

Building Energy Optimization

Amjad Aljohani, EE | Muneer Alburayh, EE | Meshal Aljohani, CE | Osamah Alrukhaimi, CE | Salman Owaidah, ISE | Inad Alrasheed, ISE

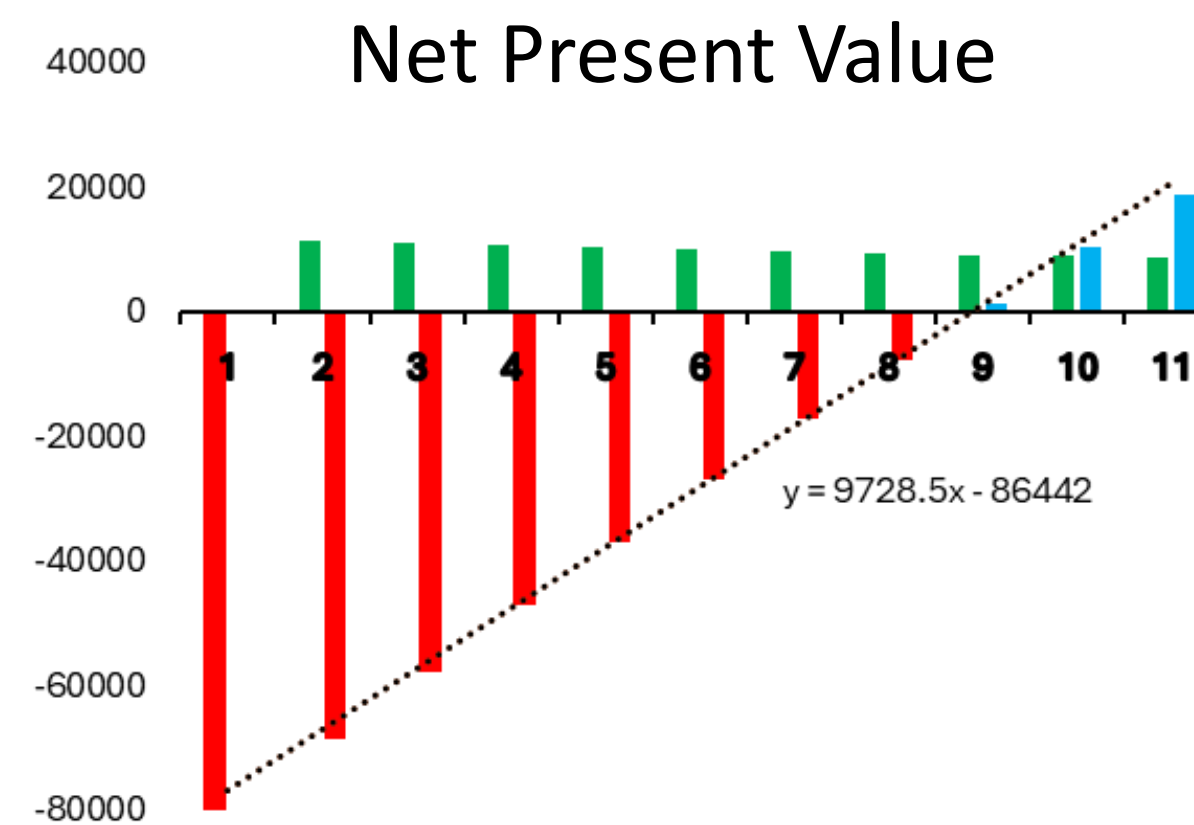
Introduction

This project endeavors to develop a smart energy management system for residential buildings utilizing solar panels, microcontrollers, and smart building techniques to achieve a zero-net-energy building (ZNE). The system empowers homeowners to generate their own electricity, utilizing surplus energy to sell back to the electrical company and drawing from the grid during periods of high demand or at night.

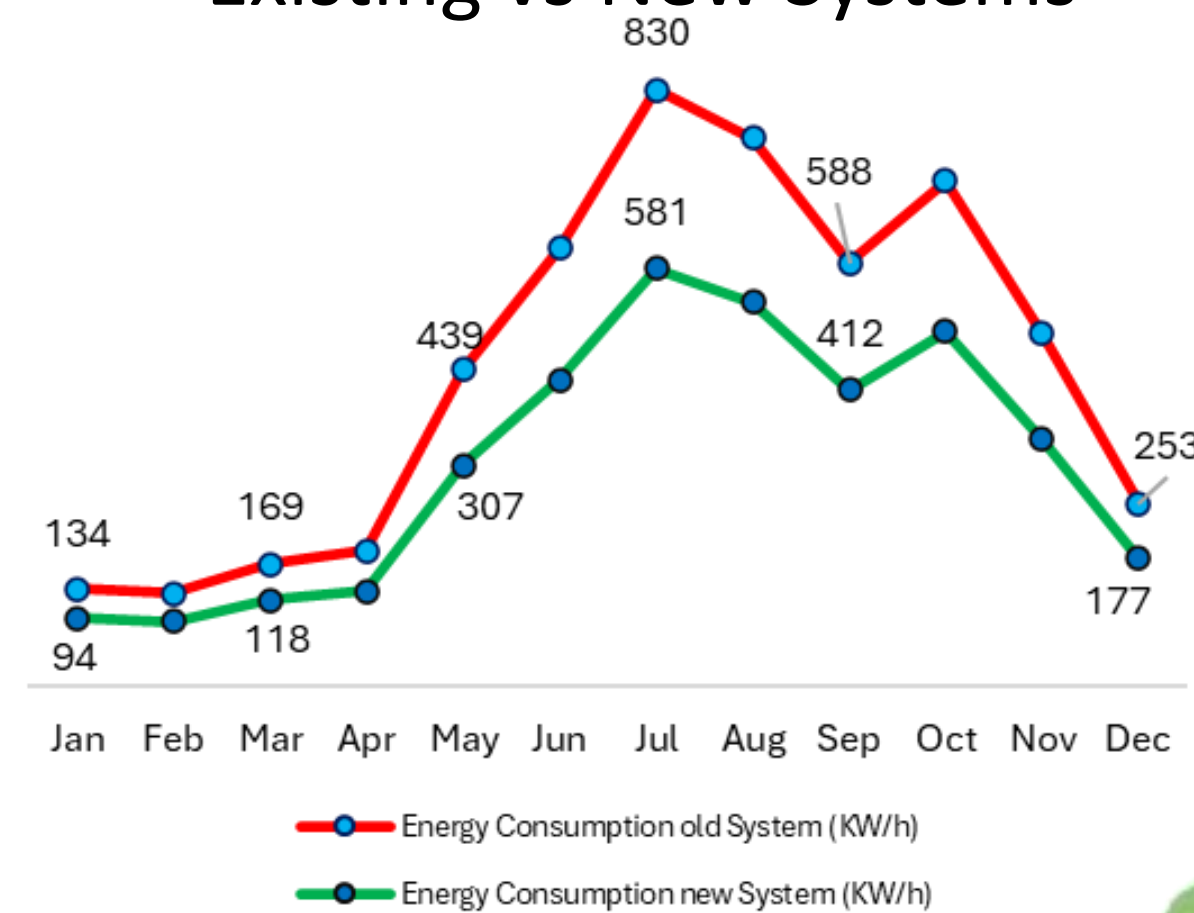
Problem statement

The need for reducing energy consumption and carbon emissions in buildings is growing due to rising energy costs and climate change concerns. Sustainable buildings are essential for occupant comfort, productivity, and market value. Optimizing energy usage can create a healthier indoor environment, attract environmentally conscious tenants, and improve overall building performance.

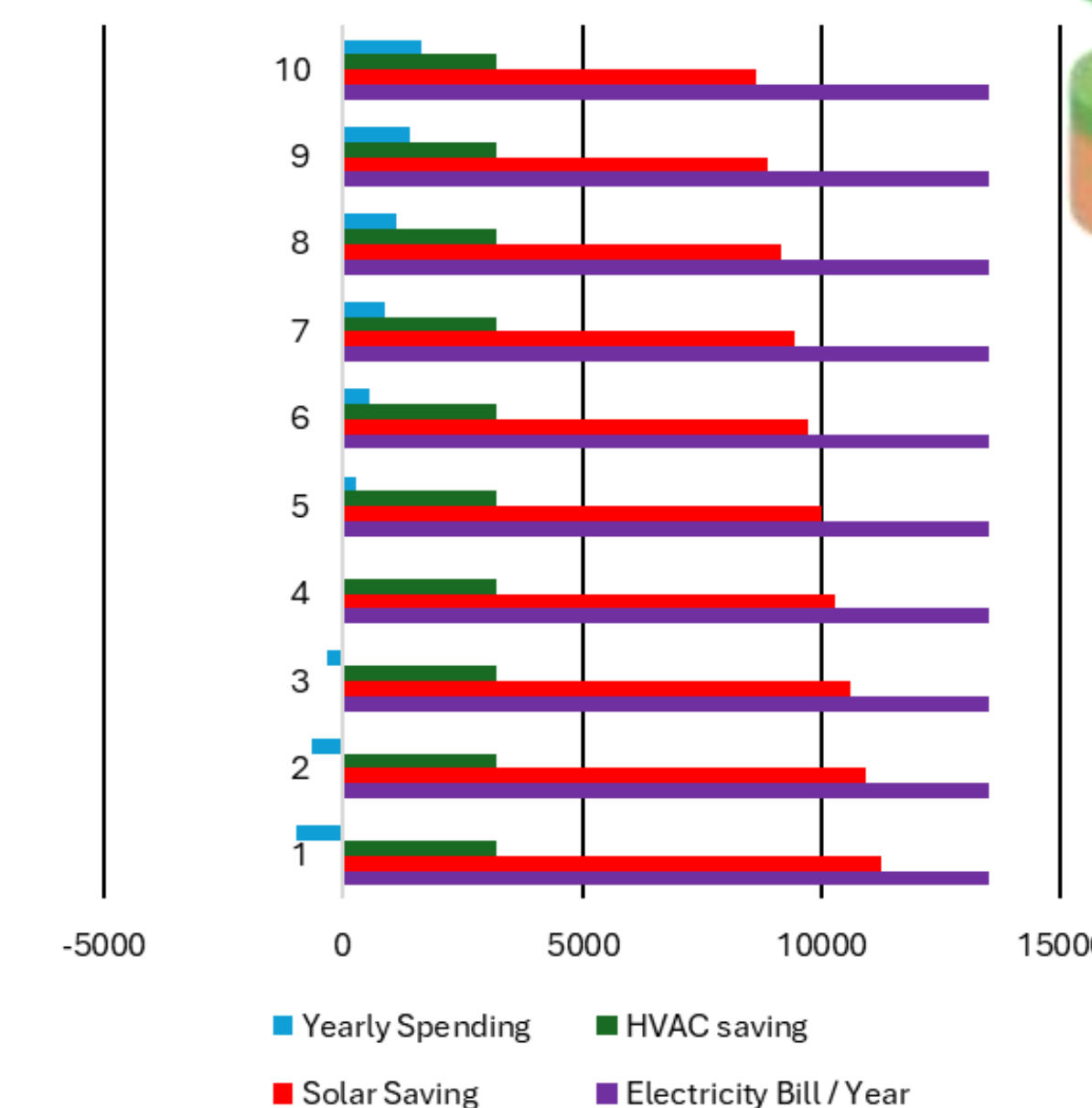
Economic Analysis



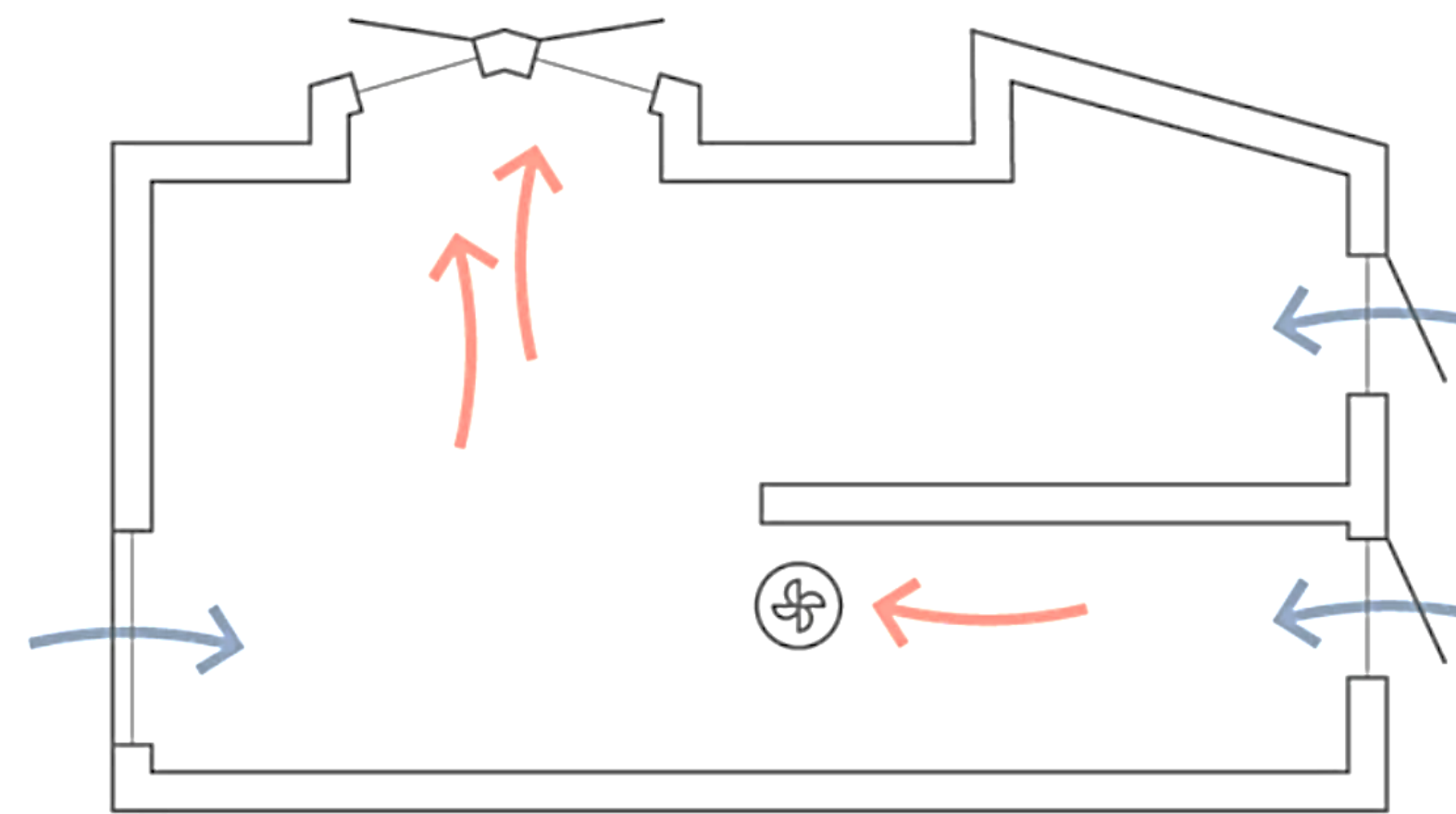
Existing vs New Systems



Savings



Prototype



Storyboard

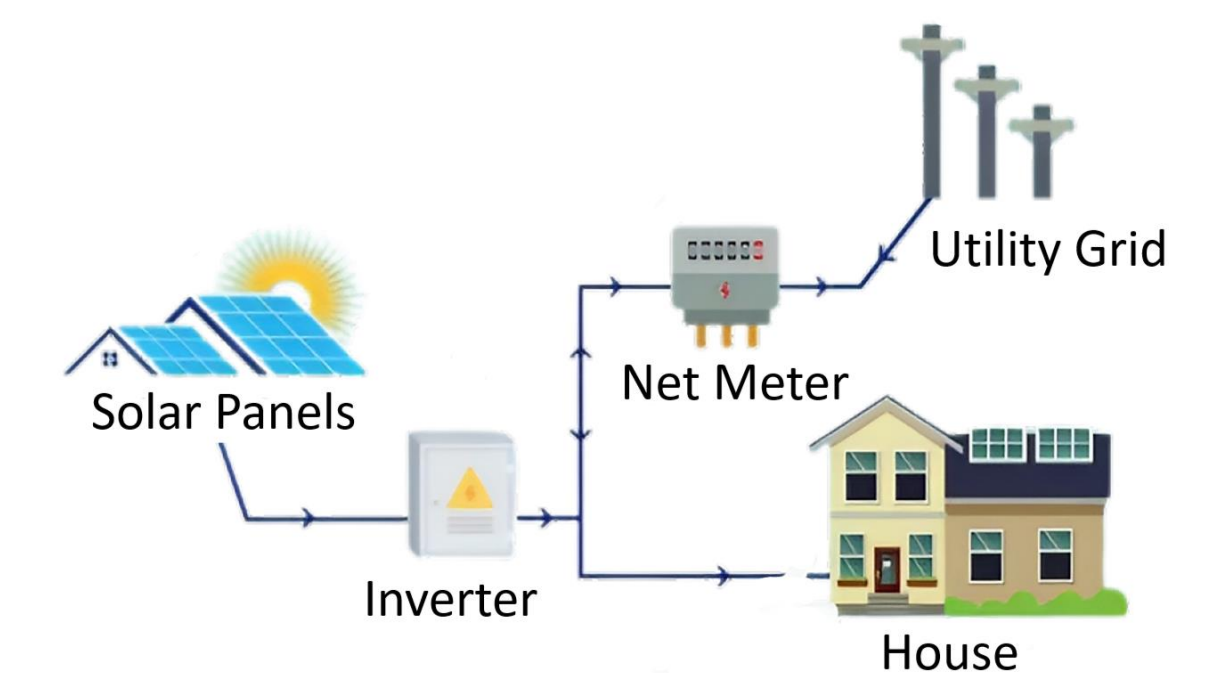
The Arduino microcontroller collects data on solar irradiance, temperature, and humidity.

The microcontroller uses this data to calculate the amount of solar energy that is available and the HVAC system energy requirement.

The microcontroller then sends signals to the solar panel controller and the HVAC controller to optimize the operation of the system.

The solar panel controller adjusts the angle of the solar panels to maximize solar energy collection.

The HVAC controller adjusts the operation of the HVAC system to minimize energy consumption while maintaining comfort.



Constraints

- Lack of Data:** Local Data deficiency hinders precise energy management system calibration.
- Cost:** High initial financial investment is required for system implementation "100k SAR".
- Air pollution:** Air pollution reduces the efficiency of solar panels by obstructing sunlight and depositing particulate matter. $88\mu\text{g}/\text{m}^3$

Specifications

Related Specification	Quantity	SI Unit	validation
Setup Time	< 30	Days	Met, from contractor quota
Grid energy consumption	< 30,000	kWh/year	Met, from economical analysis
Lifespan	> 10	Years	Met, from the datasheet
Initial cost	< 100,000	SAR	Met, from economical analysis
Maintenance cost	< 100	SAR/month	Met, from economical analysis
Total energy cost	< 500	SAR/month	Met, from economical analysis
Occupancy determination accuracy	> 80	%	Met, by testing
System response time	< 0.5	Sec	Met, from the datasheet

Conclusion

The "Building Energy Optimization" project conclusively demonstrates the effectiveness of smart systems in enhancing residential energy efficiency. By integrating solar technology and intelligent controls, we've achieved substantial energy savings and set a benchmark for sustainable living. This work paves the way for future innovations in energy management for homes.