

Solar Powered Multilevel Smart City Architecture for Rural Areas in India: A Prototype

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Abstract— At present, solar energy has transformed into a prominent energy source to meet certain need around the globe owing to the unsteadiness of the global warming issues and decrease in non-renewable energy source. India is intensely reliant on fossil fuels for its energy requirements and now it is important to handle the energy disaster through the use of renewable energy resources, for example, Wind energy, Biomass energy, geothermal energy. This paper describes about the simple solar smart city development for the rural areas where the electricity is not accessible. India is a humid country, where sunshine is accessible for longer hours per day and in huge power. Therefore, the solar energy has great potential as future energy source. With ongoing improvements, the solar energy systems are effortlessly available for factory and household use with least maintenance. By utilizing solar energy, the framework is designed to create a solar smart city which consist of proper city waste management by using solar waste decomposer, to reduce household electricity by using solar panel for energy storing, solar charger for mobile, surveillance camera and electric-car, solar street lighting, solar disaster detection alarm for every city, solar roof top, underground wiring which doesn't create problem in rainy season etc. The study is to illustrate a multilevel solar smart city architecture based on solar energy and it is described in terms of its functionality and some real time scenarios to enhance the rural areas.

Keywords:- solar energy, biomass energy geothermal energy, solar disaster detection.

I. INTRODUCTION

Solar energy is the most abundant renewable everywhere. energy ant the cleanest source which is available. Every day, the sun radiates a massive amount of energy and it is converted into thermal or electrical energy. The sun radiates more energy per day than the world uses in a single year [1]. Today, solar energy is used in number of ways like, heat for making hot water, cooking, to generate electricity, to take salt away from ocean water, and etc. The captured sunlight is used to create photovoltaic power or concentrated solar power for solar heating and this energy conversion is used to power lights, heaters, gadgets and etc .

India suffers from never-ending energy scarcity. Currently in India we are facing both environmental crisis and development crisis. In India, around 700 million people have poor access to electricity. Likewise, 700 million Indians still

were using biomass such as agricultural waste, dung, firewood and etc for cooking. This biomass energy produces toxic gases which create pollution and increase the disease. About two-thirds of Indians are still underprivileged of present energy services. Now the challenge is to meet the energy needs without compromising the ecosystem of the country.

After the Second World War, solar energy progresses have been undertaken in many countries. The first program to recognize the significant of solar power was organized by Government of India named as Rural Electrification Program to provide course of action for the implementation of solar applications in the year 2006. In 2010, solar power generating capacity was increased by 73% and Jawaharlal Nehru National Solar Mission(JNNSM) was launched to improve the usage of solar energy. The mission goal consist of off-grid solar applications, solar thermal collector in 20 million square etc. This goal is planned to fulfill by 2022 to make India a global leader in solar energy. In Fig. 1 provides a visual representation about India solar demand forecast from 2011 to 2012.

result, the electricity expenses of the electric heater can be reduced. Fig. 2 represents a various solar products using in India [5].

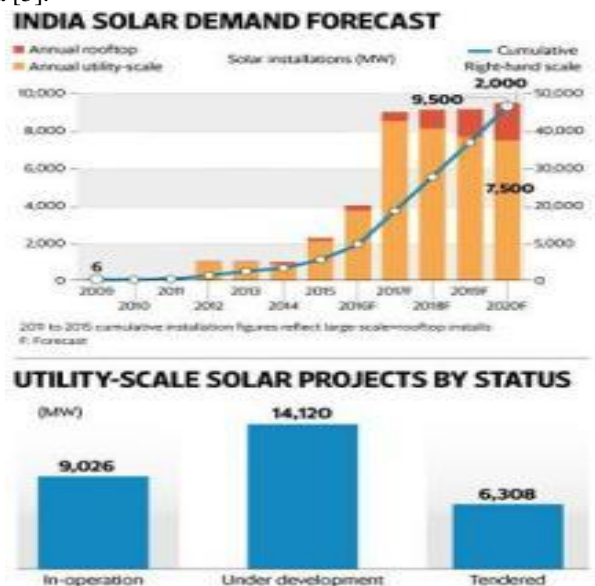


Fig. 1 India Solar Demand Forecast
Source: Mercom capital forecast

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The different solar technologies are used for various purposes like generating electricity, providing light or a comfortable environment, and heating water for domestic or industrial use. Firstly, solar water heating system is designed mainly to heat water for house hold purpose and the cost of manufacture will be moderately less and high in capacity. Secondly, solar light is required to provide lighting instead of electric lighting system. Thirdly, solar car is an electric vehicle powered by energy obtained from solar panels on the surface of the car which convert the sun's energy directly into electrical energy. Solar cars are not currently a practical form of transportation and etc. As a



Fig. 2 Various Solar Products

The Major aspect of solar research is to reduce the global carbon emissions, which is the major universal environmental, economic and social concern in recent years. For example, In California 696,544 metric tons of CO₂ have been reduced by fitting household solar systems. An another significant aspect in the universe is electricity supply, which is generated from the fossil fuels such as natural gas, coal, petroleum, oil and these conventional energy sources faces a defy such as increasing costs, security concerns for fuel import from other countries, and increasing ecological concerns over the climate changes related with power generation using fossil fuels. Therefore, the creation of solar energy in cities is a finest approach to reduce global warming by lowering the discharge of greenhouse gases and Fig. 3 shows to forbid the global warming and fossil fuels [4].



Fig. 3 Forbid Global warming and Fossil Fuels

II. SOLAR ENERGY

The Earth gets an incredible supply of solar energy, where the sun is the main resource. Without the sun, rapidly the earth's high temperature will get down and the earth will be wintry and gloomy, as a result no plant life and human on earth will stay alive. The sun is the source of diverse energy sources such as fossil fuels, wind energy, all organic substance which can be changed to heat energy and mechanical energy, etc. The sun, a star, is a combination reactor (i.e. fusion process) that has been burning more than 4 billion years. For one year, it provides an adequate amount of energy to world in one minute. Therefore solar energy is gratis and also an unlimited resources to meet up enduring universal energy crisis.

A. Functioning of solar energy

Photovoltaic cells convert sunlight to Direct Current electricity through Charge Controller. The charge Controller is used to manage the power from solar panel. Batter System is operates as electric power storage when the sunlight is unavailable (i.e. at nighttime). Then the inverter is used to convert Direct Current (DC) into Alternating Current (AC). Fig. 4 shows the functioning process of solar energy [6].

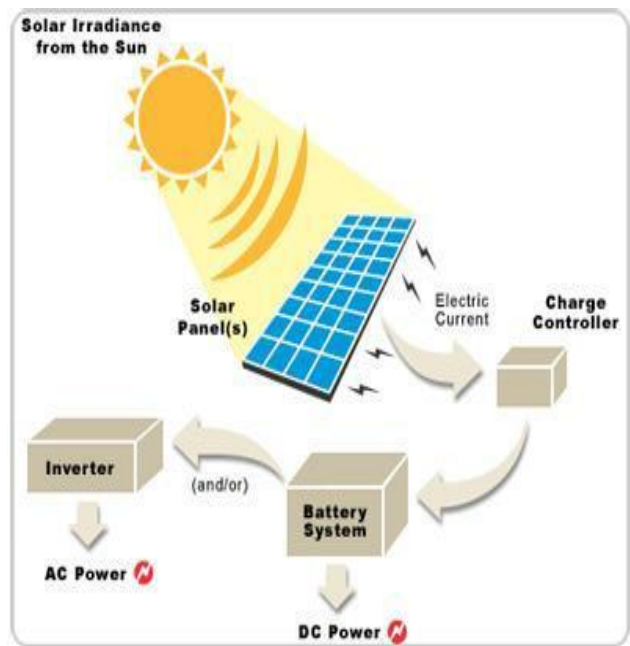


Fig. 4 Functioning of solar energy

Source: <https://www.google.com?q=working+of+solar+energy>

B. Benefits

1. It is a renewable energy source and solar energy cannot run-out like other energy sources.
2. It reduces the electricity bills.
3. It can be used to various purposes such as to generate electricity, to purify water and etc.
4. Simple installation and Low cost of maintenance.
5. Pollution free and long life energy resource.

C. Limitations

1. Initial cost of installation and purchasing solar materials such as solar panels, inverter, batteries, and wiring is moderately high.
2. The efficiency of solar system drops in cloudy and rainy season because the solar system is absolutely depends on sunlight.
3. The solar energy storage cost is very high.
4. More spaces are required to fit the solar panels.

III. HISTORICAL DEVELOPMENT OF SOLAR ENERGY IN INDIA

In 1982, the Department of Non-conventional Energy Sources, Govt. of India, undertook a number of projects and programs associated to solar energy. The Rural Electrification Program was the preliminary step by the Government of India in recognizing the significance of solar power in 2006. It gave guiding-principle for the implementation of off-grid solar applications and in 2012, only 33.8MW of capacity was installed in the course of this policy. The off-grid solar application includes solar pumps, street lighting systems, solar home system and etc [4].

In 2007, International Journal of Environmental Science: Development and Monitoring (IJESDM) is a next step in India introduced the semiconductor policy to support the IT industries and electronic industries. In January 2008, Government of India introduced Generation Based Incentive (GBI) scheme to encourage grid connected solar power plants and the GBI scheme was failed due to lack of addressing the grid availability, land acquisitions and etc. In June 2008, National Solar Mission (NSM) was introduced to improve the drawbacks in GBI scheme [7].

In 2010, Jawaharlal Nehru National Solar Mission (JNNSM) was introduced by the Prime Minister and the mission includes 20,000 MW of grid connected solar power, 2000 MW of off grid solar application, 20 million sq. solar thermal collectors, 20 million solar lights by 2022. This policy framework makes India a global leader in solar energy. At least 60 percent of renewable energy sources possibly will grow within 2035 and by 2060, four times more than today energy. In 2060, solar energy may possibly be the world's largest most important energy source [4] [7].

IV. ISSUES IN RURAL AREAS

India has both environmental and developmental crisis. In India, 70% of population living in rural areas and their main requirement is electricity. But the sad reality is more than 63% of rural household doesn't have access to electricity and the people are still using kerosene for lighting. Even in electrified rural areas, there is a huge lack of power supply. More than 700 millions of Indians use biomass such as agricultural waste, firewood for cooking, dung's and these causes pollution.

To meet the energy requirements, India is largely dependent on coal and its produces 70% of electricity. India is the 3rd largest coal producer after China and USA. But the energy given by coal causes huge environmental and health cost. Mining coal emits gas which leads to destruction of forest and wildlife which may be impossible to regenerate.

To meet the energy requirements without compromising the ecology of the country is the major challenge in India.

V. DIVERSE SOLAR POWERED PRODUCTS

A. Solar Electric Power generating System

Solar electricity is produced when the radiant energy from the sun strikes the solar cell, where the solar cell is made up of silicon and the solar cells convert the energy into electric power. Many panels are required to generate the electricity and photovoltaic (PV) systems are expensive when compare to other systems. In many rural villages, the stand alone PV systems are used to generate an electrical energy. The main advantages of these systems are no need for fuels, no need for constant maintenance and etc. Fig. 5 shows the process of Photovoltaic system [8].

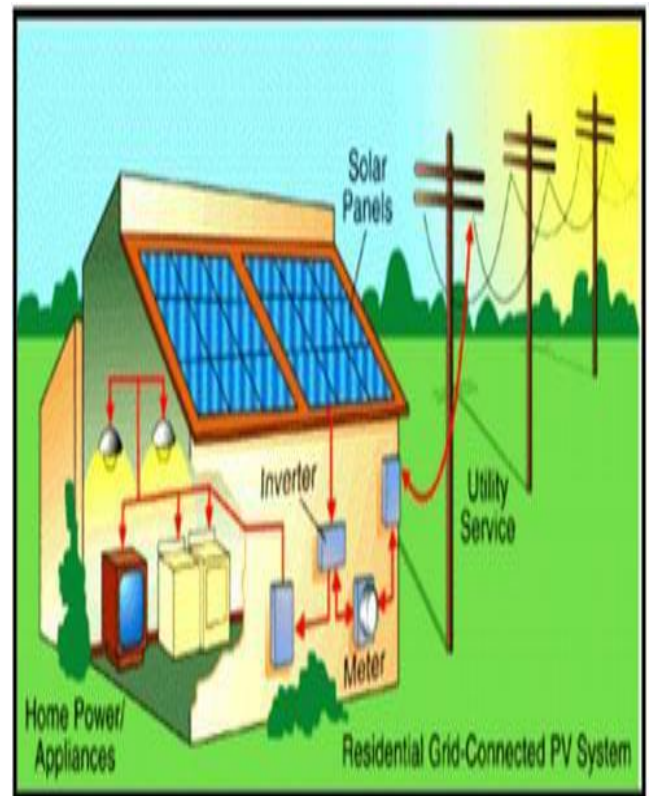


Fig. 5 Photovoltaic System

Source: <https://www.google.com?q=solar+photovalatic+s ystem>

B. Solar Water Pump

Solar pumps are applicable in domestic use, irrigation, livestock watering, aquaculture, forests watering, meadows, fountains, etc. The Solar-powered pump operates based on electricity generated by PV panels. Solar Pump has lower operation cost, maintenance costs, and lower environmental impact. Solar Pumps are very useful when the electricity is not available. The Solar pump system consists of three parts, solar panel, pump controller, and pump. The solar PV size is depends on the size of the pump and the pump controller is used to get the input source from the solar panel and also provides the voltage protection. Pump controller increase the

lifetime of the pump and also reduce the maintenance cost and finally it connected to the water pump. Fig. 6 shows the solar water pump system [8].

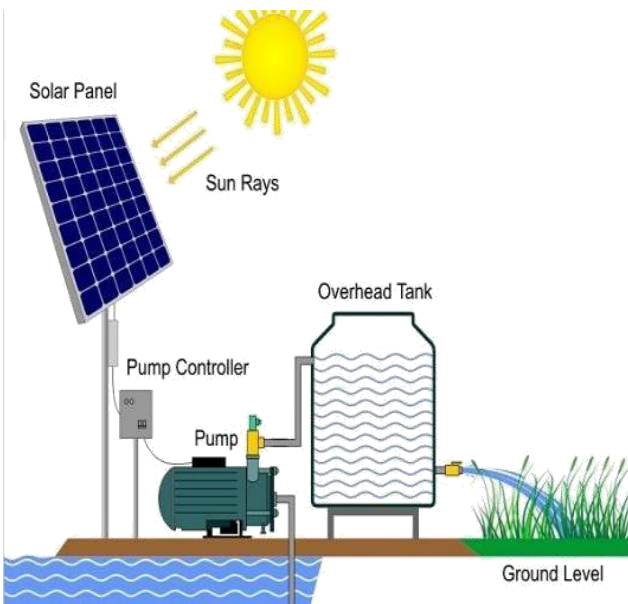


Fig.6 Solar Water Pump

Source: <https://www.google.com?q=solar+water+pump>

C. Solar Lighting

Solar powered lightning can be used in various places such as schools, roadside, marine lanterns, etc. The most important factor of solar light is to provide light at night for large cities. By sensing the outdoor light using solar panel voltage, the solar light automatically turn on and turn off. It requires less wire connections, low operation cost, maintenance cost and no electricity bill. Fig.7 represents the solar light which consist of solar panel, solar feed batteries and solar light [8].

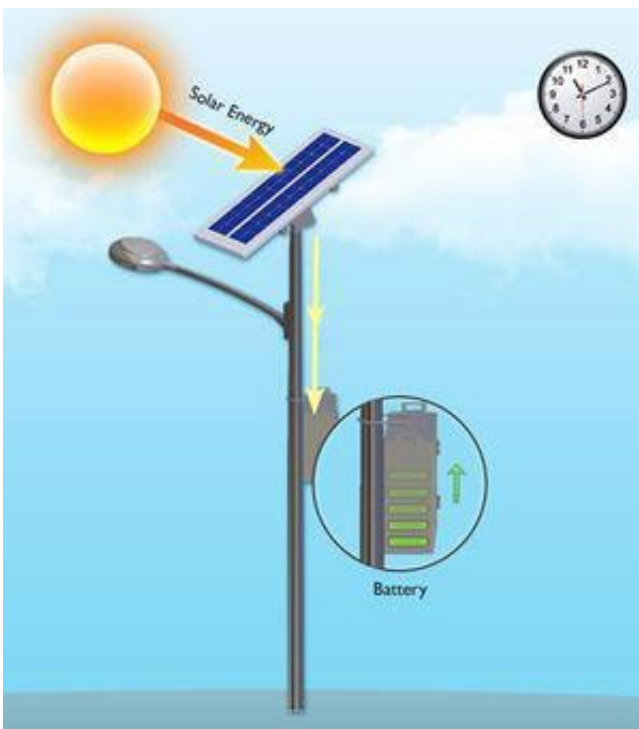


Fig. 7 Solar Light

Source: <https://www.google.com?q=solar+light>

VI. MULTILEVEL ARCHITECTURE FOR SMART CITY RESULTS

Solar smart city is a designation given to urban areas to provide the urban services such as transportation, energy, irrigation, and other utilities in order to reduce the resource consumption, wastage and overall cost. The main goal of the solar smart city is to improve the quality of living for its citizens. The major issues in urban area are high urban poverty level, environmental degradation, inadequate basic services, urban gas emission and etc. The solar smart city idea is to strengthen the urban areas by utilizing the renewable resources. Fig. 8 shows the solar station, irrigation land, hospital, school, industry and etc.

SOLAR SMART CITY

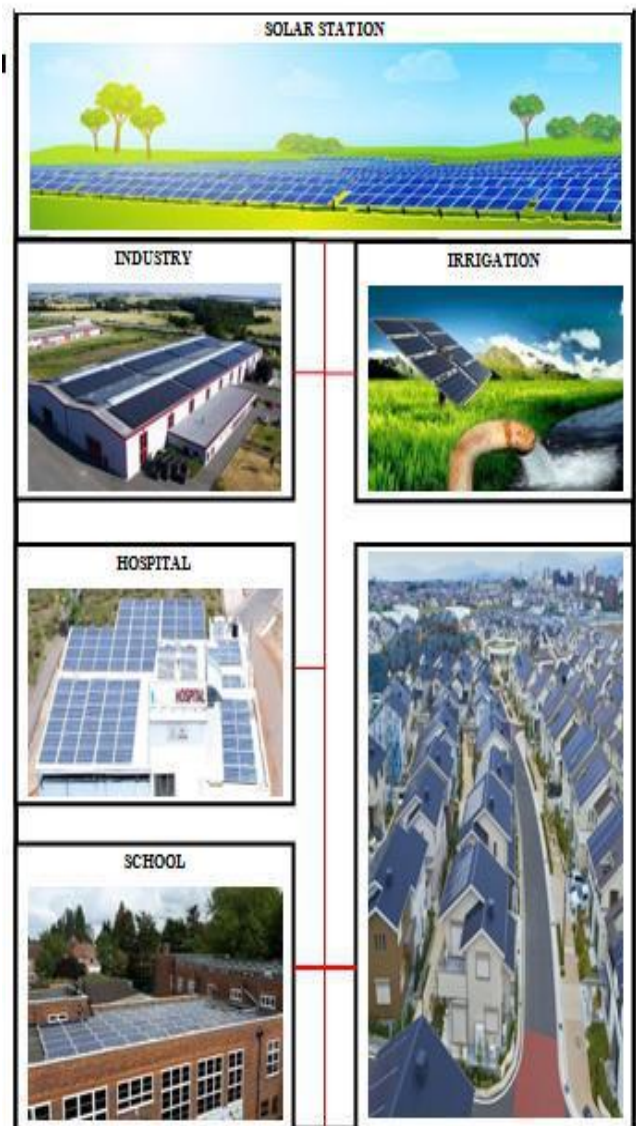


Fig. 8 Multilevel Architecture for Smart city

At night time and rainy season solar energy is unavailable and the energy storage is an important problem because our modern society needs continuous availability of energy. The solar station is a power wall that stores solar power for use as a battery backup. The solar station supplies the solar power to

the entire urban area in rainy or cloudy season. Initial cost of installation and purchasing solar materials such as solar panels, inverter, batteries, and wiring is moderately high. But it reduces the electricity bill throughout the lifetime, Low cost of maintenance and installation, pollution free and long life energy resource.

Solar power is essential for health sector, schools, industry and other public places because all these places are using a large amount of electricity in laboratories, classroom, to run the industry equipments, etc and therefore the utility bills touch the sky. For such reasons installing a solar energy system is a best way to reduce the electricity bill in urban areas, reduces the fossil fuel gas emissions and improve their overall efficiencies.

VII. CONCLUSION

The solar energy is a renewable energy that provides an unlimited source of energy supply all over the world. In India the majority of industry relies on fossil fuels such as coal, oil, and other natural gas. The fossil fuel is a non renewable resource so we need to find an alternative solution. Solar energy is a great alternative solution. It is a limitless and free source and keeps our environment clean and provides sustainable energy to power our urban area without any harm. The main goal of the solar smart city is to improve the quality of living for its citizens who are living in urban or rural areas.

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