

Optimal Design of a Photovoltaic Green Hydrogen Production System Supporting Egypt's Vision 2030

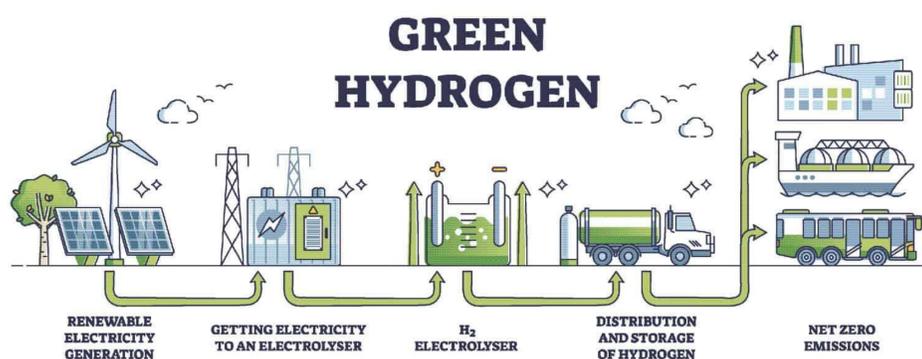
Introduction

The increasing demand for clean and sustainable energy has accelerated the global shift toward renewable resources. Green hydrogen, produced using renewable energy, is considered one of the most promising solutions for achieving a carbon-free energy future. In this project, solar energy is utilized to generate hydrogen through water electrolysis, providing a clean method for energy conversion and storage. The proposed system demonstrates an integrated approach for solar-powered hydrogen production and safe storage, highlighting its potential role in future sustainable energy systems.

Objectives

- 1-Produce green hydrogen using solar energy through water electrolysis.
- 2-Store hydrogen safely for future energy applications.
- 3-Implement protection mechanisms to ensure safe system operation.
- 4-Develop a control system for monitoring and managing system performance.

System Overview



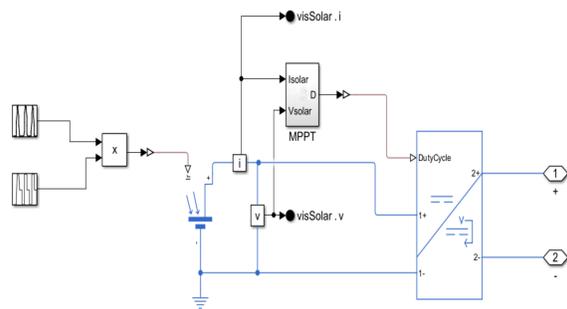
Overall block diagram of the proposed solar-powered green hydrogen system.

Simulation Using MATLAB

1- Photovoltaic (PV) System:

This section represents the photovoltaic system used to convert solar energy into electrical power.

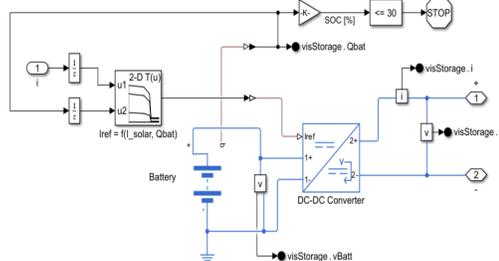
An MPPT controller is applied to ensure maximum power extraction under varying solar irradiance conditions.



2-Energy Storage:

This part illustrates the energy storage system based on batteries.

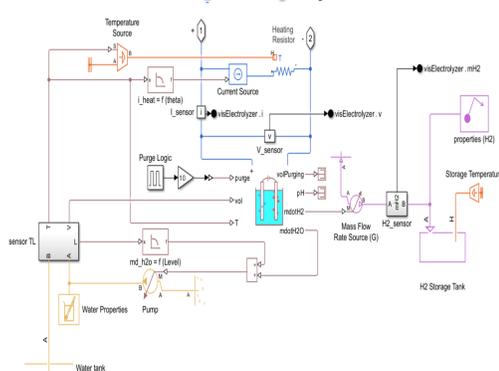
It stores excess electrical energy generated by the PV system and supplies power when solar energy is insufficient, ensuring continuous system operation.



3- (PEM) Electrolyzer

This section shows the PEM electrolyzer used for green hydrogen production.

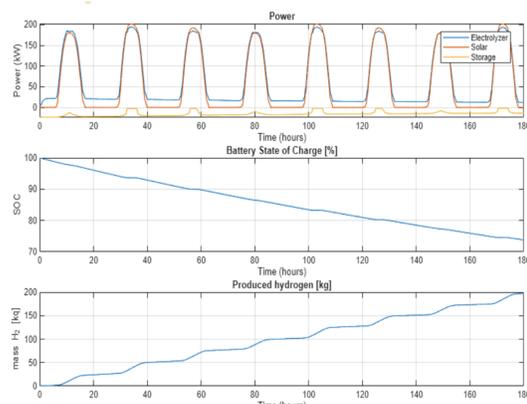
Electrical energy is utilized to split water into hydrogen and oxygen with high efficiency and fast dynamic response.



4-Result of MATLAB

This part presents the simulation results obtained using MATLAB/Simulink.

The results demonstrate system performance, stability, and electrical behavior under different operating conditions.



Manufacturing PEM Electrolyzer

- 1-PEM electrolyzer assembled for hydrogen production
- 2-Connected to DC supply from solar system.
- 3-Designed for safe and stable operation.



How the PEM Electrolyzer Works

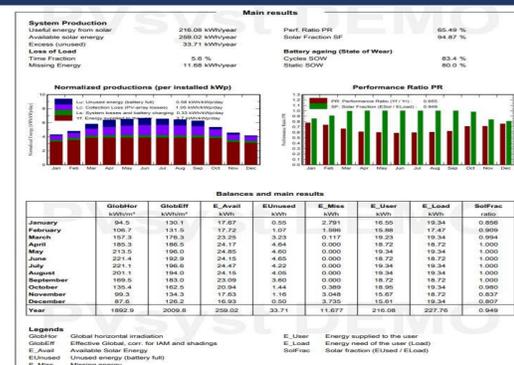
- 1-Water enters the PEM cell.
- 2-DC current splits water into H⁺ and O₂ at electrodes.
- 3-H⁺ ions form H₂ at the cathode; O₂ released at the anode.



PV*SYS-Based Performance Evaluation

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The photovoltaic system was modeled and simulated using PV*SYS software.

The obtained results validate system efficiency, energy balance, and storage performance, ensuring a reliable power supply for green hydrogen production.

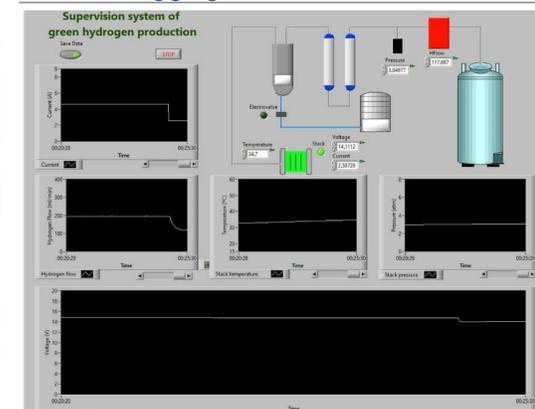
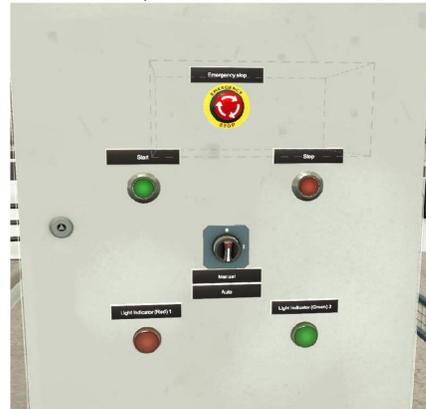


Site Location

Obour City – Ahmed Orabi Area, Egypt.

Control and Safety

- 1-System control via manual switches and LabVIEW software.
- 2-Real-time monitoring of voltage, current, and hydrogen flow.
- 3-Safety protection: prevents gas leakage, over-temperature, over-pressure, over-voltage, and over-current.
- 4-User-friendly interface for monitoring and data logging.



Completed System



Supervisor and Team

Supervisor by: Dr.Eng.Abdelaziz Ismail Dr.Eng.Consultant/Ehab Gafar
Team Members:

- 1-Omar shehta Mahmoud
- 2- Taha Magdy Taha
- 3-Mostafa Mohamed Mohamed
- 4- Mohamed magdy AbdElstar

- 5- Mostafa Ibrahim Ismail
- 6-Eslam Ashraf Subhi
- 7- Yossef ahmed AbdElatif
- 8-Sayed yousri Sayed

