# Hybrid renewable energy generation systems for eco-friendly buildings in Qatar.

ALI, D., METRY, M., GOUBA, A., KOUSSA, E. and KOLEED, M.

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# HYBRID RENEWABLE ENERGY GENERATION SYSTEMS FOR ECO-FRIENDLY BUILDINGS IN QATAR

TEXAS A&M UNIVERSITY at QATAR

## Qatar National Vision 2030

"The rights of future generations would be threatened if the depletion of non-renewable resources were not compensated by the creation of new sources of renewable wealth"

## Introduction

To meet Qatar National Vision 2030, this research aims integrating renewable energy sources (RES) into large educational, industrial and commercial buildings in Qatar while making them energy efficient.

The proposed hybrid energy system (HES) is investigated using the Texas A&M Engineering building in Qatar as the case-study. Proposed solution main components are:

1- Installing Photovoltaic panels (RES) on the roof of building.
2- Utilizing the flow of waste washing water and collected rain water in power generation.
3– Employing energy storage as a balancing mechanism, and to act as an uninterruptable power supply (UPS) during power shortages.
4- Providing the needed load dispatch criteria by control and optimization

## Objectives

1. Investigate the technical and economic feasibility of integrating the proposed hybrid renewable energy system within existing Buildings—TAMUQ building is taken as a case study.
2. Calculate the resulting reduction in carbon footprint on integrating the proposed HES.
3. Investigate, through simulation, the impact of integration of solar PV panels together with the surface water hydropower generation subsystems within Texas A&M engineering building and how it meets the building's energy needs.
4. Design a control unit to regulate the power flow between the HES components.
5. Build a prototype model that simulates the overall large-scale system
6. Enhance further the TAMUQ building energy performance by proposing and investigating sustainable approaches and specific energy efficiency solutions that can be implemented to reduce the building energy consumption.

## Proposed Hybrid Energy System

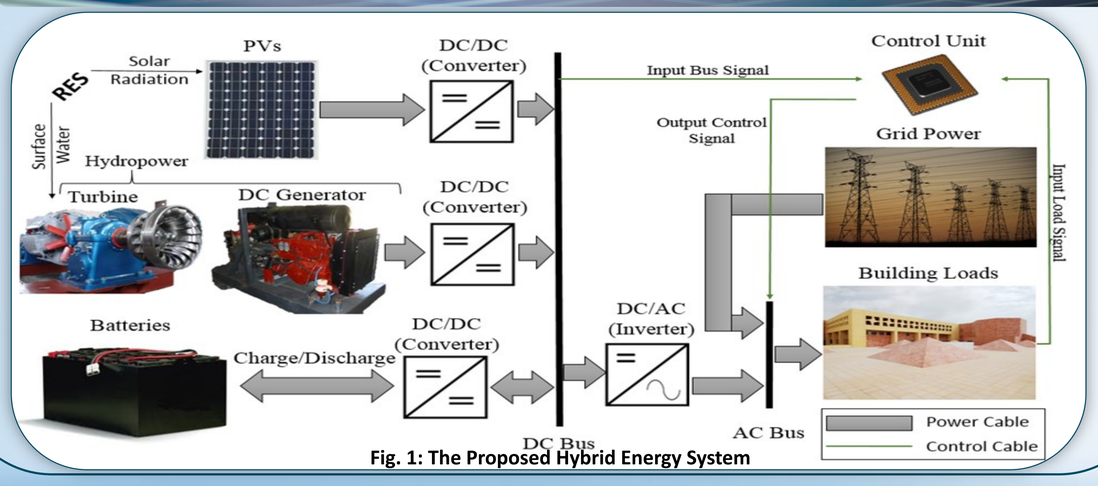
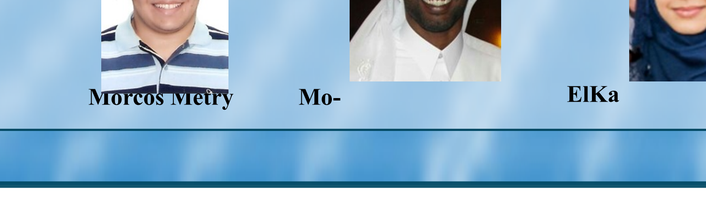



Fig. 1: The Proposed Hybrid Energy System

## PV Subsystem

- Photovoltaic (PV) systems transform sunlight into useful electricity with 12 to 20% efficiency without concentrators. The feasibility of their implementation on buildings roofs to feed portion of their power needs is investigated.
- Power conditioning is integrated into solar PV systems to transform DC output voltage to the desired level, regulate load flow and keep the total harmonic distortion (THD) within specified limits. A DC/DC converter is designed, simulated and built here as part of the proposed HES.



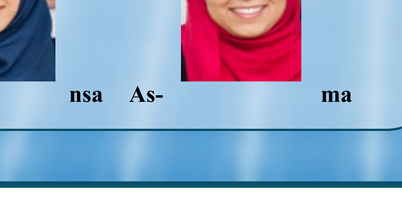




Fig. 2: Simulated DC/DC converter with PV system modules

## Micro-Hydro Subsystem

In large scale buildings, a lot of water is wasted.

- This project aims utilizing the flow of wasted washing taps surface water together with collected rain water, to generate electricity through a hydropower generation subsystem.
- A Pelton turbine and a 1400 – 2700 rpm 240 Vrms permanent magnet generator, are ordered for testing the prototype.

Fig. 3: Prototype hydro equipment

## Team Members

Morcos Metry

Mo- nsa As- ma

ElKa

## UPS Subsystem

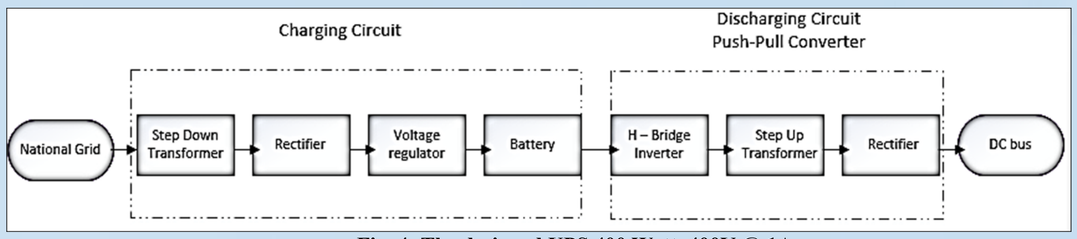



Fig. 4: The designed UPS 400 Watt, 400V @ 1A

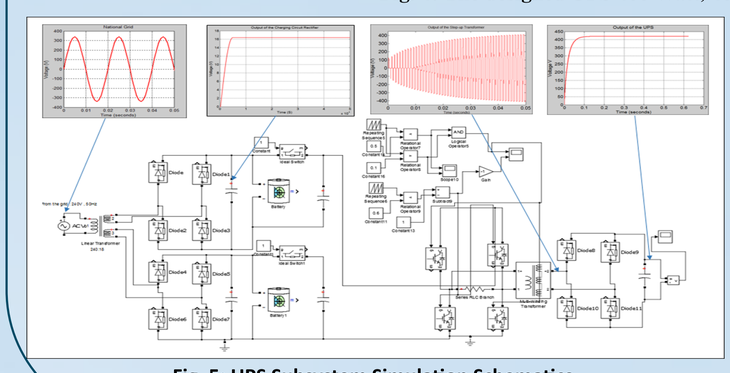


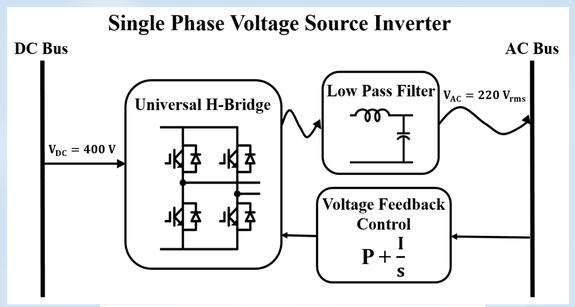
Fig. 5: UPS Subsystem Simulation Schematics

Charge and Discharge signals from the control unit will be received on two different relay circuits.

1. The first connects/disconnects the national grid to/from the charging unit.
2. The second connects/disconnects the output of the charging circuit to/from the input of the discharging circuit.

## Central Inverter

- The central inverter converts the DC bus' direct current to AC to feed the load and be connected to the grid.
- A single-phase 2kW voltage source inverter (VSI) with a closed-loop feedback system is used for the prototype to maintain a constant output voltage of 220 Vrms. The DC bus is determined to be 400V which gives a THD of 3%.
- A three-phase 250kW VSI is to be considered for the real-size system where an input of 900 volts is transformed to an output of 240 Vrms.



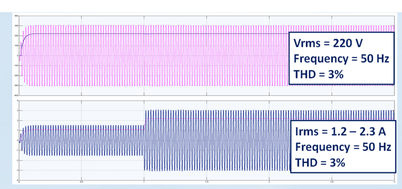
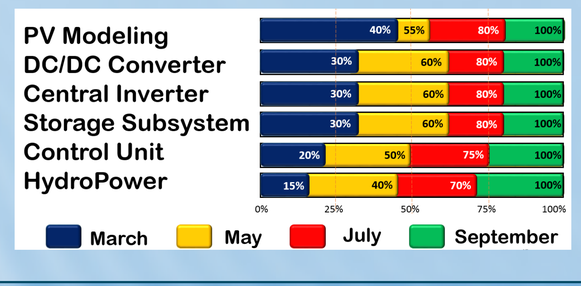




Fig. 6: Simulated Prototype Inverter

## Control Unit Subsystem

- A control unit is designed to optimize the power flow between the system sources and storage.
- The generated and stored power versus the power needs is assessed through sensing devices that measure the building's energy requirements, RES energy generation and the stored power.
- The control unit will attempt to meet the building's energy requirements from the RES. If the generated renewable energy is insufficient, the needed power will be fed from the grid. If grid fails, stored power will supply only essential load.

## Timeline

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**Project Supervisors:**

**Dr. Haitham Abu-Rub**
Professor in Electrical Engineering

**Dr. Dallia Ali**
Professor in Electrical Engineering

**Project collaborators:**

**Dr. Ziyad Shafik**
Project Assistant

**Dr. Shady Khalil**
Project Assistant

**Mr. Kais AbdelMawjood**
Project Assidtsnt

**Mr. Wesam Mansour**
Project Assistant

**Ms. Yushan Liu**
Project Assistant