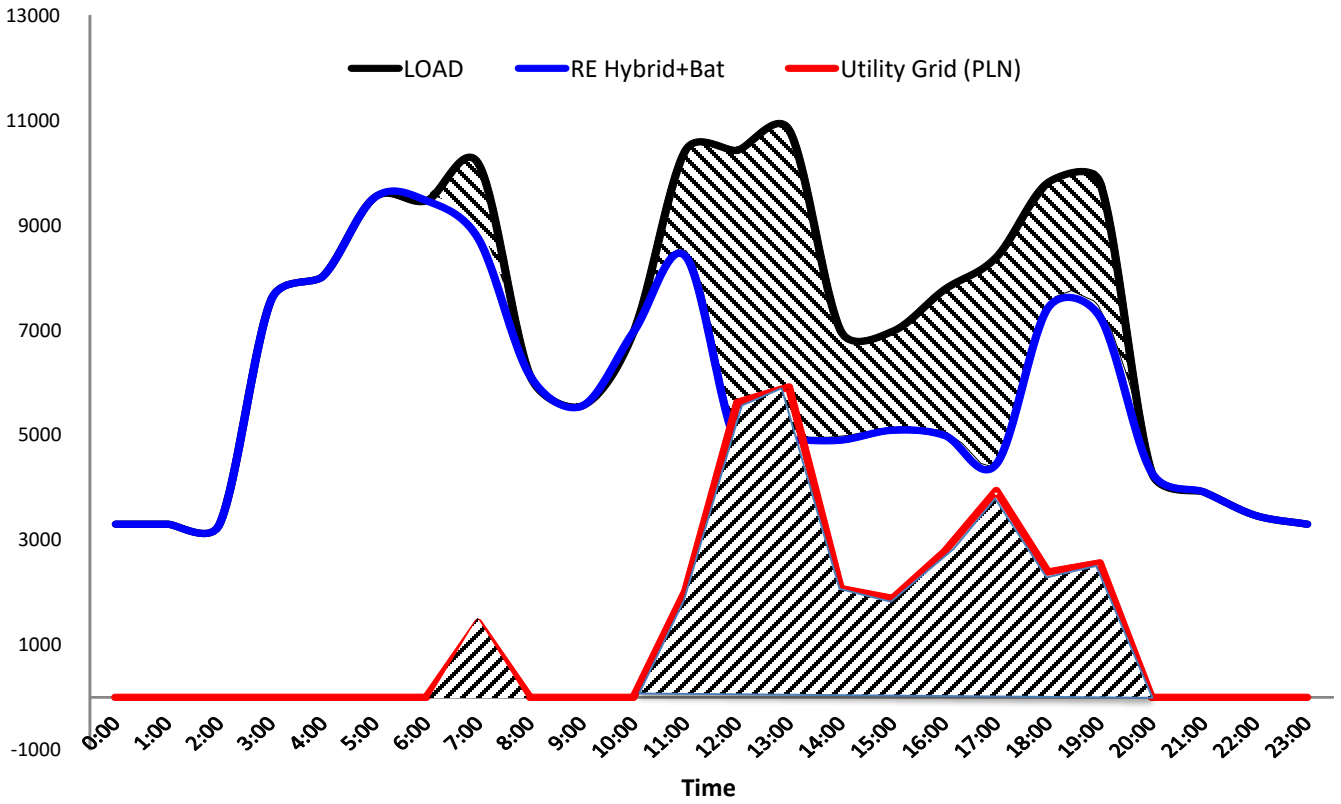
Results

The daily test results from the output of Hydro-Biogas-Solar hybrid powers and characteristic of batteries charge-discharge

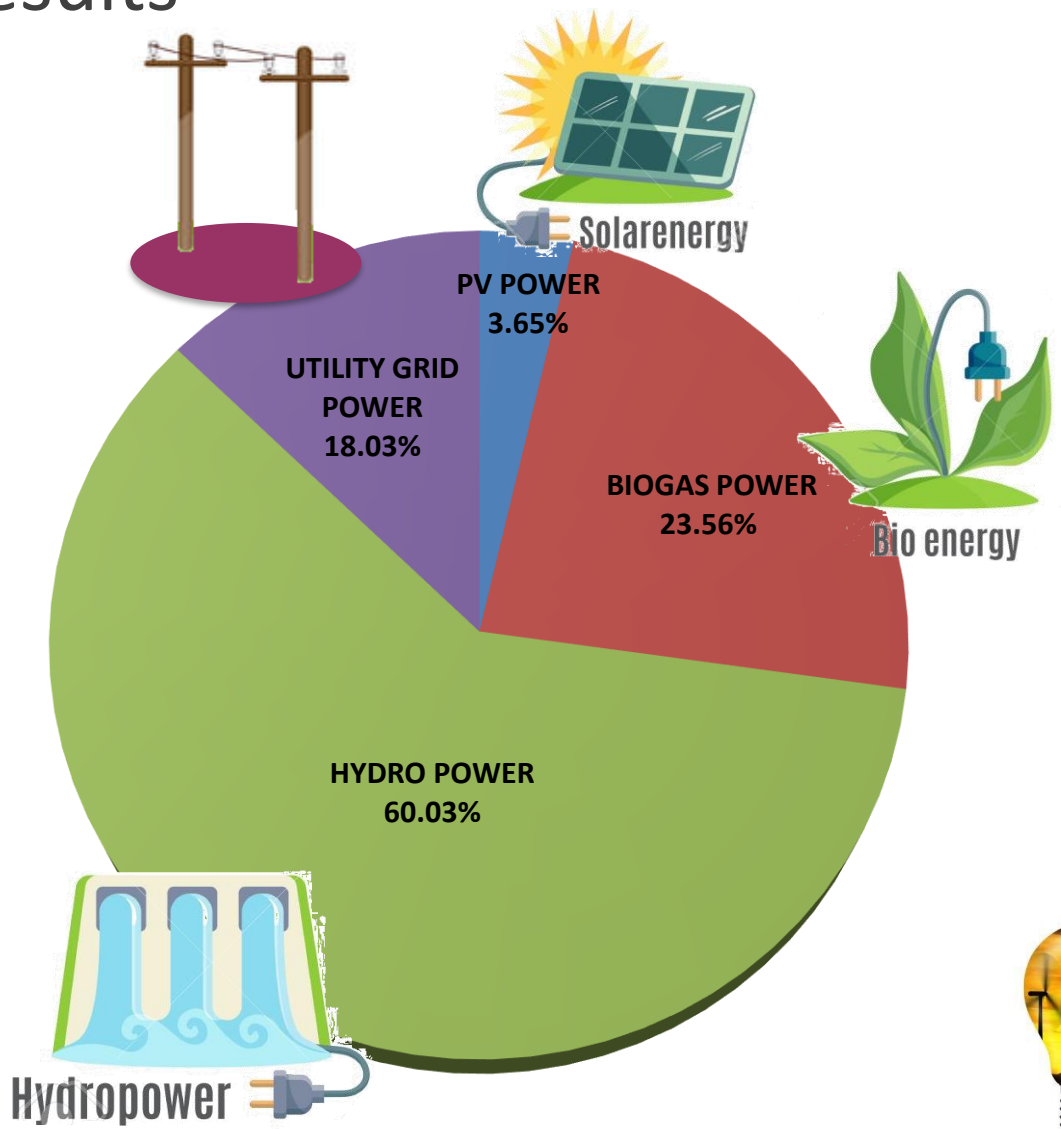


Results

The daily test results from the output of Hydro/Biogas/Solar/Battery Hybrid and Import power from Utility Grid



- Results



POWER MIX PERCENTAGES

Results

Some other modes that are important to be applied in RE power Hybrid systems are ***Grid Protection Systems***. Some of the protection modes applied in hybrid RE power are as follows:

- *Self healing*: a term used to describe the ability of an electric grid to detect, predict, anticipate and respond to disturbances that occur in the system quickly based on data or information sent by sensors that have been installed. For example, when there is a disturbance in the utility transformer, the protection system will automatically isolate the interference without waiting for the operator, so that it does not disturb other grid and does not cause blackouts.
- *Anti Islanding*: if there is a disturbance on the grid, the system will automatically disconnected the utility grid (off-grid) to ensure local grid safety and the utility operator can safely correct the problems that occur on the grid, while the load is still supplied by the local RE hybrid power system.

Conclusion

The Energy Management System (EMS) has an important role in every Hybrid power plant application. EMS is used in optimizing local energy sources, scheduling power plants, regulating power distribution in grid to be more efficient and reliable, optimizing continuous operation and matching power plants to load demands.

The results of the EMS design test on the RE hybrid power plant at the project pilot location indicate a decrease in the power requirements of the utility grid from 169,8 kWh/day to 30,6 kWh/day. It means that EMS can provide 81.88% power savings by using locally renewable energy.

With output power percentage of RE Power plants :

- Hydro Power = 60.03 %
- Biogas Power = 23.56 %
- Solar Power = 3.65 %

THANK YOU

Indonesian Institute of Sciences (LIPI)