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# A Review Paper on Solar Energy Generation along National Highways

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**ABSTRACT**- Solar energy as a source of electric power is gaining traction in Brazil, and it is the topic of global environmental debates. Electric energy, which is a right of all people, represents a large-scale use of natural resources. In 2016, state schools in Paraná spent more over R$ 46 million to provide power and therefore provide the system with necessary operating conditions. 15 schools in Curitiba/"Regional PR's Administrative do Cajuru" were assessed in terms of electric energy usage and expenditures from January to May 2017, and a solar photovoltaic system was dimensioned to meet each school's need. It was calculated that the entire savings from the energy that would no longer be spent on power could be allocated to other educational programs and community-oriented initiatives to help the school achieve sustainability. The projected yearly savings were more than R$ 435 thousand.

**KEYWORDS-** Electric, Energy, Resources, Software, Solar.

## I. INTRODUCTION

Energy from the sun may be generated in 2 ways: Photovoltaic panels (PV) and solar panels are electricity devices that transform sunlight directly into electricity. The modern photovoltaic panelling, which can be located in solar energy on buildings and laptops, is recognisable to most individuals. Figure 1 shows the Solar Energy Generator[1].

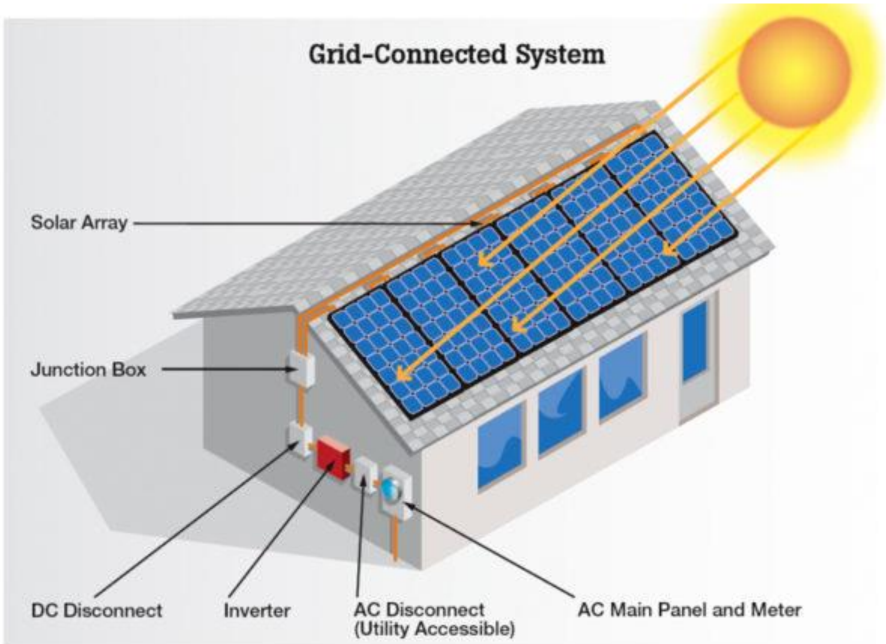


Figure 1: The above figure shows the Solar Energy Generator [amplussolar].

Many island nations, such as Fiji, Papua New Guinea, and others, continue to suffer from the lack of access to power. Due to a lack of resources, they all rely on fossil fuels, mostly diesel, to generate power. In reality, diesel generators account for 85 percent of the country's overall power production. Energy saving techniques have become more popular in recent years[2]. Every country examines the different resources at its disposal and devises strategies for making the most of them. For example, many strategies for energy sustainability are recommended in a recent detailed research in Nigeria on the energy consumption[3].

Similarly, over the last several years, the Indian solar energy industry has been quickly expanding, thanks mostly to government initiatives like as tax exemptions and subsidies. The country's geographic position, as well as the large disparity between energy consumption and generation, are additional reasons[4]. All of these reasons indicate that India has the potential to become one of the world's fastest-growing solar energy markets. The Indian government has set lofty goals for its national solar mission, aiming to reach 10,000 MW by 2017 and 20,000 MW by 2022. To achieve this goal, numerous new approaches are required, including a favourable national policy for solar businesses. In terms of grid-connected solar power production, the overall installed capacity[5].

Due to the push on solar electricity, the total cumulative solar capacity has grown 25 times in less than a year. According to the research, photovoltaic growth in India increased by approximately 45 percent each year on average between 2000 and 2009. When it comes to grid-connected solar power production per state, Gujarat alone supplied 654.8 MW. Gujarat's government is responsible for more than 65 percent of grid-interactive solar power production[6].

Land is often cited as the most significant barrier to solar energy deployment. In light of the above, our research focuses on maximizing the use of available land. National roads are being investigated for energy production utilizing solar photovoltaic technology in this direction. Figure 1 depicts our idea in the form of a schematic diagram[7–10]. The Ahmedabad-Rajkot national highway spans 205 kilometres, whereas the Ahmedabad-Vadodara national express route spans 93 kilometres. We utilized two software packages for modelling purposes: Google Earth Pro and PVsyst simulation software[11].

Solar-powered LED roadside brightness, safety illuminating, and freeway programmable messaging are some of the additional ways and approaches for employing concentrated solar technologies on roadways. Despite the reality that these are important implementations in terms of energy generation or consumption, they fade in comparison to the strategy we offer in our essay. In addition, cost-oriented modelling and design optimization for alignment may be shown to estimate the highway's operating and engineering costs[12].

The purpose of the proposed research is to determine the efficacy of utilizing the national highway system and to examine all variables that contribute to energy generation. The use of space above highways for solar panel installation has the added benefit of providing road shade. This increases vehicle efficiency by reducing energy losses caused by heat inside the vehicle, as well as the tire life of all vehicle wheels owing to the shade provided by the road. Combining the two will result in better economics via energy production as well as increased vehicle efficiency. Another benefit of the shade over the road is that it extends the life of the road and lowers the expense of road maintenance. It is a common occurrence on many roadways that potholes appear shortly after rain. If all roads have solar panels installed above them, this will be outdated[13].

Thus, our research offers a novel approach to the efficient use of roads, as well as a chance to address a key industrial challenge: land availability for grid-interactive solar power facilities. Although our research reveals many benefits, effective application requires a few more steps. For example, one must ensure that the solar panels are securely attached to the structure's foundation. Fixing solar panels at a high height, say 9 to 10 meters above ground level, exposes them to strong winds during storms or wet days[14–18]. It may be a challenge for the solar panels' stability as compared to those that are near to the earth. The panels may be able to overcome this issue if they are installed with additional care. Another issue may be dust and smoke particles generated by vehicle movement. Due to the fact that many nationwide roadways are larger and neater than that of other roadways, such as rural roadways, limited interstate freeways, or state roads, special provision shall be made to wash the screens on a daily, as contrasted to simple screens on the floor away from the crowds or distantly locations panels, which are cleaned once a week or each ten days. There will be less environmental hazards linked with automobiles and pedestrians on the screens if all or most automobiles fulfil Euro requirements for exhaust fumes. Although there are a few problems to consider if one follows the concepts of our current research, the drawbacks may be mitigated with appropriate planning, focusing mostly on solid panel mounting and frequent solar panel cleaning[19–22].

### *A. Methods:*

PVsyst and Google Earth Pro software packages were used to simulate our current research. Before getting into the approach, let us have a look at the program in more depth.

#### *a) The Software programs:*

PVsyst simulation software is famous among different software packages for analyzing the precise performance of the solar plant under field settings. It may be used in a variety of ways, such as to study the various loads on the system, to estimate the system's size, to identify the optimum size of the panel, to evaluate the system's energy production, and so on. Details the additional features and choices accessible in the PVsyst software simulation. PVsyst, a PC-based software program, may also be used to research PV system sizing and data analysis. It is utilized for a variety of system types and sizes. It has the ability to assess monthly output and performance[23–26]. It also conducts a cost-benefit analysis of the PV system during the design phase. Its software conducts comprehensive simulation and shading analysis based on a large number of factors. Figure 2 shows the systematic layout of a National Highway.

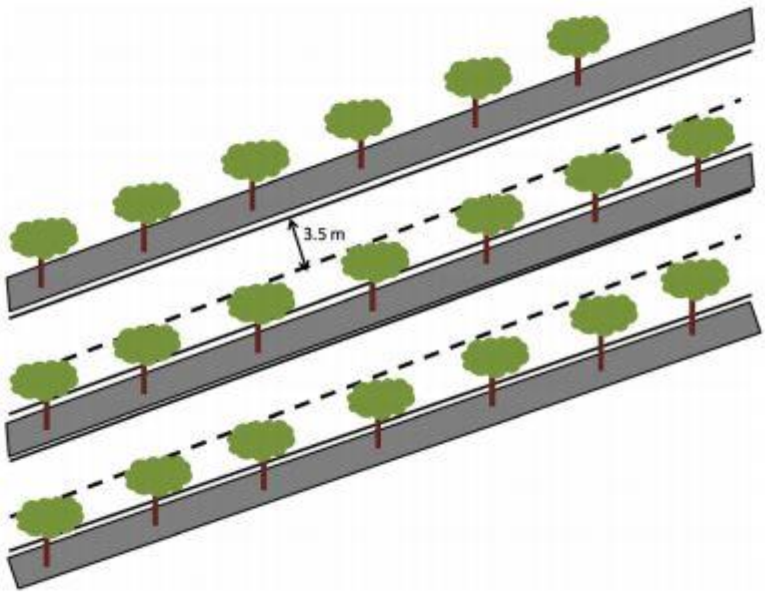


Figure 2: The above figure shows the systematic layout of a National Highway[27].

Google Earth is a popular program for viewing satellite imagery, maps, topography, 3D buildings, and other things, as well as for doing research. It also includes tools for analyzing and exploring locations, including realistic images of the region and navigation through instructions. Google Path's many features and high-quality satellite maps enable users to navigate around the Earth, locate addresses and locations, mark locations, and so on. It may also be used to get the coordinates of various locations. Shows the other different features and choices available. This may be done by using GIS software to connect the data. Figure 3 shows the schematic layout of the national highway with solar photovoltaic panels on its roof.

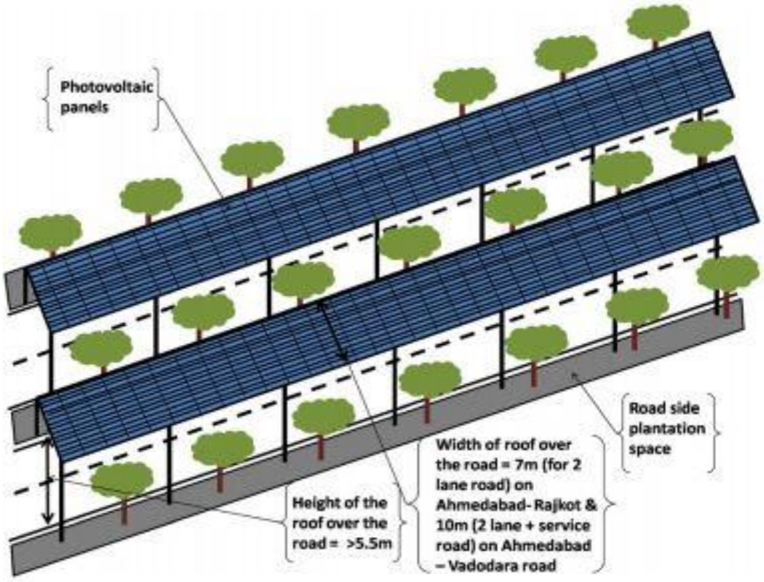


Figure 3: The above figure shows the schematic layout of the national highway with solar photovoltaic panels on its roof[27].

Another option for learning is to utilize Google Earth Pro, which is a more sophisticated version of Google Earth. This is utilized in our research to get findings that are more precise. It provides a complete geospatial database for highways and historical images with high-resolution imagery. The Earth's surface may be visually seen together with all field data. This is a highly helpful tool since it allows you to obtain field information without having to go to the place. Google Earth Pro was determined to be appropriate in our research since it is more of a regional nature. Radius and area measurements are also done using Google Earth Pro, which has built-in measuring and sketching capabilities.

***b) Info3rmation:***

PV component database, grid inverter database, geographical site information, and monthly meteorological data for horizontal global irradiance and temperature are the main input parameters for grid-connected system modelling. The Titan Energy systems silicon polycrystalline module Titan 24–100 was utilized in this research. The maximum power output of each solar module is 100 watts. For our calculations, we utilized a Sputnik Solarmax 50 C grid inverter with a 50-Hz frequency, a voltage range of 430 to 800 V, and a power rating of 50kW as one unit. The unit under consideration here spans the full length of the roadway. METEONORM version 6.1.0.23 provided the meteorological data.

Table 1 contains additional information about solar panels, including solar module technology, power rating, and associated module parameters for a 50-kW photovoltaic system. Over the sake of computation, this is treated as a single unit that will be extended for the full length of the roadway. As a result, both the Ahmedabad Rajkot national highway (four lanes) and the Ahmedabad Vadodara highway utilize 504 modules (four lanes WO service roads). The panels are slanted at a 23-degree angle. This tilt is selected to be the same as the latitude of the Ahmedabad location (23.067°).

***c) Orientation of s3olar panels:***

Generating modules aligned directly to the southeast in the northern hemispheres are well recognised for generating the most electricity. Furthermore, the amount of electricity created is lowered if the photovoltaic array is not pointing southwest. The East, West, and North are the categories of decrease in power production for different directions, depending on the composition of a 50-kW system using PV system application. When planning the installation of the screen, we recommended that the committee alignment be considered into account; this will assist to maximize the amount of energy available from the solar panel by orienting it towards the south. As previously stated, owing to the limitations of the PVsyst program, the simulation is limited to 50 kW, which covers just a tiny portion of the national highway routes.

A schematic layout of the solar panel design for two lanes that we considered for our research of the Ahmedabad-Rajkot route. As previously stated, the lane width for a multilane national highway is 3.5 m, and this is taken into account in our model research. The schematic design depicts a 7-m width of solar panels for each of the four lanes, with a 3 m separation space between the roads for tree planting, etc., based on the width of two lanes of a national highway, as shown in Figure 5. The total solar energy produced by the panels on the four lanes is calculated using PVsyst simulation software. These solar module storage options were selected based on the size of the Ahmedabad-Rajkot route. This design is arbitrary, yet it aids in the computation of parameters fast. PV modules in this arrangement can provide up to 50 kW of electricity. The results of this model, on the other hand, may be applied to any length of national highway as needed.

***d) National roadways are being modelled:***

The different factors and measurements used to calculate the sunlight resource along the Ahmedabad-Rajkot interstate roadway, i.e. the extent of the turnpike that has already been determined to be appropriate or inappropriate for the deployment of a sunlight power systems as a roadway roof for electricity production. It is 205 kilometres long and 14 metres wide. It is a two-way (four-lane) highway with a breadth of 14 metres, as previously stated. As a result, the total area accessible for solar panel installation (Area = Length x Width) is 2.87 km2. Despite the highway's length of 205 kilometres, it is impassable throughout its entire length owing to environmental problems such as dense vegetation.

As a result, of the 2.87-km2 total space available on the Ahmedabad-Rajkot national highway, 0.2 km2 is determined to be inaccessible or inappropriate for solar system installation owing to the aforementioned reasons. As a result, the effective area accessible on the national route between Ahmedabad and Rajkot is 2.67 km2. We examined the Ahmedabad-Vadodara expressway in the same manner as we considered the Ahmedabad-Rajkot motorway. It has four lanes, each with a width of 3.5 meters, and a 3-meter-wide service road on both sides of the road, as previously stated. The highway is 93 kilometres long, with a total usable road width of 20 meters (4 3.5 + 2 3). As a result, 1.86 km2 of land is accessible for solar panel installation. 0.14 km2 of the allocated land is inaccessible owing to the same environmental problems that have been addressed before for the Ahmedabad-Rajkot route. Similarly, to the Ahmedabad-Rajkot highway, the Ahmedabad-Vadodara express highway has an estimated effective size of 1.72 km2.

## II. DISCUSSION

The author has discussed about the strategy for using solar energy to solve global problems such as climate change, pollution, and energy insecurity, as well as the most significant barrier for silicon technology, namely land cost. Indian roads have a critical part in the economy via transportation, with their portion of the overall share of 40% with railroads having only risen to 60% before 2000 [30]. This implies that both vehicle economy and road life are equally essential. We are also addressing some of similar problems in our article. It is common knowledge that land is getting more costly and scarce. In light of this, our research suggested a new idea for making better use of existing land. An effort has been made in this regard to see whether the national highways, which are now solely utilized for transportation, might be used for anything else. They may also be used to generate electricity, according to our theory. For this reason, a simple elevated structure spanning the national highway lanes may be built with a one-time expenditure.

## III. CONCLUSION

The author has concluded about the solar energy generator, solar energy as a source of electric power is gaining traction in Brazil, and it is the topic of global environmental debates. Production of electricity is a sizable utilisation of mineral wealth that is a right of every citizen. For this, researchers examined at different case reports: one on the Ahmedabad-Rajkot motorway the other to the Ghaziabad motorway. It's worth mentioning that the motorway between Gandhinagar and Rajkot is aligned east-west, whereas the Ahmedabad-Vadodara expressway is oriented south north. As a result, solar panel configurations with an area equal to generating 50 kW of energy have been created using PVsyst software. This is treated as a single unit for estimating solar potential on a national roadway in order to boost electricity production. The author have also included two levels of solar panels that are stacked one on top of the other. This concept has previously been proven in the context of increased power production

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