A Study on Various Installation of Solar PV System

Mr.Bharat Rambhau Khapare and Prof.N.L.Bhirud, Mechanical department,
Sandip Institute of Engineering and Management, Nashik

Abstract— In this paper we are studying the various types of installation of solar PV system. Electricity plays an important role in human life, without electricity nothing work is done. Basically two type of solar systems are there (1)ON-GRID solar PV system; (20)FF-GRID solar PV system. Main requirement of solar PV system is GEO-COORDINATE and type of solar PV installation that defines the solar plant efficiency. GEO-COORDINATE means altitude and latitude as per solar radiation present at that area. So, solar PV system installation type is very important as per same.

1. INTRODUCTION

The need for electric energy, which is an indispensable part of life, is increasing with each passing day in parallel to the developments in technology. The electric energy is generated using a non-renewable energy sources, but the heavy pollution, high cost and limited efficiency of fossil fuel burning heating systems causes the nation environment in recent years. Energy is being obtained bring clean energy sources such as solar, tidal, biomass, hydroelectric, wind and many other non-renewable energies, in that solar energy is a massive source of heat and light. Comparatively 1kwh of solar power reduces 1kg of CO_2 emission. So, solar energy is always preferable.

Solar power system installation we require climatic condition i.e. Geo coordinate. The solar power generation efficiency depends not only on the location where it is installed, but also on the type of installation made at that particular location. Solar panels, which, with their increased power capacity, are used in homes, country cottages, street lighting, meeting the electricity needs of public buildings, farms use, remote locations, garden lighting, etc. In this study, a new approach was suggested in installation of solar systems.

How does the solar energy works?

The concept of solar energy is amazing. When photons from the sun react with the solar panel, it releases electrons that turn into electricity. Photons are present even on cloudy days. Solar power system can be installed anywhere, except in a place under constant shade. Rooftops are a popular choice, as well as the surrounding land with a ground-mounted system.

2. OBJECTIVES

2.1) To conduct the visits to study actual type of installation of solar panels.

2.2) To understand installation types by various aspects.

2.3) To study importance of GEO COORDINATE on performance of solar system.

2.4) For structure, various properties of material used as per atmospheric conditions i.e. corrosion less, high strength, etc.

2.4) Mountings of solar panels, inverter, control panels, safety switches, earthing, etc.

2.5) To implement new solar panel installation method with considering all parameters.

3. TYPES OF INSTALLATION

3.1. FLAT ROOF SOLAR INSTALLATION:

Construction:

In flat roof solar system installation, the solar panels are mounted on building roof with the use of metal steel structure. This mounting process is very commonly used and for this installation we don't have require extra area. The solar panel is mounted on steel structure with 15 to 25 degree tilt angle. This tilt angle is consider as per geo coordinate i.e. latitude and altitude and as per same the tilt angle is selected. In efficiency of solar system tilt angle plays an important role.

Mechanical attachments:

Solar panels are mounted on the roof using metal beams. The metal structure must be sustaining the solar array positions even in windy zones.

3.1.1) Flat roof mounted solar installation (Sandip Foundation, SIEM, Nashik)

Ballasts or weights:

These are suitable in low wind zones. Instead of bolting the solar panels on the roof, weights are used to clutch them in an array.

3.1.2) solar roof ballasts or weights mounting system [1]

Hybrid mounts:

In this type of solar installation uses both ballasts as well as beam to clutch the panels together and stick to the roof.

Solar panel selection

Monocrystalline solar panels, Polycrystalline solar panels, Thin film amorphous silicon solar panels.

Material selection for structure:

Galvanized hot dipped steel / Mild steel / Aluminium steel

3.1.3) Beam structure- Galvanised hot dipped steel structure

3.1.4)Slide in clamps and locked modules at ends of rails

Briefly other type installations for commercial and residential use:

1. Solar PV tiles installation:

Solar PV tiles is provides an alternative type of solar panels installation. This type of system requires the roof to be completely retailed. Solar PV tiles are more expensive than in roof and on roof solar panel installation and also be slightly less efficient.

3.1.5) Solar roof PV tiles [2]

2. Ground or Land mounted solar PV panels installation:

Same as flat roof mounted solar panels installation ground mounted solar panels installation are generally used for commercial use. Typically, this kind of solar panels installation requires large amount of land and it is to be cost effective. Planning authorization is required for this type of solar system installation.

3.1.6) Ground mounted solar panels [3]

3. Pitch roof solar panel installation:

This type of solar panel installation is made on the angular roof. This type of installation is complex because solar panels need to be held complete in the inclined surface of the roof.[4]

3.1.7) Pitch roof solar panel installation (Belgaondhaga, Nashik)

3.2 SOLAR STREET LIGHT [5]

Solar street lights are raised light sources which are powered by photovoltaic panels generally mounted on the lighting structure or integrated in the pole itself. The photovoltaic panels charge a rechargeable battery, which powers a fluorescent or LED lamp during the night.

Most solar panels turn on and turn off automatically by sensing outdoor light using a light source. Solar streetlights are designed to work throughout the night. Many can stay lit for more than one night if the sun is not available for a couple of days. Older models included lamps that were not fluorescent or LED. Solar lights installed in windy regions are generally equipped with flat panels to better cope with the winds.

Latest designs use wireless technology and fuzzy control theory for battery management.

Solar street lights consist of 5 main parts:

1. Solar panel: There are 2 types of solar panel: mono-crystalline and poly-crystalline. Conversion rate of mono-crystalline solar panel is much higher than poly-crystalline. Solar panel are varies from wattage systems.

2. Lighting fixture: LED is usually used as lighting source of modern solar street light, as the LED will provide much higher Lumens with lower energy consumption. The energy consumption of LED fixture is at least 50% lower than HPS fixture which is widely used as lighting source in Traditional street lights.

3. Rechargeable Battery: Battery will store the electricity from solar panel during the day and provide energy to the fixture during night. The life cycle of the battery is very important to the lifetime of the light and the capacity of the battery will affect the backup days of the lights. There are usually 2 types of batteries: Gel Cell Deep Cycle Battery and Lead Acid Battery and many more.

4. Pole: Strong poles are necessary to all street lights. Material of pole is required anticorrosive, high strength, etc. there for Galvanized hot dipped steel material is used. Especially to solar street lights as there are often components mounted on the top of the pole: fixtures, panels and sometimes batteries. However, in some newer designs, the PV panels and all electronics are integrated in the pole itself. Wind resistance is also a factor.

Also there are some accessories, like foundation cage and battery box.

TYPE:

3.2.1) solar street light

3.2.2) Solar Street light at the bus stop

Each street light can have its own photo voltaic panel, independent of other street lights. Alternately, a number of panels can be installed as a central power source on a separate location and supply power to a number of street lights.

3.3 SOLAR TRAFFIC LIGHT [6]

Solar traffic lights are signaling devices powered by solar panels positioned at road intersections, pedestrian crossings and other locations to control the flows of traffic. They assign the right of way to road users by the use of lights in standard colours (red - amber/yellow - green), using a universal colour code.

3.3.1) solar traffic light

Most solar traffic lights use LED lamps as they are more reliable and have more advantages over other lighting devices like CFL lamps as they are more energy efficient, have a longer life span and turn on and turn off quickly. Solar traffic lights contain enclosures which house the batteries and the control panel circuitry. Existing traffic lights can also be upgraded with an auxiliary power source using solar panels for use during power failures. The other parts in a solar traffic light include a charge controller to control the charging and discharging of the battery and a countdown timer which displays the amount of time left before the battery discharges fully.

Solar traffic light as an auxiliary system

Auxiliary solar traffic lights, in addition to the existing street lights, can be attached near the primary street lights. They are useful in regulating traffic when the primary system fails. The control system in the auxiliary traffic light monitors the primary system and when the primary system fails, it switches to the auxiliary system. Switching from primary system to the auxiliary system and vice versa can also be achieved using a hand-held transmitter unit

Solar traffic light during natural disasters

3.3.2) Probable, Solar Powered, Traffic Light used when construction workers must narrow a 2 way street to a single lane and must emplace traffic controls for safety.

Solar traffic lights can also be used during periods following natural disasters, when the existing street lights may not function due to power outages and the traffic is uncontrollable. Street lights used in such scenarios are designed to be portable enough to be carried and operated by police and relief workers wherever traffic needs to be regulated.

3.4 SOLAR TREE [7]

TREE Stands For:

T - Tree generating; **R** – Renewable; **E** - Energy and **E** – Electricity.

3.4.1) solar tree [8]

Solar Trees are efficient for capturing energy from sunlight and wind for producing energy as plants in nature.

Generation of 2MW power from PV module system requires the land of 10 Acres approximately for housing the panels only. Solar power Tree a tall pole-like structure would take only 1% of land area in comparison to general PV housing. With due adjustment of load over the pillar or pole, solar panels can be fixed throughout the tall pole following a pattern of spiraling phyllotaxy pattern as found in a natural tree.

To get the maximum sun in a day time the top panel should not obstruct the bottom panels. The each panel will be hanging through their connecting stem system attached to the main trunk (Pole) and can rotate following the sun's path throughout a day. It can also be locked

at any position to withstand the wind pressure due to heavy storm affecting over the main pole/ trunk. The panels will be naturally facing towards the sun at an angle as required so that they can collect maximum solar energy in a daytime. The system can be mounted at the roadsides, the islands in between wide roads highways, on the boundary walls of paddy lands etc.

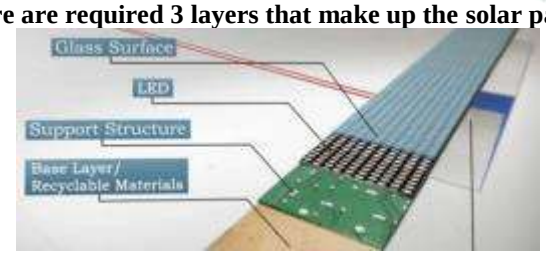
3.5 SOLAR ROADWAYS

In this type of installation, the main purpose of solar roadways is to replace asphalt roads with Solar Panels. Solar road generate energy through the sun and this energy can be used by residential or commercial purpose that are connected to the system from however the house's driveway or the industries places lot. In this type panels will also increase the number of charging stations required for electric vehicles when that station is connected to the solar roadway. In this system, each panel is roughly 12' by 12' of interlocking panels or hexagonal type and that have their individual LED lights that will be shows as the road lines. It is also be used to spell out words like "School Ahead" or "Traffic Ahead" to signal for controlling flow of traffic.

3.5.1) solar road actually construction [9]

3.5.2) solar roadway [10]

There are required 3 layers that make up the solar panels:



3.2.3) Construction of solar road [11]

1. Road Surface Layer: The Road Layer is the High Strength layer that has the photovoltaic cells which attracts the photon energy, it has grip so vehicles don't slide over the road, and it's construction is waterproof to protect the below layers of solar.

2. Electronic Layer: The Electronic Layers contain a mini microprocessor board that avoids and control the heating element of the solar panels, this technology can help melt down the snow that land on the panels so that dangerous road conditions will no longer be an issue in the more northern areas. This coating layer can sense the weight is on the panels and can control the heating element to soften the snow.

3. Base Plate Layer: This layer is collects the energy from the sun and distributes the power to the commercial and residential purpose that is connected to the solar roadways. This will also be beneficial to transfer the energy to cars as they drive over the strip to recharge the battery.

Smart GRID

The Solar Roadways generates "secure" energy; it can't be deliberately shut down. Not by terrorists, not by power companies, it simply can't be shut down. A smart grid would be more automated and more "self-healing," and so less prone to failures. It would be more tolerant of small-scale, variable power sources such as solar panels and wind turbines, in part because it would even out fluctuations by storing energy. [12]

3.6 SOLAR NOTEBOOK/LAPTOP [13]

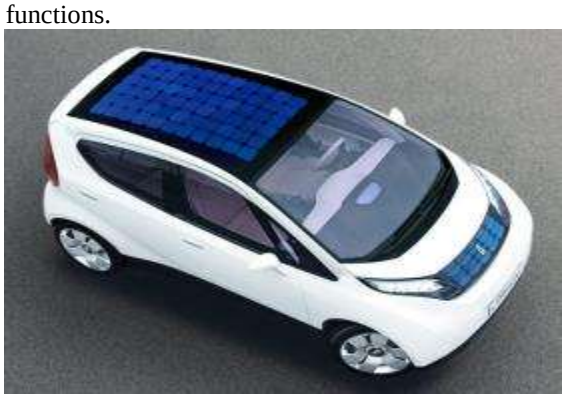
A solar notebook/solar laptop are a type of solar installation in which laptop computer having its own batteries. These batteries are recharged by a solar panel attached to the back side notebook like as off-grid solar system.

3.6.1) solar notebook/laptop [14]

Dissimilar regular laptops, some models of laptop/solar notebooks come with a flap-like structure. As per requirement we can connect a solar panel kit and can be removed. Solar kit generates the electricity required to charge its batteries. Other models feature outside solar models connected to the laptop and keyboard chargers. Where keyboard looks like a solar sheet with the outline of a keyboard fixed on solar. In this type of installation we can charge our mobile phones and all. Samsung has assimilated the solar panel in the cover (back side of the laptop display).

3.7 SOLAR VEHICES [15]

A **solar vehicle** is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy. The term "solar vehicle" usually implies that solar energy is used to power all or part of a vehicle's propulsion. Solar power may be also used to provide power for communications or controls or other auxiliary functions.



3.7.1) solar vehicle

Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However, indirectly solar-charged vehicles are widespread and solar boats are available commercially.

3.8 SOLAR-POWERED CALCULATOR [16]

Solar-powered calculators are hand-held electronic calculators powered by solar cells mounted on the device. They were introduced at the end of the 1970s.

3.8.1) Solar-powered calculator

Amorphous silicon has been used as a photovoltaic solar cell material for devices which require very little power, such as pocket calculators, because their lower performance compared to conventional crystalline silicon solar cells is more than offset by their lower cost and simplified deposition onto a substrate.

Solar calculators use liquid crystal displays as they are power efficient and capable of operating in the low voltage range of 1.5–2 V. Some models also use a light pipe to converge light onto the solar cells.

Anylite Technology is the name of a solar technology used by Texas Instruments since the 1980s in some calculators. They are intended to be able to function with less light than other solar calculators. This was essentially achieved by using relatively large photovoltaic solar cells. The use of Anylite technology in modern TI calculators is denoted by a lower case "a" at the end of the model number (e.g. TI-30a). In older models, such as the TI-36 Solar, Anylite Solar is printed on the calculator.

3.9 SOLAR PAINTS [17]

Solar Paint is an environmentally friendly solar cell technology that generate their own electricity, affordably and sustainably. This offers the tantalising prospect of paints that generate electricity directly from sunlight.

The invention involves the development of a completely printable organic solar cell based on semiconducting polymer nanoparticles dispersed in water. Essentially these tiny particles in suspension are a water-based paint, which can be printed or coated over large areas. In the first instance these coatings will be put onto plastic sheets that can be placed on the roof of a house. However, in the longer term it will be possible to directly paint a roof or building surface.

3.9.2) solar paint on pitch roof [19]

3.9.1) solar paint that generate clean energy [18]

KEY ADVANTAGES of these organic solar cells are:

- They can be printed at high speeds across large areas using roll-to-roll processing techniques thus creating the tantalizing vision of coating every roof and other suitable building surface with photovoltaic materials at extremely low cost.
- These coatings will initially be put onto plastic sheets that can be placed on the roof of a house. In the longer term, it may be possible to directly paint a roof or building surface.
- Organic solar cells will use the same standard inverter technology used by conventional solar cells to connect the electricity grid network.
- The organic solar cells are coated from water onto recyclable plastic sheets such as PET and thus are completely environmentally friendly.
- Ultimately, this invention will mean that every household in Australia will be able to generate its own electricity from a sustainable and renewable resource, using a paint coating on their own roof.

3.10 SOLAR CHARGER [20]

A **solar charger** employs solar energy to supply electricity to devices or charge batteries. They are generally portable

3.10.1) solar charger

3.10.2) solar mobile cover charger [21]

Solar chargers can charge lead acid or Ni-Cd battery banks up to 48 V and hundreds of ampere-hours (up to 4000 Ah) capacity. Such type of solar charger setups generally uses an intelligent charge controller. A series of solar cells are installed in a stationary location (i.e.: rooftops of homes, base-station locations on the ground etc.) and can be connected to a battery bank to store energy for off-peak usage. They can also be used in addition to mains-supply chargers for energy saving during the daytime.

Most portable chargers can obtain energy from the sun only. Some, including the Kinesis K3 and GeNNex Solar Cell 2 can work either way (recharged by the sun or plugged into a wall plug to charge up).

Examples of solar chargers in popular use include:

Small portable models designed to charge a range of different mobile phones, cell phones, iPods or other portable audio equipment.

Fold out models designed to sit on the dashboard of an automobile and plug into the cigar/12v lighter socket to keep the battery topped up while the vehicle is not in use.

Flashlights/torches, often combined with a secondary means of charging, such as a kinetic (hand crank generator) charging system.

Public solar chargers permanently installed in public places, such as parks, squares and streets, which anyone can use for free.

3.11 SOLAR POWERED STADIUM [22]

Energy efficient stadium is the latest trend of environmentalism in sports. Many stadiums are beginning to take measures to become more environmentally friendly and energy efficient, such as using solar energy to power the stadiums and using reusable raw materials. The first stadium successfully built to use 100 percent solar power is the Kaohsiung National Stadium in Kaohsiung, Taiwan. It earned the nickname of the 'dragon' stadium. Completed in 2009, the 55,000 capacity stadium was built for the World Games, which took place in July 2009.

3.11.1) Solar powered stadium [23]

Japanese architect Toyo Ito designed the stadium which incorporates 8,844 solar panels on the roof. These solar panels provide enough energy to power the 3,300 lights and two giant television screens. The stadium provides so much power, and not all of it is needed to power the stadium. The stadium will prevent 660 tons of carbon dioxide from being released. Not only is the Kaohsiung National Stadium 100 percent solar powered, but all of the raw materials used in the stadium are reusable.

3.12 SOLAR SHEET METAL ROOFING

In this type of solar installation system, this solar sheet metal is directly used for roofing purpose. Solar panels are directly fixed to the metal sheet and this metal sheet is used for shade on building roof top, solar carports, store room roofing purpose and many other roofing applications.

3.12.1) solar sheet metal roofing (NEC, Satpur MIDC, Nashik)

Solar panels directly mounted or adhere on metal sheet with the use of sticky material. Solar panels are connected to the inverter and sink to our home application, lightening and many other purposes.

3.13 SOLAR CARPORT SYSTEM

This type of PV solar installation is similar to other same mounted solar system, only change is the metal structure is made for carport with an appropriate angle with attachment of metal beam structure or truss. In this installation we can use solar sheet metal roofing system. This generated electricity we can use for our home application. The main advantage from this mounting is extra area not required; this installation gives simultaneous application of carport and power grid.

3.13.1) solar carport system (Hotel Grape County, Nashik)

3.14 SOLAR BASED POLY HOUSE/SOLAR AGRICULTURE GREEN HOUSE

Solar based poly house system is type of system in which the new transparent type of solar panels is used for construction of poly house without using shade net structure. Transparent solar is a new type of solar panel presents in market, that panels are used for construction of solar poly house. One side of poly house is used for mounting of solar panels which is in south facing. Generated electrical energy is used for agriculture purpose like water lifting pump system, commercial and many other applications.

3.14.1) solar based poly house

Solar greenhouse system is a new PV system of modern agriculture that combines the solar energy with agriculture production. There are two systems, one the power generation system, the other one is photo-thermal heating system. It is committed to promote the technical level of modern agriculture, meet the different demand of smart greenhouse in different area and solve the problem of continuously growth of corps and energy saving. [24]

3.15 CANEL-TOP SOLAR PV INSTALLATION [25]

Canal-top PV will save water and produce clean energy in Gujarat, India

3.15.1) India's first 1MW Canal-top solar power project

The national electrical grid in India is unstable and inefficient. During transmission and distribution, it loses 22% of what it generates in centralized coal, hydroelectric, natural gas and nuclear power plants.

By installing solar PV panels top of the Narmada canal, nearby Gujarat residents will have access to reliable off-grid power that simultaneously prevents water loss through evaporation by shielding the canal's water from sun and wind.

3.15.2) Canal-top PV Solar installation

This suspended system is the first of its kind since it is mounted over a water canal. It spans about a kilometer of the canal, but does not touch the water. Their design includes 1 MW of power over a narrow strip of one of the canal branches since the main Narmada canal is extremely wide. The site was selected because there are reliable roads and access to the electrical grid nearby. The canal also runs North-South, which maximizes the amount of sun that shines on the panels and therefore, the amount of power produced. An added benefit of installing panels over water is water will keep the panels cooler, which improves PV efficiency. Solar panels over water will end up producing more power over a longer lifespan than panels mounted on land in extreme dry conditions.

Solar Edison's design promises to save an estimated 7,000,000 L of drinkable water per year by preventing evaporation and preventing algae growth in the canal. Algae can clog the irrigation pumps, which increases maintenance costs and lowers productivity. The state appreciates that this system both will generate clean energy and conserve water. This installation does not require new land acquisition.

3.16 FLOATING SOLAR SYSTEMS [26]

The low efficiency of conversion in conjunction with multiple losses (cable, temperature, dust and DC-AC conversion) till the point of actual use, calls for large tracts of land for utility scale power generation. Converting fertile agricultural and other productive land to set up solar farms would not be wise. Also in many cases lands have to be cleared of thick vegetation that provides lung space. An attractive alternative to the land based solar generation is to utilize the surface of water bodies like lakes, ponds, reservoirs, dams which come at no cost.

PV systems floating on the water surface would be an effective method to reduce evaporation losses as they would reduce substantially the sunrays from reaching the water below. Floating PV systems has reduces up to 70% water losses.

3.16.1) World's largest floating system with tracker

The modules in floating systems operate under much cooler environment and this would reduce thermal losses and also the long term heat induced degradation. Additionally the dust collection issues would be minimum leading to enhanced generation and reduced cleaning frequency. Floating PV systems generate 11% more energy than an equivalent land based system.

Floating PV Systems also named as **Floatovoltaics**. Module racking systems are to be designed for fixing on to pontoons / HDPE plastic floats. All metallic components have to be kept above water level with floats alone in contact with water to prevent corrosion. The float material should not inject any toxic material in the water they float. The floats are to be anchored / moored properly to withstand high velocity winds and rapid flow of water during floods. Floating PV systems that can withstand wind speeds up to 190 kmph and waves of 2 meter height are now commercially available.

3.16.2) India's Largest 100 KW System, Kerala

Despite being land neutral, the cost of the floating systems including anchoring, installation, maintenance and transmission renders the overall cost of the floating solar systems are much higher than the land based systems at this initial stage of development.

4. CONCLUSION

We must think about how to terminate the use of fossil fuel, because we are going to destroy our life cycle and natural beauty life. Continuously using of non-renewable energy once it is finished. solar energy is a massive source of heat and light, we must take benefit of solar PV system, the main requirement is perfectly installation of solar system which is directly affects overall solar power plant efficiency. Geo-coordinate, place and space decides type of installation of PV solar system.

Generally solar will

1. Eliminate the uses for fossil fuel or nuclear power plants.
2. Make a positive, secure, self-curative power grid.
3. Terminate our need on oil and other fossil fuels i.e. coal, oil and natural gases.
4. Minimise our nation's greenhouse gas emissions.
5. Save and think over wild life.
6. Not only save our COUNTRY but also save our EARTH.

"Let's go for save our BEAUTY NATURE"

5. REFERENCES

[1] PV Solar Panel Flat Roof Mount & Ground Mount (Ballasted). Retrieved from URL:http://www.solarpanelsplus.com/products/PV-flat-roof-ground/

[2] Solar roof PV tiles. Retrieved from URL:https://www.google.com/search?q=solar+pv+tiles&client=firefox-b&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwiSufbBgMjaAhVKKo8KHcajBb8QsAQINA&biw=1093&bih=502#imgrc=KsJBj6bgt9J7fM:

[3] Ground mounted solar panels. Retrieved from URL:https://news.energysage.com/ground-mounted-solar-panels-top-3-things-you-need-to-know/

[4] pitch roof solar. Retrieved from URL:http://www.landpowersolar.com/Solar-Roof-Mount.html?Solar-Mounting=1&Solar-Frame=65

[5] Solar street light. Retrieved from URL:https://en.wikipedia.org/wiki/Solar_street_light

[6] Solar Traffic Lights. Retrieved from URL:https://en.wikipedia.org/wiki/Solar_traffic_light

[7] Solar tree. Retrieved from URL:https:https://en.wikipedia.org/wiki/Solar_tree

[8] solar tree. Retrieved from URL:https://www.google.com/search?q=solar+tree&client=firefox-b&tbm=isch&source=iu&ictx=1&fir=wPnpdPhjcYyhYM%253A%252COnxszPtdEpa-eM%252C_&usg=__VEcFaZzB_ROv_-yLRTZMwA70hPM%3D&sa=X&ved=0ahUKEwiu8KOF_MfaAhVKM48KHWLpDXMQ9QEILDAC#imgrc=wPnpdPhjcYyhYM:

[9] This Parking Lot Is Paved With Solar Panel. Retrieved from URL:https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=&url=https%3A%2F%2Fwww.wired.com%2F2014%2F05%2Fsolar-road%2F&psig=AOvVaw3rLEYZm2TcUzgIq9uQnG17&ust=1524276722810160

[10] Work progressing on solar panels embedded into roads. Retrieved from URL:https://antinuclear.net/2016/11/24/work-progressing-on-solar-panels-embedded-into-roads/

[11] construction of solar roadways. Retrieved from URL:https://www.slideshare.net/RamKrishnaJagali/solar-roadways-presented-by-rk

[12] Kristiyan Yotov, (700855), et al. Lecturer: A. Antonova-SOLAR ROADWAYS, Sofia University, FEBA.

[13] Solar notebook. Retrieved from URL:https://en.wikipedia.org/wiki/Solar_notebook

[14] SOL solar powered laptop runs on ubuntu. Retrieved from URL:https://www.designboom.com/technology/sol-solar-powered-laptop-runs-on-ubuntu/

[15] Solar vehicle. Retrieved from URL:https://en.wikipedia.org/wiki/Solar_vehicle

[16] Solar-powered calculator. Retrieved from URL: https://en.wikipedia.org/wiki/Solar-powered_calculator

[17] solar paint. Retrieved from URL:http://www.greenlivingpedia.org/Solar_paint

[18] solar paint. Retrieved from URL:https://www.rizistal.co.uk/

[19] solar paint. Retrieved from URL:https://www.rizistal.co.uk/

[20] Battery charger. Retrieved from URL:https://en.wikipedia.org/wiki/Battery_charger#See_also

[21] Solar mobile phone charger. Retrieved from URL:https://www.aliexpress.com/wholesale?catId=0&initiative_id=SB_20180419132123&SearchText=i+phone+solar+mobile+charger

[22] (2010,December)solar powered stadium. Retrieved from URL:https://en.wikipedia.org/wiki/Solar_powered_stadiums

[23] (2014,7,13) Brazil's Mineirão is the First World Cup Stadium Completely Powered by the Sun. Retrieved from URL:https://inhabitat.com/architecture/renovation/

[24] Solar Agriculture Greenhouse Retrieved from URL:http://www.frontierack.com/product/Show.asp?ID=326 Canal solar power project. Retrieved from URL:https://en.wikipedia.org/wiki/Canal_Solar_Power_Project

[25] Canal solar power project. Retrieved from URL:https://en.wikipedia.org/wiki/Canal_Solar_Power_Project

[26] Intersolar India. Retrieved from URL:https://www.intersolar.in/en/news-press/news/industry-news/floating-solar-systems-potential-promise-and-challenges.html