

## **GREENER, SAFER - SUSTAINABLE ENERGY EFFICIENT SHIPPING USING SOLAR POWER OPTIMIZER BY MPPT**

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### **Abstract**

*In this project work renewable energy solar power free of cost is maximum tracked by SPO & MPPT and gives constant output voltage to meet the energy demand. The shipping industry is facing ever greater challenges, especially regarding energy saving and the environment protection. Today the improvement in energy efficiency has become the most important aspect of shipping industry to achieve excellence in cost competitiveness. Energy efficiency plays a most important role in reduction of energy consumption, fuel and Co2 emission. It aims to cut carbon dioxide emissions by using renewable energy resources which is abundantly present in the earth in free of cost. The leakage inductance energy of the coupled inductor can be recycled to increase efficiency and the voltage spike on the active switch is restrained, the floating active switch isolates the PV panel's energy during non-operating conditions, thereby preventing any potential electric hazard to humans or facilities. Various step-up DC-DC converter topologies include a conventional boost and fly back converters, switched inductor converter, and switched capacitor converter, as well as a transformer less switched capacitor types, voltage-lift types, capacitor-diode voltage multipliers and boost types that are integrated with coupled inductors.*

**Key words:** Efficiency, Co2 emission, DC and capacitor converter

### **I. INTRODUCTION**

Domestic shipping and fishing activity bring these totals to 1050 million tones of CO<sub>2</sub>, or 3.3% of global anthropogenic CO<sub>2</sub> emissions. Several alternatives are proposed to reduce or to replace fossil fuels onboard a ship: sails, kites, receive electricity in ports, use of biodiesel, wind turbines, photo-voltaic modules and hydrogen fuel cells. They can be used on their own or in conjunction with what are called hybrid systems for power generation onboard a ship. These are green energy generation systems that use renewable or clean energies. Main purpose of adopting renewable energy based systems onboard merchant marine vessels is to reduce consumption of fuel and several alternatives for obtaining this desiderate are sails, kites, receiving electricity in ports, use of biodiesel instead of classical diesel oil, wind turbines, photovoltaic panels and hydrogen fuel cells. Thermal energy obtained through solar thermal system can be use onboard ship in the following directions: as an auxiliary source for generation of saturated and superheated steam; (a) as an auxiliary source in desalination process; (b) as an auxiliary source for ship propulsion; (c) as an main source for generating hot water very important aspect of the installation is the available surface. On a vessel the available surface for solar collectors installation may vary, depending on the dimensions and type of the vessel.

### **II. BACKGROUND**

#### **Major Hardware Components**

- ✓ Photovoltaic system & Solar panel
- ✓ MPPT
- ✓ DC-DC Converters
- ✓ Linear voltage converter
- ✓ Boost converter
- ✓ MOSFET
- ✓ Driver circuits
- ✓ PIC CONTROLLER (PIC16f877AIC)
- ✓ ACSOCKET
- ✓ 1 Amp bridge rectifier
- ✓ 7805 regulator
- ✓ LED
- ✓ 10 MHZ crystal oscillator
- ✓ IN4007 diode 15.100ohm, 330ohm resistor

- ✓ 16.470 mf, 10 mf, 25v switched capacitor
- ✓ 40 pinIC
- ✓ Voltage multiplier or voltage –lifttechnique
- ✓ switched-inductorconverter

### **PV Systems Installed in MarineVessels**

Considerations are held about the specification in which the PV plants have to fulfill so that they can be installed on marine vessels. Initially, a brief description of the typical electrical grid of ships is presented, distinguishing the main parts, reporting the typical electrical magnitudes, and choosing the most preferable installation areas. The technical specifications, in which the PV plants have to be compatible with, are fully described. They are determined by the special marine environmental conditions, taking into consideration parameters like wind, humidity, shading, corrosion, and limited installation area. The work is carried out with the presentation of the most popular trends in the field of solar cell types and PV system technologies and their ability to keep up with the aforementioned specifications.

The PV systems of today generate electric power that ranges from W to MW. Small solar chargers for portable devices such as laptops, cell phones, and calculators are very popular. Single or arrays of PV panels produce electric power for street lights, advertising signs, isolated agricultural electric pumps, even small houses not connected to the utility grid. In addition, PV systems, wind power systems, batteries, fuel cell generators, and other renewable energy systems work together and organize reliable microgrids. But the most common PV applications are the grid-tied ones, where single PV panels or large scale PV plants apply auxiliary electric power to the grid.

Despite their extended use at mainland applications, the PV systems presence in modern marine technology remains limited, mainly working as suppliers to small lighthouses, buoys, and chargers for the batteries of small sailing yachts. The rising transport expenses due to the fuel prices, the increasing restrictions of CO<sub>2</sub> and nitric oxides emission due to new ecological policies, and generally the need for more eco-friendly transportation were the reasons that forced the marine companies to reexamine the systematic use of PV systems on large vessels.

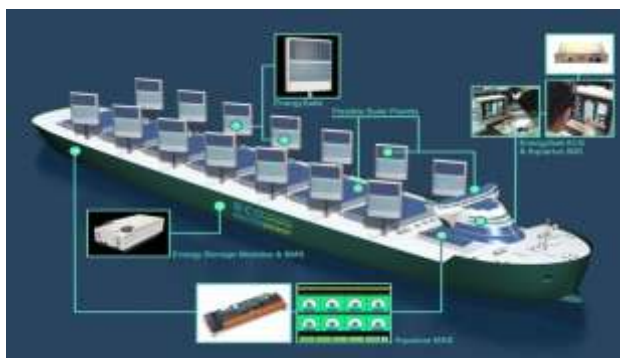
The photovoltaic technology can indeed be a really cost-effective solution for ships. PV systems can act as ideal subsidiary power sources, independent from the vessel electromechanical settlement because they (i) produce electric power without the need of transferred gas or liquid fuel, (ii) have no by-products such as gas emissions or noise, (iii) have low maintenance cost, (iv) have limited or no use of mechanical moving parts, (v) consist of few parts, with easy installation and fast replacement in case of aging or defectiveness, (vi) have satisfactory life time with a warranted PV panel output power by the manufacturers, which usually cannot be less than the 80% of the nominal one after 25 years of operation, (vii) can be placed in small surfaces with no practical use such as roofs, walls, funnels, and superstructure.

In this paper, a research is held to give answers about how the most popular technologies of the mainland PV systems can be applied, and what specifications must be fulfilled in order to be appropriate for partially or fully electrical marine vessels.

### **Ship and Marine Solar Power Products and Services**

In co-operation with our strategic and technical partners Eco Marine Power can supply globally a range of marine solar power products and services for ships and marine use including:

- Integrated solar power systems for ships with Aquarius MAS and battery pack.
- Flexible marine grade solar panels designed for use on ships and other vessels.
- Solar panel accessories.
- Maximum Point Power Tracking (MPPT) charge controllers.
- Marine batteries, battery packs and energy storage solutions.
- Solar power system & electrical system design. (including wiring diagrams)
- Installation support including on-site installation supervision.
- On-site technical support.
- System design support and consulting services.



**Figure 1**

In this project work renewable energy solar power free of cost is maximum tracked by SPO & MPPT and gives constant output voltage to meet the energy demand. The proposed converter has the following features, Its voltage conversion ratio is efficiently increased by using the switched capacitor and coupled inductor techniques, The leakage inductance energy of the coupled inductor can be recycled to increase efficiency, and the voltage spike on the active switch is restrained, The floating active switch isolates the PV panel's energy during non-operating conditions, thereby preventing any potential electric hazard to humans or facilities.

The PV panel's energy, which passes through an SPO is objective of DC micro grid system. A DC-micro grid system was proposed as an energy-efficient distribution option for data center systems and telecommunication facilities. The SPO attempts to improve the use of distributed renewable resources and lower system cost. The maximum power point (MPP) voltage range of a single PV panel ranges from 15 to 40 V and has a power capacity of about 100 to 300 W [1]. An SPO has a high step-up converter that increases low-input voltage to a sufficient voltage level. Various step-up DC-DC converter topologies include a conventional boost and fly back converters , switched inductor converter, and switched capacitor converter, as well as a transformer less switched capacitor types, voltage-lift types, capacitor-diode voltage multipliers and boost types that are integrated with coupled inductors[2]. With increasing voltage gain, recycling the leakage inductance energy of a coupled inductor will reduce the voltage stress on the active switch, which enables the coupled Inductor and voltage multiplier or voltage-lift technique to realize high-voltage gain. Its configuration is based on a high step-up DC-DC converter with an MPPT control circuit.

It may also potentially improve the efficiency of PV systems, has an anti-shadow effect, and can monitor the status of PV modules. Moreover, the DC-grid voltage is regulated by bidirectional inverter and battery tank. In case of low-loading condition, the redundant energy will store in to battery or through bidirectional inverter to AC grid. Generation of electricity can be achieved in two ways. In the first, Solar energy is converted directly in to electricity in a device called a photovoltaic (PV) cell. In the Second, Solar thermal energy is used in a concentrating solar power (CSP) plant to produce high -temperature heat, which is then converted to electricity via a heat engine and generator. Both approaches are currently in use. Furthermore, Solar driven systems, here we use the first method.

Solar power optimization was originally created to minimize environmental(Shading, clouds, dirt, debris, bird droppings) and system mismatch (string-to-string) Imbalance, different orientations, tilts, panel aging) that degrade system performance and efficiency. Through this technological innovation, system current and voltage mismatch are corrected and increased performance efficiencies are achieved, resulting in maximum PV system efficiency and the lowest cost per kWh. The power optimizer monitors and maximizes the energy harvest of each individual PV module through advanced algorithms combined with leading-edge mixed-signal technology, recouping up to 75% of the lost energy due to mismatches.

They are determined by the special marine environmental conditions, taking into consideration parameters like wind, humidity, shading, corrosion, and limited installation area. The work is carried out with the presentation of the most popular trends in the field of solar cell types and PV system technologies  
neral circuit diagram

### III. REVIEW ON ELECTRICAL SYSTEM FOR SHIP

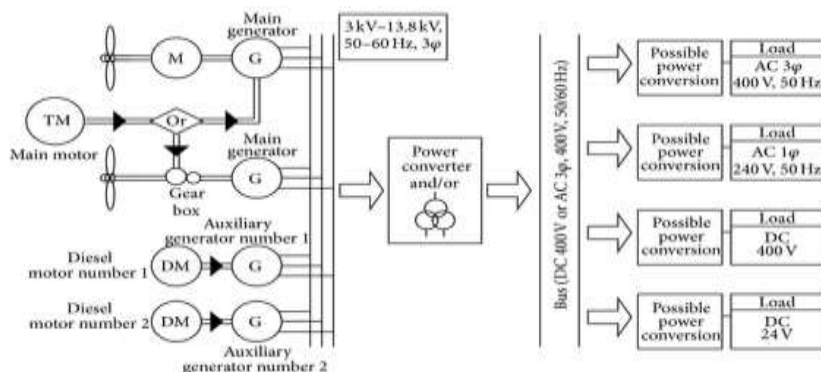


Figure 3 Electrical System for ship

Electrical System for ship the generator is coupled to the shaft through a step-up gear. It is known to the worldwide bibliography as shaft generator; and according to its position, the type of coupling and the control equipment can be categorized into fourteen types. It aims not only to produce electric power for the ship but also, in certain cases, to operate as a propulsion motor and assist the main motor engine. In the second case, the mechanical power of the thermal engine is dedicated only to drive the main generator. The generator simultaneously supplies the ship with electric power and drives an electric motor attached to the propeller. The propulsion system is known as integrated full electric propulsion (IFEP) configuration, and its main characteristic is that the shaft system is minimized, if not completely eliminated, that is, in the IFEP-pod case.

Besides the main generator, at least two additional auxiliary (diesel powered) electrical generators are connected to the electrical grid providing with electric energy. Additionally, in high load or breakdown cases (malfunction of main motor and/or main generator) they have to sustain the minimum operational standards of the vessel. According to the bibliography, the output voltages of the main and the diesel generators vary. Typical values of their magnitude and frequency are 3 kV, 3.3 kV, 4.16 kV, 6 kV, 6.6 kV, and 13.8 kV and 50 to 60 Hz. With the help of power converters and transformers, the generated power is supplied to an internal bus that transfers the power in every load over the ship. The bus can be either AC or DC. The DC buses are more popular to modern naval ships while the AC ones to cargo and passenger ships. However, the research in progress investigates the most profitable solution for the large civil vessels. Typical values for a three-phase AC bus are the 400 V, 50 or 60 Hz and for a DC bus the 400 V.

The last part of the ship electrical system is the loads. Different types of loads are connected, but the most common are the DC 24 V and 400 V, the single-phase AC 230 V, 50 Hz, and the three-phase AC 400 V, 50 Hz loads. Among the aforementioned parts of the vessel's electric system, the potential spots for the PV systems to be connected to the distribution buses along with the loads.

#### 157 Technical Specifications for PV Systems in Marine Vessels

##### PV System

The word "photovoltaic" combines two terms "photo" means light and "voltaic" means voltage. A photovoltaic system in this discussion uses photovoltaic cells to directly convert sunlight into electricity. Materials presently used for photovoltaic include mono crystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenite/sulfide. PV cells consist of organic or inorganic matter. Inorganic cells are based on silicon or non-silicon materials; they are classified as wafer-based cells or thin-film cells. Wafer-based silicon is divided into two different types: monocrystalline and multicrystalline. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. Most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and or solar tracker and interconnection wiring.

### IV. PV System for Marine Applications

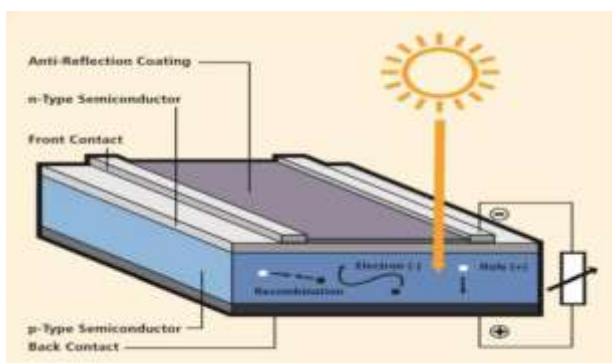
Even though the installation of PV plants to mainland is common and thoroughly examined, extra considerations must be done when they have to be installed on ships. The most important distinction between the mainland and marine PV

applications is the environmental conditions, forcing PV systems to be more tolerant to extreme winds, high humidity, and salt.

The winds on a ship are characterized by their great mutability of direction and speed, a fact that has great impact to the orientations of the applied PV panels. The use of fixed tilt offers easy and strong embracement. The marine environment can be also harmful for both the electronics and the panels of a PV system. The high levels of humidity and salt can cause short-circuits and induce corrosion to the mechanical parts of the converters. The European Committee for Electro Technical Standardization (CENELEC) has developed an ingress protection rating (IP Code) that scales the electronic circuit protection levels from solid objects, materials, and liquids [3]. According to this, the protection class of the converters embedded to the marine PV plants must be at least IP54 or IP54 W (especially the ones installed outside the ship's shell), making the ventilation weaker and the total cost higher.

To encounter the corrosion problems, the PV panel metallic frames must be specially constructed. Every metal surface must be galvanized or covered by special antirust coatings. High-quality metal must be used especially at fixing points (e.g., aluminium or V2A stainless steel). In addition, since any moisture penetration would result in cell degradation (especially in CIS cells) extra consideration must be done for the encapsulation materials (i.e., additional glass sheet as the front weatherproofing heat-strengthened, or -toughened safety glass) [4].

**Figure 4**

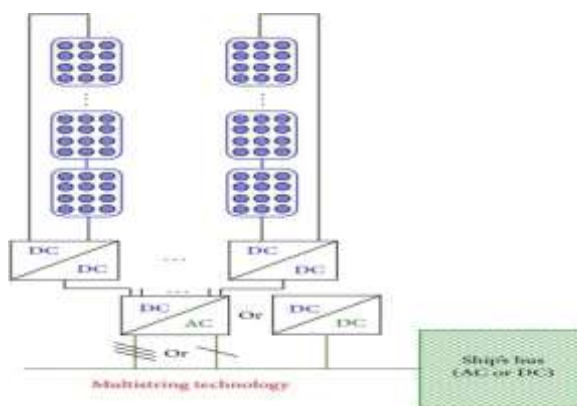


**Features of Power Optimiser**

- Higher energy yields – each panel boosted to optimum Dc voltage then inverted to Ac centrally
- Provides enhanced monitoring (at a panel level)
- Better safety and remote shutdown
- Can still use a traditional central inverter

**Maximum Power Point Tracking (MPPT)**

The solar panel is set to track variable radiation using maximum power point tracking



**Figure 5**

**V. CONCLUSION**

The result of this paper is using MPPT algorithm the maximum output is obtained and then stepped up. Thus solar power optimizer for dc distributed system is implemented using MPPT algorithm with high step up SPO using DC-

DC conversion circuit and high voltage gain that is 20 times greater than the input voltage is obtained. This project has provided a brief summary of solar power optimizer using MATLAB simulation. In this project, initially, the variation is fixed as 20000w/m<sup>2</sup> and then simulated. For different radiation the output has been simulated using MATLAB. The leakage inductance energy of the coupled inductor is recycled, thus voltage stress is reduced, increased efficiency, reduced power losses, obtained linear constant output voltage in all time with low cost and with free of renewable solar energy. A low voltage rating and low conduction resistance switch improves system efficiency by employing the incremental conductance method for the maximum power point. A 300 W SPO with a high step-up voltage gain and MPPT functions are implemented and verified.

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