

## Content of the course: Solar Powered Water Systems

Modules	Content
<b>Module 0:</b> Introduction to Solar PV energy and Solar Powered Water Systems in Humanitarian and Development Contexts.	<ul style="list-style-type: none"> <li>- Solar PV water pumping in humanitarian and development contexts.</li> <li>- Why the renewed interest in solar PV water pumping?</li> <li>- Guidance and rationale for using solar PV water pumping .</li> </ul>
<b>Module 1:</b> Main Definitions and Principles of Solar Energy Production.	<ul style="list-style-type: none"> <li>- The Solar Resource.</li> <li>- Definition of solar terms: radiation, photovoltaic, irradiance, insolation, standard test conditions, peak sun hours.</li> <li>- Basic DC Electric Concepts.</li> <li>- Solar module I-V curve and maximum power point.</li> </ul>
<b>Module 2:</b> Solar powered water system configurations and components.	<ul style="list-style-type: none"> <li>- SPWS configurations and components.</li> <li>- Equipment features and quality considerations.</li> <li>- Types of solar modules.</li> <li>- PV module characteristics.</li> <li>- SPWS controls and switchgear.</li> <li>- Balance of system components.</li> </ul>
<b>Module 3:</b> Factors influencing solar photovoltaic energy production.	<ul style="list-style-type: none"> <li>- Energy losses due to cell temperature.</li> <li>- Wiring energy losses.</li> <li>- Energy losses related to the sun irradiance.</li> <li>- Energy losses related to the PV module.</li> <li>- Energy losses related to power converters and the balance of system.</li> <li>- Estimation of the energy yield.</li> </ul>
<b>Module 4 – part 1:</b> Design of a Solar Powered Water Scheme (system planning).	<ul style="list-style-type: none"> <li>- Solar pump design data.</li> <li>- Important design concepts and considerations.</li> <li>- 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.</li> </ul>
<b>Module 4 – part 2:</b> Design of a Solar Powered Water Scheme (manual calculation).	<ul style="list-style-type: none"> <li>- Determination of pump duty point (total dynamic head (TDH) and Flow).</li> <li>- Pump selection.</li> <li>- Controller selection.</li> <li>- Solar PV array sizing, layout and selection.</li> </ul>
<b>Module 4 – part 3:</b> Design of a solar water scheme (using solar design software).	<ul style="list-style-type: none"> <li>- Design using solar pumping sizing tools.</li> <li>- Step by step examples of SPWS design.</li> <li>- Real field examples of SPWS design.</li> </ul>
<b>Module 5 – part 1:</b> Electrical and mechanical installation (equipment and control).	<ul style="list-style-type: none"> <li>- Equipment nameplates.</li> <li>- Inspection prior to installation.</li> <li>- Installation tools.</li> <li>- Physical installation checklist.</li> </ul>

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<b>Module 5 – part 2:</b> Electrical and mechanical installation (installation process).	<ul style="list-style-type: none"> <li>- Pumping system Installation.</li> <li>- Cable splicing, dry run protection, pump installation, installation of controls, cabling, module mounting structures, solar modules installation.</li> <li>- Earthing, lightning and surge protection.</li> <li>- Electrical safety.</li> </ul>
<b>Module 6:</b> Practical aspects related to solar powered water pumping.	<ul style="list-style-type: none"> <li>- Chlorination in solar pumping schemes.</li> <li>- Tank automation.</li> <li>- Sun tracking.</li> <li>- Measures to prevent vandalism and theft.</li> <li>- Over-pumping of aquifers due to solar powered schemes.</li> <li>- Solar PV in hot climate zones and hot water pumping.</li> <li>- Frequently asked questions.</li> </ul>
<b>Module 7:</b> Calls for proposal and bidding.	<ul style="list-style-type: none"> <li>- Quality criteria for solar products &amp; services.</li> <li>- Selection of quality solar products.</li> <li>- Quality of solar modules.</li> <li>- Supplier selection.</li> <li>- Bidding process.</li> <li>- Technical terms of reference.</li> </ul>
<b>Module 8:</b> Economic analysis: life cycle cost for different pumping technologies.	<ul style="list-style-type: none"> <li>- Pricing of solar schemes.</li> <li>- Life cycle cost analysis: real interest rate, net present value, payback period.</li> <li>- Economic appraisal using life cycle costing for water pumping.</li> <li>- Examples comparing LCCA of solar and generator systems.</li> <li>- Financing solar schemes.</li> </ul>
<b>Module 9:</b> Testing and commissioning, operation and maintenance.	<ul style="list-style-type: none"> <li>- Testing, commissioning and hand over.</li> <li>- Operation and maintenance of equipment.</li> <li>- Service and maintenance contract frameworks.</li> <li>- Training.</li> <li>- Health &amp; safety.</li> <li>- Spare parts management.</li> </ul>
<b>Module 10:</b> Long term management of SPWS.	<ul style="list-style-type: none"> <li>- Warranties and warranty management.</li> <li>- Social models of management.</li> <li>- Data logging and advance system monitoring and diagnosis tools.</li> <li>- Importance of monitoring SPWS.</li> </ul>