

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.	<ul style="list-style-type: none"> - 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.	<ul style="list-style-type: none"> - 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.	<ul style="list-style-type: none"> - 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.	<ul style="list-style-type: none"> - 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).	<ul style="list-style-type: none"> - 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).	<ul style="list-style-type: none"> - 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).	<ul style="list-style-type: none"> - 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).	<ul style="list-style-type: none"> - Equipment nameplates. - Inspection prior to installation. - Installation tools. - Physical installation checklist.

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<p>Module 5 – part 2: Electrical and mechanical installation (installation process).</p>	<ul style="list-style-type: none"> - 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.
<p>Module 6: Practical aspects related to solar powered water pumping.</p>	<ul style="list-style-type: none"> - 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.
<p>Module 7: Calls for proposal and bidding.</p>	<ul style="list-style-type: none"> - Quality criteria for solar products & services. - Selection of quality solar products. - Quality of solar modules. - Supplier selection. - Bidding process. - Technical terms of reference.
<p>Module 8: Economic analysis: life cycle cost for different pumping technologies.</p>	<ul style="list-style-type: none"> - 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.
<p>Module 9: Testing and commissioning, operation and maintenance.</p>	<ul style="list-style-type: none"> - Testing, commissioning and hand over. - Operation and maintenance of equipment. - Service and maintenance contract frameworks. - Training. - Health & safety. - Spare parts management.
<p>Module 10: Long term management of SPWS.</p>	<ul style="list-style-type: none"> - Warranties and warranty management. - Social models of management. - Data logging and advance system monitoring and diagnosis tools. - Importance of monitoring SPWS.