

Introduction

Access to clean water in remote, off-grid areas is a major challenge due to limited infrastructure. Our project offers a sustainable solution: a hybrid solar-wind RO system with hydrogen storage that produces 80 gallons of freshwater daily without relying on the electrical grid.

Problem statement :
Traditional desalination systems depend heavily on grid electricity, which makes them unsuitable and unreliable for off-grid and remote locations that suffer from limited or unstable energy access.

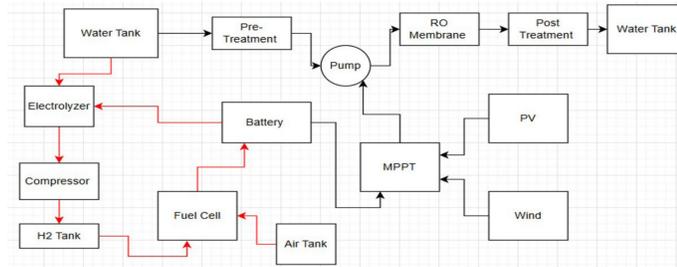
Objective

Design Renewable-Powered RO The system for desalination uses real-time data to prioritize a hybrid solar-wind system and hydrogen storage; it produces 80 GPD of freshwater as continuous and reliable energy supply for desalination processes.

Constraints

- 1- Inlet pressure of RO (43.5 psi)
- 2- Salinity of well water (900 ppm)
- 3-Weather Condition (solar Panel & Wind Turbine)

Prototye Development



Specifications

- 1- Solar 100 W and 100 W rotor wind
- 2- PH of water produced around 7
- 3-75-80% Salinity removed
- 4- Booster pump (100psi)
- 5-Electrolzer output >100 mL of H2
- 6- Water recovery >80%
- 7- Operating temperature & membrane 20-40C.
- 8- Process should be in statistical control within 3* σ upper and lower
- 9- TDS<300 mg/L
- 10-Production rate 80 GPD
- 11- Power system (30 W)

Validation and Verification

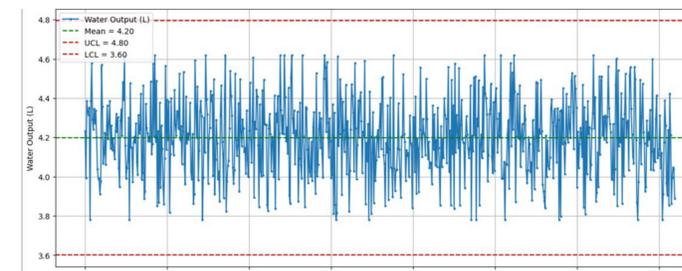
Parameter	Booster Pump	Centrifugal Pump
Efficiency (η)	80% (0.80)	65% (0.65)
Hydraulic Power (W)	180 W	200 W
Pressure Output (bar)	0.7 bar	Same as booster pump
Typical Application	Boosting pressure in existing systems	General-purpose fluid transport
Design	Compact, usually multi-stage	Wide range of designs and capacities
Maintenance	Usually lower, compact parts	Varies, can be more complex

Solar Panel Sizing

1. Daily energy requirement: 2 kWh/day
2. Panel efficiency: 18%
3. Average solar irradiance: 5 kWh/m²/day
4. Required power: ~500 W
5. Panel configuration: 2 solar panels rated at 300 W each
6. Estimated panel area: ~0.25 m² (total)

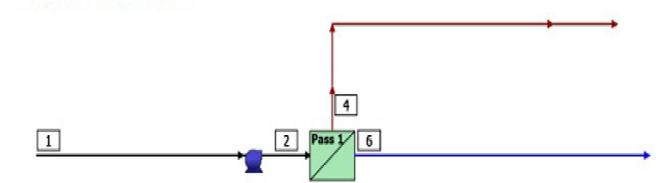
Wind Turbine Sizing

1. Average wind speed: 6 m/s
2. Air density: 1.23 kg/m³
3. Required output: 100 W
4. Operating duration: 8 hours per day
5. Calculated rotor area: ~1.08 m²



Sample Size: 1 per hour - Mean water output (μ)=4.2 L
Standard Deviation (σ): 0.20 L

RO Summary Report
RO System Flow Diagram



#	Description	Flow (gpd)	TDS (mg/L)
1	Raw Feed to RO System	105.3	900.0
2	Net Feed to Pass 1	105.3	900.1
4	Total Concentrate from Pass 1	15.3	900.1
6	Net Product from RO System	90.0	207.1

- Permeate flowrate: 90 GPD
- Permeate TDS: 207.1 mg/L
 - Salt Rejection: 77 % (Target: 75%)
 - Recovery Rate: 85.5% (Target: 80%)
 - Operating Pressure: 43.5 psi (~3 bar)
- Fuel Cell Efficiency = 50 / (42.5) * 0.40 * 100 = 47%

Conclusion

The project developed a compact, off-grid RO system powered by solar, wind, and hydrogen energy, providing 80 gallons of clean water daily. It achieved an 85.5% recovery rate, 77% salt rejection, and demonstrated reliable, sustainable performance in simulations.