LABORATORY PLANNING GUIDE

L62 v2 Advanced Renewable Energies Laboratory

Content

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Covered subjects according to the curriculum

Major topics of learning content:

- familiarisation with the functions of the flat collector and the solar circuit
  * relationship between flow and net power
  * relationship between temperature difference (collector/environment) and collector efficiency
- solar module measurements
  * physical behaviour of solar modules under a variety of effects: illuminance, temperature and shading
  * familiarisation with key parameters: short-circuit current, open-circuit voltage, current and voltage at maximum output
  * relationship between module tilt, illuminance, short-circuit current and electrical output
  * connection types for the modules: series and parallel connection
  * effect of bypass diodes
- application aspects of electrical components for photovoltaic systems
  * efficiency and dynamic behaviour of system components in grid-connected and stand-alone operation
  * function of MPP tracker, inverters and charge controllers
- conversion of kinetic wind energy into electrical energy
  * function and design of an stand-alone system with a wind power plant
  * determining the power coefficient as a function of tip speed ratio
  * energy balance in a wind power plant
  * determining the efficiency of a wind power plant
  * design and function of a wind turbine in stand-alone operation
  * energy balance of a wind turbine under real wind conditions
- determining characteristic variables of a centrifugal pump at various speeds: intake and delivery pressure, delivery height, hydraulic output, mechanical output, efficiency
- determining characteristic variables of a Pelton and a Francis turbine
  * measuring torque and speed
  * determining efficiency and mechanical output of the turbine
  * influence of the nozzle cross-section on the power output of a Pelton Turbine
  * influence of the guide vane position on the power output of a Francis Turbine
- design, operation and key components of a heat pump or refrigeration system
- representation of the thermodynamic cycle in the log p-h diagram
- biotechnical production of ethanol
  * familiarization with the necessary individual steps and system components
  * gelatinisation by steam injection
  * liquefaction by use of alpha-amylase
  * saccharification by use of gluco-amylase
  * fermentation: conversion of sugar by yeast cultures under anaerobic conditions
  * distillation: separation of ethanol from the mash

- two-stage biogas plant with continuous or discontinuous operation
  * influence of the following parameters on the biogas generation: temperature, substrate, volumetric loading and pH value
  * influence of the operation mode on the biogas yield
    -> single stage or dual stage
    -> with and without post-fermentation
    -> continuous and discontinuous
  * determining the following parameters depending on the operating conditions: biogas yield, biogas flow rate and biogas quality
- conversion of chemical energy into electrical and thermal energy
- production of biodiesel from vegetable oil
  * fundamentals of chemical transesterification
  * influence of retention time and temperature
- function and design of a fuel cell system
  * relationships of fuel cell operating parameters
  * effects on the electrical performance of fuel cells
- demonstration of the operation of a geothermal probe with heat pipe principle
  * investigation of radial and vertical temperature profiles
  * variation of the thermal load
  * variation of the quantity of working medium contained
- demonstration of the operation of a 2-well system for using geothermal energy
  * open circuit for use of geothermal energy
  * pumping behaviour of an open circuit
  * investigation of radial and vertical temperature profiles
- familiarisation with operating principle of a wave power plant
  * understanding of the energy generation from wave motion
  * measurement of wave motions
  * familiarisation with design and operation of a Wells turbine

Main concept

The laboratory is designed for accommodation of 24 students + 2 laboratory staff:

- 2 - 4 students form a team and work together at a workstation / training system
- 12 different workstations
- All workstations are floor standing
- 9 of the workstations are equipped with a PC
- Each workstation is equipped with a manual containing technical information, basic theory, experiment instructions, evaluation help and safety advice.
- Student teams are scheduled to change workstations from lab session to lab session in order to perform the entire range of experiments within the course duration.
- Average time per experiment: 90 to 120 minutes.
- 2 workstations for laboratory staff (with PC and internet access)
- 1 printer for common use
- 1 cupboard for small parts, consumables, tools, paper etc.

Initial training provided for laboratory personnel

Trainer: Specialized engineer of G.U.N.T. Gerätebau GmbH, Germany.

To be conducted immediately after installation and commissioning of the equipment.

General topics to be covered for any of the educational systems:

- Basic familiarization with the system.
- Functions and components.
- Overall system configuration aspects.
- Start-up and operational aspects.
- Conduction experiments, including evaluation and calculation.
- Using the system with and without the software (where applicable).
- Trouble shooting and maintenance aspects.
- Hands-on, practical familiarization aspects.
- Seminar participants with the delivered system.
- Details of the manuals.
- Safe operation and preventive maintenance.

Requirements / Utilities

Power supply:

- 230 V / 50 Hz / 1 phase – at least 20 power sockets
- 400 V / 50 Hz / 3 phases – at least 5 power sockets up to 32 A

Water:

- 5 x cold water
- 1 x hot water
- 5 x drain

Others:

- compressed air
- CO_2
- exit air

Laboratory computer network:

- 2 internet connections for staff
- 7 internet connections for students

Location:

- Laboratory space min 150 m²
- This laboratory should be installed on the ground floor

Schedule of requirements

Item No.	Description	Quantity
Item 1	Domestic water heating with flat collector	1 pcs.
Item 1.1	Artificial light source	1 pcs.
Item 2	Solar module measurements	1 pcs.
Item 2.1	Using photovoltaics: grid connected or stand-alone	1 pcs.
Item 2.2	Solar cell measurements	1 pcs.
Item 3	Energy conversion in a wind power plant	1 pcs.
Item 3.1	Wind power plant	1 pcs.
Item 4	Characteristic variables of hydraulic turbomachines	1 pcs.
Item 4.1	Pelton turbine	1 pcs.
Item 4.2	Francis turbine	1 pcs.
Item 5	Heat pump for cooling and heating operation	1 pcs.
Item 6	Biotechnical production of ethanol	1 pcs.
Item 6.1	Electrical steam generator 10kW	1 pcs.
Item 7	Biogas plant	1 pcs.
Item 8	Biodiesel plant	1 pcs.
Item 9	Fuel cell system	1 pcs.
Item 10	Geothermal probe with heatpipe principle	1 pcs.
Item 11	Geothermal energy with 2-well system	1 pcs.
Item 12	Wave energy converter	1 pcs.