

Content of the course: Solar Powered Water Systems

Modules	Content
Module 0: Introduction to Solar PV energy and Solar Powered Water Systems in Humanitarian and Development Contexts.	- Solar PV water pumping in humanitarian and development contexts. - Why the renewed interest in solar PV water pumping? - Guidance and rationale for using solar PV water pumping .
Module 1: Main Definitions and Principles of Solar Energy Production.	- The Solar Resource. - Definition of solar terms: radiation, photovoltaic, irradiance, insolation, standard test conditions, peak sun hours. - Basic DC Electric Concepts. - Solar module I-V curve and maximum power point.
Module 2: Solar powered water system configurations and components.	- SPWS configurations and components. - Equipment features and quality considerations. - Types of solar modules. - PV module characteristics. - SPWS controls and switchgear. - Balance of system components.
Module 3: Factors influencing solar photovoltaic energy production.	- Energy losses due to cell temperature. - Wiring energy losses. - Energy losses related to the sun irradiance. - Energy losses related to the PV module. - Energy losses related to power converters and the balance of system. - Estimation of the energy yield.
Module 4 – part 1: Design of a Solar Powered Water Scheme (system planning).	- Solar pump design data. - Important design concepts and considerations. - Steps to design a solar powered water scheme: water demand assessment, design period, water source assessment, borehole construction and pumping test, design month and design flow rate, water tank sizing.
Module 4 – part 2: Design of a Solar Powered Water Scheme (manual calculation).	- Determination of pump duty point (total dynamic head (TDH) and Flow). - Pump selection. - Controller selection. - Solar PV array sizing, layout and selection.
Module 4 – part 3: Design of a solar water scheme (using solar design software).	- Design using solar pumping sizing tools. - Step by step examples of SPWS design. - Real field examples of SPWS design.
Module 5 – part 1: Electrical and mechanical installation (equipment and control).	- Equipment nameplates. - Inspection prior to installation. - Installation tools. - Physical installation checklist.

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Module 5 – part 2: Electrical and mechanical installation (installation process).	- Pumping system Installation. - Cable splicing, dry run protection, pump installation, installation of controls, cabling, module mounting structures, solar modules installation. - Earthing, lightning and surge protection. - Electrical safety.
Module 6: Practical aspects related to solar powered water pumping.	- Chlorination in solar pumping schemes. - Tank automation. - Sun tracking. - Measures to prevent vandalism and theft. - Over-pumping of aquifers due to solar powered schemes. - Solar PV in hot climate zones and hot water pumping. - Frequently asked questions.
Module 7: Calls for proposal and bidding.	- Quality criteria for solar products & services. - Selection of quality solar products. - Quality of solar modules. - Supplier selection. - Bidding process. - Technical terms of reference.
Module 8: Economic analysis: life cycle cost for different pumping technologies.	- Pricing of solar schemes. - Life cycle cost analysis: real interest rate, net present value, payback period. - Economic appraisal using life cycle costing for water pumping. - Examples comparing LCCA of solar and generator systems. - Financing solar schemes.
Module 9: Testing and commissioning, operation and maintenance.	- Testing, commissioning and hand over. - Operation and maintenance of equipment. - Service and maintenance contract frameworks. - Training. - Health & safety. - Spare parts management.
Module 10: Long term management of SPWS.	- Warranties and warranty management. - Social models of management. - Data logging and advanced system monitoring and diagnosis tools. - Importance of monitoring SPWS.