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DISPLAY UNIT FOR COST ANALYSIS BETWEEN GRID AND SOLAR ENERGY

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Abstract

This drive for the use of renewable resources for meeting energy demands mandates that individuals are equipped with an effective means to acquire information on, as well as compare, the applications of the various types of energy generation technologies to identify the economically most feasible technique. The case study described below has been pursued with the aim of developing a tool for measuring real-time acquisition of data on energy use and costs associated with not only conventional electric power suppliers from the electric power grid, but also with solar electric systems, measuring system performance, as well as providing a means for comparing energy use and cost information of the two systems. Indeed, a comparative analysis provides a simple means with which the performance differences, available use, and economic feasibility of the two energy generation technologies can readily be identified. This research work may identify potential strengths in the use of solar energy, given that it identifies potential inefficiencies in the generation of solar energy, as it clearly provides a solid justification for making decisions based on available scientific informational needs for energy management. The result of such a comparative analysis provides significant utility to individuals, businesses, as well as government policy makers, in identifying more cost-effective, as well as more feasible, means of energy production that are environmentally less damaging.

Keywords: Grid Energy, Solar Panel Energy, Sustainable Energy, Cost Analysis, Energy Efficiency.

1. Introduction

The increase in global energy consumption has placed enormous pressure on the infrastructure that generates and distributes electricity. Most electrical power consumed is derived from conventional forms of power generation that rely heavily on fossil fuels such as coal, oil, and natural gas (fuels). In addition to the increase in fuel prices, the instability of tariff structures, and the negative health and environmental impacts related to greenhouse gas emissions means that grid-based power will be negatively impacted in the long-term. Thus, alternative forms of energy, such as solar energy, other renewable forms of energy - as opposed to fossil fuels - are likely to be used more pervasively because they are a clean, renewable, and low-cost method of generating electrical energy. The decline in the cost associated with photovoltaic technology and government incentives associated with the use of solar technology have led to an increase in the use of this source of energy in commercial and residential/industrial applications.

2. Design Overview

The system aims to offer a real-time, easy-to-understand comparison between grid electricity use and solar PV energy production. The display unit tracks how much electricity is taken from the grid and how much comes from the solar installation. This helps users see their energy mix clearly. By calculating the cost of grid electricity and comparing it with the actual cost of solar energy, the system shows the difference in operating costs and highlights the resulting savings.

Components

A. Energy Measuring Devices

1. Solar Energy Meter

Tracks solar energy usage in kilowatt-hours, volts, amps, and watts over time.

Communicates with the ESP Energy Sensor.

2. Grid Energy Meter

Tracks energy consumed from the grid and produced by or sent back to it.

Communicates with the ESP Energy Sensor.

B. Power Supply Block

5V or 12V regulated supply for the controller and display.

Isolated supply for communication with meters, by ensuring safety.

C. Power Electronics

1. Buck-Boost Converters

Using switching and energy storage components (such as inductors, diodes, capacitors, and transistors), buck converters step down (or reduce) a high DC voltage, such as 12 volts, to a lower value (such as 5 volts).

2. Voltage Sensor

A voltage sensor is an electronic component that detects, measures, and monitors voltages within a system (AC or DC). Voltage sensors have numerous uses within an electrical and embedded system.

D. Solar Panels

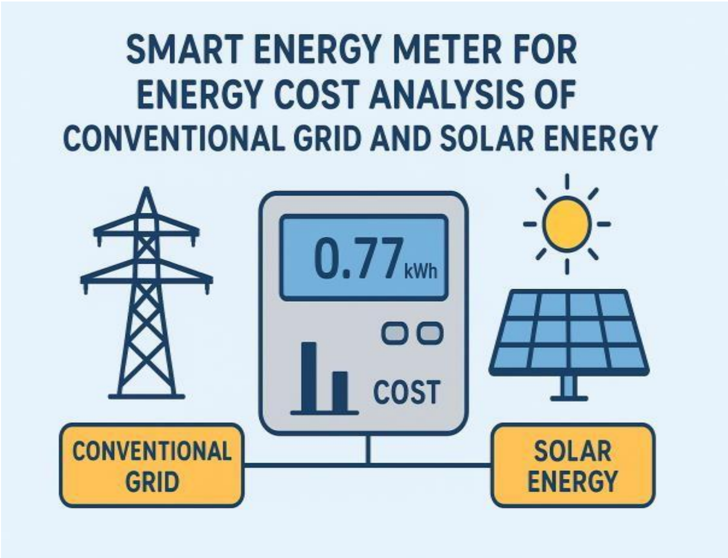
The photovoltaic cells, also known as PV cells, are used for the conversion of solar energy into electricity. The PV cells are used in photovoltaic panels, which are commonly known as PV panels. The use of photovoltaic cells has increased over the past decades, with the application involving the conversion of sunlight into electricity. There are several applications of solar photovoltaic cells, including household use, business purposes, and commercial use, particularly in power plants that are part of solar farms. The use of solar photovoltaic cells has been on the increase, resulting from improvements in efficiency and a decline in price.

E. LCD Display

Users can visually view energy flow and electricity costs from both the Utility and Solar Power through an LCD Interface, on which they are presented in real time. The LCD interface serves as the User's Interface, and displays the information in an easy-to-view format, allowing users to see how much electricity is coming from the Utility and how much energy is being generated or being paid for by Solar Power.

Information on the LCD interface may include amounts of kWh consumed, power used at that moment, cost of energy from the Utility (cost per kWh), Effective Cost per kWh for Solar Energy, and the Financial Saving Achieved. By providing users with this information, users are able to quickly calculate the performance of and savings gained from their energy management efforts, through either Utility Energy Management or Solar Energy Management, or both.

3. Functional Workflow



Step 1: Data Acquisition

The solar and grid meters send the controller real-time values of V, I, P, and kWh.

Step 2: Computation of Cost

Grid cost = kWh × tariff

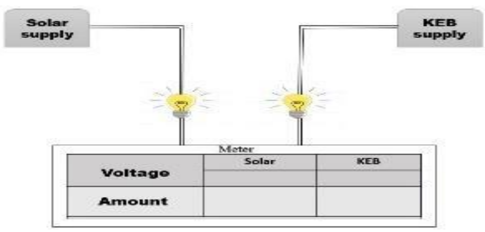
Solar cost = (kWh × LCOE)

Step 3: Displaying Data

Live flow of power

Solar vs grid kWh

Difference in cost



Step 4: Logging & Alerts (Optional)

Logs energy and cost data.

Alerts for: Grid outage

Low production of solar power, High Grid utilisation

4. Environmental Impact

Decrease in Emissions of Greenhouse Gases

Solar energy decreases dependence on fossil fuel electricity derived from the power grid. This will decrease CO_2 and other greenhouse gas emissions.

Improvement in Air Quality

Less coal and other fuels that are burned means there are fewer air pollutants like SO_2, NOx, and particles.

Decreased Carbon Footprint

By using solar energy, a home or business has a smaller carbon footprint overall than if it used electricity from fossil fuels.

Support for Increasing Energy Efficiency

Monitoring energy usage in real-time encourages users to make reductions to their usage of energy that is not needed, thus reducing waste.

Reduced Reliance on Non-Renewable Energy Sources

Solar power is renewable, hence reducing demands on limited fossil fuel resources.

Support for Climate Change Mitigation

The use of clean energy reduces global warming and contributes to reducing climate change.

Promotion of Sustainable Energy Use

The monitoring unit allows users to see how much solar energy versus grid energy is used in order to encourage most users to use renewable energy.

5. Conclusion

Cost analysis indicates that though the initial investment in solar power is higher, it generally provides greater long-term savings than grid electricity, particularly with rising tariffs every year. Rebates and net-metering kinds of incentives have increased the payback period and overall financial return for solar. Solar contributes to environmental benefits in emission reduction and lower dependence on fossil fuels. However, this advantage looks dim in the case of immediately installed solar power if there is either a low grid price or poor sunlight or a deficiency in incentives within the area. Adding battery storage adds value, but also ups the upfront system cost and complexity. Overall, the choice between solar and grid power depends upon the balance struck between an upfront cost, long-term savings, environmental priorities, and conditions prevailing locally.

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Biographies

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